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Elena G. Popkova · Aleksei V. Bogoviz · Bruno S. Sergi · Olga V. Kaurova · Alexander N. Maloletko *Editors*

# Sustainable Development of the Agrarian Economy Based on Digital Technologies and Smart Innovations

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# Sustainable Development of the Agrarian Economy Based on Digital Technologies and Smart Innovations

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# Introduction: Barriers and Prospects for Sustainable Development of Agrarian Economy Based on Digital Technologies and Smart Innovations

The problem of global hunger took on new dimensions as socio-economic systems evolved. In the era of the agrarian economic system, the essence of this problem was reduced to low and variable agricultural productivity, decreasing even with the slightest fluctuations in natural and climatic conditions. The world's population began to dramatically increase during the era of industrialization. Combined with intensive urbanization, this led to increased demand for food and limited opportunities for growth in food supply.

In an era of digitalization, the world's population continues to grow. Digital technologies and smart innovations make it possible to significantly increase the productivity of agricultural economies and improve the quality and safety of agricultural products. Digital technologies and smart innovation even help the agrarian economy cope with the risks of climate change, which radically and unpredictably changes the natural conditions for farming. A promising solution is smart vertical farms, where closed farming is practically independent of external natural and climatic conditions.

Thus, addressing global hunger in today's world involves the development of increasingly sophisticated and ubiquitous digital technologies and smart innovations. There are four barriers, the overcoming of which is critical to ensure a sustainable agrarian economy based on digital technologies and smart innovation. Although sustainable development of the agrarian economy primarily implies the realization of SDG 2, this development is not limited to it and encompasses a set of other SDGs as well.

The first barrier is regulatory. Government regulation defines the institutional environment for developing and implementing digital technologies and smart innovations in the agrarian economy. In this case, international cooperation is important. Over the past decades, active globalization has contributed to forming international supply and marketing chains in agriculture. Countries specializing in agricultural production are critically dependent on external supplies of agricultural raw materials, seeds, fertilizers, and technology and equipment, particularly agricultural machinery (farm equipment).

Although partial import substitution is possible, it usually cannot be achieved in full because it would decrease the efficiency and competitiveness of the agrarian economy. Food-exporting countries depend on the capacity and conditions of international markets for agricultural products, especially quality and safety requirements, labeling, and government arrangements for selling agricultural products.

In turn, food-importing countries depend on external food supplies, the equilibrium of supply and demand, and prices in global food markets. Inadequate state regulation and inconsistent international cooperation in the field of food security impede the sustainable development of the agrarian economy based on digital technologies and smart innovation. This barrier relates to the implementation of SDG 17.

The second barrier is organizational and managerial. Agricultural organizations need more new organizational and management schemes that are conducive to digital technologies and smart innovation. Digitalization and innovative development of agricultural organizations should not happen spontaneously—they need flexible management, considering the degree

and areas of automation and the specifics of the business processes of each agricultural organization.

The issues of financing the development and implementation of digital technologies and smart innovations deserve special attention. The investment attractiveness of innovative projects in the agrarian economy is often lower than in other sectors. Even with a high return on investment and capital, agricultural organizations sometimes cannot implement digital technologies and smart innovations due to the lack of own resources and insufficient development of agricultural lending. This barrier relates to the implementation of SDG 11 and SDG 12.

The third barrier is socio-legal. Staffing is a major barrier to digitalization and smart innovation in the agrarian economy. On the one hand, forced automation reduces the need for agricultural organizations in human resources, replacing them with technological resources. This causes a serious public outcry, similar to other areas of economic activity undergoing digital modernization.

In response to public outcry, agricultural organizations are forced to balance maintaining a stable workforce, demonstrating corporate social responsibility, providing economic efficiency, and ensuring competitiveness. On the other hand, to implement digital technologies and smart innovations in the agrarian economy, there is a growing demand for digital personnel, the mass training of which, although being carried out, does not yet fully meet the existing needs of agricultural organizations.

From the legal point of view, it is necessary to create legal mechanisms to regulate social and labor relations, protect intellectual property rights, and protect the rights of participants in international supply and marketing chains of agricultural products. So far, these legal mechanisms are imperfect, which hinders the sustainable development of the agrarian economy based on digital technologies and smart innovations. This barrier relates to the implementation of SDG 4, SDG 8, and SDG 16.

The fourth barrier is technological. Even if the barriers mentioned above are overcome, equally important is the accessibility for implementing digital technologies and smart innovations adapted to the specifics of the agrarian economy. Differences in natural and climatic conditions among regional economic systems within countries dictate the need for highly specialized digital technologies and smart innovations created for a specific territory or agricultural process.

Many crops require proprietary and unique applied technology solutions due to the specifics of their cultivation. Organic farming experiences the highest natural and climatic risks and, therefore, involves separate solutions. The considered barrier is particularly high given the long supply and marketing chains because innovative development must involve agricultural organizations at all links in these chains.

Therefore, digital technologies should be simultaneously and, preferably, jointly mastered by partner agricultural organizations. This involves the application of unified organizational and management schemes, joint investment allocation, risk sharing between the participants of innovation projects, and the selection of suitable digital technologies for all integrated agricultural organizations. This barrier relates to the implementation of SDG 9 and SDG 13.

The available literature considers the listed barriers to the sustainable development of the agrarian economy based on digital technologies and smart innovation separately. The narrow angle of study hinders the formation of a holistic scientific view on the sustainable development of the agrarian economy based on digital technologies and smart innovations. To overcome the noted deficiency in the existing literature, this book is organized to bring together the scientific knowledge on the related issues indicated above. This book aims to form a systemic scientific vision of the barriers and prospects for sustainable development of the agrarian economy based on digital technologies and smart innovations.

The scientific novelty of the book lies in the fact that it presents an innovative broad perspective on studying the sustainable development of the agrarian economy based on digital technologies and smart innovations. The book's novelty is that it, for the first time, reveals a

previously unknown but remarkable and valuable international experience of state regulation and foreign trade partnership in the field of agrarian economy. In particular, the book provides case studies from countries such as Kyrgyzstan, Russia, Vietnam, the European Union (EU), China, and Congo.

The theoretical significance of the author's conclusions made in the book is expressed in the fact that they comprehensively describe the issues of state regulation, organization and management in the activities of agricultural organizations, and socio-legal and technological support of sustainable development of the agrarian economy based on digital technologies and smart innovations. The empirical significance of scientific and practical developments and recommendations included in the book is explained by the fact that they can be implemented in the activities of agricultural organizations and agrarian regions. In particular, the book elaborates on the scientific, methodological, and applied issues of implementing digital technologies and smart innovations (in particular, robots) in the agrarian economy in the fields of irrigation, organic agriculture, winemaking, and general nature management.

The book is divided into four parts. The first part reveals and discusses international experiences, cooperation, and trade in global food markets in support of sustainable agrarian economies based on digital technologies and smart innovation. The second part elaborates on applied organizational and management solutions for the sustainable development of agricultural organizations based on digital technologies and smart innovations.

The third part focuses on the socio-legal aspects of the sustainable development of the agrarian economy based on digital technologies and smart innovation, including staffing, human resource management, and ESG management. The fourth part describes advanced digital technologies and smart innovations and provides perspectives on their application in the agrarian economies of countries, regions, and organizations in support of food security.

The book is intended primarily for scientists engaged in studying the issues of the sustainable development of agrarian economy from the perspective of various sciences: economic, agricultural, legal, technical, and natural, as well as related areas of scientific research, including environmental and climate economics and agricultural economics. For them, the book forms a systemic scientific vision of the barriers and prospects for the sustainable development of the agrarian economy based on digital technologies and smart innovations.

The book will also be of interest to representatives of state regulators of agrarian economy and agricultural organizations, who will find numerous case studies from international experience and applied recommendations for improving the management of sustainable development of agrarian economy based on digital technologies and smart innovations.

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# Contents

# International Experience, Cooperation, and Trade in Global Food Markets in Support of the Sustainable Development of the Agrarian Economy Based on Digital Technologies and Smart Innovations

# Formation of New Mechanisms for Sustainable Development of the Rice Farming in Kyrgyzstan

Eltar A. Smailov, Ruslanbek N. Arapbaev, Ainagul A. Kochkonbaeva, Zhyrgal T. Samieva, and Nurila K. Tashmatova

**Abstract**

Rice farming in Kyrgyzstan uses ancient varieties and technologies of natural steam-thermal treatment and obtaining grains of rice by peeling in mills called "Ak-Zhubaz." Rice contains more protein and fiber under the husk of unpolished rice, having a unique quality and taste. This paper aims to solve several disadvantages of the considered technology and discuss the preservation of the soil's condition. The soils of the Osh Region, where rice is cultivated, are superior to the rice fields of the Batken Region in many agrochemical indicators. Soils in both zones are medium-loam in terms of their mechanical composition. All rice cultivation areas in the south are lowly endowed with exchangeable potassium. After harvesting rice, soil acidity (pH) does not change significantly; the content of various soil trace elements decreases by 1.8–3.7 times, which worsens soil fertility. The previous condition of the soil can be restored by introducing mineral fertilizers. In the Uzgen district, farmers use natural steam-thermal treatment of sheaves of unpolished rice depending on aging in bands (stacks) to obtain three colors of a rice grain from one variety of rice; this technology is patented. Depending on the color of the rice, changes in the chemical composition showed an internal change in rice, increasing polysaccharides, ash, pectin, and hemicellulose. There is a 1.3-fold increase in the content of trace elements in rice. The disadvantage of natural steam-thermal processing is the lack of control over the technological process. To preserve the qualitative indicators of rice, an installation for steam-thermal treatment of unpolished rice was developed, for which a patent was received.

**Keywords**

Mill complex • White rice • Proteins • Dark brown • Shaly seed • Light brown • Ash • Leser • Black awn • Rice • Starch • Champion

**JEL code**

O13

## 1 Introduction

As evidenced by this research, rice cultivated in the soil and climatic conditions of Kyrgyzstan is significantly different from rice cultivated in other countries.

The main rice growing areas in Kyrgyzstan are located in the country's south: in Osh (Uzgen, Kara-Kulja, Karasu, and Aravan districts), Jalal-Abad (Suzak, Bazarkurgan, Nooken, and Aksy districts), and Batken Regions (Kadamja, Leilek, and Batken districts) (National Statistical Committee of the Kyrgyz Republic, 2022).

In the Uzgen district, there are 26,352 peasant farms and more than 70 mill complexes "Ak-jubaz," each of which has a capacity from 2 to 7 tons of rice per day. It uses technology to obtain rice grains by peeling rather than grinding. The most important difference between husked and milled rice is that the former contains more protein, fiber, thiamine, and niacin under the husk (peel) of the unpolished rice (Houston, 1976).

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The uniqueness of rice production technology in the Uzgen district is based on the cultivation of ancient local varieties of rice (Kara-Kyltyryk (with black awns) and Ak-Uruk (white rice) with a unique quality and taste. Moreover, it uses the ancient technology of natural steam-thermal treatment of the grain of unpolished rice (Arapbaev et al., 2020; Smailov et al., 2015, 2018a; Smailova, 2012a, 2012b). In this regard, the research aims to form new mechanisms for the sustainable development of the rice industry in Kyrgyzstan and improve the quality and taste of products.

## 2 Methodology

In the spring, before planting and at the end of the growing season, soil samples are taken from the depth of 0–30 and 30–50 cm on all variants of occupied rice plantings of two repetitions (first and third repetitions) on five ditches, arranged in the form of an envelope. Agrochemical and agrophysical studies were conducted in the Osh zonal agrochemical laboratory according to generally accepted methods.

The research was conducted with varieties cultivated in Kyrgyzstan. Laboratory-experimental studies were conducted in the laboratory "Chemistry and technology of plant substances" of the Institute of Chemistry and Phytotechnology of the National Academy of Sciences of the Kyrgyz Republic and in the scientific laboratory of International Uzgen Institute of Technology and Education of Osh Technological University.

To control the microclimate in the unit for steam-thermal treatment of rice sheaves with a broom, the authors used Unitzonics controllers of Vision V120 type and steam generator Steamtec Tolo-30 Ultimate AIO (3 kW).

## 3 Results

To study the ecological condition, the authors examined soil samples before sowing and after harvesting.

The soils of Uzgen district are, by many agrochemical indicators, superior to the rice fields of Ak-Turpak aiyl okmotu, where the Batken rice, which has gained good fame as a dietary rice, is cultivated. For example, soils of Ak-Turpak aiyl okmotu (Batkent Region) contain an average of 1.9% of humus. In turn, the soils of Uzgen district (Osh Region) contain an average of 2.83%–3.34% of humus. Soils of Ak-Turpak aiyl okmotu are considered to be low-provided with total nitrogen, whereas soils of Uzgen district are medium-provided. The mobile nitrogen content in the soils of the Uzgen district is much less than in the soils of the Ak-Turpak district. According to the mechanical composition, soils in both zones are medium-loam. Both areas of rice cultivation are lowly endowed with exchangeable potassium.

After harvesting rice, soil acidity *Rn* does not change significantly; soil alkalinity decreases slightly; the content of various soil trace elements decreases by 1.8–3.7 times, which reduces soil and can be restored by introducing mineral fertilizers, as confirmed by earlier studies (Goryshina, 1979; Smailova et al., 2014, 2018a, 2018b).

Additionally, to maintain soil fertility, along with nitrogen fertilizers, it is necessary to apply phosphorus and potassium fertilizers depending on the calculation of needs, although the provision of fields in southern Kyrgyzstan with potassium fertilizers is high enough. In the conditions of southern Kyrgyzstan, for objective and subjective reasons, only nitrogen fertilizers are applied during the cultivation of rice and other crops. In particular, for rice, various farms contribute from 340 to 700 kg/ha of ammonium nitrate; in translation to the active substance, this figure ranges from 100 to 210 kg/ha of active material, not including the need for mineral fertilizers (nitrogen, phosphorus, and potassium) to produce 1 centner of rice. Peasant farms must consider this fact when cultivating rice to get a certain yield. Unfortunately, this fact is either not considered. Sometimes, only organic fertilizers are introduced to save money and increase yields while preserving soil fertility.

Table 1 shows the characteristics of rice varieties cultivated in the Batken district of Kyrgyzstan.

The data in Table 1 shows that the Uzbek varieties are significantly inferior in chemical composition to the Zhaydari devzira variety. Thus, Uzbek varieties are considered dietary. The same results were obtained from comparative studies of rice varieties cultivated in the Osh Region

**Table 1** Qualitative indicators and chemical composition of varieties, Batken rice, %

| No. | Variety | Monosaccharides | Oligosaccharide | Polysaccharide | Hemicellulose | Pectin substances | Protein | Starch | Ash |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Andijan | 2.0 | 1.79 | 2.5 | 20.76 | 2.2 | 10.67 | 60.2 | 0.57 |
| 2 | Zhaidari devzira | 0.3 | 0.2 | 0.2 | 9.8 | 5.2 | 11.8 | 71.2 | 0.6 |
| 3 | Laserniy | 0.8 | 2.06 | 2.0 | 16.1 | 5.8 | 10.8 | 68.0 | 0.42 |

*Source* Compiled by the authors

**Table 2** Comparative analysis of the chemical composition of rice varieties

| No. | Variety | Polysaccharides, % | Oligosaccharides, % | Monosaccharides, % | Hemicellulose, % | Pectin substances, % | Starch, % | Protein nitrogen, % | Ash, % | Humidity, % |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | "Arpa shaly" (Ak-uruk or white rice, local variety) | 2.4 | 0 | 0.9 | 1.68 | 1.1 | 7.0 | 1.1 | 4.8 | 8.2 |
| 2 | Kara-Kyltyrak (local variety) | 2.4 | 1.2 | 0.7 | 3.0 | 5.5 | 7.2 | 1.54 | 2.1 | 8.8 |
| 3 | Alanga (Uzbekistan, 10 years) | 2.2 | 1.4 | 0.4 | 11.6 | 5.4 | 15.0 | 1.35 | 2.1 | 8.3 |
| 4 | Kazim | 0.35 | 1.5 | 0.35 | 0.8 | 0.7 | 10.0 | 1.4 | 2.1 | 8.9 |
| 5 | President (Uzbekistan, 10 years) | 0.13 | 0.06 | 0.3 | 6.8 | 0.6 | 10.0 | 1.2 | 2.0 | 8.6 |
| 6 | Margov (Uzbekistan, 20 years) | 1.6 | 3.3 | 0.94 | 7.1 | 16.8 | 11.7 | 1.6 | 2.2 | 8.7 |
| 7 | Lazerniy (Uzbekistan, 10 years) | 1.9 | 1.7 | 0.3 | 6.1 | 7.2 | 11.0 | 1.27 | 2.0 | 8.6 |

*Source* Compiled by the authors

(Table 2). These findings confirm that local varieties of rice, cultivated according to generally accepted ancient technologies in Kyrgyzstan, do not lose their originality, quality, and unique taste. Therefore, there is a problem of improving the technology of rice cultivation in Kyrgyzstan with the preservation of centuries-old traditions without the use of mineral fertilizers and local varieties, which are improved and increase yields by methods of natural selection. Nowadays, the varieties of rice obtained by natural selection are already known and popular; their yield is 1.5 times higher while the quality and uniqueness of taste are maintained.

In the Uzgen district, farmers use natural steam-thermal treatment of sheaves of unpolished rice depending on aging in bands (stacks), which is confirmed by the research results and available at https://figshare.com/ with the identifiers https://doi.org/10.6084/m9.figshare.23746680.v2. Thus, it is possible to obtain three colors of grains from one variety of rice: "Ak-Kuruch" (3 days, whitish-beige or white rice), "Zarcha" (7 days, light brown), and "Dasta Saryk" (10–12 days and more, dark brown) of high-quality. This technology is patented by the patent of the Kyrgyz Republic A01D 45/04, A01F 1/00 "Method of receiving high-quality Uzgen rice" (No. 1961).

The disadvantage of natural steam-thermal treatment for a certain period (3–7, 10–12, and more days) is the chaotic course of the fermentation process. It depends mainly on the moisture content of rice silage sheaves, climatic conditions of the harvesting period, and subsequent technological operations of rice silage processing (temperature inside the stack and humidity). The peasant farms engaged in rice cultivation cannot control and regulate this process. In this regard, to accelerate the process and improve product quality, the authors developed a mobile unit for steam-thermal treatment of grain sheaves of unpolished rice and justified the main parameters of its tanker (Smailov et al., 2022). The data and the design diagram of the mobile unit for steam-thermal treatment of sheaves of a grain of rice, which confirm the research conclusions of the study, are available at https://figshare.com/ with the identifier https://doi.org/10.6084/m9.figshare.23758317.v1.

The authors obtained the patent of the Kyrgyz Republic A01D 45/04 "Mobile device for steam-thermal treatment of rice sheaves" (No. 2328). The invention's task is to create a mobile unit for steam-thermal treatment of rice sheaves in dense mass with the regulation of temperature and humidity conditions inside the sheaves, depending on the condition of the rice stalks, which improves the quality. The results of experimental studies showed that the duration of steam-thermal treatment, depending on the temperature of the steam, varied from 8 to 20 h.

For 2023, the applied research fund under the project "Vocational Education for Economic Growth Sectors in Central Asia FM: GIZ" allocated financial resources under

local contracts for the project of the Osh Technological University "Development and practical application of new technology for post-harvest rice processing in the conditions of southern Kyrgyzstan" for manufacturing of production unit and conducting field tests.

## 4 Conclusion

1. The soils of the Osh Region are superior to the rice fields of the Batken district in many agrochemical indicators. Therefore, farmers mostly cultivate local varieties that are suitable for the region's conditions and give the greatest effect in terms of quality and taste. Rice cultivated in the Batken district is considered dietary. Rice produced in the Osh Region is considered high-calorie.
2. In the conditions of the south of Kyrgyzstan, the main method used to obtain grains of rice is husking grains of unpolished rice at the mills called "Ak-Zhubaz." The most important difference between peeled and milled rice is that the former contains more protein, fiber, thiamine, and niacin.
3. In the Uzgen district, farmers use natural steam-thermal treatment of sheaves of unpolished rice depending on aging in bands (stacks) to obtain three colors of rice grain from one variety of rice: "Ak-kuruch" (3 days, whitish-beige), "Zarcha" (7 days, light brown) and "Dasta saryk" (10–12 days and more, dark brown). This technology provides a 1.3-fold increase in the content of microelements in rice. It should be noted that the technology received a patent of the Kyrgyz Republic.
4. The authors have developed a constructive scheme of the experimental unit for steam-thermal treatment of rice sheaves, which has been patented by a patent of the Kyrgyz Republic. The results of experimental studies of the duration of steam-thermal treatment, depending on the temperature of steam in the tanker, varied from 8 to 20 h.

**Data Availability**

A figure showing bands of sheaves of rice for natural steam-thermal treatment is availiable at https://figshare.com/ with the identifiers https://doi.org/10.6084/m9.figshare.23746680.v2.A structural scheme of the experimental unit is available at https://figshare.com/ with the identifier https://doi.org/10.6084/m9.figshare.23758317.v1.

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# Accumulation and Consumption in the Agricultural Sector of the Russian Economy

Vlada V. Maslova, Natalya F. Zaruk, and Mikhail V. Avdeev

**Abstract**

The paper delves into scientific methodologies concerning the patterns of accumulation and consumption within the agricultural sector of Russia. The authors underscore that inevitable structural shifts in accumulation and consumption within the agricultural sector are driven by the imperative to establish technological sovereignty and facilitate a transition to a new technological paradigm, all against the backdrop of significant changes in geopolitical circumstances. The authors estimate the parameters and dynamics of the development of accumulation and consumption in the economy and the agricultural sector. The main factors affecting accumulation and consumption are identified. One of the main elements that affect the increase in gross value added in the agricultural sector of the economy is the increase in intermediate consumption due to the growth of material production costs. The research also examines the dynamics of accumulation in the agricultural sector of the economy, stressing that the rate and volume of accumulation, as well as its structure, is not optimal. The authors conclude that the change in the structure of consumption and accumulation in agriculture should be accompanied by the growth of gross savings. This will consequently stimulate investment endeavors within the agricultural domain, thus necessitating a qualitative advancement in final consumption. Moreover, the intermediate consumption will increase and material costs will decrease, ultimately increasing labor remuneration and social payments, which will improve the well-being of agricultural workers, thereby improving their quality of life.

**Keywords**

Agriculture • Gross value added • Gross accumulation • Intermediate consumption • Material costs • Final consumption • Investment

**JEL Classifications**

Q1 • E21 • E22

## 1 Introduction

The primary goals outlined within the strategic documents of the agro-food policy of Russia include the consistent growth in agro-food production, import substitution of resources necessary for the continuous production chain, digitalization, greening, effective labor, and the improved quality of life. The achievement of these objectives is associated with increased investment in fixed and human capital. To ensure sustainable growth rates, it is imperative to enhance the portion of accumulation in fixed capital within the range of 25–30%. Necessary conditions for increasing investment in the agricultural sector are created by providing a favorable institutional environment, improving the financial and credit mechanism, and increasing the population's demand. The strategy for developing the agro-industrial and fishery complex of the Russian Federation until 2030 indicates that the target indicator for the growth of investment in fixed capital should reach 150% by 2030; the baseline scenario provides for a slight increase—114%. One of the main strategic goals is technical and technological modernization and the industry's transition to a new technological mode. Thus, it is necessary to increase the rate of accumulation, bearing in mind the significant depreciation of fixed assets

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and the need for the widespread introduction of innovations in production. In these conditions, it is vital to conduct a thorough examination of the accumulation and consumption structure in agriculture, as well as to determine the key trends in its changes. Moreover, it is necessary to substantiate the need to optimize the structure of accumulation and consumption to increase production efficiency.

## 2 Materials and Methods

The research aims to analyze the dynamics of accumulation and consumption in the agriculture of Russia and develop recommendations to optimize the structure of accumulation and consumption given current geopolitical conditions.

The analysis will be based on a comprehensive approach in compliance with the following methodological principles:

- Objectivity (the analysis will rely on official data from domestic and international statistics, information from ministries and departments, etc.);
- Development principle (estimation of parameters, dynamics of investment activity, and proportions of accumulation and consumption will be carried out for 2012–2022);
- Systemic principle (the processes of accumulation and consumption will be studied by identifying the many factors that form them and ordering the relationships between them);
- Consistency principle (consideration of the concerns of every participant involved in investment activity);
- Synergy principle (the action of different components of innovative development enhances the processes of accumulation and consumption in the industry as a whole).

Given the tasks set, the following research methods will be used:

- Grouping (when analyzing structural shifts in consumption and accumulation in investment development in the agricultural sector);
- Comparative analysis (when studying the volume of investments in current and basic prices, etc.);
- Expert evaluations (when analyzing the opinions of individual experts on the problems of accumulation and consumption, investment development, and economic growth);
- Economic-statistical, including the use of the international statistical accounting system (inter-sectoral balance sheet) (in applying methods for studying the processes of accumulation and consumption, as well as investment development).

## 3 Results

The subject of accumulation and consumption holds a central position in the field economic science. Many scholars have explored this topic over a long period of economic thought. D. Keynes argues that consumption and investment are two key factors affecting economic growth and employment and that the government can utilize its tools to regulate the economy and reduce fluctuations in business (Keynes, 1993). R. Harrod and E. Hansen researched the issues of sustainable economic development and economic equilibrium (Hansen, 1959; Harrod, 2008). Contemporary foreign economic theory, which is a synthesis of neoclassical political economy and Keynesianism, gives the greatest importance to the issues of partial and general equilibrium and the conditions for the efficient use of resources and prioritizes the role of the market and competition (McConnell et al., 2015; Samuelson & Nordhaus, 2015).

The studies of many economists are devoted to the issues of consumption and accumulation. S. Kuznets defined the short-term and long-term consumption functions. I. Fisher developed the theory of intertemporal choice, in which consumer behavior is analyzed from the perspective of microeconomic analysis. D. Tobin created a model of firms' investment decisions based on the idea of adjustment costs. R. Solow proposed a model that makes it possible to identify the optimal savings rate, which will provide the maximum (specific) consumption. The application of this model to research at the cross-country level was continued in the work of Mankiw et al. (1992). Separate studies assess the empirical relationship between the development of financial intermediaries, economic growth, productivity growth, accumulation of physical capital, and the rate of private savings (Beck et al., 2000).

Currently, one of the main constraints of economic development in Russia is a low level of accumulation, evident from the investment activities across various economic sectors (Maslova, 2021). It is important to determine the causes of this phenomenon and the economic nature of consumption and accumulation, as well as their structural transformation. To study the structure of accumulation and consumption, it is necessary to understand their economic essence and the order of calculation of these indicators in agriculture.

In economics, gross output refers to the total value of all commodities and services generated within a given timeframe. Gross agricultural entails the entire value of crop and livestock production at current year selling prices and the value of services rendered to the agricultural sector by service industries.

When assessing the effectiveness of economic processes, it is customary to use the indicator of net output—in fact,

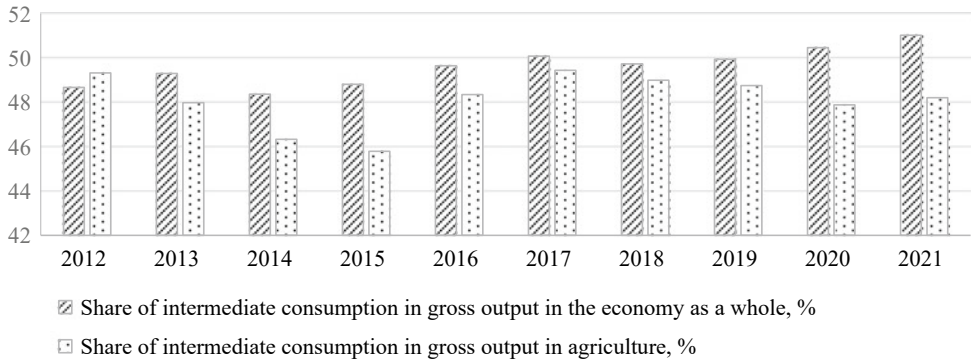


**Fig. 1** Share of intermediate consumption in gross output, %. *Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2015, 2016, 2019a, 2022)

gross value added (GVA), which is determined by the difference between gross output (GO) and intermediate consumption (IC). In this case, IC includes the value of commodities and services transformed or fully consumed in a considered timeframe in the production process (Federal State Statistics Service of the Russian Federation, 2022). In Russia, the proportion between IC and GVA has been 50/50 in recent years (Fig. 1). For comparison, in the economy of the USA, the share of intermediate consumption is about 45% of gross output while the share of services in intermediate consumption is growing dynamically.

In agriculture, intermediate consumption accounts for about 45–49% (slightly lower than the average for the economy), which may indicate higher efficiency and lower costs, particularly for labor compensation, which, despite the small growth observed in recent years, is about 70% of the average for the economy.

Intermediate consumption mainly includes material costs associated with the production of products (works, services) due to the technology and organization of production, including costs to control production processes and the quality of produced agricultural products.

Material costs used in agricultural production accounted for about 66% of the total basic production cost in 2020. Additionally, a significant share is occupied by labor costs (13.4%) and depreciation of fixed assets (10.4%) (Federal State Statistics Service of the Russian Federation, 2021a).

The cost of raw materials and supplies occupies the main share in the structure of material costs. The data show an annual increase in this expenditure item. Compared to 2010, in 2020, this expenditure item increased by almost 9% and reached 56.7%. The share of spending on fuel and energy remains at approximately the same level as in previous periods: 5.2% and 2.4% (Federal State Statistics Service of the Russian Federation, 2021a).

Thus, over the past decade, there have been significant structural shifts: the share of material costs has increased, largely due to rising prices for purchased goods and services used in agricultural production.

To optimize the cost structure of agricultural producers, determining the volume of intermediate consumption, it is necessary to build balanced price relations between the II and I sectors of agriculture, take measures to ensure the growth of yield and productivity and labor productivity and develop a system of state support.

Gross value added is used when determining the size of the gross domestic product (GDP), which characterizes the level of economic development and the society's welfare. Unlike GDP, which is calculated for the whole economy as the sum of all GVA and net taxes on products, gross value added is determined at the level of industries. Similar to GDP, GVA is spent on final consumption and accumulation.

In recent years, the structure of the use of GDP in Russia has been significantly transformed. Thus, in 2013–2022, the share of final consumption fell by 6.4% (mainly due to a reduction in household consumption); the share of gross savings fell by 2.2%; the share of net exports increased by more than 2.3 times.

The ratio of gross savings to GDP (or GVA) is an important indicator characterizing what part of created GDP (or GVA). Between 1990 and 2021, the share of gross savings to GDP averaged 25–26% globally (Fig. 2). In countries such as China, India, Turkey, Indonesia, and Vietnam, the share of gross savings has not fallen below 30% in the last three decades (Maslova, 2022).

In the 1990s, Russia's share of gross savings was at 30%. Currently, its share is at 22–23%, while the share of gross fixed capital formation is even lower (19–21%).

The dynamics of gross capital formation are determined by investment activity and the rate of expansion of investments in fixed assets. Investment in fixed capital within the economy and agricultural sector has almost doubled since 2014, reaching nearly 30.0 trillion rubles and 1.0 trillion rubles, respectively, in 2022. However, if we consider inflationary processes, the real increase in investment in the economy over the past nine years was 13%. In crop and livestock production, there was a decrease of 10% (Table 1).

A significant aspect in the structural transformation in the accumulation of fixed capital is the share of investment in

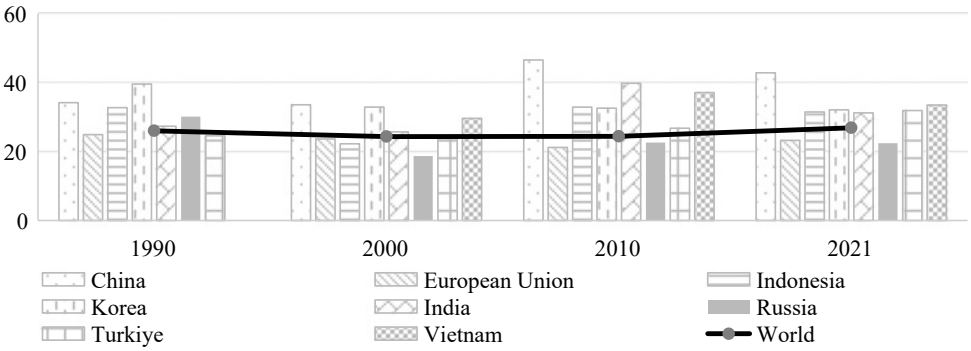


**Fig. 2** Dynamics of the share of accumulation to GDP in different countries in 1980–2021, %. *Source* Compiled by the authors based on (World Bank (n.d.))

**Table 1** Physical volume index of fixed capital investment, %

| Indicator | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2014–2022 |
| The economy as a whole | 98.5 | 89.9 | 99.8 | 104.8 | 105.4 | 102.1 | 99.9 | 108.6 | 104.6 | 113.0 |
| Crop and livestock production | 92.7 | 87.4 | 113.1 | 108.2 | 104.1 | 98.7 | 93.7 | 102.4 | 91.8 | 89.8 |

*Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2019b, 2021b); Federal State Statistics Service of the Russian Federation (n.d.)

different types of fixed assets. The largest share of investment is in buildings and construction. However, to ensure accelerated technological modernization, priority should be given to investing in machinery and equipment.

Emerging risks in the implementation of investment activities, as well as the high cost of borrowed resources, cause low investment activity in the industry (Maslova, 2022).

## 4 Discussion

As noted by Russian academic economists, to further elevate the rate of economic growth beyond global levels and ensure sustainable socio-economic progress, there will be a requirement to "increase the rate of accumulation in the economy to 25% of GDP" (Ivanter, 2019), as well as "to switch over to accelerated growth of investments (by 10%–15% annually) into fixed assets and human capital in the nearest 3–5 years" (Aganbegyan, 2022). It is argued that "expanded reproduction of human capital is the foundation of sustainable development of the contemporary economic system, and with the change of technological and world economic modes, not only the quantitative assessment of human capital but also its qualitative content" (Glazyev et al., 2020). This confirms the conclusion of the authors that the current transformation of consumption and accumulation should correspond to the directions of economic development identified by the national strategic objectives. The conducted research on changes in the structure of consumption and accumulation in agriculture confirms the importance of the growth of gross savings. Consequently, it will entail the intensification of investment activity, which should be accompanied by the growth of final consumption and optimization of the structure of intermediate consumption. The author's study identifies the main factors that influence the growth of gross savings and investment in agriculture. In previous studies, the authors contended that to guarantee sustainable industry growth, the increase in investments in fixed capital should be twice that of the production growth rate (Maslova et al., 2022). The achievement of this indicator necessitates ensuring the financial and economic stability of commodity producers, ensuring the growth in their incomes, enhancing accessibility to credit resources, and improving the investment attractiveness in agricultural sector.

## 5 Conclusion

Structural changes in accumulation and consumption in the agricultural sector of the economy are influenced by profound geopolitical changes, changes in the vectors of agricultural policy, and institutional changes. The task of technological sovereignty will cause a change in the proportions between accumulation and consumption in the industry. The study of estimation of parameters, dynamics of development of accumulation and consumption process in the economy and agriculture of Russia revealed the main factors influencing their structural changes. Currently, the share of material costs in intermediate consumption is increasing due to an increase in the cost of inputs, while the

level of labor costs is decreasing. While gross savings in agriculture are growing in absolute value, there is a decrease in the share of net savings. There is also a non-optimal structure of investment: priority investment in machinery, equipment, and new technologies is required for accelerated technological modernization.

Proposals to optimize the structure of accumulation and consumption in the agriculture of Russia can be used to improve agricultural policy and adjust the measures of state support to ensure sustainable growth in production and increase investment activity.

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# Rural Tourism as a Factor in Overcoming Poverty in the Kyrgyz Republic

Nelli I. Akylbekova, Anarkul O. Sabyrova, Qi Yang, Marina Z. Dzhumabaeva, and Ainura A. Mambetova

**Abstract**

Rural tourism was chosen as a research topic, and a study of rural tourism was conducted to find ways to develop the region and reduce poverty in the Kyrgyz Republic. As an important element of sustainable economic development, tourism is the basis of rural entrepreneurship. It can solve the social problems of the rural population. There remain certain problems in rural tourism in the Kyrgyz Republic, including the lack of material and financial resources to create tourist conditions and the lack of specialized knowledge of the tourism business. To overcome these problems, it is necessary to attract the attention of all interested parties, such as the local community, local governments, financial institutions, transport companies, hotel companies, catering companies, and others.

**Keywords**

Rural tourism • Rural population • Poverty level • Tourism infrastructure • Consumer price index • Rural entrepreneurship • Sustainable development of the economy

**JEL Classifications**

I32 • L83 • O18 • P25 • R11

## 1 Introduction

The role and contribution of rural tourism are determined by its multiplicative effect on other areas of activity. Thus, it is controlled by the government as a priority industry, especially since the development of remote rural areas is included in state development programs (Akylbekova et al., 2022). Small and medium-sized businesses should be developed, when every rural family can create their business in rural tourism with minimal financial investment. Developing entrepreneurship in rural areas will contribute to overcoming poverty, raising living standards, and solving social problems (Sayakbaeva & Akylbekova, 2022; Wei et al., 2017).

It is necessary to note the geographical feature of the Kyrgyz Republic, distinguished by many reliefs. About 75% of the country's territory is occupied by mountain systems; 50% of Kyrgyzstan has a height of approximately 1000–3000 m, and about 30% at an altitude of 3000–4000 m. Mountain tourism enthusiasts can visit Pobeda Peak (7439 m) and Khan Tengri Peak (7010 m). These features allow tourists to enjoy the views and landscapes of different heights. Moreover, flora and fauna are distinguished by a wide range of endemics. The temperature varies from −30 °C to +27 °C in winter and from +44 °C to −53.6 °C in summer. The Kyrgyz Republic is characterized by various grown agricultural products, attracting gastronomic tourists.

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Crop and livestock farming products are characterized by high quality and environmental friendliness. The culture of the people living in Kyrgyzstan, which retains its authenticity, also demonstrates its uniqueness and diversity.

## 2 Literature Review

A sufficiently large range of studies in different countries is noted. Some researchers of the current situation of rural tourism in countries where it occupies a significant share of GDP and contributes to creating sustainable economies with green principles demonstrate its synergistic combination with agriculture. Such activities of rural residents, combining different areas of entrepreneurship, show great potential for the Kyrgyz Republic, where the main labor resources are engaged in agriculture; tourism can be profitable and useful for families. This combination is supported by government programs and the regional development strategy to reduce the poor population and solve social problems (Rosalina et al., 2021; Su et al., 2019). The combination of efforts of all stakeholders, such as government authorities, entrepreneurship, and social organizations, is the most successful for promoting entrepreneurship in rural tourism. It should be noted that the rural population has limited financial resources due to the fact that they have no other way to generate income other than crop and livestock farming. Thus, public investments and preferential loans from state banks are required (López-Sanz et al., 2021).

Rural tourism attracts a wide range of tourists from the country and from abroad, which makes it possible to widely publicize the usefulness of organic products grown in environmentally friendly natural conditions, forms a positive attitude towards such products, stimulates their consumption, and promotes exports to other countries (Chen et al., 2023a; Jenish, 2017).

Urban residents are aware of the benefits of outdoor recreation in rural areas, and the experience of staying in such tourist destinations creates a positive image of rural tourism. The eco-friendliness of this type of outdoor activity is the main reason for the spread of advertising to tourists, which can easily be done through the Internet and attract potential tourists (Huete Alcocer & López Ruiz, 2020; Yarimoglu & Binboga, 2019). The importance of staying in ecologically clean areas and using organic products encourages tourists from remote countries to look for unique places to obtain environmentally friendly conditions of stay and receive unforgettable experiences that differ from those where potential consumers of tourist services usually live (Ashraf et al., 2020; Ghandour et al., 2021).

Creating quality tourism services demands the consideration of a set of tourists' requirements, including historical, hygienic, cultural, and social components, which can meet the demand and customer satisfaction of the tourism business. Such an image of a tourist destination develops not immediately but in the process of experience and interaction with, determining customers' preferences and forming a cycle of regular guests (Demidchik et al., 2022). A high level of service contributes to the formation of tourist loyalty. For this purpose, it is necessary to create the necessary infrastructure, transport network, Internet access, staff training, a benevolent attitude towards guests, and amenities. Such a formulation of the problem requires the comprehensive support of the state of local communities, entrepreneurs, and the attraction of investors (Chen et al., 2023b; Rosalina et al., 2021).

The complexity of the provided tourist service lies in the fact that the preferences of each tourist are individual and require a sensitive attitude of the staff and the creation of conditions for a comfortable and safe stay. Services in the rural tourism business should have a diverse spectrum, from gastronomic to recreational activities. Tourist safety should be elevated to the level of state policy (An & Alarcón, 2021).

The successful experience of rural tourism in countries where tourism occupies a leading position should be carefully studied; its principles and rules should be implemented in the country's development strategy and the practice of entrepreneurship of rural residents (Kastenholz et al., 2012; Zhang et al., 2023). Successful experience undoubtedly shows the interest and active assistance from the state for the activity of the rural population in providing tourism services. Creating the image of a tourist country is becoming an important matter for the government, which should provide multilateral assistance to the local community, especially entrepreneurs (López-Sanz et al., 2021; Yang et al., 2021).

Digitalization and the trend of digital technologies require its inclusion as a necessary element of the tourist service. Digital services regarding payment, digitalization of transport services, issuance of visas and permits for tourists, and provision of the Internet in places of location and residence make the tourist destination acceptable to a wide range of potential customers (Ghandour et al., 2021).

Advanced information technologies are also useful for the administration of hotel enterprises and services for image recognition and face masks for automated verification on real-time video from surveillance cameras, which will help meet the requirements for compliance with the mask regime (Demidchik et al., 2022; Kintonova et al., 2022).

Advanced information technologies are also useful for tourists (Demidchik et al., 2021).

## 3 Methodology

Conducting research on a given topic required the study of recent scientific works to obtain an up-to-date theoretical basis for understanding the essence and content of twisted

concepts and definitions. The study of research by foreign authors made it possible to evaluate the experience and highlight the positive aspects, which are especially important and applicable to the Kyrgyz Republic.

Statistical data helped assess the standard of living, poverty level, and social status of the population in rural areas by territory for 2017–2022.

## 4 Results

Statistical analysis of demographic indicators characterizing the level of urbanization of the Kyrgyz Republic suggests that in 2022, 874.4 thousand people of the country's permanent population (15.75%) and 255.8 thousand people (4.61%) lived in the large cities of Bishkek and Osh, respectively. The share of the total resident population of the Kyrgyz Republic in the Jalal-Abad Region in 2022 was 18.99%, Osh Region—20.67%, Chui Region—14.82%; other rural areas together amounted to 79.64% (Fig. 1). The population of the Kyrgyz Republic is mainly rural. Agricultural activities dominate rural employment. As an agrarian country, the Kyrgyz Republic is famous for its crop and livestock products, some of which are exported to neighboring countries. Tourism could become a useful and profitable area of employment for rural residents.

The largest part of the rural population lives in the Osh Region (1 million 354.5 thousand people; 30.2%), the Jalal-Abad Region (978.4 thousand people; 21.8%), and the Chui Region (881.7 thousand people; 19.6%). The smallest population lives in the Naryn Region (about 266.4 thousand people; 5.9%), the Talas Region (231.6 thousand people; 5.2%), and the Issyk-Kul Region (391.1 thousand people; 8.7%) (National Statistical Committee of the Kyrgyz Republic (n.d.)) (Table 1).

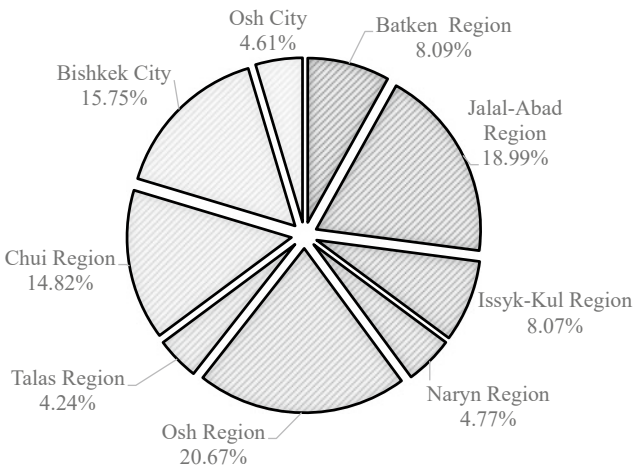


**Fig. 1** The structure of the population of the Kyrgyz Republic by territory in 2022, %. *Source* Compiled by the authors based on (National Statistical Committee of the Kyrgyz Republic (n.d.))

**Table 1** The rural population of the Kyrgyz Republic by territory in 2022

| | Rural population, thousand people | Share in the total number, % |
|---|---|---|
| Batken Region | 347.4 | 7.7 |
| Jalal-Abad Region | 978.4 | 21.8 |
| Issyk-Kul Region | 391.1 | 8.7 |
| Naryn Region | 266.4 | 5.9 |
| Osh Region | 1354.5 | 30.2 |
| Talas Region | 231.6 | 5.2 |
| Chui Region | 881.7 | 19.6 |
| Bishkek city | 6.2 | 0.1 |
| Osh city | 37.3 | 0.8 |

*Source* Compiled by the authors based on National Statistical Committee of the Kyrgyz Republic (n.d.)

In the Issyk-Kul Region, there is a beautiful mountain lake Issyk-Kul, famous for its uniqueness, purity, and beauty. However, only the summer months are used for tourism in this region. Thus, creating an infrastructure for the year-round use of this area's unique nature is necessary. This can be attributed to all regions where rural tourism entrepreneurs mainly offer their services in the summer.

Moreover, there is a high level of poverty, which increased significantly from 2017 to 2021. The highest poverty rate in 2021 was observed in the Jalal-Abad Region (43.2%), where it increased by 32.6% compared to 2017. In the Batken Region, the poverty level is also high and amounted to 40.7% in 2021, which is 0.2% higher than in 2017 (National Statistical Committee of the Kyrgyz Republic (n.d.)) (Fig. 2).

The development of the economy contributes to a decline in living standards and an increase in the consumer price index. The largest increase (113.9%) was observed in 2022. The consumer price index was 101.1% in 2019 and 103.2% in 2017 (National Statistical Committee of the Kyrgyz Republic (n.d.)) (Table 2).

## 5 Discussion

Rural areas in the Kyrgyz Republic are often characterized by limited economic opportunities and high poverty. By encouraging rural tourism, local communities can diversify their income sources beyond traditional agriculture, which is vulnerable to climate change.

Tourism in Kyrgyzstan is important due to its multiplicative effect on other areas of activity (Akylbekova et al., 2022; Sayakbaeva & Akylbekova, 2022). Additionally,

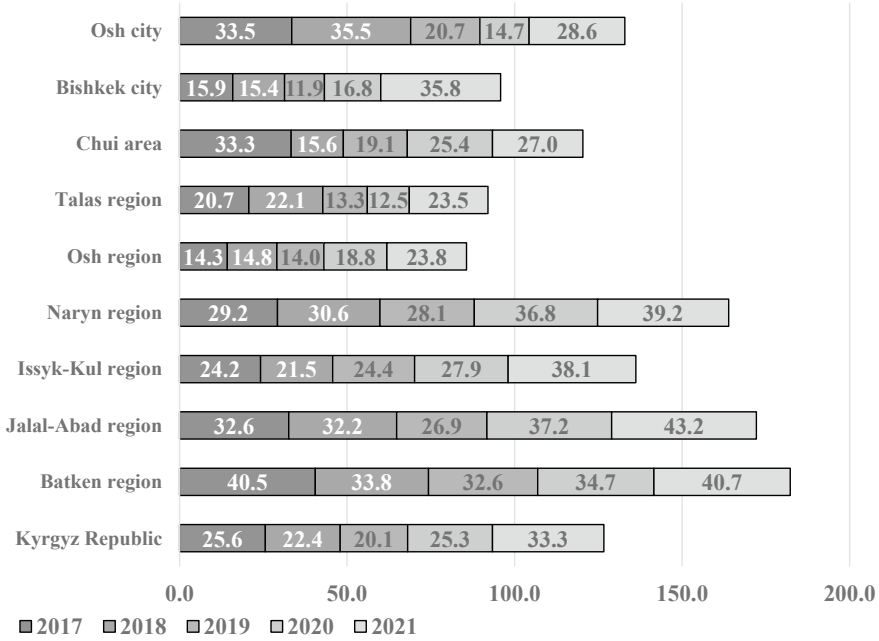


**Fig. 2** Poverty rate in the Kyrgyz Republic by territory for 2017–2022, %. *Source* Compiled by the authors based on (National Statistical Committee of the Kyrgyz Republic (n.d.))

**Table 2** The consumer price index in the Kyrgyz Republic for 2017–2022, %

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Consumer price index | 103.2 | 101.5 | 101.1 | 106.3 | 111.9 | 113.9 |

*Source* Compiled by the authors based on National Statistical Committee of the Kyrgyz Republic (n.d.)

creating green jobs can reduce poverty, which, in turn, will reduce anthropogenic pressure, primarily on mountains and other ecosystems (Mukambaeva & Mukambaev, 2020).

With the small financial investment required to set up a business, the unique natural resources of Kyrgyzstan can be used to create tourism enterprises. Cultural aspects such as pride and ethnic identity are positive factors. Negative factors include concerns about rising living costs and overcrowding in public spaces. A positive attitude of local communities towards tourism will help develop the tourism sector (Sabyrbekov, 2019).

It is necessary to promote historical and cultural monuments for the successful development of tourism. The cultural image of the destination affects the satisfaction of tourists after visiting it (Huete Alcocer & López Ruiz, 2020).

To attract tourists, rural areas often require improved infrastructure and amenities. Investments in roads, transport, accommodation, and sewerage can significantly reduce poverty and increase the region's attractiveness to potential tourists. Rural tourism development can stimulate public and private sector investment, contributing to further poverty reduction.

Active development of rural tourism requires investment. Renewal of the infrastructure necessary for tourism activities is also required.

The government should revise the Administrative Code to tighten regulations and penalties for environmental pollution at tourist sites, national parks, and nature reserves. Local authorities should regularly monitor the environmental situation and ensure compliance with these rules on the ground (Jenish, 2017; Saputro et al., 2023).

As part of the green economy, rural tourism using its principles and methods is the core of the country's sustainable economic development. Local communities, as the indigenous people of their place of residence, try to protect nature and preserve its resources in their original form as much as possible. Therefore, state environmental conservation programs will be combined with rural tourism. This attitude of local residents creates the basis for a sustainable economy, benefiting in the long term as natural resources are preserved and transferred to future generations.

Educating the local generation in the spirit of patriotism and protection of their place of residence will be passed on to the younger generation and change migration and labor policies. Labor resources are required in places of residence for rural entrepreneurship, job creation, and tourism experience.

As the leading subject of rural tourism, the country should form strategies and concepts for sustainable development and introduce green principles in business and environmental protection. Such mechanisms as green

lending and public–private entrepreneurship can be successfully applied, especially since successful experience has been studied.

## 6 Conclusion

Several internal and external factors hamper the economic development of the Kyrgyz Republic. As a result, the social sector and social security lag behind the population's needs. Poverty is one of the key indicators of social security. However, there is potential for sustainable development. Rural tourism has all prerequisites for its development, including natural, cultural, and historical resources.

The diversity of cultures of the peoples inhabiting the country, diverse landscapes, unique nature, and cultural attractions create a wide range of attractive motives for tourists, who are fascinated by the tourist opportunities of the leading tourist countries. The use of Internet marketing to create the image of Kyrgyzstan as a mountainous tourist country makes it possible to increase the flow of tourists. However, this requires the modernization of infrastructure to meet the growing needs and requirements of tourists, which requires the allocation of resources. Using financing based on public–private partnerships has great prospects for rural tourism. Attracting foreign investors can also expand the horizons of rural tourism and accelerate sustainable development and integration into the global tourism community, introduce the experience of successful tourism companies, and gain the missing knowledge of rural entrepreneurship (Akylbekova et al., 2022; Sayakbaeva & Akylbekova, 2022).

Thus, rural tourism is an attractive destination for local entrepreneurs who require insignificant financial and material resources for development. However, those who need attracted resources can turn to investors, including foreign ones, use green lending, and attract resources from public–private partnerships and other financial instruments.

However, tourism development also has a negative side, which lies in the risk of environmental pollution, for which it is necessary to provide preventive measures to create appropriate infrastructure for cleaning and removing garbage. Nevertheless, it is all worthwhile if rural tourism contributes to reducing poverty, addressing rural social problems, and improving people's living standards.

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# Changing the Global Production and Trade of Citrus Fruits

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**Abstract**

In this research paper, the authors investigated the change over 2000–2021 in global citrus fruit production and international trade. There is a considerable number of species cultivated by humans. However, oranges, mandarins, lemons, limes, pomelos, and grapefruit were the most common in terms of gross pickings and their exports and imports. Significant amounts of citrus fruits are grown, including for deliveries abroad, in countries whose territory is located in the subtropical and tropical subequatorial and equatorial climatic belts of the Earth. In 2021, the top ten of this ranking were Brazil, India, China, Mexico, the USA, Spain, Egypt, Indonesia, Iran, and Italy. During the considered period, global production of citrus fruits of all types increased 1.53-fold. In 2000, their global gross yields were 105,960 million tons. By 2021, this figure reached 161,801 million tons. The authors found that the global exports and imports of citrus fruits of all types increased by 1.91 times and 1.89 times, respectively, during 2000–2021. In particular, exports increased from 9.709 million tons in 2000 to 18.517 million tons in 2021. The authors found the countries that lead in citrus fruit exports (all types) as of 2021: Spain—19.2% of the global total, South Africa—14.03%, Turkey—10.53%, Egypt—8.62%, China—4.96%, the Netherlands—4.83%, Mexico—4.66%, the USA—3.75%, Morocco—3.22%, and Greece—2.6%. The volume of global imports of citrus fruits increased from 9.565 million tons in 2000 to 18.066 million tons in 2021. The following countries were among the leaders in imports of citrus fruits (all types) as of 2021: Russia—9.41% of the global volume of this indicator, the USA—8.54%, the Netherlands—7.69%, Germany—6.57%, France—5.77%, the UK—3.94%, Saudi Arabia—3.8%, Iraq—2.96%, Poland—2.87%, and Canada—2.76%.

**Keywords**

Citrus fruits • Global manufacturing • Export • Import • Oranges • Mandarins • Lemons • Limes • Pomelo • Grapefruit • Countries • Russia

**JEL Classifications**

F1 • F4 • F5 • F6 • O1 • O5 • Q1

## 1 Introduction

Nowadays, many countries cultivate fruit and berry plants in various areas of horticulture (Mukhametzyanov et al., 2022a). Given that most of these floras are heat-loving, these industries have developed most significantly in countries and regions of the world located in more favorable climates in terms of temperature and humidity (Mukhametzyanov et al., 2021b). Internationalization, transnationalization, and foreign economic liberalization of the world economy have strengthened the specialization of specific countries in certain areas of horticulture, as well as the development of international trade in fruit and berry products (Agirbov et al., 2019). It has grown significantly in recent decades in volume

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and value terms (Khezhev et al., 2022). As a result, according to the latter indicator, it was in second place after meat and meat products (Mukhametzianov et al., 2021a).

The concentration of countries in producing specific fruits and berries depends on objective and subjective factors (Mukhametzianov et al., 2022). The first and most important factors are natural and climatic conditions and biological characteristics of plants, which are grown to obtain a marketable mass of fresh fruit and berry products (Mukhametzyanov et al., 2005). The second group of factors is the policies pursued by countries to develop certain areas of agriculture and horticulture, as well as to develop exports of goods of this food group with certain countries or restrictions on imports from them (Frolova et al., 2021). Objective factors also determine the effectiveness of the use of subjective factors. However, the latter also affects the participation of particular states in global production and international trade of fruits, berries, and their sub-products (Mukhametzyanov et al., 2023a).

Citrus fruits lead in gross pickings, exports, and imports of fresh fruit and berry products (Mukhametzyanov, 2012). In particular, oranges were in fourth place in its global physical exports, mandarins in fifth, and lemons and limes in seventh (Ibrasheva et al., 2023). Citrus fruits are considered subtropical. Nevertheless, they are grown in significant quantities in regions of the world that are also located in the tropical, equatorial, and subequatorial belts of the Earth (Mukhametzyanov et al., 2023b). Most producers and exporters of these types of fruit and berry products are in developing countries. The importers of these products are developed countries (Mukhametzyanov & Britik, 2020). In particular, the European Union and its constituent countries are the largest subject of demand in the world market for fruit and citrus fruits in general (Platonovskiy et al., 2021). The authors support the view that increasing the parameters of their international trade benefits both categories of countries (Dzhancharova et al., 2021). On the one hand, the development of the production and export potential of countries where citrus plants are cultivated leads to an increase in their foreign exchange earnings from the supply of these fruits to other countries (Mukhametzyanov et al., 2021c). On the other hand, this process contributes to the creation of jobs and increases employment and income of the population involved in production and subsequent commodity circulation of citrus fruits and their sub-products, including abroad. Simultaneously, the assortment of fruit and berry markets of importing countries is expanding, and a year-round supply of fresh fruits is provided, which also reduces the pronounced seasonality of price formation (Agirbov & Mukhametzyanov, 2012a).

The importance of citrus fruits in the global gross collections of fruit and berry products and the volume of its international trade (Agirbov & Mukhametzyanov, 2012b) and in the food supply of exporting and importing countries determines the relevance of the chosen problem.

## 2 Materials and Method

The research aims to analyze global citrus fruit production and trade transformation over 2000–2021. To achieve the research goal, the authors identified the following tasks:

- To characterize the absolute and relative changes during the indicated period of the global gross collections of this group as a whole and of specific citrus species;
- To conduct a similar analysis regarding the transformation of the global volume of their exports and imports in physical terms;
- To identify the countries in the world that ranked in the top 10 in gross harvest and international trade of citrus fruits of all types in 2021;
- To investigate the share of the studied group in the volumes of production, export, and import of fruit and berry products as a whole.

The basis for the analytical calculations is the statistics of the Food and Agriculture Organization of the United Nations (FAO) on production and international trade (FAOSTAT n. d.). It combines some related citrus fruits into subgroups. Thus, the following are distinguished:

- “Tangerines, mandarins, and clementines”;
- “Lemons and limes”;
- “Pomelos and grapefruits”;
- “Oranges”.

Fruits not included in these subgroups are included in “Other citrus fruit, n.e.c”. During this research, the authors also adhered to this classification. Using FAO data for 2000–2021, the authors analyzed the change in global gross collection for each of these five subgroups, and for the aggregate of the five subgroups as a whole (Table 1). The authors have done the same for the corresponding data on global citrus fruit exports and imports (Table 2). Four five-year sub-periods were identified within the studied period: 2001–2005, 2006–2010, 2011–2015, and 2016–2020. The authors calculated annual averages for each of these and compared the established levels for production, exports, and imports for 2021 relative to 2000 for all five citrus fruit subgroups and for the citrus fruit population as a whole. Figures for China are presented without Hong Kong, Macao, and Taiwan because they are treated separately in FAO statistics.

**Table 1** Changes in global citrus fruit production in 2000–2021, million tons

| Type of citrus fruit | 2000 | Annual average | | | | 2021 | 2021 to 2000, times |
|---|---|---|---|---|---|---|---|
| | | 2001–2005 | 2006–2010 | 2011–2015 | 2016–2020 | | |
| Oranges | 63.851 | 62.031 | 67.783 | 72.164 | 74.511 | 75.568 | 1.18 |
| Mandarins | 18.615 | 22.508 | 23.010 | 29.864 | 35.582 | 41.950 | 2.25 |
| Lemons and limes | 10.830 | 12.093 | 15.504 | 15.677 | 18.812 | 20.829 | 1.92 |
| Pomelos and grapefruits | 5.775 | 5.228 | 6.935 | 8.368 | 9.076 | 9.557 | 1.65 |
| Other citrus fruits | 6.889 | 7.298 | 10.630 | 12.402 | 14.053 | 13.897 | 2.02 |
| Citrus fruits in general | 105.960 | 109.158 | 123.861 | 138.475 | 152.035 | 161.801 | 1.53 |

*Source* Compiled by the authors based on FAO statistical data FAOSTAT (n.d.)

**Table 2** Changes in global citrus fruit exports and imports in 2000–2021, million tons

| Type of citrus fruit | 2000 | Annual average | | | | 2021 | 2021 to 2000, times |
|---|---|---|---|---|---|---|---|
| | | 2001–2005 | 2006–2010 | 2011–2015 | 2016–2020 | | |
| *Export* | | | | | | | |
| Oranges | 4.537 | 4.898 | 5.801 | 6.964 | 7.602 | 7.248 | 1.60 |
| Mandarins | 2.536 | 2.822 | 3.911 | 4.796 | 5.267 | 5.920 | 2.33 |
| Lemons and limes | 1.598 | 1.912 | 2.328 | 2.733 | 3.569 | 4.176 | 2.61 |
| Pomelo and grapefruit | 1.037 | 1.034 | 1.162 | 1.103 | 1.180 | 1.057 | 1.02 |
| Other citrus fruits | 0.000 | 0.000 | 0.000 | 0.048 | 0.132 | 0.117 | – |
| Citrus fruits in general | 9.709 | 10.666 | 13.202 | 15.644 | 17.750 | 18.517 | 1.91 |
| *Import* | | | | | | | |
| Oranges | 4.683 | 5.149 | 5.851 | 6.680 | 7.301 | 7.291 | 1.56 |
| Mandarins | 2.380 | 2.562 | 3.518 | 4.420 | 4.944 | 5.562 | 2.34 |
| Lemons and limes | 1.450 | 1.753 | 2.162 | 2.617 | 3.530 | 4.006 | 2.76 |
| Pomelo and grapefruit | 1.053 | 1.026 | 1.093 | 1.095 | 1.147 | 1.084 | 1.03 |
| Other citrus fruits | 0.000 | 0.000 | 0.000 | 0.044 | 0.141 | 0.123 | – |
| Citrus fruits in general | 9.565 | 10.490 | 12.625 | 14.856 | 17.062 | 18.066 | 1.89 |

*Source* Compiled by the authors based on FAO statistical data FAOSTAT (n.d.)

## 3 Results and Discussion

Let us consider the global citrus fruit production change between 2000 and 2021 (Table 1). Among them, oranges were and still are in first place in terms of gross harvest (Mukhametzianov et al., 2021c). During the studied period, they increased from 63.851 million tons to 75.568 million tons (a 1.18-fold increase), which is the smallest relative increase among other citrus fruits, causing their share of this group of fruits to drop from 60.26% to 46.70%. Simultaneously, global mandarin production increased 2.25 times (from 18.615 million tons to 41.950 million tons), which is the highest relative result among the other subgroups. As a result, their importance in global citrus gross pickings has increased from 17.57% in 2000 to 25.93% in 2021. There is also a positive trend in lemons and limes: from 10.830 million tons to 20.829 million tons (an increase of 1.92 times); their share for the citrus fruit group increased from 10.22% to 12.87%. The worldwide production of pomelos and grapefruits was only 1.65 times higher (from 5.775 million tons in 2000 to 9.557 million tons in 2021). As a result, their share increased slightly from 5.45% to 5.91%. As for the subgroup "other citrus fruits", their global gross yields increased by 2.02 times (6.889 million tons in 2000 and 13.897 million tons in 2021). As a result, their value changed from 6.50% in 2000 to 8.59% in 2021. In 2021, the top ten largest producers of this group of fruit and berry products included Brazil, India, China, Mexico, the USA, Spain, Egypt, Indonesia, Iran, and Italy.

Let us characterize the change in global citrus fruit exports and imports from 2000 to 2021 (Table 2). It is noticeable that they are significantly inferior to their gross charges. In particular, data for the first of these two areas of international

trade show that global exports of oranges in 2021 were equal to 7.248 million tons (1.6-fold increase from 4.537 million tons in 2000), and of mandarins—5.920 million tons (2.33-fold increase from 2.536 million tons in 2000). Global exports of lemons and limes increased from 1.598 million tons to 4.176 million tons (2.61 times). Exports of pomelos and grapefruits increased from 1.037 million tons to 1.057 million tons (1.02 times). As a result, the content of specific fruits in global exports for the group as a whole changed during the covered study. Thus, the share of oranges dropped from 46.74% in 2000 to 39.14% in 2021. The share of pomelos and grapefruits changed from 10.69% to 5.71%. Simultaneously, the value of mandarins increased from 26.12% to 31.97%, and the value of lemons and limes changed from 16.46% to 22.55% (Brusenko et al., 2023). Other citrus fruits played almost no role in the international trade of this group. In 2021, the top ten countries leading in physical exports of citrus fruits (all types) were: Spain (19.2%), South Africa (14.03%), Turkey (10.53%), Egypt (8.62%), China (4.96%), the Netherlands (4.83%), Mexico (4.66%), the USA (3.75%), Morocco (3.22%), and Greece (2.6%). Together they accounted for 76.47%.

As for global imports of citrus fruits, there were similar trends compared to their exports, with slight variations in the corresponding indicators for specific types of citrus fruits and this group as a whole. In 2000–2021, global trade in oranges was 1.56 times greater (from 4.683 million tons to 7.291 million tons), mandarins 2.34 times greater (from 2.380 million tons to 5.562 million tons), lemons and limes 2.76 times (from 1.450 million tons to 4.006 million tons), and pomelos and grapefruits 1.03 times (from 1.053 million tons to 1.084 million tons). In 2021, the following countries were among the top ten leaders in physical imports of citrus fruits of all types): Russia (9.41%), the USA (8.54%), the Netherlands (7.69%), Germany (6.57%), France (5.77%), the UK (3.94%), Saudi Arabia (3.8%), Iraq (2.96%), Poland (2.87%), and Canada (2.76%). Together they accounted for 54.31%. Many of these countries are among the main importers of fruit and berry products in general (Agirbov et al., 2021). Russia became considerably involved in importing citrus fruits back in Soviet times; the purchase of citrus fruits (particularly oranges and lemons) was more than bananas (Mukhametzianov et al., 2021b). In 1981–1990, the average annual volume of oranges imported to the Soviet Union was 308.3 thousand tons, lemons and limes—94.6 thousand tons, and bananas—69.1 thousand tons (Agirbov, 2012). After the collapse of the Soviet Union, imports of citrus fruits to Russia began to increase gradually. In the first decade of the XXI century, Russia became one of the leading importers of citrus fruits (Udalova & Mukhametzianov, 2015).

In the second decade of the twenty-first century, geopolitical and geo-economic realities have changed significantly, including in connection with the increasing stationary pressure on Russia from the Western powers. This trend forced Russia to strengthen its food security by increasing domestic production of agricultural products (Mukhametzyanov et al., 2021d). Russia consistently pursued an import substitution policy, including in domestic horticulture (Mukhametzyanov et al., 2021b). This has led to an increase in the gross yields of Russia's traditional fruit and berry products in recent years (Mukhametzianov et al., 2022). As a result, the balance of resources and use of this food group in Russia has seen the reduced importance of foreign-made products (Mukhametzianov et al., 2021a). However, the volume of citrus fruit imports in physical mass has not decreased (relative to the average for 2011–2015 (Agirbov & Mukhametzianov, 2020)), although there is a slight decrease in value terms. Specifically, fresh and dried citrus products worth $1.268 billion were imported into Russia in 2021, compared to an average of $1.477 billion from 2011–2015 (Mukhametzianov et al., 2023). Considering that it is economically inexpedient to grow fruits and berries of tropical and subtropical origin on an industrial scale in Russia, in the future, given the country's geopolitical status, it will remain among the most important importers of these types of fruit and berry products (Mukhametzyanov et al., 2022c). This point of view fully applies to citrus fruits (Mukhametzyanov et al., 2021a).

## 4 Conclusion

Based on the analysis of changes in global citrus fruit production and international trade between 2000 and 2021, the authors drew several conclusions:

1. As we have noted, the global production of the group of citrus fruits in question has generally increased during the studied period. However, their particular species showed different rates from 2000 to 2021, which changed their share in the citrus production structure. Despite the absolute increase in gross yields of oranges, their value in the group is considered to be decreased from 60.26% to 46.7%. Simultaneously, for other types of citrus fruits, there is an increase in this indicator: mandarins from 17.57% in 2000 to 25.93% in 2021, lemons and limes from 10.22% to 12.87%, pomelos and grapefruits from 6.50% to 8.59%, and others from 5.45% to 5.91%.
2. If we consider the change in the physical volumes of global exports of fruit and berry products as a whole, they increased by 2.0 times during the analyzed period. They were at the level of 58.670 million tons in 2000 and reached 117.308 million tons by 2021. A smaller increase was observed in the citrus fruit group—only 1.91 times. In 2021, the parameters of their global

supplies were equal to 18.517 million tons (only 9.709 million tons in 2000). As a result, their share in the world export of fruit and berry products as a whole decreased from 16.55% in 2000 to 15.79% in 2021. A similar situation occurred in global imports. Whereas in the fruit group as a whole, it grew from 57.491 million tons to 115.325 million tons (i.e., by 2.01 times in 2000–2021), in the citrus group, it grew from 9.565 million tons to 18.066 million tons (i.e., by 1.89 times). As a result, the share of citrus fruits in global exports of fruit and berry products as a whole also decreased during the study period: from 16.64% to 15.67%.

3. The following trends were observed for particular citrus subgroups. Despite a rather significant decrease in the importance of oranges in both of these international trade flows, they continued to rank first in this group in 2021 with a share of 39.14% and 40.36%, respectively. The content of mandarins increased significantly: from 26.12% to 31.97% for exports and from 24.89% to 30.79% for imports. As before, lemons and limes were in the third position among citrus fruits by volume of their international trade. This subgroup also increased its importance in the corresponding global parameters for the group as a whole: from 16.46% in 2000 to 22.55% in 2021 for exports and from 15.15% to 22.18% for imports. The share of pomelo and grapefruit in these figures decreased, reaching 5.71% and 6.00% in 2021, respectively. Other citrus fruits had practically no importance in the international trade of the considered.

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# International Banana Trade: Volumes, Countries, and Trends

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**Abstract**

In this research paper, the authors analyzed changes in the 2000–2021 physical volumes and trends of international trade in bananas, identified the world's largest exporters and importers of this tropical fruit, and assessed changes in their positions in these flows during the studied period. Bananas rank first among other fruit and berry products in terms of gross yields and parameters of their international trade, which indicates the high importance of this tropical fruit in the food supply of producing and exporting countries and banana-importing countries. The research shows that the global export parameters of bananas increased by 1.71 times during the considered period. They equaled 14.336 million tons in 2000 and reached 24.584 million tons by 2021. The volume of global banana imports was 23.336 million tons in 2021, which is 1.62 times higher compared to 2000 (14.433 million tons). In 2021, the following five countries (in descending order of importance) were represented among the main exporters of the considered tropical fruit: Ecuador (27.71%), Guatemala (10.14%), Philippines (9.89%), Costa Rica (9.41%), and Colombia (8.55%). In the second five were the Netherlands (3.69%), Belgium (3.40%), the USA (2.38%), Panama (2.37%), and Mexico (1.99%). Together, these ten countries accounted for 79.54% of global exports of bananas. In this ranking, there are many countries from Latin America. In terms of banana imports, the top five leading countries in 2021 were the USA (19.86%), China (7.99%), Russia (6.26%), the Netherlands (6.15%), and Germany (6.06%). In the second five were Japan (4.75%), Belgium (4.62%), the UK (3.92%), Italy (3.33%), and France (3.20%). These ten countries accounted for 66.13% of global imports of bananas. Some of these countries, such as the Netherlands, Belgium, the USA, and Germany, are also major exporters of bananas without producing them.

**Keywords**

Bananas • International trade • Export • Import • Country ranking • Russia • Trends

**JEL Classifications**

F1 • F4 • F5 • F6 • O1 • O5 • Q1

## 1 Introduction

Since the emergence of the first countries, fruits, berries, and their sub-products have been the object of international trade (Mukhametzyanov et al., 2023a). However, until the middle of the last century, it provided the food interests of the richest segments of the population of the countries that imported them (Mukhametzyanov et al., 2022e). Simultaneously, most inhabitants of these countries met their needs for fruit and berry products by gathering, producing, or purchasing local goods from this food group on the market (Mukhametzyanov, 2012).

In the second half of the twentieth century, along with the growing incomes of the populations of countries that are now considered developed, their demand for tropical and subtropical fruits and berries increased (Mukhametzyanov et al., 2023c). Various commercial entities from these powers

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began to increase their investment in cultivating these types of fruit and berry products in the countries that were geographically, economically, and politically closest to the USA and Europe (Mukhametzyanov et al., 2022g). This has significantly increased the production and export potential of several horticultural areas in some South and Central American countries (Mukhametzyanov et al., 2021g). Additionally, due to the supply of fruits, berries, and their sub-products, they receive a fairly substantial amount of foreign exchange earnings (Mukhametzyanov et al., 2021d). Simultaneously, through imports of this food group (especially those of tropical and subtropical origin), the developed nations of North America and Europe have significantly increased their physical and economic accessibility to the country's populations (Agirbov et al., 2021). This ultimately led to an increase in the international trade of these types of fruit and berry products (Mukhametzyanov et al., 2022c).

Management practices show that the volume of international trade in fruits, berries, and processed products has significantly increased over the past few decades (Khezhev et al., 2022). This food group is currently in second place in terms of value parameters after meat and meat products (Mukhametzyanov et al., 2022h).

Bananas are one of the most important types of fruit and berry products (Zaretskaya et al., 2022). Moreover, they are in first place among other fruits and berries in terms of global production and global exports (Ibrasheva et al., 2023). The largest importers of bananas are the EU (Platonovskiy et al., 2021), as well as the USA and some other developed countries, despite the significant volume of their own production of fruit and berry products. Despite the relative liberalization of international trade, some European countries restricted the supply of the studied tropical fruit from several Latin American countries to support this horticulture area in their former African colonies (in the last decades of the twentieth century) (Mukhametzyanov et al., 2021c). This even led to the so-called banana trade war, which lasted until the first decade of the twenty-first century (Frolova et al., 2021).

The importance of this tropical fruit in the global gross collections of fruit and berry products, the volume of its international trade (Agirbov & Mukhametzyanov, 2012b), and the food supply of exporting and importing countries determine the relevance of the considered problem.

## 2 Materials and Method

This research aims to analyze the absolute and relative changes in the international trade of bananas during 2000–2021. To achieve the research goal, the following tasks were identified:

- To characterize the transformation of global physical volumes of exports and imports of this tropical fruit over a specified period;
- To consider the change in the value of bananas in similar indicators for fruit and berry products in general;
- To identify the countries that are major exporters and importers of this tropical fruit and determine the transformation during 2000–2021 of their role in its international trade;
- To show the importance of Russia in this process.

The basis for the analytical calculations in this research includes the statistics of the Food and Agriculture Organization of the United Nations (FAO) on the physical parameters of banana exports and imports (FAOSTAT (n. d.)). Based on this data, the authors compiled and analyzed the change in exports (Table 1) and imports (Table 2) of bananas in 2000–2021 globally and by the ten countries that were leading in these areas of international trade as of 2021. Four five-year sub-periods were identified within the study period: 2001–2005, 2006–2010, 2011–2015, and 2016–2020. The authors calculated annual averages for each of them and compared the level of 2021 to 2000 for all ten countries and the world. Banana imports to China are presented without Hong Kong, Macao, and Taiwan because the FAO statistics provide information on these subjects of international trade separately.

## 3 Results and Discussion

Let us consider the change in banana exports from 2000 to 2021 globally and in the top ten countries for this area of international trade as of 2021 (Table 1). As in previous years (including 2000), Ecuador was the undisputed leader (Mukhametzyanov et al., 2023d).

Ecuador ranked only fifth in the gross harvest of the studied tropical fruit after India, China, Indonesia, and Brazil (Vorontsova et al., 2022). In terms of exports, banana shipments from Ecuador to other countries increased 1.71-fold during the reviewed period. They amounted to 3.994 million tons in 2000 and 6.813 million tons in 2021. Nevertheless, there has been a slight decline in the importance of this nation in global exports of bananas: from 27.86% in 2000 to 27.71% in 2021. In addition to Ecuador, three other Latin American countries were among the top five largest suppliers of bananas in international trade: Guatemala, Costa Rica, and Colombia. However, although Costa Rica and Colombia increased exports by 1.11 and 1.34 times during 2000–2021, the increase was less than the world as a whole (1.71 times). As a result, the importance of

**Table 1** Change in banana exports globally and in ten major countries in 2000–2021, million tons

| Country | 2000 | Annual average | | | | 2021 | 2021 to 2000, times |
|---|---|---|---|---|---|---|---|
| | | 2001–2005 | 2006–2010 | 2011–2015 | 2016–2020 | | |
| Ecuador | 3.994 | 4.428 | 5.242 | 5.626 | 6.530 | 6.813 | 1.71 |
| Guatemala | 0.802 | 0.996 | 1.344 | 1.898 | 2.408 | 2.494 | 3.11 |
| Philippines | 1.600 | 1.893 | 2.011 | 2.373 | 3.106 | 2.430 | 1.52 |
| Costa Rica | 2.079 | 1.933 | 2.027 | 1.973 | 2.476 | 2.312 | 1.11 |
| Colombia | 1.564 | 1.464 | 1.687 | 1.675 | 1.881 | 2.103 | 1.34 |
| Netherlands | 0.049 | 0.038 | 0.119 | 0.290 | 0.759 | 0.906 | 18.33 |
| Belgium | 0.967 | 0.917 | 1.205 | 1.229 | 1.100 | 0.837 | 0.87 |
| USA | 0.400 | 0.429 | 0.405 | 0.542 | 0.587 | 0.585 | 1.46 |
| Panama | 0.489 | 0.393 | 0.353 | 0.257 | 0.429 | 0.583 | 1.19 |
| Mexico | 0.081 | 0.057 | 0.107 | 0.327 | 0.527 | 0.490 | 6.04 |
| Other countries | 2.311 | 2.714 | 3.305 | 3.596 | 4.930 | 5.031 | 2.18 |
| World as a whole | 14.336 | 1.263 | 17.804 | 19.788 | 24.735 | 24.584 | 1.71 |

*Source* Compiled by the authors based on FAO statistical data FAOSTAT (n.d.)

**Table 2** Change in banana imports in the world and in the top ten major countries in 2000–2021, million tons

| Countries | 2000 | Annual average | | | | 2021 | 2021 to 2000, times |
|---|---|---|---|---|---|---|---|
| | | 2001–2005 | 2006–2010 | 2011–2015 | 2016–2020 | | |
| USA | 4.031 | 3.865 | 3.903 | 4.447 | 4.708 | 4.635 | 1.15 |
| China | 0.593 | 0.384 | 0.448 | 0.832 | 1.432 | 1.864 | 3.14 |
| Russia | 0.503 | 0.757 | 0.986 | 1.281 | 1.497 | 1.460 | 2.90 |
| Netherlands | 0.160 | 0.163 | 0.205 | 0.440 | 1.058 | 1.435 | 8.99 |
| Germany | 1.115 | 1.155 | 1.342 | 1.322 | 1.338 | 1.414 | 1.27 |
| Japan | 1.079 | 1.001 | 1.094 | 1.006 | 1.012 | 1.109 | 1.03 |
| Belgium | 1.027 | 0.956 | 1.314 | 1.289 | 1.267 | 1.077 | 1.05 |
| UK | 0.743 | 0.820 | 0.955 | 1.087 | 1.059 | 0.916 | 1.23 |
| Italy | 0.605 | 0.590 | 0.675 | 0.661 | 0.752 | 0.777 | 1.28 |
| France | 0.341 | 0.374 | 0.508 | 0.576 | 0.664 | 0.747 | 2.19 |
| Other countries | 4.238 | 4.482 | 5.851 | 6.492 | 7.491 | 7.903 | 1.86 |
| World as a whole | 14.433 | 14.547 | 17.280 | 19.432 | 22.277 | 23.336 | 1.62 |

*Source* Compiled by the authors based on FAO statistical data FAOSTAT (n.d.)

Costa Rica, which was the second-largest supplier of bananas in international trade in 2000, decreased from 14.5% to 9.41%. Colombia's share also declined from 10.91% in 2000 to 8.55% in 2021. Nevertheless, Guatemala's importance in global banana exports increased significantly from 5.59% to 10.14%. As a result, this country moved from sixth place in the 2000 ranking to second place in the 2021 ranking. Despite some rotation of positions, these four Latin American countries lead in the foreign trade of the studied tropical fruit (Mukhametzyanov et al., 2022f) and in the net foreign exchange earnings from their foreign trade in bananas (Mukhametzyanov et al., 2022d).

As for the second five countries in the ranking of banana exports, two other countries from this region were in the ninth and tenth positions in 2021: Panama (2.37% of the corresponding global volume) and Mexico (1.99%). According to our ranking, the Philippines deserves attention among other countries-suppliers of bananas in international trade (which grow it themselves)—2.430 million tons (third place in 2021 with a share of 9.89%).

Let us characterize the change in 2000–2021 in the volume of imports of the tropical fruit under study in the world as a whole and in the ten major countries in this direction of international trade in bananas for 2021 (Table 2).

The USA was and still is the undisputed leader of this ranking. In 2021, the volume of imports of bananas to the country was at the level of 4.635 million tons, which amounted to 19.86% of the corresponding global figure. In 2000, the parameters of banana supplies to the USA were equal to 4.031 million tons; relative to the world, the share of the USA was 27.93%. China ranked second in this ranking, although it ranked third in the world among the nations that lead in the gross harvest of bananas. The importance of this country in global banana imports has increased from 4.11% in 2000 to 7.99% in 2021.

Russia rounds out the top three in this ranking. It should be noted that Russia made significant purchases of bananas during the Soviet period, especially in the 1970s and 1980s (Mukhametzyanov et al., 2021f). However, its imports were significantly lower than some citrus fruits, such as oranges and lemons (Mukhametzianov et al., 2021b). In 1981–1990, the average annual volume of bananas imported into the Soviet Union was only 69.1 thousand tons, whereas the import of oranges was 308.3 thousand tons, and the import of lemons and limes was 94.6 thousand tons (Agirbov, 2012). At that time, bananas were physically available mainly to the population of megalopolises and the largest cities of the European part of the Soviet Union (Udalova & Mukhametzianov, 2015). However, not even all city dwellers could afford to buy it due to the considerably higher price of this tropical fruit compared to local types of fresh fruit and berry products (Agirbov et al., 2019). After the collapse of the Soviet Union, banana purchases from Russia gradually increased; it soon became the cheapest fruit for the average city dweller (Agirbov et al., 2020). Additionally, their supplies somewhat smoothed out the pronounced seasonality of prices in the domestic fruit and berry market, which was a positive fact for buyers (Agirbov & Mukhametzyanov, 2012a). As a result, in the first decade of the twenty-first century, Russia became one of the five largest banana-importing countries (Mukhametzyanov & Britik, 2020).

After the imposition of Western sanctions in connection with the situation in 2014 (in Crimea and Ukraine), Russia was forced to strengthen its food security under new geopolitical conditions (Mukhametzyanov et al., 2021e). Russia began to purchase a consistent import substitution policy in the agro-industrial complex, including domestic horticulture (Agirbov & Mukhametzianov, 2017). As a result, in recent years, Russia has increased the production of those types of fruits and berries that have always been traditional for the country (Mukhametzianov et al., 2022a). This contributed to the decline in the share of imports in the Russian food balance of fruit and berry products (Mukhametzianov et al., 2021a). However, this did not lead to a reduction in banana imports. Moreover, the volume of their purchases abroad, as well as other major tropical fruits, increased in physical and value terms (Agirbov & Mukhametzianov, 2020). Specifically, fresh and dried bananas imported into Russia in 2021 were worth $1.08 billion, compared to an average of $0.944 billion for 2011–2015 (Mukhametzianov et al., 2023b). This gives us reason to believe that Russia will remain among the leading countries of the world in the import of bananas in the medium and long term (Mukhametzyanov et al., 2022b).

## 4 Conclusion

Based on the analysis of the changes in the 2000–2021 international trade of bananas, the authors drew several conclusions that can contribute to its further scientific discussion:

1. During the study period, the global export parameters of bananas increased 1.71 times. They equaled to 14.336 million tons in 2000 and reached 24.584 million tons in 2021. However, for fruit and berry products as a whole, the corresponding figures increased 2.0 times, namely from 58.670 million tons in 2000 to 117.308 million tons in 2021. As a result, during 2000–2021, the share of bananas in global fruit and berry exports as a whole declined from 24.44% to 20.96%. As for imports, there were similar trends. The corresponding global figure for bananas increased 1.62 times: from 14.433 million tons to 23.336 million tons. For the fruit and berry products as a whole, this indicator increased 2.01 times: from 57.491 million tons to 115.325 million tons. As a result, between 2000 and 2021, the share of bananas in global imports of fruit and berry products as a whole fell from 25.11% to 20.24%.
2. In 2021, Ecuador shipped 6.813 million tons of bananas and became the world leader in terms of banana shipments to other countries (27.71%), Guatemala shipped 2.494 million tons (10.14%), the Philippines shipped 2.430 million tons (9.89%), Costa Rica shipped 2.312 million tons (9.41%), and Colombia shipped 2.103 million tons (8,55%). Together they accounted for 65.7% of global exports of this tropical fruit. In the second top five of our ranking were the Netherlands (0.906 million tons (3.69%)), Belgium (0.837 million tons (3.40%)), the USA (0.585 million tons (2.38%)), Panama—(0.583 million tons (2.37%)), and Mexico (0.490 million tons (1.99%)). These five states accounted for another 13.83% of the corresponding global figure.
3. In 2021, the main subjects of demand for bananas were the USA (4.635 million tons (19.86%)), China (1.864 million tons (7.99%)), Russia (1.460 million tons (6.26%)), the Netherlands (1.435 million tons (6.15%)), and Germany (1.414 million tons (6.06%)). Together they accounted for 46.32% of global imports of bananas.

In the second top five of the ranking includes Japan (1.109 million tons (4.75%)), Belgium (1.077 million tons (4.62%)), the UK (0.916 million tons (3.92%)), Italy (0.777 million tons (3.33%)), and France (0.747 million tons (3.20%)). These five countries accounted for another 19.82% of the corresponding global figure.

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# Market Pattern Analysis of Russia–Vietnam Chocolate Confectionary Trade

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**Abstract**

The research focuses on the active development of the Vietnam confectionery market, which is currently seen as a great opportunity for Russian chocolate exporters. As the food markets show consistent growth in value despite all geopolitical turmoil, Russian confectionery producers have continued exploring foreign exporting possibilities. The authors analyze Vietnam's chocolate confectionery market in terms of its future potential; its contradictory nature is examined. Despite the active development of Vietnam, the market of chocolate products is still small, saturated with foreign brands, and marked by strong seasonal fluctuation. As a result, the authors conclude that the confectionery market is attractive from the point of view of filling certain niches with goods widely consumed in Russia. From the point of view of transportation, storage, and sale, this market has lots of problems and needs to be handled with care.

**Keywords**

Vietnam market • Chocolate • Confectionary market • Russian exports • Russia-Vietnam trade

**JEL Classifications**

F14 • L66 • F23

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## 1 Introduction

Vietnam is one of the most dynamically developing countries in Southeast Asia, characterized by high growth rates of domestic consumption. In this regard, the Vietnamese market has the potential to increase sales of high-quality food, not least due to the increasing population, which is to reach the level of 99 million people by the end of 2022, with a natural increase of more than a million people per year.

The overall growth represents a bright potential for confectionary: over 35% of the population lives in Vietnam's urban areas, and the number tends to increase to 50% in the next 15 years gradually. The acceleration of urbanization increases consumer density. On the one hand, consumer density makes it easier for confectionery distributors to approach higher bulk of people. On the other hand, the demand and consumption level of urban areas increases. Additionally, the per capita income in urban areas of Vietnam is almost twice as high as in the rural parts. As one can observe from the experience of neighboring Malaysia, Thailand, and China, the general economic development has a strongly positive effect on the confectionery market, and Vietnam has certainly set foot on the same path.

As could be expected, the growth of welfare, inflation, and population led to a progressive growth of the food market, which was also reflected in confectionery. The overall retail sales of food and beverages categories in Vietnam rose significantly from $34.8 billion in 2016 to $45.4 billion in 2019 (Statista, 2022). This process coincided with a significant increase in the export of Russian chocolate products and sweets to Vietnam, which caused a lot of optimistic publications in Russian periodicals about the prospects in this market. By the end of 2021, Russia increased the export of confectionery products to Vietnam by 1.7 times to $4.8 million, of which 63% was chocolate, sugar confectionary made up another 24% (Association of Confectionery Industry Enterprises, 2022). Sales of Russian



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goods are also growing due to the expansion of exports in relatively new directions for Russian producers.

According to ITC statistics, trade in chocolate products between Russia and Vietnam shows that the average growth of chocolate product shipments between 2017 and 2021 was a remarkable 23%. This growth rate significantly exceeds similar growth in other Southeast Asian countries. Such indicators allowed some market participants even to assume that by 2024 the share of Russian chocolate sweets in the Vietnamese market will grow from the current $3–$4 million to about $14 million. In the medium term, Russia has the opportunity to become one of the leaders in exporting chocolate and chocolate confectionery to Vietnam.

## 2 Methodology

The paper is based on content analysis of several statistical resources and publications relevant to the research topic. The authors use statistical data derived from specialized national and international commodity databases and information portals; the discussion points concentrate on topical journals. The amount of optimistic publications regarding the potential of the Vietnam market for Russian exports is notable (Chernenko, 2019; Dang Minh et al., 2022; Migranyan, 2019; Nguyen et al., 2020, 2021). Nevertheless, a careful examination of this market reveals some difficulties in the structure of the Vietnamese chocolate products market, which does not allow us to talk about it as unconditionally promising for the corresponding Russian manufacturers. This formulates the problem of this research—identifying factors influencing the prospects of the market of chocolate products in Vietnam as a long-term export direction of Russian manufacturers.

## 3 Results

According to the analysis of Vietnam's sweets market, its main segments include ice cream, sugar confectionery, chocolate confectionery, and preserved pastries and cakes (Table 1).

The distribution of revenue and volumes is far from being smooth. As can be seen from the figures, the "sugar confectionery" category is dominating the market, which is a direct derivative of the country's traditions.

As can be seen from the sales structure of sweets, the value and material volume of the market is steadily growing; the monetary valuation grew almost twice as intensively and reached $7.12 billion in 2021, with an increase to $7.81 billion in 2022. The part of chocolate was $0.98 billion in 2021, which is 13% of the total market; it is forecasted to reach approximately 13.6% in 2022. It should be noted that different sources use different estimates, which is due to the methodology of calculation and inclusion of different sets of goods in the market.

Thus, according to Euromonitor International, the "Snack foods" category is also included in the market, but the "Chocolate nut spreads" and "Peanut butter" categories are deducted, which is why their estimate of 2021 results exceeds $10 billion. Due to these differences, Euromonitor Passport estimates the value of Vietnam's confectionary market at $6.1 billion in 2021 and $6.5 million in 2022. Simultaneously, the Ministry of Industry and Trade of Vietnam expected an increase to $7.84 million in 2022.

Nevertheless, despite these discrepancies in methods, external analysts note the double-digit growth rates of this market. The total volume of the chocolate products market is distinguished by a high ratio of income to volume compared to other categories, which indirectly indicates that it belongs

**Table 1** The volume and revenue of confectionery products by segment in the Vietnam market in 2014–2026

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| *Volume by segment in million kilograms* | | | | | | | | | |
| Chocolate confectionery | 74.3 | 75.8 | 76.5 | 78.0 | 80.1 | 82.9 | 85.3 | 88.1 | 91.3 |
| Ice cream | 51.7 | 70.3 | 85.3 | 99.3 | 107.4 | 114.5 | 123.9 | 132.0 | 140.5 |
| Preserved pastry goods and cakes | 98.8 | 108.9 | 118.1 | 128.1 | 142.2 | 158.9 | 174.6 | 189.4 | 203.6 |
| Sugar confectionery | 431.2 | 462.0 | 484.0 | 507.9 | 529.4 | 562.1 | 590.2 | 618.3 | 650.3 |
| Total | 656.0 | 717.1 | 763.9 | 813.3 | 859.1 | 918.4 | 974.0 | 1027.7 | 1085.7 |
| *Revenue by segment in $ million* | | | | | | | | | |
| Chocolate confectionery | 606 | 625 | 658 | 708 | 769 | 838 | 917 | 983 | 1061 |
| Ice cream | 161 | 222 | 281 | 345 | 395 | 443 | 510 | 564 | 626 |
| Preserved pastry goods and cakes | 440 | 490 | 554 | 635 | 745 | 876 | 1024 | 1154 | 1293 |
| Sugar confectionery | 2248 | 2435 | 2662 | 2949 | 3249 | 3632 | 4056 | 4414 | 4835 |
| Total | 3455 | 3772 | 4155 | 4637 | 5158 | 5790 | 6507 | 7116 | 7814 |

*Source*Compiled by the authors based on Statista market insights: confectionery and snacks Vietnam (Statista, 2023e)

to the products of consumption by the middle class. The latter is also indirectly supported by the relatively high average revenue per capita of around $10 ($11.76 in the confectionery segment, $5.75 in the ice cream segment, and $45 in the sugar segment as of 2021) (Statista, 2023c). The consumption in terms of volume per capita has been stagnating at 0.9 kg since 2018 and not showing any progress, unlike other parts of the confectionery market.

Evaluations of the imported share in the Vietnam confectionary market also vary. However, all sources do not deny the growth in confectionary trade operations. The most widely accepted confectionary structure can be constructed in the following way:

- $66 million: custom group 1704—Sugar confectionery (including white chocolate), not containing cocoa (Economy, 2023),
- $31 million: custom group 1806—Chocolate and other food preparations containing cocoa;
- $17.6 million: custom group 2105—Ice cream and other edible ice, whether or not containing cocoa;
- $185 million: custom group 1905—Bread, pastry, cakes, biscuits, and other bakers' wares, whether or not containing cocoa; communion wafers, empty cachets of a kind suitable for pharmaceutical use, sealing wafers, rice paper, and similar products.

As can be seen, the suitable import groups constitute over $299 million, which, however, needs to deduct the inapplicable parts like "bread" or "cachets," which many researchers handle mediocrely. According to the Russian Association of Confectionery Industry Enterprises, the total potential of imports to the Vietnamese market in 2020 will be 55 thousand tons and $185.6 million (Agroexport, 2022). However, the total chocolate confectionery imports evaluations also fluctuate between $31 million and $50 million due to differing sets of accountable products (Observatory of Economic Complexity (OEC), 2023). The top providers are still Malaysia, Indonesia, the USA, China, and India, with a large portion of Germany, South Korea, Japan, and Belgium in packaged chocolate confectionery.

This outline shows that, despite the average higher profitability of the chocolate segment of the market, the imported share ranges within 5%–10% of the total, depending on accounted product category set. According to Table 2, the dominant part of the brands in the market is occupied by either local brand production created by international food giants or retailer private labels. It is interesting to note that many international brands like M&M's, Snickers, and others are imported from China, where large manufacturing facilities of international brands are situated.

Besides the numerical constitution of the market, it is also important to note the qualitative description of chocolate consumption. As with neighboring Taiwan, Malaysia, and Thailand, Vietnam has little to no history of cacao consumption; the market practically did not exist until approximately 2005. Most of the population still clings to more traditional fruit-or rice-based sugar sweets and pastries; chocolate consumption was brought in by the developing westernized middle class in urban areas. As the market is

**Table 2** Major brands in Vietnam's chocolate confectionary market in 2016–2021

| Geography | Category | Brand name | Company name (GBO) |
|---|---|---|---|
| Vietnam | Chocolate confectionery | KitKat | Nestle SA |
| Vietnam | Chocolate confectionery | Guylian | Lotte group |
| Vietnam | Chocolate confectionery | M&M's | Mars Inc. |
| Vietnam | Chocolate confectionery | Bella | Bien Hoa confectionery corp (Bibica) |
| Vietnam | Chocolate confectionery | Snickers | Mars Inc. |
| Vietnam | Chocolate confectionery | Munz | Maestrani Schweizer Schokoladen AG |
| Vietnam | Chocolate confectionery | Toblerone | Mondelez international Inc. |
| Vietnam | Chocolate confectionery | Hershey's | Hershey Co |
| Vietnam | Chocolate confectionery | Dars | Morinaga & Co Ltd. |
| Vietnam | Chocolate confectionery | Ferrero Rocher | Ferrero & related parties |
| Vietnam | Chocolate confectionery | Belcholat | Belcholat chocolate JSC |
| Vietnam | Chocolate confectionery | Vochelle | Maestro Swiss Corp |
| Vietnam | Chocolate confectionery | Galaxy/Dove | Mars Inc. |
| Vietnam | Chocolate confectionery | Koko Choco | Mondelez international Inc. |
| Vietnam | Chocolate confectionery | Mars | Mars Inc. |

*Source*Composed by the authors based on brand shares in Euromonitor International Passport: Chocolate Confectionery in Vietnam (Euromonitor International Passport, 2023)

still largely in the development stage, many products contain little cocoa and much sugar, as well as milk powder or starch as a filler to prevent melting in Vietnam's hot and humid climate. The latter is a huge problem in the market because transportation and storage rely on air-conditioned premises, which limits the retail channels to supermarkets and stores. Another part of the chocolate confectionary only has chocolate as a small additive ingredient to the filler (e.g., Snickers, M&M's, or KitKat bars). The consumption of whole dark chocolate is rather low, although the recent healthy eating trends are slightly increasing the interest of the middle class towards it.

It is also important to note that the average price of a chocolate confectionary unit in Vietnam ranges within $9–$12 (Statista, 2023b). Given the average wage in urban areas of approximately 7–8 million Vietnamese dong (Statista, 2023a) (almost $300 as of 2022 exchange rate). Therefore, most potential consumers are limited to purchasing chocolates only once a month. Notably, the market has large consumption spikes during major holidays—Christmas, Valentine's Day, and Tet. Confectionary is the third most popular gift and the third largest spending article on Tet (Statista, 2021a), the other holidays are not far behind. Most confectionery consumers are within 25–44 years, with a slight overweight of female participants (Statista, 2021b).

To finalize the market description, it is worth noting that several local brands of Vietnam-originating chocolate are marked with various awards in chocolate contests around the globe—Marou, Belvie, Tbros, Alluvia, Baria, and Cacao Trace. However, the production of these brands is extremely low. It almost completely focuses on exports to the Netherlands and Belgium, not impacting the development of the local market.

On the Russian side of the picture, there are also some important issues that would require consideration upon investigating the potential of the Vietnam chocolate market.

First, the Russian confectionery industry, unlike most other food industries in the country, has had stable development for more than ten years. The annual increase in production volumes in these years ranged from 3.5% to 10%. The vast majority of large and medium-sized enterprises have modernized and expanded their production base. There is a process of concentration and consolidation of manufacturers. The 2022 Russian–Ukrainian conflict has had a downward impact on the markets (Federal State Statistics Service of the Russian Federation, 2023) because the confectionary industry showed a 2.1% decrease in 2022 compared to 2021. However, the drop was largely due to a notable average price increase, as the price per unit jumped from $9.58 in 2021 to $11.62 in 2022 from the Russian supplier side (Statista, 2023d).

As of the beginning of 2023, the Russian confectionery industry has several large enterprises—"United Confectioners," "Slad Co," and, most notably, groups of enterprises belonging to the Russian branches of multinational companies, including Nestle Russia, Mars, Mondelez Rus (ex-Kraft Foods Rus), and "Dirol Cadbury." Despite some niche companies leaving the Russian market (e.g., Lindt & Sprüngli AG) and others decreasing their direct advertising or logistic operations in the country (e.g., Mars and Mondelez), most companies are continuing their activities as before the Russian–Ukrainian conflict of 2022.

The process of concentration was most pronounced in the production of chocolate, candies, and chocolate bars. This segment has been developing at the fastest pace over the past decade. In general, this group of major players in the domestic confectionery market, producing mainly chocolate and other products containing chocolate, accounts for about 25% of the total volume of products produced in the country. The rest of the confectionery products are produced by a mass of medium and small enterprises. Thus, the confectionery industry remains highly fragmented, which is not surprising with such a vast territory of the country. There are many small enterprises of district and regional scale, which are difficult to account for in the segment of flour confectionery production that does not require large investment costs for specialized equipment. Most Russian confectionery exports are chocolate (53%), pastry products (34%), and, lastly, sugar (14%) (Association of Confectionery Industry Enterprises, 2022). Currently, it is estimated that the overall drop in 2022 exports of Russian confectionery would be 5.8% in monetary terms, which is among the best results in the Russian food industry.

It turns out that until 2022, during the current analysis period, the leaders in confectionery exports were mainly Nestle Rus, Mars, Mondelez Rus, United Confectionery Holding, and Ferrero Russia. According to the results of the first six months of 2021, Mars (Snickers, Mars, M&M's, Twix, Dove, Orbit, etc.) notes an increase in export volumes by about 5% compared to the same period last year. In the first half of 2021, Mondelez Rus (Alpen Gold, Milka, Picnic, Jubilee cookies, OREO, Barney Bear biscuit, etc.) increased the volume of chocolate exports by 4.6% in physical terms and 5.5% in monetary terms compared to the same period last year. The "United Confectioners" holding (Krasny Oktyabr, Babaevsky, and RotFront brands) sends its products to 45 countries; the export growth was 18% for the first six months. Traditionally, the main supply drivers are the CIS, Mongolia, China, Germany, and other countries. The additional factor that has boosted exports to Vietnam is the Vietnam–EAEU association agreement signed in 2015. It creates a favorable trade regime between EAEU companies and Vietnam, providing a list of goods for which customs duties will be gradually reduced over the next decade. It is an important detail that the 1806 "Cocoa products" and the 1704 "Sugar-based confectionary" product groups used to

have 12–30% and 15–25% customs duty ranges accordingly, with a planned decrease to 0% in five and ten years. As can be seen, 2020 was the first year of the 0% customs duty for these groups of goods; the growth of exports from Russia to Vietnam was postponed until 2021 due to COVID-19 restrictions.

## 4 Conclusion

Summing up the above influencing factors and features, the Vietnam chocolate confectionery market as a great destination for Russian exports is showing controversial results. The chocolate segment in Vietnam is dominated by the local production of international companies, and the share of imports, regardless of the calculation methods, is very small. The consumption patterns show that chocolate products are mostly consumed by a small portion of the population, predominantly the urban middle class. This is not only due to the concentration of highly paid consumers able to afford a rather expensive sweet product but also due to climate issues, limiting the potential of sales outside air-conditioned premises. Volume and revenue per capita statistics show that the chocolate market barely grows outside of natural growth due to population increase. The increase in revenue can most likely be attributed to food inflation rather than increased demand. All optimistic forecasts from international databases showing a gradual increase in the market in the future are likely to rely on mechanical extrapolation of Vietnam's urban middle class growth and inflation. These forecasts should be revised given the ongoing gradual deglobalization and disintegration of the world economy. With the declining economic well-being of the Vietnamese middle class, it is difficult to assume their desire to increase further their consumption of chocolate, which has virtually no tradition in Vietnam except as a common gift for holidays and an association with a Westernized lifestyle.

On the Russian side, despite some export success of purely national factories like "United Confectioners" and "Slad Co" holdings, a significant part of registered chocolate sales to Vietnam was done with the same international companies that hold the production of local products. It is possible that the decrease of customs duties within the Vietnam–EAEU agreement framework led to the redistribution of exports within multinational corporations due to logistic optimization. However, this topic needs further research. With all the above considerations, the perspective of Vietnam's chocolate confectionary market is far from the optimism displayed by the publications in Russian specialist media.

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# Transformation of the Positioning of Countries as a Result of the Transition of the World Economy from Globalization to Regionalization

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**Abstract**

*Purpose*: At the present stage of the development of the world economy, new, previously unexplored factors are emerging that influence the development of relations between countries in the global aspect. This state of affairs leads to the formation of new tasks for assessing the positioning of countries in the world economy. The purpose of this article is to study the transformation of the positioning of countries under the influence of the factor of the transition of the world economy from globalization to regionalization. *Methodology*: To achieve this purpose, a number of theories of the globalization of the world economy have been considered, factors of influence on the modern process of deglobalization have been identified, processes of transformation of the positioning of countries and regions have been determined, changes in the dynamics of the globalization index and GDP growth rates of individual countries have been assessed. *Results*: As a result of the study, it has been determined that at the present stage of the development of world trade, characterized by the transition from globalization to regionalization, there is a reduced interdependence of national economies, which leads to a change in the positioning of countries and regions. *Originality/Value*: The article concludes that the transformation of the positioning of countries as a result of the transition of the world economy from globalization to regionalization is accompanied by the formation of various models and concepts of new positioning, which in the future will initiate the development of new theories of the evolution of the world economic system.

**Keywords**

Globalization • Regionalization • Country positioning • Globalization index • Transformation of the positioning

**JEL Classifications**

R01 • F22 • F63 • J15 • J61 • O15

## 1 Introduction

The world economy functioned in the context of the development of multidimensional globalization until the beginning of the COVID-19 pandemic. The acceleration of globalization was actively influenced by transnational corporations that were present in various national markets. TNCs provided more than half of the world's industrial production, thereby affecting the processes of interconnection and interdependence of national economies.

Technological progress allowed to form the specialization of countries. Globalization facilitated the movement of flows of capital, resources, people, technologies, thereby forming a certain positioning of each country in the world market. For example, the positioning of the Russian Federation, first of all, was formed as a raw state. Positioning in banking services was primarily related to Switzerland; positioning in the field of electronics was associated with countries such as Taiwan (PRC), China, Japan; in the automotive industry—with Japan, the USA, Germany, etc.

Taking a certain position in the world economy allowed the country, on the one hand, to gain competitive advantages in world trade in a specific area, on the other hand, it created dependence on exporters in various, including critical areas.

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The world economy was towards the formation of a single market for all countries, which made it possible to ensure the international exchange of goods and services, internationalization of national industries, obtaining the effect of the scale of international labor migration, increasing the pace of internationalization of capital and technology exchange, the formation of global infrastructure, and the movement towards sustainable development of the maximum number of countries involved in the world market.

Currently, the world economy is at a new stage of its development, undergoing a transformation from globalization to regionalization, providing a high level of economic security of national economies, which determines the relevance of the chosen topic. As a result of this process, there is also an active transformation of the positioning of countries on the world stage.

The purpose of this article is to study the transformation of the positioning of countries resulting from the process of deglobalization of the world economy.

We believe that the global interconnection of national economies is weakening, regional interconnections are strengthening, which in turn affects the positioning of countries. To test this hypothesis, the authors have analyzed publicly available documents, including statistical data on changes in macroeconomic indicators of leading countries in various regions of the world.

In general, it has been proved that at the present stage of world trade, the interconnection of national economies is beginning to weaken in the context of the transition from globalization to regionalization, which leads to a change in the positioning of countries and regions, and in the future will result in the strengthening or declining positions of countries on the world stage.

## 2 Methodology

Domestic and foreign economists have been paying great attention to the issues of globalization for more than fifty years. There are scientific debates, on the one hand, about the very concept of globalization and its impact on the world economy, and on the other, about its further development. Globalization, which implies the connection of the world, is full of contradictions and heterogeneities (Perelman, 2015).

The appearance of the term "globalization" is attributed to Harvard Business School professor Theodore Levitt, whose article "Globalization of Markets" was published in the Harvard Business Review in 1983 (Levitt, 1983). T. Levitt, without a doubt, made a great contribution to the popularization of the term. In fact, it was determined that globalization begins with the economic sphere. However, there had been articles devoted to the process of globalization even before T. Levitt's publications. So, back in 1944, the terms "globalize" and "globalism" already appeared in an article by American authors (Reiser & Davies, 1944). In the 90 s, K. Ohmae, describing the process of globalization, came to the conclusion that states were ceding the leading role to "global firms" (Ohmae, 1990), thus continuing to share T. Levitt's views in his works.

The vision of globalization was also reflected in the works of the British scientist Ronald Robertson (Featherstone et al., 1996). The issues of globalization were also discussed in the works of such Russian scientists as Baburina (2009); Chistyakova (2015); Drobot (2008); Inozemtsev (2008); Remnev (2010); Tsaregorodtsev and Muradov (2007).

Over the last 10–15 years, there has been a clear trend of strengthening the regionalization process in the world. S. O'Neil writes that modern globalization would be more correctly called regionalization. It is regionalization that "is the economic history of our time" (O'Neil, 2022). In his book, the economist also named losers from globalization—Latin America, Africa, India, South Asia, and the Middle East, explaining the slow growth of the economies by the fact that each region of these countries accounts less than a fifth part of total trade.

The works of such scientists as Boyko (2022); Kozlov (2018); Simon (2007), are devoted to the processes of regionalization.

In 2002, a research group of KOF Swiss Economic Institute, with the participation of specialists from the Swiss Federal Institute of Technology, presented the Index of countries' level of globalization (KOF Globalization Index) (Dreher, 2006). This rating measures 3 main areas of globalization using different weighting factors: economic (36%), political (25%), and social (39%). In total, 24 indicators are analyzed. S. Gygli, F. Haelg, N. Potrafke, and J. E. Sturm proposed to increase the number of variables of the globalization index from 24 to 43 (Gygli et al., 2019).

## 3 Results

Analyzing the dynamics of the globalization process based on the KOF index, it is possible to identify a number of trends. For example, in the 1990s, the buoyant growth of the pace of globalization began, caused primarily by the end of the cold war and the rapid involvement of Eastern European countries in the processes of international economic, social, and political integration. At this stage of development, the world economy is characterized by increasing interdependence. There was also a high rate of growth in the level of globalization in the next decade, which was associated with the effect on the world economy from China's entry into WTO in 2001. However, since 2010, there has been a transformation of the content of the globalization process

and a slowdown in the growth of globalization with a gradual transition to the stagnation stage of integration processes caused by a number of factors. Such factors include the consequences of the global financial crisis of 2008, the policy of the EU countries to limit cultural and economic influence from China, the "trade war" between the United States and China. In addition, there has been a shift in the management of global economic and social processes from a focus on transnational corporations towards the state interests of individual countries with a regional level of organization.

The evolution of the economic structure of the world economy has shaped the specialization of countries and regions of the world, including their positioning on the world stage. The economic structure itself is determined by three sectors of the economy: the primary sector (non-processed products), the secondary sector (manufacturing industry), and the tertiary sector (service industry), whose roles have constantly changed throughout the history of the development of world trade (Fig. 1). In the post-industrial period, the leading role has been playing the service sector, and industry and agriculture have been in second and third places, respectively.

It is also possible to determine the positioning of regions according to their economic development. Thus, Latin America is characterized as an agrarian region with high potential. Africa is an agricultural region with low potential. The positioning of Southwest Asia and East Asia—the oil region and the high-tech region, respectively. Southeast Asia is associated primarily with authentic tourism. Central Asia is developing countries, Europe is developed countries, and North America is the leaders of the world community.

The current stage of the development of the world economy displays a high degree of unpredictability and the strengthening of the role of the state, which leads to a tightening of the conditions for the positioning of countries in the international arena. This state of affairs results in a revision of views on the processes of globalization by individual countries, based on the principles of strategic improvement of the competitiveness of national economies in world markets.

The trends that have emerged in the US economy towards the nationalization of science, technology, the production base, and the creation of closed scientific and industrial ecosystems indicate the strengthening of the role of the state to achieve strategic competitiveness in global markets.

The first factor, which has influenced the beginning of the process of deglobalization on the world market, was the trade war that began in early 2018 during the presidency of D. Trump, who accused the authorities and companies from the People's Republic of China of illegal use and plagiarism of intellectual property from the United States.

The COVID-19 pandemic was the second factor that influenced the decline in the level of globalization, as it became obvious to many governments that they were economically dependent on imports of goods and services, which meant a high level of threat to national economic security. The most important resources for the world economy (capital, people, goods, and services) have become limited in movement: from a high level of restriction related to people to a low level related to financial resources. Consequently, the volume of world trade decreased by 17.6% in May 2020 compared to the same period last year. However, by August, the reduction in annual terms was 4.4%.

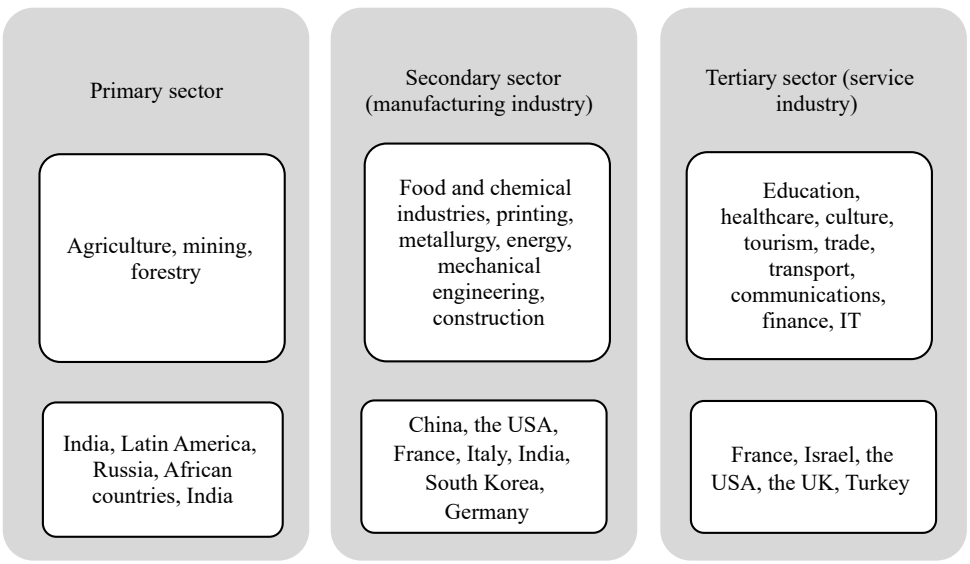


**Fig. 1** Positioning of countries according to the economic structure of the world economy. *Source* Developed and compiled by the authors

**Table 1** Globalization Index and real GDP growth rate (%)

| Country | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| *China* | | | | | |
| GDP growth rate, % | 6.6 | 5.9 | 2.3 | 8.1 | 3 |
| Globalization Index | 61.23 | 65.08 | 64.28 | 64.57 | 65 |
| *India* | | | | | |
| GDP growth rate, % | 7.0 | 4.2 | −8.0 | 8.7 | 6.8 |
| Globalization Index | 56.77 | 62.1 | 62.23 | 62.48 | 63 |
| *Japan* | | | | | |
| GDP growth rate, % | 6.2 | 6.0 | −9.6 | 1.7 | 1.1 |
| Globalization Index | 77.30 | 78.59 | 78.40 | 78.45 | 75 |
| *Turkey* | | | | | |
| GDP growth rate, % | 2.6 | 0.9 | 1.8 | 11.4 | 5.6 |
| Globalization Index | 70.87 | 71.58 | 70.57 | 70.64 | 71 |
| *USA* | | | | | |
| GDP growth rate, % | 2.9 | 2.2 | −3.5 | 5.9 | 2.1 |
| Globalization Index | 79.95 | 82.41 | 82.28 | 82.28 | 81 |
| *Great Britain* | | | | | |
| GDP growth rate, % | 1.4 | 1.5 | −9.8 | 7.5 | 4 |
| Globalization Index | 87.23 | 89.84 | 89.39 | 89.39 | 89 |
| *Germany* | | | | | |
| GDP growth rate, % | 1.4 | 0.6 | −4.9 | 2.6 | 1.8 |
| Globalization Index | 86.89 | 88.6 | 88.83 | 88.73 | 88 |
| *France* | | | | | |
| GDP growth rate, % | 1.7 | 1.5 | −8.1 | 6,8 | 2.6 |
| Globalization Index | 87.34 | 87.25 | 87.69 | 87.63 | 87 |

*Source* Developed and compiled by the authors based on data from the IMF and KOF Swiss Economic Institute (Real GPR Growth, 2023)

The container ship "Ever Given," which stuck in the Suez Canal in March 2021, became the third factor influencing the processes of transition of the world economy from globalization to regionalization. The accident blocked about 10–12% of the volume of all world trade.

The geopolitical crisis in Ukraine is the fourth factor that has had a significant impact on accelerating the processes of deglobalization. Unprecedented sanctions pressure on the Russian economy has had a high impact on Russia's integration into the world economy. However, taking into account the fact that Russia is a significant subject of international relations, it is important to note that such a sanctions policy also leads to a negative effect for other countries.

Comparing the GDP growth rates and the globalization index from 2018 to 2021, we can conclude that it is difficult to determine the relationship between them. Despite China's insufficiently high level of globalization (64.57 in 2021), GDP growth rates are significant, including in the crisis year 2020 and in the following 2021, which are 2.3% and 2.8%, respectively. At the same time, it is worth noting that in the crisis year 2020, countries with a high level of globalization had negative GDP growth rates: USA–3.5%, Great Britain–9.8%, Germany–4.9%, and France–8.1%. Thus, the most affected countries during the period of the negative effects of COVID-19 were countries with a high level of involvement in the globalization of the world economy (Table 1).

Using the example of China, it is possible to analyze whether there is a relationship between the GDP growth rate and the globalization of the economy. To do this, we use the formulas of correlation and regression analysis, which allows us to determine the closeness and direction of the relationship:

$$y_x = a_0 + a_1 x \tag{1}$$

$$a_0 = \frac{\sum y \sum x^2 - \sum yx \sum x}{n \sum x^2 - \sum x \sum x} \tag{2}$$

$$a_1 = \frac{n \sum yx - \sum x \sum y}{n \sum x^2 - \sum x \sum x} \tag{3}$$

We also use a linear correlation coefficient, which can take any values from −1 to +1. The closer the modulus of the coefficient value is to 1, the closer the relationship

**Table 2** Parameters of correlation and regression analysis of the relationship between the GDP growth rate and China's globalization index (2018–2022)

| Globalization index ($x$) | GDP growth rate, % ($y$) | $xy$ | $x^2$ | $y^2$ |
|---|---|---|---|---|
| 61.23 | 6.6 | 404.118 | 3749.113 | 43.56 |
| 65.08 | 5.9 | 383.972 | 4235.406 | 34.81 |
| 64.28 | 2.3 | 147.844 | 4131.918 | 5.29 |
| 64.57 | 8.1 | 523.017 | 4169.285 | 65.61 |
| 65 | 3 | 195 | 4225 | 9 |
| Total 320.16 | 25.9 | 1653.951 | 20,510.72 | 158.27 |

*Source* Developed and compiled by the authors

between the features. In this case, the "+" sign means a direct relationship, and the "−" sign means an inverse relationship (Table 2):

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{\left(\sum x\right)^2}{n}\right) \times \left(\sum y - \frac{\left(\sum y\right)^2}{n}\right)}} \quad (4)$$

$$a_0 = 33.19$$
$$a_1 = -0.44$$
$$y_x = 33.19 - 0,44x$$
$$r = -0.285, \quad r^2 = 0.08(8\%)$$

The GDP growth rate decreases by 0.44% with an increase in the globalization index by one unit. The correlation coefficient has a value of −0.285, which indicates a weak relationship between the globalization index and the GDP growth rate; moreover, this relationship is inverse. At the same time, 8% of the deviations are explained by the 92% globalization index and are explained by the influence of other factors.

Given the influence of the four factors described above, globalization has begun its transformation, and its significant transition to regionalization is expected in the future. This, in turn, leads to the transformation of the positioning of countries and regions. The factors listed above have actively influenced the beginning of the transfer of production of transnational companies closer to the destination markets, which will cause an increase in the share of intraregional flows. General cultural and political similarities, which are often combined with geographical borders, also influence the strengthening of regionalization, and the presence of a leading country in the region makes these processes quite active, accelerating the transformation of the world economy, and the positioning of countries. Transnational companies are also involved in this process. They analyze the self-sufficiency of the region and the presence of a high level of concentration of finance, production, and consumption, and on the basis of these data expand their presence in it.

For example, China's positioning as "a country of cheap labor and cheap production" and "a country that is a world's factory" is transformed. At the current stage of the development of the world economy, the PRC has already overcome the peak of the industrial revolution and is one of the major participants in the world market, so it cannot occupy a leading position only in certain niche segments. The implementation of the "One Belt, One Road" model will allow the country to gain leadership in the world market, strengthen this position, as well as form a large trade and economic space.

Turkey is becoming the leader of the "Eastern Mediterranean" region, transforming its positioning from "a permanent applicant to the EU" to "a country that is an active participant in regulating relations between the West and the East." Due to the global geopolitical situation, exports of goods from Turkey in 2022 reached a historic high of 185 billion US dollars, and compared to 2021 increased by 12.9%.

The South Asian region is transformed from positioning as the "Poorest region of Asia" into a "Pole of Power" led by India, which is becoming an active participant in regionalization.

## 4 Conclusions

Until 2018, the world's leading economists had argued that countries with a globalization index tending to 100 had relatively high GDP growth rates. It was the developed countries that demonstrated a high rate of GDP growth. However, this has begun to change radically in 2018. The influence of four factors has led to an active transition from the globalization of the world economy to its regionalization. Globalization has ceased to be the driving force behind the high GDP growth rates of countries, as it was at its initial stage of development, which ensured the economic prosperity of Western countries at that time.

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# The Impact of Parallel Imports on the Activities of Russian Marketplaces

Diana O. Yampolskaya, Daria S. Poberezhnaya, and Alice D. Krivomlin

**Abstract**

The phenomenon of parallel imports is a logical response of the economy to the changes taking place in it: a reduction in goods and supplies, a rise in demand, and an increase in prices. The current situation in the Russian market has led to changes in the legal sphere, in the activities of Russian sellers, and in the life of the consumers. There has been a massive departure of a large number of brands familiar to consumers from the Russian market, which has caused a shift in consumer demand in many segments of goods towards e-commerce. Marketplaces have taken a special place in the retail sector. In addition, parallel imports, which were officially authorized by the government of the Russian Federation in the spring of 2022, gave a new impetus to the development of electronic platforms. Now this retail segment is an oligopoly with clear, dominant leaders. Parallel imports also affected the level of competition of retail platforms and revealed the need for positioning marketplaces and adjusting their strategy. The study of the phenomenon of parallel imports on Russian marketplaces is the key purpose of this article. The main method of research is content analysis of open sources of information: official websites and other open sources of information. The result of the study is the formation of parallel import directions on Russian marketplaces.

**Keywords**

Marketplaces • Parallel import • Retail • Strategy of marketplaces • Positioning

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## 1 Introduction

Modern marketplaces are a type of procurement trade, which was previously inherent in wholesalers. Since the announcement of comprehensive sanctions and a significant drop in sales in mid-2022, marketplaces have often been the only way to maintain the assortment at the same level of consumption. A significant part of the trade has moved to this channel of distribution (by the end of 2022, the e-commerce market in the FMCG sector grew by 44% compared to 2021 (Rossii, 2021)). In December 2021 (on the eve of the events of the special military operation-SVO) in one of the interviews, Maxim Reshetnikov, head of the Ministry of Economic Development, noted that the work of marketplaces solves two problems: the development of non-resource non-energy exports and the development of small- and medium-sized enterprises (SMEs), since a significant proportion of suppliers are SMEs. In addition, regional business is developing and new sales markets are emerging (Llc, 2023). Thus, even before the start of the special military operation, the government paid attention to this type of trade in order to create favorable conditions for business. Due to the change in the conditions of export–import operations, the importance of the work of small- and medium-sized businesses, which sanctions do not reach, has begun to increase. After February 2022, small- and medium-sized businesses have received new opportunities to implement parallel import. Banks, which have not fallen under sanctions, have largely focused on servicing participants of foreign economic activity (NielsenIQ announced a drop in consumer demand in Russia below the level of 2014, 2023). Thus, there is an active formation of infrastructure for the development of parallel import.



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Parallel import is not a new phenomenon for modern Russia. In the 90 s of the last century, it was actively developed in our country, when commercial channels of commodity distribution were just organized. And only in 2002, it was stopped in order to attract foreign investment and the world's leading brands. After the mass departure of foreign companies from the Russian market in 2022, it was decided to return to the practice of parallel import. The situation on the Russian market required actions to prevent a shortage of goods and empty shelves (Kovaleva & Tulaeva, 2023). The way to deal with these problems was parallel import, which stimulated the development of Russian business that did not fall under sanctions.

Parallel import has a number of undoubted advantages. Firstly, it helps to maintain and expand the range of trading platforms, and secondly, it makes it possible to carry out a more flexible pricing policy. The total sales of goods on Russian marketplaces by the end of the second half of 2022, according to Data Insight estimates, will amount to 500 billion rubles. 80% of the annual market growth in terms of the number of orders is provided by five marketplaces: AliExpress, Ozon, Wildberries, SberMegaMarket, and YandexMarket. Wildberries and Ozon are the leaders in online orders—their joint share was 68%. The growth rate for a very problematic year was 8%. There is an active revenue growth among sellers working on these marketplaces. The most widely represented category on marketplaces is home and garden goods: from 32 to 37% of sellers, depending on the platform (Goods imported by parallel import may become cheaper, 2022).

In the short-term (tactical) aspect, there are more advantages than negative aspects in the use of parallel import. At the moment, it is difficult to determine what the consequences of parallel imports will be for the Russian market. In strategic terms, despite the fact that the government makes strong statements on the development of domestic production, international cooperation cannot be canceled. Moreover, the role of the brand in the consumer market is of great importance (Yampolskaya & Poberezhnaya, 2022).

According to some researchers, the range of criteria for evaluating the effectiveness of marketplaces should take into account not only the breadth of the assortment, but also the number of sellers on the platform. It is required to analyze economic cooperation with friendly countries of the post-Soviet space, as well as China and Turkey for the development of parallel import (NielsenIQ announced a drop in consumer demand in Russia below the level of 2014, 2023). The question arises of how to evaluate the effectiveness of modern marketplaces and determine what changes in their activities occur under the influence of parallel import.

## 2 Methodology

The method of content analysis was taken as the basis for the study of the issues of the activities of marketplaces as the main elements of maintaining consumer demand in modern conditions. This method seems to be the most acceptable, since traditional mathematical and statistical methods do not give accurate results due to the high volatility of the initial data in a rapidly changing political and economic environment. As a result of the content analysis, marketing metrics were obtained, according to which the objects of research were analyzed using the Osgood scale.

## 3 Results

According to the resolution of the Constitutional Court of 13.12.2018 No. 8-P, parallel import is the import of products regardless of the consent of the manufacturer of the product or its official distributor (The Resolution of the Constitutional Court of the Russian Federation, 2023). If the ordinary import involves the presence of three main participants: the manufacturer of the goods, the distributor, and the buyer, then with parallel import, another participant is added—the distributor of another country. For example, in order to purchase, for example, a Sony PlayStation (included in the list of goods for parallel import, adopted by the Ministry of Industry and Trade) with the help of parallel import, you need to go through certain steps:

1. Sony Interactive Entertainment produces Sony PlayStation.
2. The distributor of another country (for example, Kazakhstan) officially purchases the product from Sony Interactive Entertainment.
3. A distributor in Russia purchases goods from an "intermediate" distributor.
4. Consumers buy Sony PlayStation in Russia.

The scheme is simple and, at first glance, very clear. However, it is advisable to consider in more detail the parallel import by the key participants: the seller and the buyer. Table 1 shows the risks and benefits of parallel import for the seller.

In the current situation, the number of companies selling goods using parallel imports has increased by only 20% in three months (Molchanova, 2022), which indicates a low level of competition for sellers. In addition, the sphere itself and high demand implies a good margin. From a legal perspective, the most obvious and main drawback of parallel import is that suppliers importing goods in a "gray" way are accused of counterfeiting. This problem is not fully

**Table 1** Risks and benefits of parallel import

| Factor | Seller | Buyer |
|---|---|---|
| Risks | 1. Parallel import has no legal force<br>2. Parallel imports are often mistaken for counterfeit<br>3. It may fall under Articles 1359 and 1487 of the Civil Code of the Russian Federation | 1. Purchase of counterfeit goods<br>2. Lack of service and guarantees<br>3. Increased cost |
| Support | 1. Decree of the Government of the Russian Federation No. 506 dated 29.03.2022<br>2. Order of the ministry of industry and trade dated 19.04.2022 No. 1532<br>3. List of parallel import goods from the ministry of industry and trade | 1. Import duties have been abolished on some goods<br>2. The marketplace itself creates conditions for partners |
| Benefit | 1. Relatively low level of competition<br>2. Financial benefit | 1. Reducing the deficit<br>2. Regulation of price growth |

*Source* Compiled by the authors based on (Molchanova, 2022; The Decree of the Government of the Russian Federation 2022; The Law of the Russian Federation, 2023; The Law of the Russian Federation 2023; The Resolution of the Constitutional Court of the Russian Federation 2023)

regulated, which is why companies have difficulties. There are two articles in the current Civil Code that regulates import:

1. The Civil Code of the Russian Federation, Article 1359. Actions that are not a violation of the exclusive right to an invention, utility model, or industrial design (The Law of the Russian Federation 2023).
2. The Civil Code of the Russian Federation, Article 1487. Exhaustion of the exclusive right to a trademark (The Law of the Russian Federation 2023).

However, it is worth noting that as a support for sellers of parallel import, the government has adopted several important documents concerning parallel import in general and Articles 1359 and 1487 of the Civil Code of the Russian Federation in particular:

3. Постановление Правительства РФ от 29.03.2022 N 506 (The Decree of the Government of the Russian Federation, 2022).
4. Order of the Ministry of Industry and Trade of Russia dated 19.04.2022 N 1532 (as amended on 21.10.2022). List of goods allowed for parallel import (The Order of the Ministry of Industry & Trade of the Russian Federation, 2023).

The seller, by purchasing and distributing goods of parallel import from the list, does not violate the Civil Code during the period of validity of the order and resolution. From the customer's point of view, the main risk associated with the purchase of goods of parallel import is counterfeit. Nevertheless, the consumer will face two serious problems even with full confidence in the originality of the product: lack of service and overpricing.

In order to reduce the risk of forgery, marketplaces have been officially allowed parallel import on websites, but subject to certain conditions. Duties have been abolished on the following goods to reduce their cost: components for electronics; building materials; fertilizers; pharmaceutical substances; fabrics and yarn; packaging; paper and cardboard (The Decision of the Council of the Eurasian Economic Commission, 2022).

It should also be noted that parallel import gives the buyer a number of direct advantages. The most obvious plus is the availability of the product itself, which implies a less obvious, but really important positive effect—a reduction in prices. Due to the fact that the product is present on the shelves, the buzz around the product is reduced and the final price, which was increased due to the excessive demand, is reduced as well.

At the beginning of 2022, representatives of Western business began to actively leave the Russian market. By the beginning of 2023, almost all significant Western brands had left the Russian market or suspended their activities. Figure 1 shows data on the actions of major foreign companies in the Russian market.

The most affected industries are food, beverages, restaurant business, alcoholic beverages, high-tech goods, clothing, shoes, cosmetics, and household chemicals. Thus, significant segments of the consumer market have been freed up.

*Segment 1*. Food and drinks, restaurant business. The revenue of the global food market amounted to $8.66 trillion (Global food market: what will change in 5 years, 2022). Russian production of soft drinks in 2022 amounted to 19.8 billion liters, which is 7.3% lower than in 2021 Rosstat recorded the growth of the Russian market of "food away from home" in 2022 by 4.7% compared to 2021—up to 2.28 trillion rubles (turnover of restaurants, cafes, and bars) (The restaurant market of Russia, 2022).

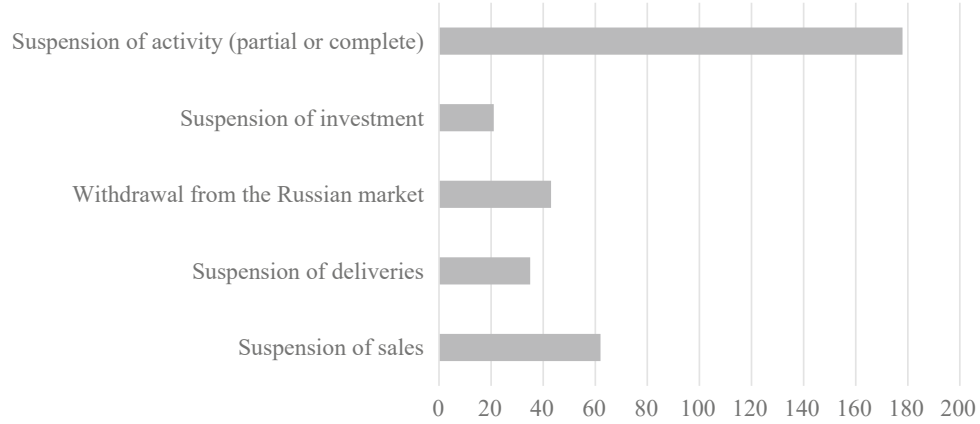


**Fig. 1** Decisions of foreign companies regarding doing business in Russia, 2023. *Source* Developed and compiled by the authors based on (Online market of clothes and shoes for 2021: general figures, audience portrait, competition and interaction of players, 2022; Overview of the detergent market of the Russian Federation, 2022; Romir: How Russians relate to ecosystems, 2022; Russian alcohol market players, 2023; Russian marketplaces: Sellers in, 2022; The leaders of the food industry in Russia demonstrated dynamic revenue growth at the end of last year, 2022)

(a) The leaders of the "food away from home" segment were (Rating of catering chains: McDonalds is the most noticeable than everyone & KFC is the most reliable, 2021):
   1. McDonald's (has left the market).
   2. KFC—has reported on the sale of Russian assets. At the moment, the brand Rostic's is registered (as well as a number of others).
   3. Burger King—has suspended the activities of some restaurants.

(b) The leaders of the food segment were (The leaders of the food industry in Russia demonstrated dynamic revenue growth at the end of last year, 2022):
   1. Danone—Representatives of the company have announced plans to sell assets.
   2. Mars (brands Milky Way, Snickers, Twix, etc.)—has suspended deliveries, investment, and the release of promotional products.
   3. Nestle—has suspended investments, including Kit-Kat and Nesquik brands.

(c) The leaders in the drinks segment were (Beverage production: the largest companies, 2023):
   1. Coca-Cola (Fanta, Sprite, Dobry, etc.),—has announced plans to completely leave the Russian market.
   2. PepsiCo (Pepsi, Mirinda, 7Up, Vesely Molochnik, Domik B derevne, etc.)—has suspended sales.

*Segment 2*. Alcoholic beverages. Alcohol production in Russia in 2022 increased by 2.24% compared to the previous year and exceeded $ 1 billion. The leaders of this segment were (Russian alcohol market players, 2023):

1. Anheuser-Busch InBev (Bud, Corona, Stella Artois, Hoegaarden)—has decided to leave the Russian market and sell its joint ventures in Russia.
2. Smirnoff—has suspended sales.
3. Heineken—has suspended production and sales.

*Segment 3*. Clothes, shoes, etc. Despite the high figures of 2020, the volume of the fashion segment of the Russian e-commerce market increased by 37.9% and amounted to 648.7 billion rubles compared to 470.4 billion in 2020 (Online market of clothes and shoes for 2021: general figures, audience portrait, competition and interaction of players, 2022). The leaders of this segment were:

1. Adidas—has suspended sales and partnership with the Russian Football Union.
2. H&M—has announced plans to completely leave the Russian market and has begun the sale of the remains of the goods.
3. Inditex (Zara Home, Massimo Dutti, Bershka, Oysho, Pull & Bear, Stradivarius, Uterqüe)—sale of assets.

*Segment 4*. High-tech products. The entire market of household appliances and electronics by the end of 2021 grew by 18%, approaching 2.6 trillion rubles (Household appliances and electronics (Russian market) 2023). The leaders of this segment were:

1. LG Electronics—suspension of supplies to Russia.
2. Apple—has suspended the sale of products (ApplePay).
3. Bosch—is selling factories in St. Petersburg.

*Segment 5.* Cosmetics, household chemicals. The volume of the household chemicals market in Russia is estimated at 300 billion rubles (Overview of the detergent market of the Russian Federation, 2022).

(a) The leaders of this segment were:
1. Procter & Gamble—has suspended deliveries, only basic hygiene products will remain on sale.
2. Henkel (Losk, Taft, Ceresit, Fa, Vernel, Bref, Persil, ΠPemolux, Laska, Syoss, Glue Moment, and others)—has announced a complete departure from the Russian market.
3. Dove—has suspended deliveries.

The market volume of cosmetics and personal care products in Russia in 2021 amounted to 712.9 billion rubles (Market analysis of cosmetics, perfumes & personal care products in Russia, 2022).

(b) The leaders of this segment were:
1. L'Oreal (Maybelline and other brands)—has suspended its operations.
2. Estee Lauder—has suspended its operations.
3. Essity (Zewa, Libresse, Libero)—is planning to leave the Russian market.

Based on the information provided above, it can be concluded that almost all strong brands that had a significant impact on consumers have left the market.

Since mid-2022, marketplaces have been actively engaged in parallel import. The first sites that publicly announced their intentions to support parallel import were Ozon, Wildberries, and Yandex. Market. First of all, household appliances and electronics, cosmetics, perfumes, and clothing are imported into the country through parallel import, because only 10–30% of goods in these categories are produced in Russia.

To solve one of the main problems of parallel imports—the fear of buying counterfeit products—the government turned to leading marketplaces with a request to introduce measures to track counterfeit goods. Such measures (at least in words) are being taken. Suppliers must have the appropriate certificates.

The second issue is pricing. In order to import goods into the country using parallel import, it is necessary to create new logistics chains with a larger number of links. Experts note that goods can rise in price by 5–50% depending on the category and logistics. Since the main players in the e-commerce market are marketplaces, a significant part of consumers purchase parallel import goods there. Statistics show that the number of unique users per month at leading marketplaces is a significant number: Yandex. Market −16.86 million, Ozon −11.78 million, Wildberries −11.25 million, AliExpress −7.21 million.

Competition continues to grow in the e-commerce segment, which forces each seller to look for their position, which is quite difficult in the circumstances. Figure 2 shows the profiles of the leading marketplaces, which were compiled as a result of a survey of buyers.

Ozon, Wildberries, and Yandex Market have a very similar position in the eyes of buyers. These marketplaces have a common strength—convenient and fast delivery, although the position of Wildberries has somewhat deteriorated. On this indicator, AliExpress lags considerably behind. However, it has a wider range and is perceived cheaper. One thing unites all marketplaces—this is the low quality of goods. The scores range from 1 to 2 points. A clear outsider in this group is the SberMega Market. It lags behind in all parameters and has no competitive advantages over competitors yet. In addition to the parameters of consumer choice, other indicators of marketplaces can be noted, which are presented in Table 2. The popularity of marketplaces and the confidence index are almost the same, with a slight fluctuation.

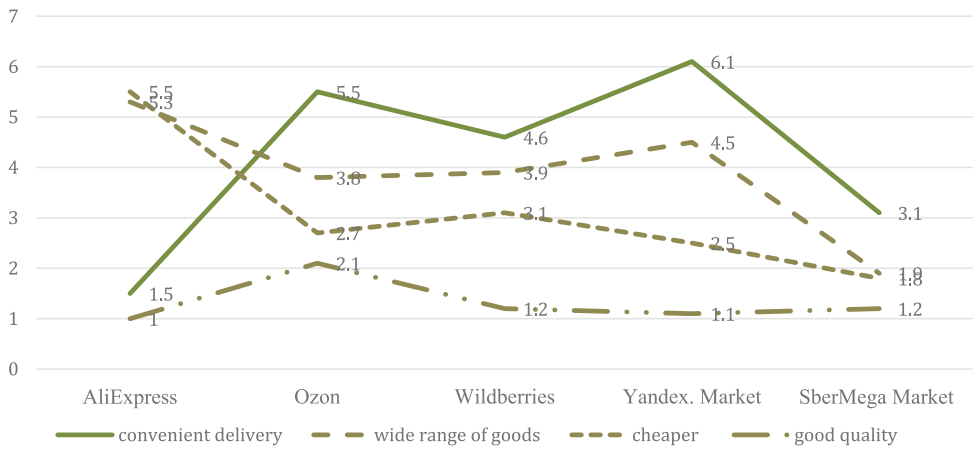


**Fig. 2** Profiles of leading marketplaces (positioning). *Source* Compiled by the authors based on (Purchases of Russians on marketplaces, 2021)

**Table 2** Indicators for assessing leading marketplaces

| Marketplaces / Criteria | Yandex | Sber | Ozon | Wildberries |
|---|---|---|---|---|
| Ecosystem popularity index (%) | 97 | 98 | 96 | 94 |
| Ecosystem confidence index | 90 | 86 | 92 | 87 |
| Profitability of sales (%) | −114.6 | −450.3 | 26.6 | 14.2 |
| Revenue (million rubles) | 35,288 | 2,281,555 | 17,695,919 | 224,940,746 |
| Number of app installs on the AppStore (February 2021–January 2022) | 2,589,908 | 1,624,067 | 4,767,8444 | 5,149,367 |
| Number of app installs on Google Play (February 2021–January 2022) | 6,708,459 | 3,477,162 | 11,152,488 | 10,915,620 |

*Source* Developed and compiled by the authors based on (Household appliances and electronics (Russian market), 2023; MARKETPLACE LLC, 2023; Points of growth: international settlements & import substitution, 2023; Romir: how Russians relate to ecosystems, 2022; Wildberries LLC: accounting statements, 2023)

## 4 Conclusion

Modern consumption trends were formed under the domination of Western brands. Now consumers have to change their behavior. This refers not only to their commitment to certain brands, but also to changing consumer habits when choosing products due to the desire to save money. According to NielsenIQ research: 47% of consumers are looking for local brands, 36% are loyal to familiar brands, and 17% seek to find a replacement for a foreign brand among other foreign manufacturers (NielsenIQ announced a drop in consumer demand in Russia below the level of 2014, 2023). Thus, there is a transformation of the range products, which is formed taking into account the possibilities of parallel import.

The assessment of the impact of parallel import on the activities of marketplaces is determined in two directions: changes in the assortment and the growth of the number of sellers. These two directions form the strategy of modern marketplaces.

Direction 1. The work with a cheaper assortment, which involves maintaining as large coverage of the target audience as possible and attracting even more sellers. However, this strategy leads to a reduction in the effective margin. In order to maintain the margin level, it is necessary to influence suppliers and sellers in order to prevent price increases. But this is not always possible, since sellers who do not fall under sanctions either do not want or cannot keep prices at the same level (e.g., small- and medium-sized businesses).

Direction 2. Marketplaces are forced to switch to strategies for high-quality growth. This is related to the task to increase margins. This way involves increasing the value of the product to the consumer at the expense of the brand. And this is the main problem of marketplaces—the complexity of forming an assortment in expensive and cheap niches at once. The solution to this problem is seen in the development of new, national brands.

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# Ways to Improve the Innovative Development of Kyrgyz Agriculture

Murat Zh. Abdiev, Kubanych K. Toktorov, Oyonbek E. Abdrakhmanov, Umetbek N. Momunov, and Kutpidin A. Ergeshov

**Abstract**

The research aims to theoretically and methodologically substantiate innovative development of agriculture in the Kyrgyz Republic (KR) and develop practical recommendations. Drawing from the analysis and evaluation of the innovative development landscape in the agricultural sector of the Kyrgyz Republic, the authors identified problems in this industry and determined the degree of their development and factors and circumstances contributing to the industry's limited innovative advancement. They proposed the need to create the appropriate infrastructure and integration of agricultural producers and processors through the formation of an association that operates on the foundation of innovation and investment. The subject and object of this research are organizational and economic mechanisms interconnected with the agriculture's innovative development. The authors attempt to formulate particular recommendations for fostering agricultural development through innovative means. Based on the research results, the authors substantiated theoretical and methodological foundations of the current state and prospects of innovative agricultural development and offered practical recommendations. The use of theoretical and practical recommendations will make it possible to create conditions for large-scale analysis of innovative development of agriculture of the Kyrgyz Republic, effective solution of important problems of this industry, and application and regulation of long-term strategic indicators. The research results serve as a basis for scientific developments in the direction of innovative development of agriculture. The research methods include system analysis, economic and statistical methods, monographic methods, comparative methods, and others.

**Keywords**

Agriculture • Innovation • Production • Efficiency • Mechanism • Regulation • Support • Integration • Strategy

**JEL Classifications**

D20 • E23 • F15 • Q12 • R11 • R58

## 1 Introduction

Currently, agriculture in the Kyrgyz Republic (KR) continues to develop on an extensive basis. Its basis is small commodity production and small peasant character of management, which leads to further deconcentration of production, its small landownership, and low technical and technological equipment of agricultural production. As a result, the labor intensity of production is increasing, crop yields and livestock productivity remain at a low level, and the level of labor productivity is absolutely low. The processes of agricultural cooperation and integration are poorly developed in agriculture; profitability and profitability of the sector are not growing. The extensive nature of agricultural production limits the possibilities of innovative development, attraction of investments and effective state regulation, and the industry support.

In the context of economic integration, the vital strategic pathways for ensuring the steadfast growth of the nation's agricultural sector encompass scientific and technological advancement and innovative procedures. These factors promote the sustained evolution of production through the application of scientific knowledge and the incorporation of technological advancements.

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The urgency of solving the issues of improving the innovative development of agriculture and insufficient study of theoretical, methodological, and practical aspects, considering the resource potential of the agricultural industry in relation to the conditions of market relations, predetermined the choice of the research topic, and a wide range of issues considered in it.

The problems of innovation, innovative economic development, and management of innovation activity are raised in the works of scientists-economists of the CIS: Abalkin et al., (2000); Azgaldov (2008), and others.

The problems of increasing the innovative development of the Kyrgyz Republic, including in agriculture in various periods, are deeply covered in the works of such Kyrgyz scientists as Abdymalikov & Zhumabaev (2012); Atyshov (2012), Dzhailov e al. (2017), Kamchybekov et al. (2021), Koichuev (2012), Kupuyev and Obdunov (2009), Musakojoev (2017), Oruzbayev (2000), Toktomamatov et al. (2017), Zhumabaev et al. (2015), and others.

## 2 Methodology

The theoretical and methodological foundation of this research draws upon the contributions of foreign and Kyrgyz researchers who have been actively involved in the innovative development of the agricultural sector. The information, empirical, and normative-legal foundations encompass legislative and regulatory documents and resolutions of the Kyrgyz Republic, data sourced from the National Statistics Committee and the Ministries of Economy and Agriculture, materials published in Kyrgyz and foreign scientific journals and periodicals, as well as internet resources.

This research employs various methods, including economic-statistical analysis, economic-mathematical analysis, monographic analysis, system and situational analysis, comparative-analytical approach, and calculation-constructive approach.

## 3 Results

The importance of agriculture as one of the main branches of material production, providing the population with food and processing enterprises with raw materials is inestimable. In the Kyrgyz Republic, where two-thirds of the population live in rural areas, the standard of living mainly depends on the development of agricultural production, characterized by the following:

- Slow pace of development of domestic agriculture.
- Poor equipment with advanced technical means necessary for the development of agriculture and animal husbandry.
- Inadequate financial capital for fostering the innovative advancement of economic entities.
- Unattractiveness of agricultural specialties for young people and weak innovation policy (Abdiev & Parpieva, 2021; Abdiev et al., 2018, 2023).

The foundation of innovating the agricultural process encompasses structures, techniques, incentives, resources, and mechanisms for implementing innovative activities and facilitating scientific and technological progress in Kyrgyz agriculture.

The process of innovation comprises two distinct components. The first block pertains to organizational aspects and encompasses tasks such as planning and organization of research and development work, fostering entrepreneurial growth within the scientific and technological domain, disseminating innovations, and integrating them into production processes. The second block concerns economic aspects and encompasses the following elements:

- Funding and credit support for entities engaged in the creation and development of innovation, taxation, and insurance.
- Encouragement of the innovation process.
- Pricing of scientific and technological products—completed R&D.
- Advancement of new technologies.

Supervision of agricultural production within the sphere of innovation activity management is conducted by the Ministry of Agriculture of the Kyrgyz Republic. Scientific and technical activity, including the implementation of innovation projects, are carried out by sectoral scientific institutes.

Many years of experience in the implementation of innovation activities of distant foreign countries (i.e., the Netherlands, the USA, Israel, New Zealand, etc.) are considered relevant for Kyrgyzstan (Mamasydykov, 2011).

The experience of introducing innovations in agriculture on the example of neighboring Kazakhstan and Uzbekistan from the countries of the near abroad indicates that the state should be the main initiator in the formation of organizational and economic mechanisms of innovation activity in agriculture.

The introduction of promising innovation projects at the state, regional, and on-farm levels contributes to a significant increase in the economic, financial, and social sustainability of agricultural enterprises.

In 2021, the number of farms (peasant farms) compared to large farms amounted to 75.78%. They play a special role in agricultural production. Simultaneously, it is necessary to attract investments in farms (peasant farms) and organize innovative activity.

Based on the research on innovative development in the Kyrgyz agriculture, the authors can provide examples of innovative activities in the regions of the countries. In 2020, under the projects "Leasing of highly productive breeding cattle" by JSC "Ayil Bank," a total of 59 cattle were imported from the Russian Federation and allocated to the ownership of the "Chabrets" peasant farm in the Sokuluk District of the Chui Region.

The Talas Region applies advanced organizational and economic measures in the production of beans, cultivation of elite varieties, and application of resource-saving technologies and deep processing of beans.

According to the results of studying innovative development in agriculture, the authors propose the following measures:

- To finance new technologies based on a targeted government program and projects.
- To attract additional financial sources from extrabudgetary funds, investments, leasing, and loans.
- To attract investment and motivation to create and use new technologies.
- To development and implementation of a unified state S&T policy; elaboration of laws.
- To designate tax benefits up to exemption from them for users (consumers) of new technologies, etc.

The developed Strategy of Agricultural Development for 2022–2035 allows us to identify opportunities and further develop the agricultural sector of the country on an innovative basis. Developing and implementing this strategy in agriculture, considering the agricultural resource potential, includes the following stages (Fig. 1).

The authors propose the "Strategy of Innovative Development of the Agricultural Sector for 2023–2035" to the higher executive bodies of the Kyrgyz Republic. This strategy is the main normative document with innovation orientation in the agricultural sector of the country's economy.

The primary objective of the proposed strategy is the efficient development of the contemporary agricultural sector of the country. It includes the issues of increasing the volume and quality of the gross product of the agricultural sector, increasing the number of livestock and poultry, their productivity, and their yield, and ensuring the profitability of products and employment of the population.

Based on the research, the authors developed a model of associations of agricultural producers working on innovation and investment basis (Fig. 2).

Further development of innovative development of agriculture is closely connected with the introduction of innovative cluster policy in agriculture in the Kyrgyz Republic. In this regard, the authors developed the "Regional model of innovation cluster policy in agriculture," which can become an effective mechanism in implementing innovation policy in this sector.

## 4 Conclusion

To substantiate the scientific and innovation strategy of agriculture, the authors propose the following mechanisms:

- Creation and improvement of advanced state policy related to strengthening the legislative and regulatory framework of the agricultural sector of the Kyrgyz Republic.
- Supporting the country's financial and credit institutions to promote innovation-oriented agriculture.
- Consolidation of small agricultural entities into larger agricultural formations.
- Creation of value chain and introduction of cluster method of development.
- Provision of all advisory assistance to rural producers and informing them about new knowledge on innovative technologies.
- Formation of market infrastructure, creation of transport and logistics centers, and equipping them with advanced technical and technological equipment.

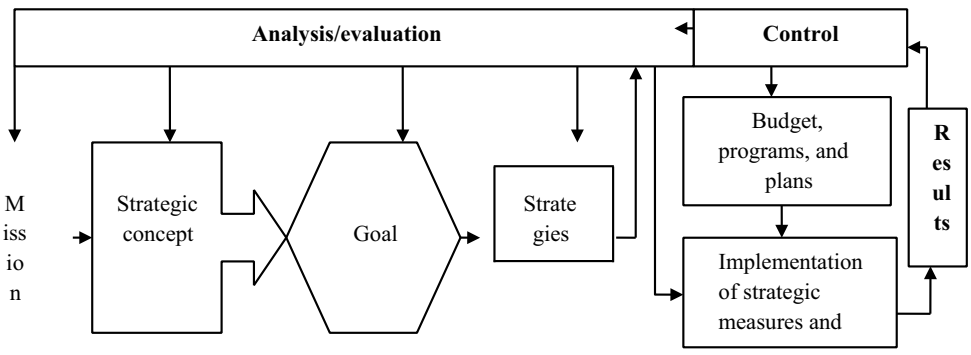


**Fig. 1** Developing an innovation strategy in agriculture. *Source* Compiled by the authors

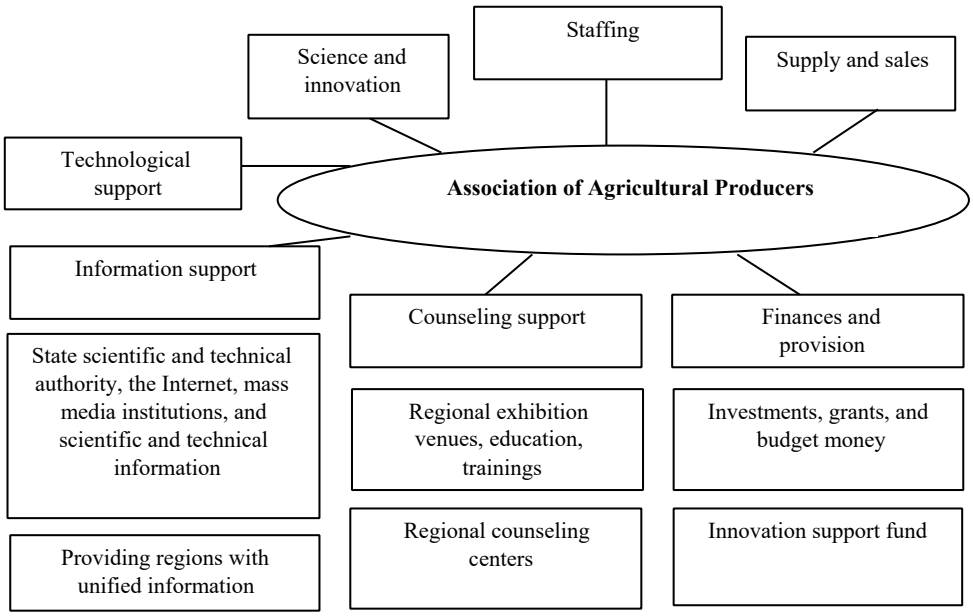


**Fig. 2** Association of agricultural producers working on an innovative basis. *Source* Compiled by the authors

Thus, the efficiency of the agricultural sector largely depends on the formation and implementation of innovation orientation of the country, using modern scientific achievements.

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# The Impact of Anti-Russian Sanctions on the EU

Dmitry A. Alekseenkov and Daria S. Sokolan

**Abstract**

The research aims to consider the impact of anti-Russian sanctions on EU countries. The authors analyze the impact of anti-Russian sanctions on the EU in today's conditions and conclude that it has a negative effect on several basic indicators for assessing the economy of the European Union. The research results allow the authors to conclude that in the absence of positive changes in the development of the military-political situation with the constructive participation of European countries, the socioeconomic crisis in Europe is to escalate with its development into a large-scale political crisis. It became a revelation for Western politicians that the anti-Russian sanctions imposed hit them hard and caused many questions from the people of Europe. The economic situation is getting worse every day. This is clearly evidenced by the reaction of the population, which is trying to protest because of rising prices for energy and food. However, the Americans will continue to insist on increasing pressure on Russia.

**Keywords**

Sanctions • European countries • European Union • Influence • Economy • GDP • Inflation • Unemployment

**JEL Classifications**

F29 • F42 • H82 • L32 • O52

## 1 Introduction

Western countries have increased sanctions pressure on Russia against the background of a special military operation of the Russian Federation on the territory of Ukraine, starting in February 2022. The imposition of sanctions was aimed at weakening the Russian economy. However, anti-Russian sanctions have already turned into economic problems in Europe. Indeed, the EU faced significant challenges due to the sharp increase in fuel and food prices. The increase in prices put pressure on consumers' wallets and had a detrimental impact on industries that heavily rely on energy and raw materials, such as petrochemical and metallurgical sectors. The rising energy costs posed a threat to the competitiveness of European industries because they faced higher production costs compared to countries with cheaper energy sources. To mitigate these challenges, some European companies had to consider relocating their facilities to countries with lower production costs or explore alternative energy sources. The financial strain encountered by industries led to job losses as companies struggled to sustain their operations amidst the economic crisis. Moreover, bankruptcies within the petrochemical, metallurgical, and other sectors were a real concern, posing a threat to employment rates and the overall economic stability of affected regions. The EU implemented measures to promote energy efficiency, invest in renewable energy sources, and diversify energy supply routes to address these issues. These actions aimed to reduce dependency on expensive energy imports and increase self-sustainability. Additionally, various support programs were implemented to assist struggling industries and promote innovation to enhance competitiveness. While these challenges were significant, the EU has undergone adaptation and transformation processes to overcome them. The pursuit of sustainable and resilient economic growth, combined with the diversification of energy sources and enhanced support

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for vulnerable industries, has been crucial for the EU's recovery from the economic crisis and its transition to a more sustainable and competitive economy.

## 2 Materials and Methods

In the process of writing the article, the authors analyzed a wide range of data, including documentation on the official website of the Council of Europe, statistical data on the official page of Eurostat, OECD (2022), IMF (2022), and UNCTAD, and an overview of information on the impact of anti-Russian sanctions on the EU in the works of Spartak (2022) and V. V. Frantsuzov. The impact of sanctions on Russia and the EU was assessed in the works of A. A. Shirov, A. A. Yanovsky, and V. V. Potapenko. During the research, the authors applied the methods of analysis, deduction, induction, and statistical and graphical methods to analyze the effects of anti-Russian sanctions on the economy of EU countries.

## 3 Results

Russia and the EU countries are long-standing trading partners. The imposition of sanctions on either side has an impact on all participants. Over the past twenty years, Russia has consistently been among the top five main trading partners of the EU (Institute, 2022). At the end of 2021, Russia became the fifth-largest trading partner of the EU with a share of 5.8% (it should be borne in mind that Russia occupied such a high position even with the sanctions of 2014). At the end of 2021, Russia's share in EU imports was 7.7% (third place after China and the USA). In value terms, EU exports to Russia amounted to 99 billion euros; imports amounted to 158.5 billion euros. The EU and Russia have a stable negative trade balance in goods, which is offset by a positive balance in services. Let us compare the structure of EU exports and imports with Russia as of the end of 2021 (Fig. 1).

As the data in Fig. 1 show, the main share of EU imports from Russia is the category "fuel and mining products," which accounts for more than 60% of all imports from Russia. The EU also imports iron and steel, wood, and fertilizers—these categories are required by EU countries to create finished products on their territory. The reduction in exports of machinery, equipment, and cars to Russia (together accounting for about 40% of all exports to the Russian Federation) will also have negative consequences in the foreseeable future. These categories relate to expensive high-tech products; finding a new market for such products is rather difficult. Given the growing competition with China, the EU countries voluntarily give up positions and the market to their competitor. While German car brands are leaving the Russian market, China has increased exports of its cars to Russia by more than 50% in 2022 (Newspaper, 2022).

From January 2022 to October 2022, the EU experienced a significant decline in imports from Russia by 36%, accompanied by a 4141% decrease in exports. Germany, Italy, and the Netherlands notably reduced their imports from Russia during this period. However, it is interesting to observe that certain EU countries, including Austria, Bulgaria, Greece, Croatia, Hungary, Luxembourg, and Slovenia, took a different approach by increasing their imports in specific categories (Christen et al., 2014). These categories encompassed pharmaceuticals, various chemical products, fuels and oils, fertilizers, aluminum and its derivatives, as well as optical, medical, and surgical instruments and electrical equipment (IMF, 2022).

The situation is about the same with exports. Bulgaria, Estonia, Greece, Croatia, Ireland, Lithuania, Latvia, and Slovenia increased exports to Russia over the year (Sharma & Zilli, 2023). Thus, despite the sanctions, the EU countries

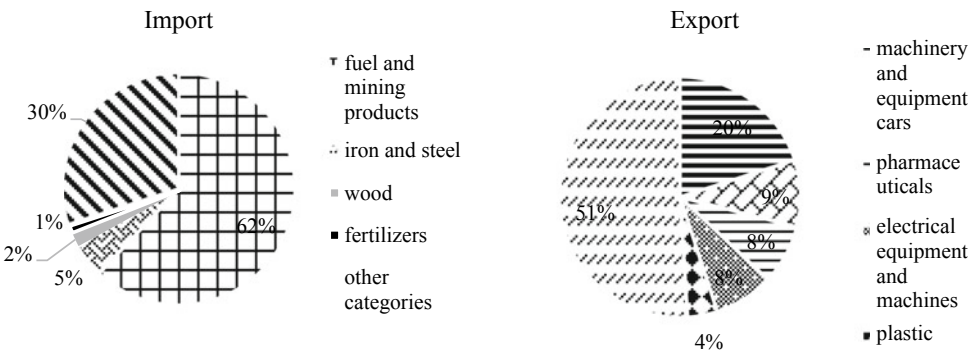


**Fig. 1** Structure of EU exports and imports with Russia at the end of 2021. *Source* Compiled by the authors based on Eurostat

cannot refuse to cooperate with Russia. Some EU countries, on the contrary, demonstrate even greater interest in strengthening trade turnover.

The EU heavily relies on the USA as its main partner, causing it to prioritize decisions that benefit the USA. This weakens the EU's position as a political and economic bloc and leads to economic instability in the region (Commission, 2023). One of the main sanctions imposed was a restriction on importing Russian energy resources. While the USA completely banned the import of Russian coal, oil, and gas, which made up a small portion of their imports, the EU faced greater challenges in completely cutting off these resources. Only coal and oil imports are prohibited, with some exceptions for Eastern European countries. The EU relies on imports for 60% of its energy resources, with Russia being the primary supplier of natural gas, oil, and coal.

As of 2020, Malta, Cyprus, and Luxembourg have become the most dependent EU countries on imports of Russian energy resources, which are more than 90% dependent on Russian energy resources (Shirov et al., 2015). The least dependent EU countries are Estonia (10.5%), Romania (28.2%), and Sweden (33.5%). In general, more than half of the EU countries depend on Russian energy imports by more than 50%.

An embargo on Russian gas is currently impossible. Thus, the EU is discussing other measures to restrict imports, particularly the introduction of a price ceiling. Additionally, on February 22, 2022, Germany suspended the Nord Stream 2 pipeline certification. Many European countries are trying to reduce the consumption of even permitted Russian energy carriers, planning to abandon them by the end of the decade if possible.

In response to these actions, the Russian government forced foreign countries to pay for Russian gas in rubles through a Gazprombank account; the rejection of this scheme led to the termination of supplies to Poland, Bulgaria, and Finland.

Gazprom also has the opportunity to use difficulties with the supply of turbines for the Nord Stream-1 gas pipeline after their scheduled repair in Canada as a natural counter-sanction. Due to technical conditions, the gas run was reduced, which led to a significant increase in gas prices in Europe. Additionally, the economic impact of the accident that occurred on the Nord Stream highway near Bornholm, a Danish island, has yet to be assessed. On the evening of September 26, multiple gas leaks were detected on three lines of the gas pipeline at once. The next day, the growth of exchange prices for gas in Europe accelerated sharply and reached almost 350 euros per thousand cubic meters.

It is worth noting that Germany, the EU's main economy, is quite dependent on Russian gas (Russian gas accounted for more than 55% of energy imports until 2022). By the end of 2022, the country managed to reduce gas imports by up to 20%. However, this has negative consequences for the German industry. German enterprises and households have become accustomed to the abundant reserves of Russian gas and oil for many years. Steel, pharmaceutical, and chemical companies are very dependent on Russian gas. For example, in October 2022, BASF announced that it would permanently "reduce" its European operations (Partridge, 2022).

The EU countries allocated a total of 450 billion euros for measures to combat the rise in fuel and raw materials prices from September 2021 to September 2022 (study by the Bruegel Institute in Brussels, 10/26/2022). Without such injections, it would be inevitable to expect an increase in social tension in the fall–winter period (as a consequence of growing unemployment, lack of heat, increased consumer inflation, etc.).

The impact of sanctions on energy is difficult to overestimate.

Among the EU countries, Belgium (67%) and the Netherlands (58%) recorded the highest rates of energy price inflation in January 2022, followed by Lithuania (43%), Estonia (41%), and Greece (40%). On the other hand, Malta's energy inflation rate was 0%, followed by Croatia and Portugal, both with 12%.

It is important to understand that energy resources are key resources for the EU; any change in their cost and availability can significantly affect the region's economy.

Table 1 shows the introduction of sanctions by the EU and Russia's response.

In conclusion, anti-Russian sanctions have a serious impact on the EU economy and require serious analysis and evaluation by government agencies.

The introduction of anti-Russian sanctions has positive and negative consequences for the EU. On the one hand, sanctions are a powerful tool for influencing Russia that can force the country to change its policy in certain areas. On the other hand, sanctions can considerably impact the EU economy and lead to a decrease in economic stability in the region.

**Table 1** Anti-Russian sanctions after February 24, 2022

| | |
|---|---|
| Sanctions (EU) | Bans on imports and a decrease in the volume of purchases of Russian energy resources<br>Stop Nord Stream 2 |
| Counter-sanctions (Russia) | Sale of gas for rubles (as a consequence—the stoppage of supplies to Poland, Bulgaria, and Finland) |

*Source* Compiled by the authors based on Eurostat

Most experts believe that the introduction of anti-Russian sanctions was inappropriate. They indicate that the sanctions have not achieved their goal. Moreover, they have worsened the growing crisis of the EU and severed the "normal" relationship with the main source of their resources.

In 2022, Russia set a record for the number of sanctions imposed on it, overtaking Iran, Syria, and North Korea. Within the framework of the Eastern Economic Forum (WEF-2022), the Minister of Economic Development of the Russian Federation stated that about 12,000 restrictions had already been imposed against the Russian Federation as of September. They led to the withdrawal of large foreign companies from the Russian market, disruption of supply chains, severance of cooperation with many countries, and the imposition of an embargo on some Russian goods.

It is also worth evaluating the indicator of GDP growth in the EU in dynamics (Fig. 2).

If we look at the dynamics of this indicator, we can notice a significant decrease in growth rates from the winter of 2022 to the present day due to the application of a large package of sanctions against Russia. Moreover, we can pay attention to such a significant indicator as inflation in the EU. From October 2022 to this moment, the inflation rate has been steadily increasing. This tells us about the damage caused by anti-Russian sanctions, which is reflected in pricing and, therefore, directly affects the end consumer. If we look at the dynamics from 2022 to today, the unemployment rate in the EU is consistently high and does not fall below 6%, which just indicates the deterioration of the economic situation in the EU countries.

The industry of the EU countries feels the most negative consequences of sanctions. In December 2022, compared with December 2021, industrial production decreased by 1.7% in the eurozone and by 0.4% in the EU countries (ZEW—Leibniz Centre for European Economic Research, 2023). Among the EU member countries for which data are available, the largest annual decline in industrial production was registered in Slovakia (−13.1%), Estonia (−11.5%), and Luxembourg (−8.4%).

The increase in energy prices and the reduction in industrial production negatively affect not only the socio-economic indicators of the EU countries but also undermine the region's future competitiveness. Nowadays, the EU countries, reducing cooperation with Russia, are beginning to increase trade with China. At the end of 2022, China became the EU's largest import partner (20.8%). The continuing trend of strengthening ties with China leads to a new dependence on the EU, not from the USA, but from China. Additionally, the EU countries have freed up the multimillion-dollar Russian market for Chinese goods. Given the growing competition between the EU and China in the field of high-tech production, it is safe to say that the EU countries have significantly lost their competitive positions in 2022, having untied China's hands from all sides.

## 4 Conclusion

Russia has been living under enormous economic pressure from the EU and the USA since 2014. The sanctions are getting tougher annually. This was supposed to bring the expected success and knock Russia economically out of the saddle. However, the consequences that the EU and the USA are now reaping have become much worse than they were before.

The analysis of the impact of anti-Russian sanctions on the European economy shows the following. First, due to the high importance of Russia as an exporter of many strategic goods, primarily energy carriers, anti-Russian sanctions, and the general deterioration of conditions for Russia's foreign trade destabilized world markets and caused crisis phenomena in the economies of European countries, especially

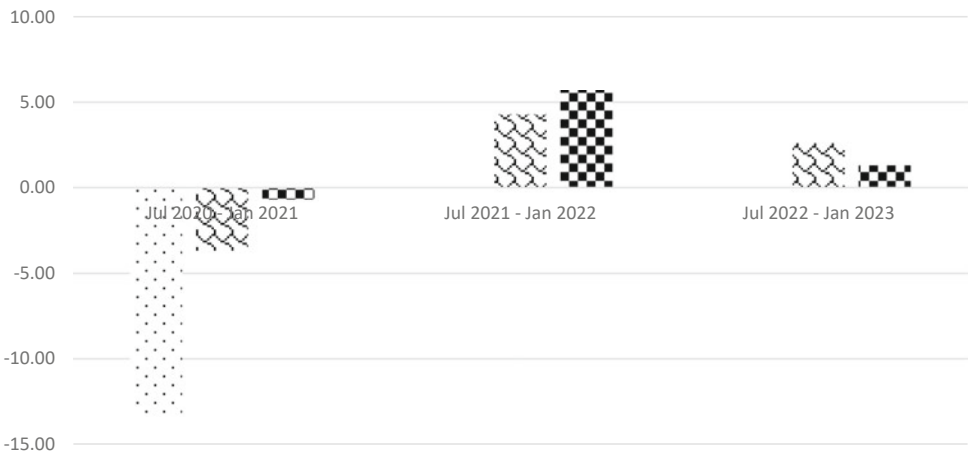


**Fig. 2** GDP annual growth rate in EU. *Source* Compiled by the authors based on Eurostat

heavily dependent on supplies from Russia. The loss of the Russian market in many positions has also had a painful effect on European business.

The price of palladium has jumped sharply in the metals market. Russia controls up to 50% of the market for this raw material, which is critically important in producing electronics (from ordinary laptops to aviation systems). The price of noble gases (neon, helium, argon, and xenon) is also growing. They are necessary in the production of microchips. Titanium has increased in price by a quarter; Boeing (by a third) and Airbus (by two-thirds) depend on its supplies from Russia. The West does not manage to minimize losses from its own restrictions. However, some politicians are eager for more.

Wheat prices are approaching a historical maximum; corn and barley are growing strongly. They cannot find alternative suppliers in Europe because there is no possibility yet to completely abandon Russian energy resources.

Second, the crisis provoked by the deterioration of the geopolitical situation has engulfed the absolute majority of European countries. Third, the crisis phenomena are estimated to intensify even more in 2023, which may destabilize the socio-political situation in European countries against the background of the worsening crisis of the cost of living in conditions of record inflation. Fourth, traditional economic policy instruments show low efficiency in an unprecedented depth and combination of negative effects of the current situation. Therefore, in the absence of positive changes in the development of the military-political situation with the constructive participation of European countries, an escalation of the socio-economic crisis in Europe with its development into a large-scale political crisis becomes very likely.

The real consequences of anti-Russian sanctions are presented in an article of the Politico newspaper. For example, Germany has adopted a new law on "saving electricity," which introduces a temporary ban on lighting attractions. According to the publication, the regions of Germany that are most dependent on Russian gas are trying to find solutions to reduce consumption. In Hanover, for example, they switched to cold showers in all public institutions.

It is also reported that a curfew has been imposed in Spain, and now shops must turn off the lights and close at exactly 22:00.

According to the publication, Paris began to turn off the light on the Eiffel Tower an hour earlier than usual. Street lighting was completely or partially turned off at night in twelve thousand French communes. The French authorities also launched an "energy sobriety" program to reduce electricity consumption by 10%.

Some enterprises, including two large glass manufacturers, Duralex and Arc, had to reduce production volumes and transfer several employees to part-time employment. The increased bills led to the termination of several dozen pools.

The impact of anti-Russian sanctions on the EU has covered all sectors, namely political, economic, and social. Despite all forecasts of European politicians, sanctions against Russia cause more damage to the EU than good. People began to protest. There are industrial strikes almost every week in France, which already has enough problems (e.g., with refugees). This suggests that the political pressure on Europe from the USA is enormous.

If the sanctions policy against Russia is extended (with the implementation of additional sanctions), considering the separatist aspirations of several countries to leave the EU's political and economic bloc, it is worth considering the durability of this union. As time goes by, the advantages of remaining united are diminishing.

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# Prospects for Development Cooperation Between China and the Republic of the Congo

Irina N. Belova and Mupegnu Nzoussi Kevin Gras

**Abstract**

The research shows the motives of Chinese investment in African countries and presents the features and trends of economic cooperation between China and the Republic of the Congo. The research determined the positive and negative sides of the influence of Chinese investments on the economic growth of African countries. Additionally, the research assessed the current state of trade relations between China and the Congo. The dynamics and sectoral structure of Chinese investments in the Congo economy were analyzed. The authors revealed the share of Chinese public investments in key sectors of the Congo economy. The authors also proved that the largest projects of private Chinese investors are also associated with these sectors. The advantages and disadvantages of mutual cooperation are revealed, and the prospects for economic cooperation between the two countries, as well as the main limitations of these processes, are presented. The research substantiated that it is necessary to find a compromise between the interests of the two countries to realize the potential of collaboration.

**Keywords**

Trade cooperation • Foreign direct investment • Africa • Export • Import • Republic of the Congo

**JEL Classifications**

F18 • F21 • F40

## 1 Introduction

China's policy toward the countries of the African continent has undergone significant transformation since the 1950s. In the last decade, it has changed dramatically, considering the scale of the economic involvement of the People's Republic of China on the continent. Africa is now an important source of natural resources and a vast market for Chinese products. For the continent's undemocratic regimes, China plays a similar role in easing tensions with the USA and EU countries. This raises the question of the extent to which the Chinese presence is useful in building political, economic, and social governance in Africa, which is the basis for sustainable development.

China's policy toward Africa in official documents is based on the following principles stemming from current geopolitical conditions and short-term goals (Chou et al., 2018):

(1) Peaceful coexistence.
(2) Mutual economic benefits.
(3) Strengthening cooperation in international forums.
(4) Development assistance to Africa.

However, the analysis of China's policy toward Africa indicates that it is aimed at achieving the following pragmatic goals (Biryukov & Dyuzheva, 2021, Cohen & Lee, 2020):

(1) Obtaining raw materials (in particular, oil) while observing the principle of non-interference in internal affairs.
(2) Expanding market access to more than one billion potential consumers by offering economic assistance in return.
(3) Increasing China's role in the international arena by increasing political support from African countries in exchange for protecting African interests, for example, in the UN Security Council.

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Thus, we can conclude that the main thing for China is to maintain its position and strengthen its political and economic influence in this region.

It is necessary to note that, unlike Western countries, China invests in high-risk projects in the most problematic countries in Africa.

Assessing the Chinese presence in Africa is complex. While the ruling elite welcomes Chinese investment and development aid, society is more divided. Economic factors are often the source of tension. The textile sector, where Africa can compete on low labor costs, has to cope with an influx of cheap Chinese products. As a result, Chinese exports negatively affect local textile production, leading to increased domestic unemployment. Simultaneously, investments in energy and infrastructure contribute to creating new jobs (Liu, 2021).

The above confirms the feasibility of this research: an analysis of the features and trends of economic cooperation between China and the Republic of the Congo, the phenomenon of investing abroad, and the motives for China's direct investment at the present stage of development.

## 2 Methodology

The methodological basis of the research includes the results of research by foreign and Russian scientists devoted to the following:

- The place and role of Africa in the world economy.
- The problem of attracting foreign direct investment to countries located below the Sahara.
- Analyzing the growth of China's influence on the African continent, including the Republic of the Congo.

Statistical data on Chinese investments in the economy of the Congo and their systematization also helped to approach the disclosure of the chosen topic objectively. The main methods include comparison and generalization based on content analysis of information sources, analysis and synthesis, and methods of system and structural-logical analysis.

## 3 Results

Africa is a continent rich in all sorts of minerals, of which China is one of the largest consumers. China's new policy finds particular expression in its economic rapprochement with Africa, which has seen strong GDP growth in recent years. While the EU and the USA remain important sources of direct investment and official assistance to African countries, China's share in foreign investment and trade with African countries shows increasing importance and steady growth.

For twenty years, the volume of China's imports and exports to African countries has increased several times. The effect of the consistent go-to-street policy is an impressive increase in the cost of trade between China and the countries of the African continent. China's trade with African countries is dominated by demand for natural resources, especially oil (about 70% of exports from Africa), iron ore, timber, and diamonds (15%). A significant contribution to the expansion of business contacts is made by the summit of the Forum on China-Africa Cooperation (FOCAC), which is attended by representatives of various regional and international organizations in addition to African countries and China (Smirnov & Lukyanov, 2021).

Although China's trade with Africa is less than that of its traditional EU-27 partner, the growing trade volume does not translate into a mutual benefit. There is a relatively small trade deficit on a continental scale. Meanwhile, only major oil exporters such as Angola and Sudan have large trade surpluses with China (including the Republic of the Congo, Equatorial Guinea, and Gabon), while most (non-oil) countries have trade surpluses.

Thus, China's investment policy divides African countries into exporters and other countries that are doomed to bear the consequences of the presence of a powerful economy in their markets. China is creating special economic zones to facilitate mutual trade, attract investment, and integrate economic activities across the continent (Döttling & Ratnovski, 2021). The zones' activities are focused on extracting raw materials (Zambia) and creating modern manufacturing centers, including computers, televisions, medical equipment, medicines, machinery and specialized equipment, and financial services tourism (Mauritius).

The growth of Sino-African trade in the last decade has been significant. However, the asymmetric nature of the exchange remains a weak point of cooperation. For Africa, trade with China represents 10% of the continent's turnover (exports and imports). For China, the value of trade with Africa is only about 4%.

Similar trends can be traced in the dynamics of China's foreign direct investment in African countries (Fig. 1).

As we can see, Africa became an investment destination after China joined the WTO in 2001, when Beijing began implementing its going global strategy. Government openness policies in Beijing encourage Chinese exporters to seek new economic partners and private and public investors to invest by facilitating quick investment approval, credit support, financial counseling, and business travel arrangements. Consequently, there has been an impressive increase in Chinese investment in African countries.

China invests mainly in the oil and mining sectors, telecommunications, textiles and household appliances, and banking. The country is not afraid of investment risks. For example, closed copper mines in Zambia have resumed

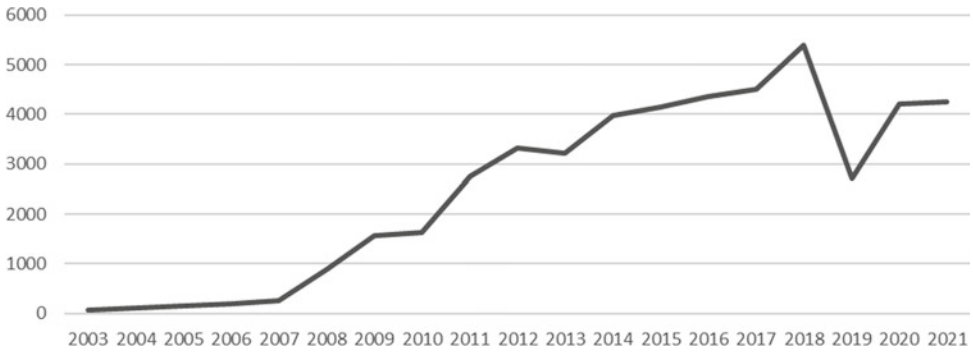


**Fig. 1** Dynamics of China's foreign direct investment in African countries, $ million. *Source* Compiled by the authors based on UNCTADstat (2023)

production thanks to the Chinese capital, as well as long-abandoned oil wells in Gabon. The authorities in China are encouraging companies to invest in Africa, particularly by creating the China-Africa Development Fund. However, despite the growing volume of Chinese FDI in the African continent, their share is still much smaller than in Asia or Latin America. Africa attracts only about 4% of Chinese foreign investment, while 75% goes to Asian countries and the Middle East (UNCTADstat, 2023).

On the other hand, the presence of Chinese National Oil Corporations (NOCs) in Africa is growing dynamically through active licensing or joint ventures with domestic companies. However, compared to the investment participation of Western companies, it is still negligible. Additionally, despite the intensive growth of oil imports to China, Africa still exports more of this raw material to the USA and EU countries. The advantage of Chinese aid and investments lies in the fact that the possibility of receiving them is not associated with the mandatory requirements of fulfilling any political (i.e., democratization, anti-corruption, and human rights), economic, and environmental conditions on the part of the recipient, contrary to the demands of Western countries or international financial institutions (e.g., the World Bank), criticized for imposing a single development model for all. Thus, the West is being squeezed out, and its ability to influence African countries is gradually reduced. However, Chinese aid to Africa should be described more as barter. In exchange for raw materials, mining concessions, and the right to buy oil fields, China heavily invests in infrastructure such as roads, dams, bridges, schools, hospitals, and seaport repairs.

Investments financed with Chinese loans are often subsequently made by Chinese state-owned companies. This is where pragmatism in dealing with Africa is on full display. China is offering assistance conditional on the participation of Chinese companies in outsourced public procurement. In this context, aid is a tool aimed at laying the foundations for increasing bilateral trade and activities of Chinese companies.

With this approach, Europe represents the world's most developed countries (counting on meeting specific standards of democratic countries). Africa represents developing countries (with a different culture and mentality). Devoid of a colonial past and guaranteeing a policy of non-intervention, it is much easier for China to build a political and economic partnership. The scale of investment and trade in the first decade of the twenty-first century makes China a new force influencing the continent's life and its economic development. China's activity in Africa is particularly evident in the resource-rich parts of Central Africa, where China takes advantage of the absence of Western companies.

This dependency is a significant driver of Chinese investment in the Republic of the Congo. Despite this, the weight of China in public investment in various sectors of the Republic of the Congo is relatively high in telecommunications, industry, and energy (Table 1).

As we can see, most of China's public investment is directed to the transport sector, industry, and telecommunications. The largest projects concluded by private Chinese investors in the Congo are also related to these sectors of the economy (American Enterprise Institute, 2023). The main projects of Chinese companies are presented in Table 2.

Table 2 shows a similar trend. That is, the motives of China's public and private investors are the same and have a strategic focus.

**Table 1** Share of Chinese public investment in the sectors of the economy of the Republic of the Congo

| Sector | Share |
|---|---|
| Electricity connection | 66.2 |
| Industry | 54.8 |
| Transport | 45 |
| Energy | 21.7 |
| Medical care | 10.4 |
| Education | 5.0 |
| Public utilities | 5.0 |
| Real estate | 5.0 |
| Agriculture | 0.2 |

*Source* Compiled by the authors based on UNCTADstat (2023)

**Table 2** Main projects of Chinese companies in the Republic of the Congo, $ million

| Year | Company | Sum | Sector | Subsector |
|---|---|---|---|---|
| 2006 | Weihai | $160 | Transport | Aviation |
| 2009 | Sinoma | $140 mln | Real estate | Real estate |
| 2010 | China National Machinery Industry (Sinomach) | $280 mln | Energetics | Hydro |
| 2010 | China Communications Construction | $250 mln | Transport | Cars |
| 2011 | Gezhouba | $110 mln | Energy | Hydro |
| 2012 | China National Machinery Industry (Sinomach) | $310 mln | Public utilities | |
| 2013 | China National Machinery Industry (Sinomach) | $650 mln | Energetics | |
| 2013 | Power Construction Corp. (PowerChina) | $120 mln | Real estate | Construction |
| 2014 | China State Construction Engineering | $520 mln | Entertainment | |
| 2014 | China National Machinery Industry (Sinomach) | $130 mln | Transport | Cars |
| 2014 | China National Machinery Industry (Sinomach) | $250 mln | Public utilities | |
| 2014 | China State Construction Engineering | $680 mln | Transport | Cars |
| 2014 | Sinoma | $180 mln | Real estate | Construction |
| 2014 | China Communications Construction | $240 mln | Transport | Cars |
| 2014 | China State Construction Engineering | $590 mln | Real estate | Construction |
| 2016 | China Communications Construction | $2300 | Transport | Transportation |
| 2016 | Sino Great Wall | $300 mln | Real estate | Construction |

*Source* Compiled by the authors based on China global investment tracker (American Enterprise Institute, 2023)

As for imports and exports between the two countries, their volumes grow yearly. Congo's imports from China consist mainly of manufactured goods and foodstuffs. Four types of products dominate: rice, tobacco, cement, and building materials. Congo exports oil, non-ferrous metals, and wood to China.

Congo has a positive trade balance with China. It can be noted that the positive trade balance of the Congo is explained by the growing demand from China for exports from the Congo. The country's limited financial capabilities constrain imports from China. In 2022, Congo's exports to China amounted to $5.6 billion, and imports—$976 million (International Trade Centre (ITC) 2023).

The Congo's trade relationship with China has a positive impact. It allows trading partners to diversify in an environment where trade has been polarized since independence in 1960 from the EU for imports and the USA for (oil) exports. While exports have seen rapid development with an increasing share destined for China, imports have seen little evolution and still little impact, indicating the dominance that EU countries (particularly France) continue to play as the primary food suppliers in the Congo (Ermachenkova, 2021).

Congo's imports have not changed much, as well as exports. France, the main and traditional partner, continues to dominate as a supplier to the Congo; the USA takes the second position. As for China, its share has slightly increased. Thus, if the influence in the field of exports of the Congo is significant and leads to a change in the geographical structure in favor of China, then this influence, on the contrary, is small concerning the geographical orientation of imports. Traditional partners maintain their former positions, and China's weight is still insufficiently high.

Chinese cooperation and assistance are directed mainly at the health, water, and education sectors. It allows China to reap political and economic benefits. Politically, the aid helps further tie the government to China as a friendly country. On an economic level, this assistance is used by China due to its close relationship with government agencies to obtain government contracts, which it is also willing to pre-finance and repay for loans based on low (concessional) interest rates (Dollar, 2016). Additionally, these government contracts allow China to sell its equipment and products and thus offer outlets to its public and private companies. Finally, through these public markets, China creates jobs for its workforce.

## 4 Conclusion

Thus, China's cooperation in the Congo essentially takes two forms: public investment and private collaboration. The work is carried out by Chinese companies, whose tendency is to import from China raw materials and resources needed for projects, as well as a significant part of the workforce. Skilled workers are primarily Chinese; the local workforce mainly comprises unskilled and often low-paid workers.

The following tendencies of China's influence on the economy of the Republic of the Congo are highlighted. The first trend is that China's economic relations with the Republic of the Congo are promising for both countries. The African country has the opportunity to diversify its trade; EU countries have long dominated the sources of financing. Chinese demand is pushing up commodity prices on the world market, which is positive for Africa. Additionally, China's financing is in sectors that promote growth, such as infrastructure, which has long been neglected in favor of social sectors. The share of FDI destined for the Republic of the Congo has increased due to economic relations with China.

The second trend is that these relationships are negative. Chinese influence could exacerbate the Republic of the Congo's dependence on regressive specialization, which is limited to the role of a supplier of raw materials and counteracts diversification efforts. Manufacturing industries (e.g., textiles) will likely suffer from competition from cheap Chinese products. Similarly, the debt of the state and private business of the Republic of the Congo may increase, making it even more dependent on Chinese influence. Finally, compliance with social and environmental laws is at risk of being compromised by Chinese companies that are more committed to profitability and do not care about the rights and obligations imposed by the legal system. To realize the potential of cooperation between the two countries, it is necessary to find a compromise between their interests. For the Republic of the Congo, this is the diversification of industry, the development of communications, and the increase in exports, primarily high-tech.

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# Investment Cooperation in Agriculture Between China and Russia: Current Status, Problems, and Prospects

Zhang Junfeng

**Abstract**

Both China and Russia are large agricultural countries, and cooperation in the field of agriculture between the two countries has a long history and a deep foundation. In recent years, cooperation between China and Russia in the field of agriculture has deepened, moving from spontaneous and decentralized regional traditional trade to standardized and orderly multi-level and multifaceted economic cooperation, such as trade, investment, and scientific and technical exchanges. The bilateral mechanism of agricultural cooperation between China and Russia has also been officially established by the two countries. The demand for strengthening agricultural cooperation is high, and the prospects for future agricultural cooperation are wide. Currently, investment cooperation in agriculture has become one of the strategic areas of cooperation between China and Russia. Despite the complementarity of advantages and the avoidance of disadvantages, the improvement of the structure of the agricultural sector of the two countries through industrial cooperation is the main direction of future cooperation This article will examine in detail the situation with investment cooperation in agriculture between China and Russia from three points of view: the current situation, problems, and prospects.

**Keywords**

Investment • Cooperation • Cooperation between China and Russia • Agriculture • Geographical characteristics

**JEL Classifications**

F15 • F21 • F23 • Q14

## 1 Introduction

The Central Document No. 1 of the Communist Party of China of 2014 established as one of the priorities of national policy the strengthening of national food security and support for agriculture in the face of environmental degradation. It was decided to maintain self-sufficiency in rice and wheat and possibly increase the import of other crops. Ideally, such import is provided by Chinese companies leasing land abroad. In recent years, the strategies of Chinese agricultural investors have changed.

Firstly, there is still a lot of criticism of China's agricultural investment projects in terms of environmental and cultural issues. Secondly, the investments of Chinese agribusiness in most cases are associated not only with the lease of land, but also with its cost, including the capture of important food markets. Greater attention to the development of relevant production chains in local countries is of great importance for China's foreign investment in agriculture.

## 2 Methodology

Investment cooperation in agriculture between China and Russia is studied in the works of Makarov (2017), Sukhodolov (2020), Huiming & Xueling (2017), Jianming (2015), Guolyan & Kailu (2021), Hongxia (2020), Dong et al. (2019), Hongpeng & Di, (2018), and Huimin (2017).

The analysis of investments in agriculture is studied in the works of Jiaoyang et al. (2017).

The article also uses a tabular method to display data on the flows and stocks of China's direct investment in agriculture in Russia from 2013 to 2020.

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## 3 Results

Chinese investments in agriculture are mainly concentrated in the field of production. According to statistics from the Ministry of Commerce of China, in 2020, Chinese companies invested $49.94 million in crop production, forestry, animal husbandry, and fishing in Russia, which is 8.7% of the total Chinese direct investment in Russia and 2.2% of the total Chinese foreign investment in agricultural, forestry, fishing, and hunting farms. Direct investments in the agricultural, forestry, fishing, and hunting industries of Russia amount to $2771.86 million, which is 23% of the total direct investments in Russia (Table 1).

Currently, the main direction of Chinese agricultural investment in Russia is the development of agricultural resources through land leasing, the creation of joint agricultural parks and scientific and technical agricultural parks, etc., which allows combining Chinese predominant production factors, such as agricultural machinery, production technologies, and labor, with Russia's rich resources for the development of cultivation of grain, legumes crops, vegetables, cattle breeding, and processing of agricultural products.

Although crop production is still the main area of investment of Chinese enterprises in Russian agriculture, they continue to expand the production chain upstream and downstream based on the stabilization of investment in the crop industry, expanding the scope of investment from planting to many links, such as processing of agricultural products, warehousing and logistics, agricultural trade, agricultural technology, and SCO agricultural services. This made it possible to realize numerous links in the production chain and increase the added value of investment in agriculture.

According to the "Analytical Report on Foreign Investment and Cooperation in Agriculture of China," prepared jointly by the Department of International Cooperation of the Ministry of Agriculture and Rural Affairs and the Center for Foreign Economic Cooperation of the Ministry of Agriculture and Rural Affairs, from 2013 to 2020, the share of Chinese enterprises investing in Russia's agriculture, forestry, animal husbandry, and fishing has reached 40%, which is 67.80% of the total number of companies that have invested in Russia this year. The technical content of investment of Chinese enterprises in Russian agriculture has been improved, and the volume of investments has been expanded.

In addition, in 2020, the number of enterprises investing in more than two production units and operating them simultaneously will be 34, and in total there will be 11 enterprises engaged in agricultural technologies, processing of agricultural products, trade in agricultural products, agricultural logistics and warehousing. Most Chinese enterprises investing in agriculture in Russia, in addition to investing in the crop industry, are also constantly expanding the production chain by investing in the extractive and processing industries of crop production and gradually implementing the improvement and integration of the investment production chain.

From the point of view of the ownership structure of investment enterprises, private enterprises have become the main source of investment in Russian agriculture. Statistics from the "Analytical Report on Foreign Agricultural Investment and Cooperation of China" show that in 2018 the number of state-owned enterprises (including collectively owned enterprises) has increased. The number of Chinese enterprises investing in agriculture in Russia decreased from 10 in 2013 to 5, that is, by 50%; state-owned strategic agricultural enterprises from 4 in 2013 to 2 in 2018, the number of private enterprises increased approximately 10 times from 2013 to 2018.

As for the scale of investments, the flow of investments by Chinese private enterprises into Russian agriculture in 2018 amounted to 110 million US dollars, while the total

**Table 1** Volume of Chinese direct investments in agriculture in Russia (USD million)

| Year | Investment flow in agriculture (million rubles) | Investment reserve in agriculture (million rubles) | Gross investment flow (million rubles) | Gross investment stock (million rubles) |
|---|---|---|---|---|
| 2013 | 400.42 | 1682.49 | 1022.25 | 7581.61 |
| 2014 | 352.34 | 2099.7 | 633.56 | 8694.63 |
| 2015 | 346.83 | 2462.94 | 2960.86 | 14,019.63 |
| 2016 | 432.76 | 3006.71 | 1293.07 | 12,979.51 |
| 2017 | 289.9 | 2701.66 | 1548.42 | 13,871.6 |
| 2018 | 398.3 | 3028.58 | 725.24 | 14,208.22 |
| 2019 | 258.39 | 2831.71 | −379.23 | 12,803.97 |
| 2020 | 49.94 | 2771.86 | 570.32 | 12,070.89 |

*Source* Developed and compiled by the author based on (Analytical Report on China's Foreign Agricultural Investment and Cooperation (2013–2021); National Bureau of Statistics of China, 2013)

volume reached 590 million US dollars. Compared to 2013, the flow of investments for these two indicators decreased by about 25%, but their stock decreased. The increase was approximately 66.7%. Compared to 2013, both the flow and the volume of investments of state-owned enterprises in agriculture in Russia decreased in 2018. The flow decreased by about 20%, and the stock decreased by about 32.1%. Although the enthusiasm of private enterprises to invest in Russian agriculture is growing, due to limited financial stability, the scale of investments is relatively small, and the volume of investments in a single project is significantly less than that of state-owned enterprises.

In terms of industry characteristics, non-agricultural enterprises have significantly increased their investments in Russian agriculture. In many areas of agricultural activity, besides crop production, such as agricultural technology development, agricultural logistics and warehousing, investments of non-agricultural enterprises are obviously higher than those of agricultural enterprises. The increase in investments of non-agricultural enterprises in agriculture in Russia has also affected the overall structure of the production chain and investments of Chinese enterprises in Russian agriculture. In 2018, the number of non-agricultural enterprises investing in Russia reached 21, which is 21.6% of the total number of enterprises investing in Russia this year, which was more than three times more than in 2013.

From the point of view of the regions where Chinese enterprises are located, the enterprises of the northeastern region bordering Russia are pioneers and the main driving forces of investment in agriculture in Russia. In the early years, most of the enterprises investing in Russian agriculture in the Northeast were small businesses, some of which were small family businesses. Now some large enterprises are investing more. In terms of registered investment enterprises, Heilongjiang Province has the largest number of agricultural enterprises investing in the Russian economy. According to the "Analytical Report," 22 enterprises of Heilongjiang Province invested in Russian agriculture in 2020, which is 37.28% of the total number of enterprises that invested in Russia that year. Heilongjiang Province is the main grain production area in China. It not only possesses advanced agricultural technologies, but also has many agricultural enterprises with rich investment experience. The scale of investments of enterprises investing in Russia in this province is greater than that of enterprises in other provinces. Currently, there are six enterprises in Heilongjiang Province engaged in large-scale investments in agricultural planting in Russia; the largest leased land area has reached 20,000. They mainly specialize in the cultivation of soybeans, corn, and other crops, and also provide assistance in animal husbandry. Enterprises in other provinces and regions of China show increasing enthusiasm for investing in Russian agriculture, and they demonstrate significant interest in the Russian investment environment in agriculture. Enterprises from Guangxi, Guangdong, Zhejiang, and other places have begun to invest in Russia on a large scale. In general, enterprises from 12 provinces and municipalities of China have carried out agricultural investment activities in Russia.

Problems of Chinese enterprises investing in Russian agriculture:

(1) The current problems of Chinese enterprises investing in Russian agriculture are associated with a poor investment environment, relatively large political restrictions, financial difficulties, and high currency risk, as well as the fact that investment decisions are made by Chinese enterprises themselves. If sufficient research and demonstrations are not carried out before investing, the risk cannot be fully predicted or there is no mechanism to respond to the risk, it will inevitably increase.
(2) The phenomenon of homogenization of investments is seriously affected by Sino-American trade frictions. Over the past five years, China's wholesale imports of agricultural products from the USA have been declining, especially soybeans and corn. However, the market demand for these two products is great, and in combination with a well-developed transport link between China and Russia, especially the railway system between the adjacent areas of the two countries, the cost of transportation is much lower than when importing from Brazil and Argentina. For this reason, the investments of some Chinese enterprises in agriculture in Russia are mainly focused on soybean cultivation and trade, and the homogeneous competition between them is relatively serious. These homogeneous investment methods and areas of activity have intensified vicious competition between enterprises and reduced the return on investment of enterprises.
(3) Russia is rich in agricultural and forest resources, has a large amount of uncultivated land, and is the largest belt of chernozem in the world. In addition, the vast lands are sparsely populated, which is very suitable for large-scale agricultural production and exploitation. However, most of China's investment enterprises in Russia are private enterprises that are limited in financial capabilities and also have a shortage of high-level specialists and support services, so it is difficult for them to carry out large-scale operations. At the same time, in order to reduce risks and shorten the investment cycle, most enterprises invest mainly in the production of agricultural primary products, and the product sales market is focused only on China and Russia, and therefore it lacks planning for other markets. Although

some Chinese enterprises invest in Russian agricultural social services, Russia is too vast to provide sufficient support for Chinese enterprises' investments in agriculture, and domestic agricultural social services in Russia are not well developed, and there are few professional enterprises associated with them. This leads to excessive investment costs for Chinese enterprises.

Based on the state of agricultural resources, the level of agricultural production, the political situation, and the existing basis for cooperation between China and Russia, the prospects for agricultural cooperation between China and Russia in the future will be broad. The main areas of cooperation are the exchange of agricultural science and technology, the cultivation and processing of agricultural products, the construction of agricultural infrastructure and pelagic fishing.

In the field of cultivation and processing of some key agricultural products, the factors of agricultural production between China and Russia largely complement each other. Taking into account Russia's rich basic agricultural resources, China's high level of domestic production, a good investment base in Russia and high market demand, wheat and soybean cultivation, greenhouses for fruits and vegetables, livestock products, water products, as well as the production and processing of organic food are key areas of current and future cooperation.

In 2016, Russia became the world's largest wheat exporter. The conditions of production of spring wheat grown in Russia are similar to the conditions of production of spring wheat in Heilongjiang, Inner Mongolia, and other provinces of China, and the conditions of production of winter wheat grown in Russia are similar to the conditions of production of winter wheat in Henan, Hebei, and other provinces. Thus, China and Russia can strengthen cooperation in the wheat industry. With regard to wheat cultivation, it is necessary to make fuller use of the germplasm resources of the two countries; expand joint research on the development of new wheat varieties; strengthen technical exchanges in the field of cultivation technologies, pest control, etc.; support research and development of production tools and materials, such as wheat production equipment, pesticides, and the use of chemical fertilizers. Moreover, we will use the Chinese technology of deep processing of mature wheat and the experience of industrialization development for cooperation with Russia in this area in order to expand the production chain.

## 4 Conclusion

The complementary advantages and resources of China and Russia, good-neighborly relations, political mutual trust, and strategic coordination have laid a solid foundation for agricultural cooperation between the two sides. Cooperation in the field of investments in agriculture will strengthen regional geographical advantages and open up both broad opportunities for the economic development of China and Russia, and for the development of Chinese-Russian agricultural cooperation. It is important to use China's relatively rich capital to attract other international capital, thereby contributing to the development of the agricultural industry in Russia to strengthen its competitiveness at the international level and coordinate regional development.

China and Russia can take the following measures to expand the scope of investment cooperation in the field of agriculture:

- To create a bilateral mechanism for cooperation in the field of investments in agriculture, to strengthen policy communication and information exchange, as well as to build mutual confidence.
- To promote cooperation between agricultural enterprises of both sides, to encourage Chinese and Russian enterprises for cooperation in the field of agricultural production, processing, marketing, and other relations, and to contribute jointly to the modernization of agriculture.
- To enhance scientific and technical cooperation, to conduct research and development in the field of agricultural technologies and introduce innovations, as well as to promote high-quality seedlings, highly efficient agricultural machinery, and advanced agricultural management methods.
- To strengthen cooperation in agricultural trade, to expand its scale, to promote deep processing of agricultural products and the provision of value-added services, as well as to increase the added value of agricultural products.
- To strengthen cooperation in the development of agricultural talents, to carry out bilateral exchanges and training of agricultural talents, as well as to educate outstanding agricultural entrepreneurs, scientific researchers, and skilled workers.
- To become more flexible regarding the possible lease of land in Russia by Chinese companies. Such a lease can bring a lot of benefits to the Russian economy, and it is unacceptable to miss, following obsessive phobias. At first, large agricultural projects should be implemented with the participation of the Russian-Chinese agricultural fund.

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# International Cooperation in the Field of Food and Mineral Fertilizers

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**Abstract**

The research aims to show the importance of solving the global problem of hunger to achieve world stability and economic development. Of decisive importance for achieving this goal is the international cooperation of all countries and the activities of international organizations that promote the interaction of countries in the field of obtaining affordable and high-quality food. Information sources for the research include data from Russian and international statistical institutions (Federal State Statistics Service of the Russian Federation, Ministry of Agriculture of Russia, and FAO) and content analysis of news feeds and Internet resources. The interaction of countries as part of various integration associations and their participation in the work of international institutions in the field of food distribution, dissemination of efficient agricultural technologies, and food production will contribute to solving social problems and achieving sustainable economic growth and coordinate the export and import of food to create conditions for the full reproduction of the healthy population of the planet.

**Keywords**

Food • Mineral fertilizers • International cooperation • Food security • Food crisis

**JEL Classifications**

F15 • L66 • N50

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## 1 Introduction

International cooperation is the cornerstone of the fight against today's global problems. The interaction of countries provides certain benefits, including the acquisition of goods, services, technologies, R&D innovations, the influx of investments, an increase in tourist flows, the exchange of specialists, etc. Moreover, it helps to jointly solve the most pressing problems, such as poverty, diseases, food shortages, and hunger.

Food shortages and famine have significant political, economic, social, health, and other consequences. According to Ivannikov (2020), the emergence of the global problem of hunger is caused by various objective and subjective reasons. These reasons include climate change caused by human activity, the lack of land resources suitable for agricultural work, change in diet and deterioration of its quality, overproduction of food in some regions, disruption of food logistics, and shortcomings in the distribution system. Overcoming the global problem of hunger is possible only by joining the efforts of all countries.

## 2 Methodology

This research is based on a statistical analysis of data obtained from official sources: the Federal State Statistics Service of the Russian Federation (Rosstat), the Ministry of Agriculture of Russia, FAO, and the Federal Customs Service of the Russian Federation. Additionally, the authors used data characterizing the state and problems of Russian exports of food products and mineral fertilizers obtained from news feeds.

## 3 Results

International cooperation in solving the problem of hunger arose in the middle of the twentieth century. At that time, a specialized international organization was created within the



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framework of the United Nations in the field of nutrition, food, and agriculture—the Food and Agriculture Organization of the United Nations (FAO). Along with it, a great contribution to the organization of international cooperation is made by the World Grains Council, the International Sugar Organization, the International Coffee Organization, the International Committees for Olive Oil, Tea, etc., the World Food Program (WFP), the World Health Organization (WHO), and other organizations.

The result of the cooperation of FAO, WHO, and WFP with the participation of the UN Standing Committee on Nutrition (SCN) and the Committee on World Food Security (CFS), with the support of other international and regional organizations and platforms, was the announcement of 2016–2025 as a Decade of Action in the field of nutrition (Chernova, 2020; Committee on World Food Security (CFS) 2017).

Despite all efforts made, in the past few years, the situation with food shortages has worsened because of the COVID-19 pandemic, the energy crisis, ineffective policies of European governments, and the conduct of a special operation in Ukraine. The world's largest humanitarian organization, the World Food Program, has called 2022 the year of unprecedented hunger. According to the organization, the number of undernourished people worldwide has increased from 135 to 345 million since 2019; 50 million people from 45 countries were on the verge of starvation (Odintsova, 2022).

African countries (including Senegal, Mauritania, Algeria, Nigeria, Chad, Cameroon, Sudan, Eritrea, etc.), the Central African Republic, Syria, Yemen, Afghanistan, Haiti, and some other Central American countries suffered the most. More than 50 countries are almost completely dependent on wheat exports from Russia and Ukraine; about 30 countries are more than half dependent. The imposition of sanctions against Russia led to a decrease in food supplies. As a result, food supplies to countries in need were disrupted. The World Food Program was forced to raise more than $22 billion for food aid to 152 million people, which is half the amount already allocated to Ukraine for US military assistance ($54 billion) (Odintsova, 2022).

Under the current circumstances, FAO is unlikely to achieve its goal of ending hunger by 2030. In the meantime, the number of the hungry continues to rise. Earlier, there was a question about the economic accessibility of food in several countries. In turn, there is a serious risk that food will become physically inaccessible to certain population groups (Karabut, 2023).

The causes of food shortages listed above have contributed to a significant increase in agricultural prices. A significant role in this was played by the restriction of access to Russian mineral fertilizers. About 25 countries receive more than a third of fertilizers from Russia. Crop yields depend on the use of fertilizers.

As is known, three types of mineral fertilizers are the most popular in the world—nitrogen, phosphorus, and potash. Of these, the greatest demand in the world market is for nitrogen fertilizers; the less demanded is potash fertilizers. The main producers of fertilizers are China, the USA, Russia, India, and Canada. Since almost all major fertilizer producers work for the domestic market, Russia is the world's most significant exporter of mineral fertilizers. In 2021, the country exported 64% of mineral fertilizer production. The largest buyers of fertilizers are Brazil, India, the USA, China, and France (Delovoy Profil, 2022b).

Although fertilizers from Russia were not included in any of the sanctions lists, exporters of these products felt the indirect impact of sanctions. There were problems with transportation, insurance, and payment for supplies.

These difficulties led to a serious decrease in Russian fertilizer exports in the spring of 2022. Prices of Russian fertilizer rose sharply. The situation began to improve in May–June. The cost of Russian fertilizers began to decline (Sputnik, 2022). In April 2022, many Russian companies reduced the export of fertilizers. In May, they began to increase it. For example, having reduced the supply of fertilizers to Europe, Phosagro increased their supplies to India by almost 2.5 times (Agency & "SeaNews", 2022), becoming the main supplier of nitrogen-phosphorus fertilizers to this country.

Russia increased the supply of mineral fertilizers to the markets of friendly countries. For example, supplies to the Middle East (mainly Turkey) increased by 40%. Vietnam annually buys about 3.5 million tons of various fertilizers (Russian Fertilizers Producers Association, 2022).

From May to September 2022, Russian fertilizer producers exported about 9 million tons of fertilizers, mainly to Asia and Africa. As of the end of November 2022, the supply of fertilizers to India increased eightfold (Delovoy Profil, 2022a).

Despite the difficult global situation, the production of the main types of mineral fertilizers in the Russian Federation in 2022 increased by 5% in physical weight (Russian Fertilizers Producers Association, 2022).

Due to the high price of fertilizers in 2022, Russian companies achieved record revenues. According to the FAO, revenue from the export of Russian fertilizers in 2022 increased by 70%, while its volumes fell by 10%. For ten months of 2022, the cost of fertilizers supplied abroad reached $16.7 billion (Miklashevskaya & Mordyushenko, 2023).

Rising prices for mineral fertilizers are fraught with serious consequences for agricultural producers. High prices for mineral fertilizers reduce their use and, consequently, crop yields (Dlutsky, 2022).

According to experts, the state of the world economy promotes the growth of the production of nitrogen fertilizers in Russia. Potential competitors in several countries have stopped production due to the rise in gas prices. On the contrary, Russia can increase its capacity to produce nitrogen fertilizers due to excess gas. The creation of additional capacities is problematic due to the dependence on foreign equipment and technologies. Therefore, NovaTEK PJSC postponed creating a large-scale ammonia production at the Ob Mining and Chemical Combine. The chemical holding Phosagro postponed the commissioning of the ammonia-urea complex in Cherepovets from 2025 for an indefinite period. Fertilizer manufacturers are developing contacts with alternative suppliers of technologies and equipment, including Russian ones (Kudiyarov, 2022).

Experts believe that, due to the energy crisis, sanctions on the supply of mineral fertilizers, and a reduction in acreage in Europe and the USA, world food prices will continue to rise in 2023. High prices have already led to a slowdown in the growth rate of the agro-industrial complex (AIC) to 1.1% per year, which is not enough to feed the planet's growing population (Karabut, 2023).

Without urgent measures, the world is threatened with famine, political destabilization, and unregulated migration.

If these trends continue, the world will face the problem of hunger and an unregulated flow of migrants. Integration associations such as APEC, the EU, the CIS, the EAEU, and others understand the seriousness of the problems that have arisen in the field of ensuring food security and are taking various measures to expand cooperation in the field of food and fertilizer supplies. Nevertheless, the country's level of ensuring food security remains the main one.

In 2019, a Memorandum of Cooperation in the field of agro-industrial complex was signed between the Eurasian Economic Commission (EEC) of the EAEU (Eurasian Economic Union includes the Republic of Armenia, the Republic of Belarus, the Republic of Kazakhstan, the Kyrgyz Republic, and the Russian Federation) and the government of the Argentine Republic. The document is aimed at cooperation between countries in the field of agricultural industries, the exchange of food production technologies, investments in the processing of agricultural raw materials, and the development and application of uniform veterinary and phytosanitary measures in mutual trade (Eurasian Economic Commission, 2023).

In September 2020, a meeting of experts from the EAEU countries was held to develop a unified policy to ensure food security for the implementation of the draft Strategic Directions for the Development of Eurasian Economic Integration until 2025 (Decree of the Supreme Eurasian Economic Council No. 1 dated May 19, 2020) (Eurasian Economic Commission, 2023).

The EEC is working to harmonize the legal documents of the EAEU with the acts of the World Organization for Animal Health (OIE), which includes 182 countries, including the EAEU countries. An agreement was reached between the EEC and the World Bank on the provision by the bank of analytical materials related to attracting investment in the agro-industrial complex on the example of Brazil, India, and China to disseminate experience among the EAEU countries (Eurasian Economic Commission, 2023).

In 2021, the Islamic Organization for Food Security (IOFS) and the Eurasian Economic Commission (EEC) signed a Memorandum of Cooperation, which reflects common approaches and principles to ensure food security, considering FAO approaches. The Memorandum outlines the main areas of cooperation between the countries in the field of creating common trade corridors and creating free trade zones with countries that are not members of the EAEU (particularly with Egypt, Bangladesh, and the Persian Gulf countries). Moreover, it forms a system of wholesale distribution centers to stabilize food prices (Arutyunov, 2021).

Russia has been one of the key and largest donors to the UN World Food Program (WFP) for many years. Since 2003, the country's government has sent more than $430 million to support humanitarian operations and develop projects of WFP in the world (UN World Food Programme, 2022).

Even though Russia's positions in ensuring its food security are stable, the leadership considers it important to establish close cooperation on food issues with such countries as India, Iran, Turkey, Uzbekistan, and China. There are good reasons for that.

In 2022, Russian farmers harvested a record harvest of grain and other crops. The volume of grain and vegetable oil production exceeded domestic needs by several times. In 2022, food inflation (more than 30%) is also emerging, which is a serious problem (Karabut, 2023).

It is quite possible to solve some issues through new technologies and the interaction of specialists and scientists from different countries. For establishing cooperation, Russia is interested in those countries where R&D centers in the field of agriculture have been established.

Belarusian scientists successfully work in terms of selection. As a result, the average seed yield in Belarus increased by 76.1% in 2020. Indonesia is interested in producing agricultural drones that analyze the territory and the crops available on it. Then, based on precision farming technologies, specialists ensure the growth of crop yields on them. Brazil is implementing a project to launch self-driving harvesters.

Russian agricultural companies also perform well. Manufacturers of city farms IFarm and GreenBar are successfully operating in the UAE and Qatar. The integrator of precision

farming technologies Agronote is operating in Kazakhstan. The Far East Peat Company supplies agrochemicals to China (Sypchenko, 2023).

The agricultural markets of Latin America, Southeast Asia, Africa, and India are of interest to Russia. Over the past five years, Russian exports of agricultural products (mainly sunflower and soybean oil) to India have grown almost fivefold and approached $800 million (an average increase of 7%). Russia exports food products to Africa and the Middle East. These countries are interested in the supply of grain, dairy and meat products, etc. (Sypchenko, 2023). Therefore, Russia could well cooperate with them in food supplies.

The growing problems in connection with the COVID-19 pandemic have become an occasion to think about the methods used for producing, processing, marketing, and consumption of food, as well as waste disposal (i.e., on the state of world food systems) (Medvedev, 2020). There is a need to transform them toward inclusiveness and sustainability.

Updated food systems should consider aspects related to nature and climate to a greater extent: use advanced technologies and rational integrated approaches to managing land, soil, water, and other resources (Food and Agriculture Organization (FAO), 2020).

Systems that are in harmony with nature and people can only be created through joint efforts based on a coordinated approach that unites the efforts of government agencies, the private sector, consumers, non-profit organizations, and other sections of civil society.

Much of food security will depend on the ability of collective planning and rapid response to instability (Vartanova, 2020).

Digital technologies give humankind great opportunities for interaction without loss of time and significant funds. The cooperation of countries makes it possible to solve several problems in the field of doing business and scientific research (e.g., biological, medical, etc.), the adaptation of common rules of conduct in the event of a threat of a pandemic and epidemiological risks, the transition to a new digital format of interaction (remote), the development of new requirements for the functioning of sectors that directly determine the conditions of human life (i.e., education, health care, culture, tourism, recreation, work, etc.).

## 4 Conclusion

Ensuring global, regional, and national food security is extremely important for the sustainable development of all countries and the world (Shchetinina, 2018).

The crisis provoked by the COVID-19 pandemic endangered the lives of millions of people and exposed the risks that many advanced countries were not ready for, dealt a blow to globalization, which was considered the basis of interstate interaction in the present century.

The scale of the disaster indicates that only coordinated universal work to overcome the global crisis, which has no analogs in recent history (Delovoy Profil, 2022a), can become effective.

Cooperation of countries within the framework of various international associations and unions, as well as the participation in the work of various organizations in addressing issues of food security and the functioning of different markets, strengthens national positions and makes it possible to counter global risks and threats, distribute the latest technologies, digitalize business processes in the agro-industrial complex, ensure high requirements for product quality, and coordinate export and import quotas on mutually beneficial terms.

The tasks of the current stage involve the development of measures that meet current challenges and form a new institutional environment for ensuring food security.

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# Applied Organizational and Management Solutions for the Sustainable Development of Agrarian Organizations Based on Digital Technologies and Smart Innovations

# Comparative Comprehensive Assessment of Agricultural Organizations Toolkit

Marina G. Leshcheva, Tatyana N. Steklova, Tatyana N. Uryadova, Yusupzhan A. Yuldashbaev, and Tatyana N. Cheprakova

**Abstract**

An important aspect of managerial activity in the agricultural sector of the economy is an objective assessment of the work of agricultural organizations. Its results are demanded by external and internal users and serve as a basis for making decisions on investment, interaction as a business partner, directions and forms of state participation, and adjustment of development strategy. To provide information for these needs, it is advisable to use rating methods. The existing methodological apparatus of its implementation needs to be improved and adapted to the conditions of the agro-industrial complex (AIC). The research aims to clarify and supplement the tools of rating assessment of agricultural organizations. The research objectives are to form a system of indicators that most reliably and comprehensively reflect the level of development of agricultural organizations and to complement the technology of multidimensional comparative assessment with an algorithm for determining the uniformity of the development of agricultural producers. The methodological basis of the research was general scientific methods of analysis and systematization of data: comparison, generalization, rating assessment, and economic and statistical analysis. As a result, the authors developed a system of evaluation indicators, reflecting the availability and use of material and technical base, financial condition, investment activity, use of labor force, effectiveness, and efficiency of agricultural organizations. The rating assessment toolkit is supplemented by calculating the variation indices of the rating scores. The results of approbating the proposed methodology on the materials of the Kochubeyevsky municipal district of the Stavropol Territory are presented. The system of rating indicators, reflecting the main aspects of agricultural organizations, is formed. The construction of the rating is supplemented by the calculation of the variation indices of the rating scores, which allowed the authors to draw conclusions about the uniformity of the development of agricultural organizations in the region.

**Keywords**

Business economy • Enterprise and development • Regional analysis • Microeconomic analysis • Agriculture

**JEL Classifications**

M210 • O120 • O180

## 1 Introduction

An important methodological tool for the managerial evaluation of economic entities is the construction of ratings. The rating makes it possible to conduct an individual assessment of an organization according to certain criteria based on inter-farm comparisons. This assessment is necessary for the internal management system and external stakeholders.

Assessment of the financial and economic situation of agricultural organizations from the position of regional level management is necessary to trace the level and trends of their development and adequately adjust industry strategy and directions and forms of state participation. Agricultural organizations are in search of effective business models. They are interested in creating a benchmark of sustainability

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for benchmarking; receiving a positive rating is an additional competitive advantage for them. Investors need information to determine investment attractiveness and make an informed choice of business counterparties.

For informational satisfaction of the requests of all stakeholders, an easy-to-use methodological basis is needed, which makes it possible to measure the results achieved and conduct a multidimensional comparative assessment of the activities of different organizations, coherent for the organizational and regional levels of management. This research aims to refine and supplement the toolkit for rating assessment of agricultural organizations. The research tasks are as follows:

- To form the system of indicators that most reliably and comprehensively reflect the level of development of agricultural organizations.
- To supplement the technology of multidimensional comparative evaluation with an algorithm for determining the uniformity of agricultural producers' development.

## 2 Methodology

The methodological basis of this research includes general scientific methods of analysis and systematization of data: abstract-logical, monographic, and computational-constructive methods.

Many authors focus on the issues of assessing the activities of business organizations. Increased attention is paid to the rating assessment of the financial condition of organizations; such studies are conducted by Baranov & Khokhrina (2021), Bashirov & Lukyanova (2019), Soldatova (2022), Slutskaya & Chalganova (2019). Ivkina (2020), Martynenko (2020) use ratings to assess competitiveness. Plaskova & Prokofieva (2021)use ratings for assessing investment attractiveness. E. E. Dozhdeva and P. S. Kharitonova use it to diagnose the enterprises' financial security (Dozhdeva & Kharitonova, 2022). Oborin (2022) proposes a method of constructing a rating of territories. Antonova & Plotnikova (2019), Fomin & Mukhametzyanova (2023), and Melnikova & Petrova (2020) describe the performance ratings of enterprises in various industries. The peculiarities of the construction of ratings of small business entities are given by Burda & Burda (2022), and Skiba (2021). Kasymova (2023) considers the formation of ratings as an element of management.

The multifunctionality of rating assessment determines the wide possibilities of its application and a variety of methods for forming evaluation indicators of the rating. A review of the economic literature allowed the authors to systematize them and distinguish two approaches. In the first case, the rating is based on a single indicator. In the second case, the rating is based on a system of indicators.

In our opinion, using a single evaluation indicator is acceptable to build a rating for individual, narrow aspects of the organization. A comprehensive rating assessment requires a system of indicators. The rating assessment that is based on a set of indicators will make it possible to characterize the position of an economic entity more comprehensively and objectively. These ratings make it possible to compare multidimensional objects, identify effective and problem areas, and, on this basis, adjust the development trajectory.

This is especially important for agricultural organizations because they are complex socio-economic systems with many factors affecting their condition. The most objective judgment about their activities can be obtained based on a comprehensive analysis, which will reveal the real level and efficiency of the use of material, technical, labor, and financial resources, investment activity, and financial condition of the organization.

The choice of evaluation criteria plays a decisive role. These criteria must be as informative and reliable as possible in reflecting the real situation of the evaluated objects. The proposed approximate list of indicators for evaluating certain aspects of agricultural organizations includes three groups of indicators.

The first group includes the most general indicators of the results of economic activity: revenue per unit area, the average growth rate for the last 2–3 years, the level of productivity calculated based on the method of the Ministry of Economic Development as a measure of added value per one employee of the enterprise. The sum of three financial indicators is used as components of value added: profit before taxation, wages, and salaries with deductions to non-budgetary funds, and depreciation.

The second group includes the organization's net profit per unit area and relative performance indicators, which generally represent the ratio of various categories of profit to certain resources of the organization involved in its formation. These indicators include return on assets that characterizes the efficiency of the use of all property, the rate of return on production that reflects the efficiency of current costs, and return on sales that makes it possible to judge the effectiveness of marketing activities.

The third group consists of indicators to assess the financial condition of the organization, characterizing its financial stability and reliability. These indicators include the current liquidity ratio that characterizes the organization's solvency, the coefficient of autonomy that shows its dependence on creditors, and the ratio of reserves by own funds that reflects the ability to self-finance the current activities.

The fourth group consists of indicators to assess the state of the material and technical base of the organization. These indicators include equipment, capital equipment, and the serviceability factor of fixed assets.

Indicators of the investment activity of organizations are allocated to a separate group. These indicators include the three-year average rate of investment in fixed capital per unit of cultivated area, the three-year average rate of growth of investment, and the coefficient of investment load calculated as the ratio of the amount of capital investment to revenue.

The sixth group consists of indicators characterizing the use of live labor and the social sustainability of the organization: the annual output per employee, the average salary, and the coefficient of change in the number of employees.

The inclusion of pace indicators in the system of evaluation indicators will provide information about the current position of the organization and trends in its changes.

The calculation of the integral index of comprehensive assessment is carried out based on private integral indicators for each group, which makes it possible to determine the position of each organization in different areas of activity. Due to the specific nature of agriculture, there are no normative values for most of the criteria selected for evaluation. This fact rules out the normative approach. In this case, the benchmark for rating construction is the best of the achieved in the totality of the values of the compared indicators. A benchmark organization is formed, which does not exist in reality but is characterized by the best values for all evaluated indicators. This approach eliminates the subjectivity of expert evaluations and guides agricultural producers to the levels of development actually achieved by their neighbors. The calculation is made based on method Sheremet & Horin (2019), which involves determining the deviation of actual indicators from the best, taken as a benchmark. In this case, the rating involves not the absolute values of indicators but coefficients calculated as the ratio of the actual indicator to the benchmark. Companies are ranked based on the evaluation results. The organization with the lowest score has the highest rating. The evaluation is conducted separately for each group of indicators. Next, an aggregate indicator is calculated, which includes the results of the evaluation for each group with equal weights.

The rating makes it possible to identify the advanced and lagging farms and structure the population by identifying organizations with stable production parameters and intensive growth rates, farms with the potential to improve performance, and organizations with low parameters and negative dynamics.

Supplementing the rating with the calculation of the variation indices of rating scores makes it possible to obtain information about the uniformity of development of agricultural organizations in the region.

During the research, the authors used specialized software, which made it possible to calculate standardized coefficients, rank them, and determine the indicators of variation in rating grades.

## 3 Results

The proposed methodology was tested on the materials of agricultural organizations of the Kochubeyevsky municipal district of the Stavropol Territory. The authors compiled ratings according to the indicators that characterize the main aspects of the activities of agricultural organizations. Based on the developed ratings, the authors conducted a comprehensive assessment and determined an integral rating (Table 1).

In terms of performance, the best results are shown by the Agricultural production cooperative "Polyarnaya Zvezda," "Belomechetskoye" LLC, and Agrofirm "Agrosakhar-3" LLC. In terms of the state of the material and technical base and availability of fixed assets, the best indicators are observed at Agrofirm "Agrosakhar-3" LLC, "Kolos" JSC, and "Mezhdurechye" LLC. "Mezhdurechye" LLC, Agricultural production cooperative "Polyarnaya Zvezda," and "Kolkhoz-plemzavod named after Chapaev" LLC are the most active in terms of investment activities. According to the indicators of personnel use, the leaders are Agrofirm "Agrosakhar-3" LLC, "Kolos" JSC, and Agrofirm "Agrosakhar-3" LLC. All analyzed enterprises of the Kochubeyevsky district are financially stable and solvent. The differences mainly concerned the provision of current operations with own funds. The best results from the position of complex evaluation were shown by the Agricultural production cooperative "Polyarnaya Zvezda," which had the minimum rating number (4.33). The least successful is "Novy Put" LLC, with a rating number of 7.06.

The variation indices of the rating scores are calculated in addition to the rating. The results of the calculations show that the greatest unevenness is observed in the development of agricultural organizations in investment, financial condition, and performance efficiency (Table 2).

Distribution of agricultural organizations of the district by the degree of investment burden confirms the conclusion about the differentiation of organizations in this area of activity:

- 16% do not make investments.
- 16% have a share of investment in revenue less than 10% (low level).
- 60% of agricultural organizations have an investment burden of 10%–30% of revenues (average level).
- 8% invest more than 40% of revenues (high level).

**Table 1** Results of a comprehensive rating assessment of agricultural organizations of the Kochubeyevsky municipal district

| Names of organizations | Rating by aspects evaluated | | | | | | Final rating score | Places in the rating |
|---|---|---|---|---|---|---|---|---|
| | Efficiency | Results | Material and technical resources | In vestment | Use of personnel | Financial condition | | |
| Agricultural production cooperative "Polyarnaya Zvezda" | 0.61 | 0.45 | 1.00 | 0.85 | 0.61 | 0.81 | 4.33 | 1 |
| Agrofirm "Agrosakhar-3" LLC | 0.87 | 0.76 | 0.77 | 1.56 | 0.38 | 0.24 | 4.58 | 2 |
| "Belomechetskoye" LLC | 0.78 | 0.89 | 1.20 | 0.94 | 0.68 | 0.11 | 4.60 | 3 |
| Agricultural enterprise "Kolos" JSC | 1.26 | 0.69 | 0.88 | 0.96 | 0.59 | 1.00 | 5.38 | 4 |
| "Kolkhoz-plemzavod named after Chapaev" LLC | 1.52 | 0.55 | 1.04 | 0.69 | 0.79 | 1.00 | 5.59 | 5 |
| Agricultural production cooperative Kolkhoz-plemzavod "Kazminsky" | 0.97 | 0.53 | 1.37 | 1.13 | 0.70 | 1.00 | 5.70 | 6 |
| Agricultural enterprise "Starodvortsovskoye" LLC | 1.09 | 0.73 | 1.05 | 1.72 | 0.69 | 0.51 | 5.78 | 7 |
| "Mezhdurechye" LLC | 1.30 | 0.55 | 0.94 | 0.71 | 0.77 | 1.53 | 5.80 | 8 |
| "Runo" LLC | 0.92 | 0.82 | 1.21 | 1.08 | 0.79 | 1.00 | 5.82 | 9 |
| "Selkhozprom" LLC | 1.31 | 0.90 | 1.14 | 1.73 | 0.66 | 0.45 | 6.19 | 10 |
| Agricultural enterprise plemzavod "Kuban" LLC | 1.57 | 0.80 | 1.28 | 1.07 | 0.77 | 1.00 | 6.47 | 11 |
| "Novy Put" LLC | 1.66 | 0.99 | 1.46 | 1.73 | 0.87 | 0.35 | 7.06 | 12 |

*Source* Compiled by the authors

**Table 2** Indicators of variation in rating scores

| Names of organizations | Efficiency | Results | Material and technical resources | In vestment | Use of personnel | Financial condition | Final rating score |
|---|---|---|---|---|---|---|---|
| Scope of variation | 1.0 | 0.538 | 0.68 | 1.33 | 0.33 | 0.45 | 2.73 |
| Variance | 0.11 | 0.03 | 0.04 | 0.16 | 0.02 | 0.17 | 0.64 |

*Source* Compiled by the authors

## 4 Conclusion

The proposed toolkit of comparative analysis of the activities of agricultural organizations is designed to form an objective view of their activities and meet the information needs of stakeholders. The formed system of evaluation indicators objectively and reliably characterizes the main aspects of agricultural organizations. The presented methodical approach and calculation algorithms expand the information capabilities of the rating assessment and are aimed at improving the methodological support of analysis, control, and management of decision-making.

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# The Concept of Re-equipment of Nevinnomysskiy Azot JSC Production in the Conditions of the Development of Agricultural Economy Based on Digital Technologies

Elena N. Pavlenko, Elena V. Vernigorova, Aznaur Z. Mamkhyagov, and Olga V. Krasovskaya

**Abstract**

The objective of this research is to examine the challenges related to the output of chemical industry enterprises. The study is based on the theoretical and methodological framework established by previous scientific research and publications from both Russian and international authors who have investigated various aspects of enhancing the efficiency and competitiveness of large industrialized agricultural enterprises and complexes. This includes evaluating the effectiveness of long-term investment projects in the agricultural industry. The existing approaches for improving industry competitiveness are mostly context-dependent and may not be universally applicable. Currently, Nevinnomysskiy Azot JSC faces the important task of achieving dynamic growth in organic synthesis production and delivering high-quality, competitive products. This involves enhancing existing resource-saving and environmentally friendly technologies while introducing new ones. To address the issues discussed in this research, the authors propose two specific solutions: (1) implementing a scheme to separate the acetaldehyde fraction from the distillate of the column using an additional rectification column, which will enable its transfer to acetaldehyde production in shop No. 9, and (2) installing two additional heat exchangers, one for each synthesis unit, to preheat the steam-gas mixture before entering the reactors. The MS-20 oil, emerging from the synthesis reactors, will be used as a heat carrier, thereby reducing steam-20 consumption for vinyl acetate production. The research also addresses the challenges in increasing the efficiency of the vinyl acetate production shop and proposes potential approaches to enhance overall productivity. An essential prerequisite for successfully achieving these goals is the increased adoption of domestic digital innovations within the agricultural sector.

**Keywords**

Digital technology • Innovative technology • Organic synthesis • Modernization • Increased productivity • Reconstruction • Vinyl acetate

**JEL Classifications**

L65 • M29 • Q12

## 1 Introduction

In the present-day context, ensuring the effectiveness of agricultural complexes is crucial, considering the escalating sanctions pressure, the shift toward import substitution, and the rising prices of key raw materials for foreign agricultural complexes. These factors contribute to decreased profitability. The effectiveness of agricultural complexes is especially important, necessitating the exploration, development, and implementation of products aimed at enhancing competitiveness, productivity, and the timely assessment of agricultural product demand (Gordeev et al., 2019).

Although current approaches to improving industry competitiveness are largely situational, their applicability is generally universal (Bogdanov, 2018). Nevertheless, taking into account sector-specific factors can contribute to the implementation of more efficient mechanisms, including in agricultural production. As a representative example of mass production, the agricultural industry faces the challenge of determining efficient production in the current circumstances (Aptekman et al., 2017).

In the past decade, numerous large companies have adopted formal corporate governance policies through the

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utilization of project management methodologies (Kochetkov et al., 1993). The application of project management techniques proves particularly effective in areas such as space, communications, electronics, fuel and energy, construction, and several other technologies, given their inherent dynamics. The growth of these industries is accompanied by the increased size and complexity of the organizations and businesses involved. This trend holds particular relevance for the agricultural industry, thus informing the choice and focus of the current research topic (Gordeev et al., 2019).

## 2 Methodology

The scientific research is grounded on the theoretical and methodological foundations presented in the scholarly papers and publications of both Russian and foreign authors who investigate a wide range of issues related to enhancing the efficiency (competitiveness) of large industrialized agricultural enterprises and complexes, as well as evaluating the effectiveness of long-term investment projects in various industries, with a specific focus on the agricultural sector (Reus & Zinchenko, 2019).

The classification of projects demonstrates that project management is a pivotal area in contemporary management and public administration (Romanova, 2019).

The production planning process generally involves several stages. Initially, it is essential to establish the project's goals, objectives, format, and scope. Subsequently, the planning budget needs to be determined, necessary resources allocated, and responsible parties identified for project implementation and development. The outcome of the initial planning phase is a comprehensive project master plan, encompassing schedules, activities, budgets, and other relevant documents (Efremov, 2010). The resources required for project execution, as well as the sequence, duration, and cost of production, determine the project's format and scale (Pokrovsky, 2017).

Risk planning, including identification, recognition, and assessment, as well as risk management, significantly influence scheduling and budgetary requirements (Diethelm, 2018). Clearing goals, defining boundaries for unique tasks, and structuring teams and responsibilities provide a solid foundation for project creation's effectiveness (Chernikov, 2019).

Practical experience demonstrates that project management is increasingly being applied throughout the economy, especially within individual industries. The significance of studying the management characteristics of agricultural projects primarily stems from the requirement to accelerate economic development through more balanced resource management (Gray & Larson, 2003).

Research has revealed that all projects share a common characteristic of being complex processes with distinct features or attributes. At the same time, each project remains independent and unique (Voropaev, 2018). Projects are carried out to benefit project stakeholders, including organizations, groups, or individuals with a vested interest in achieving project outcomes. Often, these innovative projects are of significant importance to society or the economy as they contribute to scientific and technological progress (Lipsitz & Kosov, 2019).

Today's priorities for developing and implementing projects in various industries are of great importance from a practical point of view.

The analysis makes it possible to determine the critical areas of the development and implementation of projects in the agro-industrial complex (AIC). From the authors' point of view, the most promising areas are as follows:

The implementation of import substitution policies has provided a significant boost to the growth of innovative projects in numerous areas of project management within these industries. This development can be attributed to the imposition of raw material sanctions and geopolitical constraints, which have necessitated a shift toward self-reliance and the development of alternative solutions.

According to UN projections, the global population will reach 9.8 billion people by 2050 (Fig. 1).

The analysis of the population growth rate (Fig. 1) and the agricultural production growth rate (Fig. 2) shows that there will be a severe food shortage in the world in the foreseeable future. Under sanctions pressure, the search for ways to transition to import substitution, including in the AIC, is underway. For example, Russia has been experiencing an acute shortage of seeds for growing crops since 2022.

The main key problems of the AIC are as follows:

- Weak competitiveness of agricultural products on the world market;
- Significant wear and tear and obsolescence of basic agricultural assets.

The project planning process involves many interrelated iterations. The result of these studies is a single consolidated plan (Milner, 2019).

Implementing such planning can be carried out through information management systems, such as those based on geographic information technology (Popov & Yakovenko, 2018).

The following is defined during the planning with the use of GIS technologies:

- Land use efficiency;
- Technology need;

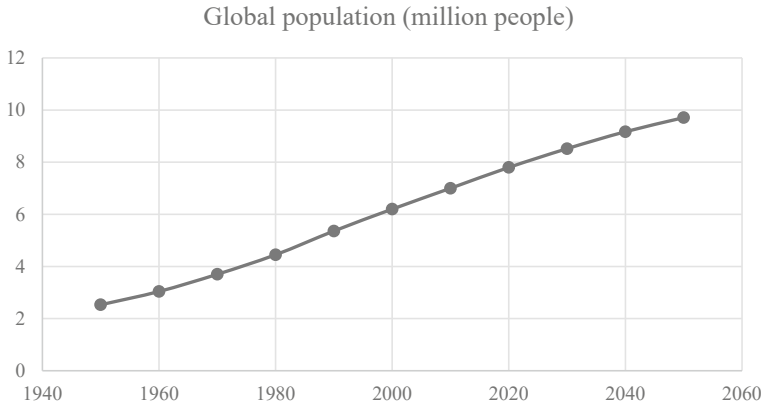


**Fig. 1** Population growth rate. *Source* Compiled by the authors based on (Gordeev et al., 2019)

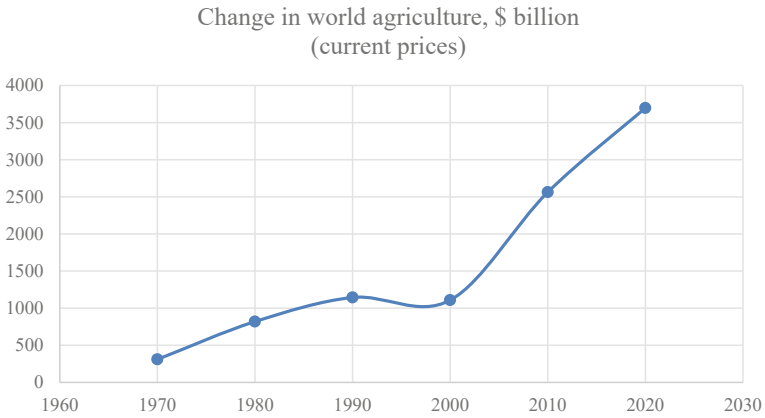


**Fig. 2** Change in world agriculture. *Source* Compiled by the authors based on (Gordeev et al., 2019)

- Calculation of the amounts of seeds and fertilizers;
- The sequence of tillage and introduction of fertilizers and protection products.

This planning eliminates the downtime of mechanized equipment used for tillage, sowing, and harvesting.

Additionally, GIS technologies are used to monitor the condition of soils and crops continuously.

The utilization of Geographic Information System (GIS) technologies plays a significant role in the management and planning of agricultural production. These technologies enable the collection, storage, processing, and analysis of geodata associated with crops, soils, climatic conditions, and other relevant parameters. With the help of GIS technologies, it becomes possible to accurately assess the potential of land plots, identify optimal seeding locations, and optimize resource utilization, such as water and fertilizers. Furthermore, GIS technologies facilitate the monitoring of crop conditions and the prediction of yields, providing valuable insights for informed decision-making in agricultural production management. In essence, GIS technologies serve as a powerful tool for enhancing the efficiency and economic effectiveness of agricultural production while minimizing its environmental impact.

GIS technologies offer the capability to conduct comprehensive data analysis and present the results in the form of specialized graphs and tables, thereby enabling more effective data visualization.

The evaluation of accumulated data and the outcomes derived from the use of GIS technologies make it possible to forecast future yields across different sections of fields and make informed decisions regarding the sequence and cultivation methods for sown areas. Additionally, they can help predict crop losses resulting from weather and soil conditions.

To enhance the unified system of project management in the Agricultural Industry Complex (AIC), the incorporation of drone technology is of utmost importance (Porshneva et al., 2019). The widespread adoption of drones allows for real-time assessment of field conditions, monitoring crop maturation processes, and early detection of insect infestations. Furthermore, agricultural drones enable the creation of electronic field maps, monitoring of agricultural activities, and safeguarding of farms. Through video monitoring, the condition of the soil can be determined, serving as the basis for selecting suitable areas for sowing. Unmanned aerial vehicles can also be employed for crop and soil treatment using agrochemical substances (Orlova et al., 2020).

According to J'son & Partners Consulting, the analysis of the smart farming market revealed that in 2010, there were no more than 20 companies prepared to undertake projects for automating agricultural management (Kalyanov, 2017). Presently, the number of such companies has reached approximately 2000. This analysis highlights the formation of a distinct market sector known as AgTech, which has experienced consistent investment growth, surpassing FinTech within a few years (Gordeev et al., 2019).

The experience of leading Russian companies and agricultural holdings demonstrates that leveraging innovative technologies and enhancing digital interactions can result in cost reductions and enhance the industry's competitiveness. Research indicates that the decision to digitally transform the industry should be straightforward, cost-effective, and accessible to most businesses as it is essential to increase the production of high-quality goods (Thompson & Strickland, 2012).

Smart agricultural technologies encompass innovative solutions that improve production processes and optimize resource utilization in agriculture. These technologies can be broadly classified into four main categories: sensors and monitoring, process automation, data analytics, and robotics. Sensors and monitoring systems are employed to gather diverse data, including soil conditions, climate factors, and moisture levels, among others. This data assists agricultural producers in making informed choices regarding seeding, fertilization, and irrigation. Process automation enhances the efficiency and precision of production processes such as harvesting and tillage. Data analytics aids in processing large volumes of information and identifying patterns, enabling agricultural producers to make accurate decisions. Additionally, robotics enables the automation of labor-intensive tasks, replacing manual operations with automated alternatives. Overall, smart agricultural technology serves as a crucial tool for improving efficiency and economic effectiveness in the field of agriculture (Voropaev, 2018).

Currently, Russian experts acknowledge the challenges in accurately assessing the economic impact of agricultural digitization. Nevertheless, these technologies hold the potential to enable efficient and rapid management of this sector. According to experts, we can expect three key developments in the near future for the agricultural industry: the emergence and growth of digital platforms focused on product promotion, the advent of new technological solutions in breeding and plant protection, and the necessity for training staff in new hard and soft skills (Korolev, 2018).

Amid heightened competition from chemical and petrochemical producers in Asia and the Middle East, the chemical industry in Russia is grappling with declining profitability due to escalating costs of essential raw materials. In this context, the stringent requirements imposed by the Russian Federation to ensure the efficiency of the chemical complex play a significant role, necessitating the exploration and development of novel approaches to enhance product quality, processes, and competitiveness of chemical enterprises.

Present approaches to improving industry competitiveness tend to be context-dependent, with limited universal applicability. However, considering the unique characteristics of the chemical industry can contribute to the introduction of new mechanisms aimed at enhancing the efficiency of economic entities. As a representative example of mass production, the industry faces the challenge of determining optimal production strategies in the current environment (Zarenkov, 2017).

The primary production facilities of chemical enterprises were established during the 1960s and 1970s, with some old equipment still in operation and outdated technology being used. In a highly competitive landscape, increasing consumer demands for the quality of finished products compel companies to incorporate new materials and technologies into production processes, undertake modernization efforts on obsolete equipment, or entirely replace them, and actively implement resource-saving technologies. Thus, there exists a clear imperative to modernize outdated production facilities while establishing new ones (Thompson & Strickland, 2012).

Currently, a large share of variable costs is associated with hydrocarbons, particularly natural gas. The share of the cost of purchased gas is about 30% of the total variable costs for certain types of products. However, in the medium term, given the planned increase in the price of hydrocarbons, it is expected that the value share of this type of raw materials will increase to 75% by 2025.

Such rates of price increases will cause chemical companies to lose a significant portion of their profits due to increased costs, including those for hydrocarbon raw materials. These consequences can be avoided if companies start modernizing outdated technology and production now.

## 3 Results

The dynamic development of organic synthesis production and the production of high-quality and competitive products based on the enhancement of existing and the implementation of new resource-saving and environmentally friendly technologies is currently a crucial objective for Nevinnomysskiy Azot JSC.

Regarding the prominent issues pertaining to the existing vinyl acetate production at Nevinnomysskiy Azot JSC, the following aspects can be highlighted. The vinyl acetate production facility of Nevinnomysskiy Azot JSC was established in 1973. The technological process consists of two synthesis units, AS-1 and AS-2, as well as one rectification unit, ensuring continuous production. Acetylene and

acetic acid, both manufactured at Nevinnomysskiy Azot JSC, serve as raw materials for vinyl acetate (VAC) production. Zinc acetate catalysts in the form of granules of active carbon impregnated with zinc acetate solution are employed.

In accordance with the current technological scheme, distillation of the vinyl acetate fraction containing acetaldehyde is carried out in a distillation column. The distillation process generates a distillate with a mass content of acetaldehyde amounting to 55%. Subsequently, the distillate undergoes thermal decontamination and incineration. The distillate flow rate from the column reaches up to 50 L per hour. Analytical control performed by the COTK-IC reveals that the mass content of acetaldehyde in the distillate corresponds to 55%, equating to approximately 160 tons of acetaldehyde per year (Nevinnomysskiy Azot JSC, 2021).

As per the existing technological scheme, the heating of the vapor–gas mixture (VGM) before its introduction into the reactors occurs in two stages. Initially, after passing through the evaporators at a temperature ranging from 68 to 100 °C, the VGM enters the inter-tube space of the recuperator, where it is heated by the reaction gases emitted from the synthesis reactors. Subsequently, the VGM proceeds to the heater, where it is heated to a temperature between 165 and 185 °C, essential for the synthesis of VAC, depending on the catalyst's service life.

The following technical solutions are offered to solve the problems of production technologies:

- It is proposed to create a scheme for separating acetaldehyde fraction from the distillate of the column on an additional rectification column for subsequent transfer to the production of acetaldehyde in shop No. 9 for sale to a third-party consumer or subsequent processing. As an additional column to the existing column, it is proposed to use a rectification column for the production of butyl acetate that was decommissioned;
- It is proposed to install two additional heat exchangers, one on each synthesis unit, for heating the VGM before entering the reactors using MS-20 oil, leaving the synthesis reactors as a coolant, which will reduce steam-20 consumption for vinyl acetate production. Steam-gas mixture with a temperature of 160 ºC under the pressure of 0.5 kgf/cm$^2$ after the heaters (instead of steam-20, it is proposed to use steam-10 as a heat carrier in heaters) will go to the inter-tube space of a newly installed recuperator, where it will be heated to a temperature of 175–195 ºC by oil MS-20. The VGM will then be sent to the reactors. Oil MS-20 with a temperature of 175–205 ºC will be fed into the pipe space and then, according to the existing scheme, will be sent to the suction of circulating pumps (Nevinnomysskiy Azot JSC, 2021).

The implementation of the mentioned solutions will make it possible to increase the capacity of the existing vinyl acetate production and, consequently, increase the profit due to sales of additional product volume (vinyl acetate and acetaldehyde), reduce variable costs of finished product output (vinyl acetate), extract up to 160 tons of acetaldehyde per year, reduce the volume of emissions into the atmosphere by reducing the amount of acetaldehyde fraction previously burned at the thermal decontamination unit, reduce the cost of acetaldehyde and vinyl acetate production, and keep the competitiveness at the sales market.

## 4 Conclusion

The agricultural sector in Russia is experiencing rapid growth and possesses the necessary resources to embrace digitization within the industry.

Given that the pricing policy greatly influences the sale of domestic agricultural products, the vital prerequisite for advancing the agricultural sector lies in the adoption of Russian digital innovations. Strengthening state support for the chemical industry and Russian scientific research, as well as optimizing state regulation, are crucial in achieving an optimal approach to addressing the digitalization of agriculture (Gordeev et al., 2019).

Simultaneously, effective management of projects within the Agricultural Industry Complex (ACI) necessitates a comprehensive approach to agricultural development, integrating new technological solutions, particularly in the realm of continuous crop monitoring.

The concept of production re-equipment at Nevinnomysskiy Azot JSC, in the context of cultivating an agricultural economy founded on digital technologies, aims to enhance production efficiency and market competitiveness. This concept entails the implementation of advanced digital technologies in production processes, including automation of management, system monitoring and diagnostics, optimization of planning processes, quality control, and resource management. Furthermore, it involves the application of novel methods and technologies such as artificial intelligence, the Internet of Things, big data, and data analytics. By implementing the concept of production re-equipment based on digital technologies, Nevinnomysskiy Azot JSC can increase production efficiency, elevate product quality, reduce production costs, mitigate environmental risks, and enhance labor safety.

Moreover, the introduction of digital technology in production will bolster the company's market competitiveness and contribute to regional economic growth. As a result, the concept of production re-equipment at Nevinnomysskiy Azot JSC, in the context of an agricultural economy built on

digital technologies, exhibits substantial potential to refine production processes and promote competitiveness within the enterprise.

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# SDG7. New Assessment Methods

Elena B. Zavyalova, Tatyana G. Krotova, and Parul Tyagi

**Abstract**

The research analyzes the elements of the assessment of Sustainable Development Goal 7 (SDG 7) and proposes modifying them to make them more representative of reality. According to the UN methodology, SDG 7 is assessed by four key elements: the share of the country's population with access to electricity, the share of the country's population with access to clean fuels, $CO_2$ emissions from electricity production, and the share of renewable energy sources in the total volume of primary energy supplies. This research proposes that it would be more logical to use indicators such as the level of electrification of the country, the price per kW of electricity for consumers, the price of natural gas, the share of renewable energy in a country's energy balance, the share of nuclear power plants in a country's energy balance, and coal consumption. Based on the results of the analysis carried out using the UN methodology, the authors compiled a final rating and a table of gaps (the difference between the country's indicator and 100% of achieving the indicator).

**Keywords**

SDG 7 • Assessment method • Affordable energy • Reliable energy • Sustainable energy

**JEL Classifications**

C13 • C18 • C83 • F62 • F64

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## 1 Introduction

Traditionally, the OECD countries have been featured as the leaders in the UN Sustainable Development Report for achieving SDG 7 due to the large share of renewable energy sources (RES) in their energy balance. However, electricity prices in these countries are very high after an increase in gas prices in 2022. The increase is so significant that large production facilities have to be transferred from the EU to other countries; and people are organizing rallies against exorbitant electricity bills. This fact casts doubt on the composition of the statistical parameters used to calculate SDG 7 in the official UN report. In the research, the authors propose a set of parameters that better reflect current trends in achieving the goal of accessibility to clean energy sources for everyone. Conclusions are drawn based on the results obtained.

## 2 Methodology

In their work, the authors used economic analysis, empirical and analytical methods of examining official statistics, and methods of calculation and ranking to present the obtained results.

## 3 Results

According to UN experts, the achievement of all seventeen SDGs is possible only with the collective investment of governments, non-governmental organizations, and all other stakeholders in six main areas (Olivier & Peters, 2019).

The UN Sustainable Development Report specifies that the third transformation, which affects clean public energy and a closed-loop economy, aims to ensure universal access to advanced energy sources and de-carbonize energy systems by 2050 in accordance with the Paris Agreement.



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To achieve climate neutrality, countries need to make three types of commitments:

- To join the Net Zero 2050 alliance under the auspices of the UNFCCC and other partners;
- To integrate the principles of climate neutrality into their national policies and legislation;
- To adopt and implement policies, create regulations, and invest in achieving climate neutrality by the middle of the century (Olivier & Peters, 2019).

According to Climate Action Tracker (CAT), an organization that independently evaluates 36 countries and the EU (with a total share of about 80% of global emissions), none of the G20 countries have made enough commitments to meet the Paris Climate Agreement. According to Energy Policy Tracker, the G20 countries provide subsidies for fossil fuels in economic recovery packages post-COVID-19 pandemic, which directly contradicts the Paris Agreement (Polyakova, 2022). Moreover, after the 2022 sanctions and the subsequent multiple gas price increases in the EU, the climate agenda has been completely ignored, with the opening of coal mines in the UK (Jacobs, 2022) and permitting the cutting of trees in France due to the incredibly high price of firewood.

As of April 2021 (Welker et al., 2022), the largest subsidies for fossil fuels in USD per capita are provided by the United Kingdom ($590), Canada ($467), the USA ($219), and Germany ($196). To comply with the terms of the Paris Climate Agreement, this parameter must be zero.

However, this fact does not affect the SDGs indicators of achievement for these countries by 2030 because this parameter is not considered in the rating.

The UN methodology for assessing achievement of SDG 7 includes percentage of the country's population with access to electricity, clean fuels, and technologies for cooking; $CO_2$ emissions from electricity generation ($MTCO_2/TB_T$ and share of renewable energy sources in the total volume of primary energy supplies. These sources include geothermal, solar, wind, tidal, and wave sources, as well as energy obtained from solid biofuels, biogas, biodiesel, and other liquid biofuels and biogas.

It is not surprising that with such a calculation methodology, OECD countries are the leaders in achieving SDG 7. However, the reality in 2022 was that these countries experienced a tenfold increase in energy prices. The increase was so steep that it forced the local manufacturers to close production facilities and relocate elsewhere to countries where energy was more affordable. Moreover, citizens had to reduce the temperature in their residences and still pay hefty electricity bills. In the reports, we see impressive figures for the sustainable achievement of clean energy availability. In reality, despite 100% physical accessibility to sources, the unaccounted/disregarded financial developments lead to job losses due to the relocation of production and there was a significant drop in the living standards of the population (Sachs et al., 2021).

Additionally, the terms "environmentally friendly energy sources" and "renewable energy sources" are not interchangeable. Renewable energy sources include solar panels, wind turbines, tidal installations, hydroelectric power plants, and thermal power plants. For some reason, only the volume of emissions during the operation of these installations is considered, which is certainly less. However, the environmental damage during their production and disposal is no less (and sometimes even more) than that of thermal power plants powered by natural gas and nuclear power plants (emissions from which are extremely small during operation) (Earthworks, 2021). In 2020, greenhouse gas emissions from the entire Russian nuclear industry amounted to only 0.04% in $CO_2$ equivalent (CIA World Factbook, 2021). Although it is not based on renewable energy sources, electricity generated by one nuclear power plant can meet the needs of an entire city at an affordable price. The transition to purely renewable energy sources should not be made until the invention of environmentally friendly way of their disposal is found.

With this objective, clean public energy sources (nuclear power stations) should definitively be added to clean public energy sources. It is also too early to abandon gas-fired thermal power plants, given that they emit significantly less greenhouse gases than coal and are available at an affordable price.

We need to also consider the cost of a kilowatt of electricity in countries with a high share of RES in the country's energy balance, which consequently leads in achieving SDG 7. For example, the share of renewable energy in the energy balance of the Netherlands is 33%, while electricity and gas prices are very high (CIA World Factbook, 2021). This fact shows that a high proportion of unlimited energy sources does not guarantee their free-of-charge availability. The price of electricity per kW in the Netherlands was $0.338 in 2021 (Uberti, 2022), which is four times more than that in Russia. All developed countries promoting renewable energy in the world have the same problem. Although general access to electricity is provided, in terms of its accessibility to the consumer, these countries are much inferior to Russia, Turkey, and Iran, which have been under sanctions for forty years but provide the most affordable gas and electricity for the end user (Bazarbaeva et al., 2021).

Due to the consideration of only RES as a clean energy source to fulfill SDG 7, developing and underdeveloped countries (even those with their own sources of natural gas) are forced to incur high costs in purchasing wind turbines

and solar panels, which are mainly produced in developed countries. Instead of investing this money in their own economy or providing jobs and higher salaries, they are just supporting the production of RES (E2nergy, 2018).

We will use the following indicators to look at the SDG 7 achievement in terms of environmental friendliness and affordability, as well as to compile the rating and identify the countries' problems in achieving this goal:

- The price per kW of electricity for consumers;
- The price of natural gas;
- The share of renewable energy in the country's energy balance;
- The share of nuclear power plants in the energy balance countries;
- The consumption of coal, which is considered one of the main sources of $CO_2$ emissions when used in industry (especially when burned at thermal power plants) (Table 1).

The data for the selected group of countries were recalculated according to the UN methodology according to the following formula:

$$x' = \frac{x - (x)}{(x) - (x)},$$

where max/min denotes the boundaries for the best and worst values of the indicator (taken as the average of five worst and best values); $x'$ is the normalized value after re-scaling; $x$ is the data for this indicator for a particular country.

If no value was available for a country, it was excluded from the calculation and not taken as 0 not to spoil the country's statistics and give a distorted picture.

Based on the analysis results, a final rating and a table of "gaps" (the difference between the country's achievement and 100% achievement on the indicator) were compiled (see Table 2). Bold in the table indicates that the target will not be achieved by 2030, but there is significant progress. Italic signals that the target will not be reached while the bolditalic shows that not only will the goal not be reached, but there are sizable unsolvable problems.

When such indicators are used to determine the achievement of SDG 7, the challenges and solutions for countries and the statistics used to calculate the necessary rates of growth or decline are visible. Moreover, this approach considers the achievements and problems of developed, developing, and underdeveloped countries for which the Sustainable Development Concept was originally designed.

For example, it is visible why the Netherlands and China are so close in the ratings.

High coal consumption is the main reason for China's poor ranking. In 2021, the country consumed 4102 million tonnes of coal, while the value calculated for the minimum consumption (average of five minimum) is 1 million tonnes of coal per year. Thus, coal consumption in the country should be reduced by an average of 40% annually in the next decade to achieve this value (US Energy Efficiency Renewable Energy (EERE), 2022).

The Netherlands was among the laggards due to high energy prices. Despite the high share of renewable energy in the country's energy balance, electricity prices there are extremely high (Welker et al., 2022). Consequently, even with unlimited energy sources, their availability to the consumer is not guaranteed. This limits the development of production in the country.

## 4 Conclusions

During the research, the UN statistics used to compile the final ranking of countries in the implementation of SDG 7 were questioned. After analysis, the following set of criteria was proposed:

- The level of electrification of the country;
- The price per kW of electricity for consumers;
- The price of natural gas;
- The share of RES and nuclear power plants in the country's energy balance;
- Coal consumption, considered one of the main sources of $CO_2$ emissions when used in industry (especially during combustion at thermal power plants).

The analysis was carried out according to the ranking methodology with equal weightage to all incoming parameters proposed by the UN (Jacobs, 2022). Thus, we can conclude that no country will reach SDG 7 by 2030. However, the leaders on the rating list are not Scandinavian countries (as in the UN reports) but Ukraine (for 2021), Canada, Norway, and Turkey. In terms of the physical availability of energy resources and their cost, these countries are leaders because the price of a kilowatt of electricity in these countries is the most affordable. Cheap electric power allows industry to develop and provide a decent standard of living for the country's citizens as they do not have to pay exorbitant electricity bills, contrary to what we see in Europe as of the end of 2022 with multiple increases in gas prices.

China and the Netherlands close up on these ratings. The reasons are very different. While China consumes a lot of coal, the price of energy resources in the Netherlands is very high despite the high share of RES in its energy balance (which is considered in the EU as the best way to achieve

**Table 1** Indicators of coal consumption, the share of RES and nuclear power plants in the country's energy balance, price of electricity, and natural gas for the households

| Country | Coal consumption in the country (million tons), 2021 | Share of renewable energy sources in the energy balance, % | Share of nuclear power plants in the country's energy balance, % | Price per kW of electricity, USD | Natural gas prices for households, December 2021 (kWh, USD) |
|---|---|---|---|---|---|
| Australia | 92 | 26.66 | 0 | 0.224 | 0.076 |
| Algeria | 0 | 0.79 | 0 | 0.037 | 0.003 |
| United Arab Emirates | 3 | 4.04 | 1.3 | 0.081 | |
| Argentina | 1 | 24.51 | 7.2 | 0.045 | 0.008 |
| Belgium | 4 | 23.79 | 50.8 | 0.322 | 0.104 |
| Brazil | 29 | 78.35 | 2.4 | 0.184 | 0.178 |
| Great Britain | 9 | 40.72 | 14.8 | 0.334 | 0.108 |
| Germany | 164 | 41.53 | 11.9 | 0.342 | 0.144 |
| Egypt | 2 | 9.72 | 0 | 0.044 | |
| India | 1024 | 20.39 | 3.2 | 0.075 | |
| Indonesia | 138 | 18.66 | 0 | 0.097 | |
| Iran | 3 | 2.27 | 0.1 | 0.005 | 0.001 |
| Spain | 5 | 47.11 | 20.8 | 0.326 | 0.093 |
| Italy | 9 | 41.38 | 0 | 0.244 | 0.138 |
| Kazakhstan | 76 | 10.93 | 0 | 0.042 | |
| Canada | 22 | 67.97 | 14.3 | 0.114 | 0.034 |
| China | 4102 | 28.80 | 5 | 0.081 | |
| Columbia | 5 | 74.51 | 0 | 0.138 | 0.041 |
| Malaysia | 38 | 18.05 | 0 | 0.05 | 0.027 |
| Mexico | 7 | 21.95 | 5.3 | 0.084 | 0.069 |
| Nigeria | 0 | 19.81 | 0 | 0.057 | |
| Netherlands | 9 | 32.78 | 3.1 | 0.338 | 0.189 |
| New Zealand | 3 | 80.95 | 0 | 0.189 | 0.06 |
| Norway | 1 | 99.01 | 0 | 0.139 | |
| Poland | 112 | 17.42 | 0 | 0.163 | 0.062 |
| Portugal | 0 | 65.55 | 0 | 0.235 | 0.075 |
| Russia | 214 | 19.26 | 20 | 0.085 | 0.009 |
| Romania | 20 | 44.37 | 18.5 | 0.192 | |
| Saudi Arabia | 0 | 0.11 | 0 | 0.048 | |
| USA | 497 | 20.54 | 19.6 | 0.162 | 0.043 |
| Taiwan | 65 | 6.51 | 0 | 0.095 | 0.03 |
| Thailand | 38 | 17.66 | 0 | 0.103 | |
| Turkey | 124 | 35.18 | 0 | 0.052 | 0.01 |
| Uzbekistan | 9 | 9.12 | 0 | 0.027 | |
| Ukraine | 40 | 16.10 | 55 | 0.057 | 0.028 |
| France | 11 | 22.61 | 69 | 0.188 | 0.1 |
| Czech | 36 | 13.91 | 36.6 | 0.25 | 0.117 |
| Chile | 13 | 47.19 | 0 | 0.154 | 0.097 |
| Switzerland | 2 | 67.04 | 30.8 | 0.228 | 0.239 |
| South Africa | 188 | 9.16 | 0 | 0.15 | |
| South Korea | 117 | 8.62 | 28 | 0.1 | 0.05 |
| Japan | 182 | 22.35 | 7.2 | 0.224 | 0.09 |

*Source* Data compiled by the authors based on open sources (CIA World Factbook, 2021; Earthworks, 2021; US Energy Efficiency Renewable Energy (EERE), 2022)

**Table 2** Final ranking of countries according to SDG 7

| Country | Achievement of SDG 7 (in %) | Gap in the achievement of SDG 7 (in %) | Country | Achievement of SDG 7 (in %) | Gap in the achievement of SDG 7 (in %) |
|---|---|---|---|---|---|
| Ukraine | **94** | **6** | Saudi Arabia | ***66*** | ***34*** |
| Canada | *89* | *11* | Chile | ***65*** | ***35*** |
| Norway | *88* | *12* | Thailand | ***64*** | ***36*** |
| Columbia | *84* | *16* | South Africa | ***63*** | ***37*** |
| Argentina | *84* | *16* | Indonesia | ***63*** | ***37*** |
| Turkey | *81* | *19* | Brazil | ***61*** | ***39*** |
| Nigeria | ***79*** | ***21*** | USA | ***61*** | ***39*** |
| Russia | ***79*** | ***21*** | Belgium | ***60*** | ***40*** |
| New Zealand | ***78*** | ***22*** | Spain | ***59*** | ***41*** |
| Algeria | ***75*** | ***25*** | Switzerland | ***58*** | ***42*** |
| Malaysia | ***75*** | ***25*** | Poland | ***58*** | ***42*** |
| Iran | ***75*** | ***25*** | Czech | ***55*** | ***45*** |
| Romania | ***75*** | ***25*** | Australia | ***54*** | ***46*** |
| South Korea | ***72*** | ***28*** | Great Britain | ***52*** | ***48*** |
| France | ***72*** | ***28*** | Japan | ***51*** | ***49*** |
| Mexico | ***69*** | ***31*** | Italy | ***49*** | ***51*** |
| Uzbekistan | ***69*** | ***31*** | Arab Emirates | ***47*** | ***53*** |
| Egypt | ***69*** | ***31*** | India | ***43*** | ***57*** |
| Kazakhstan | ***68*** | ***32*** | Germany | ***43*** | ***57*** |
| Portugal | ***67*** | ***33*** | China | ***42*** | ***58*** |
| Thailand | ***66*** | ***34*** | Netherlands | ***36*** | ***64*** |

*Source* Obtained by the authors based on the conducted analysis

SDG 7). Additionally, a certain variation in the concepts of environmentally friendly energy sources and carbon neutral and renewable energy sources was revealed. It was pointed out that Renewable energy sources only transfer the carbon footprint to the point of production and processing while $CO_2$ released when using gas and nuclear power is less on an average (Ecology of Russia, 2021).

Finally, releasing greenhouse gases during the extraction, processing, and transportation of fossil fuels is one of the main sources of $CO_2$ in the atmosphere. However, with advanced technologies that make it possible to use associated gas to generate electricity, emissions into the atmosphere can be reduced by 97%, ensuring circularity and energy efficiency of production.

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# Exit Interview as a Tool to Reduce Staff Turnover in an Organization

Svetlana N. Kaznacheeva, Irina B. Bicheva, Lyubov Yu. Shobonova, Tatiana V. Krylova, and Natalya V. Belinova

**Abstract**

The authors discuss an important tool, an exit interview that makes it possible to reduce staff turnover and increase the attractiveness of the company's HR brand. Opportune and high-quality decision-making is the main task of any manager who strives to work for the benefit of their company. After all, a competent decision and the lack of a solution can cost the company a lot and have irreparable consequences for its development. A problem is the primary motivating element of each administrative decision-making process. The essence of the decision-making process is to develop a strategy to bring a given object to the desired state. In choosing and implementing a solution to the problem, various criteria that allow choosing acceptable ones from a variety of existing proposals are applied. From them, the most important and preferred ones are chosen for achieving the goals and mission of the organization. The quality of the personnel management system is an urgent area of research by scientists from various countries. Content analysis of research shows that conducting interviews with employees is usually considered part of the selection and evaluation of personnel. The authors studied the essence and main goals of the exit interview. An exit interview with an employee is not conducted or is conducted relatively formally. There are the results of a study of the practice of using exit interviews in the activities of large Russian employers. The necessity and expediency of using the exit interview in the process of dismissal of employees of the organization is proved. There are basic principles of exit-interview implementation.

**Keywords**

Personnel • Personnel management • Dismissal of employees • Interviews • Exit interviews

**JEL Classifications**

M12

## 1 Introduction

Opportune and high-quality decision-making is the main task of any manager who strives to work for the benefit of their company. After all, a competent decision and the lack of a solution can cost the company a lot and have irreparable consequences for its development (Shkunova et al., 2018; Sineva & Yashkova, 2017). The result of a specific administrative activity of management is a management decision. P. V. Magdanov gives the following definition of a management decision, "a management decision means the preparation of a set of assessments and conclusions about the current and future state of the management object and the adoption by an authorized person of a final and binding resolution about the control action on the management object" (Magdanov, 2011). A problem is the primary motivating element of each administrative decision-making process. The essence of the decision-making process is to develop a strategy to bring a given object to the desired state. Thus, the basis for developing a goal is the situation that causes the problem. Its description makes it possible to understand the factors that need to be thoroughly analyzed when making a decision.

The process of developing an administrative decision is as follows. Initially, as a criterion for finding a problem, the target setting is most often used, by changing which the problem's existence is judged. The management decision-making stage begins with collecting and processing information necessary to create a course of action.

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In choosing and implementing a solution to the problem, various criteria that allow choosing acceptable ones from a variety of existing proposals are applied. From them, the most important and preferred ones are chosen for achieving the organization's goals and missions.

Improving the effectiveness of personnel policy in today's conditions is considered one of the key areas of management activity. From the point of view of ESG management, this reflects the fundamental provisions of the social responsibility of the head of the organization to the staff in attracting, retaining, and motivating them (Borisova & Belonogov, 2022).

A competent employee can increase labor productivity. Therefore, the quality of the personnel management system is an urgent area of research for scientists from various countries. Researchers pay their attention to the following individual problems and ways to improve the personnel management system:

- The development of a system of motivation for innovative labor activity of employees at small enterprises,
- The primary adaptation of personnel as a process of assimilation of organizational culture,
- The improvement of the effectiveness and efficiency of personnel selection and evaluation,
- Management of the formation and development of the system of internal corporate training of personnel and others.

Content analysis of research shows that conducting interviews with employees is usually considered part of the selection and evaluation of personnel. This is primarily because employers do not always know the true reasons for the dismissal of their employees (HeadHunter, 2021; Skirta & Morozova, 2015).

## 2 Methodology

An interview is a method of collecting objective information based on verbal interaction between people. The interview is used primarily at the stage of personnel selection for an open or planned vacancy in the future (Eliseeva, 2022). Additionally, it is advisable to conduct interviews when making personnel decisions such as training and development planning, formation of a personnel reserve, individual and group evaluation, career counseling, outplacement, or dismissal. Table 1 shows the main types of interviews.

Recruitment takes up a significant part of the recruiter's working time. It analyzes the applicants' questionnaires, selects the most suitable ones, then conducts an interview and makes a conclusion. When interviewing an applicant, there is a risk of being "deceived." The reason for the risks may be professionally performed self-presentation and biased assessment by the employer (the appearance of sympathy or antipathy to the applicant). As a result, an error occurs when hiring: an applicant who does not have the essential competencies can get a vacancy (Pavlova, 2022). Additionally, the recruitment process requires certain funding. For example, specialists from HR services may be invited, or a request is sent to develop various kinds of tests to identify certain competencies. In this regard, mistakes made when accepting an employee often lead to leaving the organization before he or she has worked for a year. Moreover, the employer does not always understand the reasons for dismissal because only 65% of companies conduct exit interviews (HR Pro News, 2022).

**Table 1** Types of interviews

| Criteria | Interview |
|---|---|
| By structure | Structured<br>Unstructured |
| By the format | Individual<br>Mass<br>Collegial/panel<br>Telephone/video |
| By functionality | Elimination<br>Qualifying<br>Final/exit |
| By content | Bibliographic<br>Situational/case interview<br>Behavioral<br>Stress<br>Interview on competencies<br>Projective deep<br>Mixed |

*Source* Developed and compiled by the authors

## 3 Results

Usually, an exit interview with an employee is not conducted or is conducted relatively formally. At best, HR staff offers an exit questionnaire, which the retiring employee fills out also formally (Kaznacheeva & Kaznacheev, 2023).

According to FinExpertiza, 77% of the total number of retired employees in Russia left of their own volition over the past 2022. Several reasons were listed HR Blog "Potok." (n.d):

- Low salary level—31%;
- Stress at work, burnout—15%;
- Lack of career growth—13%;
- Desire to work closer to home—7%.

Among other reasons are an unfavorable atmosphere in the team, conflicts with management, and an unofficial salary.

**Table 2** At what point is it best to conduct an exit interview?

| Answer options | Percent |
|---|---|
| When an employee just announced his or her resignation | 41 |
| When all documents are completed and material assets are handed over | 30 |
| When the final decision is made and the application was signed | 24 |
| Other | 5 |

*Source* Compiled by authors based on (HR-media, 2015)

Foreign studies show that insufficient pay takes only the third place; the first two factors are a lack of professional growth and a bad manager. According to Gallup, 52% of those who quit say that their manager or organization could have done something to prevent them from leaving their jobs. The lack of feedback from their supervisors becomes an indirect reason for leaving. Therefore, an increasing number of companies are using exit interviews to study problem areas. According to Headhunter, 75% of Russian employers put the final interview into practice, including Lenta, Gazpromneft, Econika, etc. (HR-media, 2015).

We would like to submit the results of a survey of Russian employers on the following issues:

- "Are exit interviews conducted in your company?" (Fig. 1);
- "When, in your opinion, is it impossible to do without an exit interview?" (Fig. 2);
- "At what point is it best to conduct an exit interview?";
- "Do you see prospects for the development of such a form of work with personnel as an exit interview?" (HR-media, 2015).

The research data show that most Russian employers (75%) conduct exit interviews when dismissing employees. Moreover, in 39%, this interview is considered a standard procedure. According to every tenth employer, the importance and prospects of such a practice are noted.

As can be seen from Fig. 2, more than half of employers (65%) consider exit interviews as a necessary and mandatory procedure, primarily in dismissing personnel of professional value to the organization. Additionally, exit interviews are advisable in case of controversial cases and high staff turnover (57% and 56%, respectively).

Most respondents chose the answer "when an employee has just announced his or her resignation departure" (41%). According to 30% of respondents, it is better to do this when all documents are completed.

The following responses were received to the question "Do you see prospects for the development of such a form of work with staff as an exit interview?" (HR-media, 2015):

- Yes, it is a very useful and informative tool—41%;
- Yes, I noticed that many companies began using it—38%;
- No, I do not think it will be used in the Russian labor market—5%;
- I can say nothing about this—10%;
- Other—5%.

Most respondents are inclined to believe that this form has prospects for development and consider it a useful tool for working with personnel (41%). According to 38% of respondents, many companies actively use exit interviews. Simultaneously, 10% of employers find it difficult to answer the question. The impossibility of exit interviews in work practice is noticed by 5% of respondents. In general, almost 20% of employers do not define exit interviews as significant and relevant in personnel policy.

However, a properly conducted exit interview can be one of the effective tools for reducing staff turnover and

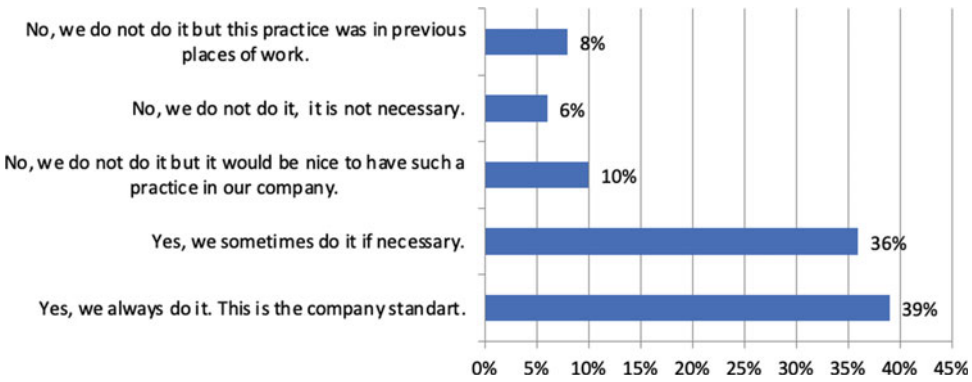


**Fig. 1** Do exit interviews occur in your company (exit interview)? *Source* Compiled by the authors based on (HR-media, 2015)

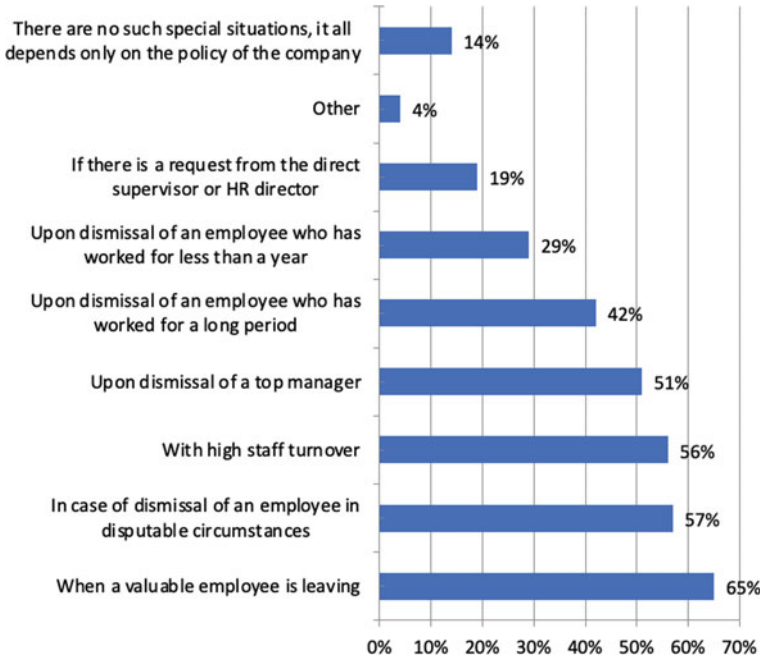


**Fig. 2** When, in your opinion, is it impossible to do without an exit interview? *Source* Compiled by authors based on (HR-media, 2015)

increasing the attractiveness of the company's HR brand. Let us highlight several advantages of exit interviews.

First, the employee conducting this interview can express gratitude to the employee on behalf of the employer and clarify what, in his or her opinion, problems exist in business processes. As a result, the formal nature of the interview acquires the features of a professional dialogue, which allows the employee to maintain a favorable impression of the organization and reduces the likelihood of negative reviews about the company.

Second, by offering assistance to an employee, one can recommend taking a test and discussing the results together, demonstrating attention to the employee and showing his or her value to the organization. In such conditions, an employee who made a decision to dismiss "on negative emotions" often realizes his or her mistake and can continue professional activity.

One of the successful trends in the dismissal of an employee in the considered context is a chatbot, which makes it possible to determine strengths and weaknesses quite effectively and efficiently.

When conducting an exit interview, the following principle should be followed: the interview should not be conducted by a direct supervisor. An employee planning to leave the organization will not always be frank, and the manager may not be objective enough.

An employer can achieve various goals using exit interviews (HR Pro News, 2022). Let us highlight the main ones:

1. Identification of HR problems based on the study of objective reasons for dismissal. The solution to this goal is to find ways to increase the effectiveness of recruiting, motivation systems, the transformation of the organizational foundations of professional activity, professional and interpersonal relationships in the team, etc.
2. Identification of non-obvious violations. For example, the reason for the dismissal of an employee is an interpersonal conflict. In this situation, a "stipulation" of one of the colleagues often requires special care and objectivity when analyzing the causes of violations.
3. Reduction of the number of dismissals caused by the emotional instability of the employee and his or her inability to assess the situation adequately. Conducting a confidential conversation with such an employee and correctly formulating questions reduce his or her negative manifestations, allowing him or her to think and change his decision.
4. Protection of the company's reputation. An employee who leaves the organization due to accumulated resentment against the management or colleagues may spread negative information about the organization. To prevent this, one can simply allow the retiring employee to speak out. The employer's representative, having carefully listened to "all grievances," respectfully accepts them. Thus, the personnel service determines the negative aspects, which can be the basis for preparing for a possible information blow to the company's reputation in the future.
5. Maintaining friendly relations with former employees. The solution to this goal allows the organization to preserve the opportunity for a retired employee who has the necessary professional skills to return, which will

improve the reputation and activities of the company. The application of the principle "out of sight–out of mind" or "you cannot enter the same river twice" shows weaknesses in the field of human resource management in the organization.

## 4 Conclusion

Thus, a professionally conducted exit interview will reduce staff turnover in the organization, thereby saving the organization money allocated for the search for new employees. The results obtained after the exit interview will make it possible to monitor the situation in dynamics and respond promptly to emerging critical moments.

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# Prospects for the Development of Innovations in Digital Marketing

Olga V. Fokina, Anastasia A. Sozinova, Sergey V. Volkov, Vitaly V. Rychkin, and Pavel V. Orlov

**Abstract**

Digital innovative technologies are the driver of the modern economy, as they have a significant impact not only on the emergence of new professions, goods, and services, but also stimulate the activity of enterprises and organizations in various fields of activity. All this makes the purpose of the study—to study the prospects for the development of innovations in digital marketing—relevant. The problem-oriented approach, which makes it possible to focus on the analysis of innovative tools and technologies of digital marketing, has been chosen by the authors as the leading one. As a result, the article reveals the role of digital technologies at various stages of marketing development, analyzes the indicators of digital marketing development, identifies promising innovative tools, considers factors influencing the development of digital innovations, and outlines the directions of innovation development in digital marketing. The practical significance of the research results is the possibility of using digital innovation in business analytics and practice. The theoretical significance lies to highlight the scientific problem of the prospects for the development of innovations in digital marketing.

**Keywords**

Digital marketing • Innovation • Technologies • Tools • Development • Prospects

**JEL Classifications**

O30 • O31 • O33 • Q01 • Q02

## 1 Introduction

In modern conditions of market development, digital marketing is one of the most effective activities of organizations in every field. At the same time, the issues of innovation development in this sphere are not widely covered, which is one of the key problems of modern studies (Blanutsa, 2021). This determined the purpose of the work—to study the prospects for the development of innovation in digital marketing. The assumption of the leading role of innovation in the development of digital marketing is put forward as a working hypothesis. In accordance with the purpose, the article examines the role and trends in the development of digital marketing, reveals promising innovative technologies and tools, identifies factors affecting the spread of digital innovation, and identifies promising areas for the development of innovation in digital marketing.

The results of the study will be useful for the practical implementation of innovation in the field of digital marketing and are also of interest for further theoretical and practical developments.

## 2 Methodology

The theoretical and methodological basis of the research is based on the application of general and particular research methods. Analysis, synthesis, analogy, generalization, formalization, and others are used as general methods; comparison, measurement, and description are used as particular methods.

The logic of the study included the study of concrete and abstract concepts, judgments, and conclusions, which made

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it possible to put forward and substantiate the hypothesis of the study, to consider the main innovative tools of digital marketing, trends, and prospects for the development of innovations in digital marketing.

## 3 Results

Along with the active growth of scholary interest in innovation in digital marketing, which can be seen in many works by Zastupov (2020), Malyshev (2020), Karieva et al. (2021), Oklander et al. (2018), Pirogova et al. (2021), Popkova and Sozinova (2022), issues affecting the prospects of innovation development have not widely covered in the domestic scientific literature, with the exception of individual publications. It should be noted the works of Penkova (2023), Budagov and Molchanova (2022), Suraeva and Kochetova (2021), Shendo and Sviridova (2022), Krasnov et al. (2018), Isaeva et al. (2022). The prospects for the development of innovation in the field of digital marketing are considered in more detail in the works of foreign scientists, in particular Sitlani and Agarwal (2018), Mukhammadiev and Kasimova (2022), Mazur (2023), Gowsalya et al. (2020), Varadarian et al. (2021). A review of the scientific literature has shown that the issues of prospects for the development of innovations in the field of digital marketing are not fully highlighted. In addition, the factors determining the success of the development of digital innovation have not been sufficiently studied. All of the above indicates the need for research on this topic.

One of the most comprehensive definitions of digital marketing was given by the British Institute of Direct and Digital Marketing (IDM): "Digital marketing is the integrated use of information channels in the virtual space to support the company's marketing activities aimed at generating profit and retaining customers by recognizing the strategic importance of digital technologies and developing an integrated approach to best meet the needs of customers and to increase their awareness of the company, brand, products" (Luneva & Rebrova, 2021). During the development of Marketing 2.0, digital marketing means were mainly used to create advertising companies and segment customers. During the Marketing 3.0 period, digital marketing, which gave manufacturers new opportunities to promote brands, radically influenced the change in consumer behavior, where consumers turned from passive users into active participants in marketing activities. Marketing 4.0 is called a "reversal" from traditional marketing to digital. As F. Kotler states: "…Marketing 4.0 blends online and offline interaction between companies and customers, combines style with reality when creating brands and complements intercomputer communication with a human factor" (Kotler et al., 2019). In the Marketing 5.0 period, the role of digital marketing is to reproduce human abilities, find unstructured data about consumers and useful patterns in their behavior: "… The goal is to create a new generation of customer experience… To achieve this purpose, it is necessary to use a symbiosis of human and machine intelligence" (Kotler et al., 2021). Thus, digital marketing makes it possible to realize the goals set for the functioning of the enterprise in a digital environment, while using innovative tools that expand the information field of organizations and customers, contributing to the growth of customer satisfaction.

The digital share of marketing costs is constantly growing. In 2020, the global digital marketing market was estimated at $350 billion and is projected to reach $786.2 billion by 2026 (165 statistics, 2023). Digital marketing is also actively developing in Russia: if in 2017 the digital share in marketing costs was 40.6%, then in 2021 it was more than 52% (Market Sentiment Index, 2021). The segment ranking by digital share in budgets for the period 2020–2021 is presented in Table 1.

During the period under study, digital technologies showed the highest rates of development in the field of medical services and in the segment of communications. The transport segment noticeably lost ground, shifting from 6th place to 10th.

In the context of the dynamics of the digital market share for the period 2017–2021, almost all segments showed growth, with the exception of e-commerce (− 2.3%) and the segment of construction, finishing materials, plumbing (− 0.3%). The largest growth was shown by Internet services (+ 32.7%), trade (+ 25.9%), medical services (+ 25.8%), transport services (+ 24.9%), and the segment of medicines and dietary supplements (+ 22.5%) (Fig. 1).

In the context of industries, the largest volumes of digital marketing fall on advertising: in 2022, global spending on digital advertising was estimated at $441 billion and, according to forecasts, will reach $85 billion in 2023 (165 statistics, 2023). According to the Russian Association of Communication Agencies, the share of the Internet advertising market increased from 31.5% in 2015 to 82.9% in 2022, with growth rates exceeding market volumes (Advertising market volumes, 2022).

Every year, the marketing system is updated with innovative digital technologies and tools for influencing customers. The following are recognized as the most promising.

1. Short video formats that give commercials the effect of a reality show. At the same time, the cross-country differences determined the presence of a strong video trend in developed markets (The state of consumer technology, 2022). Users of the world's leading economies mainly focus on marketplaces, while in emerging markets social

**Table 1** Segment ranking by digital share in marketing budgets

| Place in the ranking | | Segment | Digital share, % | |
|---|---|---|---|---|
| 2021 | 2020 | | 2021 | 2020 |
| 1 | 1 | Audio, video products, games | 74.4 | 73.9 |
| 2 | 2 | Internet services | 67.7 | 64.7 |
| 3 | 10 | Medical services | 66.1 | 58.3 |
| 4 | 3 | Car dealers | 65.8 | 64.4 |
| 5 | 4 | Educational institutions | 65.6 | 62.2 |
| 6 | 5 | E-commerce | 64.3 | 61,7 |
| 7 | 7 | Tourism, sports, and recreation services | 61.9 | 60.3 |
| 8 | 9 | Real estate services | 61.2 | 58.6 |
| 9 | 8 | Appliances | 60.0 | 60.0 |
| 10 | 6 | Transport and related products | 60.0 | 61.3 |
| 11 | 16 | Communication facilities and equipment | 58.3 | 51,1 |
| 12 | 13 | Audio, video, film, and photographic equipment | 57.5 | 53.8 |
| 13 | 11 | Computer equipment and software | 57.1 | 55.2 |
| 14 | 12 | Mass media | 55.4 | 55.0 |
| 15 | 15 | Beauty and health products | 53.2 | 51,7 |
| 16 | 17 | Financial services | 52.5 | 50.3 |
| 17 | 14 | Entertainment industry services | 52.5 | 52.5 |
| 18 | 18 | Clothing and shoes | 48.6 | 43.6 |
| 19 | 20 | Catering services | 46.1 | 40,6 |
| 20 | 19 | Construction, finishing materials, plumbing | 45.4 | 42.1 |
| 21 | 21 | Medicines and biologically active supplements | 44.7 | 38.5 |
| 22 | 22 | Trade services | 40.9 | 37.8 |
| 23 | 23 | Food products | 39.4 | 36.8 |
| 24 | 25 | Communication services | 38.9 | 32.0 |
| 25 | 24 | Alcoholic beverages | 35.5 | 32.1 |
| 26 | 26 | Medical equipment and materials | 34.5 | 30.5 |

*Source* Developed and compiled based on (Market Sentiment Index, 2021)

networks are more actively used. This is confirmed by the statistics available in the Report on the state of consumer technologies and durables for 2022 (The state of consumer technology, 2022).

The reasons why companies resort to video formats in marketing are shown in Fig. 2.

2. Chatbots, available 24/7, instantly respond to requests. Over the period 2021–2022, the volume of the chatbot market grew by 92%, where 58% of B2B enterprises and 42% of B2C websites use them. At the same time, the reduction of operational costs for customer support reached 30% (Todorov, 2023). It is assumed that the development and customization of chatbots will become one of the most popular professions with a low entry threshold and high demand (Chatbot development trends, 2022).
3. Voice search with voice recognition, which helps to make orders and manage smart devices. According to a Microsoft report, 72% of users search for information through voice assistants and 25% of users make such purchases (Voice report, 2019). According to forecasts, in 2024, the global market for intelligent voice-activated speakers may reach $30 billion. It is expected that voice applications will become more intuitive, responsive, and easy to use in the future, which determines their further development.
4. Virtual (VR), augmented (AR), and mixed (MR) reality. According to the portal hypergridbusiness.com, 75% of the world's leading brands have already integrated technology into their marketing strategy (Raiskaya, 2019). Currently, there are about 80 thousand jobs in the field of VR, and it is expected that by 2030 their number will reach 2.32 million. The expected average annual growth of the market will reach 31.4% (Virtual reality statistics, 2023). The largest growth is predicted in the gaming industry, in the areas of manufacturing,

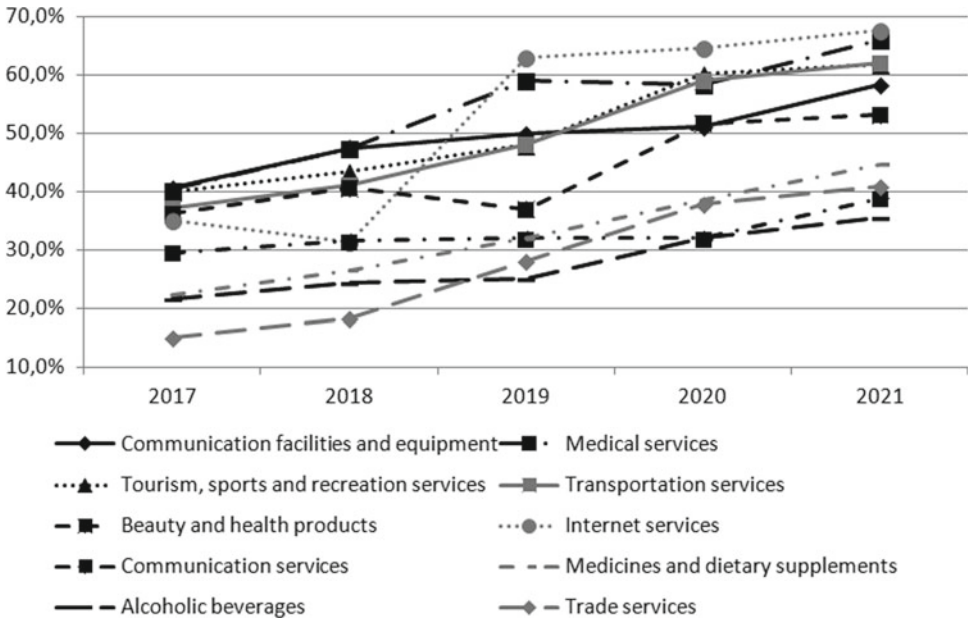


**Fig. 1** Dynamics of the digital share in marketing budgets by segment. *Source* Developed and constructed based on (Market Sentiment Index, 2021)

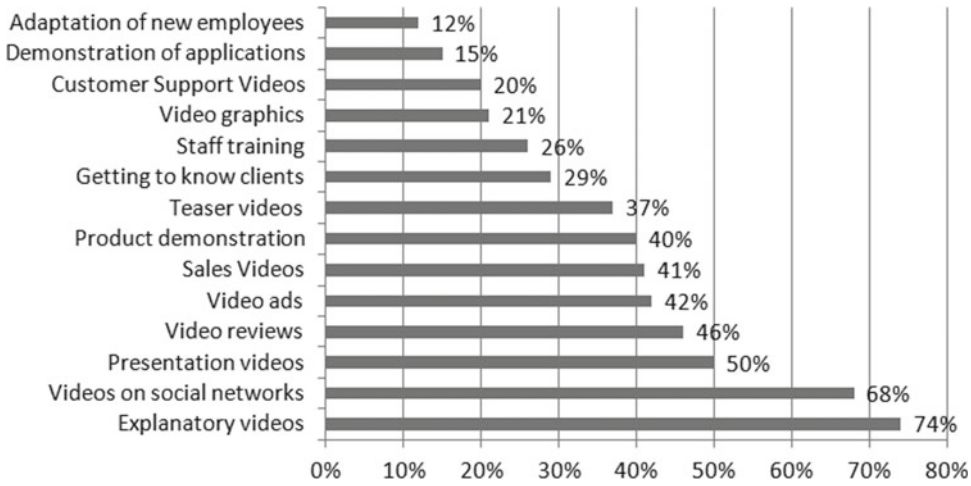


**Fig. 2** Reasons why companies use video. *Source* Developed and built based on (Digital Marketing, 2023)

automotive, marketing, and advertising. It is supposed to actively introduce technologies into educational processes.

5. Accelerated mobile pages (AMP). As a result of the use of technology, the download speed increases up to five times. Studies have shown a higher efficiency of contextual advertising on AMP compared to conventional pages: showing ads in the visible part of the screen increased by 80% and the clickability of ad blocks—by 90% (What AMP is, 2023).
6. Progressive web applications (PWA), which are the boundary between a regular website and an application. You can download such an application on an ordinary personal computer, as well as on a trading terminal and other device with Internet access. PWA development and support costs up to 70% cheaper than mobile. The creation of new, unique advanced products and technologies in the field of digital marketing is an essential element of the development of the economies of countries and one of the stimulating factors of innovative development in general. To date, it should be noted the most promising directions for the development of innovation in digital marketing.

1. Active implementation of artificial intelligence, which allows expanding contact with the audience through accurate audience profiling, improving the quality of information collection and analysis, retrieving customer behavior patterns, personalizing advertising exhibitions and design formats, etc.

2. Increasing attention to the formation of user experience, which is the basis for satisfying and creating a segment of loyal customers as a result of rising brand perception.
3. Development of influencer marketing. At the same time, it is assumed that the segment of influencers will gradually give way to content creators who are more focused on original content, rather than on creating an audience for which influencers receive payment.
4. Development of omnichannel marketing, which enables the interconnection of various channels for a more holistic interaction with customers, building stronger relationships, facilitating the process of making purchases, tracking the process of interaction with potential customers.
5. Development of technologies aimed at supporting employees, where their personal assets are often a more effective and loyally perceived tool by customers than business accounts and company assets.
6. Work with niche communities and forums, which are a safe space for participants to interact and a good way for customers to share information, get support, and also allow brands to adjust their algorithms.
7. Increasing attention to the creation of relevant, informative and high-quality content available to users at all digital points of interaction, minimizing the need to search for information elsewhere.

The undoubted advantages of innovation in digital marketing are the possibility of a more accurate understanding of the values and needs of customers, the creation of unique customer experiences, the wider use of communication channels, the processing of significant amounts of data, and so on. At the same time, there are still difficulties in implementing the innovative concept of digital marketing, in particular, insufficient competence of personnel, the complexity of integrating technologies into the marketing infrastructure, the possible opacity of decision-making by artificial intelligence, data leakage, and so on. Nevertheless, it is innovation that is the basis for the modern development of digital marketing, which allows, through the reasonable integration of technology and human resources, to effectively interact with customers, promptly respond to the needs of the target audience, evaluate, and predict the results of marketing decisions.

## 4 Conclusion

Thus, innovation in the field of digital marketing is gaining increasing popularity, being the basis for the emergence of new services. The largest growth over the past five years has been shown by services in the field of trade, medical, transport services, and the segment of medicines. Innovative technologies and digital marketing tools such as short video formats, chatbots, voice search, virtual, augmented and mixed reality, accelerated mobile pages and progressive web applications should be mentioned as the most promising. Promising areas for the development of innovation in digital marketing are the introduction of artificial intelligence; increased attention to the formation of user experience; the development of influencer marketing; the development of omnichannel marketing; work with niche communities and increased attention to the creation of useful content.

Radical innovation has been replaced by a constant transformation, which has led to the progressive active development of digital technologies in marketing, which enables companies to manage marketing activities, evaluate it at any point of interaction with the client, and increase the degree of customer satisfaction.

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# Parameters of the Development of Organizational-Economic Processes of Agriculture in the Conditions of Transformation

Lyubov B. Vinnichek and Nadezhda L. Smelik

**Abstract**

The research aims to identify the parameters of the development of organizational-economic processes of agriculture in the conditions of transformation for 2014–2020. The authors used an analysis of the chain growth rate and the average growth rate of livestock indicators for 2014–2020 and calculated the elasticity coefficient (ratio of relative increments) of crop yields for the corresponding acreage and the average elasticity coefficient for the considered period. The specific features of this stage of transformation of investments are determined. To assess the federal and regional transformation, it is recommended to calculate the average coefficient of elasticity of the yield of sunflower seeds and sugar beet, calculated by their sown area. The regional parameters of transformation in agriculture are the average coefficient of elasticity for potato yield by acreage.

**Keywords**

Organizational-economic processes • Transformation • Parameters • Agriculture • Region

**JEL Classification**

Q1

## 1 Introduction

The issues of transformation of socio-economic systems are currently actualized by various global impacts on the economies of many countries. Therefore, assessing the content of transformational processes at various levels is extremely relevant.

Thus, to study the macroeconomic transformation in the GDP of the Russian Federation, the Ryabtsev index is used as a stochastic average (industry ratios) in terms of natural and cost indicators (Shelegeda et al., 2018).

CP Timer, having studied the indicators of some countries, identified the growth rate of agricultural production and its share in GDP as a component of the transformation (Timmer, 2017).

Transformational shifts are calculated in the estimates of non-economic value criteria (changes in the standard of living and the rank of the country) (Martynov, 2018).

The measurement of transformation (digital) is proposed to be considered as structural changes in demand (for digital competencies) (Aletdinova et al., 2017).

The assessment of the transformation process is also carried out by the rates (economic growth of inflation, inflation), index (prices, agricultural production), and level (unemployment, productivity of factors of production) (Baranov & Bessonov, 2018). The analysis of China's economic transformation emphasizes that a decrease in the rate of economic growth is combined with a shift from exports and investments to consumption and an improvement in the quality of life (Martynov, 2019).

The three-sector model of structural transformation (in which agriculture is in the first place, the service sector is in the second, and industry is in the third) reveals a tendency for the duration of work and value-added in agriculture to increase with the level of development for 16 European countries (Herrendorf et al., 2013).

Endogenous structural transformations are investigated based on social planning in static, dynamic, and structural models (Lin & Xing, 2021).

The economy and agriculture of the Russian Federation do not have full access to financial resources in Europe. A significant consequence of such economic pressure was the transformation of the financial structure of investments in the industry under study. According to the authors, such a change in the predominant share of funds in the investments

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of the industry is called a structural transformation of investments in agriculture (Vinnichek & Smelik, 2022). Simultaneously, the transformation mechanism includes the coordination of changes (Smelik, 2014).

Therefore, it is important to study the nature of the coordination of the transformation of the external factor and organizational–economic changes in the industry. The research aims to identify indicators of the development of organizational and economic processes in agriculture in the conditions of transformation of the structure of investments in the industry. The objectives of the study are to evaluate the parameters of organizational and economic processes when comparing the coefficients of elasticity of indicators in periods of predominance of own funds.

## 2 Methodology

The authors analyzed the time series of indicators of agricultural production in the modern period of transformation (Federal State Statistics Service of the Russian Federation, 2021). In the dynamic series, the elasticity coefficients $E$ are calculated as modules of the ratio of relative increments of indicators. The authors calculated the average chain growth rates for 2015–2020. Data on agriculture of the Russian Federation and the Leningrad and Penza Regions were used for calculations (Federal State Statistics Service of the Russian Federation, 2022).

## 3 Results

As shown in Table 1, changes in yield are coordinated in various ways with changes in the acreage of agricultural crops in the Russian Federation and its regions.

The authors analyzed the current period of transformation (2014–2020). In the dynamic series, the elasticity coefficients $E$ are calculated as modules of the ratio of relative increments of indicators. Additionally, the authors calculated the average chain growth rates for 2015–2020.

At the present stage of transformation, the parameter of this process in the Leningrad Region can be considered the average coefficient of yield elasticity by acreage for potatoes ($E$ = 3.0), spring wheat ($E$ = 1.8), and vegetables ($E$ = 2.1).

For the Penza Region, the most stable in this dynamic series is the elasticity coefficient for potatoes and sugar beet. The highest average value of this indicator is typical for sunflower seeds ($E$ = 7.8), which confirms its value at the macro level ($E$ = 7.2).

Additionally, in the Penza Region, there is a similar coordination of yield and acreage ($E$ = 3.7) for sugar beet as at the level of the Russian Federation ($E$ = 3.8). Therefore, the average coefficient of elasticity for the yield on the sown area of sunflower seeds and sugar beet can be used as transformation parameters at the macro and regional levels. The average coefficient of elasticity for potatoes in the Penza Region ($E$ = 3.1) and the Leningrad Region ($E$ = 3.0) is the same, while it is significantly lower ($E$ = 1.4) at the level of

**Table 1** Elasticity of crop yields by their area of crops

| Names of cultures | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Average values |
|---|---|---|---|---|---|---|---|
| *Russian Federation* | | | | | | | |
| Winter wheat | 0.9 | 3.4 | 1.6 | 6.8 | 0.8 | 1.5 | 2.5 |
| Potato | 3.1 | 0.4 | 0.5 | 2.3 | 0.8 | 1.2 | 1.4 |
| Vegetables | 180.0 | 0.6 | 1.7 | 0.5 | 2.0 | 2.1 | 31.1 |
| Sugar beet | 0.4 | 2.5 | 0.7 | 2.3 | 16.0 | 1.2 | 3.8 |
| Sunflower seeds | 5.4 | 0.7 | 0.7 | 4.9 | 2.7 | 29.0 | 7.2 |
| *Leningrad region* | | | | | | | |
| Winter wheat | 0.0 | 0.5 | 1.2 | 0.3 | 0.1 | 0.9 | 0.5 |
| Potato | 1.6 | 3.2 | 1.5 | 1.4 | 1.2 | 9.3 | 3.0 |
| Vegetables | 0.5 | 5.2 | 0.2 | 0.5 | 1.2 | 4.8 | 2.1 |
| *Penza region* | | | | | | | |
| Winter wheat | 0.2 | 27.4 | 5.8 | 4.9 | 7.1 | 6.4 | 8.6 |
| Potato | 3.3 | 1.5 | 5.5 | 3.1 | 1.1 | 4.2 | 3.1 |
| Vegetables | 0.2 | 0.4 | 0.7 | 1.1 | 2.4 | 1.9 | 1.1 |
| Sugar beet | 1.0 | 2.6 | 0.1 | 6.1 | 11.1 | 1.6 | 3.7 |
| Sunflower seeds | 29.9 | 0.0 | 2.2 | 6.1 | 1.5 | 7.0 | 7.8 |

*Source* Author's calculation

**Table 2** Chain growth rates of indicators

| Names of cultures | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Average values |
|---|---|---|---|---|---|---|---|
| *Russian Federation* | | | | | | | |
| Cattle | 98.4 | 98.5 | 99.7 | 99.2 | 99.8 | 99.4 | 99.2 |
| Pigs | 110.0 | 102.4 | 105.2 | 102.8 | 106.0 | 102.7 | 104.8 |
| Sheep and goats | 100.6 | 100.4 | 98.6 | 94.8 | 97.7 | 95.7 | 98.0 |
| Milk | 99.6 | 99.6 | 101.3 | 101.3 | 102.6 | 102.5 | 101.1 |
| Egg | 100.7 | 103.5 | 102.9 | 100.2 | 100.0 | 100.0 | 101.2 |
| *Leningrad region* | | | | | | | |
| Cattle | 100.9 | 100.7 | 99.9 | 99.7 | 99.2 | 100.0 | 100.1 |
| Pigs | 103.1 | 94.4 | 95.8 | 99.4 | 96.0 | 107.1 | 99.3 |
| Sheep and goats | 115.2 | 112.1 | 101.5 | 102.4 | 94.0 | 98.4 | 103.9 |
| Milk | 104.1 | 103.3 | 102.9 | 100.5 | 102.1 | 103.3 | 102.7 |
| Egg | 98.9 | 96.0 | 107.6 | 98.9 | 97.0 | 104.5 | 100.5 |
| *Penza region* | | | | | | | |
| Cattle | 98.4 | 98.0 | 95.1 | 97.1 | 98.4 | 98.3 | 97.5 |
| Pigs | 99.5 | 65.6 | 120.9 | 114.7 | 130.4 | 87.4 | 103.1 |
| Sheep and goats | 100.0 | 96.5 | 94.8 | 95.3 | 99.7 | 92.8 | 96.5 |
| Milk | 101.5 | 101.2 | 102.2 | 99.4 | 100.8 | 111.5 | 102.8 |
| Egg | 100.0 | 100.0 | 100.2 | 85.2 | 105.4 | 113.3 | 100.7 |

*Source* Author's calculation

the Russian Federation. Thus, at the regional level, the average coefficient of elasticity for potato yield by its sown area can be used as a transformation parameter.

Additionally, the elasticity coefficient for winter wheat remains stable for the Penza Region. The average value of the elasticity coefficient of this culture ($E = 8.6$) exceeds similar values for the Leningrad Region ($E = 0.5$) and the Russian Federation ($E = 2.5$), which apparently constitutes a competitive advantage for this subject.

An analysis of the growth rates of livestock indicators in the country and regions is presented in Table 2.

The highest average growth rate is typical for the number of pigs (104.8%). The average rate decreased for cattle (99.2%), sheep and goats (98.0%). The production of milk (101.1%) and eggs (101.2%) increased slightly.

The Leningrad Region has its own characteristics. Significant growth in 2015–2020 is typical for the number of sheep and goats (103.9%) and milk production (102.7%). The number of pigs (99.3%) and cattle (100.1%) remains unchanged.

There is a coordination of average growth rates for cattle in the Russian Federation (99.2%) and in the Leningrad Region (100.1%). A similar coordination of rates is noted for the production of eggs in the country (101.2%) and in the Leningrad Region (100.5%), as well as milk (101.19% and 102.7%, respectively). We can conclude that the parameters of transformation at the macro level and at the level of the Leningrad Region in the reviewed period are the average growth rates of cattle, milk, and egg production. A decrease in average growth rates is noted for sheep and goats (96.56%) and cattle (97.5%).

Coordination of changes in the Penza Region and the Russian Federation is noted at an average rate for the number of pigs (103.1% and 104.8%, respectively), sheep and goats (96.5% and 98.0%, respectively), milk production (102.8% and 101.1%, respectively), and eggs production (100.7% and 101.2%, respectively).

A comparison of the indicators of the Penza and Leningrad Regions reveals a synchronous change in the growth rates of milk production (102.8% and 102.7%, respectively) and egg production (100.7% and 100.5%, respectively). These indicators are also consistent with indicators at the macro level for milk production (101.1%) and egg production (101.2%). Thus, the average growth rates of milk and egg production can be used as transformation parameters in agriculture.

## 4 Conclusion

The parameters of modern transformation in agriculture can be considered average elasticity coefficients yields on the sown area of sunflower seeds and sugar beet, average growth rates of milk and egg production.

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# Financial Transparency of Economic Activity as a Principle of Corporate Management of Agricultural Enterprises

Svetlana M. Bychkova and Zhanna V. Mikhaylova

**Abstract**

The authors reveal the concept of financial transparency of the economic activity of enterprises of the agro-industrial complex (AIC) using the methodology of strategic analysis. In the context of introducing digital technologies at agricultural enterprises, the flow of financial and non-financial information is increasing, which is inaccessible to many stakeholders of organizations. The research aims to implement the ESG approach in terms of corporate governance on the example of the agro-industrial complex using the methodology of strategic analysis. As a result, the authors identified significant groups of stakeholders of agro-industrial enterprises that have a direct or indirect influence on the formation of all types of reporting organizations. The stakeholders' influence on the reporting content is due to their information requests and special economic ties with the agro-industrial enterprise. To achieve financial transparency of economic activity, the authors defined a methodology for strategic analysis with the allocation of the main components: indicators, key indicators, and reporting. Using the data of an agro-industrial enterprise as an example, the authors presented the relationship between strategic objectives, indicators, and key indicators. The structure of the report for the main groups of stakeholders is proposed. The analytical data of the submitted report contain key indicators substantiated by certain indicators and strategic objectives for the development of the agro-industrial complex, making it possible to assess the effectiveness of management and the achievement of long-term goals.

**Keywords**

Strategic analysis • Stakeholders • Agribusiness • Financial transparency • ESG approach

**JEL Classifications**

D8 • G3 • M1 • M2

## 1 Introduction

The development of the ESG approach over the past 3–5 years in the corporate governance of many large organizations is essential. The current trend of economic development is reflected in the development of long-term sectoral strategies for large organizations and industries. In this context, at the end of 2022, a program for the long-term development of the agro-industrial complex of the Russian Federation (Strategy for the development of the agro-industrial complex of the Russian Federation until 2030) was approved.

The agro-industrial sector is an integral part of the economy of any country. It performs an important support function in the life of every economic entity. Despite the economic sanctions against Russia, which also affected the agro-industrial complex (AIC), the growth in the volume of export products in 2021 amounted to a total of 22% compared to the previous period. The share of exports of grain crops increased by 10% in the total structure of the country's agricultural exports. The share of oil and fat products increased by 48% (Expert, 2022). Export is the most profitable activity of the AIC, as evidenced by the results of the ratings of the leading companies in the industry (Da-Strategy Group, n.d.; Expert, 2022).

Satisfying the interests of users of the agro-industrial sector through the introduction and application of digital technologies at agro-industrial enterprises leads to an

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increase in various information sources that require certain processing, ordering, and data analysis.

The research aims to increase the financial transparency of the economic activity of agro-industrial enterprises using the methodology of strategic analysis.

To achieve the research goal, the authors solved the following research tasks:

1. To identify the main groups of industry stakeholders that determine the content of reporting that meets the criteria for financial transparency;
2. To determine the main directions of strategic analysis that contribute to the growth of financial transparency of the economic activities of agro-industrial enterprises;
3. To generate a report for the main groups of stakeholders using the methodology of strategic financial analysis.

The problem of generating open data on the results of activities is especially typical for large corporate structures, such as enterprises of the AIC. The formation and growth of financial transparency of the data provided for the main groups of stakeholders provide an opportunity for enterprises to gain a competitive advantage over similar industry organizations. Additionally, the information openness of the enterprise contributes to creating a positive business reputation on an industry scale and among other large organizational structures.

The financial transparency of economic activity characterizes the qualitative side of information data, representing the most open possible way of bringing information to the interested users of enterprises. The level of financial transparency of the economic activity of an industry enterprise is considered when building international and national ratings, making investments and choosing collaborates, and determining the degree of business confidence.

## 2 Materials and Methods

Russian and foreign scholars conduct research on the implementation of ESG principles in large corporate structures. Particularly, the authors studying the issues of disclosure of financial information include M. V. Melnik, O. V. Rozhnova, R. P. Bulyga, I. V. Safonova, and T. S. Lisitskaya (Bodiako et al., 2020; Bulyga et al., 2020; Da-Strategy Group, n.d.), M. G. Samoilenko, V. M. Igumnov, V. F. Nesvetailov, and others.

According to some authors (Bulyga et al., 2020; Nesvetailov, 2011; Ziyadin et al., 2018), the requirement to comply with financial transparency in reporting arose as a result of the implementation of the basic principle based on constant information and control in the management and decision-making system. Problems in the formation of open data are due to contemporary Russian legislation, which limits business in interaction with interested user groups, including the presentation of financial statements, as one of the main sources of data on the economic condition of the organization.

The authors note the significant influence of key stakeholders significant for corporate structures and industry enterprises on the formation and presentation of various types of financial and non-financial reporting. One of the objectives of the successful development of the enterprise is to satisfy the information and financial interests of the main groups of interested users, which is especially important for agro-industrial enterprises as economic entities significant for the economy and the public. The task of financial data generated by agricultural enterprises is to provide the main groups of users with open, accessible, and useful information they need to assess the current and future state of the industry.

Additionally, there is close attention to understanding and determining the level of financial transparency of corporations on the part of international and Russian rating agencies. Agro-industrial enterprises are rarely listed in the Top 100 international rating of economic entities with high financial transparency (Da-Strategy Group, n.d.). For example, PJSC PhosAgro has a low rating for this indicator among other significant corporate structures in Russia (CK Staff, 2021). Each independent rating agency sets its own criteria for assessing financial transparency, which include information about affiliates, financial performance, sustainable development policy, participation in public procurement and contracts, and other information.

The main sources for conducting a study of the financial transparency of the economic activities of agro-industrial enterprises are as follows:

- Official open data of industry organizations and corporations;
- Accounting (financial) reporting and other reporting of organizations;
- Data from independent rating agencies assessing financial transparency;
- Research by other authors in the field of financial transparency.

The methods used in this research include analysis, synthesis, induction, deduction, comparison, generalization, and a graphical method of presenting the results.

## 3 Results

Various studies interpret the concept of financial transparency differently, sometimes comparing it with transparency (Ahlberg & Jonnergård, 2014; Bulyga et al., 2020;

Zarsky, 2013). From the position of industry significance, financial transparency of economic activity is characterized by assessing the main groups of interested users of the enterprise's business activity in accordance with the selected information criteria (i.e., openness, understandability, accessibility, and usefulness). In independent studies and ratings, the criterion of financial transparency is of great importance among other business performance assessments.

Financial transparency of economic activity is a qualitative characteristic of the presentation of reporting information, which is based on a certain choice of accounting principles and reporting in the organization. The openness of the reported data should be observed for all major groups of interested users, considering their diverse requests.

However, the existing financial statements, generated in accordance with the requirements of the current legislation, do not meet today's requirements of usefulness for many groups of stakeholders (Efimova et al., 2021; Ziyadin et al., 2018).

When solving the problem of establishing the possible direct and indirect influence of the main user groups on reporting and, accordingly, achieving financial transparency of the economic activity of an industry enterprise, it is necessary to determine the following:

- The main groups of interested users, whose decisions are based on positive trends in the strategic development of the industry and on increasing the financial transparency of the economic activities of enterprises;
- Essential requirements and expectations of the identified stakeholder groups.

Based on the data of the official websites of agro-industrial organizations, available financial and other reporting, and various sources of published information on the activities of agricultural enterprises, the main groups of stakeholders of the AIC are identified, including the following:

1. Having a direct impact on the formation of reporting in the context of increasing financial transparency of the economic activities of agro-industrial enterprises: the state represented by the Government of the Russian Federation as the main regulator of agro-industrial complex facilities; other founders of agribusiness organizations (subsidiaries); other regulating state bodies; private investors; contractors and suppliers; and management of agro-industrial enterprises (top management).
2. Having no direct influence on the formation of reporting in the conditions of increasing financial transparency of economic activity: auditors and financial analysts; creditors and banks; employees of agricultural enterprises (middle and junior staff and management); and the region's population.

Stakeholders who influence (or do not) the reporting of the AIC are any business structures (legal entities) or significant individuals that form special economic and production ties with the enterprise.

The government, as the main regulator of the AIC objects, represented by the Government of the Russian Federation, performs the following functions:

- Controls the observance of national food security;
- Contributes to attracting investments in order to implement the objectives of the Development Strategy;
- Determines the degree and scope of openness of financial information of agro-industrial organizations.

In terms of the disclosed financial statements, information is not available on projects, areas, and individual facilities, the main state investments for which are made in solving the strategic tasks of the development of the AIC. It should be noted that information about the target capital management of the AIC is useful and interesting for other major groups of stakeholders (partners, investors, customers, and the public).

Other state regulatory bodies perform a supervisory function over the activities of the agro-industrial complex. This group of stakeholders regulates the presentation and format of open reporting based on financial and accounting data.

Disclosure of financial information characterizing the specifics of the activities of the AIC is not mandatory. For major aspects of the activities of agro-industrial enterprises, state authorities require disclosure based on laws or additional information requests. As part of the published reports of agro-industrial enterprises, financial information on the significance of the territories, the population, and the fulfillment of long-term development tasks are not presented.

The founders of subsidiaries are limited in obtaining confidential financial information on implementing certain strategic projects and activities.

Private investors determine the type of information requests that characterize the intended use of capital in the implementation of the main provisions of the Strategy for the development of the agro-industrial complex. Private investors are interested in obtaining data on the amount of return (profit) from their investments in long-term projects and types of activities. Additionally, they estimate the maximum size of their profit when comparing different types of projects within the framework of the strategic development of the AIC.

The management of agro-industrial enterprises (top management) is responsible for implementing the tasks set in the context of strategic development until 2030. The amount of remuneration for managers, as a rule, directly depends on the result of solving specific strategic tasks, including

increasing the financial transparency of the economic activities of enterprises. The financial transparency of the information provided (including reporting) on the activities of agro-industrial enterprises contributes to attracting the largest amount of public and private capital. However, they are significantly affected by the principles of corporate ethics and the requirement to comply with trade secrets.

Contractors and suppliers are interested in implementing the strategic plans of agro-industrial enterprises to provide them with the necessary resources. This group of stakeholders is interested in obtaining information about maintaining a constant flow of funding to solve the industry's strategic tasks. However, groups of users who have a direct influence on the formation of the level of financial transparency of economic activity have certain limitations in disclosing and obtaining the necessary information.

Lenders and banks belong to the group of stakeholders that do not directly affect organizations' reporting. The financial partnership is ensured by the successful implementation of the objectives of the Strategy for the development of the AIC.

Financial analysts and auditors are interested in obtaining reliable data on the strategic development of agro-industrial organizations to generate reasonable analytical reports for other users.

Employees of agro-industrial enterprises can influence the strategic development of industry enterprises, influencing the formation of individual financial indicators as part of their duties. Financial transparency of activities allows employees to assess the possibilities of maintaining a job at a given enterprise.

The region's population is interested in developing a certain territory in terms of food security and the availability of additional jobs, which can be assessed by analytical indicators of the industry's strategic development.

It is proposed to use the methodology of strategic financial analysis to increase the financial transparency of economic activity and provide reporting data for the main groups of stakeholders.

Strategic analysis is part of economic analysis, which is based on the generalization and evaluation of the organization's credentials (Gresko et al., 2020; Thomas et al., 1989). Such components as indicators, key indicators, and reporting are proposed to increase the financial transparency of economic activity in the context of the strategic development of the agro-industrial complex. The relationship between indicators and key indicators is shown in Fig. 1.

Figure 1 shows a list of possible indicators in the context of strategic development and the main groups of key indicators that reveal the selected indicators. The proposed indicators characterizing the financial transparency of agro-industrial enterprises are compared with the selected key indicators.

The indicators presented as the main components of the strategic analysis are the characteristics of the studied objects, processes, or results. On the one hand, the choice of key indicators from the total number of applied (and possible) indicators is determined by industry specifics. On the other hand, it meets the requirements of financial transparency (i.e., understandability, usefulness, and openness).

The implementation of the methodology of strategic financial analysis is reflected in the final internal report

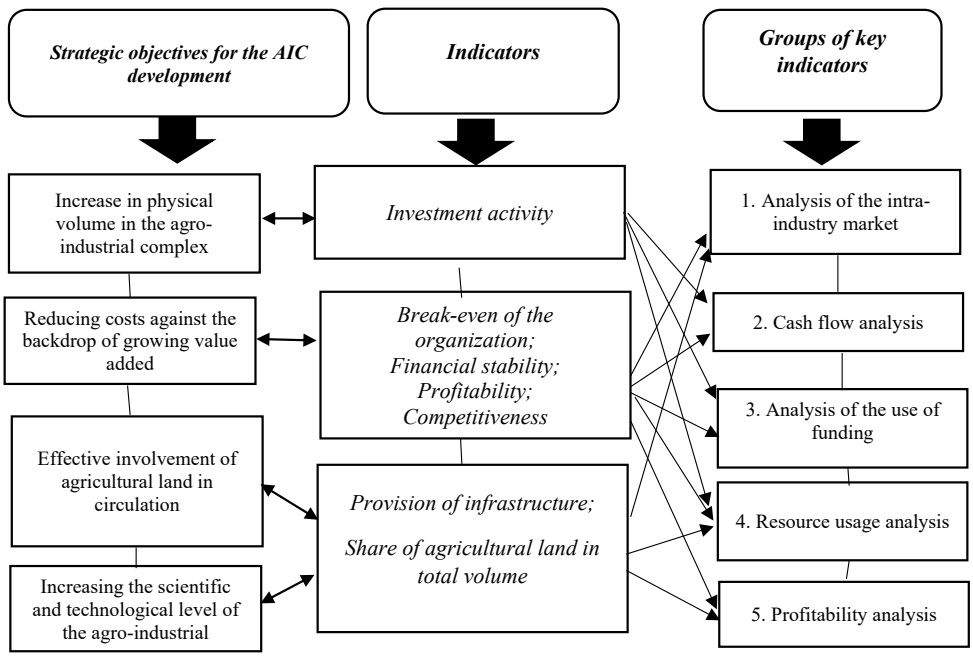


**Fig. 1** Formation of the main components of strategic analysis at AIC enterprises. *Source* Developed by the authors

generated for stakeholders. An AIC enterprise engaged in the cultivation of agricultural products (APK-1 JSC) was chosen to test the proposed method of strategic financial analysis. The necessary financial and accounting information about the company's activities was obtained from open sources. Based on the given internal report and its content, it becomes possible to obtain reliable analytical data on the main activity of the economic entity (Table 1).

1. Indicators that reveal the positive dynamics of the economic development of the enterprise. These include the following:

**Table 1** Report of APK-1 JSC based on key indicators

| Indicators | Key indicator (Mikhaylova, 2022) | Standard or industry average value of a key indicator* | Years | | | | | General trend of key indicator value |
|---|---|---|---|---|---|---|---|---|
| | | | 2017 | 2018 | 2019 | 2020 | 2021 | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Break-even of the organization<br>Competitiveness<br>Infrastructure provision | The ratio of the share of profit of the enterprise in the total amount of profit of the industry for similar products (work and services), CU | – | 0.46 | − 59.56 | − 27.42 | 9.93 | − 9.05 | Instability |
| | The growth rate of the enterprise output (Kvpr) | – | 0.98 | 1.05 | 1.05 | 0.88 | 1.11 | Increase |
| | Growth rate of the volume of similar products in the industry (Kvot) | – | 2.23 | 1.11 | 1.21 | 1.82 | 1.05 | Decline |
| | Lead coefficient (Kop) | > 1 | 0.44 | 0.95 | 0.87 | 0.48 | 1.05 | Increase |
| Investment activity<br>break-even of the organization<br>Financial stability<br>Profitability<br>Competitiveness | Cash adequacy ratio (Kd) | > 1 | 0.07 | 0.07 | 0.47 | 0.24 | 0.19 | Increase |
| | Solvency ratio (Kpl) | ≥ 1 | 1.11 | 1.05 | 1.05 | 1.06 | 1.05 | Without changes |
| | Net cash flow efficiency ratio (Kchdp) | – | – | − 0.57 | − 1.05 | − 0.84 | − 0.36 | Increase |
| Investment activity<br>Break-even of the organization<br>Financial stability<br>Profitability<br>Competitiveness | Ratio of own financing in the total amount of financing (Kf) | > 0.5 | 0.80 | 0.74 | 0.65 | 0.49 | 0.57 | Instability |
| | Government funding ratio in total funding (Kgf) | – | 0.20 | 0.26 | 0.35 | 0.51 | 0.43 | Increase |
| | Return on total capital (KRsk) | 0.12–0.15 | − 0.98 | 0.00 | 0.01 | − 0.25 | 0.36 | Increase |
| | Coefficient of the effect of financial leverage (Kef) | – | 11.50 | 10.23 | 9.33 | 6.57 | 10.22 | Instability |
| Investment activity<br>Profitability<br>Output volume<br>The share of the company products in a particular region | Current assets turnover ratio (Koa) | > 1 | 0.18 | 0.35 | 0.38 | 0.40 | 0.60 | Increase |
| | Ratio of administrative expenses per unit of production (Kup) | < 1 | 3.38 | 3.24 | 3.47 | 4.69 | 4.17 | Increase |
| | Growth rate of management costs per unit of output (Krup) | – | 1.41 | 0.96 | 1.07 | 1.35 | 0.89 | Decline |
| | Growth coefficient of the specific value of expenses (Kras) | – | 1.01 | 1.01 | 1.08 | 1.14 | 1.11 | Without changes |
| Break-even of the organization<br>Financial stability<br>Profitability<br>Competitiveness | Return on equity ratio (KRsk) | 0.12–0.15 | 0.31 | 0.01 | − 0.01 | 0.02 | − 0.02 | Decline |
| | Profitability ratio of state capital (KRrk) | 0.12–0.15 | − 7.90 | 0.01 | 0.01 | − 0.08 | 0.09 | Increase |
| | Profitability ratio of the sales structure (KRpr) | 0.15–0.20 | − 8.37 | 0.06 | 0.14 | − 0.53 | 0.58 | Increase |

*Source* Compiled by the authors based on (Mikhaylova, 2022)
*Note* *The average industry value or standard value of key indicators is indicated only in certain cases—if it is reasonable to calculate them

- An increase in the factor of growth in the volume of production of the enterprise (Kvpr) from 0.98 in 2017 to 1.11 in 2021; growth of the lead coefficient (Kop) in the conditions of the intra-industry market to a value of 1.05 (normative level) in 2021;
- Decrease in the indicator of resource use and growth rate of management costs per unit of output (Krup) from 1.41 in 2017 to 0.89 in 2021;
- Growth of the profitability ratio of the sales structure (KRpr) from − 8.37 in 2017 to 0.58 in 2021.

2. Indicators reflecting the negative development of the enterprise. These results include the following:
   - A decrease in the amount of cash flows, the net cash flow efficiency ratio (Kchdp) for the analyzed period to − 0.36;
   - Lack of funds as a result of a decrease in the value of the cash adequacy ratio (Kd) to a value of 0.19;
   - An increase in the volume of state financial support from 0.2 to 0.43 in the total share of financing, government funding ratio in total funding (Kgf).

## 4 Conclusion

Based on the analysis of financial and other data of AIC enterprises, the authors identified the main groups of stakeholders, which determine the need to increase the financial transparency of economic activity. The lack of access to the necessary and useful information for stakeholders from the available data sources led to the choice of a strategic analysis methodology that helps increase the financial transparency of economic activity.

Based on the three components of the strategic analysis, the authors proposed a methodology for forming an internal report in the context of the strategic development of the AIC. The internal report reflects a set of selected special (key) indicators based on approaches to determining the financial transparency of economic activity. Key indicators are formed based on selected indicators.

The obtained positive values of key indicators correspond to the achievement of the strategic goals of the development of an agro-industrial enterprise. Simultaneously, negative values of key indicators signal a decline in management efficiency indicators and failure to achieve the set strategic objectives.

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# Potential Effect of Digitalization of Fixed Asset Management at the Enterprises of the Agro-Industrial Complex

Akylbek A. Alikhanov and Shukur I. Kadyrov

**Abstract**

The information society demonstrates increased loyalty and shows a steady demand for domestic high-tech products, preferring them to imported analogues. In the conditions of digitalization, brands of national products of the Kyrgyz Republic and local products of its regions and cities of the agro-industrial complex are being formed for this purpose. Along with this, voluntary certification of product quality is carried out, which makes it possible to better deliver information to consumers about its high-tech and unique nature. The focus of the authors is on the enterprise, where there is a critical need to carry out a number of measures that contribute to increasing the efficiency of the continuous use of fixed assets in the conditions of digitalization. The authors have also proposed measures of a multilateral nature and are effective methods for the development of domestic high-tech industries, which will create a favorable market environment. The article analyzes the use of software that can improve the efficiency and accuracy of production, as well as reduce labor costs. Thus, the developed mechanism to ensure management in the conditions of digitalization has formed a systematic vision of the prospects for the practical implementation of strategic directions for improving this system. The driving forces and technologies in the context of the selected subjects of fixed asset management in the conditions of digitalization have been identified in this mechanism. The advantage of the mechanism is that it provides a potential effect expressed in the accelerated pace and advanced development of the digital economy, as well as in ensuring its stable efficiency and balance.

**Keywords**

Digitalization of the economy • Effect of digitalization • Digital technologies • Fixed asset management • Support mechanism • Economic efficiency

**JEL Classifications**

O440 • M110 • M150 • Q11

## 1 Introduction

The information society demonstrates increased loyalty and shows a steady demand for domestic high-tech products, preferring them to imported analogues. In the conditions of digitalization, brands of national products of the Kyrgyz Republic and local products of its regions and cities of the agro-industrial complex are being formed for this purpose (The concept of digital transformation, 2018). Voluntary certification of product quality is also carried out, which makes it possible to better inform consumers about such characteristics of the products as high-tech character and uniqueness (Akunzhanov, 2021).

Thus, the developed management mechanism in the conditions of digitalization has formed a systematic vision of the prospects for the practical implementation of strategic directions for improving this system. The driving forces and technologies in the context of the selected subjects of fixed asset management in the conditions of digitalization have been identified in this mechanism (Alikhanov et al., 2022). The advantage of the mechanism is that it provides a potential effect expressed in the accelerated pace and advanced development of the digital economy (Alikhanov, 2022), as well as in ensuring its stable efficiency and balance.

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## 2 Methodology

The article conducts research on the basis of the enterprise of the agro-industrial complex LLC "Three T," where there is a critical need for a number of measures aimed at improving the efficiency of the use of fixed assets (Markova & Mongush, 2018).

Figure 1 shows the measures to improve the efficiency of the use of fixed assets of LLC "Three T," that is, more advanced equipment for collecting eggs, feeding, and the most basic is the poultry manure cleaning equipment, since it is poultry manure that causes the main harm to human health, which can be avoided with the introduction of computer software.

From 2019 to 2021, there was a continuous increase in the number of buildings and facilities related to production funds, as well as the purchase of equipment that increases the efficiency of workshops. The proposed increase in fixed assets occurs in connection with LLC "Three T," equipped with facilities that are configured for the production of certain types of products that are considered profile for LLC "Three T."

Figure 2 shows that vehicles prevail among fixed assets at LLC "Three T" (65%), followed by equipment (19%), and buildings and structures occupy the third position (10%); this is the main share of fixed assets. This is due to the fact that vehicles are of particular importance for LLC "Three T" in terms of providing markets with its products. However, as we all know, all indicators always have a reverse side. An analysis of three years of activity of LLC "Three T" shows that it is mainly related to the production of table eggs, while in the reporting from 2019 to 2021, the specialization of the enterprise is defined as agricultural (Official site of LLC, n.d.).

A significant increase in fixed assets from 2019 to 2021 played a significant role in the development of the enterprise. LLC "Three T" increases the output, product range and becomes more cost-effective every year at the expense of fixed assets.

As can be seen from Table 1, changes in 2021 of fixed assets of LLC "Three T" compared to 2019 amounted to 27,366,335 KGS; in relation to the base part, the active part increased by 0.05%, respectively, the passive part decreased by 0.05%.

Analysis of the movement of fixed assets in LLC "Three T," as well as their technical condition, is calculated using the deterioration, renewal, retirement, and growth coefficients (Markova & Mongush, 2018).

This factor is necessary for the constant management of the fixed assets, for making quick management decisions, overall calculation, as well as for identifying the shortage of necessary modern equipment.

Thus, the renewal coefficient in 2020 was 0.08%, and in 2021, it was 0.25%. The retirement rate in 2020 was 0.12%, and in 2021, it already amounted to 0.0001%. Another indicator of the movement of fixed assets is the growth rate, which in 2020 was 0.12%, the same indicator in 2021 showed 0.16%.

Having considered the availability and movement of fixed assets in LLC "Three T," we can conclude that all the changes, that is, the modernization of large special equipment, had taken place before 2019, the impetus for this had been in 2012–2018, but in subsequent years the modernization was suspended. Therefore, the growth rate of fixed assets increased only in 2021, when fixed assets were updated.

In LLC "Three T," the renewal coefficient is higher than the retirement rate, which indicates that the trend toward an

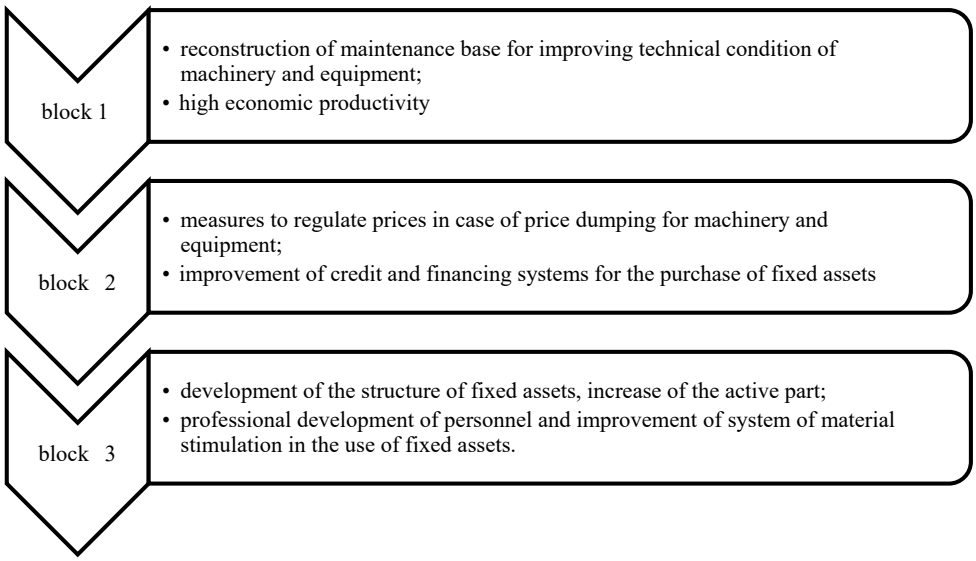


**Fig. 1** Measures aimed at improving the efficiency of the use of fixed assets. *Source* Developed and compiled by the authors

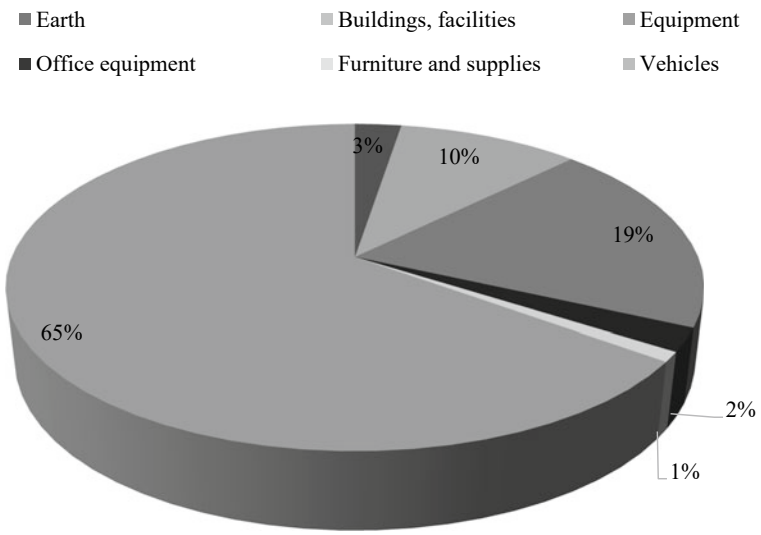


**Fig. 2** Percentage of fixed assets at LLC "Three T" for 2021. *Source* Developed and compiled by the authors

**Table 1** Analysis of changes in the structure of fixed assets (Financial statements of LLC, n.d.)

| Years | Active part | | Passive part | | Total fixed assets | |
|---|---|---|---|---|---|---|
| | Thousand KGS | The share, % | Thousand KGS | The share, % | Thousand KGS | The share, % |
| 2019 | 146,203,734 | 99.92 | 119,511 | 0.08 | 146,323,245 | 100 |
| 2020 | 129,742,769 | 99.94 | 89,633 | 0.06 | 129,832,402 | 100 |
| 2021 | 173,622,355 | 99.97 | 67,225 | 0.03 | 173,689,58 | 100 |
| Changes in 2021 to 2019, (+,–) | + 27,418,621 | + 0.05 | − 52,286 | − 0.05 | + 27,366,335 | – |

*Source* Developed and compiled by the authors

effective fixed asset management policy continues, that is, the final results are constantly improving. Modern conditions require from LLC "Three T" constant attention to the rational use of available resources and the search for reserves to improve the efficiency of functioning with the maximum benefits provided by the external environment, along with competently implemented internal potential and capabilities of the external environment.

Further in the article, we will present calculations of the project on capacity utilization, purchase of equipment and then we will make a forecast of the effect of the digitalization project of LLC "Three T."

Calculation of the cost of production at 50% capacity utilization, that is, direct costs:

- Feed (vitamins, premixes, etc.) is 4.2352 soms or 70% of the production cost;
- Packaging materials (trays, boxes) are 0.2111 soms or 3% of the production cost;
- Depreciation of the commercial brood is 0.7019 soms or 11.6% of the production cost.
- Calculation of general production costs:
- Resource costs (wage fund, electricity, gas, water, etc.) are 0.3599 soms or 6% of the production cost;
- Depreciation of fixed assets is 0.4477 soms or 7% of the production cost;
- Debt costs (%) are 0.3317 soms or 5% of the production cost;
- The cost of by-products is 0.2118 soms or (3.5%) of the production cost.

Thus, all the above calculations totaled 6.0757 soms, that is, the cost of a commercial egg is 100%.

It should be noted here that the studied enterprise LLC "Three T" has its own feed production, which involves the process of developing land with a total area of 3000 hectares, growing crops and then producing ingredients for feed (Financial statements of LLC, n.d.).

This project has a high economic potential due to the competitive technology of production of commercial eggs. In addition, the technological implementation of the project is ensured by the work of an experienced team of specialists, connections with a breeding company, as well as carefully selected suppliers of the main production equipment (Official site of LLC, n.d.).

There is a critical need to carry out a number of activities at the LLC "Three T," aimed at improving the efficiency of the management of fixed assets, which will determine the

**Table 2** Price proposals for equipment

| No. | Equipment\supplier | Country | Quantity | Cost per unit, USD | Total cost | Notes |
|---|---|---|---|---|---|---|
| 1 | Cage equipment for laying hens | | | | | Cage capacity |
| | Big Dutchman GMBH | Germany | 1 | 616,980 | 616,980 | 89,856 hens |
| | LLC "Techna" | Russia | 1 | 637,640 | 637,640 | 85,800 hens |
| | Kutlusan | Turkey | 1 | 467,251 | 467,251 | 92,160 hens |
| | JSC "DAHMIRA-S" | Russia | 1 | 325,716 | 325,716 | 45,056 hens |
| 2 | Egg sorting equipment | | | | | Capacity |
| | Nabel Canopus | Japan | 1 | 384,200 | 384,200 | Up to 40 thousand eggs/hour |
| | SIME-TEK | Italy | 1 | 307,360 | 307,360 | Up to 45 thousand eggs/hour |
| | MOBA | Netherlands | 1 | 395,500 | 395,500 | Up to 36 thousand eggs/hour |
| 3 | Equipment for converting poultry manure into energy | | | | | |
| | Special equipment | Russian Federation | | Special equipment | Russian Federation | |
| 4 | Equipment for processing, granulating poultry manure, animal manure, food waste, and producing fertilizer from sapropel | | | | | |
| | Special equipment | China, Tianyuan, Xinxian | | Special equipment | China, Tianyuan, Xinxian | |

*Source* Developed and compiled by the authors

further directions of its development. For example, one of the proposed measures is the purchase of new equipment for the operation and maintenance of laying hens and an egg sorting machine.

It is necessary to purchase new equipment given in Table 2 for the keeping of laying hens and an egg sorting machine, as well as equipment for processing, granulating poultry manure, animal manure, food waste, and producing fertilizer from sapropel within the project.

However, there is a burning question of how to purchase all this equipment and where to find the funds. The situation is very frequent today, because with the acquisition of new and modern equipment, leasing has become a new and specific form of investment activity (Ospishchev, 2021). This is a good alternative to regular bank lending; leasing operations are available to businesses of any type. It is leasing that makes it possible for agro-industrial enterprises to have equipment of any kind, as well as computer and office equipment, and thus avoid large one-time costs (Research of the leasing operations market of the Kyrgyz Republic, 2016).

Now, according to the proposed project of LLC "Three T," we will make a forecast of cash flows for 2023–2028 and give the values of such indicators as sales revenue, net profit and profit growth in percentage equivalent.

2023—revenue of 380,505 thousand soms, where the growth will be 9.7%, and net profit will be 68,523 thousand soms.
2024—revenue of 417,424 thousand soms, where growth will show 2.0% and net profit will amount to 79,655 thousand soms.
2025—revenue of 425,773 thousand soms, where growth will show 2.0% and net profit will amount to 83,665 thousand soms.
2026—revenue of 434,288 thousand soms, where growth will show 2.0% and net profit will amount to 88,099 thousand soms.
2027—revenue of 442,974 thousand soms, where growth will show 2.0% and net profit will amount to 92,710 thousand soms.
2028—revenue of 451,834 thousand soms, where growth will show 2.0% and net profit will amount to 97,513 thousand soms.

Financial modeling of the project demonstrates the sustainability of the project under consideration even in a conservative scenario (Official site of LLC, n.d.). Financial stability indicators are at a satisfactory level.

The choice of various types of improving the efficiency of fixed asset management of LLC "Three T" is associated with the acquisition of more modern equipment for collecting eggs, feeding poultry, as well as equipment for cleaning poultry manure, which is very important, since it is the latter that causes the main harm to human health. Such equipment helps to reduce the harm to the health of employees, which is the main problem at the enterprises of the agro-industrial complex where poultry meat is produced.

It is proposed to implement the following measures to improve fixed assets in the context of digitalization:

- Automation of production processes (control of all machines using a computer). The installation of sensors and other devices that enable the control of machines and

equipment using a computer or software can improve the efficiency and accuracy of production, as well as reduce labor costs.

- Introduction of environmentally friendly technologies (use of solar panels). Fixed assets powered by energy are the main source of environmental pollution. Measures to improve fixed assets, allowing the use of more environmentally friendly technologies, such as solar panels or hybrid engines, will help reduce both harmful emissions and energy costs.
- Improvement of safety. The introduction of new technologies, such as safety systems that prevent accidents at work or automatically shut down equipment in the event of Ageeva et al. (2022), Akunzhanov (2021) emergency, will help reduce risks for workers and equipment.
- Improvement of the design associated with the improvement of its characteristics such as compactness, ease of use, and transportation. Work on the design of fixed assets can improve their productivity, reliability, and efficiency.
- Upgrading of old equipment. Upgrading of old fixed assets can increase their productivity, reliability, and efficiency. For example, replacing outdated components with more modern and efficient ones.
- Implementation of the Internet of Things (IoT), which can help in monitoring.

All the measures we propose are of a multilateral nature and serve as methods for the effective use of fixed assets, which can significantly improve their productivity, reliability, and efficiency (Kryuchkova, 2018). Thus, the installation of sensors and remote control devices, which will enable the employees of the enterprise to manage production without being in a room with a specific smell of poultry manure. In addition, the software can improve the efficiency and accuracy of production, as well as reduce labor costs.

## 3 Results

Among the positive aspects, we can distinguish:

(1) The project team has successful experience in the field of production and processing of agricultural products, including the team of LLC "Breeding Poultry Plant "Three T," which is the largest supplier of breeding egg-laying hens (Financial statements of LLC, n.d.);
(2) Stable financial position;
(3) Significant own contribution to the project (> 40%);
(4) Transparent accounting;
(5) Positive credit history;
(6) Availability of the necessary production area with the required infrastructure for the expansion of the poultry farm;
(7) Availability of existing egg production and distribution channels;
(8) Availability of exclusive distributorship of the breeding company Hy-Line;
(9) Own production of feed and cooperation with dealer partners of the Dutch company Nutreco for the supply of premixes and vitamins for cattle and poultry;
(10) Competitive cost of the final product.

The negative aspects are:

(1) The need to pay attention to the issue of poultry waste disposal. At the moment, the possibility of selling older hens with low egg production to households is considered, since older hens retain their ability to lay eggs that is sufficient for farm household, but their eggs become very small, as well as they have value as meat and chicken offal.
(2) High requirements for biosafety in production. A full range of work is underway to ensure biosafety, including the removal of the top layer of soil, as well as the creation of sanitary zones, that is, the utilization of poultry manure.
(3) Competition in the conditions of gray egg imports in the Kyrgyz Republic. The established Association of Poultry Farmers of the Kyrgyz Republic carries out an effective fight against the smuggling of commercial eggs (Usonov, 2022).

## 4 Conclusion

Thus, this project has a high economic potential due to the competitive technology of production of commercial eggs. In addition, from the point of view of the technological implementation of the project, the company has an experienced team of specialists and contacts with the breeding company, and reliable suppliers of the main production equipment have been selected.

The introduction of new technologies at the enterprise under consideration, such as safety systems that prevent accidents at work or automatically shut down equipment in the event of emergency, will help reduce risks for workers and equipment.

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# Shaping Buying Behavior with Regard to Food Selection and Consumption

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**Abstract**

Changing trends in food choices, cooking methods, and consumption are essential in today's evolving economic environment. The above significantly impacts the formation of food supply in the market. This research attempts to determine the relationship between the transformation of purchasing behavior with respect to food choices and formed purchasing habits using the example of food choices of plant and animal origin. The research presents the results of a marketing study conducted in the form of interviews in Russian cities. Moreover, the research highlights the main factors that guide consumers' food choices, considering environmental influences, and focuses on food preparation and consumption processes. The authors determine the vectors of development based on the regularity of several characteristics in relation to the formation of the model of purchasing behavior of end consumers of food products depending on their age and social status. Additionally, the authors reveal the relationship between income levels and purchasing preferences for food choices, as well as the formation of purchasing habits in relation to the entire life cycle of the product. The main conclusions regarding the definition of significant characteristics that guide the consumer in the choice of food of plant and animal origin are presented.

**Keywords**

Consumer preferences • Food demand • Market research • Buying behavior • Food market

**JEL Classifications**

Q1 • Q11 • Q13

## 1 Introduction

Currently, the development of several priority sectors of agriculture is a significant task of the country, where the main goal is undoubtedly to ensure its food security. However, at the present development stage, consumers play an important role in shaping the market offer, particularly the transformation of consumer preferences and formed habits regarding the choice and consumption of food. Due to severe import restrictions on some products and production means, technology organizations are forming new development strategies, which should be built considering the development vectors of consumer behavior in relation to food choices (Ashmarina et al., 2021; Paptsov, 2018). This approach will allow manufacturers to build a new level of quality model of marketing relations with consumers and, consequently, increase their competitiveness (Biryukova & Ashmarina, 2021). The aspects mentioned above point to the importance of this research, which is based on the analysis of purchasing behavior in relation to the entire process of decision-making on the purchase of food of plant and animal origin (Boer et al., 2004; Grashorn & Serini, 2006; Grunert, 2006).

## 2 Materials and Methods

This research aims to identify factors and trends in the choice of food of plant and animal origin, considering the formation of purchasing behavior during the entire life cycle

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of the product (selection, preparation, and storage). Based on this goal, the following tasks were identified:

- To identify major trends in plant- and animal-based food choices, considering environmental influences;
- To characterize the main trends in the development of food habits in different target groups of consumers;
- To determine the constants of the consumer's food behavior model that guide their food choices of plant and animal origin (Biryukova et al., 2023; Chutchev et al., 2019).

The information basis of this research includes the results of market research conducted in the panel form in December 2022 in Moscow and Krasnodar.

## 3 Results

In accordance with the goal and objectives of this research, the authors conducted marketing research in the panel form among different groups of consumers. In the research sample, 71% are women, and 29% are men. The respondents' age composition is as follows:

- 37%—between the ages of 36 and 44;
- 24%—between the ages of 45 and 54;
- 19%—between the ages of 55 and 64;
- 11%—between the ages of 25 and 35;
- 9%—younger than 24.

The level of education among those surveyed corresponded to the following values:

- 1.7% do not have a complete secondary education;
- 19.2% have a high school education;
- 33.8% have secondary vocational education;
- 42.3% have higher education.

Of all those surveyed, there were those who did not answer this question and about 7.5% of those who had a scientific degree.

The majority of the respondents surveyed live in a family of two (38%), households of three persons (25%), and households of four or more persons (22%). The remaining respondents live alone (15%).

All respondents live in the city. About 74% of respondents have lived in the city for more than 15 years, 21% have lived in the city for about 7–10 years, and the rest have lived in the city for more than 2–5 years. About 83% of respondents are working people, of whom 46% work in executive positions and 17% are housewives. Regarding the differentiation of consumers by target group, it is necessary to determine the level of income. The study found that most respondents have an income per family member ranging from 46 to 65 thousand rubles (37%) and from 21 to 45 thousand rubles (32%). The number of respondents with an income of less than 20 thousand rubles was about 18%. As a rule, this group of respondents included households of four or more people (64%). An important criterion for selecting respondents was their interest in the research purpose, which was reflected in their responses to questions about determining aspects of product quality, price, attitudes toward healthy lifestyles, and approaches to handling the product throughout its lifecycle. The questions in the study were grouped relative to three vectors: food choice, preparation, and consumption and disposal of leftovers (Marwa et al., 2012; Sergeyeva, 2020). During the analysis, the authors managed to establish the main criteria for food selection. The distribution of responses regarding the choice of product criteria is presented in Table 1. It is necessary to note the high orientation of respondents with regard to the definition of significant characteristics and the choice of certain categories of products. According to the majority of respondents (73%), the main criteria for choosing a product are related to the way of eating the product and the speed of its preparation. The majority of respondents associate the cooking stage with a routine process, for which they strive to reduce the time spent (Biryukova et al., 2021). This is why there is a great preference for semi-finished products, as well as products that require less effort to prepare them for cooking.

As a rule, the choice of product, in particular meat and meat products, is seriously connected with the brand's positioning, which is indicated by 81% of respondents. Respondents associated this indicator with other criteria, such as price, variety of assortment, and product safety. In their opinion, the brand is the standard of product quality. If a well-known brand introduces new products in the range, about 62% of respondents are willing to try them. Product freshness (78%) and taste (77%) are equal factors in the choice of meat and meat products, with product freshness sometimes being compared with shelf life and appearance in respondents' answers. These answers indicate the transformation of these concepts in the choice of semi-finished products, which the respondent evaluates depending on the choice of semi-finished product and the way it is packaged. The respondents considered the product's taste in the totality of the cooked dish, where about 34% importantly highlighted the presence of sauce or seasoning used during cooking or consumption of the food. About 57% agreed that eating meat and meat products is the basis of a complete diet. About 23% believe buying meat as a stand-alone product that requires additional preparation costs becomes a holiday meal or a product to prepare dishes or semi-finished products on weekends. This state of affairs is due to the amount of time required to prepare meat. Most respondents agreed that

**Table 1** Distribution of respondents' answers regarding the product choice model

| Criteria for evaluating purchase factors | Distribution of respondents' answers regarding the priority of criteria selection (out of 211 interviewees) |
|---|---|
| *Meat and meat products* | |
| Brand | 169 |
| Product freshness | 165 |
| Flavor qualities | 164 |
| Cooking time | 147 |
| Nutritional benefits | 128 |
| Package size | 122 |
| Variety of assortment | 101 |
| Cost | 94 |
| Product safety | 37 |
| *Vegetables* | |
| Appearance | 210 |
| Freshness | 179 |
| Health benefits of healthy eating | 143 |
| Variation in cooking | 139 |
| Time needed for cooking | 116 |
| Price | 105 |
| Package size | 102 |
| Manufacturer | 78 |

*Source* Compiled by the authors based on research conducted

this process is mostly done by women (89%); the dishes to be prepared are discussed by all family members. That is why great attention is paid to the range of products offered to consumers (48%). Health benefits are no less important criteria for product selection (61%). It should be noted that women and men rated this parameter equally high. The respondents noted the high quality of processed meat products on the market, which, in their opinion, mostly include semi-finished products prepared by major brands from raw meat. According to the respondents, usefulness is characterized by such criteria as the amount of fat in the product (78%), the category of meat used in the product (63%), and possible cooking methods (45%). However, we should also note the high interest of respondents in factors related to production processes. Thus, 18% of respondents said that the conditions of animal breeding and the use of growth stimulants and hormones in production are significant for them. These factors mainly interested people with higher education and a scientific degree. In their opinion, these criteria characterize the product's safety and are fundamental when choosing meat products. The quality of animal fattening is significant for 11% of those surveyed. About 4% would like to be able to observe the process of raising animals, in particular, to attend tours of the company or follow production processes online.

The interview also focused on the choice of vegetables offered in the market to better understand the transformation of the model of purchasing behavior in relation to the evaluation of a wholesome meal. Thus, for the majority of respondents (98%), the main criterion for choosing vegetables is the dish they cook. About 74% of those surveyed buy vegetables in the store in advance; the decision to cook the meal is made on the cooking day. As a rule, such responses were given by households of three or more people. For all respondents, a significant characteristic when choosing vegetables is the appearance, by which the majority of respondents mean the size of vegetables, cleanliness, and consistency. The possibility of choosing was a significant aspect for 63% of respondents. In their opinion, it is important to self-assess each vegetable and choose the required amount of products. The product's freshness was characterized by the majority of respondents as a factor of choice, as well as a criterion for making a purchase or refusing a purchase by 85%. Thus, the sluggish appearance of the vegetables, as well as the presence of signs of spoilage, was an undoubted factor in seeking alternatives or refusing to buy. For 39% of those surveyed, product freshness was associated with harvest time. About 94% of the women surveyed believe that adding vegetables to meals is the basis of a healthy diet. Answering the question "What dishes would you refer to a healthy diet," about 72% listed dishes of traditional Russian cuisine, in particular borscht, cabbage soup, solyanka, etc. However, about 53% of the respondents indicated the need to allocate additional time for their preparation.

About 66% believe that the possibility of cooking different dishes is an important factor when choosing vegetables. However, most respondents (about 64%) could not list more than five positions of combined dishes. For 55% of respondents, the important criterion was the time they would spend on cooking a meal, which characterizes the current transformations in the formation of the model of purchasing preferences of urban households.

The survey formulated the main food habits of different target consumer groups. Thus, for most young people under 30, about 20% of those surveyed cited quickness of cooking and eating as the main criterion. Of them, about 35% described cooking as a routine process. In their view, food should be cheap and easy to prepare; the process of eating is a formal need to satisfy hunger. At the same time, about 75% of respondents confirm the importance of nutrition as a factor influencing health and choose products belonging to the healthy food category.

For respondents between the ages of 30 and 40, the quality of the chosen products and the benefits they bring to their

health are significant aspects. However, attitudes toward eating in this group were significantly transformed, with this group of respondents emphasizing the evening meal, when all family members gather around the table, as the main meal of the day. The rest of the meals were not perceived as nutritious and, according to 56% of those surveyed, were snacks on the go. For people over 40, eating habits are comparable and based on the formation of three full meals. However, the trend of reducing the time for cooking and simplifying the meals is also present in these segments.

In recent years, price has become an increasingly important factor in choosing food. However, according to respondents, the quality and taste of the product should not depend on the price. This is believed mostly by respondents with less income per family member. Another important factor in the choice of products of the studied categories is the presence of ongoing promotional events. However, most respondents do not buy products in the presence of promotions in advance.

## 4 Discussion

Thus, the formed criteria for the choice of meat and vegetable products are dictated by the transformation of the model of consumer behavior in relation to the entire life cycle of the product (Biryukova et al., 2023; Grashorn & Serini, 2006). Consumers believe the brand is the primary motivating factor in choosing meat products. When choosing vegetables, the consumer is guided by such criteria as the product's appearance and freshness. The criterion of health benefits is becoming increasingly important despite the simplification of cooking methods and the reduction of full meals. Consumers of all ages increasingly focus on their health, which is a significant aspect of their food choices. However, eating on the go seriously reduces food choices and cooking variations. Most respondents try to cook full meals on weekends or in the evenings. Significant transformations in the choice of food are more characteristic of the choice of meat and meat products, where consumers prefer semi-finished products as a product of everyday cooking.

## 5 Conclusion

Thus, the main established factors that influence consumer behavior when choosing meat and meat products are brand, the product's freshness, taste, cooking time, health benefits, and package size. The main factors influencing purchasing behavior when choosing vegetables are the appearance, freshness, health benefits, variability in preparation, and time spent on preparation.

These significant characteristics show a significant transformation in the development of the model of the purchase decision-making process, considering the further processes of food preparation and consumption. This research is fundamental to developing product policy vectors for organizations operating in this area. Of particular significance is the definition of the vector of the conceptual development of the transformation of food habits in relation to the preparation and consumption of food, which has a considerable impact on consumer demand. We believe it is necessary to continue research in this area and evaluate the process of cooking and eating in depth to determine the influence of factors on the transformation of food habits in different segments. In our opinion, this research should be carried out considering the analysis of the range of products offered and the analysis of the preparation of the main dishes to determine new vectors for the development of assortment categories.

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# Assessment of Adaptation Activity of Agricultural Business Subjects in the Project-Based Approach

Olga A. Rodionova, Anatoliy S. Truba, Irina D. Eryukova, and Tamara G. Evsyukova

**Abstract**

The paper aims to assess the adaptive activity of the agribusiness depending on the scale of its activities using the project approach. The authors use various statistical methods, including rankings and indexes. The objectivity of the developed method lies in the use of weighted average indicators in the examination. During the analysis, the authors used data from the federal tax service of 11 regions of the Russian Federation with a developed agro-industrial complex. The structural analysis of the entrepreneurial activity of economic agents—participants in various links of agri-food chains—is presented. The analysis identified the most active business entities in two types of activities. The first is agriculture and forestry, hunting, and provision of services, and the other is food manufacturing industries. The authors propose a methodical approach to assessing the adaptive activity of agricultural business entities based on financial and economic indicators that reflect the sustainability of economic development, considering regional specifics. The paper determined the level and state of adaptive activity of business entities that implement lean production principles within the framework of the national project "Labor productivity and employment increase." A discussion of the presented research results among Russian and foreign scientists is provided. Attention is focused on studying industry specifics of the project transformation of agriculture and other sectors of the agro-industrial complex. The results obtained can be used to diagnose the adaptive behavior of agribusiness organizations in the system of economic interaction.

**Keywords**

Project-based approach • Business entities • Sustainable development • Lean manufacturing • Tax burden

**JEL Classifications**

O13 • Q13

## 1 Introduction

The processes occurring in the global economy have an ambiguous impact on the development of Russian business. However, they also determine the search for new solutions that combine market and government tools for regulating intersubject interaction. It is impossible to provide a management organization built on lean manufacturing principles to increase Russian organizations' sustainability without regulation. This requirement fully applies to the economic entities of regional agri-food systems.

The promotion of the concept of lean manufacturing into practice to economically use resources and expand competitive products has noticeably intensified after the imposition of sanctions by the EU countries and the USA. Modernization of business processes in regional agri-food systems is underway. Participants are manufacturers of agricultural products and equipment, mineral fertilizers, crop protection agents, veterinary medicine, and food products. Logistics approaches are changing because of the departure of foreign companies integrated into agri-food chains. The search for new partners and contractors slows down the adaptive activity of business entities.

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One of the directions of structural transformation is the use of lean manufacturing tools. It was implemented through the national project "Labor productivity and employment support." The project started in 2019 and should end in 2024. Nevertheless, it is planned to be extended by the decision of the Russian government. During the implementation of the national project, necessary infrastructure was created, including the Federal Competence Center (FCC) and Regional Competence Centers (RCC). They provide various kinds of consulting services to implement elements of lean manufacturing.

Analysis of adaptive activity is impossible without objective and reliable information. During the research, the authors used data from the official websites of the national project "Labor productivity and employment support" and the Federal Tax Service of Russia (Federal Tax Service of the Russian Federation, 2023; National Project "Labor Productivity & Employment Support", 2023).

Scientists at the University of Cambridge carried out studies of the adaptation of agricultural organizations to transformational processes (Feindt et al., 2022). They considered the impact of the pandemic crisis on the agricultural economy, as well as the reaction of business entities to changes as the ability to adapt. The research focuses more on the behavioral aspect than on financial indicators.

Economists successfully apply the project-based approach in studying the sustainable development of the agricultural economy. For example, Matthieu Bellon supposes that project implementation could be important in addressing the adaptation challenge (Bellon & Massetti, 2022; Soriano et al., 2023). When assessing the achievement of sustainable development goals, Patrick Moriarty considers various projects and their effectiveness and effect (Moriarty & Damon, 2020). However, these studies are carried out from the point of view of ecology and environmental impact. Thus, it is necessary to conduct research in the field of socio-economic development as a tool for assessing the sustainable development of the agricultural economy.

When characterizing adaptation, considered as a process of adaptation of economic entities, attention is paid to the fundamental features of an economic entity, for example, the status as a business entity and the main type of economic activity according to the official Russian classification of activities.

## 2 Materials and Methods

The research is based on methodological tools for determining the socio-economic adaptation mechanism. It includes building analytical tables in the Excel software module for calculating indicators (growth (decrease) indices of average monthly wages, sales profitability, and tax burden). These indicators were the criteria for the rating in the context of business entities (small, medium, and large) to identify leaders in assessing the mechanism for adapting to socio-economic development. The authors provide an assessment of the financial condition based on CVP analysis. The calculations were carried out on the example of economic entities located in the developed agricultural regions of the Russian Federation for two types of economic activity: (1) agriculture, hunting, and the provision of services in these areas; (2) food production branches. The integral indicator is calculated by the index method, i.e., by multiplying the indices of the three indicators.

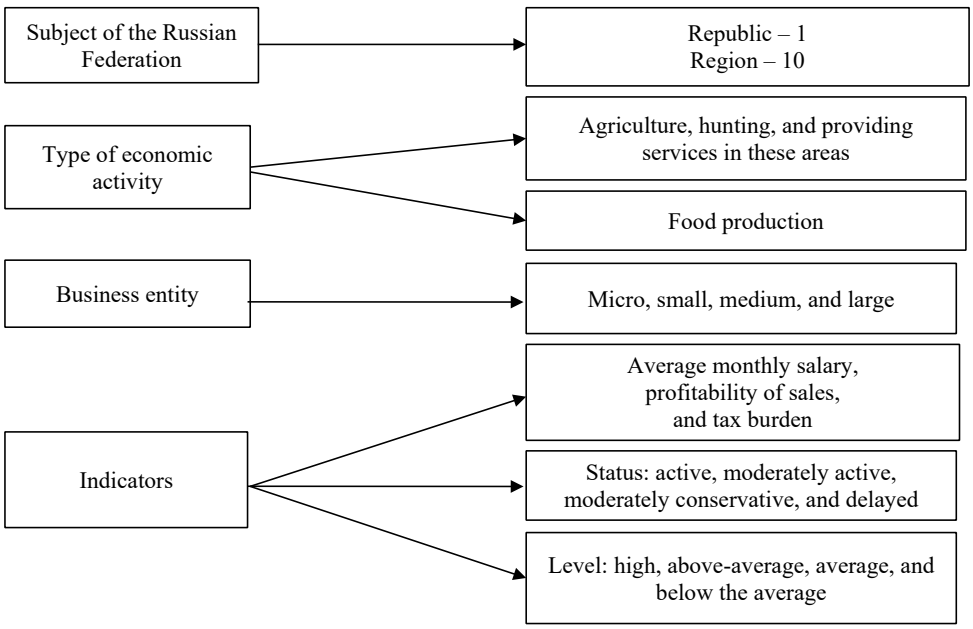


**Fig. 1** Scheme of information support for evaluation adaptive activity of business entities. *Source* Created by the authors

When developing approaches to determining the adaptation of economic entities, special attention is paid to the observance of the principle of information security. For this purpose, the authors used data from two official websites: the national project "Labor productivity and employment increase" and the Federal Tax Service of Russia. The formation of information support is schematically shown in Fig. 1.

## 3 Results

In general, the results of the activities of the participants of the national project to ensure the growth of labor productivity and sustainable growth in the incomes of the population are as follows. As of June 14, 2023, the number of participants in the national project consisted of 4836 organizations from 84 entities in 706 areas of activity. One of the most important indicators is the growth of gross added value (GAV). The amount of GAV of the participants in the national project represented five real sectors of the economy and amounted to 51.1 trillion rubles, or 43% of its total volume (Fig. 2).

It should be noted that regions that implement the principles of lean manufacturing and characterized by (1) a large number of organizations participating in the national project and (2) volumes of sales proceeds (Table 1).

In accordance with the characteristics of business entities, according to the criterion "sales proceeds," 7 out of 11 Russian regions belong to the category of large enterprises. This corresponds to the limit value for this indicator—over 2 billion rubles. Small and medium-sized enterprises are typical for agriculture; medium and large entities are typical for the field of food production. These industries differ not only in the scale of activities but also in the level of concentration and diversification of production. This affects the stability of their development and adaptation to structural changes. Additionally, business entities as participants in agri-food

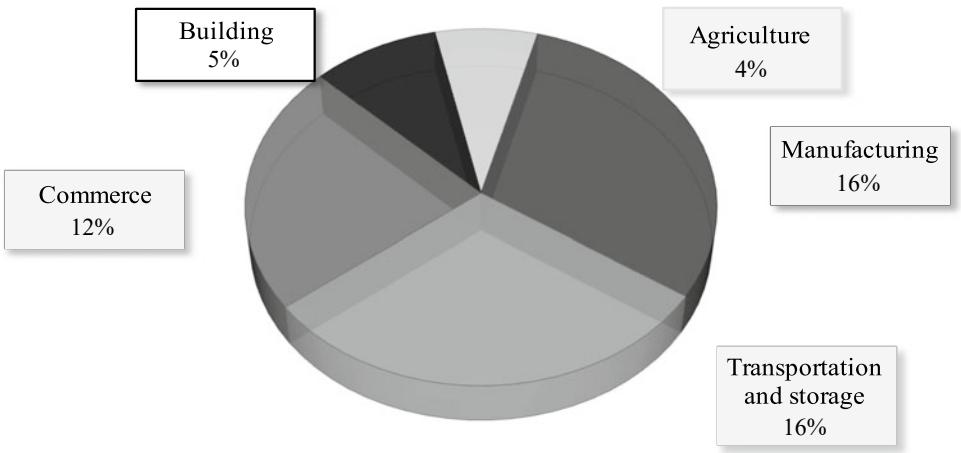


**Fig. 2** Share of GAV of participants in the National project "Labor productivity and employment increase" by type of activity. National Project "Labor Productivity & Employment Support". *Source* Calculated by the authors based on data of National Project (2023)

**Table 1** Number and revenue from sales of organizations—participants of the National project "Labor productivity and employment increase"

| Russian Federation subject | Number of organizations, units | Sales revenue per 1 organization, bln rub | Business entity |
|---|---|---|---|
| 1. Krasnodar Territory | 259 | 2.60 | Large |
| 2. Novgorod Region | 227 | 1.88 | Medium |
| 3. Republic of Tatarstan | 217 | 2.87 | Large |
| 4. Sverdlovsk Region | 194 | 3.0 | Large |
| 5. Moscow Region | 175 | 1.95 | Medium |
| 6. Republic of Bashkortostan | 158 | 1.97 | Medium |
| 7. Rostov Region | 153 | 2.89 | Large |
| 8. Samara Region | 149 | 1.96 | Medium |
| 9. Chelyabinsk Region | 123 | 2.22 | Large |
| 10. Perm Region | 117 | 3.41 | Large |
| 11. Belgorod Region | 103 | 2.67 | Large |

*Source* Calculated by the authors based on (National Project "Labor Productivity & Employment Support", 2023)

chains have sectoral differences in terms of the level of integration, i.e., they may operate independently or be a part of large holding companies.

To confirm what has been said, we used a methodological approach based on three indicators according to the website of the Federal Tax Service of Russia for 2021. The indicators characterize: (1) the socio-economic aspect—the average monthly wage per one average annual employee; (2) the production and commercial aspect—profitability of sales; (3) and the fiscal aspect—the level of the tax burden.

The change in the value of each of the analyzed indicators can be influenced by its average value in the industry as a whole and in the context of business entities (small, medium, and large enterprises). The task was solved using the index method, based on the construction of calculation tables for three indicators for each group of enterprises in 11 regions. The average values of each indicator are determined by a power function. Then, the deviations of individual values from the average value were calculated. The values of indicators for each group of enterprises were distributed on a scale and entered at specified intervals in the appropriate cell by multiplying by coefficients defined as growth or decline rates in 2021 compared to 2019. Calculations of the integral indicator were carried out separately for organizations of agriculture and food production.

Based on the above indicators, the authors used the rating, which made it possible to obtain a characteristic of the adaptive activity of business entities in the agri-industrial complex (Table 2).

The high level of adaptation activity is most pronounced among business entities in the Republic of Bashkortostan, which was achieved due to the growth of sales profitability and the reduction of the tax burden, mainly in large enterprises with revenues of over 2000 million rubles and more than 250 employees. High values of profitability of sales were also noted in small agricultural and food enterprises with revenues from 500 to 800 million rubles.

The implementation of the national project measures is carried out with the support of federal or regional centers of competence, or independently using the participant's funds. In terms of budgetary support, the participants were distributed according to the following scheme: 6 organizations entered the project with support from regional budgets, 5—at their own expense, and 1—using the support funds of the federal competence center.

## 4 Discussion

The study of the problem of adaptation is considered in the context of a new institutional theory with an emphasis on limited reality and rational expectations to explain the behavior of economic agents in terms of creating and using opportunities for mutually beneficial exchange. In O. Wilmson's theory, behavior models are divided according to two criteria: the first—by information provision, the second—by focusing on the interest of an economic agent (Wilmson, 1996).

Research of agricultural entrepreneurship from the standpoint of their behavior (roles) is conducted by group of scientists from CEIGRAM—Universidad Politécnica de Madrid, Spain (Soriano et al., 2023). They conducted a study, identifying five groups of behavior of agricultural enterprises based on social and environmental factors. The assessment of the roles was carried out based on issues relevant to agriculture in the EU countries.

In our research, attention was focused on the analysis of the second criterion, which is due to the introduction of numerous sanctions by the EU countries and the USA. Their use increased the degree of tension in the functioning of business entities and influenced the results of their activities. The assessment of the adaptation level of entrepreneurial activity was carried out using the project-based approach. Adaptation issues are described in more detail in the

**Table 2** Characteristics of the state and level of adaptation of business entities of the agri-industrial complex

| Integral component | Level | State | Area of interest |
|---|---|---|---|
| *Organizations of agriculture, hunting, and providing services* | | | |
| From 120.0 and above | High | Active | Republic of Bashkortostan |
| 110.0 to 120.0 | Above average | Moderately active | Region: Tula, Kaluga, and Bryansk |
| 100.0 to 110.0 | Average | Moderately conservative | Region: Voronezh, Kursk, Lipetsk, Moscow, Orel, Ryazan, and Tambov |
| *Food industry organizations* | | | |
| From 120.0 and above | High | Active | Region: Lipetsk and Kursk |
| 110.0 to 120.0 | Above average | Moderately active | Republic of Bashkortostan |
| 100.0 to 110.0 | Average | Moderately conservative | Region: Belgorod, Voronezh, Kaluga, and Moscow |

*Source* Compiled by the authors based on data of the Federal Tax Service of the Russian Federation (Federal Tax Service of the Russian Federation, 2023)

collective monographs prepared at VNIOPTUSH (Rodionova, 2022; Rodionova & Evsyukova, 2020). They contain conceptual, methodological, and analytical developments that characterize changes in the mechanisms of adaptation of business entities in the agro-industrial complex, considering regional specifics. First, based on the analysis results, it was determined that the average revenue per one small agricultural organization in 82 Russian regions is 207 million rubles. The authors propose extending support measures addressed to peasant (farm) enterprises to micro and small agricultural enterprises with revenues of up to 120 million rubles per year (Rodionova & Evsyukova, 2020). Second, business entities are heterogeneous in terms of profitability of sales and the level of budget support, which influenced the nature of adaptive behavior. A moderately active adoptive position toward technological and organizational and managerial changes is occupied by business entities for the production of grain and milk. The group with a moderately conservative type of behavior included organizations producing flour and bakery products, as well as dairy products (Rodionova & Evsyukova, 2020). Increasing trends in the growth rate of wages—an indicator of social orientation in the mechanism of adaptation are noted in micro and small (Rodionova & Eryukova, 2023).

## 5 Conclusion

The ongoing changes in the institutional and sectoral structure of the economy necessitate the assessment of the socio-economic mechanism of adaptation and sustainable development of business entities that are interconnected at various stages of agri-food chains. This requirement is due to the need to fulfill the parameters of food security, enhance labor productivity, and increase real incomes of the population. The practical significance of the proposed scientific and methodological solutions aimed at increasing the adaptive activity of business entities to structural changes lies in the fact that they can be used in the regions when adjusting priority areas for the development of the agri-food sector.

First, this is necessary to make rational decisions about the sustainable development of industries and economic entities of the agro-industrial complex at the regional and local levels. The fulfillment of this task is impossible without coordinating the interests of all participants in the product movement chain: from producer to consumer; secondary redistribution of income using measures of budgetary support. Second, adaptive activity depends on the impact of digitalization on the mechanism of social and labor relations (rethinking the content of labor functions and changing social guarantees and the minimum wage). Third, under the influence of the active development of digital platforms, the mechanism of public–private partnership is changing. Therefore, it is important that structural transformation does not have a destimulating (negative) impact on the adaptation of small producers and their entrepreneurial activity.

The results of the rating for small, medium, and large business entities based on an integral indicator for two types of economic activity are such that among agricultural organizations with a high level of adaptation there was only one region (the Republic of Bashkortostan), above the average—3 regions, and the average level of adaptation—7 areas. A high level of adaptation is defined in food industry organizations (2 regions), above average—5 regions, medium—4 regions. There are no enterprises with a slow state of the socio-economic adaptation mechanism. Food industry organizations have a higher level of adaptation to structural and technological transformation.

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# Method for Assessing the Economic Efficiency of Digital Technologies in Dairy Farming Considering Changes in Process Parameters

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**Abstract**

The research develops a method for assessing the economic efficiency of digital technology in dairy cattle breeding. The research aims to improve the accuracy of predicting the effectiveness of these technologies and reduce the risks from unjustified decisions on the digitalization of this livestock production. The proposed method is based on the idea of estimating economic efficiency depending on the time cows spend in selected physiological states. The intensities of the process transition from one state to another are regarded as functions of the measures implemented. It is envisaged that some process parameters, in particular, yields from cows in selected states, change over time with age. It is proposed to consider the impact of digital technology on economic efficiency through changes in the intensity of process transitions from one state to another. According to the method, the process of the productive life of cows is described in the form of a graph of sixteen physiological states. A multistep resolution of the system of differential equations corresponding to this graph is provided to assess the economic efficiency of digital technologies for possible changes in process parameters. The simulation results confirm the possibility of obtaining more accurate estimates of the economic efficiency of digital technologies in dairy cattle breeding primarily due to a more complete accounting of the specifics of the analyzed process.

**Keywords**

Dairy farming digitalization • Digital technologies • Efficiency assessment • Economic efficiency • Mathematical modeling

**JEL Classifications**

Q13 • Q18

## 1 Introduction

Currently, the capabilities of the dairy farming management system do not quite match the level of dairy productivity and high production concentration (Chinarov, 2022; Chinarov et al., 2022; Tsoy et al., 2022). The consequence of this is a decrease in the level of health of highly productive cows and herd reproduction, as well as an increase in production costs. Great hopes for alleviating the problem are pinned on the widespread use of digital technology (Nikulina, 2023). They should provide effective control of milking cows, milk collection and cooling, feed preparation and distribution, the microclimate in livestock buildings, and observation, recognition, and prediction of the physiological conditions of animals.

Any implementation of digital technology in dairy farming must be economically justified, considering the process specifics. For this purpose, it is necessary to have appropriate methods for analyzing the cost-effectiveness of such technologies.

There are Russian (Surovtsev et al., 2017) and foreign approaches (Abeni et al., 2019; Abuova et al., 2020; Carillo & Abeni, 2020; DeLay et al., 2022; McFadden et al., 2022;

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Örs et al., 2022; Steeneveld et al., 2015) to evaluating this indicator, of which the main ones are technical efficiency analysis (DeLay et al., 2022; McFadden et al., 2022), which involves the construction of the function of production possibilities, and the calculation of the savings of individual cost elements (Abeni et al., 2019; Carillo & Abeni, 2020; Steeneveld et al., 2015). Model calculations are used much less frequently (Abuova et al., 2020; Örs et al., 2022). Model calculations are intended mainly to analyze cost-effectiveness at the stage of digital technology development and under conditions of limited data or observable objects.

Economic efficiency can be assessed at different levels and stages of the dairy farming process. It is desirable to obtain integral estimates of this efficiency over a long period, considering possible physiological conditions of cows, their age, and living conditions, including measures to prevent and treat diseases. Typical approaches to assessing the economic efficiency of digital technology in dairy cattle breeding are based on the average values of individual indicators. The time factor, the dynamics of the process, and changes in its characteristics for objective and subjective reasons are poorly considered. This does not make it possible to obtain accurate predictive estimates of the studied efficiency and exclude risks from unjustified decisions on the digitalization of dairy cattle breeding.

The authors propose considering a method for assessing the economic efficiency of digital technology in dairy cattle breeding, devoid of the noted shortcomings.

## 2 Materials and Methods

To obtain accurate predictive estimates of the studied efficiency of digital technologies in dairy cattle breeding and eliminate the risks of unjustified decisions on its digitalization, the authors propose a new method based on the idea of assessing the economic efficiency depending on the time cows spend in the selected physiological states. The intensities of the process transition from one state to another are seen as functions of the implemented measures for digitalization of production, feeding, milking, disease prevention and treatment, and others. It is assumed that some process parameters change over time. These parameters include yields from cows in selected states depending on age. The number of cows in a dairy herd may decrease or increase; the intensity of cow transitions from one physiological state to another may also change, including through the gradual introduction of digital technology. According to the method, the process of productive life of cows is described in the form of a graph of sixteen states (Fig. 1). The arcs on the graph correspond to the intensity of transitions from one state to another, which depend on the measures implemented, including the use of digital technology.

Considering the limit theorem for the flow of events, the studied process is Markovian. The graph in Fig. 1 is assigned a system of sixteen linear differential equations. Such a system can be solved for given input data using well-known application software packages, such as MatLab. Input data are the probabilities of finding the process in selected states at time $t = 0$ and the values of transition intensities. The system resolution result is the values of the probabilities $P_i(t)$ of the process being in the $i$-states of interest at a given point in time. Knowing the yield from cows in each state per unit of time and being able to determine $P_i(t)$, we can find the integral yields in each state. By summing up these returns, we get the final estimate. Subtracting the estimate without digital technology from the estimate obtained when using digital technology, we determine the gain from the implemented digitalization.

To assess the cost-effectiveness of digital technologies for possible changes in process parameters, the authors provide a multistep resolution of the system of differential equations. According to Fig. 1, at each step, the initial process states are recalculated, and transition intensities are changed as a

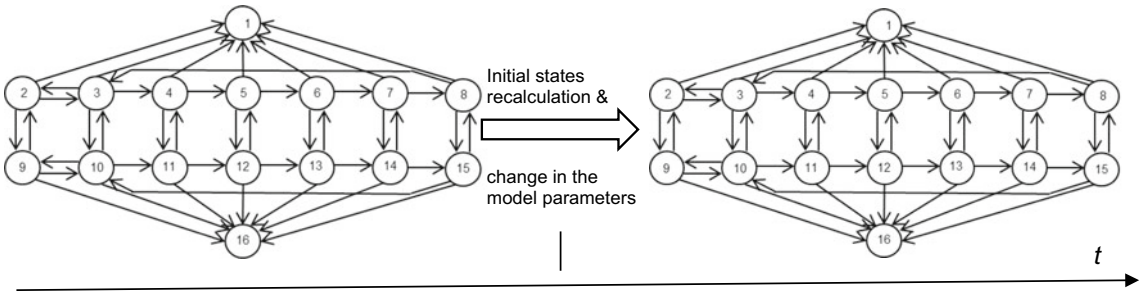


**Fig. 1** Model of the productive life process of cows: 1—withdrawal from the herd; 2—unseeded in the lactation stabilization phase; 3—stabilization of lactation (hunting, insemination, and the first stage of pregnancy); 4—decline in lactation (intense growth of the fetus and a decrease in milk productivity; 5—interlactation period (cows are in the drying-off stage); 6—transit period before calving (cows in the maternity ward); 7—calving and the after-calving period; 8—increasing in the milk yield (increase in milk productivity, restoration of cows' health after calving, and preparation for insemination); 9–15—states similar to states 2–8, but in the presence of disease(s) of the animal; 16—forced culling (forced slaughter). *Source* Compiled by the authors

function of the age of cows and measures taken to prevent and treat diseases, introduce digital technologies, and others. With this in mind, the integral assessment of the economic efficiency of the digital technologies introduced in dairy cattle breeding without considering the rearing and forced culling can be defined as follows:

$$\Delta W(T) = W_I(T) - W_0(T), \quad (1)$$

$$W_{1(0)}(T) = \sum_{j=0}^{M-1} \sum_{i=2}^{15} N_j \cdot V_{ij} \cdot \int_{t_j}^{t_{j+1}} P_{ji1(0)}(t)\mathrm{d}t, \quad (2)$$

where

$W_I(T), W_0(T)$ integral economic effects with and without the introduction of digital technology;
$M$ the number of time intervals at which the economic effect is estimated;
$N_j$ the number of cows at the $j$th time interval;
$V_{ij}$ yield from one cow at the $j$th time interval;
$P_{ji1(0)}(t)$ at time $t$, the probability of cows in the $i$th state at the $j$th time interval with the introduction of digital technology (1) and without it (0).

In the reviewed case, only the effects of cows in states 2–15 are considered.

## 3 Results

Based on the processing of statistical data for each state of the considered process, the profit (yield) per one healthy and one sick cow per day was determined. For the selected states, these values of profitability (rubles/day) had the following values (shown in brackets behind the state numbers): 2 (250), 3 (250), 4 (130), 5 (− 400), 6 (− 400), 7 (303), 8 (150), 9 (230), 10 (230), 11 (110), 12 (− 400), 13 (− 400), 14 (280), and 15 (120). The average values of the times of transitions from one state to another for a typical situation were also determined, which served as the basis for determining the corresponding intensities. Different variants of initial distributions of the states of cows at the moment $t = 0$ were set. For these data, the authors evaluated the integral economic efficiency of dairy farming without and with the introduction of digital technologies for monitoring, recognition, and prediction of the physiological conditions of cows. A package of applied programs was used for modeling. The following is an example of writing the system of integral equations in MatLab for the graph in Fig. 1:

```
function F = Cows_23_1(t, y)
F = 0.00476 * y(2) + 0.0019 * y(3) + 0.0019 * y(4) + 0.00217 * y(5)
  + 0.00714 * y(6) + + 0.001 * y(7) + 0.0018 * y(8);
0.00714 * y(3) + 0.00533 * y(9) - (0.00476 + 0.0476 + 0.00238) * y(2);
0.0476 * y(2) + 0.00533 * y(10) + 0.009 * y(8) -
 - (0.0019 + 0.00714 + 0.00952 + 0.0095) * y(3);
0.00952 * y(3) + 0.00533 * y(11) - (0.0019 + 0.00952 + 0.0095) * y(4);
0.00952 * y(4) + 0.00533 * y(12) - (0.00217 + 0.0217 + 0.00108) * y(5);
0.0217 * y(5) + 0.00533 * y(13) - (0.00714 + 0.0714 + 0.00357) * y(6);
0.0714 * y(6) + 0.00533 * y(14) - (0.001 + 0.1 + 0.0050) * y(7);
0.1 * y(7) + 0.00533 * y(15) - (0.0018 + 0.009 + 0.00908) * y(8);
0.00238 * y(2) + 0.00714 * y(10) - (0.00476 + 0.0476 + 0.00533) * y(9);
0.0095 * y(3) + 0.0476 * y(9) + 0.009 * y(15) -
 - (0.0019 + 0.00714 + 0.00952 + 0.00533) * y(10);
0.0095 * y(4) + 0.00952 * y(10) - (0.00533 + 0.00952 + 0.0019) * y(11);
0.00108 * y(5) + 0.00952 * y(11) - (0.00533 + 0.0217 + 0.00217) * y(12);
0.00357 * y(6) + 0.0217 * y(12) - (0.00533 + 0.0714 + 0.00714) * y(13);
0.0050 * y(7) + 0.0714 * y(13) - (0.00533 + 0.1 + 0.001) * y(14);
0.00908 * y(8) + 0.1 * y(14) - (0.00533 + 0.009 + 0.0018) * y(15);
0.00476 * y(9) + 0.0019 * y(10) + 0.0019 * y(11) + 0.00217 * y(12)
  + 0.00714 * y(13) + + 0.001 * y(14) + 0.0018 * y(15)].
```

In this system, values of intensities, which were changed due to the introduction of digital technology, are highlighted in bold.

Figure 2a shows the change in yield per cow over time (in days) in states 2–8 (curve 1) and 9–15 (curve 2) without the implementation of digital technologies for monitoring, recognition, and prediction of the physiological state of cows. Figure 2b shows the same indicator with the application of digital technologies.

In Fig. 2c, curve 3 corresponds to the change in yield for state 1; curve 4 corresponds to state 16 without digital implementation. According to Fig. 2d, when they are implemented, the yield in state 1 (curve 3) rises, and the yield in state 16 (curve 4) falls.

## 4 Discussion

The analysis of the curves in Fig. 2 shows that even a small introduction of digital technology can provide a significant increase in the economic efficiency of dairy production. The decline of curve 1 and curve 2 in Fig. 2a, b is primarily due to the effects of picking and forced culling. Integral estimates of the economic efficiency of introducing digital technology according to Eqs. 1 and 2 with changes in parameters at given time intervals were also determined. Without digital technology, the yield per cow in states 2–15 at the interval of 1800 days was 102,250 rubles; in the presence of these technologies, this indicator reached 104,930 rubles.

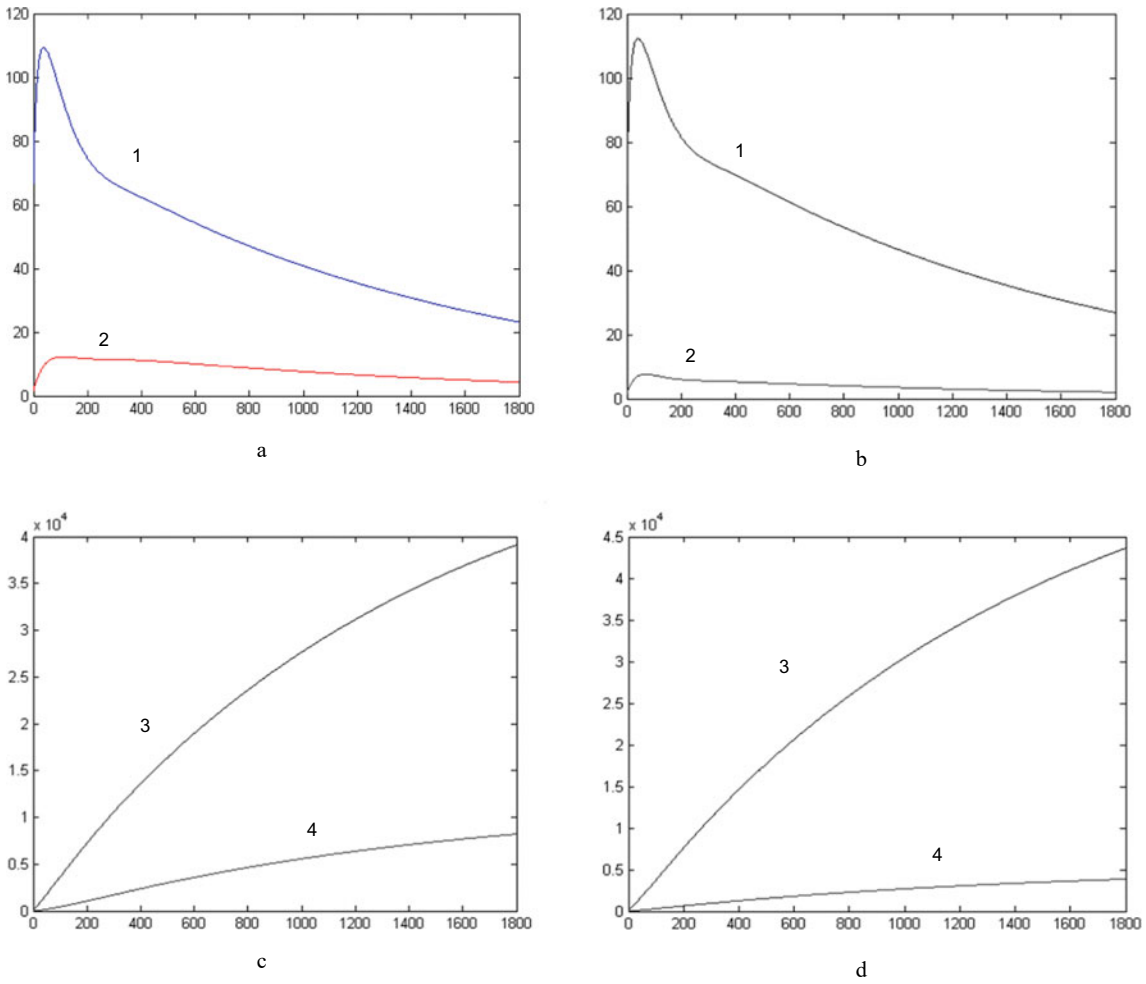


**Fig. 2** Simulation results. *Source* Compiled by the authors

## 5 Conclusion

The authors proposed a method for assessing the economic efficiency of introducing information technologies in dairy cattle breeding based on a new Markov model of the productive life of cows. Sixteen basic physiological states of cows and possible transitions are defined. The impact of information technology on economic efficiency is proposed to consider through changes in the intensity of process transitions from one state to another. The obtained modeling results confirm the possibility of obtaining more accurate estimates of the economic efficiency of these technologies in dairy cattle breeding, primarily due to a more complete accounting of the specifics of the analyzed process. The results obtained can also be used to predict the physiological states of cows depending on other factors.

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# Marketing of Contemporary Agricultural Businesses: Problems and Growth Prospects

Marina D. Samakaeva, Irina N. Kovalyova, Svetlana I. Afanasyeva, Kira V. Chernysheva, and Olga N. Ivashova

**Abstract**

Russia's agro-industrial complex has great potential for growth in the coming years due to the increase in labor productivity in agriculture, introduction of new technologies, development of exports, and support of this area by the government. Additionally, the growing demand for food products in the world can also stimulate the growth of Russia's agro-industrial complex. However, there are also risks, including climate change and economic and political factors that can affect the development of these areas in Russia. The research aims to form theoretical and methodological provisions for the development of digitalization in the sphere of marketing of agro-industrial complex. The research methods include induction, deduction, comparative analysis, general scientific methods, generalization, functional method, situational method, comparative method, economic and statistical method, and theoretical and practical works of the authors. In this regard, the modern marketing approach to consumer demand management using socio-ethical marketing, cross-cultural marketing, and collaboration in digital projects is new. When implementing marketing approaches in agricultural marketing, it is necessary to use the accumulated not only Russian but also foreign experience, which determines the need for methodological substantiation of its development level, identification of opportunities, and points of sustainable growth.

**Keywords**

Investment • Collaboration • Projects • Agricultural marketing • Management • Tourism • Cross-marketing • Promotion • Agribusiness • Digitalization

**JEL Classifications**

Q13 • Q18 • Q10

## 1 Introduction

Today's conditions of the sanctioned market economy in Russia require the development of new approaches and methods to marketing management in the digital environment.q

Due to the annexation of Crimea and the beginning of the Special Military Operation, and sanctions imposed against Russia, Russian agribusinesses have to pursue a policy of import substitution (Samakaeva & Kovalyova, 2023; Samakaeva et al., 2023; Zhigulina & Efimova, 2019).

Agricultural marketing requires ongoing consumer and market research to determine consumer needs and preferences, as well as the competitive environment. Based on this data, marketing strategies and tactics are developed to promote products in the market.

One of the basic principles of agricultural marketing is consumer orientation, price, demand, and sales management to ensure maximum profitability of the enterprise while maintaining the competitiveness of products on the market (Biryukova & Ashmarina, 2022; Bryanskaya, 2017; Charykova et al., 2020).

The use of digital marketing in the agricultural business system allows enterprises to improve the quality and

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quantity of products, reduce production costs, increase resource efficiency, and improve environmental performance. It makes it possible to use drones and other automated systems to control crops, fertilizers, and irrigation.

In general, digital agriculture is an important tool for improving the efficiency and competitiveness of agricultural enterprises.

Agricultural marketing is the process of promotion and marketing of agricultural products on the market. Its tasks include: market research, development of promotion strategy (selection of sales channels, determination of pricing policy, branding, and positioning of products on the market); product promotion (advertising campaigns, participation in exhibitions and fairs, and use of social networks to attract new customers); sales management (control of sales volume, inventory management, and distribution of products through sales channels); ensuring product quality; customer satisfaction (providing quick and high-quality services); sales and marketing of agricultural products; sales management (control of sales volume, inventory management, and distribution of products through sales channels); quality assurance (ensuring the quality of products); customer satisfaction (ensuring the quality of products and services to customers).

The goal of agricultural marketing is to maximize profits for agricultural producers and meet the needs of consumers (Biryukova & Ashmarina, 2022; Churakova, 2022; SendPulse, 2023).

Digital agricultural marketing makes it possible to assess and forecast the development of the situation in the agricultural market, make effective decisions on the production, marketing, and promotion of agricultural products, and develop a competent competitive strategy and planning (Akkanina et al., 2016; Bryanskaya, 2017; Samakaeva et al., 2023).

## 2 Materials and Methods

Market mechanisms of agricultural marketing require solving several methodological problems related to studying consumer behavior, food production, and marketing. It is required to develop new effective and inexpensive marketing approaches in the use of digital marketing tools, considering foreign experience in the management of demand and sales of agricultural products (Erlygina & Vasilyeva, 2020).

The research object is the organizational and managerial activity of the use of digital marketing of agricultural businesses.

The research subject is the organizational and economic relations arising in the process of ensuring digitalization of marketing activities of agricultural enterprises.

The theoretical basis of this research includes the works of Russian and foreign scientists, experts involved in the formation of digital infrastructure of the agro-industrial sector of the economy, normative and legal acts in the field of formation, and functioning and regulation of agribusiness issues of the Russian Federation.

The research aims to form theoretical and methodological provisions for the development of digital marketing of today's agricultural businesses.

The realization of this goal requires the following tasks:

1. To analyze theoretical issues of using digital marketing tools in the complex of promoting products of agribusinesses;
2. To study the problems of production and sales of products produced by Russian companies;
3. To develop proposals to improve the efficiency of using digital marketing tools of agricultural businesses, contributing to the growth of sales and reducing the costs of promotion and marketing of agricultural products.

The realization of the research objective was achieved by comparing the dynamics of the development of key factors contributing to the effective use of digital marketing of agricultural businesses, determining the conditions of digitalization of agricultural enterprises, and developing a methodological framework for the analysis of these phenomena and processes.

The research methods include induction, deduction, comparative analysis, general scientific methods, generalization, functional method, situational methods, comparative methods, economic and statistical methods, and theoretical and practical works of the authors.

The issues of digital marketing, including in agriculture have been addressed by such scholars as Akkanina et al., (2016), Biryukova and Ashmarina (2022), Bryanskaya (2017), Erlygina and Vasilyeva (2020), Ivashova and Yashkova (2018), Kamilov et al., (2015), Konobeeva et al., (2022), Poshataev and Bespalov (1995), Zhigulina and Efimova (2019); and other Russian and foreign scholars.

These scholars have not considered these problems from the perspective of collaboration, cross-marketing, and interaction marketing using digital tools of the development of agricultural marketing.

The research hypothesis is the position that the use of digital marketing tools (e.g., collaboration, cross-marketing, and interaction marketing) and the implementation of joint projects to promote products and services in digital agricultural marketing will solve issues related to the promotion and marketing of products of agricultural businesses. The use of new approaches in studying the problems of digital agricultural marketing determines the need for

methodological substantiation of its development level and the identification of opportunities and growth points for it. Russian agribusinesses need to learn to effectively integrate and unite in competition with global high-tech agricultural holdings and companies using digital agricultural marketing tools. Only joint efforts in promoting Russian products can solve the issues related to the rapid realization of manufactured products in the Russian and foreign markets. The analysis of methodological approaches to studying the problems of Russian agricultural enterprises has shown that the introduction of new approaches to marketing management can solve a set of problems faced by enterprises in the industry, increase profits, and reduce costs of companies by introducing digital technologies and digitalization of marketing processes. An important element of the assessment of digital marketing management to ensure agro-industrial production in the Russian Federation is to assess the level of digitalization of agricultural enterprises. The analysis has shown that it is currently not sufficient to meet the needs of the agro-industrial complex sphere (Biryukova & Ashmarina, 2022; Churakova, 2022; Ivashova & Yashkova, 2018; Konobeeva et al., 2022).

In this regard, it is necessary to use a comprehensive approach to the digitalization of the marketing of this sector.

The agro-industrial complex (AIC) is a set of enterprises and organizations engaged in the production and processing of agricultural products and providing their storage, transportation, and sale on the markets. They have different structures and opportunities for the development of digitalization and the use of marketing promotion technologies. The agro-industrial complex includes the following sectors of the economy: agriculture, food industry, chemical industry, transportation and logistics, financial sector, and research and development sector. Thus, a worker employed in agricultural production creates more than 20 jobs in related industries. These areas can be integrated into a single system of digital marketing in the agro-industrial complex. According to the Ministry of Agriculture of the Russian Federation, the output of agricultural products increased by 10.2% in comparable prices for 2022 compared with 2021 (Tadviser, 2023). The dynamics of indicators by years is presented in Fig. 1.

In recent years, there has been a noticeable trend of increasing agricultural production, which allows us to conclude that it is necessary to develop digital marketing in this industry.

The share of profitable farms increased, reaching over 90% at the end of 2022, compared with 86% in 2021 (Charykova et al., 2020; Tadviser, 2023).

There is also a noticeable tendency to increase the share of agricultural output of peasant (farmer) enterprises (Fig. 2).

Output of agricultural (farm) enterprises from 2000 to 2021 changed from 23.6 billion rubles to 1185.0 billion rubles Federal State Statistics Service of the Russian Federation (2022), Samakaeva et al., (2023), and Tadviser (2023). These farms do not have the opportunity to hire competent agricultural marketers, which requires them to search for new approaches and solutions for independent survival in the competitive Russian market using marketing tools.

## 3 Results

In today's agricultural production, there is a shortage of highly qualified agricultural marketers; the management system lacks the development of marketing strategies for developing agricultural enterprises. Enterprises of processing industries are constantly experiencing a shortage of products for processing; their quantity and quality are limited.

There is a lack of market research of product consumer markets and planning (Kamilov et al., 2015; Samakaeva et al., 2023). They are not carried out due to the lack of various resources, including financial resources and information and technological means necessary for this purpose. The country does not sufficiently provide information and consulting support to peasant (farming) enterprises (P(F)Es) and agricultural enterprises (Churakova, 2022).

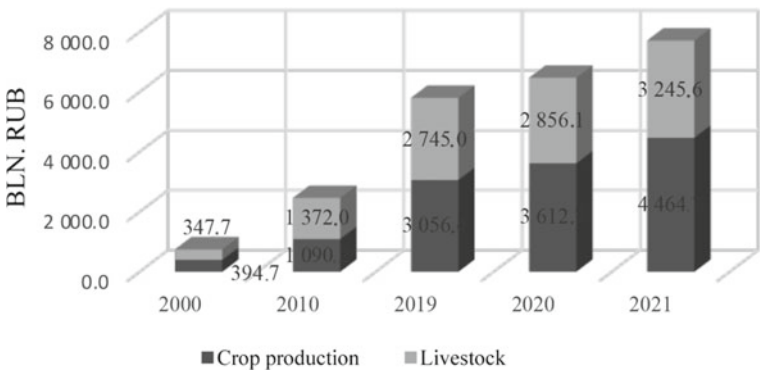


**Fig. 1** Agricultural products of all categories, billion rubles. *Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2022)

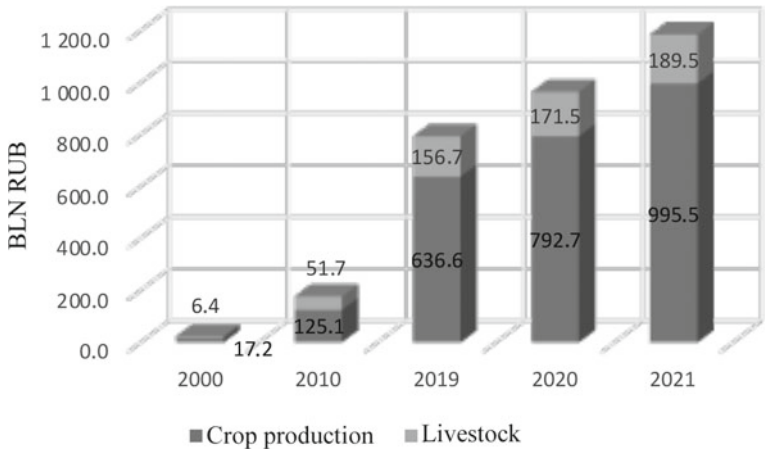


**Fig. 2** Agricultural output of peasant (farm) enterprises, billion rubles. *Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2022)

Problems of agro-industrial marketing have their specific features of development, associated with digitalization of this industry, environmental issues, and economic processes of integration and globalization of agricultural markets in many countries of the world (Biryukova & Ashmarina, 2022; Bryanskaya, 2017; Erlygina & Vasilyeva, 2020; Zhigulina & Efimova, 2019).

## 4 Discussion

We can identify the following problems of marketing development in the Russian Federation, the digitalization of which can reduce the costs of promotion and marketing of AIC products:

1. Low awareness of market needs;
2. Insufficient development of marketing and selling skills;
3. Lack of effective sales channels;
4. Low level of product quality;
5. Insufficient financing of marketing research;
6. Lack of qualified personnel who can work with advanced digital technologies can often be a problem;
7. Lack of motivation of manufacturers to implement these technologies;
8. Difficulties with legislation;
9. Insufficient government support;
10. Problems with infrastructure.

Businesses should be focused on competing with Western companies. Domestically, it would be more effective to implement collaboration and cross-marketing and develop a marketing approach to managing business processes and resources.

Collaboration involves two or more people or organizations working together on a commercial project with the goal of creating or redesigning a product and expanding the brands audience. Collaboration is a joint pooling of efforts and resources, which will provide an opportunity to find new markets domestically and expand communication and sales channels. Collaboration is primarily concerned with competitors (Churakova, 2022; Poshataev & Bespalov, 1995).

Cross-marketing is a marketing strategy that aims to increase sales and expand the customer base by collaborating with other companies or brands. In AIC, cross-marketing can be carried out in the following ways through cooperation: with other manufacturers, with retail chains, with travel agencies, with restaurants and cafes, and with online stores (Churakova, 2022; Poshataev & Bespalov, 1995).

This can be affiliate marketing, event marketing, co-branding, sponsorships, content marketing, loyalty programs, influencer marketing, and resale.

Cross-marketing tools that can be used in digital agri-marketing include joint ventures, guest posting, cross-promotions and contests, copacint, co-promo campaigns, e-mail newsletters, banner ads, pop-up windows, native advertising, Instagram, Facebook, Telegram, WhatsApp, VKontakte chatbot marketing, cross-marketing in SendPulse, and websites (Churakova, 2022; Poshataev & Bespalov, 1995).

The life of an agricultural farm, production technology, animal husbandry, and environmentally friendly food production can be interesting for consumers. The formation of ecobrands within the country will help solve the problems of marketing of ecologically clean products of agricultural producers (Kamilov et al., 2015), as well as the development of eco or agricultural tourism (Ivashova & Yashkova, 2018; Kamilov et al., 2015; Konobeeva et al., 2022). Advocacy and collaboration of this process at the level of government, organizations, and individuals can change the trends and

tendencies of rural population outflow to urban conglomerations that have emerged in recent decades (Churakova, 2022).

Thus, collaboration in agribusiness among competing firms has the following areas for development: cooperation among farmers, partnership with suppliers and buyers, exchange of experience and knowledge, participation in associations and unions, and cooperation with scientific and research institutes (Churakova, 2022; Ivashova & Yashkova, 2018). Thus, the strategy for the development of agricultural marketing should contribute to improving the efficiency of sales and realization of products of agricultural enterprises.

## 5 Conclusion

The research identified factors affecting the digitalization of processes in the country's agriculture and priority areas for the development of digital agricultural marketing.

External factors include government policy, availability of appropriate regulatory framework in the field of digital agricultural marketing, innovation processes in the agro-industrial complex and their financial support, availability of cheap credit for the development of agribusiness and marketing, and the availability of developed logistics and road and technological infrastructure.

Internal factors of digital agricultural marketing are determined by the degree of the use of material and technical base and telecommunication means by agricultural businesses.

If we talk about the problems of digitalization of agriculture in Russia, we can highlight the following: lack of digital technologies, lack of access to the Internet, insufficient funding, low culture of digital security, and insufficient information support. In Russia, there are not always enough information resources and services that can help agricultural producers to develop and use digital technologies (Samakaeva & Kovalyova, 2023; SendPulse, 2023; Tadviser, 2023).

The authors suggest that agricultural marketers make greater use of such digital marketing tools as collaboration and cross-cultural marketing, joint projects in the sphere of agro-industrial enterprises, even those competing with each other at the moment in the Russian Federation. Private and public companies are to expand the use of appropriate agro-marketing platforms, blockchain technology, virtual digital assistants, smart contract technology, artificial intelligence, implement warehouse robotization, and network infrastructure, which will make it possible to more effectively and with minimal cost to conduct market research and consumer needs and develop marketing and sales skills. Farmers need to be trained in the basics of marketing and sales to be able to sell their products at favorable prices, create effective marketing channels, improve product quality, and finance joint marketing research. For agro-industrial complex enterprises, it is necessary to use marketing approach in management (Biryukova & Ashmarina, 2022; Bryanskaya, 2017; Churakova, 2022). The AIC of Russia employs about 113 thousand specialists in the field of information technologies. For every 1000 employees, there is one employee who knows information and communication technologies in the sphere of marketing and marketing communications, which requires the necessary restructuring in the training of specialists of this profile in the system of specialized secondary and higher education (Charykova et al., 2020; Erlygina & Vasilyeva, 2020).

To realize these directions, it is necessary to develop secure information technologies and platforms that will increase the efficiency of agribusiness and have specialists in the industry skilled in these technologies.

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# Agile Project Management as a Factor of Competitiveness of Russian Companies in a Turbulent Economic Environment

Vitaly V. Cherkasov and Nikita V. Cherkasov

**Abstract**

This research focuses on project management approaches effective for Russian companies in the current geopolitical and economic environment. The scientific and methodological basis of the conducted research is the contemporary understanding of project management in a traditional, flexible, and hybrid way. According to the authors, approaches to project management require modernization at the current stage of development of the Russian economy. The authors identify the key project management factors for the sustainable development of Russian companies. The research shows that the predominant use of traditional project management methods is ineffective. The paper analyzes the differences between traditional and agile approaches in project management. To determine the advantages of flexible and traditional management models, the authors analyze the actions performed under these models. The authors argue that the success of Russian companies, including those developing in innovative sectors, can be achieved through a combination of flexible and traditional project management. According to the authors, this kind of management should involve the factor of adapting the practical methods and approaches to a particular company or project (an approach called tailoring). In addition to the formalisms and tailoring algorithm, when choosing agile or traditional project management methods, it is also important to consider the project environment, such important criteria as requirements stability, corporate culture, the number of participants in the project team, potential risks, and human resources. The proposed innovations will result in a significant increase in organizational development.

**Keywords**

Project management • Flexible management • Success factors • Performance indicators • Traditional management

**JEL Classification**

M10

## 1 Introduction

At the current stage, the economic system of Russia and the global economic system is developing dynamically and unpredictably. The turbulence of the external and internal environment is increasing. Digital technologies are rapidly bursting into companies' operations. Companies that have not adapted to the challenges of digitalization are losing leadership.

The responsibility of managers in the context of globalization and digitalization is to ensure that companies achieve economic growth in a sustainable and quality manner by applying communication and information technologies. This causes the need to modernize approaches in management activities, restructure internal systems, adapt them, and develop greater flexibility within structural units responsible for production, marketing, finance, and personnel management. The predominant use of traditional project management methods is insufficiently effective.

Change in environments characterized by unpredictability, interdependence, and complexity requires flexible project management approaches that consider the specific characteristics of the changing context and adjust as the organization evolves.

The new management model should utilize the company's existing scientific potential and consider its competitive advantages in domestic and foreign markets.

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The authors aim to identify the features of project management, which would be oriented to consider the individual characteristics of the activities of organizations or projects, as well as mechanisms for its effective implementation. To achieve the research objective, the authors analyzed the available approaches to project management in Russian companies and explored the possibilities of applying a hybrid approach in project management built on a combination of traditional and flexible methods.

## 2 Methodology

The issues of traditional project management received considerable attention in Russian and foreign scientific literature. According to researchers, traditional project management can become highly effective if the project scope is known in advance (Eisenblat, 2012). According to research (Komus, 2017), about 12% of companies still perform their project development in a purely traditional way. Nevertheless, the toolkit offered by traditional management does not make it possible to define flexible mechanisms of reaction to changes in the external environment and, accordingly, to develop the principles of appropriate organizational adaptation. Additionally, the specificity of individual organizations and their projects is not considered.

The topic of agile change management is a relatively new research area. Although it has been reviewed in the works of D. Anderson, D. Hester, M. Cohn, D. Sutherland, D. Highsmith, R. Stacey, K. Schwaber, and other authors, there is a lack of systemic analysis of this project management model (Kohnke & Wieser, 2019). Typically, companies turn to agile change management to optimize product launch time (61%), optimize quality (47%), and mitigate project risk (42%); it is allowed to change the project's name (Komus, 2017, p. 27).

Hybrid project management includes a combination of traditional and agile approaches (Wendt, 2016). According to Komus (2017), 37% of companies use hybrid methods in their development processes. The methodology combines at least two procedures that can be characterized by a high degree of opposites (Komus, 2017, p. 15), lacks any empirical basis, and requires clarification and development.

Thus, the studies of available methods and tools of project management require additional elaboration to make project management systems flexible and adaptive, increase their comprehensiveness, and consider the specifics of their implementation.

The authors used scientific methodology based on general scientific methods, including synthesis, analysis, comparison, demonstration of analogies, and system-structural approach.

## 3 Results

J. Preußig's research allows us to conclude that the influence exerted by stakeholders decreases at different stages of project realization in the case of traditional project management and remains at a constant level under agile management. Consequently, the cost of implementing changes late in the project increases with the traditional approach and decreases with the agile approach (Preußig, 2018, pp. 12, 15).

These and other differences between the traditional and agile approaches in project management, systematized by the authors based on the analysis of scientific sources, are presented in Table 1.

The authors analyzed the actions taken under these models to determine the advantages of agile and traditional management models. The results of the analysis are summarized in Table 2.

The comparison made it possible to conclude that agile project management models are characterized by iterativity, absence of phases, adaptation to changes in scope, flexibility, and increased orientation to practice. Traditional project management models are characterized by sequencing, phases, lack of scalability, lack of flexibility, and a partially practice-based nature.

As a result of further research, the authors have made suggestions as to when it is appropriate to combine traditional and flexible approaches:

1. In the beginning, requirements are instantiated through an agile design. Then, the requirements brought to a stable state are realized through a V-model or waterfall model;
2. Development projects that are managed through the traditional model contain flexible subprojects;
3. Within Agile development projects, requirements are documented accurately and traceable. At the end of each requirement there are phases to verify and validate the requirement;
4. Agile development projects that require transparent and traceable change management according to project-specific requirements are implemented.

Several formalisms are proposed to integrate agile methods into a project implemented by traditional management methods. For this purpose, in the initial period of the project realization and during its execution, it is necessary to carry out requirements management to find out and observe the interdependencies between the requirements. It is also important to consider that project management should be based on preparing an overall project plan. This plan should be implemented and monitored throughout the project.

**Table 1** Comparison of traditional and agile project management

| Traditional project management | Flexible project management |
|---|---|
| There is a set of requirements at the beginning of the project | Requirements at the beginning of the project are vague |
| As the project progresses, changes in requirements are difficult to implement | As the project progresses, any changes to the requirements are welcome |
| Making changes to requirements late in the process is fraught with increased costs | Modifications to requirements at later stages have moderate costs |
| The project task is prepared based on technical data | The project task is based on the client's understanding of the requirements |
| The project is developed sequentially | Project development is iterative |
| The process is characterized by rigid execution | The process is characterized by continuity |
| The client receives the final product | The client has access to the intermediate results of product development |
| In the event of temporary difficulties, project phases are shifted | In case of temporary difficulties, the effort is reduced |
| It is possible to create large teams within the project | Relatively small teams are sufficient for project implementation |
| A strict hierarchy is followed | Teams function on the principles of self-organization |
| The project team includes a large number of specialists | Each team member is responsible for the result |
| Team members are located in different locations | Team members are located in one location |
| The team works on several projects simultaneously | Teams focus on a single project |
| Project tasks are distributed | Project tasks are selected |
| Interaction is carried out through document preparation and lengthy meetings | Interaction is carried out during scheduled meetings |
| The project manager evaluates project contributions | All team members are evaluated for their contribution to the project |

*Source* Compiled by the authors (Preußig, 2018)

**Table 2** Advantages and disadvantages of traditional and agile action models in project management

| Criteria | Waterfall model | V-model | XP | SCRUM |
|---|---|---|---|---|
| Presence of phases | ✓ | ✓ | ✗ | ✗ |
| Adapting to changes in scale | ✗ | ✗ | ✓ | ✓ |
| Flexibility | ✗ | ✗ | ✓ | ✓ |
| Implementation method | Sequentially | Sequentially | Iteratively | Iteratively |
| Availability of methods | ✗ | ✓ | ✓ | ✓ |
| Availability of tools | ✗ | ✓ | ✗ | ✗ |
| Supporting processes | ✗ | ✓ | ✗ | ✗ |
| Practice orientation | ✗ | ✓ | ✓ | ✓ |
| Risk management | ✗ | ✓ | ✗ | ✗ |
| Quality level support | ✓ | ✓ | ✓ | ✓ |

*Source* Compiled by the authors based on Kirchhof and Kraft (2012)

Activities related to quality management should take the form of involving customers and testers in the project, who should conduct their work together. Additionally, the implementation plan for an agile project should contain information about the customer's requirements and wishes (Kirchhof & Kraft, 2012; Trepper, 2012, p. 11).

The authors concluded that implementing the individual formalisms listed above is insufficient. Although the scientific literature tends to suggest that traditional methods have universal applicability, this thesis is often not confirmed in practice. The authors believe that hybrid project management should involve the factor of adapting the methods and approaches used in practice to a particular company or project. In this case, it is advisable to introduce an approach called tailoring.

In Russian companies, the proposed methods are currently undergoing their adaptation as they are being implemented. This presents some difficulty because it is difficult to

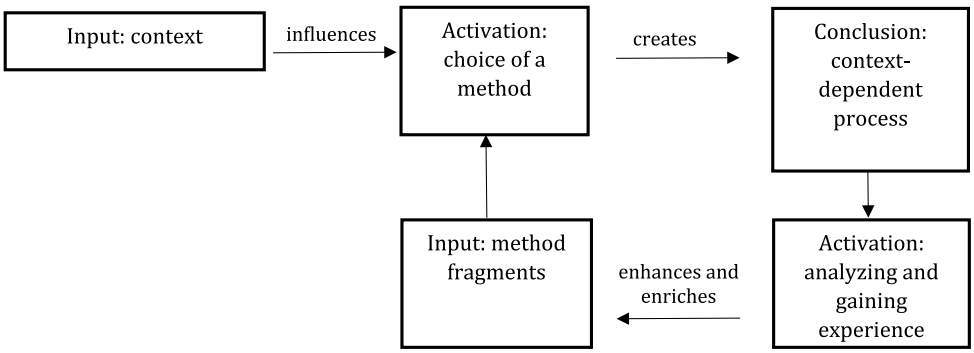


**Fig. 1** Tailoring algorithm. *Source* Compiled by the authors based on Cesare et al., (2004) and Trepper (2012)

identify those making the adjustments. Thus, while not enshrined in any documentation, the experience is not transferable. Due to the tailoring approach presented in Fig. 1, an algorithm (Trepper, 2012, p. 12) is implemented, according to which the documented adaptation is realized (Cesare et al., 2004).

Adaptation is done based on the incoming context, i.e., the method needing the adaptation process. When performing the initial customization, a context-dependent process is created, which is a derivative of several fragments of the method being implemented. In analyzing this new process, new experiences are developed that can form the basis for improved fragments of the method.

In addition to the formalisms and tailoring algorithm proposed for implementation, it is also important to consider the project environment when choosing agile or traditional project management methods (Boehm, 2004; Seel & Timinger, 2016). It is important to consider such important criteria as requirements' stability, corporate culture, number of participants in the project team, potential risks, and human resources. These criteria are presented in Fig. 2. The use of a flexible approach may be recommended depending on how the criterion is centered (Boehm, 2004). For example, this approach might be offered to a potentially low-risk project with volatile requirements, where staff is highly skilled, a project culture is characterized by chaos, and the team size is limited. Conversely, the traditional management method could be applicable in the case of a large team, an established culture, unchanging requirements, and a low-risk level (Seel & Timinger, 2016, p. 2).

## 4 Conclusion

The conducted research makes it possible to conclude that traditional and agile project management methods have their strengths and weaknesses. They both can be effectively implemented in practice. The correct choice of method will ensure ultimate success. When implementing hybrid project management methods, it is important to consider the

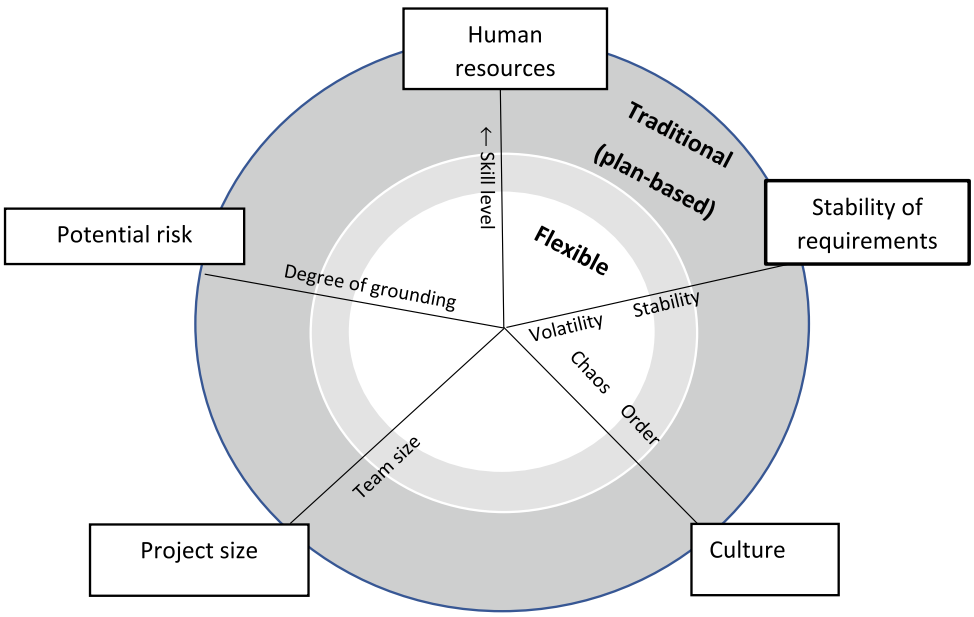


**Fig. 2** Choice of approach according to the criteria of the project environment. *Source* Compiled by the authors based on Seel and Timinger (2016)

implications of the resonance between hybrid, traditional, and agile aspects. In this case, verifying the implementation of traditional and flexible approaches and promptly taking corrective actions are advisable. Simultaneously, it is important to monitor and control the company's project environment. Control can be implemented through requirements management, quality management, and project management that is tailored to the work of a particular organization. When analyzing the project environment, it is necessary to examine the project for the suitability of traditional and agile methods, as well as the possibility of using a hybrid approach. In the hybrid method, it will be necessary to implement adaptation and development steps on an ongoing basis and develop an individual project approach.

According to the authors, it would be advisable to conduct more in-depth research based on specific practical scenarios to identify areas for further development and promotion of hybrid project management. It is also of scientific interest to study the advantages and disadvantages of traditional and agile project management methods as applied to specific project management methods SCRUM, Prince2, and others, as well as to the waterfall model and V-model. This research may help to identify the most flexible and easily mastered ways to utilize them in a hybrid form. To assess how hybrid procedures can be applied in different circumstances, it is required to create certain schemes that will include ready configurations of models of hybrid nature. It also seems important to conduct research on the direction of hybrid models of action.

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# Social and Legal Aspects of the Sustainable Development of Agrarian Economy Based on Digital Technologies and Smart Innovations: Staffing, Human Resources Management, and ESG Governance

# Agricultural Policy in Russia: Prospects for Transformation in the Context of Deglobalization

Rustam E. Salnichenko and Vladislav Yu. Velichkin

**Abstract**

The research relevance is based on some changes in the Russian agricultural sector, which occurred due to the deglobalization and sanctions imposed by developing countries. It is worth mentioning that food security nowadays is an important part of providing sovereignty. The main goal of this investigation is to analyze Russian agricultural policy within new economic conditions and assess new qualitative directions in this policy. To achieve the research goal, the authors applied comparative and statistical-economic methods, as well as theoretical and practical results of research by Russian authors. To identify trends in the Russian agricultural sector which have the advantages under deglobalization conditions, the authors conducted a statistical, economic, and theoretical analysis of scientific research. The method based on comparison and practical-oriented representation allowed the authors to detect some issues in the agricultural policy of Russia. Some directions to be improved were found. These areas relate to economic deepening and technical equipment supported by effective and well-established public policies.

**Keywords**

Deglobalization • Agro-industrial complex • Protectionism • Sanctions • Government support • Exports

**JEL Classifications**

F2 • H50

## 1 Introduction

Russia's agricultural policy has witnessed certain changes previously related to deglobalization. These changes primarily affect the country's economy. The economy of agriculture is included in the common country's economy.

The works of such Russian scientists as Artemyeva et al. (2022), Kozlova and Dubrovina (2021), Makhotlova et al. (2023), Rezvyakova and Lilenko (2022), and others make it possible to combine recent scientific evidence about Russian agricultural complex. These works also make it possible to create some directions for enhancing the agricultural complex in Russia through deglobalization, sanctions, and restrictions. Currently, many scientific papers and conclusions are provided in connection with the review of the agricultural sector. However, deglobalization remains understudied, from which the consideration of the Russian agro-cultural sector in the current economic reality has insufficient elaboration and requires additional research.

## 2 Materials and Methods

At each research step, the authors pursued the main goal—to study existing trends and develop proposals to improve the state of the Russian agricultural complex during sanctions.

For more efficient development of proposals, the authors adhered to the following tasks:

- To conduct a comprehensive assessment of the agricultural complex in Russia considering previous achievements and existing macroeconomic conditions;
- To consider the impact of Russian government structures on the development of agricultural complex in worldwide amending circumstances;
- To detect the main problems of interaction between the authorities and the Russian agricultural sector.

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During the research, the authors used the works of Russian scientists and analytical data from open-access resources. Statistical and economic methods, sociological and analytical research methods, and structural and comparative methods were also applied.

## 3 Results

Deglobalization is a complex phenomenon, indicating a decrease in the level of international integration between economic entities at all levels and in various spheres of public life (Artemyeva et al., 2022).

By analyzing the KOF Globalization Index, we can see a slowdown in the economic sector, especially if we compare the pace of recent years with the boom that began in 1990 and lasted about a decade (KOF Swiss Economic Institute, 2023). The agro-industrial sector of Russia is a national priority of state policy; Russia has been the largest wheat exporter since 2016 (United States Department of Agriculture, 2023, p. 8). The Russian Federation is also one of the top three wheat producers, not being even in the top ten wheat importers (United States Department of Agriculture, 2023, p. 5). For 2023–2024, production is expected to decrease by 11%, with a decrease in yield and crop area (United States Department of Agriculture, 2023, p. 3).

COVID-19 and sanctions affect all supply chains and the movement in the Russian agricultural sector. For instance, the Government of the Russian Federation introduced an export quota of seven million metric tons of wheat, rye, barley, and corn between April 1 and June 30, 2020. In 2022, the largest container carriers left the Russian market (e.g., Maersk and MSC), after which the cost of supplies increased. There also occurred failures in settlements with foreign suppliers due to sanctions against Russian banks (Sukhorukova, 2022). As a result, the export of grain crops, with overall growth, decreased in 2018–2020 and, according to preliminary data, fell to 40 million tons in 2022 (Statista, 2023b).

A downward trend can be traced in terms of cattle. In 2001, the population (all forms of farms are considered) amounted to more than 27 million heads. In 2022, according to preliminary calculations, the population was 17.5 million heads. The highest figure was recorded in 1986 and amounted to 60.5 million heads (Federal State Statistics Service of the Russian Federation, 2022, p. 413). Revenues received from the sale of eggs and dairy products also have a positive trend. Comparing the Russian indicators with world ones from 2023 to 2028, we can see a stable movement of revenue changes. Moreover, the change in revenues after the sale of this type of product in Russia exceeds the global figures (Statista, 2023a), which proves the potential for developing the agricultural sector in Russia.

Russia has fallen under sanctions in the first half of 2022. These sanctions may negatively affect the development of agriculture in Russia. The imposed restrictions break the movement of Russia from a market economy to a digital one.

In view of the utmost importance of the agricultural sector for the Russian economy and the strengthening of the Russian economy by it, additional investment should be directed precisely to the internal development of Russia, which will support Russian agriculture (Rezvyakova & Lilenko, 2022).

The preservation of domestic products and the limitation of export levels for 2018–2023 can be estimated from publicly available data. Nevertheless, it is planned to gradually increase wheat exports from the Russian Federation by 2031 (Table 1).

The agricultural complex is developing not only thanks to the business entities participating in it but also thanks to state authorities. The largest landowners in Russia in 2022 are Miratorg, Prodimex, and Tkachev Agricultural Complex. The top three owners of the most valuable agricultural lands included Pokrovsky Concern, Tkachev Agricultural Complex, and AgroGrad (Forbes, 2022).

Despite the significant impact on the country's economy through the sale of products on the domestic market and income from exports, the sanctions imposed on the Russian Federation can negatively affect the development of agricultural business in Russia. In the conditions of sanctions pressure and deglobalization, further development of agriculture is challenging without government support.

Thus, one of the measures to support agribusiness is the memorandum of understanding between the United Nations Secretariat and the Russian Federation on helping to promote Russian food and fertilizers to world markets. This document primarily aims to promote sustainable development (Ministry of Foreign Affairs of the Russian Federation, 2022).

Decree of the President of the Russian Federation "On national goals and strategic objectives of the development of the Russian Federation until 2024" (May 7, 2018 No. 204) is an essential document that aims to develop the agricultural sector in Russia. This and other legal documents aim to develop agriculture in Russia so that exports are increased by increasing the activity of the country's agribusiness entities (Presidential Executive Office, 2018).

The Federal Scientific and Technical Program for the Development of Agriculture for 2017–2025 is a document created in an attempt to reduce the import dependence of Russia on seed production and breeding livestock. This program also aims to reduce the dependence on advanced technological developments and make domestic products more competitive on the world stage (Duma, 2020, pp. 49–50).

**Table 1** Export values of agricultural products from Russia, million metric tons

| Volume of wheat exported from Russia | | | | Export volume of cereals from Russia | | | |
|---|---|---|---|---|---|---|---|
| | Years | Volume | Dynamics ratio (%) | Years | Volume | Dynamics ratio (%) | |
| | 2011 | 21.71 | – | 2000/01 | 1.27 | – | |
| | 2012 | 6.59 | 30.35 | 2001/02 | 7.03 | 553.54 | |
| | 2013 | 18.49 | 280.58 | 2002/03 | 16.24 | 231.01 | |
| | 2014 | 22.11 | 119.58 | 2003/04 | 6.26 | 38.55 | |
| | 2015 | 25.41 | 114.93 | 2004/05 | 9.15 | 146.17 | |
| | 2016 | 27.60 | 108.62 | 2005/06 | 12.09 | 132.13 | |
| | 2017 | 40.81 | 147.86 | 2006/07 | 12.30 | 101.74 | |
| **Protectionism** | **2018** | **35.67** | **87.41** | 2007/08 | 13.30 | 108.13 | |
| | **2019** | **34.11** | **95.63** | 2008/09 | 23.59 | 177.37 | |
| | **2020** | **38.32** | **112.34** | 2009/10 | 21.34 | 90.46 | |
| | **2021** | **30** | **78.29** | 2010/11 | 4.51 | 21.13 | |
| | **2022*** | **36.86** | **122.87** | 2011/12 | 27.49 | 609.53 | |
| | 2023* | 39.90 | 108.25 | 2012/13 | 15.55 | 56.57 | |
| | 2024* | 42.96 | 107.67 | 2013/14 | 25.57 | 164.44 | |
| | 2025* | 43.99 | 102.40 | 2014/15 | 30.99 | 121.20 | |
| | 2026* | 44.66 | 101.52 | 2015/16 | 34.64 | 111.78 | |
| | 2027* | 45.28 | 101.39 | 2016/17 | 36.54 | 105.48 | |
| | 2028* | 45.93 | 101.44 | 2017/18 | 52.79 | 144.47 | |
| | 2029* | 46.56 | 101.37 | **2018/19** | **43.86** | **83.08** | **Protectionism** |
| | 2030* | 47.19 | 101.35 | **2019/20** | **43.06** | **98.18** | |
| | 2031* | 47.84 | 101.38 | **2020/21** | **49.30** | **114.49** | |
| | | | | **2021/22*** | **39.44** | **80.00** | |
| | | | | **2022/23*** | **53.29** | **135.12** | |

*Source* Compiled by the authors based on Stat (2023) and Statista (2022, 2023b)
*Note* * Forecast for the year

All measures described above can potentially impact agriculture in Russia with high strength. However, it is necessary to consider the actions (state investments) of state authorities in the context of several countries—exporters of wheat (Fig. 1).

The graph compiled by the authors shows that European countries, Russia, and India have systematically increased their cash flows in developing the agricultural sector and livestock in their countries since 2001. However, after 2014, Russia, like other European countries (France and Germany)

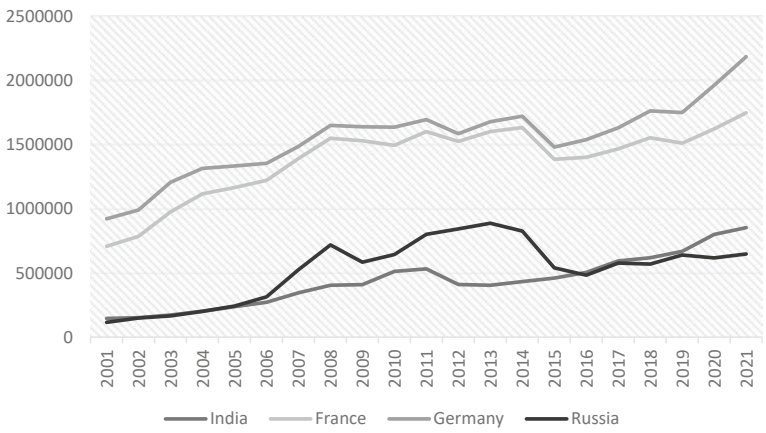


**Fig. 1** Public cash flows in the agricultural sector of different countries ($ million). *Source* Compiled by the authors based on FAOSTAT (2023)

sharply reduced public cash flows in the development of agriculture. Since 2016, India has been ahead of Russia in terms of public investment.

European countries also try paying attention to food security, for which a strategy of "reasonable, sustainable, and comprehensive growth" was invented. The essence of this strategy is to combine knowledge and innovation while emphasizing the environmental friendliness of production and social orientation (Kozlova & Dubrovina, 2021).

According to the study of the Russian food sector, we can identify some problems that have disrupted the development of agriculture and may have a negative impact on agriculture in the future.

The forecast of the Higher School of Economics describes one of the risks for the Russian agro-industrial sector. The reason is high urbanization, which affects many regions of Russia. Urbanization itself reflects the economic growth of cities, but at the same time the agricultural sector continues extensive development, which causes problems of staff outflow, lack of development of robotic technologies, reduced investment, and, accordingly, this leads to threats to the financial development and social spheres of our society (Ministry of Agriculture of the Russian Federation & National Research University "Higher School of Economic", 2017, p. 11).

Within the framework of WTO, some developed counties target their policies through non-tariff regulation to create restrictions in their markets. These restrictions are also aimed at limiting the openness of the domestic market of developing countries. Such policies have a negative impact on the Russian agricultural sector, which adheres to a policy of open markets. Barriers aimed at trade relations of the Russian Federation are used to protect national producers (Ministry of Agriculture of the Russian Federation & National Research University "Higher School of Economic", 2017, p. 12).

Also, one of the problems manifested in the agro-industrial sector of Russia and many developing countries is the increase in subsidies to the agricultural sector in globalization circumstances. When entering the agro-industrial markets of developed countries, Russian agricultural holdings should consider the barriers that they may face (Ministry of Agriculture of the Russian Federation & National Research University "Higher School of Economic", 2017, p. 12).

The identified problems require certain government measures. Sanctions and COVID-19 entailed a sharp change in agricultural policy in Russia. The Ministry of Agriculture has adopted the instruments of preferential lending, monetary compensation, and reimbursement to agricultural producers of part of production costs, and uses it in accordance with the national projects of Russia (Ministry of Agriculture of the Russian Federation, 2023). Simultaneously, the legislative authorities are developing different strategies that the agricultural complex may expect in the future. Thus, in accordance with Appendix No. 4 "Main directions and stages of scientific and technological development of the agro-industrial complex until 2030," Russia has two ways in the agro-industrial sector. The first implies a small local growth. The second way is called "Global breakthrough" and consists of identifying potentially important points for growth, as well as more specific activities of each point and the percentage of their implementation in case of reaching one of the scenarios (Ministry of Agriculture of the Russian Federation & National Research University "Higher School of Economic", 2017, pp. 107–123). The item "Accurate agriculture" deserves special attention in the context of deglobalization and restrictions on the import of advanced technologies from developed countries.

Based on visible evidence of Table 2, the "Local growth" scenario is potentially achieved only if the state's policy in the agro-industrial sector is amazingly effective. Under conditions of sanctions pressure, this policy should be even more effective. As Makhotlova and her colleagues correctly noted in their study, the agro-industrial sector is a difficult part of the national economy. Therefore, when modernizing the agricultural sector, it should be based on natural laws, considering national and geographical characteristics (Makhotlova et al., 2023). Simultaneously, government employees should resolve the sphere of agricultural reforms with legal and financial support. In Russia, subsidized support methods are actively used by the state. Nevertheless, according to the authors' opinion, the Russian government should think about stimulating market competition and incentive of population to develop the agricultural sector with a desire to satisfy the Russian domestic market's requirements and expand production abroad.

## 4 Discussion

In connection with the considered negative consequences of the sanctions imposed on Russia and the deglobalization that affected the country, the authors developed a proposal that aims at the joint work of the authorities of the Russian Federation, the BRICS countries, and business entities of all union members (Fig. 2).

In modern world, the Russian agricultural sector has a wide range of problems that should be solved if agriculture in the country is to follow the path of potential development. Deglobalization is currently one of the barriers in the framework of increasing Russian impact on worldwide agricultural business.

**Table 2** Agribusiness development strategies until 2023

| Direction of scientific and technological development | Scenario "local growth" | | | Scenario "global breakthrough" | | |
|---|---|---|---|---|---|---|
| | 2020 | 2025 | 2030 | 2020 | 2025 | 2030 |
| *Complex precision farming technologies* | | | | | | |
| Technologies for using uncrewed aerial vehicles and agricultural apparatus | | Possible with the favorable internal development of the scenario | | + | | |
| Nano- and pico-satellite technology in agriculture | | With possible favorable conditions in adjacent industries | | | + | |
| Full autopilot technology | | | | | + | |
| Deep processing of agricultural raw materials directly at the place of collection using mobile semi-autonomous mini-mill systems | | | | | + | |
| Technologies of big data and the Internet of Things in agriculture | | | | | | + |
| Technologies of new electronics, especially wireless microsensor networks | | | | | | + |
| Advanced robotic technology based on artificial intelligence, swarm intelligence, and machine learning | | | | | | + |

*Source* Compiled by the authors based on Ministry of Agriculture of the Russian Federation and National Research University "Higher School of Economic (2017, p. 116)

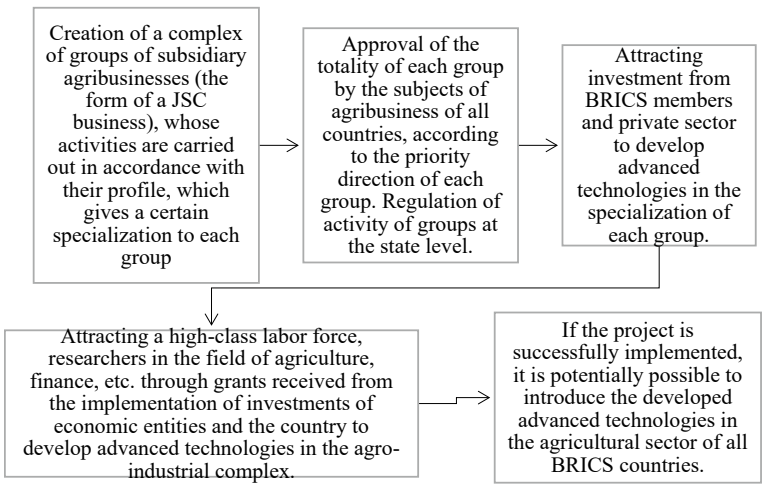


**Fig. 2** Example of Russian's action plan for cooperation in the agro-industrial sphere. *Source* Created by the authors

## 5 Conclusion

In accordance with the research goal and objectives, it was revealed by the statistical and economic method that agricultural culture has an enormous impact on the Russian economy, and the spheres related to food production are actively developing. Measures to support the subjects of agriculture and animal husbandry, which were developed by the state, were considered. Using the comparison method, the authors defined the effectiveness of public investment in agriculture. Some conclusions were made by the analysis. These conclusions are about determining that the conversion of the agricultural sector has some restrictions in the deglobalization framework. The most glaring of them are increasing urbanization intensity, restrictions by sanctions, trade wars, and not quite developed agricultural equipment.

Based on some analyzed data and identified problems, the authors have developed several ways to develop the framework of deglobalization of the agro-industrial sector:

(1) cooperation with the BRICS countries, (2) development of innovative approaches to the fulfillment of support measures, and (3) transformation based on natural laws.

The empirical significance of the research is that ensuring food security in Russia and other countries is one of the paramount tasks in the changing supply chains around the world, especially in times of crisis. Accordingly, research in this area provides the best way to pass the full transformation of the agricultural sector in the deglobalization framework. The prospects for studying the development of the agricultural sector in the deglobalization framework are extensive and can affect many aspects of this form of economic relations.

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# Food Security of Russia in the Context of International Economic Sanctions

Arif G. Ibragimov, Maria A. Romanyuk, Vyacheslav G. Borulko, Natalia V. Chekmareva, and Maria A. Suharnikova

**Abstract**

The authors present the results of a study of the state of food security in Russia under international sanctions. During the research, the authors analyzed long-term trends in the development of agricultural industries, studied the main provisions of state strategic documents regulating the development of agricultural producers and food markets, recommended directions for solving problems in ensuring the country's food security, and assessed the state of food security in Russia. It is established that the agricultural policy of Russia aimed at supporting agricultural producers and import substitution over the past decade has yielded positive results. It allowed the country to reach the level of self-sufficiency in the parameters of the Doctrine of Food Security. In terms of self-sufficiency, the authors identified three groups of food products: export-oriented (grain, fish, and vegetable fat), unsecured (milk, potatoes, vegetables, and fruits), and secured (meat and eggs). Based on the method of strategic groupings, the authors established disproportions in the dynamics of the development of various sub-sectors in agriculture. It turned out that the most efficient and fastest-growing industries are those that are export-oriented. Based on the research results, the authors offer some recommendations for improving market situations when working in conditions of international sanctions: (a) in the foreign market—measures to reorient export channels and build new supply chains; (b) on the domestic market—a program of preferential purchase of domestically produced food products for low-income residents of the country.

**Keywords**

International sanctions • Food security • Import substitution • Food market • Agricultural sectors • Agricultural producers • Self-sufficiency

**JEL Classification**

Q180

## 1 Introduction

In the world economy, the process of providing food to countries is integrated into the international division of labor, associated with the development of world trade in agricultural products and food, as well as the globalization of the world economy. Therefore, ensuring the food security of a particular country without interstate cooperation is difficult. In this sense, the unfavorable geopolitical situation around Russia, created in recent years, threatens its food independence. Since 2014, many world's leading countries, led by the USA, have pursued a sanctions policy against Russia by restricting trade relations. In turn, Russia applies counter-sanctions against these countries to protect its economy. Thus, Russia found itself in economic and trade isolation. All sanctions measures applied by unfriendly countries are ultimately aimed at weakening Russia's national security. The national security of any country, in turn, is directly dependent on its economic security, part of which is food security (Dolgova et al., 2022; Dzhancharova

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& Leshcheva, 2020; Leshcheva, 2020; Presidential Executive Office, 2020).

Analyzing the circumstances formed around Russia, we can say that it is impossible to ensure the country's food security without a special regime of state regulation of agricultural production and agro-food markets. This is especially relevant in the current environment when sanctions almost completely isolate Russia's economy from the leading world countries (Federal State Statistics Service of the Russian Federation, 2023; Ibragimov et al., 2022a).

### 1.1 Purpose and Objectives

The research aims to identify the main directions of food security in Russia. The set research goal defined the following tasks (stages) of the study:

- To analyze long-term trends in the development of agriculture;
- To analyze state measures of regulation of the factors forming food security;
- To formulate problems and areas of development to ensure the country's food security.

The research object is the agro-food markets of Russia.

## 2 Materials and Methods

To ensure the objectivity of the research results, the authors used data from official statistical reports of government agencies of the Russian Federation, particularly the Federal State Statistics Service of the Russian Federation (Rosstat) and the Ministry of Agriculture.

The authors also conducted a comprehensive analysis of the scientific works of leading scientists in this area and, based on their critical understanding and the authors' observations, provided conclusions and recommendations.

## 3 Results and Discussion

As the basis of food security, food independence characterizes the provision of the country's population with food at the expense of its own production. According to Food and Agriculture Organization of the United Nations (FAO) regulations, this figure is 70%. According to Russia's Food Security Doctrine for different types of food, this indicator ranges from 60% (for fruits and berries) to 95% (for potatoes and grains) (Ibragimov et al., 2023; Leshcheva et al., 2021; Presidential Executive Office, 2020).

Food market conditions are formed under the influence of the dynamics of domestic agricultural production and the level of effective demand, which directly affects the size, range, and price of imports. Secondary factors can include the consumer habits of the population, the quality of products, and the level of market infrastructure development (Dzhancharova et al., 2022; Koshelev et al., 2023).

The state regulation of agricultural production and the agro-food market in Russia since 2003 has made it possible to overcome several problems that arose as a result of economic reforms. However, there remains the question of the effectiveness of the current mechanism of state regulation under economic sanctions (Ibragimov & Platonovsky, 2021).

Over the past 20 years, the state objectives in developing agro-industrial complexes and food markets in Russia were focused on solving two urgent problems: providing the country's population with food and improving the living standards of rural residents. The global financial crisis of 2008 and external sanctions pressure since 2014 have increased the government's attention to agricultural development. Import substitution policy has become one of the priorities of Russia's state objectives (Ibragimov et al., 2022b; Sukhanova & Lyavina, 2023).

The strategic documents governing the development of agriculture and food markets, which are in effect until 2030, include goals to ensure import substitution (for products for which the parameters of the Doctrine have not yet been met) and increase food exports (Kheifets & Chernova, 2022; Romanyuk et al., 2020).

Nowadays, it can be argued that the objectives aimed at ensuring food independence in the parameters of the Doctrine have not been implemented for all types of food. Simultaneously, several sectors of agriculture are already producing for export.

The most important indicator characterizing the level of food independence is self-sufficiency. The analysis of the dynamics of self-sufficiency in the main types of food in 2014–2021 showed that this is not fulfilled for all products (Fig. 1) (Federal State Statistics Service of the Russian Federation, 2023; Takhumova & Ibragimov, 2021; Yakimovich, 2023).

We can distinguish three groups of food products in terms of self-sufficiency: export-oriented (grain and fish), unsecured (milk, potatoes, vegetables, and fruits), and secured (meat and eggs).

Based on the analysis of the development of agricultural sectors and food markets, the authors formulated the following main trends:

1. Positive trends are as follows:
   - Physical volumes of production of almost all types of agricultural products reached the pre-reform level

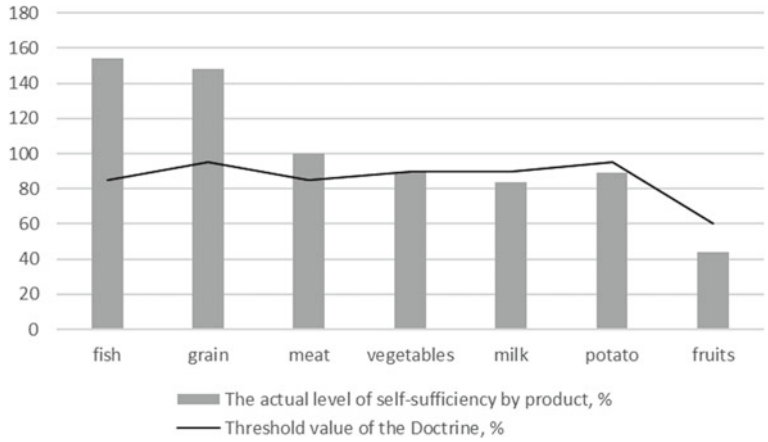


**Fig. 1** Level of self-sufficiency in basic types of food in 2021, %. Federal State Statistics Service of the Russian Federation (2023), and Presidential Executive Office (2020 *Source* Compiled by the authors based on)

(1990) and have a steady upward trend (Tables 1 and 2);

- The growth of agricultural production is more due to an increase in animal productivity and crop yields than to an increase in the number of animals and the area occupied by crops;
- The structure of agricultural producers tends to increase the share of large and profitable agricultural organizations;
- There are opportunities for extensive development of agriculture through the involvement of 25 million hectares of abandoned agricultural land in economic turnover.

2. Negative trends are as follows:
   - The trend of underproduction of milk remains due to insufficient numbers of cattle and cows;
   - Agricultural producers depend on imported inputs (i.e., machinery, seeds, fodder, plant protection products, etc.);
   - Insufficient provision of agricultural land with machinery;
   - Insufficient fertilizer application.

The crop industry is generally developing faster and more efficiently than the livestock industry for objective reasons (Tables 1 and 2). The most effective and fastest-growing sectors are those focused on exports: fish, grain production, and oilseeds (sunflower and soybeans) (Federal State Statistics Service of the Russian Federation, 2023).

The livestock industry is growing dynamically, producing meat, eggs, and honey. The structure of meat production is dominated by types with a short technological cycle (poultry and pork) (Table 2).

The grouping of staple foods in relation to growth rates for the period from 2014 to 2022 and the level of self-sufficiency gives an idea of the uneven development of agro-food markets (Table 3).

## 4 Conclusion

The rate of the development of agricultural production in Russia over the past decade has generally ensured that the country reached self-sufficiency in basic foodstuffs. Simultaneously, there is heterogeneity in the rate of development of various sub-sectors of agriculture in Russia. Sub-industries of agriculture with short technological cycles, such as crop, poultry, and pork are growing at a faster rate than dairy and beef cattle. The energy and mechanization of agricultural production is also growing very slowly. Agricultural enterprises and organizations mainly use old,

**Table 1** Crop production in Russia in 2014–2022, million tons

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Grains | 105.3 | 104.8 | 120.6 | 135.4 | 113.5 | 113.3 | 124.4 | 121.4 | 153.83 |
| Vegetable oil | 4.5 | 4.9 | 5.3 | 5.7 | 5.9 | 6.7 | 7.4 | 6.5 | 8.8 |
| Sugar | 5.2 | 5.7 | 6.02 | 6.7 | 6.3 | 6.6 | 6.1 | 5.9 | 6.35 |
| Potato | 6.2 | 7.2 | 6.8 | 6.7 | 7.2 | 7.6 | 6.8 | 5.8 | 7.2 |
| Fruit and vegetable crops and gourds | 44.8 | 46.3 | 44.2 | 43.1 | 45.3 | 45.6 | 43.8 | 44.8 | 47.2 |

*Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2023)

**Table 2** Production of livestock products in Russia in 2014–2022, million tons

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Beef | 1.62 | 1.62 | 1.59 | 1.57 | 1.61 | 1.62 | 1.63 | 1.67 | 1.72 |
| Lamb, thousand tons | 203.9 | 202.2 | 202.5 | 203.1 | 201.8 | 201.3 | 200.8 | 200.6 | 205 |
| Pork | 2.96 | 3.08 | 3.36 | 3.52 | 3.74 | 3.93 | 4.09 | 4.3 | 4.5 |
| Poultry meat | 4.16 | 4.64 | 4.62 | 4.94 | 4.98 | 5.01 | 5.01 | 5.07 | 5.23 |
| Milk | 30 | 29.9 | 29.8 | 30.2 | 30.6 | 31.4 | 32.2 | 32.3 | 32.6 |
| Food eggs, bln | 41.8 | 42.52 | 43.63 | 44.8 | 44.9 | 44.9 | 44.9 | 44.9 | 45.0 |
| Fish | 4.03 | 4.3 | 4.5 | 4.9 | 5.1 | 5.0 | 4.7 | 5.4 | 5.5 |

*Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2023)

**Table 3** Grouping of main food products by market development level for the period from 2014 to 2022 in the Russian Federation

| | *Characteristics of the market according to the level of self-sufficiency* | | |
|---|---|---|---|
| | Export-oriented | Secured | Unsecured |
| *Growth rate of production in 2022 relative to 2014, %* | (The level of self-sufficiency is greater than 100%) | (The level of self-sufficiency is greater than the Doctrine threshold) | (The level of self-sufficiency is lower than the Doctrine threshold) |
| **High** (Higher than 20%) | Fish<br>Grain<br>Vegetable oil | Pork<br>Poultry | |
| **Medium** (From 10 to 20%) | | Sugar<br>Eggs | Potato |
| **Low** (Lower than 10%) | | Lamb<br>Beef | Milk<br>Vegetables<br>Fruits and berries |

*Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2023), and Presidential Executive Office (2020)

physically, and morally obsolete machinery and equipment. More than 40% of agricultural machinery and equipment have reached the end of their useful life and are being slowly updated. This negatively affects the crop yield in crop production and productivity in animal husbandry, as well as reduces labor productivity, ultimately leading to lower economic efficiency of agricultural production.

Another urgent problem is overcoming the imbalance in the pace of development of sub-sectors of agriculture, which, in turn, affects the food market's capacity. Additionally, the decline in effective demand of the population also affects the domestic market situation in the direction of reducing the share of expensive products, including imported ones, in the consumption structure.

The strategic goals of developing Russia's agro-industrial complex are to ensure the population's food security. However, the problem of high dependence on imports in these conditions becomes a threat to national security. Therefore, the targets in the import substitution policy should be shifted from performance indicators (the share of imports in the consumption of the final product) to factor indicators (the share of imports in the means of production).

In addition to the negative impact of sanctions in the context of the economic crisis, the problem of access to food for all segments of the population is exacerbated. Additional measures of state regulation of the food market, including targeted assistance to vulnerable population segments, are necessary.

In addition to the apparently negative manifestations of external sanctions, such conditions make it possible to develop and implement extraordinary managerial decisions at various levels, which may become drivers of the growth and development of Russia in the future.

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# Agricultural Insurance as a Factor of Sustainable Agricultural Development

Irina I. Glotova, Elena P. Tomilina, Yuliya E. Klishina, and Olga N. Uglitskikh

**Abstract**

Producers of agricultural products face various risks that can disrupt the production cycle. Agricultural insurance is inextricably linked to the peculiarity of agriculture—the cultivation of crops is directly dependent on the weather and natural disasters. In this regard, farmers who have insured their crops can count on insurance compensation for losses incurred. The likelihood of bankruptcy and insolvency of agricultural producers can lead to a significant reduction in crop production, a decrease in product quality, and an increase in food prices. The level of national food security is directly influenced by the level of financial well-being of agricultural producers, where one of the factors ensuring it is the use of such an instrument as agricultural insurance. Government support for agricultural insurance stimulates the development of the insurance market and increases the competitiveness of Russian products in the Russian and international markets. The conducted research assesses the current state and trends in the development of agricultural insurance in Russia. The role of state support of farmers as a factor of risk minimization in conditions of macroeconomic instability is substantiated. This research aims to comprehensively analyze the functioning and operation of the new system of agricultural insurance in today's conditions to substantiate the need for its use and assess the impact on the sustainable development of agricultural production. The theoretical basis of the research was formed by studies on the development of agricultural insurance. Additionally, the authors assessed state support in terms of insurers' participation in this segment of the insurance market. The market analysis, with a reflection on the infrastructural participants, made it possible to identify disadvantages, namely the high cost of insurance premiums, a limited list of insurable risks, and low efficiency of payments upon the occurrence of the insured event. The authors developed proposals for the elimination of drawbacks. The main proposals are related to the improvement of methods of making payments to agricultural producers to speed up the algorithm of their receipt processing and increase the efficiency of document flow between the insurer and the agricultural producer.

**Keywords**

Insurance market • Agricultural companies • Agricultural insurance • Agricultural risks • Government support for agricultural insurance

**JEL Classification**

Q19

## 1 Introduction

Agriculture remains the most important sector of most economies in the world. The pandemic period and sanctions restrictions aimed at destabilizing Russia's economy have completely changed the economic situation in Russia and throughout the world. Despite negative orientation in relation to foreign economic relations, these factors played one of key roles in the active development of Russian agriculture over the past year.

Sustainable development of agricultural production and the country's food security are directly related to the risks that arise at all stages of the life cycle of agricultural products. The danger is that most risks cannot be completely leveled due to the lack of human control over them. First and foremost, they can include risks associated with the occurrence of emergencies of natural and climatic character.

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Climate disasters can severely disrupt the production chain in the agro-industrial complex (AIC). As a result, the company loses some crops and a significant portion of future profits. However, during the period of sanctions restrictions, the number of possible risks increases manifold. For example, in 2022–2023, there were certain difficulties with exporting agricultural products, the cost of imported parts for equipment increased significantly and a significant reduction in demand amid rising yields (Agibalov et al., 2017).

The instability of the economic situation over the past few years has contributed to an increase in external risks, resulting in increased financial losses for agricultural producers. This situation has increased the relevance of the use of agricultural insurance by many agricultural producers because this tool has become one of the forms of the compensatory mechanism that helps ensure the continuity of the reproductive process in the industry and reduce fluctuations in cash flows during the production and commercial activities.

The main purpose of agricultural insurance is either partial or complete reduction of risks and compensation for damages incurred in the production or sale of agricultural products. One of the advantages of this type of insurance is the reimbursement of losses (prescribed in the contract) incurred by the agricultural producer in case of an insured event.

The active development of agricultural insurance is impossible without government support. The regional body of the agro-industrial complex (Ministry of Agriculture and Department of Agriculture of the region) provides subsidies for this type of insurance, making it much easier for many companies to obtain an insurance policy. Nowadays, the segment of agricultural insurance with state support accounts for about 90% of the market. If we follow all relevant norms in the existing agricultural insurance contract developed by the National Association of Agriculture Insurers (NAAI), the budget can pay from 50 to 80% of its cost to farmers.

In 2022, agro-climatic conditions were generally favorable for production. As a result, agricultural companies started to act noticeably relaxed against the background of the active growth of the agro-industrial complex. According to K. D. Bizhdov, President of the National Association of Agriculture Insurers (NAAI), "good weather conditions and expectations of a good harvest—which was indeed a record—reduced the demand for insurance of winter crops in fall 2021 and spring sowing in spring 2022 in the Volga, Southern, and Central Federal Districts" (Internet Portal "Insurance Today", 2023). Global price volatility has affected the reduction of free resources from farmers for insurance. This once again confirms the importance of the development of agricultural insurance in all regions of Russia and the introduction of new innovative trends and technologies that will assist the state and agricultural producers in carrying out their tasks.

## 2 Materials and Methods

Agricultural insurance has been in the focus of many government agencies at the highest level for several years. This is due to the fact that agricultural insurance has received a new impetus for active development as a tool to minimize risks in the current environment. However, as foreign and Russian experience shows, the effective functioning of this system is possible only with large-scale and long-term government support.

The catastrophic events of the spring and summer of 2020 were an additional impetus to implement adjustments to the crop insurance law for the risk of emergencies. In the fall of 2019, the NAAI presented the concept of amendments to the legislation. In the summer of 2021, the Federal law "On amendments to the Federal law 'On state support in agricultural insurance' and on amendments to the Federal law 'On the development of agriculture'" (June 11, 2021 No. 177-FZ) was adopted, which predefined flexible and suitable insurance conditions for farmers (Federation, 2021; Rodionova & Logacheva, 2020).

Considering the role of agricultural insurance in ensuring sustainable development of agriculture, the research aims to comprehensively analyze the current system of agricultural insurance, identify shortcomings, and develop recommendations for their elimination.

In order to achieve the set goal, the authors defined the following research tasks:

1. To provide an objective assessment of the efficiency of agricultural insurance in Russia based on the analysis of concluded contracts and the total value of insurance premiums;
2. To determine the level of the development of agricultural insurance in certain regions of Russia based on the assessment of insured agricultural areas and livestock of farm animals;
3. To identify the current problems faced by agricultural producers during their main activities;
4. To develop recommendations to eliminate existing shortcomings of the current agricultural insurance system in Russia.

The theoretical (collection, processing, and analysis of information) and practical (comparison and generalization) research methods formed the methodological basis of the research. The paper contains data obtained using the graphical method, methods of abstraction and formalization, and the method of expert evaluations.

## 3 Results

Agriculture is the most important sector of the Russian economy, which directly ensures and supports the food and economic security of the country. It generates about 4.5% of the country's total GDP (Tkachev & Sukhorukova, 2022). The development of the agro-industrial complex stimulates economic growth, reduces social tensions, and ensures the country's food security.

Insurance is one of the ways to reduce risks in agriculture, which allows one to cover losses as a result of an insured event and avoid bankruptcy. Thus, it gives agricultural producers confidence in achieving positive results of activity.

Next, let us consider the participation of the state in the support and development of the agricultural insurance system. Based on analytical studies (Fig. 1), the total number of contracts with insurance companies in the field of agricultural insurance tended to decline from 2012 to 2020. Throughout the studied period, the average annual rate decreased by 16.49%. Thus, for eight years, the total number of contracts decreased by 154.4 thousand (more than 76% in relative terms).

There is one problem—the procedure for obtaining money for the damage caused. It is hard for agricultural companies to get the entire insurance indemnity after the occurrence of an insured event (Uglitskikh & Klishina, 2017). The insurer can make this payment even after one year. For agricultural companies, this period is too long because most agricultural producers are heavily indebted due to the industry specifics. They often lease agricultural equipment and get credits for the opening of new production lines. The profitability of production is lower than the average for other industries, which is due to the seasonality of sales. Therefore, the long repayment period is too critical in today's environment. Moreover, it is worth noting that insurance companies sometimes refuse to pay insurance compensation when an insured event occurs.

A different situation can be observed in the second indicator—the number of contracts concluded with insurance companies through state support (Fig. 1).

In 2015, there was a significant decrease in the number of contracts signed with state support. As of 2019, the number of contracts has been increasing significantly compared with the previous year. However, it still does not change the situation: during the studied period, the share of contracts with state support in the total volume of agricultural insurance contracts is low (Tkacheva et al., 2017). The authors found that the lack of necessary and effective means of protecting the interests and rights of agricultural producers in relation with insurers is one of the key problems in developing Russian market of agricultural insurance (Mironova, 2020). Even the currently existing measures of government support do not give the expected results (Fig. 1).

If we estimate the volume of premiums on agriculture (Fig. 2), we can see a significant reduction in this indicator in 2015: from 16.85 billion rubles to 7.8 billion rubles. This decrease is due to the fact that the cost of insurance rates fell markedly in 2015. As a result, many insurance market players did not consider it necessary to develop this type of insurance. As for the last few years, we can see an upward trend since 2018. Over the past four years, the total volume of premiums has increased from 3.7 billion to 9.1 billion rubles (145.95% in relative terms). The volume of premiums on agricultural insurance without state support decreased by 27.78%.

Thus, over the past four years, the volume of premiums for agricultural insurance with state support is markedly increasing against the background of a significant reduction in the total number of contracts for this type of insurance. Despite the contribution of the state in agricultural insurance to support agricultural producers, this type of assistance goes to a few companies; the number of participants in the insurance market is constantly decreasing. The reason for these active measures on the part of the state is the fact that

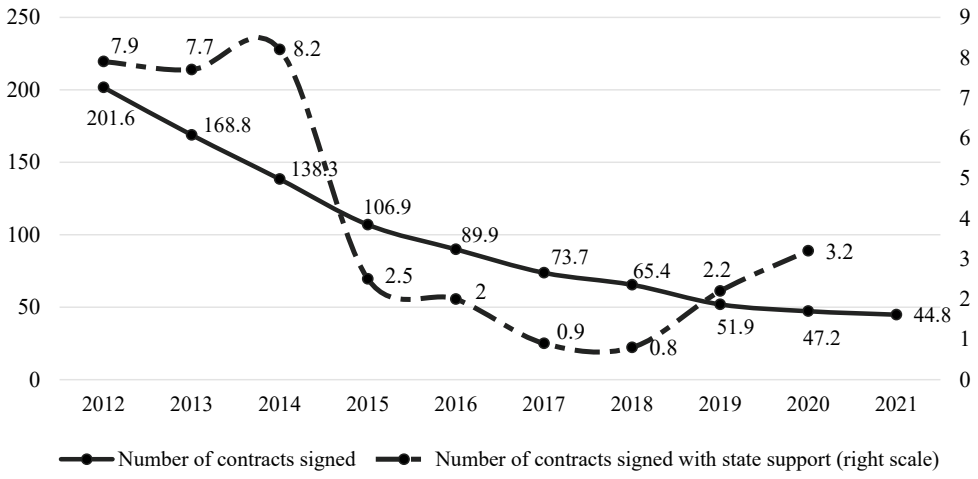


**Fig. 1** Number of agricultural insurance contracts concluded in 2012–2020, thousand pcs. *Source* Compiled by the authors based on Institute for Comprehensive Strategic Studies (2021)

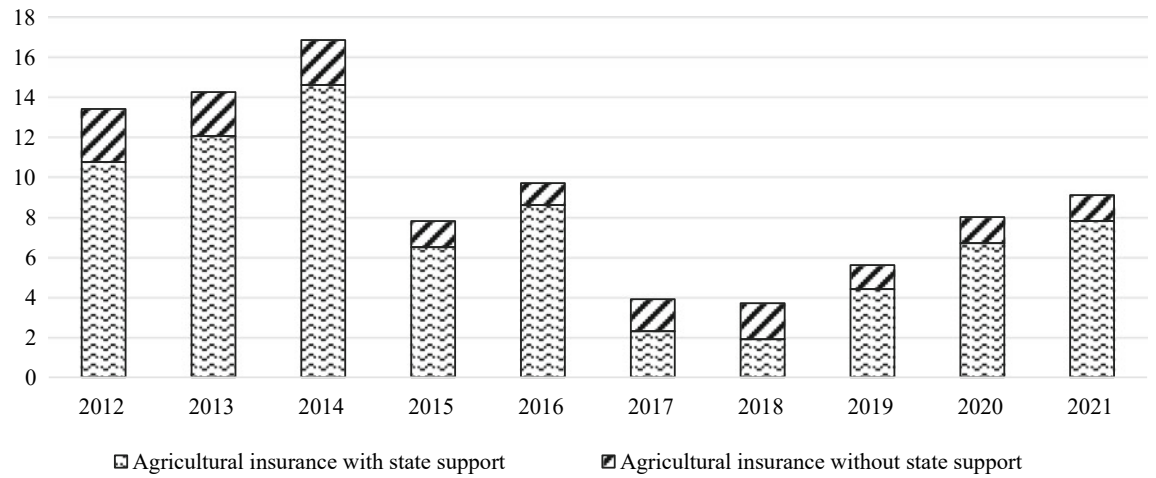


**Fig. 2** Volume of premiums on agricultural insurance with and without state support in 2012–2021, bln. rub. *Source* Compiled by the authors based on Institute for Comprehensive Strategic Studies (2021)

agriculture accounts for 48% of the total production of the agricultural sector, 68% of fixed production assets, and 67% of labor resources in Russia (Insurance, 2021). These statistics confirm the need to provide all possible assistance to the agricultural industry to stimulate its development and preserve the solvency of agricultural producers.

The volume of payments to agricultural producers for insured events is one of the indicators that shows the attractiveness of agricultural insurance in Russia. According to the data provided by the management bodies of the agro-industrial complex of Russia, the Stavropol Territory occupies the leading place among the regions of Russia in terms of the insurance market (Table 1). The region takes a high position in the ranking due to a combination of several factors. The Stavropol Territory is the largest agricultural region of Russia that produces a significant part of agricultural products. Its market share exceeds 14%. Moreover, many different enterprises and organizations in the region are engaged in developing technology and innovation in agriculture. In general, the Stavropol Krai has developed a stable system of agricultural insurance, which makes it possible to protect agricultural companies from all kinds of risks and contributes to the improvement of agriculture in the region and the country.

Based on Table 1, we can say that the major regions of the North Caucasus and Southern Federal Districts are among the top ten regions by market volume, including the Stavropol Territory, the Krasnodar Territory, the Rostov Region, and the Volgograd Region. The share of these regions in the agricultural insurance market of Russia is 25.8%; the amount of insurance premiums exceeds 2460 million rubles.

Agricultural insurance in Russia is developed unevenly. Insurance is most often used in large regions with the developed agricultural industry. Agricultural insurance is practically not used in small regions, where small and medium-sized farms are mostly presented. However, the year 2021 showed active growth and development of the agricultural insurance market in the regions that are not included in the top ten rankings (the volume of insurance premiums increased by 25%) (National Association of Agriculture Insurers, 2022). The regions of central Russia have shown one of the highest levels of use of agricultural insurance. In 2021, the five best regions in terms of insured area included the Omsk Region (652 thousand ha), the Tambov Region (517 thousand ha), the Stavropol Territory (498 thousand ha), the Voronezh Region (410 thousand ha), and the Orenburg Region (332 thousand ha). In 2021, the regions listed most actively developed crop insurance. The Belgorod, Bryansk, Tambov, Kursk, and Voronezh Regions were the regions that most actively developed insurance for farm animals. In total, more than 4120 thousand animals were insured in these territories (Bizhdov, 2022).

## 4 Conclusion

Agricultural insurance is one of the important tools for the sustainable development of agriculture in Russia. It protects crops, animals, property, and financial resources of farmers from the unwanted effects of natural disasters and other types of risks. Agricultural insurance contributes to the security and stability in the agricultural sector, increasing the country's economy and improving the quality of the population's life (Baeva, 2021). It also encourages increased investment in agriculture and reduces the need for government subsidies.

**Table 1** Top ten regions by volume of the agricultural insurance market in 2021, mln. rub

| No. | Subjects of the Russian Federation | Market volume (insurance premium), mln. rub | | | Region's share in the Russian market, % |
|---|---|---|---|---|---|
| | | Total | Insurance with state support | Insurance without state support | |
| 1 | Stavropol Territory | 1401 | 1302 | 99 | 14.3 |
| 2 | Moscow | 1029 | 885 | 144 | 11.2 |
| 3 | Voronezh Region | 813 | 725 | 88 | 8.9 |
| 4 | Krasnodar Territory | 517 | 441 | 76 | 5.6 |
| 5 | Republic of Tatarstan | 471 | 407 | 64 | 5.1 |
| 6 | Samara Region | 397 | 395 | 2 | 4.3 |
| 7 | Republic of Mordovia | 305 | 287 | 17 | 3.3 |
| 8 | Rostov Region | 278 | 242 | 36 | 3.0 |
| 9 | Volgograd Region | 266 | 261 | 5 | 2.9 |
| 10 | Orel Region | 258 | 255 | 3 | 2.8 |
| | Total | 5736 | 5200 | 535 | 62.5 |
| | Other regions of Russia | 3442 | 2645 | 797 | 37.5 |
| | Total for Russia | 9178 | 7845 | 1332 | 100 |

*Source* Compiled by the authors based on National Association of Agriculture Insurers (2022)

State support in agricultural insurance plays an important role in ensuring stability and security in agriculture. It includes financial assistance (i.e., subsidies and insurance benefits) and the establishment of norms and standards governing agricultural insurance. State subsidies also contribute to the development of the agricultural insurance market and increase the availability of insurance services for small and medium agricultural businesses, leading to increased competitiveness and economic stability in the agricultural sector.

The conducted research reflects the need to form compensatory mechanisms in agricultural insurance. Their main focus should aim to level out the risks of the internal and external environment, which directly impact agricultural activities. The following measures to eliminate the deficiencies can be highlighted:

1. Improvement of payment methods to agricultural producers to accelerate the algorithm of processing the receipt of funds;
2. Speeding up the document flow between the insurer and the agricultural company;
3. Introduction of differentiated insurance rates;
4. Increase in the types of risks insured.

The agricultural insurance market will be under active development for several years to come. In this regard, the above recommendations will reduce the negative impact of many factors on the stable functioning of the agricultural industry. The market leaders and the NAAI take several measures to simplify the design of the insurance program by improving the order and conditions of the insurance contract and implementing insurance payments.

Thus, agricultural insurance is an integral part of agricultural development that should be widely implemented in the practice of agricultural enterprises at all levels.

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# Preparing Future Teachers to Use Digital Learning Technologies

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**Abstract**

The research aims to substantiate the possibilities of preparing future teachers to use digital learning technologies within the framework of the Core of Higher Pedagogical Education. During the research, the authors applied praximetric (study of regulatory documentation—the national program "Digital economy of the Russian Federation," "Concept of training teachers for the education system for the period until 2030," and "Strategies for the digital transformation of education") and theoretical methods (analysis of Russian and foreign literature, generalization, comparison, forecasting, and pedagogical modeling). The authors analyzed the tasks of preparing future teachers for solving the problems of digital transformation of the economy and public life and the possibility of using disciplines and design and technological practice of the communicative-digital module of the core. The content of disciplines, the use of flipped class technology, open online courses, the project method, and the capabilities of the technological park of universal pedagogical competencies are substantiated. The research analyzes various digital tools, digital educational resources, and end-to-end digital technologies that future teachers should master for their further use in their professional activities.

**Keywords**

Digital transformation • Digital education • End-to-end technologies • Digital competencies • Educational resources • Digital tools

**JEL Classification**

I230

## 1 Introduction

Nowadays, Russia has a trend of digital transformation of education, which is typical for many world countries. In the summer of 2022, the "Concept of training teachers for the education system for the period until 2030" was adopted (Government of the Russian Federation, 2022).

The main principle of the concept is the teacher's role as a key figure. The teacher must ensure the quality of general education for the country's future development (Uvarov, 2018).

Pedagogical universities are faced with the task of developing the skills of future teachers to competently integrate advanced digital technologies into their subject, overcome existing barriers and limitations, and prepare them to develop digital content, use digital pedagogical technologies, solve the problems of early profiling of schoolchildren, organize additional education for children in the field of robotics, artificial intelligence, and virtual and augmented reality, and design technological and meaningful digital solutions for a contemporary school. Simultaneously, teachers of pedagogical universities should demonstrate examples of the effective use of blended learning technologies, mobile technologies, flipped learning, distance education, and various digital resources and services. It is important to use the possibilities of technological parks of universal pedagogical competencies and quantoriums, which pedagogical universities are equipped with today. It is necessary to acquaint students with the best practices of digital transformation of school education and involve them in teaching, research, and project work on the design and development of digital educational resources (Smirnova et al., 2022).

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Since 2022, all pedagogical universities in Russia introduced the Core of Higher Pedagogical Education. Its purpose is to ensure uniform approaches to the training of future teachers in any university in Russia. The development of a model for the formation of digital competencies of students in pedagogical areas of training, integrated into the Core of Higher Pedagogical Education, is seen by the authors as an important scientific and practical task. The formation of the necessary digital competencies should begin with the use of the capabilities of the communication-digital module of the Core.

## 2 Methodology

Digital transformation as a trend in the development of higher education is discussed in detail by Gravshina (2022). Of particular interest are the studies of Kozlov and Mikhailov (2021) and Lubkov and Karakozov (2017), as well as the study of the transformation of teacher education discussed by Kazakova (2020). The authors of the publications consider the digital transformation of education to be an inevitable stage that unfolds after the introduction of digital technologies in all areas of society. According to Starichenko (2020), the result of digital transformation is the growth of qualitative indicators of the educational process, which can be achieved by integrating content and software into the educational process, built, among other things, on artificial intelligence, virtual reality, and big data.

The "Concept of training teachers for the education system for the period until 2030" sets the task of including digital content and environmental solutions used in the modern digital school in the training programs for pedagogical personnel. The relevance of this problem has increased in the context of the introduction of the Core of Higher Pedagogical Education in 2022. Sirenko (2022) emphasizes that the introduction of the requirements of the Core for personnel training based on unified approaches will force the update of the system of higher pedagogical education.

Digital transformation of education requires the creation of a specially organized digital environment in each educational organization. The role of the digital educational environment in the training of future teachers is considered in the works of E. K. Samerkhanova and co-authors (Samerkhanova et al., 2020a, 2020b). The authors are sure that the digital educational environment of a pedagogical university should provide conditions for the professional growth of students who can work in the future in the context of the digital transformation of an educational institution. For such training, one should use the capabilities of the communicative-digital module, which is part of the Core of Higher Pedagogical Education.

The model for the formation of digital competencies of students of pedagogical areas of training within the framework of a communicative-digital module should include the innovative content of the disciplines of the module, the pedagogical technologies used (e.g., network communication technologies, distance learning, blended learning, and organization of student project activities) (Admiraal et al., 2015; Frolova & Perevoshikova, 2022), the use of massive open online courses (MOOCs), and the development of advanced evaluation tools (Krupoderova & Krupoderova, 2021; Lebedeva et al., 2022).

Digital distance technologies allow participants in the educational process to interact synchronously and asynchronously. The pros and cons of these modes of interaction are discussed by L. Watts (Watts, 2016).

## 3 Results

The communicative-digital module includes the disciplines "Speech practices," "Foreign language," "Technologies of digital education," and educational (design and technological) practice. To strengthen digital education, the Minin Nizhny Novgorod State Pedagogical University introduced the discipline "Advanced information technologies" to this module, as well as the elective disciplines "Introduction to artificial intelligence" and "Introduction to machine learning." The goals used by digital and pedagogical technologies in disciplines directly aimed at the formation of digital literacy of future teachers are presented in Table 1.

Let us dwell in more detail on the methodological and informational support of the disciplines.

The name of the discipline, "Advanced information technologies," speaks for itself. Thus, the main sections of the discipline are "End-to-end digital technologies" and "Network technologies for information processing." A MOOC has been developed for the discipline. Simultaneously, MOOCs were first analyzed for developing various digital technologies, primarily end-to-end digital technologies, on various domestic platforms. MOOCs for computer science and information technology courses were analyzed. It was found that the content of online courses often overlaps with classical computer science topics, repeating the school curriculum in some cases. There are practically no topics related to end-to-end digital technologies. However, considering today's requirements, courses on end-to-end digital technologies appear on some open education platforms. For example, the MOOC "Application of VR technologies in school education" from the Far Eastern Federal University is hosted on the Stepik educational platform. This platform also hosts the MOOC "Augmented reality at school: Creating an AR project in EV toolbox" from EligoVision, and the MOOC "Designing intelligent agents" from the Volga State

**Table 1** Disciplines of the communication-digital module

| Discipline | Purpose of the discipline | Digital technologies | Pedagogical technologies |
|---|---|---|---|
| Advanced information technologies | Create conditions for mastering advanced ways and means of working with information and form communicative and digital competencies of students | Basic information technologies, cloud technologies, Web 2.0 services, artificial intelligence, and VR and AR | Laboratory workshop, flipped learning using MOOCs, design methods, and zone training |
| Technologies of digital education | Create conditions for students to acquire the skills of integrating advanced pedagogical and digital technologies in the educational process; to form the readiness to use information technologies in the self-acquisition of new knowledge, skills, and abilities | Network technologies, artificial intelligence, VR and AR, and other end-to-end technologies | Flipped learning using electronic educational and methodological complexes (EUMC), remote technologies, discussions, project method, and case technologies |
| Introduction to artificial intelligence/introduction to machine learning | Create conditions for students to acquire the skills of integrating artificial intelligence technologies in the educational process; to form the readiness to use advanced digital technologies in the self-acquisition of new knowledge, skills, and abilities | Artificial intelligence, robotics and sensors, and the Internet of Things | Case technology, critical thinking development technology, contextual learning, and flipped learning using EUMC |
| Educational (design and technological) practice | Obtaining primary professional pedagogical skills and communication skills in organizing and implementing e-learning and using distance learning technologies, designing elements of a digital educational environment | Office technologies, network technologies, artificial intelligence, VR and AR, robotics, and programming technologies | Project method, educational and research work |

*Source* Compiled by the authors

Technological University hosted on the platform Mooped (Portal of Online Education of the Volga Regional Competence Center, n.d.).

Learning Management System (LMS) Mooodle was used as a platform to create MOOCs in the discipline "Advanced information technologies." From 12 to 15 10-min videos were developed for each section. Control questions and tests are offered for self-control of mastering the topic. Training is conducted using the technology of a flipped classroom. Students watch the video and answer control questions. In the laboratory classes, there is practical development of certain technologies.

One of the main tasks of the discipline "Advanced information technologies" is the formation of information culture. Therefore, one of the laboratory works of the discipline is devoted to working with information resources on the Internet. Students select textbooks in electronic library systems and articles in the Cyberleninka electronic library

(Scientific Electronic Library "Cyberleninka", n.d.) on the use of end-to-end digital technologies in education, work with electronic dictionaries and reference books, and select MOOCs for self-education on the Universarium open education platforms (Portal of Online Courses "Universarium", n.d.) and National Open Education Platform (Portal of Online Courses "Open education", n.d.).

Nowadays, there are convincing examples of the use of such end-to-end digital technologies as distributed registries (Grech & Camilleri, 2017), artificial intelligence (Korovnikova, 2021; Samerkhanova et al., 2020b), and virtual and augmented realities (Paskova, 2019) in the educational process. Therefore, acquaintance with the possibilities of these technologies for future teachers is an important task of the discipline "Advanced information technologies."

One of the practical classes is devoted to artificial intelligence. Students select examples of domestic projects on the use of AI. The joint table describes socially significant problems that could be solved using artificial intelligence.

In the discipline "Advanced information technologies," students also master various Internet services (wiki articles, Yandex Tables, online questionnaires, mental maps, and timelines).

Digital tools are being studied for organizing distance and blended learning, implementing a competency-based approach, providing network project activities, and organizing assessments.

The first section of the discipline "Technologies of digital education" is called "The place and role of digital technologies in the professional activities of a teacher." It discusses the concepts of digital transformation of education, digital educational environment, and digital literacy of teachers and students. The section also analyzes pedagogical technologies that owe their appearance to the digitalization process: flipped learning, zone learning, adaptive technologies, mobile technologies, distance learning, etc.

In a practical lesson, students build a mental map using one of the indicated pedagogical technologies using online services for building memory maps. The map should show the advantages of the technology, the risks of its use in school, and the requirements for resource provision. It is proposed to select links to publications, videos of open lessons, master classes, etc.

Future teachers are also offered a role-playing game. Students are divided into four role groups "Teachers," "Students," "Parents," and "School Administration." A "brainstorming" is conducted on a joint online board to identify the problems of transition to blended learning; "intersecting" problems relevant to all subjects of educational relations are identified.

Building a digital educational environment is impossible without providing educational organizations with digital equipment. Currently, multimedia projectors, interactive whiteboards and tables, document cameras, digital laboratories and microscopes, electronic voting systems, and other equipments have become widespread in educational organizations. Future teachers get acquainted with this equipment in the "Hardware and software for organizing the educational process" section. Students learn the general principles and methods for creating an interactive presentation. The choice of method is largely determined by the goals and objectives of a particular lesson stage. However, when creating an interactive presentation, priority should be given to methods that involve working with an interactive whiteboard for teachers and students. According to the principle of working with the board, all methods can be divided into the following groups: methods of working with a marker, movement methods, hiding methods, and combined methods.

Currently, many educational organizations are equipped with equipment for conducting classes as part of classroom and extracurricular activities using robotics, artificial intelligence, the Internet of Things, and virtual and augmented reality. Future teachers can get acquainted with this equipment based on the university's technological park.

In the virtual reality laboratory, students master educational VR content according to their profile. For example, students of the Computer Science and Technology major assemble a system unit and motherboard in the PC Virtual LAB application or perform various "cooking" tasks in the Cooking Simulator VR virtual kitchen.

Nowadays, developers offer comprehensive solutions for building digital educational environments for schools. Students perform a comparative analysis of such systems. Various criteria are used, including the presence of an electronic journal and diaries, the organization of distance learning, the possibility of maintaining a portfolio of students, and ways of interaction between participants in the educational process, cost, and technical support. Such school information systems as a digital educational platform "Dnevnik.ru," NetSchool, Avers, 1C: School, and information system "Electronic Journal for School" are compared.

The section "Network technologies in the educational process" is devoted to the analysis of the didactic possibilities of Internet services. Some services are described by E. K. Samerkhanova and co-authors (Samerkhanova et al., 2017). Based on these services, students build interactive worksheets, develop tasks for forming specific universal learning activities, and create assessment tools. Table 2 presents examples of the use of Internet services by students in the tasks developed for future students (Google, n.d.; Piktochart, n.d.; Timetoast, n.d.; Bubbl.us, n.d.; Mindomo, n.d.; Yandex, n.d.).

In the section "Designing a digital educational resource," approaches to classifying digital educational resources (Ponachugin & Lapygin, 2019) are studied, and catalogs of

**Table 2** Examples of using Internet services

| Web 2.0 services | An example of using the service |
|---|---|
| Google forms | Interactive worksheet on literature "Creativity of S. Yesenin" (https://clck.ru/33Zhgy) |
| Google drawings | Interactive worksheet on informatics "Types of modeling" (https://clck.ru/33ZhPA) |
| Yandex documents | Interactive worksheet on life safety "Bad habits" (https://clck.ru/33ZiB9) |
| Bubbl.us | Cluster "Immunity" (https://clck.ru/33Zi2J) |
| Mindomo | Mental map "Gene engineering—the science of the future" (https://clck.ru/33ZiaT) |
| Timetoast | Timeline "10 most important discoveries in biology" (https://clck.ru/RMqPu) |
| Piktochart | Web 2.0 Services infographic (https://clck.ru/PBPg2) |

*Source* Compiled by the authors

digital resources are compiled for their subject area. One of the examples of a catalog compiled by a student is the catalog "Future technology teacher" (Example of a Catalog Compiled by a Student—A Future Technology Teacher, n. d.). Learning to analyze digital educational resources, tools, and services and evaluate their pedagogical potential is one of the components of the professional competence of a teacher.

Future teachers select digital resources to use in their future professional activities on Russian educational platforms: Yaklass (n.d.), Yandex.Tutorial (n.d.), Foxford (n.d.), Mobile e-education (n.d.), Russian Electronic School (n.d.), and Uchi.ru (n.d.).

The variety of Internet services makes it possible to create content, including educational content, in the form of websites and blogs, photo and video albums, interactive tasks, didactic games, and more. For example, the web service Learningapps (n.d.) is an interactive exercise builder. Future teachers select ready-made tasks on this resource and develop the author's ones.

When selecting or designing their own digital resources, future teachers should be well aware of their place in the educational process, including in the organization of educational, research, and project activities.

The design method has almost a century of approbation experience. Nowadays, developing key competencies of the digital economy requires the project method. There is no doubt that the project activities of schoolchildren can be organized more efficiently using new digital tools (i.e., digital educational resources, Internet services, and end-to-end digital technologies (e.g., artificial intelligence, virtual and augmented reality, robotics, etc.)). This determines the relevance of preparing future teachers for the organization of project activities for schoolchildren in a digital educational environment.

In the discipline "Digital education technologies," future teachers analyze various Internet projects on a joint online interactive whiteboard. In this case, the strategy "3-2-1" is used: three most striking moments of the project, two questions to the author, and one sentence. An example of completing the task is available at https://clck.ru/33XYwe (using the service Padlet) (Padlet, n.d.).

The theoretical knowledge gained by students in the course of mastering the discipline "Technologies of digital education" is consolidated in educational (design and technological) practice. The internship takes place over four weeks on the basis of multi-level educational institutions and in the technological park of Minin University. Students get acquainted with the digital educational environment of the organization, master specific digital platforms and school information systems, assemble and program robots, and create AR and VR applications. Examples of topics for individual tasks include "Development of presentations for an interactive whiteboard," "Development of interactive videos," "Development of tests using online test designers," "Development of tests with LMS Moodle," "Creation of educational screencasts," "Development of tasks for joint activities of students," "Development of educational chatbots," "Development of a web quest," etc.

In the second year, students are offered the disciplines "Introduction to artificial intelligence" or "Introduction to machine learning." It is expected that education will soon be impossible to imagine without the participation of artificial intelligence. The task of these disciplines is to prepare future teachers for this. Digital education should be based on technologies, the development of which by future teachers takes place within the framework of subject-methodological modules.

## 4 Conclusion

The authors consider approaches to the formation of digital competencies of future teachers within the framework of the communicative-digital module of the Core of Higher Pedagogical Education. The content of the disciplines "Advanced information technologies" and "Technologies of digital education" is considered. Additionally, the authors showed

the prospects of using open online courses, flipped learning, and the project method.

The didactic possibilities of using various digital tools are considered. The research provides examples of assignments for the development of end-to-end digital technologies, innovative models of lessons in a digital educational environment, school information systems, digital educational resources, and various Internet services.

The role of educational (design and technological practice) and elective disciplines in achieving the task of the communicative-digital module is shown—the formation of communicative and digital competencies in students and their readiness for professional activities in the digital space.

Further training of future teachers for solving the problems of digital transformation of education should be carried out within the framework of subject-methodological modules.

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# The Problem of Training Digital and Creative Personnel for the Production Sector of the Economy

Zhanna V. Chaykina, Olga V. Katkova, Natalia A. Tikhonova, Zhanna V. Smirnova, and Olga V. Golubeva

**Abstract**

*Purpose*: At present, the Russian economy is faced with objective issue of increasing the success of training highly qualified engineering and technical personnel with digital competencies and creative thinking. This problem is closely connected to the process of choosing a professional path for young people, namely, the development of professional interest of adolescents in professions related to technology and digital technologies. The authors of clause associate the solution of this problem with the possibility of attracting youth to educational robotics classes. Educational robotics has a number of advantages compared to other areas of scientific and technical creativity in problem decision of vocational guidance for students. The content of educational robotics programs involves not only the mastering of one of the relevant digital technologies in demand in modern production, but also the acquisition by students of personal qualities necessary for a modern professional: creativity, technical thinking, design skills and abilities. *Design/methodology/approach*: In progress of the research activities, the authors used theoretical methods: analysis of theoretical sources and practical experience, synthesis and generalization when formulating conclusions, practical methods: experiment, questioning, quantitative and qualitative processing of results. *Findings*: Educational robotics has unique opportunities for the development of creative technical mind and digital competencies of adolescents. The program on educational robotics can be implemented both in a general education school at technology lessons, in extracurricular activities, and in the organization of additional education for pupils. *Originality/value:* The use of exercises on designing robotic objects and solving technical problems in educational robotics classes recreates the required circumstances for the forming of creative technical mind, digital competencies, and the interest in the profession of the younger generation. Classes in educational robotics are considered as a means of vocational guidance for the younger generation.

**Keywords**

Digital competencies • Robotics • Career guidance • Personnel training • Additional education • Students

**JEL Classifications**

i2 • i25 • j2 • j24

## 1 Introduction

Recently, the key vectors of Russian economy development have been undergoing significant changes. The manufacturing sector is becoming a priority area, requiring an influx of qualified engineering and technical personnel who own digital technologies and are able to solve creative design problems (Chaikina et al., 2021). Thus, according to a study conducted by the Russian Technological University (MIREA) together with HeadHunter, it was revealed that during the past three years, engineering professions have been among the most in demand on the labor market in Russia. The study notes that the number of vacancies for engineers is growing annually in the country, while there are less than two applicants for one open vacancy (https://1prime.ru/society/20210325/833314664.html). In addition, the labor market is marked by the increased requirements of modern business to the digital competencies of future

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professionals. The training of such specialists should begin at school, since it is at school age that the technical thinking necessary for the successful mastering of digital technologies is laid and the creative powers of adolescents develop. Teenagers show interest in modern technology and enthusiastically master new technologies. Children are particularly interested in digital technologies and, in particular, robotics. The educational programs of individual academic subjects of a secondary school are aimed at achieving educational results related to the formation of information and communication competencies, as well as solving career guidance tasks. The initial acquaintance of the children with the elements of robotics has organized in the framework of the school curriculum subjects. Such academic subjects include, for example, technology. According to the educational standard, the definition of which sections (modules) of the curriculum of an educational subject will be studied by students and their volume depends on the material and technical capabilities of a particular educational organization (Chaikina et al., 2018; Malushko & Lizunkov, 2020; Smirnova et al., 2020). Such academic subjects of the school curriculum include "Technology". In the of the Federal State Educational Standard of basic general education on the educational subject «Technology», educational guidelines have been laid down for the forming of the required qualities in students, namely: «development of innovative creative activity of students in the process of solving applied educational problems; mastering the methods of educational, research and design activities, solving creative problems, modeling, designing and aesthetic design of products; development of skills to apply technologies for the presentation, transformation and use of information, to assess the possibilities and areas of application of ICT tools and tools in modern production or the service sector» (GEF Basic General Education, 2010).

In this study, robotics will be considered as a leading means of developing digital skills and creativity. The content of educational robotics includes the basics of engineering, programming, and the foundations of natural and mathematical disciplines, such as physics, algebra, geometry, computer science. The development of educational robotics by children and adolescents can begin at preschool age, continue in primary and primary school. To organize such classes, sets of robotic designers of various configurations will be required. Usually these sets are focused on a certain age of students.

Elements of educational robotics are studied within the school curriculum in such academic subjects as: technology, computer science, physics. In addition, robotics is widely represented in educational programs of additional education. These programs take into account the cognitive interests and needs of potential customers of these services to a greater extent. The development of robotics in educational institutions of additional education of children can be organized at different levels, taking into account the identified interests of students.

## 2 Methodology

During the research, specially organized classes with schoolchildren were considered as an effective means of developing digital, engineering, and creative skills of the younger generation, during which the teacher creates conditions for active and purposeful design and technological activities of schoolchildren to create robot models.

Robots have recently been the heroes of science fiction novels. Currently, this is a reality that has become a key technology for the intensification of production (https://digital.gov.ru/uploaded/files/07102019robototehnika-i-sensorika.pdf?utm_referrer=https%3a%2f%2fyandex.ru%2f). It is known that robots are designed to replace humans when performing routine, dirty, dangerous work, as well as where high accuracy and repeatability are required. The scope and prospects of modern robotics are exceptionally wide: robots are already used in everyday life, in the field of human services, in medicine, in agriculture and many other types of work.

The technology associated with the use of robotics in production is considered by researchers as an applied science, the text of which is based on the methods of mechanics, electronics, mechatronics, and other sciences. Robotics as a science is primarily associated with the design of automated technical systems (Vaganova et al., 2019).

Technical tasks solved in robotics classes determine the development of design, programming, communication skills, individual and group work skills, increase the degree of independence in solving a problem, and in general, develop the creative potential of adolescents. Educational robotics in this case acts not as a goal, but as a learning tool that has a major impact on change of all cognitive processes (memory, attention, thinking, imagination, etc.), volitional and emotional procedures (Petrakova, 2019). In the processes of educational robotics classes, we have the opportunity to identify the technical inclinations of young people at the initial stage of their formation and also to ensure their support and development. According to N. V. Belenov, educational robotics can be considered as a new educational technology, within which students are introduced to technical creativity, design, and programming (Belenov, 2015). Thus, educational robotics can be considered as a means of developing the professional interest of young people in technical professions, the formation of digital competencies and creative technical thinking (Chaikina, 2011).

Robotics classes with teenagers involve, first of all, the design of technical objects, which gradually becomes more complicated as new knowledge and skills are gained. Design

tasks should be created in consideration the age, individual and personal characteristics of students, their interests and needs.

In domestic research, design technical tasks are divided into two groups: typical tasks and creative tasks. The solution of typical problems is carried out using standard techniques and methods, using certain algorithms of actions that are familiar to students. Creative tasks involve an independent search for solutions based on existing theoretical and practical knowledge and skills. There is a technical problem in creative technical tasks, that will allow you to identify a technical contradiction and eliminate it in the course of solving the problem. When solving creative problems, ready-made models and algorithms are not required; on the contrary, it is necessary to search for ideas, put forward hypotheses and test them (Chaikina, 2016; Litova, 2020).

In robotics classes, different design tasks can be used depending on the overall goal:

(1) modeling tasks—creating a layout of an object according to a ready-made model, diagram, sketch. When performing this task, the child is asked to assemble a model of a robot performing a certain technical task based on a ready-made sample or image using a set of parts of a robotic designer;
(2) tasks for additional design—refinement of a technical device or search for a missing link. By completing this task, the student must supplement the design of the robot created from the parts of the constructor kit so that the new design can perform the proposed task;
(3) tasks for improvement—making structural changes to a technical device to improve certain indicators of its work. This task involves posing a problem to the student related to the need to improve the technical or functional characteristics of a robot created from parts of a set of designers;
(4) tasks for designing according to one's own plan or technical specifications—the creation of a technical device based on the goal. This task involves using the creative abilities of the child. It may be of a project nature. The student independently determines for himself the task of designing a robot and suggests ways to solve it. As a result of the work, a new design is created according to the developer's plan (Litova, 2020).

The use of robotics as a means of teaching in the classroom with students provides an opportunity to combine elements of technical creativity and gaming activities, which increases interest and helps the formation of internal motivation for engineering and technical activities (Belenov, 2015).

Robotics classes fulfill the task of modern education: creating an environment that can make it easier for a student to discover his personal potential. In this case, the teacher performs the role of the organizer and creator of this new educational environment and encourages the student to cognition and creative activity. In robotics classes, using design tasks, optimal conditions are created for the formation of students' abilities to invent, implement creative ideas, conduct research, and develop digital competencies.

## 3 Results

The study had a purpose to identify and theoretically substantiate the features and experimental verification of the impact of classes in educational robotics on the development of students' interest in engineering professions and the formation of creative technical mind.

To diagnose the technical thinking of students, the Bennett test and the «Intellectual lability» method in an adapted version of G.V. Rezapkina. To identify the level and nature of students' interest in engineering and technical activities, a short questionnaire was proposed, which was asked to be filled in anonymously in order to make the reliability of the answers higher.

The pilot study involved 20 children aged 11–13 attending robotics classes at the Center for Technical Creativity. In total, two groups of respondents were formed: experimental and control, each group included ten schoolchildren.

During the experimental work, both groups of schoolchildren took part in ascertaining, forming, and control experiments. The general results and conclusions will be discussed in this article.

The holding of ascertaining experiment involved measuring the initial state of development of respondents' technical thinking. The measurement of the state of development of technical thinking of respondents in the robotics circle was carried out on the basis of the following characteristics:

(A) the low level of development of technical thinking is characterized by the presence of difficulties for students during the creating of models made of structural materials; knowledge of only individual concepts or symbols; poorly formed understanding about the actions of simple mechanisms; the lack of a skill to combine disparate information into a system;
(B) the average level is represented as the students' mastery of the basic techniques of construction; the knowledge of basic technical concepts, the ability to calculate the gear ratio; the ability to use schemes; the ability to

make models of medium complexity; the ability to extract the necessary information; difficulties in applying existing knowledge in specific situations;

(C) the high level of development of this characteristic assumes that schoolchildren have the ability to understand and apply in practice special technical terms and concepts related to robotics; knowledge and use of basic design techniques at a high level; create symmetrical models; the ability to give arguments, the ability to present their actions, the conclusions obtained; the ability to quickly switch from one property of objects to another; the ability to perform models of any complexity and create their own designs, based on the knowledge gained, using creativity and imagination.

Intermediate levels of technical thinking development were established if students partially demonstrated academic achievements from a higher level.

Based on a juxtaposition of the results of the ascertaining and control experiments, it is possible to argue that the degree of progress of technical thinking in the two groups differs: In the experimental group (EG), the dynamics are more pronounced than in the control group (CG): 30% have a high level, 40% have a level above average, 30%—average level. The level below the average and the low level in the experimental group (EG) were not detected (Fig. 1).

Preliminary diagnostics (ascertaining experiment) of the degree of progress of technical thinking of adolescents demonstrated the predominance of the average level of development of this parameter among schoolchildrens, as well as the presence of a sufficiently large number of schoolchildrens with a low level of development of technical thinking.

The outcome of the first stage of experimental work allowed us to obtain the initial data for the ongoing study. Both groups of students demonstrated approximately the same results of the degree of progress of technical thinking among students. Thus, the schoolchildrens of the control and experimental groups at the initial stage of the study had mainly an average and low level of development of technical thinking.

During the formative experiment, an experimental educational program was developed to teach students the elements of robotics. The program included four thematic blocks: the introductory block «Programming Environment», the theoretical block «Programming and Programs», the theoretical and practical blocks «EV3 Software», «EV3 Sensors», and the practical block «Programming Lego Mindstorms EV3 Models».

At the second stage of experimental work, a series of classes was conducted in the experimental group (EG) of schoolchildrens, according to the developed educational program. Practical classes in the program included design tasks for schoolchildren of different levels of complexity.

In accordance with the training program, teenagers mastered the basics of programming and computer control of robots. The students solved design technical problems using Lego Mindstorms EV3 constructors. Classes were held 2 times a week, and the duration of one lesson was 45 min (1 academic hour).

In order to increase interest in engineering activities, the formation of sustainable internal motivation, the following means were used:

- the use of all types of visualization: visual, sound, video;
- use of competitive elements: performance of tasks for speed;
- organization of game forms of classes: competitions of robots.

Thus, during the re-diagnosis after the formative experiment, adolescents demonstrated a higher level of mastery of basic concepts, the ability to operate with spatial images, the ability to argue and justify their actions and decisions, and switch attention from one task to another.

In the course of an experimental study, another indicator was monitored—intellectual lability. This indicator

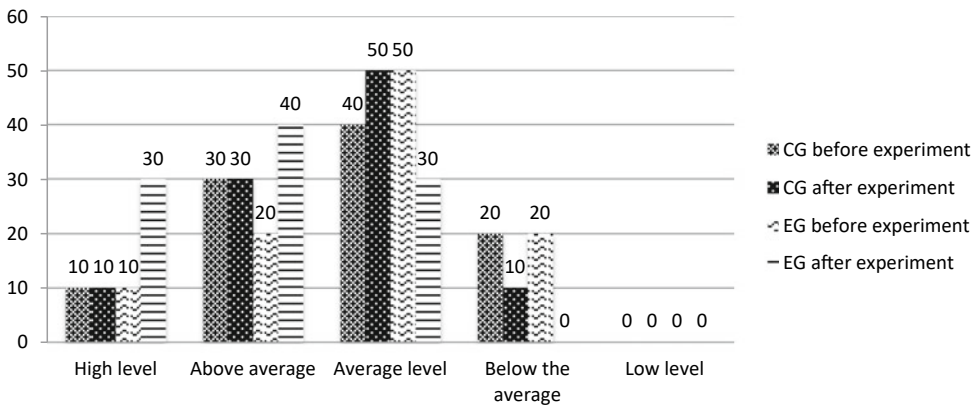


**Fig. 1** Comparative results of diagnostics using the Bennett test of the control group (CG) and the experimental group (EG). *Source* Developed and compiled by the authors

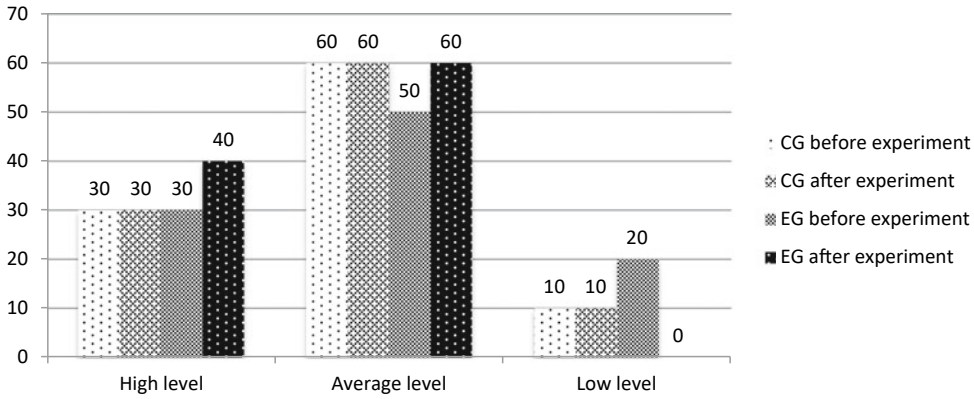


**Fig. 2** Comparative results of diagnostics using the «Intellectual lability» technique of the control (CG) and experimental groups (EG). *Source* Developed and compiled by the authors

characterizes a person's ability to switch attention, the ability to quickly move from solving one task to performing another without making mistakes. This indicator is an important criterion for evaluating the figurative and practical components of technical thinking. In accordance with the age of the subjects, a variant of the method has adapted by G. V. Rezapkina, including 30 tasks. In the process of diagnosis, the subjects must complete simple tasks in a limited period of time.

Intellectual lability was measured at the ascertaining and control stages of the study. As a result of repeated diagnostics, it was found that 40% of the respondents in the experimental group (EG) had a high level of intellectual lability, and 60% had an average level (Fig. 2).

No changes were found in the control group (CG) compared to the ascertaining experiment. The results obtained prove the effectiveness of the conducted complex of classes focused on the development of technical thinking.

Thus, the results of repeated diagnostics showed positive dynamics mainly in an experimental group (EG) of students. The participants of the experimental group (EG) demonstrated steady progress in the development of technical thinking and intellectual lability. In addition, almost all students (95%) of the experimental (EG) and control (CG) groups showed interest in engineering professions.

## 4 Conclusion

Thus, the study showed that educational robotics classes using design specifications promote toward the formation of creative technical thinking and digital competencies of adolescents and promote to the expansion of the younger generation's ideas and interest in engineering and technical professions.

Classes in educational robotics with students in classes at school or in the process of education in the system of additional education of children contribute to solving the urgent task of the modern economy—career guidance of young people for professions in demand in the industrial sphere, namely, professions in which information technologies are used, requiring advanced technical thinking and creative skills.

Robotics classes contribute to solving the actual task of the contemporary economy—the career guidance of young people to professions that are currently in demand in industrial sectors. Classes in educational robotics expand students' understanding of modern digital technologies, form practical skills in the field of designing robotic systems, and contribute to the formation of creative abilities.

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# Human Resource Management Tools for Companies Based on ESG Guidelines

Irina S. Vinnikova, Maria P. Prokhorova, Tatiana V. Krylova, Angelika A. Shkunova, and Julia N. Zhulkova

**Abstract**

The research aims to study and systematize the tools for managing human resources in Russian corporate structures considering ESG guidelines. The authors analyze the tools of HR companies in the implementation of the social component of the ESG policy. The authors' research is based on a number of publications that determine the high role of S (social) factors of ESG metrics in corporate development and substantiate the importance of the interrelation of such components as smart goal-setting, corporate culture, eco-friendly work environment, and continuous learning. The research is based on a competency-based approach, which determined the choice of methods: extrapolation and modeling. On this basis, in the context of the study, attention is paid to the value-semantic component. Based on the analysis of research data, the authors systematize HR tools that implement the social component of the ESG policy, identify the human resource management tools of the top ten Russian companies in the ESG rating according to the S-criterion as of April 1, 2023, and the experience of implementing the social component of ESG policy on the example of Russian companies is summarized. It is shown that sustainable development goals of companies are inextricably linked with the social responsibility of business, environmental, social, and management priorities and can be achieved with the timely application of HR tools that implement the social component of the ESG policy. The conducted research has significant prospects for further research related to studying the influence of the social component on the efficiency and effectiveness of Russian companies in the context of ESG guidelines.

**Keywords**

ESG policy • Development of S (social) metric • HR tools • Human resource management • Russian companies

**JEL Classifications**

M12 • M14 • M53

## 1 Introduction

The present time is characterized by a significant amount and prospects for further impact on the sustainable development of enterprises, the modification of society, new patterns of interaction between individuals and legal entities, the restructuring of business processes, the modernization of traditional management models, and the revision of the terms of the interaction of economic entities in the global market, and the attention of companies is increasingly focused on the search for promising options to respond to global social and environmental challenges.

The indicated phenomena clearly confirm the demand and the need for companies to consider the three indicated areas or ESG principles in their activities (environmental, social, and governance), that is, the principles of environmental, social, and corporate governance.

Currently, the ESG principles are the basic model of sustainable development of companies. They serve as the basis for companies to achieve their goals in terms of social solutions (related to the sustainable development of society and improving the quality of life) and environmental (in terms of waste management and the level of emissions in the atmosphere) and managerial (providing stakeholders with transparent non-financial information about the company's activities) tasks.

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Changes in the set of tools that form and ensure economic processes lead to the modification and revision of the requirements for the qualitative and quantitative parameters of the labor resources of companies. The latter is associated with a significant change in priorities toward active and fruitful interaction with employees to achieve SDGs.

Thus, it is necessary to substantiate a new concept for forming its own methodological basis for sustainable development and create mechanisms for its application in the company's HR management system based on ESG principles. The application of the principles has led to a change in the requirements for HR.

The research aims to study and analyze HR management tools that are currently used in some Russian companies that follow the ESG principles in their development.

The research objectives are as follows:

- To clarify the content of ESG principles and the development of the social component in the activities of companies;
- To systematize HR management tools implemented in companies implementing the social component of the ESG policy;
- To discuss a range of problems related to the implementation of the social component as an essential component of the ESG policy in the activities of Russian companies.

## 2 Materials and Method

The methodological basis of this study is the provisions of the concept of sustainable development and the ESG approach.

Sustainable development acts as a fundamental vector and basic element of the strategic planning system at the state and business levels. The new approach based on sustainable development is based on the use of energy-efficient and resource-saving technologies, wider use of renewable energy sources, reduction of the carbon footprint, which together ensure the preservation of the environment. Simultaneously, it is incorrect to limit the main goal of sustainable development solely to reducing environmental risks because the principle underlying this concept of ensuring a balance between its three components involves achieving social justice, the growth of people's well-being, and, in the end, economic growth.

The study of scientific publications and reviews of HR practices has shown few studies on the specifics of using HR management tools to implement ESG policies. S. N. Gagarina and E. S. Eskova (Gagarina & Eskova, 2021) analyze the state of social responsibility of Russian companies and in accordance with global trends. It is concluded that there is a lag in the pace and insufficient coverage of small and medium-sized businesses. I. P. Dovbiy and L. N. Kovrizhkina presented the development of the theory of business social responsibility in the context of global ESG transformation in relation to Russian business (Dovbiy & Kovrizhkina, 2022). The issues of personnel training and development as a condition for successful ESG transformation are considered by Timofeeva (2022).

The study was carried out within the framework of a systemic approach. The main research methods are general scientific methods, including analysis, synthesis, comparison, and other methods. At the first stage of the research, the authors identified the tools for implementing the ESG principles in HR, studied the HR management tools of the top ten ESG rating of Russian companies according to the S-criterion as of April 1, 2023, and summarized the problems associated with the implementation of the social component of ESG policy in the activities of Russian companies. At the second stage, the authors drew conclusions regarding the extent to which Russian companies use HR tools that implement the social component of the ESG policy.

## 3 Results

At the beginning of the research, it was necessary to clarify the content of the ESG development of the S (social) metric in the activities of companies. Timely identification of industry risks, risks of the country, and risks of economic entities, as well as the degree of their impact on the activities of companies, made it possible to determine the key ESG factors. Using the indicative format of the quantitative characteristics of each group of factors, their frequency of application, industry presence, and unlimited choice of companies for analysis, the authors determined the structural weight of each factor. The development of the S sector and its factors plays a key role in the development of any company.

According to the developed assessment methodology (Expert, 2023b), the ESG ranking of companies is built.

The importance of each factor of the development of the S (social) metric in ESG is represented by the following main (basic) components:

- The current social policy and program of the company, considering specific goals, time targets, and coverage of key risks based on the results;
- The level of reporting formed considering completeness, consistency, comparability, and verification;
- The efficiency and effectiveness of the company's activities, which affect the leveling of risks (Expert, 2023a).

The development of the S (social) metric makes it possible to highlight the factors of human capital (labor practices, labor protection and health, attraction and retention of talent, diversity, and inclusiveness) and corporate social responsibility (social benefits, corporate social responsibility, and human rights) (Fig. 1).

Further, within the research framework, the authors identified and systematized HR tools that implement the social component of the ESG policy.

The study of a responsible approach to human capital management made it possible to identify the following strategic interrelated areas (TalentTech Consulting, n.d.):

- An innovative corporate culture, which assumes that the values of sustainable development and social responsibility should become a kind of guideline for the company's employees. In such a culture, employees will begin to offer social initiatives. The task of management is to support significant projects. The work of the team of sustainable development ambassadors of the company will bring the organization to a new level.
- Smart goal-setting makes it possible to plan correctly and not miss anything. The goal tree in the performance management system will help make business processes predictable and manageable.
- Continuous training will allow employees to always have the necessary competencies.
- The involvement of company employees in an environmentally friendly working environment is one of the requirements of the ESG guidelines. Creating an environmentally friendly working environment will identify barriers and manifestations of toxicity in the team and eliminate them.

The analysis of the above sources made it possible to systematize the HR tools that ensure the implementation of the ESG policy (Fig. 2).

To analyze the HR management tools of enterprises that implement an active ESG policy, the authors used the results of the monthly ESG ranking of Russian companies (Expert, 2020). The first ten positions according to the S-criterion were analyzed as of April 1, 2023. The information on the websites of the ESG leader companies according to the S-criterion and their public reporting was studied. The information is presented in Table 1.

Based on the results of the study of public reporting of HR management tools of the top ten rating of Russian companies in terms of ESG according to the S-criterion, the following trends were identified.

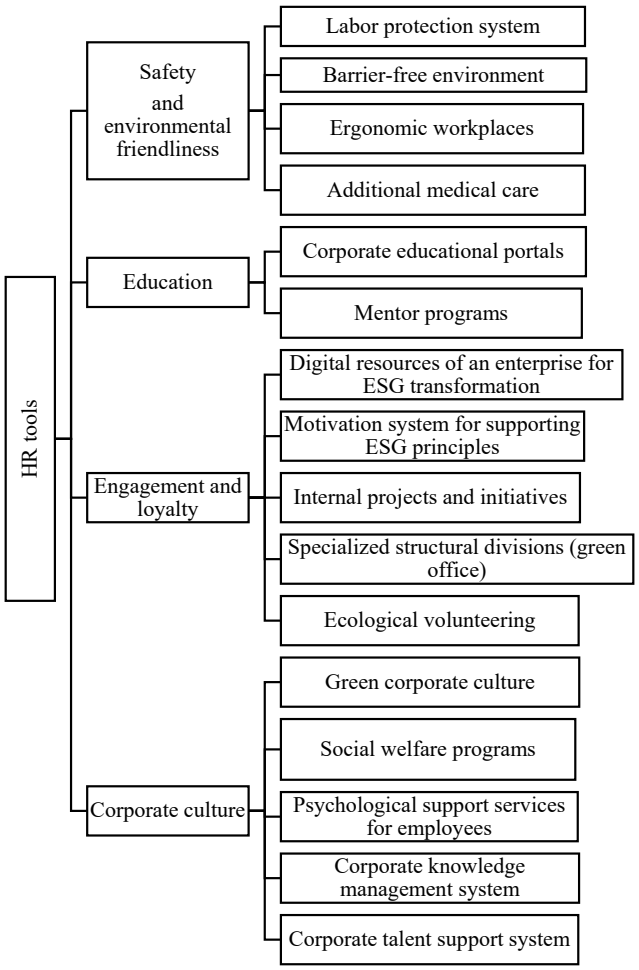


**Fig. 2** Tools for implementing ESG principles in HR. *Source* Developed by the authors

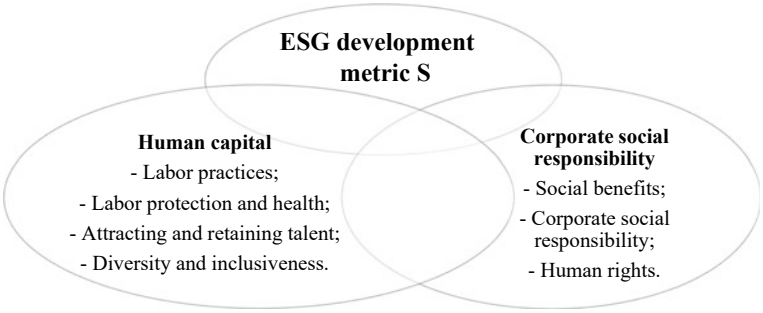


**Fig. 1** Factors of the development of the S (social) metric in ESG. *Source* Developed by the authors

**Table 1** HR management tools of the top ten Russian companies in terms of ESG according to the S-criterion

| No. | Company | Safety and environmental friendliness | Education | Engagement and loyalty | Corporate culture |
|---|---|---|---|---|---|
| 1 | "Uralkali" (Uralkali Group, 2023) | System controlling, scheduled and unscheduled assessment of working conditions | The educational products of the leading educational centers of the country and the region are used. We use our own training programs | External and internal involvement is used | Analysis of feedback from employees; Top proclaimed values: anti-corruption, health, family, profession, creation, and age |
| 2 | NISW (NLMK Group, 2023) | Comprehensive control over the maintenance of the safety management system of contractors | Training planning | External involvement is used | Top proclaimed values: anti-corruption, employee safety (health), employee comfort (remote work, online training), and age |
| 3 | MISW (PJSC "Magnitogorsk Iron Steel Works", 2023) | Comprehensive control over the maintenance of the safety management system of contractors | Cooperation with corporate training centers | Internal involvement of young employees | Corporate culture of opportunity; Top proclaimed values: anti-corruption, health (disease prevention, working conditions of employees), and age |
| 4 | PJSC "MTS" (PJSC "Mobile TeleSystems", 2023) | Part-time or full-time remote work | Launch external training projects | Educational projects in universities | Corporate culture of opportunity Top proclaimed values: helping colleagues, capacious and substantive communication, novelty, and area of responsibility |
| 5 | "Polymetal" (Polymet al., & International plc, 2023) | The procedure for identifying the hazard and assessing the system of labor protection and industrial safety | The use of individual development programs for key employees, including regular assessment of qualifications | Constant monitoring of engagement | Top proclaimed values: continuous training of employees and innovation |
| 6 | "Yandex" (Yandex, 2023) | Energy efficiency of data centers (free-cooling, heat recovery: heating of data centers); caring for users by creating ecosystems | Uses and develops its own platforms for education | Monitoring and surveys for involvement in the company | Culture of openness, communication on an equal footing. Top proclaimed values: health (health of employees and their families, online training with a corporate trainer), living conditions, psychological health, and environmental friendliness |
| 7 | PJSC "Unipro" (Unipro, 2023) | Creation of a system of corporate values, in which the health and safety of the company's employees and contractors are a key link | Use their own online and offline learning programs. Forms of training: short-term training and training in a second profession | Projective and focus group research | Top proclaimed values: health, leadership, teamwork, and personal contribution |
| 8 | "NOVATEK" (PAO "NOVATEK", 2023) | Implemented complex preventive measures to strengthen control. It is planned to create a coordinating council on industrial safety | The system of individual training of employees | Corporate volunteering and corporate social programs | Top proclaimed values: anti-corruption, health; (sports, nutrition, and disease prevention), family (living conditions), profession, creation, and age |

(continued)

**Table 1** (continued)

| No. | Company | Safety and environmental friendliness | Education | Engagement and loyalty | Corporate culture |
|---|---|---|---|---|---|
| 9 | PJSC "EL5-Energo" (PJSC "EL5-Energo", 2023) | Integrated policy in the field of labor protection | Continuous staff training, availability of a corporate platform | Climate monitoring in the team | Top proclaimed values: ensuring comfortable working conditions, the priority of labor protection and industrial safety, openness and readiness for dialogue, education and development, social initiatives and volunteer projects, and diversity and inclusion policy |
| 10 | "Severstal" (Severstal, 2023) | The Committee for Security and Sustainable Development has been established. Safety Committees production | Corporate training system for managers | An external attraction system is used. The company's corporate website is used for monitoring | Corporate volunteering; Top proclaimed values: labor safety, attention to clients, efficiency, respect for people, and teamwork |

*Source* Developed by the authors

The principle of safety and environmental friendliness is the most developed criterion. Most system solutions have a clear algorithm and are identical in different organizations. The solutions include a set of measures to ensure safe working conditions, considering the specifics of technological production processes. From the standpoint of compliance with the safety culture, such solutions include a formed labor protection policy, a developed system of industrial safety and environmental protection, which determines issues in the field of personnel policy, organizational culture. The advantages of a system solution are that the tools for working in the field of ESG principles are structurally assigned to departments or directorates and are adopted centrally.

Learning tools imply the use of external educational products from the leading training centers of the country and the region. However, not all represented organizations have their own corporate system. Companies are developing the planning of individual training programs, various in form, duration, and focus. Nevertheless, not all companies have digital equipment to manage, multiply, and accumulate educational content. According to the systemic implementation of the principles, it can be concluded that the corporate culture tool is not fully expressed because, according to the authors, there is no process of knowledge accumulation, which is a very important component, along with well-being programs, talent maintenance, and social guarantees. It is advisable to single out the companies Uralkali, Severstal, and NOVATEK as examples of the system integration of ESG principles into work with personnel.

An analysis of the HR management tools used to implement the ESG policy of companies makes it possible to formulate several features of the implementation of the latter in the Russian economy.

First, Russian enterprises demonstrate a low level of development of the educational component, expressed in a shortage of system training programs for employees in ESG areas. According to a study conducted by You Social, a consulting integrator in the field of ESG, 47 short-term programs, 14 paid online courses, 12 undergraduate programs, 22 master's programs, 3 MBA programs, and 10 advanced training programs are currently being implemented in Russia (Arslanova et al., 2023). Given the growing demand for such programs from specialists, this number is clearly insufficient to ensure support for ESG principles among senior managers and specialists involved in ESG transformations of companies.

Second, Russian companies need a more active translation of ESG principles into the system of work with human resources. The analysis shows that the presence of a corporate concept of sustainable development does not guarantee its understanding and support from the staff. Therefore, it does not provide a positive synergistic effect from implementation. Orientation to external stakeholders in the face of business owners, partners, and clients in the formation and implementation of the ESG policy makes the latter non-systemic and ineffective.

Third, the active use of ESG policy tools in relation to personnel in contemporary conditions implies the active use of specialized digital solutions that provide comprehensive

coverage of all work areas with a social component. In other words, the entire system of work with human resources should be permeated with ESG principles, which is impossible without restructuring internal corporate digital resources. Thus, the problems of complex digitalization of companies' work as part of the ESG transformation became the object of study by the Center for Sustainable Development of the Skolkovo School of Management. According to the results of this research, only 35% of companies currently use specialized digital solutions that implement ESG principles; 50% of companies use digital solutions only for some tasks. The study noted that the main barriers to the ESG transformation of companies are associated with a lack of competent specialists in this field (45%), poor development of ESG practices (44%), a lack of understanding of the benefits of digitalization of ESG activity (40%), weak cooperation within companies in the direction of implementing ESG solutions (40%), and insufficient development of digital practices (11%). It can rightly be argued that the main barriers to the ESG transformation of companies require comprehensive and systemic work with human resources (Skolkovo Moscow School of Management, 2022).

## 4 Conclusion

The conducted research makes it possible to state that the issues of managing the sustainable development of Russian companies require the active use of ESG policy tools in relation to personnel. Management is inextricably linked with the social responsibility of business, environmental, social, and management priorities. It is effective with the timely application of HR tools that implement the social component of the ESG policy.

The research results make it possible to state the following:

- Various forms of personnel training, practices of involving employees in corporate initiatives, and measures to support corporate culture can be considered the most developed tools for managing human resources in leading Russian companies.
- Russian enterprises demonstrate a low level of development of the educational component, expressed in a shortage of system training programs for employees in ESG areas;
- Most companies need more active translation of ESG principles into the system of work with human resources;
- Despite the fact that the active use of ESG policy tools in relation to personnel in today's conditions involves the use of specialized digital solutions, it should be borne in mind that they require comprehensive coverage of all areas of work with a social component.

The topic, which is central to this article, is actively studied by Russian authors in various aspects. Thus, special attention is paid to the following aspects:

- The issue of the availability and development of the necessary skills among the staff (Lebedeva et al. 2022; Sukhodoev et al. 2021).
- Features of training the young generation in accordance with the requirements of the leading industry enterprises are presented in the scientific article by Konovalov and Lyzhin (2022).
- Problems in managing industrial systems due to the human factor in management are analyzed in "Worldwide management problems" (Kaznacheeva et al., 2017).

In this regard, the prospects for further research are to clarify the possibilities of using human resource management tools of various organizations that provide the greatest efficiency in the context of ESG guidelines.

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# Development of Vocational Education in the Context of Sustainable Development of Society

Svetlana M. Markova, Svetlana A. Zinovieva, and Ekaterina A. Urakova

**Abstract**

The research substantiates the mutual influence of the sustainable development of vocational education and the sustainable development of society. The category of socio-economic, professional, pedagogical, and philosophical nature is professional education, which is associated with social intelligence, affecting sustainable development. The sustainability of vocational education depends on external trends in scientific, socio-economic, cultural, technical, and technological development. To ensure sustainable development, the study identifies the factors and mechanisms for the sustainable development of vocational education. Humanization, integration, intensification, technologization, cooperation, democratization are focused on sustainable development and scientifically substantiate the development of vocational education. The integration mechanisms of economic development, scientific and technological progress, digitalization, social partnership between an educational institution and an enterprise determine the development of vocational education. The division of labor is a characteristic of the sustainable development of vocational education. On the example of Minin Nizhny Novgorod State Pedagogical University, an analysis of sustainable development was carried out. The main criteria indicators of the university (the potential of the educational organization, performance indicators, quality of work, and the reaction of the university to external and internal factors of development) are considered within the framework of the study.

**Keywords**

Vocational education • Development of society • Sustainable development • Trends • Integration mechanisms

**JEL Classification**

Y800

## 1 Introduction

Innovative processes in vocational education determine sustainable development, which is reflected in federal and state legal documents (Federal State Educational Standards (FSES), professional standards, federal programs for the development of vocational education).

The legal documentation reflects the development prospects, priority functions, and mechanisms for the functioning of vocational education. It is required to dismantle sustainable mechanisms for the development of vocational education in order to ensure stable development. This is determined by the dynamics of the socio-economic, scientific-technical, and technical–technological development of society. Economic, social, and environmental factors actualize the educational activities of professional educational institutions. The development of directions for the development of vocational education should correspond to the trends of conservation and change in society, which ensures the distribution of vectors and factors that ensure the sustainable development of vocational education.

Vocational education will comply with the conceptual provisions and sustainable development mechanisms. It will be aimed at the socialization and professionalization of young people and the development of morality, spiritual culture, and professional competencies if it is created based on a new paradigm of education, forecasting scientific

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research based on the dynamics of socio-economic changes in the future.

It is necessary to take into account global trends in vocational education in order to ensure sustainable development.

The sustainability of vocational education depends on external trends in scientific-technical, socio-economic, cultural, and technical–technological development.

The category of socio-economic, professional, pedagogical, and philosophical nature is professional, associated with the development of social intelligence that affects sustainable development (Lapshova, 2019).

Vocational education ensures the reproduction of social intelligence, which is ahead of scientific and technological development and socio-economic and environmental changes in the system of human life. Vocational education becomes the main factor in economic development, where there is a revival of human capital and the development of productive forces and productive relations, leading to the development of social, intellectual, and spiritual development of humankind (Markova et al., 2017).

Investments in human capital ensure the development of intellectual capital aimed at developing new industries and technologies. These processes are accompanied by the development of technological production methods and social relations. The change of labor as the main form of production will ensure the expansion of the scope of the worker's activity and the expansion of the professional profile of mastering related professions (Fedorov et al., 2017a, 2017b). The development of technological production is characterized by the formation of an employee's value system due to three components:

- Personal space (formation of worldview, value orientations and citizenship);
- Political space (political relations of a person in society and the development of social systems);
- Personal–professional space (education of a person and collective-organizational processes of production).

Determining the factors and mechanisms for the sustainable development of vocational education is aimed at ensuring sustainable development.

## 2 Methodology

The most important methodological issue of theoretical research is the relationship between the sustainable development of vocational education and society as a whole.

The mutual influence of this connection is carried out using theoretical methods (analysis and synthesis, induction and deduction, and others) and empirical methods (collection of primary information, observation, experiment, measurement, evaluation, and others) (Markova & Tsyplakova, 2017).

The choice of methods is based on the following provisions:

- The basis for choosing research methods is the goal of the research, which is set from the outside and is related to the specific tasks of vocational education;
- Variety of options for using general scientific methods.

The choice of theoretical research methods depends on the following classification features:

- Compliance with the nature of the studied object;
- Degree of use in science;
- Performance in the study (reliability and completeness of the disclosure of the results of vocational education are determined by a considerable number of various factors) (Markova et al., 2019).

A systemic approach is a universal method that makes it possible to penetrate into the mechanisms of sustainable development of society and education. It is possible to identify trends in the development of vocational education with the help of system analysis, which ensures the sustainable development of vocational education and the training of competent workers and specialists (Markova et al., 2018).

The systemic approach made it possible to solve the following research problems:

- To determine the theoretical provisions of the sustainable development of vocational education;
- To ensure the interaction of internal and external relations of the development of vocational education and society.

## 3 Results

The scientific justification for the development of vocational education focused on the sustainable development of society lies in implementing the following trends: humanization, integration, intensification, technologization, cooperation, and democratization.

Humanization is the primary trend in the sustainable development of society, manifested through the development of a person, their value orientations, and their needs and abilities.

The requirements for a new type of worker are changing due to the introduction of innovative processes, scientific and technological progress, and new managerial tasks (Gruzdeva et al., 2018).

The mechanization and automation of production and complex technical and technological processes require highly intellectual work of workers and a high level of general educational, scientific, technical, and professional development. When forming a system of professional activity (including social, technological, research, subject-practical, organizational, and managerial activity), the social activity of employees increases. Under these conditions, it is necessary to humanize the educational and production process and develop professional and creative activities of students and teachers (Ilyashenko et al., 2019).

In the conditions of educational and cognitive activity and educational and production activities, the education of future workers is also carried out based on contemporary forms of labor organization, pedagogical technologies and methods of professional education, and innovations in engineering and technology. The humanization of vocational education is associated with the intensification of educational, cognitive, and industrial activities, during which mental and physical development occurs, and professional knowledge is assimilated. It is also expressed in friendship, cooperation, and mutual assistance (Ilyashenko et al., 2018).

The content of academic disciplines reveals the basic worldview, technical ideas, patterns, and principles. It interprets facts, processes, and phenomena of production and social activity. The interaction of nature and man, man and technology, theoretical and practical activities is considered within the framework of humanization in academic subjects and is characterized by the following factors of vocational education:

- Unification of content;
- Experience of innovators and inventors;
- Integrative and differentiated part;
- Development of modules with variable content to expand professional profiles.

The trend of integration permeates all areas of the educational process.

Integration processes make it possible to ensure the unity of professional training levels and consider the need for production workers of a certain skill level. Additionally, integration reflects changes in the work content and the professional mobility of workers through the socialization of the labor content. It reveals the general patterns of production activity, which ensures the development of the ability of future workers and specialists to change labor and forms their professional stability (Myalkina, 2011).

Integration mechanisms of economic development, scientific and technological progress, digitalization of production and education, social partnership of educational institutions, enterprises, scientific and social institutions determine the content of education.

All activities of vocational schools are covered by the integration of vocational training.

The structure of the content of vocational education, which is characterized by socio-economic, technical, and technological integration and differentiation, does not fully reflect changes in the content of workers' labor (Smirnova et al., 2018).

The basis for choosing the content of vocational education is the division of labor. Based on social relations, tools, production technologies, and the organization of production, it is possible to determine the professional division between workers (classification of versatile forms of division of labor in enterprises).

The expansion of industrial production is realized through various technological processes. Automation and digitalization form the general technical basis for transitioning from one type of activity to another. In this regard, the role of polytechnic training increases in professional training content (Myalkina, 2011).

Integration processes in production technology determine the increase and complexity of the equipment. Enlarged centers and intersectoral educational and professional complexes are being created, which changes the structure of industrial training.

The division of labor is the methodological basis for the content of vocational education. Scientific and technological progress requires implementing differentiated processes of the employee's professional activity (Lapshova, 2019).

Achievement of qualitative professional training of workers is carried out through intensification, interaction of socioeconomic, scientific-technical and psychological-pedagogical components, due to which the results of professional training and education are improved. Establishing the relationship of future workers with production specialists and the combination of cognitive activity in educational institutions with the professional activity of students in production makes it possible to form professionals who are ready for production works (Markova et al., 2017).

The development of a sustainable need for production work among students of professional educational institutions is provided by the relationship of scientific understanding of professional activity and their participation in the production process (Lapshova, 2019).

The intensification of vocational training is based on the unification of educational content. On the production and technological basis, the unification of the content is carried out and is characterized by:

- The need for students of theoretical knowledge for future professional activities;
- Scientific substantiation of technological processes;
- Interconnection and continuity of academic disciplines;

- Transition to practical activities;
- The study of all aspects of the production process with the help of various sciences, without violating its integrity.

The need for the development of pedagogical technologies is determined by the development of vocational education (interactive methods, means, and forms of vocational training and education), which is aimed at the formation of professional competencies of workers for a particular industry (Semarkhanova et al., 2018).

To work with automated systems, it is important to combine pedagogical and production technologies. In the context of digitalization of production and education, an electronic educational environment has been created. Teaching technologies imply the introduction of digital technologies and automated learning systems.

In this regard, the intensification is realized through the automation of pedagogical functions, changing the teacher's role in vocational training and education.

The trend of cooperation between education, production, and social systems is particularly important for the sustainable development of vocational education. It is determined by partnerships between educational institutions and enterprises, the broad professionalization of young people, and the prospects for socio-economic development (Markova et al., 2017).

Professional educational institutions become socio-economic organizations that implement social orders for the professional training of workers and specialists and the satisfaction of the needs of individuals in the professional and cultural life of society (Markova et al., 2017).

The need for cooperation between educational institutions, industries, and social systems for the sustainable development of society is due to the following factors:

- Organization of industrial training at enterprises;
- Free employment of graduates;
- Social protection of working youth;
- Creation of conditions for continuous education.

In the development of new forms of organization of the pedagogical process and the differentiation of educational subjects, cooperation is carried out within educational institutions. Cooperation is also implemented in the programs of entrepreneurial activity of future employees, which causes the relationship of the educational and production process with employment, and work on orders from enterprises to manufacture products (Markova & Tsyplakova, 2017).

On the example of Minin Nizhny Novgorod State Pedagogical University, an analysis of the sustainable development of an educational institution was carried out.

The main criterion indicators of the university (potential, indicators of efficiency and quality of work, reaction to external and internal factors of development) are considered.

One of the indicators of the educational organization's potential, which affects its sustainable development in a market economy, is the qualification composition of an educational organization.

The functioning of educational programs is provided by scientific and pedagogical staff (388 people, of which 287 people have an academic degree and title (58 Doctors of Science and 229 Candidates of Science) and social partners of the university (92% of full-time employees).

The potential of the university is characterized by the presence of recognized scientific schools (14 scientific schools in the social, humanities, and natural sciences). The university is part of the Nizhny Novgorod Scientific and Educational Center—a consortium that includes educational and scientific organizations and industrial enterprises. The result of the consortium's activities is the development of innovative technologies, the commercialization of products, and the training of a new type of personnel.

An indicator of the sustainable development of vocational education is the information and competence base. Modular and project technologies, e-learning, and distance learning are used in the educational process. On the basis of the ya.miniuniver.ru portal, personal categories of students and teachers have been created that provide access to the schedule of classes, curricula, teaching load, an electronic record book, and an electronic library (Vaganova & Lapshova, 2019). As part of the study, one of the indicators of the usefulness of labor was the proportion of university graduates working in accordance with their profession.

The strategic guidelines of Minin Nizhny Novgorod State Pedagogical University are determined by effective interaction with organizations (social partners) and the rankings of universities on a personal level.

The employment of university graduates is stable in the labor market. Table 1 presents the results of monitoring the employment of graduates.

The level of assessment of students' knowledge in the learning process is an important indicator of the quality of work. We analyzed the quality of students' education in the field 44.03.04 "Vocational training (by industry)", which is reflected in Figs. 1 and 2.

The presented trends in the sustainable development of vocational education provide the following:

- By regulating the requirements for the results of training and the system for monitoring the effectiveness of employees, the quality of professional training of workers and specialists is improved;

**Table 1** Results of monitoring the employment of graduates in 2021–2022

| Form of study | Graduation | | | Employment, pers. (%) |
|---|---|---|---|---|
| | Bachelor's degree | Specialist's degree | Master's degree | |
| Full-time education | 789 | 14 | 320 | 1123/1031 (91.8%) |
| Part-time education | 136 | 0 | 27 | 163/155 (95%) |
| Distance learning | 632 | 0 | 0 | 632/619 (98%) |
| Total, % | | | | 94.9% |

*Source* Developed and compiled by the authors

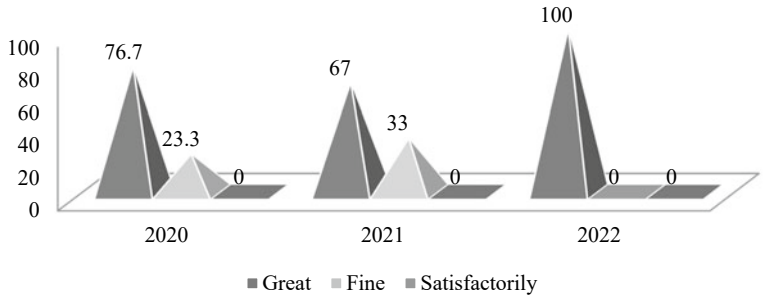


**Fig. 1** Results of the professional training of graduates in the field 44.03.04 "Vocational training (by industry)"/economics and management (defense of the graduate qualification work [GQW] in % of the total number of graduates). *Source* Developed and compiled by the authors

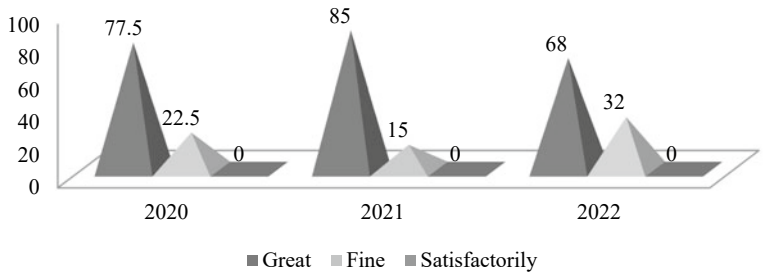


**Fig. 2** Results of the professional training of graduates in the field 44.03.04 "Vocational training (by industry)"/jurisprudence and law enforcement (defense of the GQW in % of the total number of graduates). *Source* Developed and compiled by the authors

- Preserving and developing the unified educational and economic space of Russia;
- Ensuring hierarchy and systemic organization of professional competencies of future employees and specialists;
- The possibility of participation of Russian educational institutions in the international labor market and educational services.

## 4 Conclusion

Thus, the sustainable development of vocational education is influenced by external factors that are transformed into pedagogical processes. This happens due to socio-economic, national–technical, and integrative–differential factors. General trends permeate vocational education, ensuring its sustainable development, expressed in the fundamental nature of various branches and processes of vocational education. Highly competent and competitive employees increase the effectiveness of vocational training, solve the problems of socialization and professionalization of the individual, and achieve success in training by substantiating the sustainable development of vocational education. Sustainable interaction between vocational education and the development of society is ensured in this way.

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# Theoretical Foundations for Creating a System of Independent Assessment of the Educational Results of Future Teachers

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**Abstract**

The research focuses on the problem of developing conceptual frameworks for carrying out the procedure for evaluating educational results, the relevance of which is due to the need to develop uniform requirements for assessing the quality of student training and obtaining objective information about the comprehensive assessment of student training in the educational process and the degree of mastering by students of the main professional educational program in pedagogical profiles preparation. The theoretical and methodological basis for creating such a system is systemic, activity-based, competence-based, criteria-based, and level-based approaches that make it possible to define and reveal the essence and describe the key components of such a system, including goals, assessment objects, assessment tools, assessment procedures, and levels of achievement. Based on the identified approaches, the need to consider three types of student activities (i.e., educational, practice-oriented, and professionally oriented activities) is substantiated. The results of this assessment make it possible to describe their components in the form of measurable actions and assess the degree of achievement of results. The authors identified difficulties associated with the assessment of competencies and substantiated the transition to the use of the concept of educational results. Research reveals the essence of such concepts as educational results and a three-component form of presentation of the evaluation tool.

**Keywords**

Independent assessment system • Future teacher • Educational outcome • Assessment tools • Levels of achievement

**JEL Classifications**

I100 • I12 • I21 • I23

## 1 Introduction

The relevance and significance of the problem of developing conceptual foundations for evaluating the educational results of graduates of pedagogical universities are due to the need of society to develop a unique Russian system for assessing the quality of future teachers (Bolotov, 2005). In the described realities of the system of higher professional education, the development of a new objective system becomes obvious, which would be aimed at a comprehensive assessment of the educational results formed by students in the process of studying at a university. The solution to this problem is formulated in a document that reflects new approaches to assessing educational results in the system of training future teachers until 2030 (Government of the Russian Federation, 2022, p. 6). However, the analysis of existing approaches to assessing competencies and educational results showed that there is currently no clearly defined mechanism for obtaining objective information about assessing the formation of competencies. Additionally, unified approaches to interpreting the concept of educational results of future teachers have not been developed. As a rule, the existing assessment tools do not make it possible to identify the levels of achievement of educational results (Minin University, 2022; Paputkova & Filchenkova, 2020; Smirnova et al., 2022). The results obtained by us in the course of a theoretical analysis of various approaches and

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systems for assessing learning outcomes were taken as the basis for the development of a model that includes various structural units and allows for an independent and independent assessment (IAS) of the quality of training of graduates of pedagogical universities and their educational results (ER). All of the above served as the basis for setting the research goal, which consists of the theoretical substantiation of the method for constructing IAS educational results for future teachers. To achieve this goal, it was necessary to determine the structural components of the system, highlight the design features of evaluation tools, and test them experimentally.

## 2 Materials and Method

The theoretical and methodological basis for the development of a system that allows for an independent assessment of the educational results of graduates of pedagogical universities was based on such approaches as: competence-based, determined by educational standards for universities, activity-based, and system-based, allowing to determine the structure and types of activities of students, as well as criteria and level-based approaches that orient both the teacher and the student in the degree of formation learning outcomes at the exit of their university. The following methods were chosen as research methods: synthesis and generalization, comparison, as well as analysis of normative and methodological literature of pedagogical and psychological–pedagogical nature.

## 3 Results

The systemic approach underlying the research makes it possible to identify the key components of IAS and establish links between them. It is possible to assume that IAS should become part of the system of higher pedagogical education and comply with the legal documents adopted in education. To solve the problem of determining the structural components of a system that allows using an independent approach to assessing learning outcomes, it is important to rely on the content basis and requirements presented in the educational standard of higher education in the pedagogical area of training (FSES HE) (Teplov, 1941), as well as those defined for each profession, and in particular the teacher, labor actions described in the professional standard (Perevoshckikova, 2022). This means that the target component should be the first key component of the designed IAS. Therefore, the main purpose of creating a system of such quality assessment is to identify the correspondence between the individual achievements of students and determine the degree of mastering the BPEP (BPEP). For these purposes, unifying the requirements for developing evaluation tools is necessary.

Next, in the logic of building a new system, is the allocation of objects of evaluation. To this end, we analyzed various approaches and determined that it would be effective to rely on the integration of such approaches as competence-based, systemic, and activity-based.

In accordance with the FSES HE, the assessment objects are competencies. The FSES HE presents the sets of competencies by describing the types and tasks of professional activity that determine the scope of students' readiness. However, the analysis of studies and existing practices of formation and assessment showed that it is quite difficult to assess the formation of competencies in the process of preparing a future teacher (Bershadskaya et al., 2019; Kuzminsky, 2019; Perevoshckikova, 2022). We will only point out some problems. First, competencies, as a rule, are formed nonlinearly and in different academic disciplines. Second, competencies can be assessed only in the post-graduate work of a student when the experts are not university teachers but representatives of employers. Thus, to describe the assessment objects in the IAS system, it is necessary to consider the types of activities that students perform when mastering the BPEP: educational, practice-oriented, and professionally oriented. These activities are carried out by students in the study of all disciplines included in the curriculum to train future teachers. They are aimed at the formation of competencies. Consequently, the objects of assessment should be the results of the students' performance of the named types of activities, which reflect their achievements in the process of mastering the BPEP. Based on the adopted approach, the following definition of the concept of educational outcome was formulated. "Under the educational result, we mean the result of the student's mastering the BPEP or its part during the period of study at the university, presented as a set of actions that the student can demonstrate when performing educational, practice-oriented, and professionally oriented activities at a certain stage of mastering the BPEP, and allowing to quantify the degree of mastering knowledge, skills, competencies, and experience in accordance with the requirements of the FSES HE and the Professional standard of a teacher" (Perevoshckikova, 2022). Let us pay attention to one more aspect inherent in the definition of the concept of ER. The wording provides for the mandatory coordination of the result with the competencies and labor actions from the Teacher's professional standard (Ministry of Labour & Social Protection of the Russian Federation, 2013). An essential condition in the description of the ER is the requirement associated with the allocation of the measured actions of the student. From the standpoint of the activity approach, this means the need to highlight such actions in the structure of future professional activity and present them

in the form of descriptors. In this sense, coordinating system and activity approaches to describing the set of measured actions can be the basis for building a system of indicators (Shityakova & Verkhovykh, 2018). This research stage is associated with analyzing indicators of the achievement of competencies presented in various regulatory documents and the concept proposed by us. Each indicator serves as a necessary condition for achieving the ER; their combination can be considered as a criterion for achieving the ER.

Since appropriate tools are needed to assess the results achieved at the stages of intermediate and final certification of students, we consider assessment tools built in accordance with the criteria approach as the next component of the IAS of the educational results of future teachers. Difficulties in implementing such an approach in the field of higher education are associated with the construction of evaluation criteria and a description of the IAER for each ER and evaluation indicators (Perevoshckikova, 2021).

During the research, we concluded that it is necessary to build assessment tools in a special way to implement the criteria approach and obtain an objective assessment of educational results. We need such a form of presentation of the evaluation tool that would allow answering the following questions:

- What is measured and why (i.e., determine the purpose and object of assessment)?
- The development of what content is planned to be assessed (i.e., describe the content of the control measure)?
- How is evaluation carried out (i.e., formulate criteria, indicators, and evaluation procedure)?

Therefore, in this form, the objects of assessment should be identified, a control task should be presented, and the criteria and indicators of assessment should be defined (Bolotov, 2005, p. 16).

A necessary condition for creating a system for assessing the learning outcomes of future teachers is to rely on a tiered approach that underlies the assessment procedure and allows an objective assessment of the degree of formation of the OR at various stages of student learning. In particular, I would like to emphasize the need and importance of defining all the components that we have included in the concept of "educational result" that would be evaluated and directly developed objective assessment tools. Moreover, it is fundamental to determine the relationship between the results that were planned and the results that were achieved by students. In this research, relying on the studies of Teplov (1941), we consider the levels that characterize the degree of success of the subject's activity when performing the control task, which is included in the presentation form of the evaluation tool. These levels include the optimal, acceptable, critical, and unacceptable levels. The degree of success is established based on correlating the test result with the indicators of achieving the educational result and with the limits of points established within the 100-point assessment scale adopted at Minin Nizhny Novgorod State Pedagogical University (Minin University, 2022; Perevoshckikova, 2022). Simultaneously, the objectivity and openness of the evaluation procedures are ensured by the presence of evaluation criteria and indicators provided for in the criteria part of each evaluation tool.

To test the effectiveness of the created sets of evaluation tools, their experimental verification was carried out as part of internal testing. Approbation was carried out as part of the intermediate certification of students of the Minin Nizhny Novgorod State Pedagogical University in the direction of training 44.03.05 "Pedagogical education" (Ministry of Education & Science of the Russian Federation, 2018). An electronic educational and methodological complex (EEMC) in the Moodle system was developed to conduct the experiment, including the following modules: psychological and pedagogical, methodological, preparation for educational activities, and preparation for subject activities. These modules included sets of assessment tools in the selected areas of training future teachers.

Let us give an example of building a case task for assessing the ER in the field of psychological and pedagogical training of students, highlighting three parts of the task.

1. Organizational and methodological part. The object of assessment is ER 9, built based on GPC-9 at the skill level. ER 9 demonstrates the ability to choose the necessary advanced digital tools to solve the problems of professional activity (plan the behavior of students in a real and virtual environment, work with digital information using a computer and communication tools, comply with the rules for protecting information and personal data, organize pedagogical activities and activities of students, and use the resources of the information educational environment to solve educational problems and personal development of students, considering their individual characteristics). Indicators of achieving this result will be given in the third part of the assessment tool.
2. Content. First, a description of the situation is provided. A letter from a student of one of the Russian secondary schools Vasilisa M. was published on the website of Russian education. In her letter, the schoolgirl identified the following problem and asked to explain to her the following: why teachers in their lessons began to use video material very often when studying new material.

The schoolgirl is perplexed, because the time of distance education during the pandemic is over, and there are many other methods of explaining the educational material, but teachers continue to use the method of self-development of the program with the help of video tutorials. In recent years, thanks to the active use of distance learning, especially during the COVID-19 pandemic, the use of such a form as a "video lesson" in the classroom has become fashionable. In conditions of self-isolation, this phenomenon was justified. But why are they needed in a face-to-face format when the teacher can explain topics by conducting a dialogue with students? What, then, is the function of the teacher? Commenting on her judgment, the tenth grader refers to the opinion of some teachers who justify the use of video lessons by the fact that the new generation of students can perceive information only visually, presented with pictures and slides, using voice accompaniment. Next, students are to analyze the situation and provide answers to the following questions:

(1) Analyze the proposed situation and name what is positive and what has negative sides in the use of video materials by teachers in lessons.
(2) Justify your position in relation to the statement that "the new generation of students can perceive information only visually, presented with pictures and slides, using voice accompaniment." Highlight the didactic principles of teaching that are characteristic of the informatization of education.
(3) Considering your training profile, develop a lesson plan in which it is advisable to use the information and educational resources to achieve educational results.

3. Criteria-evaluation part. To evaluate the answer to each question of the case task, it is necessary to use the following indicators: the degree of completeness, the degree of correctness of the answer, and the degree of the answer's validity; if this indicator is provided in the question.

The indicators for assessing the student's answer to the third question are as follows. The test subject's answer is evaluated with a maximum score of three points if it meets the following requirements. First, the lesson should correctly indicate information and educational resources and justify the expediency of their inclusion in the lesson's structure to achieve educational results for students. Second, at least three structural components of the lesson from the following list should be correctly disclosed:

- The purpose and objectives of the lesson;
- Motivation and updating;
- Compliance of the activities of the teacher and students with the type of lesson;
- Changing the types of activities of students to achieve educational results.

A grade reduction of 1–2 points is provided in cases where violations are made when performing the following skills:

- Can develop a lesson plan considering the training profile;
- Can substantiate the expediency of using information and educational resources in the lesson's structure to achieve educational results.

Similarly, the criteria-evaluative part is built on other issues of the case task. Thus, the assessment for each question of the case is carried out based on the selection of actions in the question to be evaluated in accordance with the indicators of completeness, correctness, and validity. The selected rating scale for the answers to each question and the distribution of points from three to one show that the maximum score for completing the given case task is nine points.

The total score for the case task and the establishment of the level of achievement of the ER is calculated depending on the share (percentage) of correct answers to all questions. Therefore, the final score for the case task can equal 9, 8, 7, 6, and 5 points. The lower limit of 5 points indicates that the subject gave, in general, only 55% of correct answers when completing the case task.

Based on the 100-point rating scale, we will determine the boundaries of points for completing a case task, depending on the proportion (percentage) of correct answers.

If the answers to the three questions of the case task are given 8–9 points in total, then the correct answers of the subject range from 86 to 100%. In the five-point grading system, these limits correspond to the mark "excellent" and characterize the optimal level of success of the activity performed. In this case, the ER is reached at the optimal level.

If the sum of points for the answers to three questions of case tasks is 6–7 points, then the correct answers of the subject are from 71 to 85%. In the five-point scoring system, these boundaries correspond to the "good" mark. Within this research, it shows the acceptable level of success in the activities performed. Therefore, we can say that the ER, in this case, is reached at an acceptable level.

If the total score for the answers to three questions of the case task is 5 points, then the correct answers of the subject are from 55 to 70%. In the five-point grading system, these limits correspond to the "satisfactory" mark. Within this research, it shows the critical level of success in the activities performed. Therefore, we can say that the ER, in this case, is reached at a critical level.

If the sum of points for the answers to three questions of the case task is less than 5 points, then the correct answers of the subject are less than 55%. In the five-point scoring system, these boundaries correspond to the "unsatisfactory" mark. Within this research, it shows an unacceptable level of performance. Therefore, we can say that the educational result, in this case, is not achieved.

Thus, a case task is considered to be completed successfully if the result of its execution is at least 5 points.

In total, 267 students of 2–5 courses participated in the approbation. They are full-time students in the training profiles "History and social science," "Physical education and life safety," "Geography and biology," "Biology and chemistry," "Mathematics and economics," and "Mathematics and informatics." Of all participants, 52 people performed tasks in the field of methodological training, 73 people—in the field of psychological and pedagogical training, 55 people—in the field of preparation for educational activities, and—87 students in the fifth year in the field of subject training. An integral assessment for completing a set of tasks, including a test and a case task, showed that 56, 64, 75, and 52% of the subjects in the field of psychological and pedagogical, educational, methodical, and subject activities, respectively, reached the optimal level.

The results of the approbation carried out to assess the achievement of educational results in the selected areas of training of students show that the sets of assessment tools developed for all groups of educational outcomes are quite understandable for the subjects. The data obtained are informative for an objective and independent assessment of the level of achievements by students of the ER in the audited areas of training of future teachers. During the approbation, the procedure for evaluating the educational results of future teachers was tested and implemented, which is the basis for developing the terms of reference for creating an appropriate digital platform.

## 4 Conclusion

Thus, the analysis of approaches to the assessment of educational results available in the Russian and foreign education systems, based on currently existing documents regulating the process of higher professional education in Russia, allows us to conclude that an objective assessment of the learning outcomes of future teachers can be effective if it is based on the integration of approaches such as competence-based, activity-based, criteria-based and others, and also contains key components of assessment, including criteria and levels of HR formation and assessment tools.

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# Regional Labor Market in the Period of Digital Transformation of a Traditionally Agricultural Region: Assessment and Forecasting of the Conjuncture

Viktoriya Yu. Skripnichenko, Alexey N. Gerasimov, Oksana P. Grigoryeva, Yuri S. Skripnichenko, and Ekaterina I. Lelikova

**Abstract**

The purpose of this study is to determine the main directions for the development of the labor market in a traditionally agrarian region during the period of digital transformation. An additional goal is to forecast the potential of human resources in the region in the long term. The research used methods of extrapolation, modeling, and forecasting. The initial set of data was the official statistical information on the labor market of the Stavropol Territory for 2012–2021. The study made it possible to form forecast models that served as the basis for obtaining scenario forecasts of the number and wages of workers in the regional agricultural market. The models obtained in the study are applied in practice. This use made it possible to determine the trend toward a reduction in the total number of labor resources in the Stavropol Territory and also to identify an increase in average wages and an excess of the proportion of older workers over younger ones. The authors consider the current trend negative for the region's digital transformation.

**Keywords**

Digital transformation • Agricultural region • Labor market • Agriculture • Econometric modeling • Forecasting

**JEL Classifications**

A10 • Q18

## 1 Introduction

The issues of staffing agricultural production are part of Russia's priority national strategic task of sustainable population growth and life expectancy. The provision of rural areas with labor resources is a condition for maintaining food security and the country's general welfare and sustainable development. These processes are occurring in the conditions of active digital transformation of the traditionally agricultural region.

An analysis of the cost structure for technological innovations (costs for innovative activities) in the Stavropol Territory shows a practically unchanged share in the cost structure in manufacturing industries (a decrease in the share from 94.75% in 2006 to 82.53% in 2021). The share of innovations in manufacturing industries in the pre-crisis period is especially significant. Simultaneously, in post-crisis 2009, the costs of innovation in the sector of information and communications increased significantly (by 1.65 times in 2009 compared to 2006) and amounted to 29,902.6 thousand rubles. There was a 51.75% change in the costs of innovation in the information and communication industry in 2021 compared to 2006. Compared with the crisis of 2008, the cost of technological innovation increased by 23%. Compared to the pandemic 2020, the cost of technological innovation increased 2.87 times (63,129 thousand rubles in 2020 compared to 181,278.2 thousand rubles in 2021) (Trukhachev, 2019; Trukhachev & Manzhosova, 2018).

In 2021, the cost of technological innovation in manufacturing increased by 71.11% compared to the pre-crisis period. During the crisis, the cost of technological innovation decreased by 31.76% compared to the pre-crisis period (exceeds the value of costs in 2021 by 2.5 times). Until the crisis of 2014, organizations in the manufacturing industry increased their spending on innovation (an increase of 4.57 times in 2014 compared to 2009). Then, there was a decline (by 34% in 2015 compared to 2014) (Bobryshev, 2018; Dorofeev & Nikulina, 2019).

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Thus, innovation costs form an added value in manufacturing but do not form an additional product in agriculture, tourism, and the digital economy.

L. V. Bondarenko and V. G. Novikov studied the methodology of the formation of labor resources and staffing in agriculture. Focusing on the unfavorable demographic situation and the reduction of rural settlements, the authors concluded that it is necessary to develop an econometric model for the transformation of employment, which will increase incomes and realize the labor potential of rural areas in the context of digital transformation (Bondarenko et al., 2021; Novikov et al., 2017).

The improvement of the methods of work of labor resources in agriculture is discussed by A. V. Alpatov, A. S. Volchenkova, E. S. Surovtseva, and A. D. Ten. The authors propose the main groups of indicators for the methodology for assessing personnel involved in agricultural production. These indicators are as follows:

- Quantitative: dynamic, structural, cost, natural, and efficiency of use;
- Qualitative: functional, social, managerial, strategic, and production.

The study noted the need to develop scientific approaches to the formation of labor resources in the agro-industrial complex. According to the authors, it is labor resources that are the main factor of production in agriculture, especially in the context of the digital transformation of the region (Alpatov et al., 2022).

Based on the existing negative trends and the main problems of the formation of labor resources in agriculture, A. G. Semkin proposed the following indicators for assessing the management of human resources in the agro-industrial complex:

- Qualitative: qualification, age, education, health, and work experience;
- Quantitative: management structure, the composition of employees, indicators of personnel movement, level of training and advanced training, and norms of behavior;
- Socio-psychological: the ability to perform a certain type of work, personal and physical qualities, aesthetic and ethical stability, and the ability to make non-standard decisions;
- Economic: potential efficiency, self-organization, motivation and stimulation, innovation and value-semantic component, and costs.

The author focuses on the fact that the formation of a staffing system requires an integrated approach based on effective state regulation of the reproduction of labor resources (Semkin, 2021).

Many scientific papers have been written about labor productivity. The studies of Adukov (Adukov & Adukova, 2020; Adukov et al., 2020), Proka (2018), Sklyarov et al. (2018), Ushachev et al. (2017), and Yarkova (2015) are relevant for us. In the works of these authors, emphasis is placed on labor productivity as a determining factor in the development of agricultural production. Researchers identify this factor as the main criterion for evaluating the effectiveness of the agro-industrial complex.

According to V. A. Bogdanovsky, the problem of efficient use of labor resources should be the object of special attention of management of agro-industrial complex and the scientific community (Bogdanovsky & Kirichenko, 2015). A. F. Serkov and V. S. Chekalin consider labor productivity as a factor development of agro-industrial production. Scientists have proposed a scheme for calculating labor productivity for each category of farms (Serkov & Chekalin, 2008).

To assess the effectiveness of agricultural labor, A. O. Khramchenkova proposed a classification of criteria, including objective factors that characterize the production and economic activities of agricultural organizations and subjective factors that reflect the personal and motivational side of labor resources (Khramchenkova, 2020).

A. V. Belokopytov studied the efficiency of the use of agricultural labor. The authors disclosed the features of measuring labor productivity indicators and substantiated methods for regulating the dynamics and structure of total costs (Belokopytov, 2004).

Despite the fairly rich experience in conducting research in the field of the formation and use of labor resources in agriculture, there is no single methodology for assessing their formation and use. Consequently, the considered methodology for assessing the formation of the personnel structure of agriculture requires additions. Such clarifications can be an assessment of the need for labor resources in rural areas. Accordingly, this research aims to assess the prospective number of agricultural workers in the Stavropol Territory in the context of the region's digital transformation.

## 2 Methodology

Digital transformation is actively occurring in the Stavropol Territory. In the context of digital transformation, the costs of technological innovation are increasing. These costs are mostly used in the manufacturing industry. It also has an indirect impact on agriculture, since it is a supplier of products for manufacturing industries. Therefore, the authors are interested in assessing digital transformations in the economy of a traditionally agricultural region and their impact on the regional labor market.

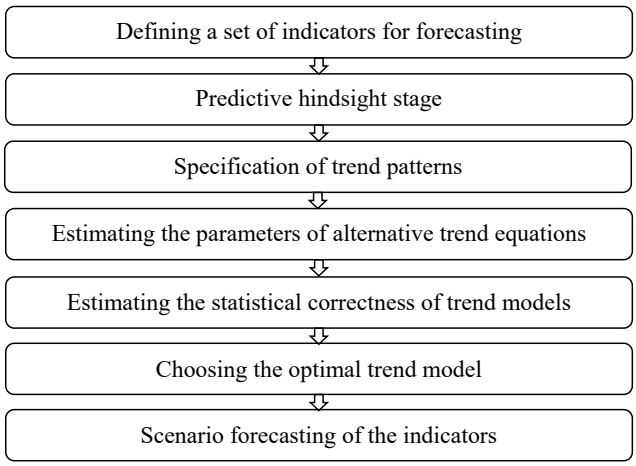


**Fig. 1** Scenario forecasting algorithm for the number of agricultural workers. *Source* Compiled by the authors

To obtain a long-term forecast of the dynamics of changes in the average annual number of employees, the authors proposed a procedure for scenario forecasting. For its use, a step-by-step algorithm was developed (Fig. 1).

The period for which the forecast was developed was a one-time interval. Then, the forecast value of the level of the time series obtained in the course of prospective extrapolation was added to the initial information base. Thus, the initial series of dynamics was consistently increased by the attached time interval. The stepwise extrapolation procedure ends when the upper limit of the forecast horizon is reached.

In order to implement the first stage of the developed algorithm, indicators of the need for specialists in the agrarian profile of the region were selected:

- Average annual number of agricultural workers (people);
- Average monthly accrued nominal wages (rubles).

The data of form No. 5-APK, developed by orders of the Ministry of Agriculture of the Russian Federation, were used as a source of information.

The information stage of the predictive study made it possible to form databases on the number of agricultural workers and their wages in the Stavropol Territory. The time interval for which data were collected covers the period from 2012 to 2021.

In the third stage, it is necessary to carry out the specification of the predictive trend model for each indicator. For the trend model, the specification consists of choosing the optimal mathematical function that most adequately reflects the trend that has developed in the retrospective period.

The authors consider it expedient to use the method of experimental selection of the form of the trend equation, which consists in estimating the parameters of alternative forms of equations with subsequent calculation of the quantitative characteristics of the statistical correctness of the obtained models. Based on the comparison of the characteristics obtained, one can judge the possibility of their further use for forecasting and the likelihood of achieving the predicted indicators in the future.

The following functions were used as alternative models for experimental selection: linear, logarithmic, inverse, exponential, and exponential. Statistical criteria for assessing the correctness of the obtained models: coefficient of determination, F-Fisher's criterion, and p-value.

## 3 Results

As a result of parameterization and identification of model of the average annual number of agricultural workers in Stavropol Territory, the parameters and statistical criteria for the quality of the resulting model were obtained (Table 1).

Practical approbation of the step-by-step extrapolation procedure in relation to the time series model used to substantiate long-term forecasts of average annual number of agricultural workers in Stavropol Territory made it possible to improve the statistical characteristics of its quality. Simultaneously, the value of the determination index changed from 0.834 to 0.864, which indicates an increase in the

**Table 1** Results of econometric modeling of the average annual number of agricultural workers in the Stavropol territory

| Retrospective period | Forecast period | Model regressors | | Statistical quality indicators | | |
|---|---|---|---|---|---|---|
| | | a | b | $R^2$ | F | p |
| 2012–2021 | 2022 | 49,696.746 | 6379.564 | 0.834 | 40.269 | 0.000 |
| 2012–2022 | 2023 | 49,696.746 | 6379.564 | 0.841 | 47.731 | 0.000 |
| 2012–2023 | 2024 | 49,696.746 | 6379.564 | 0.847 | 55.472 | 0.000 |
| 2012–2024 | 2025 | 49,696.746 | 6379.564 | 0.852 | 63.458 | 0.000 |
| 2012–2025 | 2026 | 49,696.746 | 6379.564 | 0.857 | 71.658 | 0.000 |
| 2012–2026 | 2027 | 49,696.746 | 6379.564 | 0.860 | 80.050 | 0.000 |
| 2012–2027 | 2028 | 49,696.746 | 6379.564 | 0.864 | 88.613 | 0.000 |

*Source* Compiled by the authors

explained variation over time of the predicted indicator from 83.4% to 86.4%.

Point forecast estimates do not have a high probability of their achievement. Therefore, they should be supplemented by the calculation of upper and lower confidence bounds based on the standard error of the predictive model. As a result of evaluating such confidence boundaries, three forecast scenarios were obtained: neutral (corresponding to a point forecast), positive (corresponding to the distance from the forecast point to the upper confidence bound), and negative (corresponding to the distance from the forecast point to the lower confidence bound) (Fig. 2).

For the trend model of the number of employees of agricultural organizations in the Stavropol Territory, the following estimates of statistical quality were obtained: the actual value of Fisher's F-test was 40.269, and the significance (Sig.) was 0.000, respectively. These estimates make it possible to recognize the model as the most significant (since 0.000 is less than 0.001, and statements with probability errors $p \leq 0.001$ are recognized as the most significant).

Significant statistical significance of synthesized time series model makes it possible to use it to study changes in the number and average wages of employees of agricultural organizations in the Stavropol Territory in the long term.

If the current trend continues, the number of employees of agricultural organizations will decrease by 1219 people (2%) by 2028 compared to 2021 results.

The implementation of the optimistic scenario allows us to expect an increase in the average annual number of agricultural workers in the region at any point from the area of the positive scenario shown in Fig. 2. The maximum number of employees may reach 52,166 people by 2028, which is 2% higher than in 2021.

The implementation of the pessimistic scenario may lead to a decrease in the number of employees in the area of the negative scenario shown in Fig. 2. According to the forecast results, the minimum number of employees in 2028 may reach 47,978 people, which is 6% lower than the results of 2021.

## 4 Discussion

As a result of assessing the dynamics of the age structure of agricultural workers in the region, a shift in the ratio of the share of working pensioners and adolescents was revealed. If the current trend continues by 2028, we can expect an additional decrease in the number of agricultural workers. This may cause an additional shortage of agricultural labor, the forecast of which is available at https://figshare.com/ with an identifier https://doi.org/10.6084/m9.figshare.23049857.v1.

The results of forecasting the number of employees of agricultural organizations in the region based on the global method demonstrate an even greater decrease in the number of labor resources in the next seven years compared to the results of applying the traditional extrapolation method. The analysis is available at https://figshare.com/ with an identifier https://doi.org/10.6084/m9.figshare.23050235.v1.

Thus, an even greater shortage of labor resources in the agricultural production of the Stavropol Territory is expected, which will increase from 418 workers in 2022 to 1244 workers in 2028.

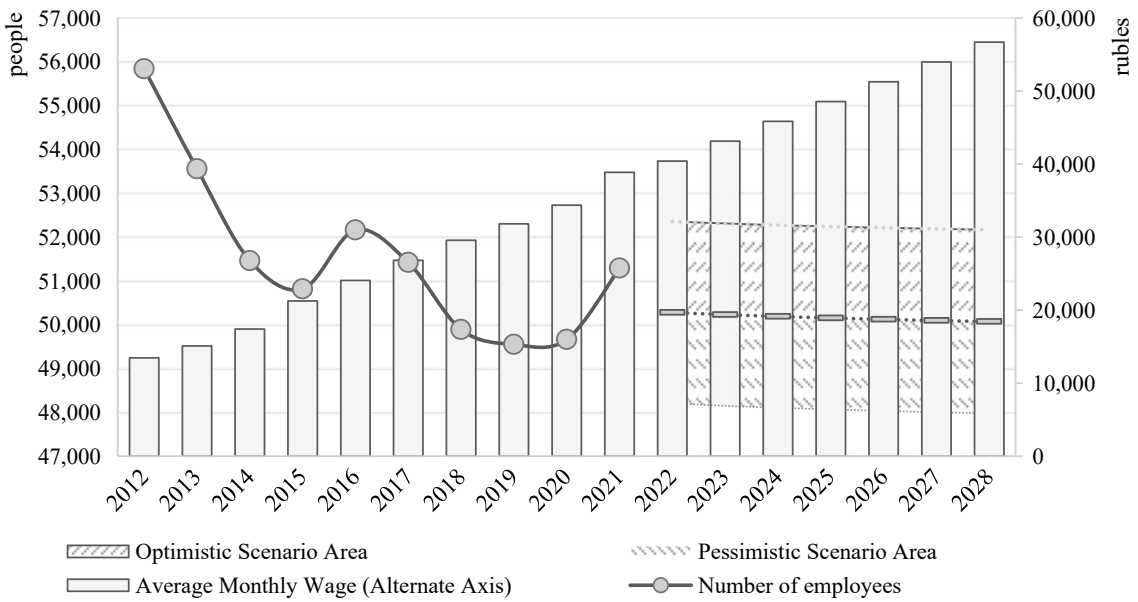


**Fig. 2** Results of scenario forecasting of the average annual number and wages of employees of agricultural organizations in the Stavropol territory. *Source* Compiled by the authors

## 5 Conclusion

The research carried out on the materials of the Stavropol Territory provides several conclusions. The assessment of the conjuncture of the regional labor market on the example of employees of agricultural organizations is due to the agricultural specialization of the region's economy. A significant proportion of the population of rural areas is also involved in agricultural production or related sectors for the processing of agricultural products.

The application of the obtained models in practice made it possible to note a general orientation toward reducing of number of labor resources in the regional labor market. This negative trend is exacerbated by a marked focus on the aging of agricultural workers. Against the background of a general decline in labor resources, an increase in the average wage of workers can be noted. By 2028, an increase in wages by 17,816 rubles is expected, which is almost 1.5 times higher compared to the level of 2021.

There is a more intensive outflow of the population from rural areas due to digital transformation. Such migration affects mainly the agricultural sector of the economy. The movement of labor resources occurs in other industries that do not require heavy physical labor.

Traditional methods of studying the regional labor market require additions in terms of statistical evaluation of parametric criteria. This will make it possible to forecast them in the long term. The identified prospects imply the achievement of indicators of rural development strategies. In addition, it becomes possible to track the achievement of goals set in each specific situation.

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**Data Availability** Data about the change in the age structure of agricultural workers in the Stavropol Territory are available at https://figshare.com/ with an identifier https://doi.org/10.6084/m9.figshare.23049857.v1.

Data about the assessment of the predicted need for agricultural specialists in the Stavropol Territory are available at https://figshare.com/ with an identifier https://doi.org/10.6084/m9.figshare.23050235.v1.

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# ESG-Principles in the Practice of Sustainable Economic Development

Mikhail N. Korablin, Pavel N. Kosov, Aleksei A. Kiritsa, and Yuliya V. Chutcheva

**Abstract**

The development and application of ESG practices in the Russian agricultural sector are currently not a fashionable trend, but an objective necessity. The efforts of the state to develop institutional and legal conditions for the introduction of ESG principles in the Russian economy, the current trends in this area allow the development of more targeted investment and organizational measures in order to unlock the potential of the effectiveness of sustainable financial instruments. This is especially important in terms of introducing the principles of the circular economy to involve small and medium-sized businesses in the development of new production chains, to expand the use of responsible consumption and development practices, to accelerate the renewal of agricultural machinery. The article discusses the possibilities to improve the practices of responsible consumption and production in the agricultural sector of Russia as one of the key directions of ESG transformation of the agricultural sector within the framework of the paradigm of sustainable development. The main approaches to the problems of waste management (not SMW) in the agricultural sector along with practical ways to solve the problem taking into account ESG factors are analyzed. It is shown that in Russia the problem of food losses and food waste is currently not paid enough attention. The directions of improvement and development of this approach based on ESG practices within the framework of sustainable development of waste management in the agricultural sector are proposed.

**Keywords**

Food losses • Agricultural sector • ESG practices • Waste management issues • Sustainable development

**JEL Classifications**

Q01 • O1 • D2

## 1 Introduction

In modern conditions, the practical interaction of the main elements of the social system (business, state, society) has increasingly become focused on the paradigm conceptually described from the point of view of CSR (the concept of social responsibility of business). From this point of view, the policy of corporate social investment is the most important financial mechanism for ensuring interaction between business and society within the framework of the concept of sustainable development (SD) as the main model of human development in co-evolution with the environment (Korablin & Kuritsa, 2022).

One of the key topics in the field of sustainable development is the principles of rational production and consumption. The agricultural sector, from this point of view, is one of the most important industries. This is due to the very nature of agriculture, firstly, as a production that provides humanity with food, and secondly, as a social, ecological, economic agent whose activities have as much impact on the biosphere as the activities of industrial sectors recognized as the most "negatively affecting" the life-supporting resources of mankind (chemical, oil and gas, coal industry, etc.).

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## 2 Methodology

The methodological basis of the research consists of general scientific methods and techniques (analysis and synthesis, economic and statistical methods, expert assessments, etc.).

## 3 Results

One of the most important goals of sustainable development and the key direction of ESG transformation in agriculture is responsible consumption and production (Seventeen goals to transform our world, 2023). Within this direction, the problem of waste management plays a special role, which is interpreted in two ways in the agricultural sector (Kiritsa et al., 2021):

- as a problem of food losses and food waste (i.e., as the need to reduce the volume of waste generated at all stages of food production and marketing, while ensuring high quality products and an appropriate level of food security of the state);
- as a problem of reducing waste generated in the production process that is not intended for food (for example, tops of root crops, substrates used in greenhouse crop production, animal feed, etc., are not "food losses and food waste"), as well as the possibility of their disposal and processing.

In other words, these are two different approaches to the problem, which significantly affects the understanding and setting of goals and objectives in solving it. It is not surprising that this often leads to misunderstandings and disagreements in the interpretation of statistical data, the allocation of criteria for the effectiveness of projects, the goals of socially responsible investment.

Thus, in the domestic normative and legal framework, relations in the field of production and consumption waste management are regulated by Federal Law No. 89-FZ of 24.06.1998 "On Production and Consumption Waste" (Federal Law No. 89-FZ, 2023). The same law gives a key definition of the concept of "production and consumption waste". Such waste is defined as "substances or objects formed in the processes of production, performance of works, provision of services or consumption, which are disposed of, intended for disposal or are subject to disposal" in accordance with the federal laws of the Russian Federation (Federal Law No. 89-FZ, 2023). This definition does not allow to distinguish food losses and food waste as a separate component, while an inaccurate interpretation of the term leads to the fact that food losses are often understood as any (including non-food) waste generated during agricultural activities (for example, tops of root crops, substrates used in greenhouse crop production, animal feed, etc.). For example, the problem of waste management have been made a separate area within the developed by VEB. RF (Decree of the Government of the Russian Federation No. 3024-r of 18.11.2020, 2023) the national system of green financing (green taxonomy), according to which the directions of green activity in the country are defined and regulated, and which also acts as a criterion basis for providing priority financing to sustainable development projects (Decree of the Government of the Russian Federation No. 1587, 2023). At the same time, it completely lacks the concept of food losses and food waste.

Only the treatment of "non-food" waste generated during agricultural activities (with the exception of SMW) is considered (mainly their disposal for recycling purposes, as well as disposal for energy production) as falling under the criteria and standards of green development. The lack of legislative definitions makes it impossible to consider as sustainable development projects such projects as, for example, investment projects to reduce food losses and food waste at various stages of the supply chain, which can be, among other things, a financial motivation for renewal of the fleet of agricultural machinery of agricultural enterprises of small and medium-sized businesses, as well as the disposal of agricultural machinery withdrawn from exploitation. The newer agricultural machinery is used in the fields, the lower the food losses at the harvest stage, while the development of conditions for the use of recycling schemes for the disposal of agricultural machinery allows reducing the environmental burden on the territory, returning secondary resources into circulation, and efficiently using the technical reserves of the machine and tractor fleet (Kiritsa, 2022).

Small and medium-sized businesses are gradually adopting their standards of activity in order to maximize the opportunities of the external business environment (formed mainly by large companies). This is largely due to the creation of legal and institutional conditions, financial incentives, the introduction of new mechanisms (for example, agroleasing). In particular, since 2020, the ESG approach has started to penetrate into medium and small businesses, since large leasing companies (Rosagroleasing JSC, GTLK JSC, etc.) have begun to actively use ESG evaluation of projects when making investment decisions (Kiritsa, 2022). In addition, with the introduction of a national green (and, in the near future, social) taxonomy, many domestic banks are also going to be guided by official ESG criteria when making credit and investment decisions.

The official collection and processing of statistical information on waste management in Russia (based on the annual data submitted by organizations in the form 2-TP (waste) is carried out by Rosprirodnadzor (Information about

**Table 1** Dynamics of waste generation, processing, and disposal in agriculture of the Russian Federation, 2020–2022

| Indicator | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | | 2021 | | 2022 | |
| | Crop production | Animal husbandry | Crop production | Animal husbandry | Crop production | Animal husbandry |
| *Volumes of waste generation, processing, and disposal, million tons* | | | | | | |
| Generation | 1065.0 | 6984.3 | 1168.8 | 19,063.3 | 1113.4 | 14,656.9 |
| Processing | 1.0 | 46.0 | 2.0 | 542.8 | 1.6 | 389.2 |
| Disposal, total, including | 589.9 | 6087.4 | 598.2 | 14,031.5 | 725.6 | 10,138.1 |
| Recycling | 205.6 | 2438.1 | 186.4 | 4742.9 | 165.0 | 3552.3 |
| *Dynamics of waste generation, treatment, and disposal, %* | | | | | | |
| Generation (%) | 79.6 | 16.3 | 109.8 | 272.9 | 95.3 | 76.9 |
| Processing (%) | 11.1 | 0.7 | 193.0 | 1179.5 | 80.7 | 71.7 |
| Disposal, total, including (%) | 73.3 | 19.1 | 101.4 | 230.5 | 121.3 | 72.3 |
| Recycling (%) | 41.4 | 30.3 | 90.7 | 194.5 | 88.5 | 74.9 |
| *The average annual growth rate of waste disposal during the period under review, %* | | | | | | |
| | Crop production | | | Animal husbandry | | |
| Disposal (%) | 98.7 | | | 107.3 | | |
| Recycling (%) | 73.5 | | | 99.9 | | |

*Source* Calculated by the authors based on (Information about the formation, processing, disposal, neutralization, placement of production & consumption waste, 2023)

the formation, processing, disposal, neutralization, placement of production & consumption waste, 2023). Table 1 shows the dynamics of the formation, processing, and disposal of "non-food" waste generated during agricultural activities in recent years.

As can be seen from the data in Table 1, the volume of waste generation in agriculture has been steadily increasing (although in 2022 there is a slowdown in growth, both in crop production and in animal husbandry). At the same time, the average annual growth rate of waste disposal, including with the receipt of material products and secondary raw materials (recycling), is higher in animal husbandry than in crop production. But the share of the most modern waste management practices, such as recycling, is decreasing from year to year, both in the total volume of waste generated and in the total volume of disposed waste (Fig. 1).

At the same time, the problem of food losses and food waste is currently practically not considered in Russia—neither from the point of view of state policy (this direction is not even in the national taxonomy of green projects), nor from the point of view of business and society. This is largely due to the lack of reliable statistical information on this

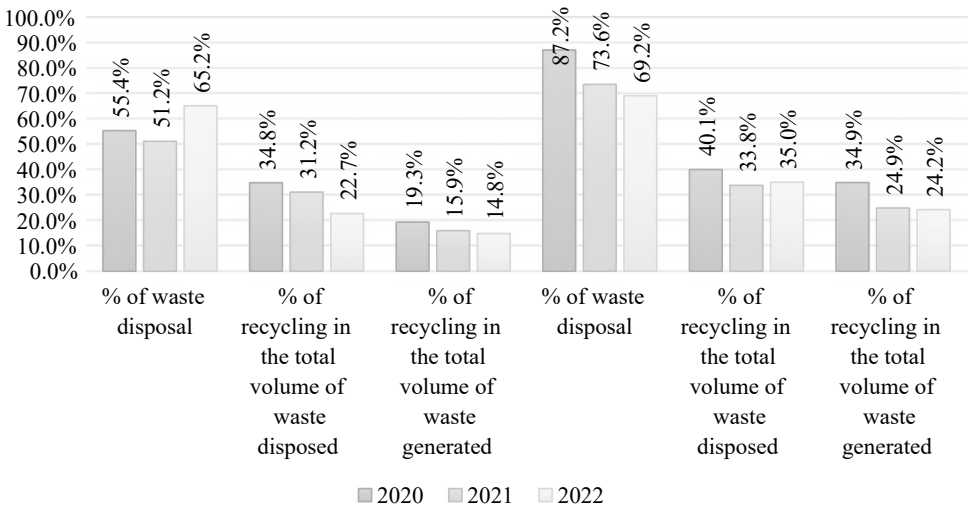


**Fig. 1** Dynamics of the share of various waste management practices in the structure of generated waste, %. *Source* Calculated and constructed by the authors based on Information about the formation, processing, disposal, neutralization, placement of production & consumption waste, (2023)

**Table 2** Average annual percentage of food losses by types of agricultural products over a 10-year period (according to Rosstat), 2012–2021

| Indicator, million tons | | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Grain | Production | 70.9 | 92.4 | 105.2 | 104.7 | 120.7 | 135.5 | 113.3 | 121.2 | 133.4 | 121.4 |
| | Losses | 1.10 | 1.20 | 1.00 | 1.10 | 1.20 | 1.50 | 1.20 | 1.20 | 1.20 | 1.10 |
| | Average annual percentage of losses for the period | | | | | | | | 1.1% | | |
| Vegetables | Production | 14.33 | 14.09 | 14.35 | 14.97 | 15.06 | 15.43 | 15.66 | 15.89 | 15.45 | 15.38 |
| | Losses | 0.52 | 0.50 | 0.48 | 0.51 | 0.51 | 0.51 | 0.47 | 0.50 | 0.49 | 0.52 |
| | Average annual percentage of losses for the period | | | | | | | | 3.3% | | |
| Milk | Production | 31.20 | 29.87 | 30.00 | 29.89 | 29.79 | 30.19 | 30.61 | 31.36 | 32.23 | 32.34 |
| | Losses | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.06 | 0.04 |
| | Average annual percentage of losses for the period | | | | | | | | 0.1% | | |
| Meat | Production | 8.08 | 8.53 | 9.03 | 9.52 | 9.85 | 10.32 | 10.63 | 10.87 | 11.22 | 11.35 |
| | Losses | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Average annual percentage of losses for the period | | | | | | | | 0.2% | | |
| Fruit | Production | 2.79 | 3.20 | 3.35 | 3.20 | 3.66 | 3.26 | 3.96 | 4.18 | 4.34 | 4.74 |
| | Losses | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.10 | 0.07 | 0.07 | 0.07 | 0.09 |
| | Average annual percentage of losses for the period | | | | | | | | 2.6% | | |

*Source* Calculated by the authors based on (Production and consumption waste, 2023)

issue. The volumes of food losses calculated by Rosstat in the Balance of Food Resources of the Russian Federation at first glance are quite "reassuring".

Thus, according to Rosstat (Production and consumption waste, 2023), the volume of food losses for various types of agricultural products in the Balance of Russia's Food Resources has been no more than 3.5% over the past 10 years. According to Rosstat data for the last 10 years, the average annual percentage of food losses for the following types of agricultural products is: grain—1.1%, meat—0.2%, milk—0.1% (Table 2).

Nevertheless, according to the expert community (Food losses and organic waste in the consumer market of the Russian Federation, 2023), food losses are significantly higher at various stages of the value chain in agriculture. So, in particular, in meat animal husbandry, food losses at the stage of raising livestock and poultry can reach from 10 to 20%; in crop production, the highest food losses are noted at the stages of transportation, storage, sale of products (from 15 to 30%) (Food losses and organic waste in the consumer market of the Russian Federation, 2023).

The results of the research conducted by the Consumer Market Development Center of the Moscow School of Management "Skolkovo" show that, according to experts, average food losses in Russia account for at least a third of the total volume of food production (Food losses and organic waste in the consumer market of the Russian Federation, 2023). The correctness of such estimates is also confirmed by global indicators: for example, on average, according to FAO experts, world food losses and food waste reach a third of all global food production (Chitimiea et al., 2021).

## 4 Discussion

Thus, the problem of food losses in Russia requires much closer attention from both the state and other interested parties.

Currently, it is necessary to ensure the following important processes on the way to sustainable development in the field of agricultural waste management:

- amendments to the regulatory framework (including the differentiation of food and non-food waste (with the exception of SMW), assessment of the real scale of food losses and their causes based on the provision of adequate data by Rosstat);
- development of a complex of necessary works to minimize food losses (taking into account the principles of SD and the circular economy);
- the use of modern financial mechanisms to stimulate the introduction of SD practices for waste management in small and medium-sized businesses (agroleasing, corporate socially responsible investment: financing sustainable development projects through VEB.RF (as a sustainable development bank), green bonds for financing municipal–private and public–private partnership projects);

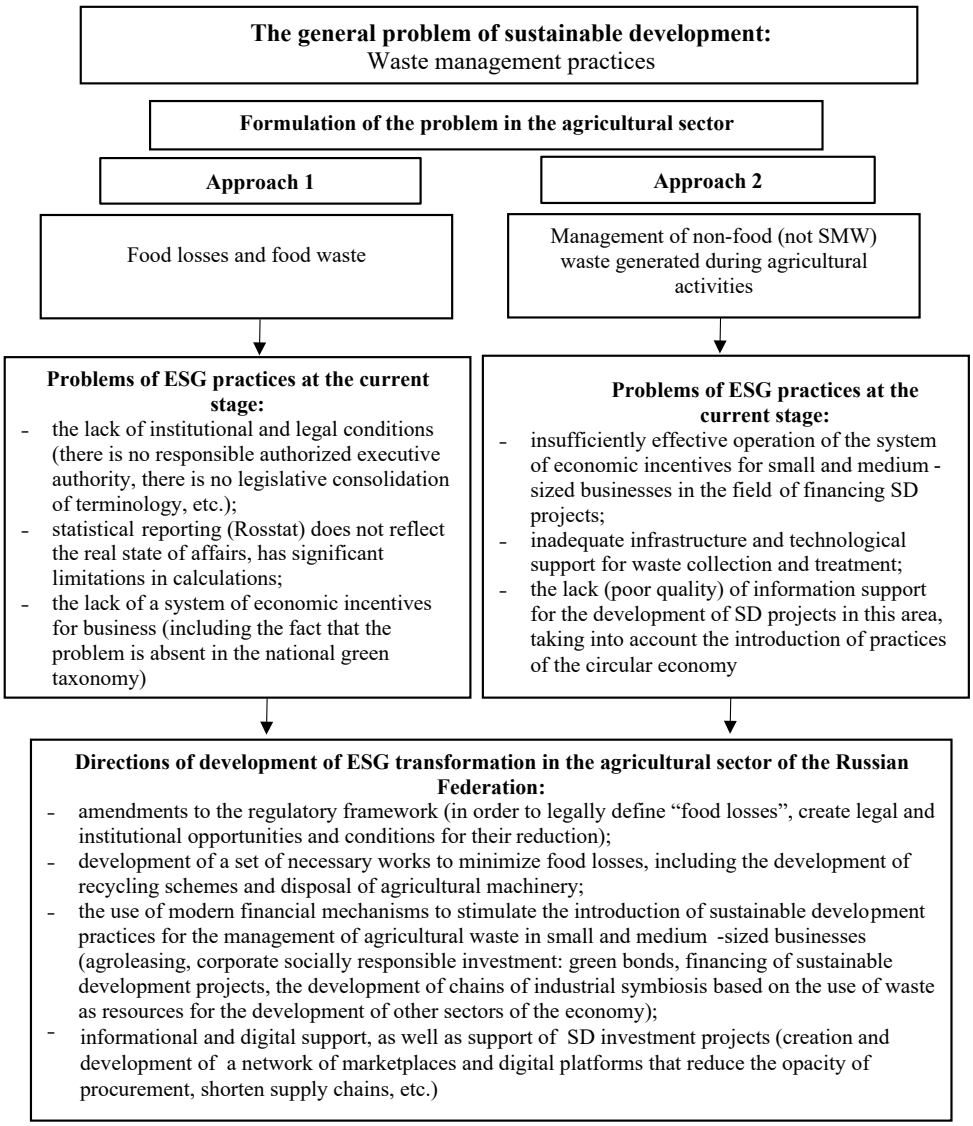


**Fig. 2** Directions for improving ESG practices in the framework of sustainable development of waste management in the agricultural sector. *Source* Developed and compiled by the authors

– informational and digital support, as well as support of investment projects based on the principles of sustainable development (creation and development of a network of marketplaces and digital platforms that allow developing new connections in the market, shortening distribution chains, etc.) (Fig. 2).

## 5 Conclusion

The problems of waste management are now in the focus of public attention. In the agricultural sector, this problem is considered from the point of view of two approaches: as a problem of food losses and food waste and as a problem of management of non-food waste (not SMW) generated during agricultural activities.

The second approach has already taken shape in the domestic institutional and legal framework (federal laws and by-laws have been adopted that develop the field of waste management within the framework of national development strategies, federal and regional programs and projects; a national green taxonomy has been created, in which waste management has been made a separate area as one of the main directions of sustainable development, which implies the priority of financing such projects at least by VEB. RF), and infrastructure projects, necessary for recycling or disposal of waste, are gradually being implemented.

At the same time, the problem of food losses and food waste is currently practically not considered in Russia—neither from the point of view of state policy, nor from the point of view of business and society. This is due, firstly, to the lack of key legislative definitions on this topic in Russian legislation, and secondly, insufficiently reliable statistics of

food losses in our country. According to experts and specialists, food losses at all stages of the industrial supply chain reach a third of all food production (although according to Rosstat they amount to no more than 3.5%).

The following directions have been proposed for the implementation of sustainable development practices and ESG transformation in the agricultural sector to solve the problems of sustainable development of society and business:

- development of regulatory and methodological approaches in order to introduce legislative definition of the concept "food losses", creation of legal and institutional opportunities and conditions for the reduction of such losses;
- development of a set of necessary works to minimize food losses, including the development of recycling schemes and disposal of agricultural machinery;
- development of modern financial mechanisms to stimulate business to expand the implementation of SD practices and principles of the circular economy;
- development of information and digital support for investment projects based on SD principles (including at the state level: national digital platforms, improvement of national taxonomies of sustainable development, creation of SD investment funds).

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# Competition as a Form of Exercising the Right to Entrepreneurial Activity: A Civilistic Aspect

Agnessa O. Inshakova, Tatiana V. Deryugina, Tatiana N. Litvinova, and Nikolay I. Litvinov

**Abstract**

The change in economic patterns, the emergence of new forms of entrepreneurship, and the diversification of production cause the need to create new mechanisms of legal regulation of relations and transformation of existing ones. One such mechanism is competition. The research solves the problems of legal regulation of the exercise of competition as a form of exercising the right to entrepreneurial activity and identifies and systematizes its limits and restrictions. The use of a system of logically grounded universal (dialectical, system approach, and determinism) methods allowed the authors to establish the regularities of competition development, distinguish the legal nature of similar phenomena, and systematize new scientific knowledge about competition. Using the mechanism of legal regulation of entrepreneurial activity as a form of exercising the right to conduct entrepreneurial activity, the study of the function of competition provides conclusions about the legal nature of competition and distinguishes the positive and negative factors of its existence. The authors established the correlation with the categories of good faith and bad faith competition and entrepreneurial activity. The signs of behavior qualifying it as a restriction of competition are formulated. The comparative analysis of restriction of competition and abuse of rights allowed the authors to draw conclusions about their nonidentity. Based on considering the influence of competition on public and private interests, the authors revealed the means of the mechanism of legal regulation of competition.

**Keywords**

Competition • Business activity • Abuse of right • Restriction of competition • Good faith • Unfair competition

**JEL Classifications**

K15 • K29 • L26 • L29 • L88 • M38

## 1 Introduction

The emergence of eco-entrepreneurship (Inshakova & Deryugina, 2022; Sun et al., 2020) as the latest basis for sustainable development (He et al., 2020), the introduction of innovative technologies, the development of digitalization (Inshakova et al., 2020b), digital entrepreneurship (Gregori & Holzmann, 2020), etc., are elements of a continuous chain directly related to the need for balanced and effective economic development. Like many other countries, Russia is on the threshold of development of the sixth technological mode, based on artificial intelligence (AI), biotechnology, etc., which requires the law to create a new system of legal regulation reflecting the occurring changes. The created legal mechanisms of regulation of relations are closely connected with the already existing regulators, which have shown their effectiveness for more than one decade.

Among the main functions of competition, we can single out its focus on the coordination of entrepreneurial activity, leveling of conflicts of interests of its subjects, and minimization of administrative interference. Legislators should

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use new means of legal regulation (Anisimov et al., 2020), making it possible to bring the subject of entrepreneurship to responsibility.

When building a system of legal regulation, along with positive aspects, the development of competition has negative aspects. Particularly, scientific literature refers to the formation of monopolies and market monopolization as negative consequences of competition development (Parashchuk, 2019). Consequently, in regulating these relations, the legislator should find an optimal balance that makes it possible to consider the interests of each group of participants (entrepreneurs, consumers, and the state). The overweighing of any of the interests will lead to the opposite result.

The problems of legal regulation of competition, bona fide unfair business activities, and competition have been investigated by Anisimov et al. (2020); Gabov (2016); Inshakova et al. (2020a); Istomin (2021); Parashchuk (2019); Zenin (1992); and others. Competition as a form of implementation of certain types of entrepreneurial activities related to environmental and digital entrepreneurship, as well as to other types of activities, was analyzed in the works of Gregori and Holzmann (2020); He et al. (2020); Inshakova and Deryugina (2022); Sun et al. (2020). Nevertheless, the systemic problems of competition as a form of entrepreneurial activity, which includes economic relations, have not yet been solved.

The authors of this research see their goal in resolving problematic issues related to the implementation of competitive actions in the process of doing business and improving the legal regulation of emerging entrepreneurial legal relations. The following tasks will contribute to achieving the research goal:

- To define the category of "competition" and identify its essential features.
- To identify the constitutive differences between the legal phenomena of fair and unfair competition and abuse of rights.
- To establish the conditions of private-law liability in case of revealing the actions aimed at limiting competition.
- To make proposals for a new law on entrepreneurial legal relations.

## 2 Materials and Methods

In developing the research topic, the authors used universal methods, including dialectical methods (to reveal the unified laws of competition development), system approach (which dictates the need to consider competition as a system), and determinism. The application of general scientific methods traditionally used for scientific analysis made it possible to identify general and special features of competition, consider it within the system of entrepreneurial legal relations, and determine competition on the rights of entrepreneurs. Special-legal methods allowed the authors to establish the regularities of competition development, distinguish the legal nature of similar phenomena, consider the modeled system within the existing economic and social reality, and formulate proposals to improve the legal regulation of competition relations as a form of entrepreneurial activity.

## 3 Results and Discussion

The main means of legal regulation aimed at the development of this priority direction include the following (Russian Federation, 1994):

- Creating equal conditions for business entities.
- Providing conditions for the development of investments.
- Minimizing control by the state and municipalities with simultaneous optimization of the forms of control.
- Encouraging good faith and fair competition.

It is characterized by the removal of these rules for a number of business entities and other activities. Moreover, there is a tendency to increase the number of such entities that are not subject to competition rules. Natural monopolies can be singled out among such entities.

Competition has several positive aspects related to the following:

1. Preventing the market's monopolization.
2. Preventing unfair conduct.
3. Preventing restriction of competition.

However, excluding natural monopolies from these rules reduces the effectiveness of the proposed measures. This situation should be changed by amending the current antimonopoly legislation.

The problem associated with the legislative enshrinement of competition is that even fair competition can ruin the rival (Zenin, 1992). An entity engaged in entrepreneurial activity, among the subjective rights granted to it by the state, has the right to competition. Thus, in the process of entrepreneurial activity, a person does not cause unfavorable consequences to other participants. Any income-generating activity may cause losses to competitors (Anisimov et al., 2020). However, such activities cannot be considered unlawful if they are carried out within the framework of the law and do not contradict the general principles of law. Thus, the right to entrepreneurial activity includes the right to competition.

Non-compliance with competition rules naturally leads to a number of adverse consequences, including market monopolization and unfair competition. The legislator, realizing some illogic of considering the restriction of competition as a limit on exercising a right, specifies that civil rights cannot be used to restrict competition. Thus, restricting competition is a consequence of exercising the right; it will entail unfavorable consequences only if the holder of the subjective right aims to restrict competition.

However, this criterion is hardly conducive to correctly qualifying the subject's behavior restricting competition. The average entrepreneur has the goal of making a profit. In the process of such activity, there may be consequences in the form of competition restriction. In light of the above, the legislator is to solve the issue of criteria that make it possible to attribute certain behaviors to actions aimed at restricting competition (Gregori & Holzmann, 2020). Subject to legal assessment is the behavior of a business entity that resulted in the restriction of competition. Accordingly, the criteria should be developed in relation to the subject's behavior and not in relation to the category of restriction of competition.

As a rule, the same approach is outlined in science, with scientists paying attention to the legal uncertainty of the connection established by the legislator (Parashchuk 2019; Russian Federation 2006). Although the above criteria characterize the category of unfair competition, the legal nature of the behavior underlying unfair actions is different. Thus, if we are talking about actions that violate legal norms (i.e., specific prohibitions or prescriptions), then we are talking about an offense. In such a case, liability should come in accordance with a special norm containing a prohibition or prescription. If there is no specific prohibition, such indication of the legislator should be considered as an establishment of the limit of exercising the right; in qualifying the behavior and incurring liability, the subjects should be guided by Article 10 of the Civil Code of the Russian Federation.

Thus, unfair competition should be considered as the use of unfair ways of doing business, violation of legislative prohibitions, and failure to comply with regulations, as there is a real possibility of causing harm or harm that has already been caused. Unfair competition is the cause, and restriction of competition is its effect. However, the consequences of unfair competition may be expressed not only in the possibility of causing harm to a particular business entity.

Restriction of competition, caused by unfair competition, can be talked about in a broad sense as the infliction of harm to specific business entities, their associations, and the state as a whole (Anisimov et al. 2019; Parashchuk 2019). In civilization literature, monopolistic activity is considered as a type of anti-competitive behavior (Istomin, 2021). As a rule, scholars include the following elements as structural parts of the definition of monopolistic activity:

1. Abuse of dominant position.
2. Actions restricting competition (Inshakova et al., 2020a).

Abuse of a dominant position is an offense, the content of which is defined in a special norm containing a prohibition of such behavior. It follows that a business entity has no right to behave in a certain way. In turn, abuse of rights is characterized by the fact that a person is the owner of a subjective right, the exercise of which brings adverse consequences to other subjects. There is no specific prohibition on such behavior or methods of exercising the right in the law (He et al. 2020; Sun et al. 2020).

Conditions for bringing to responsibility from the position of private law (the presence of harm, etc.), as well as the purpose of the offender's behavior, do not have any legal significance. What is important is that the offender commits actions that violate the rule of law. This approach is more typical for bringing to responsibility in public branches of law (e.g., criminal and administrative), where the consequences are of secondary importance. This is a fundamental difference in all other civil offenses because civil law has a general rule: no harm (here, we should talk more broadly about adverse consequences)—no liability.

Conclusion of agreements or concerted, other actions limiting competition as a form of monopolistic activity is characterized by two features: (1) the presence of coordination in any form (oral or written) and (2) the presence of adverse consequences for specific subjects and the market as a whole. Like abuse of a dominant position, as well as any actions aimed at restricting competition, such agreements cannot be regarded as a form of abuse of right; business activity does not abuse the right but violates it. Moreover, as a legal consequence of concluding an anti-competitive agreement, the law enforcer, as a rule, sees the application of the consequences of invalid transactions, which is generally true. However, if there is a special liability in the form of invalidation of the transaction for this offense, it is unnecessary to talk about the application of the general rule on the abuse of subjective civil rights (Gabov 2016; Inshakova et al. 2020b). This approach seems to be correct because the recognition of an anti-competitive agreement as an abuse of rights would reduce its scope to the framework of a civil law relationship. However, as follows from the study, competition is a cross-sectoral category regulated by private and public branches of law.

## 4 Conclusion

The research allowed the authors to justify a narrower approach to understanding the restriction of competition, which is expressed in actions related to unfair competition and actions aimed at the market's monopolization.

It is substantiated that the criteria for assessing the behavior of an entity for possible qualification of its actions as anti-competitive should be the purpose of actions—obtaining unjustified advantages and the presence of harm.

The presence of harm should be a necessary condition for bringing a person engaged in unfair competition or monopolistic activities to responsibility. Otherwise, a business entity can be held liable in any case, including if it carries out normal business activities (e.g., changing the prices of goods). The presence of harm as a condition of liability protects the entrepreneur from the possibility of arbitrary application of state coercive measures. The range of persons to whom harm is inflicted goes beyond the scope of one branch of law because harm may be inflicted on particular business entities or society as a whole.

When distinguishing between the inflictions of harm, it should be assumed that the infliction of harm to a single entity without global consequences for the market or commodity turnover cannot be considered as a restriction of competition. Based on the above, it seems correct and necessary to have conditions for the occurrence of legal liability. Particularly, one of such conditions should be the presence of harm caused as a result of entrepreneurial activity.

The rules on unfair competition and monopolistic activities, as well as unfavorable consequences expressed in state coercive measures, should apply to natural monopolies, which should be enshrined in the current antimonopoly legislation.

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# Legal Presumptions of Good Faith and Reasonableness of Entrepreneurial Activity

Agnessa O. Inshakova, Tatiana V. Deryugina, Tatiana N. Litvinova, and Nikolay I. Litvinov

**Abstract**

When creating a model of entrepreneurial activity, it is necessary to study the main elements of the structure of such a model to identify their legal essence, distinguish them from similar legal categories, establish key features, and formulate proposals aimed at improving the current legislation. The key means and ways to achieve the goal is to study the categories of good faith and reasonableness of entrepreneurial activity using system approach, determinism, modeling, abstraction, concretization, analogy, formal-legal method, comparative-legal method, and the method of legal forecasting. The research raises problems related to the fundamental categories of realization of the subjective right to conduct entrepreneurial activity and the categories of good faith and reasonableness. A comparative analysis with antagonisms (bad faith and unreasonable behavior) is carried out. The study of good faith and reasonable exercise of the right by subjects of entrepreneurial activity regulation made it possible to express a negative attitude to the used legal means in the form of establishing prohibitions, as well as the applied legislative technique. The authors formulated proposals to optimize the system of legal regulation of relations.

**Keywords**

Reasonableness • Good faith • Lawful conduct • Wrongdoing • Means of regulation • Principles of law • Presumptions

**JEL Classifications**

K15 • K29 • L26 • L29 • L88 • M38

## 1 Introduction

Good faith and reasonable behavior can stimulate the development of entrepreneurship, increase its efficiency, and create a positive climate for developing the country's economy. Modeling legal support for the development of entrepreneurial activity is impossible without creating and analyzing the fundamental basis and the principles that underlie such activity. When conceptually solving the problems of civil turnover development, it is necessary to consider two perspectives—objective, reflecting the economic side of entrepreneurial activity, and subjective, consisting of the need for the subject of entrepreneurship to assess the consequences of its activities in relation to other persons.

It is necessary to model the characteristic properties of the system's elements and their static and dynamic single-level and multi-level relationships. We should not underestimate the influence of subjective factors on the stimulation of the activity of economic entities and the development of entrepreneurial markets. Considered as principles of law implementation, reasonableness and good faith reflect the special orientation of law as a social regulator and form the framework of lawful behavior of participants of entrepreneurial legal relations. Establishing a general behavior model, these basic principles affect each subject of civil legal relations: individuals, legal entities, and public entities (Inshakova et al., 2020a).

Unlimited recognition of any interest, whether private or public, is incompatible with the satisfaction of other private or public interests (Inshakova & Deryugina, 2022). Reasonableness and good faith put that limit in the realization of one's interest, which makes it possible to balance and equilibrate such interests and level possible contradictions

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(Federation, 2001). Thus, scientific analysis of legal presumptions of reasonableness and good faith and the improvement of the model of their legal regulation is an urgent task aimed at solving legal problems and developing entrepreneurial relations, which are the basis for the effective development of the economy (Inshakova et al., 2020b).

The influence of social norms on legal categories was considered by Meek et al. (2010). The problem of good faith and reasonable behavior of subjects of entrepreneurial relations was discussed in the works of E. S. Boltanova (Anisimov et al., 2020); Daar (2020); Emelyanov (2002); Inshakova and Deryugina (2022); Inshakova et al. (2020a); Ivanova (2005); Novitsky (1916); Shershenevich (2005); and Sklovsky (2002). The main aspects of civil liability for bad faith and unreasonable behavior are reflected in the works of Bublitz et al. (2019) and Ross (2009).

This paper investigates the main approaches to formulating the criteria of good faith and reasonable behavior and formulates proposals related to these categories. Additionally, one of the tasks is to improve the legal regulation of civil legal relations.

## 2 Materials and Methods

The method of system approach makes it possible to study the signs of good faith and reasonable behavior in the system of lawful behavior of the subject of entrepreneurial activity and establish the factors that ensure the functioning of the system as an integral entity. The method of determinism helps understand good faith behavior of the subject of entrepreneurial relations and studied concepts, compare homogeneous legal phenomena, and identify the prospects for the development of legal relations in dynamics.

## 3 Results and Discussion

Entering into different legal relations, a subject of entrepreneurial activity has different benchmarks (limits) for realizing subjective rights granted. Conventionally, the limits of exercise can be divided into subjective (those that characterize the subject of entrepreneurial activity as a person; these are the subject's internal ideas about goodness, good faith, fairness, morality, reasonableness, etc.) and objective (limits reflected in the norms of law).

Current civil legislation repeatedly refers to the categories of reasonableness and good faith in regulating entrepreneurial relations. Such appeal is popular in international acts and in Russian regulatory legal acts. Particularly, the UN Convention on Contracts for the International Sale of Goods (concluded in Vienna on April 11, 1980) (UNCITRAL, 1980) refers to the concept of a reasonable person (Article 8). The behavior of an ordinary participant in economic turnover should be compared to this standard (Article 25). In Russian civil legislation, the term reasonableness is used many times and carries different semantic loads (Federation, 1994, 1995).

Scientific literature associates the concept of reasonableness with the implementation of lawful actions (Ivanova, 2005). However, acting, for example, in circumvention of the law (i.e., unlawfully), an entrepreneur may nevertheless act reasonably from the position of obtaining the highest profit. Some authors believe reasonable behavior should have minimum mandatory utility for the counterparty (Emelyanov, 2002). However, by virtue of the legislative fixation, the subject of entrepreneurial activity acts with their will and in their interests. Thus, their reasonable behavior is related to their interests, not the interests of partners.

Reasonableness should be primarily associated with taking available and necessary measures specific to each case. Available measures should be understood as those measures that are possible under the circumstances. In turn, necessary measures are those that should be taken in a given situation and without which the result will not be achieved. The totality of these criteria will make it possible to qualify a given behavior as reasonable or unreasonable.

The law of numerous countries considers good faith as a principle. For example, the Swiss Civil Code (approved December 10, 1907) (Federal Assembly of the Swiss Confederation, 1907) establishes the obligation to act in good conscience (Art. 2). Similar norms are contained in §157 and §242 of the German Civil Code (approved July 14, 1896) (Bundesrat, 1896; Novitsky, 1916).

Many authors characterize good faith from the position of subjective characteristics of behavior or attitude to their behavior. Particularly, good faith is defined as a moral conviction of a person respecting their counterparty (Sklovsky, 2002), as subjective ignorance of their unauthorized behavior, or ignorance of any circumstances (Bogdanov, 1999). A number of civilists believe that good faith behavior implies the obligation to observe the rights and interests of other subjects of economic turnover (Chukreev, 2002). However, this is where the difficulty of assessing the behavior of an entrepreneur as good faith or bad faith arises. A classic example can be given when one entrepreneur opens a bakery next to another and the first one goes bankrupt (Shershenevich, 2005). In such a case, can the actions of the second entrepreneur be recognized as bad faith? The answer is no. However, we must assume that when opening a bakery, an entrepreneur was primarily guided by his or her own interests and was less concerned with the interests of other entrepreneurs.

Since the principle of good faith is enshrined in the current legislation, it ceased to be only a criterion for assessing moral or immoral behavior. For good faith

behavior of a subject of entrepreneurial activity, it is necessary that the subject is aware of possible negative consequences of its activities for other business entities (the so-called reflex action of law) and builds its lawful behavior to avoid violating it. This approach manifests the subjective characteristic of good faith behavior of a subject of entrepreneurial activity.

When formulating provisions in good faith, it is inadmissible to use prohibitions. Good faith is always a requirement of certain behavior. Thus, the technique of prohibitions can be used within certain limits. The legislator often contrasts good faith conduct with bad faith behavior by characterizing it as a subject of entrepreneurial activity (Federation, 2006). Unfair behavior is identified by the legislator as unlawful and is considered as actions that violate the norms of law. Moreover, some scientists also believe that bad faith behavior is not only unlawful behavior but also guilty behavior (Bogdanov, 1999) (contamination of objective and subjective factors). This point of view is extremely popular in scientific literature.

Unlawful behavior violates the norms of law, including the norms that emerged under the contract and other local acts. Unfair behavior is not associated with a direct violation of the norms of law. For example, the carrier delivers the cargo to the destination. Simultaneously, the carrier chooses the longest possible route. The cost of delivery is much higher than the shortest route. There is no formal violation of legal norms, but there is bad faith behavior. Given the considered case, all cases of economically unjustified costs can be attributed to bad faith behavior. However, this criterion alone is not enough.

If we consider the example of a trading organization, the price for a business entity is a legitimate action. Actions may be aimed at ruining a competitor who cannot keep prices low. Consequently, the purpose transforms lawful behavior into bad faith and, in certain cases, unlawful behavior. Thus, the purpose of exercising the right is another criterion for classifying actions as bona fide or bad faith.

The motivating factor for bad faith behavior is also important—the desire to achieve greater effect and maximum profit, which is not bad faith in itself. However, if the basis of activity is the desire to achieve biased results, then we can talk about bad faith behavior.

## 4 Conclusion

The role of fundamental principles of law, including the principles of good faith and reasonableness, cannot be underestimated. Good faith and reasonableness of actions of participants in entrepreneurial activity can affect not only specific relations arising between different entrepreneurs but also the stability of civil turnover in general.

Exercise of rights, considering the principles of reasonableness and good faith, positively affects the legal relations of business entities, forms their lawful behavior, creates the necessary balance of private interests of various persons, and harmonizes private and public interests.

Particularly, it is necessary to supplement the current civil legislation with four criteria, making it possible to assess the reasonableness of behavior and good faith. The first criterion relates to assessing the actor's behavior in terms of available measures, which should be understood as those measures that can be taken in the relevant circumstances.

The second criterion is the purpose of exercising the right. This is the motivating factor that forces them to perform certain actions. In this case, the desire to achieve the greatest profit is legitimate and bona fide in conducting business activities. Nevertheless, if the basis for exercising the right is the goal of achieving a biased result, then we should talk about bad faith behavior.

The fourth criterion is the need to exercise subjective rights not to violate the rights of other participants of economic turnover. The above criteria will make it possible to qualify certain behaviors as reasonable and bona fide.

It is necessary to change the legislative technique used to regulate the studied legal relations because good faith and reasonableness are a requirement of certain behavior, to a greater extent expanding the authority of norms and, to a lesser extent—prohibitions.

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# Advanced Digital Technologies, Smart Innovations, and Prospects for Their Application in the Agrarian Economies of Countries, Regions, and Organizations in support of Food security

# Export Potential of the Region: Problems of Estimation, Modeling, and Forecasting

Viktoriya Yu. Skripnichenko, Alexey N. Gerasimov, Oksana P. Grigoryeva, Yuri S. Skripnichenko, and Ekaterina I. Lelikova

**Abstract**

The research aims to compare the cost of production, sale, and export of the two most promising types of products in the region—wheat and meat. Based on this comparison, the authors assess the level of the region's export potential. The research relies on the methods of econometric modeling and forecasting. The information base for the research includes the data of the official statistical reporting of agricultural organizations of the Stavropol Territory of the Russian Federation for 2010–2020. Application in practices of synthesized econometric models, the authors found probabilistic forecasts of the production, sale, and export the most common agricultural products of the region. Based on the results, key economic regressors affecting the export potential of regional agricultural production have been identified. The practical application of the econometric modeling method made it possible to predict the production, sale, and export of the main export-oriented crop and livestock products of the Stavropol Territory.

**Keywords**

Export potential • Agriculture • Econometric modeling • Forecasting • Import substitution

**JEL Classifications**

A10 • Q18

## 1 Introduction

International trade is a priority area for the active development of the regions. It creates a basis for attracting additional funds to the region's economy, as well as large foreign investments. Export-oriented production is the main condition for regional development in general. It accumulates valuable material and financial resources and attracts highly qualified personnel. It is the main user of inventions and innovations. Moreover, it provokes structural changes in economic sectors (Voronkova et al., 2020).

The authors analyze the domestic market of export-oriented agricultural products. Supply and demand, characterized by a close relationship, are the main economic factors influencing the agro-industrial complex. Dudin et al. (2019) and Ivanyo et al. (2020) rightly note the great influence of these factors on the development of the regional agricultural market. The study of demand is necessary to determine the total sales of a certain product for a certain period (Dudin et al., 2019; Ivanyo et al., 2020).

In this work, we used official statistical data for analysis. Such data are indicators that reflect the development of the export potential of the Stavropol Territory. Production, sales, and export of the main agricultural production groups in the region (grain and meat) were chosen as the object of analysis.

The issues of developing the agri-food market and providing the population with domestic food have been and remain the most pressing problems for government bodies, scientific institutions, and non-governmental public organizations. The determining factor for this is the organization of effective interaction of all participants in the agricultural market. Such interaction can be achieved through the introduction of such processes as increasing agricultural production, testing pilot projects in various agricultural sectors of the region, identifying an effective balance between food securities, and building export operations (Kozlov et al., 2018; Minina & Minin, 2020).

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Ensuring the national security of the state in the medium term involves maintaining a high level of food security at the regional level. In addition, this is a significant factor in preserving the sovereignty of the state, the most important component of demographic policy, a condition for increasing the quality of life of the population. (Evdokimov & Guliyev, 2020).

It is known that the population should be provided with high quality and safe agricultural products.

Thus, the goal of ensuring the food security of the state is achieved. In this regard, Boldyreva and the team of authors (Boldyreva et al., 2017) rightly point out the need for sustainable growth in agricultural production. The researchers point out that the provision of this condition probably guarantees the provision of the population with quality food, taking into account the conservation of the necessary resources.

In May 2018, the President of Russia signed the Executive Order "On National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024" (Presidential Executive Office, 2018). This order makes it possible to ensure compliance with the country's national interests. They consist of increasing the competitiveness of the national economy, individual regions, industries, economic entities, and types of products (Presidential Executive Office, 2018).

Nationwide, agricultural exports showed an increase of 21%, resulting in $20 billion. This is 5 billion more than arms exports bring. External grain supplies are growing most rapidly; their volume has increased by 1.7 times (Ryabova et al., 2020).

The Stavropol Territory has significant potential for the development of the domestic market for agricultural products. This region of Russia with agrarian specifics is one of the main participants in food exports. Grain exports account for 58% of the total international sales of agricultural products in the region. The share of meat and meat offal is 19% (Samygin et al., 2019).

The Stavropol Territory has the following tasks:

- To ensure the creation by organizations of a modernized agricultural product with high added value.
- To increase the level of export orientation of agricultural products.
- To ensure a high degree of competitiveness of agricultural products in the world market.
- Development of rural cooperation and introduction of a support system for agricultural producers.

## 2 Methodology

The authors used econometric modeling to determine the level of export orientation of agricultural products in the region. The authors believe that the methodology used helps achieve the optimal level of management decisions and ensures the effectiveness of production activities. The identification of econometric models made it possible to determine significant factors affecting the region's export potential. Additionally, the accuracy of forecasts and the objectivity of conclusions are increased (Timiryanova et al., 2020).

The authors consider the use of complex econometric models to be optimal. These models make it possible to consider the multidirectional relationships between indicators for a qualitative and quantitative assessment of processes.

To determine the level of the region's export orientation, it was decided to model the production indicators of the main export-oriented products of crop production and animal husbandry using the example of the Stavropol Territory. These products are grain and meat (Chernova et al., 2020).

The authors used the algorithm for constructing a complex econometric model (Fig. 1).

The first stage of the algorithm for constructing the model made it possible to identify a set of effective variables:

$Y_1$—Production of Grain.
$Y_2$—Sales of Grain.
$Y_3$—Export of Grain.
$Y_4$—Production of Meat.
$Y_5$—Sales of Meat.
$Y_6$—Export of Meat.

The second stage of the model construction algorithm provides for the collection of official publications of statistical reports of organizations for 2010–2021. The step of constructing econometric models made it possible to obtain coefficients under the regressors of six main models.

Model 1 is as follows:

$$Y_1 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4, \quad (1)$$

where $Y_1$—grain production volume (thousand tons); $X_1$—profitability of grain production (%); $X_2$—sunflower growing profitability (%); $X_3$—grain yield (centners per hectare); $X_4$—sown area of grain in agricultural organizations (thousand hectares); $\alpha$—the average level of grain production volume in the case where other factor variables do not affect; $\beta_1$—regressor $X_1$ parameter; $\beta_2$—regressor $X_2$ parameter; $\beta_3$—regressor $X_3$ parameter; and $\beta_4$—regressor $X_4$ parameter.

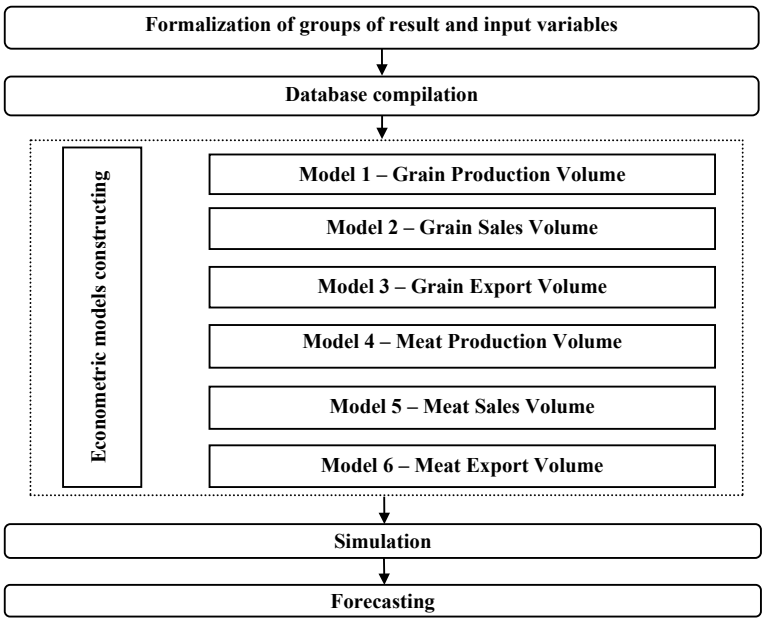


**Fig. 1** Algorithm for constructing a complex econometric model. *Source* Compiled by the authors

Model 2 is as follows:

$$Y_2 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \gamma Y_1, \quad (2)$$

where $Y_2$—grain sales volume (thousand tons); $X_1$—profitability of grain production (%); $X_2$—labor costs in grain production (thousand human-hours); $X_3$—average grain price (rubles per ton); $X_4$—productivity of grain crops (centners per hectare); $X_5$—the area under grain crops in agricultural organizations (thousand hectares); $X_6$—average monthly wages of employees (rubles); $Y_1$—production of grain (in thousand tons); $\alpha$—theoretical sales of grain in the case where other factor variables do not affect; $\beta_1$—parameter at regressor $X_1$; $\beta_2$—regressor $X_2$ parameter; $\beta_3$—regressor $X_3$ parameter; $\beta_4$—regressor $X_4$ parameter; $\beta_5$—regressor $X_5$ parameter; $\beta_6$—regressor $X_6$ parameter; and $\gamma$—regressor $Y_1$ parameter.

Model 3 is as follows:

$$Y_3 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \gamma Y_1, \quad (3)$$

where $Y_3$—export of grain (in thousand tons); $X_1$—economic efficiency of grain production (%); $X_2$—average prices of grain sales (in rubles per ton); $X_3$—Grain yield (quintals per hectare); $X_4$—area of grain crops (ths. ha); $X_5$—wages of agricultural workers (in rubles); $Y_1$—Production of grain (ths. tons); $\alpha$—average level of grain exports in the case where other factor variables do not affect; $\beta_1$—parameter at regressor $X_1$; $\beta_2$—regressor $X_2$ parameter; $\beta_3$—regressor $X_3$ parameter; $\beta_4$—regressor $X_4$ parameter; $\beta_5$—regressor $X_5$ parameter; and $\gamma$—regressor $Y_1$ parameter.

A feature of Models 2 and 3 is the presence in them of the effective variable of Model 1 as a regressor. Thus, grain production volume will be considered as a significant factor influencing the grain sales volume and grain export volume.

Model 4 is as follows:

$$Y_4 = \alpha + \beta_1 X_1 + \beta_2 X_2, \quad (4)$$

where $Y_4$—meat production volume (thousand tons); $X_1$—profitability of livestock products (%); $X_2$—livestock in agricultural organizations (thousand heads); $\alpha$—the average level of meat production (without the influence of factor variables of the model); $\beta_1$—regressor $X_1$ parameter; and $\beta_2$—regressor $X_2$ parameter.

Model 5 is as follows:

$$Y_5 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \gamma Y_4, \quad (5)$$

where $Y_5$—sales volume of meat products (thousand tons); $X_1$—profitability of livestock products (%); $X_2$—livestock in agricultural organizations (thousand heads); $\alpha$—the average level of meat production (without the influence of factor variables of the model); $\beta_1$—regressor $X_1$ parameter; $\beta_2$—regressor $X_2$ parameter; and $\gamma$—regressor $Y_4$ parameter.

Model 6 is as follows:

$$Y_6 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \gamma Y_4, \quad (6)$$

where $Y_6$—meat export volume (thousand tons); $X_1$—profitability of livestock products (%); $X_2$—livestock in agricultural organizations (thousand heads); $Y_4$—meat production volume (thousand tons); $\alpha$—the average level of meat production (without the influence of factor variables of

the model); $\beta_1$—regressor $X_1$ parameter; $\beta_2$—regressor $X_2$ parameter; and $\gamma$—regressor $Y_4$ parameter.

A feature of Models 5 and 6 is the presence of the effective variable of Model 4 as a regressor. Thus, meat production volume will be considered as a significant factor influencing the meat sales volume and meat export volume.

## 3 Results

The model simulation step yielded the results presented in Tables 1 and 2.

Model 1, describing grain production volume, was derived from a step-by-step specification. The results of identifying this model show that it is statistically correct. Fisher's F-test value shows that the factor variance of the outcome variable is substantially higher than the residual variance of the outcome variable. The probability of obtaining erroneous values of model levels of grain production volume is only 4%. The $R^2$ determination coefficient obtained for Model 1 was 0.997. Consequently, grain production volume could be declared a 99.7% variation in the set of regressors. Therefore, the model is highly significant. The standard error value of Model 1 also indicates the high statistical correctness of this model. Thus, one can expect an average deviation of the actual level of grain production volume from the model by 63.8 tons.

Model 2, describing grain sales volume, was derived from a step-by-step specification. The results of identifying this model show that it is statistically correct. Fisher's F-test value shows that the factor variance of the outcome variable is substantially higher than the residual variance of the outcome variable. The probability of obtaining erroneous values of model levels of grain sales volume is only 3.3%. The $R^2$ determination coefficient obtained for Model 2 was 0.993. Consequently, grain sales volume could be declared a 99.3% variation in the set of regressors. Therefore, the model is highly significant. The standard error value of Model 2 also indicates high statistical correctness. Thus, one can expect an average deviation of the actual level of grain sales volume from the model by 231.7 tons.

Model 3, describing grain export volume, was derived from a step-by-step specification. The results of identifying this model show that it is statistically correct. Fisher's F-test value shows that the factor variance of the outcome variable is substantially higher than the residual variance of the outcome variable. The probability of obtaining erroneous values of model levels of grain export volume is only 1.2%. The $R^2$ determination coefficient obtained for Model 3 was 0.921. Consequently, grain export volume could be declared

**Table 1** Grain production, sales, and export models

| Models | Regressor's parameter | Parameter's value | $R^2$ | $S$ | $F$ | $p$ |
|---|---|---|---|---|---|---|
| *Grain production model 1* | $\alpha$ | −8854.6 | 0.997 | 63.8 | 381.9 | 0.04 |
| | $\beta_1$ | −0.64 | | | | |
| | $\beta_2$ | 0.17 | | | | |
| | $\beta_3$ | 195.1 | | | | |
| | $\beta_4$ | 4.14 | | | | |
| *Grain sales model 2* | $\alpha$ | 85,422.3 | 0.993 | 231.7 | 29.6 | 0.033 |
| | $\beta_1$ | 75.9 | | | | |
| | $\beta_2$ | −0.78 | | | | |
| | $\beta_3$ | −2.1 | | | | |
| | $\beta_4$ | −1802.8 | | | | |
| | $\beta_5$ | −36 | | | | |
| | $\beta_6$ | 0.6 | | | | |
| | $\gamma$ | 9.6 | | | | |
| *Grain export model 3* | $\alpha$ | 85,403.2 | 0.921 | 324.2 | 16.3 | 0.012 |
| | $\beta_1$ | 65.2 | | | | |
| | $\beta_2$ | −2.3 | | | | |
| | $\beta_3$ | −1202.8 | | | | |
| | $\beta_4$ | −24 | | | | |
| | $\beta_5$ | 0.5 | | | | |
| | $\gamma$ | 0.92 | | | | |

*Source* Compiled by the authors

**Table 2** Meat production, sales, and export models

| Models | Regressor's parameter | Parameter's value | $R^2$ | $S$ | $F$ | $p$ |
|---|---|---|---|---|---|---|
| *Meat production model 4* | $\alpha$ | 18.5 | 0.852 | 0.9 | 12.2 | 0.005 |
| | $\beta_1$ | 0.06 | | | | |
| | $\beta_2$ | −0.19 | | | | |
| *Meat sales model 5* | $\alpha$ | −28.1 | 0.847 | 4.6 | 18.5 | 0.005 |
| | $\beta_1$ | −0.33 | | | | |
| | $\beta_2$ | 0.16 | | | | |
| | $\gamma$ | 0.8 | | | | |
| *Meat export model 6* | $\alpha$ | 12.1 | 0.887 | 6.4 | 13.2 | 0.006 |
| | $\beta_1$ | 0.31 | | | | |
| | $\beta_2$ | 0.13 | | | | |
| | $\gamma$ | 0.8 | | | | |

*Source* Compiled by the authors

a 92.1% variation in the set of regressors. Therefore, the model is highly significant. The standard error value of Model 3 also indicates high statistical correctness. Thus, one can expect an average deviation of the actual level of grain export volume from the model by 324.2 tons.

Model 4, describing meat production volume, was derived from a step-by-step specification. The results of identifying this model show that it is statistically correct. Fisher's F-test value shows that the factor variance of the outcome variable is substantially higher than the residual variance of the outcome variable. The probability of obtaining erroneous values of model levels of meat production volume is only 0.5%. The $R^2$ determination coefficient obtained for Model 4 was 0.852. Consequently, meat production volume could be declared an 85.2% variation in the set of regressors. Therefore, the model is highly significant. The standard error value of Model 4 also indicates the high statistical correctness of this model. Thus, one can expect an average deviation of the actual level of meat production volume from the model by 0.9 tons.

A step-by-step elimination of non-essential variables is applied. The result was Model 5. Table 2 shows the high-quality characteristic of this model. Thus, the probability of error in forecasting the level of sales of meat products is 0.5%. The value of the coefficient of determination shows that the variables included in the model affect the result by 84.7%. The standard error value of Model 5 also indicates the high statistical correctness of this model. Thus, one can expect an average deviation of the actual level of meat sales volume from Model by 4.6 tons.

Model 6, describing meat export volume, was derived from a step-by-step specification. The results of identifying this model show that it is statistically correct. The probability of an error in the values of the predicted levels of exports of meat products is only 0.6%. The determination coefficient ($R^2$) for Model 6 was 0.887. Consequently, meat export volume could be declared an 88.7% variation in the set of regressors. Therefore, we can conclude that the model is highly significant. The standard error value of Model 6 also indicates the high statistical correctness of this model. Thus, one can expect an average deviation of the actual level of meat export volume from the model by 6.4 tons.

Synthesized econometric models can effectively predict grain and meat production, sales, and exports in the medium term. Predictions of dependent variables of grain production, sales, and export are presented in Fig. 2.

The obtained forecast estimates allow us to conclude that the volume of grain production in the region is likely to increase to 9115.8 thousand tons. Consequently, the increase in grain production may reach 941.6 thousand tons or 11.5%. The volume of grain sales may grow to 9104.7 thousand tons. Consequently, the increase in grain sales may reach 1329.1 thousand tons 17.1%. The export of grain may increase to 8287 tons. Consequently, the increase in grain exports may reach 86 tons or 1.2%.

The obtained forecast estimates allow us to expect an increase in meat production to 389.0 thousand tons. Consequently, the increase in meat production may reach 6.3 thousand tons or 1.6%. Meat consumption in the region may grow to 380.7 thousand tons by 2026. Consequently, the increase in meat sales may reach 27.3 thousand tons or 7.7% by 2026. Meat export volume in the region is highly likely to increase to 240.9 tons. Thus, we should expect an increase in meat export volume by 5.1 tons or 2.2%.

## 4 Discussion

Econometric models used for forecasting made it possible to establish that the main types of agricultural production in the region (grain and meat) have a fairly high level of export potential. Thus, the production and sale volume of products

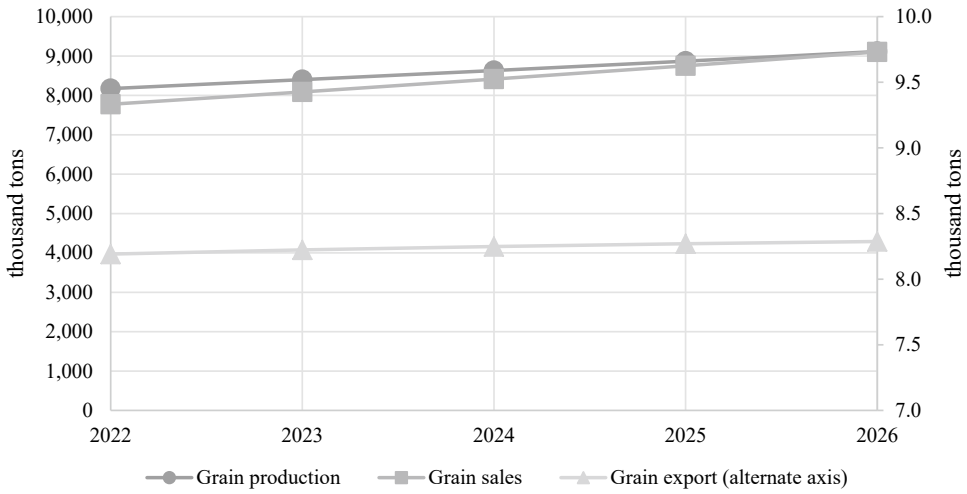


**Fig. 2** Results of forecasting production, sales, and export of grain. *Source* Compiled by the authors

significantly exceeds the volume of exports. This trend is expected to continue in 2022–2026. Therefore, agricultural producers can meet the requirements of the region and ensure the export of products.

At the same time, we consider it necessary to introduce additional measures to ensure the stability of agricultural exports. These include improving trade and geopolitical conditions for agricultural producers and introducing targeted export incentives and information and financial assistance to exports.

In our opinion, it is necessary to introduce a set of measures to increase the volume of agricultural exports: the popularization of export activities and the formation of an effective infrastructure for supporting exports and ensuring the entry of regional producers to foreign markets.

## 5 Conclusions

To develop mechanisms for information and consulting and export promotion support, the following is necessary:

- To conduct research and define a list of problems in the field of exchange and dissemination of trade information for the implementation of export operations, strengthening the capacity of trade support institutions to collect, analyze, and provide trade information.
- To conduct marketing research to promote products of priority sectors to target markets.
- To create a single portal of trade information and ensure its functioning.
- Assistance to private agricultural producers in organizing and participating in agricultural fairs, coordinating the activities of Russian trade missions abroad in terms of supporting export projects (Antamoshkina & Rogachev, 2020).

To provide financial support, it is necessary to optimize the mechanisms of lending, insurance, guarantee support. In addition, it is necessary to increase export subsidies for organizations, reimburse them for part of the cost of paying interest on loans, tax incentives. It is important to subsidize scientific research and encourage foreign direct investment.

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**Data Availability** Data about predictions of dependent variables of meat production, sales, and export is available at https://figshare.com/ with an identifier https://doi.org/10.6084/m9.figshare.22925072.v1.

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# Water Resources as a Strategic Factor of the Region's Sustainable Development

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**Abstract**

The research aims to assess the relationship between the state of the region's water resources and the sustainability of its development. The research design includes an analysis of the state of water resources of the Rostov and Volgograd Regions in the first stage and an analysis of the impact of the state of water resources of the region on individual subsystems of sustainable development of the region in the second stage. The research used a combination of qualitative and quantitative methods, including cross-regional comparisons and methods of economic analysis. The analysis carried out by the authors demonstrated the existence of a relationship between the state of the region's water resources and the sustainability of its development. It has been revealed that the ecological subsystem is the most sensitive to the state of water resources in the Volgograd Region. In the Rostov Region, the most sensitive is the social subsystem. This research is important for understanding the role of water resources in the sustainable development of the region on a long-term basis. The results obtained are important for regional strategizing from ecological and socio-economic points of view.

**Keywords**

Sustainable development • Water resources • Regional economy • Water consumption • Water capacity of GRP • South of Russia

**JEL Classifications**

O13 • O44 • P18 • P28 • Q25 • Q57

## 1 Introduction

The tasks of sustainable development of territories are formed within the framework of national imperatives of resource conservation and resource efficiency. Water resources are strategically important for the sustainable development of regions, especially for regions of agro-industrial specialization. Water participates in the technological processes of agro-industrial enterprises, is used for watering and irrigation of lands, and is critically important for the population's health.

The economic growth of regions inevitably increases the water demand. Economic development can be restrained by the degradation of water resources and a decrease in their biodiversity. The Government of Russia is striving to develop a policy promoting the rational use of water resources. Such a policy includes the following:

- Setting standards for water resources management;
- Financing projects for the development of water management infrastructure (reservoirs and sewage treatment plants);
- Implementing public information dissemination programs on the need for efficient use of water resources.

However, there is limited understanding concerning specific characteristics of water resources determining the sustainability of regional development. Whereas the study of

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the quantitative and qualitative characteristics of the state of the region's water resources, the determination of their role in creating the prerequisites for the sustainable development of the regional economy enables to assess the compliance with the strategic development goals.

The research aims to assess the relationship between the state of the region's water resources and the sustainability of its development. The authors believe that the regional policy in relation to water resources management should determine the factors that contribute to the territory's sustainable development.

## 2 Materials and Method

In world practice, systems of sustainable development indicators have been developed, of which the OECD indicator system and the UN Commission on Sustainable Development indicator system are the most famous. These systems require adaptation to the specifics of a particular country (region). Therefore, various indicators exist in practice.

Sustainability is a more complex category than economic development, implying the intersection of economic, social, and environmental goals. To assess it, researchers use various tools and practices with an emphasis on economic, environmental, or social aspects of development (Brown, 2012). For example, Yu. Maksimov, S. Mityakov, and others define four regional subsystems: economy, innovation, ecology, and social sphere, with the allocation of "costly" and "effective" indicators (Maksimov et al., 2011). G. Gagarina, L. Chainikova, and others define the GRP per capita and the human development index as indicators of sustainable development while ignoring the ecological subsystem (Gagarina et al., 2019). A. Dawodu et al. assess sustainability based on the availability of conditions for business development and improving the quality of life in the region (Dawodu et al., 2019). Determining sustainability indicators, Ch. Wulf, J. Werker, P. Zapp, et al. suggest focusing not on problems but on strategic development goals (Wulf et al., 2018).

When studying the impact of the state of water resources on the sustainability of regional development, most scientists focus on the environmental consequences (Chen et al., 2017; Giakoumis et al., 2020; Liu et al., 2021). Few studies draw attention to the socio-economic consequences. In particular, E. Ahmadov notes that when managing the region's water resources in the context of achieving sustainable development objectives, one should consider water demand for irrigation and industrial production, water tariffs, and impact on export potential (in the context of transboundary cooperation) (Ahmadov, 2020).

The design of the research is as follows. In the first stage, the authors analyze the state of water resources of the Rostov and Volgograd Regions. In the second stage, the authors analyze the impact of the state of the region's water resources on the individual subsystems of the region's sustainable development.

The authors used three groups of evaluation indicators. To study the impact on economic sustainability, the authors used indicators reflecting the possibility of obtaining economic effects in the region. To study the impact on social sustainability, the authors used indicators related to the availability of social services for the population and improving their quality of life. To study the impact of environmental sustainability, the authors focused on the conservation of nature and the environment. The research object is the Volgograd and Rostov Regions.

## 3 Results and Discussion

### 3.1 The Economic Subsystem of the Regions

Water resources can significantly affect the region's economy. They can be used for agriculture, fish farming, electricity generation, and the supply of drinking water to the population. They can also serve as a source of tourist activity and recreation. Agriculture is an important sector of the economy that requires considerable water resources to irrigate crops. This industry may be more or less developed depending on the natural conditions and available water resources. Water resources can also be used for fish farming in freshwater and marine waters. This can be an important sector of the economy that provides jobs and invests in the region's economy. The production of electricity from water resources (e.g., waterfalls, rivers, and ponds) can also be important for the region's economy. This industry can be of great importance, especially in countries that lack other energy sources.

Thus, the role of water resources in the region's economy can be significant. The availability and quality of these resources can significantly affect its economic development.

The characteristics of the region's water resources are given in Table 1.

One of the most important indicators for the rational use of water resources is the water intensity of GRP (Matveeva et al., 2018; Mitrofanova & Chernova, 2022; Mitrofanova et al., 2021). The share of agricultural production and fish farming in regions accounts for 10.5% of the GRP.

The dynamics of changes in the GRP water capacity level in the studied regions are shown in Fig. 1. As we can see from this data, given the comparability of the sectoral structure of the regional economy and despite the existing tendency for a decrease in the level of GRP water

**Table 1** Main characteristics of the water resources of the Volgograd and Rostov regions

| Indicator | Volgograd region | Rostov region |
|---|---|---|
| River network density, km/km$^2$ | 0.33 | 0.24 |
| Average long-term river runoff, km$^3$ per year | 258.6 | 26.2 |
| Anticipated groundwater resources, thousand m$^3$ per day | 3672.0 | 3836.0 |
| Lakes, % | 3.72 | 1.83 |
| Surface water area, thousand hectares | 525.0 | 401.1 |

*Source* Compiled by the authors

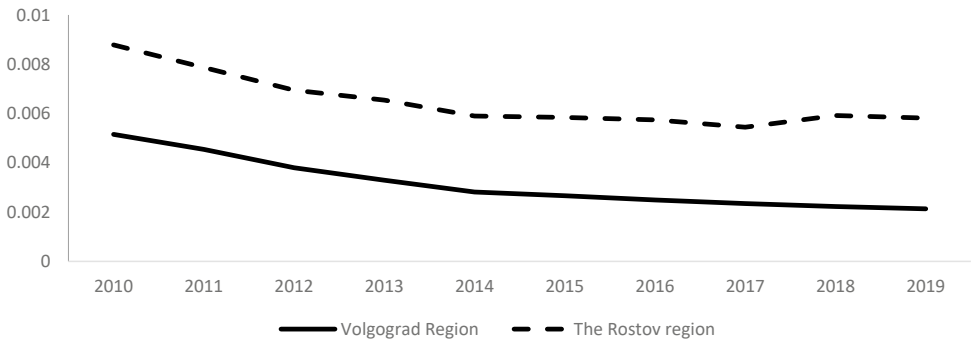


**Fig. 1** Water capacity of the GRP of the Volgograd and Rostov Regions, m$^3$/ rub. *Source* Compiled by the authors

consumption in both regions, there is irrational water consumption in the Rostov Region.

Considering the dynamics and structure of water intake, we can note that reused water predominates in both regions. However, the volume of water intake in the Rostov Region is almost three times higher than in the Volgograd Region. To a large extent, this situation is associated with significant water losses in the Rostov Region during transportation and the need to compensate for these losses. Thus, in the Volgograd Region, the total losses amount to about 11% of the withdrawn water (compared to the average Russian indicator). In turn, in the Rostov Region, the water losses significantly exceed the average Russian indicator and amount to 22%.

In both regions, 96% of water withdrawals are from surface water sources. However, for the Volgograd Region, this is 0.5% of the river flow; in the Rostov Region, this indicator is 24%.

The Rostov Region experiences a high level of losses of water resources during transportation, as well as a significant load on the river network, together with irrational use of water resources. This creates high risks for its sustainable development. The role of water resources in creating the prerequisites for sustainable development of the regional economy can be assessed positively in the Volgograd Region (Nikitaeva & Shestopalova, 2022; Nikitaeva et al., 2022).

## 3.2 The Social Subsystem of the Regions

Water resources can have an important impact on the social sphere in the region. First, they can serve as a source of drinking water for the population, which is a necessary condition for people's health and vital activity. The availability of high-quality and affordable drinking water reduces the risk of diseases and improves the quality of the population's life.

Second, water resources provide the availability of places for recreation and entertainment. The presence of ponds and lakes, coastal zones, and other water bodies can create opportunities for various types of outdoor activities, including swimming, water sports, and fishing. In turn, this contributes to improving the population's health and life quality.

Additionally, water resources can influence the development of tourism in the region, which can create new jobs and increase the region's economic potential. The tourist flow can lead to improved infrastructure, strengthening cultural ties, and expanding the social circle of the region's population.

Thus, water resources can be of great importance for the social sphere of the region because they affect the population's health, recreation, and socio-cultural life. Moreover, water resources create opportunities for tourism development and the region's economic growth.

The population of the Rostov and Volgograd Regions is differently provided with water resources. In the Rostov region, this indicator is 15 times lower than the average Russian indicator and almost six times lower than the indicator of the Southern Federal District. In the Volgograd Region, the indicator is more than two times higher than the average for Russia and almost five times higher than the indicator of the Southern Federal District.

Drinking water tariffs in the Rostov Region are significantly higher than in the Volgograd Region. From January 1, 2021, until June 30, 2021, the tariff for cold water supply, including VAT, was 44.95 rubles per $m^3$ in the Rostov Region; from July 1, 2021, it was increased to 45.8 rubles. In the Volgograd Region, the tariffs were 25.09 and 26.09 rubles per $m^3$, respectively. The tariffs for wastewater disposal in the Rostov Region are also almost twice higher than the corresponding tariffs in the Volgograd Region. According to Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing (Rospotrebnadzor), the parameters of drinking water go beyond the specified standard values. Drinking water does not meet the water supply requirements established in the region. This significantly affects the quality of life of the population. In the Rostov Region, 34% of the samples taken do not meet the standards. In the Volgograd Region, the proportion of samples that do not meet the requirements is 12%. The average proportion for Russia is 13%.

### 3.3 The Ecological Subsystem of the Regions

Water resources play an important role in the region's ecological sustainability because they provide several interrelated ecological functions. These functions are as follows:

1. Water Purification. Aquatic ecosystems can purify natural water and wastewater, preserving the quality of water resources. This is one of the most important aspects of interacting water resources with environmental sustainability.
2. Regulation of the Water Regime. Water resources are an important element of the hydrological cycle, which allows them to regulate the groundwater level, control damage caused by floods and droughts, and equalize climate fluctuations.
3. Diversity of Biological Species. Aquatic ecosystems are the habitats of many plant and animal species, which contributes to the maintenance of the biological diversity of the region.

Economic growth leads to the emergence of many negative effects on the scale of production, expressed in the anthropogenic impact on water resources. An additional load on water resources is created by shipping transport, which pollutes the waters of the regions with oil products, fuels, and lubricants.

The dynamics of the indicators of the discharge of polluted wastewater in the Rostov and Volgograd Regions are shown in Fig. 2.

The primary pollutants in the Rostov Region are sodium, magnesium, sulfides, and hydrogen sulfide. In the Volgograd Region, the primary pollutant is chloroform. The water pollution level in the Rostov Region is 19.3%, in the Volgograd Region—81.6%.

The state of water resources can significantly affect tourism. If the water quality does not meet the standards, this can lead to a sharp decrease in tourists' interest in this area and reduce its value as a tourist destination. In turn, clean and attractive water resources can become a significant attraction for tourists and contribute to tourism development. Additionally, water resources can be an important source of drinking water for the population and tourists, which is also important for maintaining the quality of the tourist product (Mitrofanova et al., 2021). Along with this, insufficient engineering preparation of technical structures leads to the swamping of territories. The swampiness of the territory in the Volgograd Region is 0.33%, in the Rostov Region—0.54%.

### 3.4 Dependence of Regional Sustainability on the State of Water Resources

In the first stage, the authors will conduct a pair-by-pair comparison of the significance of the impact of the state of water resources on individual components of the region's sustainable development. For this purpose, the authors will use a 10-point scale. If the influence of the compared trends is of equal significance, five points are assigned. If the influence of the trend is not equal, a greater number of points

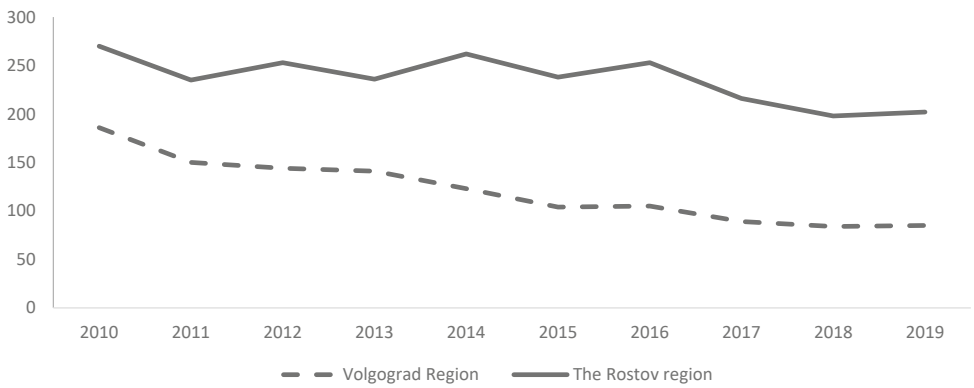


**Fig. 2** Dynamics of discharge of contaminated wastewater in the Volgograd and Rostov regions, mln. $m^3$. *Source* Compiled by the authors

**Table 2** Results of calculating the integral values of indicators

| Regional subsystems | Assessment indicators | Average score | Weight | Total |
|---|---|---|---|---|
| *Volgograd region* | | | | |
| Economic subsystem | Water capacity of GRP | 5.5 | 0.5 | 4.95 |
| | Water intake | 4 | 0.2 | |
| | Loss of water during transportation | 5.5 | 0.3 | |
| Social subsystem | Water supply for the population | 6 | 0.4 | 5.1 |
| | Water tariffs | 4.5 | 0.3 | |
| | Sample compliance | 4.5 | 0.3 | |
| Ecological subsystem | Discharge of water resources | 5.5 | 0.2 | 6.25 |
| | Share of polluted wastewater | 7.0 | 0.7 | |
| | Swampiness of the territory | 2.5 | 0.1 | |
| *Rostov region* | | | | |
| Economic subsystem | Water capacity of GRP | 3.5 | 0.3 | 5.2 |
| | Water intake | 4.5 | 0.3 | |
| | Loss of water during transportation | 7 | 0.4 | |
| Social subsystem | Water supply for the population | 3.5 | 0.3 | 9.45 |
| | Water tariffs | 8 | 0.4 | |
| | Sample compliance | 3.5 | 0.3 | |
| Ecological subsystem | Discharge of water resources | 7.5 | 0.4 | 5.5 |
| | Share of polluted wastewater | 4.5 | 0.4 | |
| | Swampiness of the territory | 3.5 | 0.2 | |

*Source* Compiled by the authors

is assigned. The sum of the marks for the compared criteria should be equal to 10.

Next, the authors will determine the integral values of the level of impact of the state of water resources on regional subsystems as weighted average values. The values of weight values are determined in such a way that their sum is equal to 1 for each subsystem.

The results of calculating the average score and the integral values of the indicators are shown in Table 2.

From the data presented, the influence of water resources on individual subsystems of the Volgograd Region is generally equivalent. In this case, the most significant influence is exerted on the ecological subsystem. In the Rostov Region, the most significant is the impact on the social subsystem, which is associated, as indicated earlier, with high water tariffs, low quality of drinking water, and a low level of provision of the population with water resources.

## 4 Conclusions

The research showed that water bodies significantly contribute to ensuring the sustainability of regional development.

The research shows that the characteristics of the use of water resources affect the state of individual regional subsystems. Effective management of water resources must be carried out not only from an environmental but also from an economic and social perspective.

The assessment of the impact of the state of water bodies on the sustainability of regional development demonstrates the need to adjust the existing policy for the development of water resources in the region. The following projects are implemented within the framework of the national project "Ecology":

1. A regional project aimed at preserving unique water bodies is being implemented in the regions;
2. A regional project "Clean Water" aimed at providing the population with high-quality water from centralized water supply systems.

The development of technologies for reusing wastewater, increasing the level of ecological culture of the population, and disseminating the principles of the green economy are highlighted as key areas for the conservation of water resources in the region. However, the main attention is paid to the environmental aspects of sustainable development. The tasks of socio-economic development, as a rule, are not documented.

This research is important for understanding the role of water resources in the sustainable development of the

regions on a long-term basis. The results obtained are important for regional strategizing from an ecological and socio-economic point of view.

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# Analysis of the Dependence of Agricultural Production Efficiency in the Regions of Russia on the Availability of Resources Based on the Multidimensional Grouping Method

Tatiana N. Lubova, Guzel A. Salimova, Damir R. Islamgulov, and Ramzilya R. Bakirova

**Abstract**

Agriculture is extremely dependent on limited resources. It is relevant to rationally use production resources in the sectors of agriculture to increase the efficiency of economic entities, provide the population with food, and achieve the country's food security. The issues of resource availability and efficiency of agricultural production and the use of research methods that make it possible to take a systemic and multifaceted approach to its study are relevant and widely discussed. The research aims to examine the impact of the resource provision of agricultural enterprises in the regions of the European part of the Russian Federation on the results of their functioning and work. The research methodology is represented by cluster analysis. The authors developed a system of indicators for analysis and formed clusters of regions based on these indicators. The authors provide recommendations for the regions of each cluster. The authors define methodological techniques, formulate recommendations in the field of application of cluster analysis of agricultural enterprises. The authors assess the impact of the availability and resource endowment of agricultural enterprises on the efficiency of production, the use of production resources. The study used general scientific methods, such as the monographic method, methods of system and cluster analysis, abstract-logical method, and graphical method. The main conclusions are based on a multidimensional grouping of regions. The results of the analysis allowed the authors to develop ways and directions for the development of agricultural production, strategies for the development of agriculture for the relevant groups of regions and territories.

**Keywords**

Cluster analysis • System of indicators • Indicators • Groups of regions • Availability of resources • Development of territories

**JEL Classifications**

C15 • Q19

## 1 Introduction

The agriculture sector is a strategically important industry for any state. The level of development of economic entities of this type of economic activity depends on the availability of resources for enterprises in other sectors of the economy. Agriculture is the backbone of the country's food security. The sustainable development of rural areas depends on the level of development of this industry. The standard of living and health of the population depends on the level of development of agriculture, the efficiency of the enterprises of the industry. The issue of providing agriculture with sustainable resources is important. It is important to guarantee the efficiency of the use of production resources in agriculture, to ensure the efficiency of the industry. Many specific indicators are used to characterize the activities of agricultural enterprises. The range of products produced by the agricultural sector is extensive. Huge territories are used in the type of economic activity agriculture. Therefore, there is a need to apply a systematic approach and multidimensional methods to study the resource endowment of agricultural enterprises and its impact on production results.

Scientists use a variety of methods to study agricultural production, the availability of its resources, and performance indicators. Based on secondary and primary data, the authors study the impact of enterprise scale, returns on total and variable costs, and the structure of production on production

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efficiency (Yue et al., 2021). The authors conduct econometric analysis, principal component analysis, and probit-binary models to determine factors affecting agricultural production and its adaptation to climatic conditions (Jeder et al., 2021). Many studies focus on the empirical measurement and analysis of the production efficiency of various types of industry products (Nie et al., 2021).

The importance and necessity of the transition to a much more efficient economic system is noted. This economic system should encourage agricultural enterprises to develop innovative solutions to reduce the level of production waste, for the efficient use of production resources (Golikova et al., 2019). It is necessary to introduce innovations that can ensure the environmental safety of ongoing agricultural production. The health of the population is largely determined and depends on the quality of food products, on food supply. Therefore, it is necessary to develop innovative technical solutions that will be aimed at improving the quality of food products (Pan et al., 2017). Scientists offer various solutions in the field of innovative development of the economy, including agricultural production, agricultural economics. The development of a cluster policy based on the methods of cluster analysis can affect the strategic development of rural areas, the region as a whole (Pan et al., 2017). The formation and further progressive development of regional clusters are accompanied by the rapid spread of innovative products. The efficiency of information exchange between cluster members is increased (Gagulina et al., 2019; Popkova & Ostrovskaya, 2019). As a representative of the global innovation capital and industrial cluster, Silicon Valley is wowing the world with scientific and technological innovation (Săvescu & Rotaru, 2021).

C. Castillo et al. note that urbanization, demographic change, the transition to digital and energy technologies, climate change, and increasing inequality affect the development of the territory and agricultural production (Castillo et al., 2022). F. Pagliacci and D. Salpina apply cluster analysis to identify spatial foci of geographical indications of the agri-food industry at risk of climate disasters. They perform cluster data analysis at the municipality level. The analysis covers physical, social, and production characteristics (Pagliacci & Salpina, 2022). J. Yi, Z. Fang, G. Yang, S. He, and S. Gao point out that cluster analysis, as an effective method of data mining, is important for discovering the natural structure of data to obtain useful information from huge amounts of data. However, they note that many existing and applied clustering algorithms have the problem of low clustering accuracy and suggest updated and improved clustering algorithms (Yi et al., 2022). P. Bartesaghi, G. P. Clemente, R. Grassi, and D. T. Luu apply cluster analysis to study trade transactions and note that clusters can change and evolve. These changes in major international and regional clusters will reflect the results and dynamics of cooperation, choice of partners, and competition between industries and countries (Bartesaghi et al., 2022). We believe that this advantage of the method is especially important in today's changing structure of the economy and changes in the areas of cooperation between territories and countries. These studies set new challenges for further research.

Thus, the issues of resource availability and efficiency of agricultural production and the application of research methods that allow a systemic and multifaceted approach to its study are relevant and widely discussed by scientists. This research aims to examine the impact of the resource endowment of agricultural enterprises on the efficiency of their activities in the regions of the European part of the Russian Federation. To reveal the purpose of this study, specific tasks were defined:

- To build a system of indicators for grouping regions by multivariate analysis;
- To identify groups of regions united and similar by the considered indicators;
- To characterize the selected clusters by average values of system indicators;
- To develop recommendations to the regions of each cluster to solve problems of resource provision of agricultural production and elaborate strategies of its development for certain territories;
- To determine a vector for further research of resource provision problems.

## 2 Materials and Methods

The method of cluster multivariate analysis represents the scientific methodology of the study. The main advantage of the method of grouping by cluster analysis is the possibility to group the units of the population under study not by one attribute or indicator but simultaneously by the entire set of attributes. The cluster analysis methodology does not limit the type of considered objects, studying the set of presented empirical data of any dimension and type.

The analysis is based on the data presented in the official information publications of the National Statistical Service of the Russian Federation (Federal State Statistics Service of the Russian Federation, 2022). Among the calculated and published statistical indicators, 17 indicators characterizing the resource provision and economic efficiency of agricultural enterprises were selected. The constructed system of indicators for analysis includes the following indicators of the resource provision of agriculture:

- Availability of agricultural labor resources;
- There are fixed production assets for 1 hectare of agricultural land and for 1 agricultural worker;
- The amount of feed consumed by farm animals;
- The amount of mineral fertilizers applied for crops;
- The amount of depreciation of fixed production assets used in agriculture;
- The amount of investments directed to fixed production assets per 100 hectares of agricultural land;
- The amount of domestic spending on R&D per researcher in the field of agricultural sciences.

The indicators of economic efficiency of agricultural enterprises are as follows:

- Yields of potatoes, cereals, and leguminous crops;
- Productivity of cows;
- Gross agricultural output per one employed in the industry;
- Accounts for gross agricultural output in terms of the value of fixed production assets;
- Accounts for gross agricultural output per 1 hectare of agricultural land;
- Financial result in agriculture per one enterprise;
- Profitability of the sales of crop products;
- Profitability of the sales of livestock products.

The data processing program "Statistica" was used for the cluster analysis. Instead of the original values of the variables included in the analysis when grouping regions, the authors use the standardized variables obtained as a result of the normalized transformation. Standardization allows bringing indicators measured in different scales and expressed in different units into a single view. The association of indicators and regions into clusters was performed through the Manhattan distance, in which the distance between two points is calculated by summing the absolute values of deviations of object indicators.

## 3 Results

A cluster analysis procedure was carried out. The set of regions of the studied European part of the Russian Federation was divided into several clusters according to the first group of indicators characterizing the resource endowment of agricultural enterprises. The association tree diagram is shown in Fig. 1.

The numbering of regions on the dendrogram is as follows: Republic of Bashkortostan (1), Republic of Mari El (2), Republic of Mordovia (3), Republic of Tatarstan (4); Udmurtian Republic (5), Chuvash Republic (6), Republic of Adygeya (32), Republic of Kalmykia (33), Republic of Daghestan (38), Republic of Ingushetia (39), Kabardino-Balkarian Republic (40), Karachayevo-Chircassian Republic (41), Republic of North Osetia—Alania (42), Chechen Republic (43), Republic of Karelia (45), Komi Republic (46), Kirov Region (8), Novgorod Region (9), Orenburg Region (10), Penza Region (11), Samara Region (12), Saratov Region (13), Ulyanovsk Region (14), Belgorod Region (15), Bryansk Region (16), Vladimir Region (17), Voronezh Region (18), Ivanovo Region (19), Kaluga Region (20), Kostroma Region (21), Kursk Region (22), Lipetsk Region (23), Moscow Region (24), Orel Region (25), Ryazan Region (26), Smolensk Region (27), Tambov Region (28), Tver Region (29), Tula Region (30), Yaroslavl Region (31), Astrakhan Region (35), Volgograd Region (36), Rostov Region (37), Arkhangelsk Region (47), Vologda Region (48), Kaliningrad Region (49), Leningrad Region (50), Novgorod Region (51), Pskov Region (52), Kurgan Region (53), Sverdlovsk Region (54), Tyumen Region (55), Chelyabinsk Region (56), Perm Territory (7), Krasnodar Territory (34), and Stavropol Territory (44).

Cluster I included 20 regions (35.7% of the studied population), cluster II included 8 regions (14.3% of the studied population), cluster III included 7 regions (12.5% of the studied population), cluster IV included 11 regions (19.6% of the studied population), cluster V included 5 regions (8.9% of the studied population), and cluster VI included 15 regions (26.8% of the studied population).

The territories of cluster I are mainly located in the southern part of the territorial location of the studied population. The territories of cluster VI are mainly located in the western part of the territorial location of the studied population. The compositions of other clusters are characterized by dispersion over the studied territory.

The best resource availability is observed in the regions of the fourth, fifth, and sixth clusters. The regions of the second cluster are located in a zone with favorable natural and climatic conditions. Simultaneously, the regions of the first cluster are characterized by a significantly larger territory, which is a determining factor in the low level of resources. Lower values of the considered indicators are observed in the regions of the cluster I. The regions in the third cluster have an average level of all indicators. The dependence of performance indicators on resource provision is revealed. Thus, the regions of the fifth and sixth clusters (which have the best supply of agricultural production resources) were able to achieve the best level of productivity and labor efficiency, the level of profitability of crop production, and the profitability of animal husbandry. In these regions, the best level of financial results of agricultural enterprises is observed. It should be noted that the value of internal costs for R&D in the agro-industrial complex plays an important role in ensuring and improving the efficiency of agricultural production. Internal R&D costs are expressed

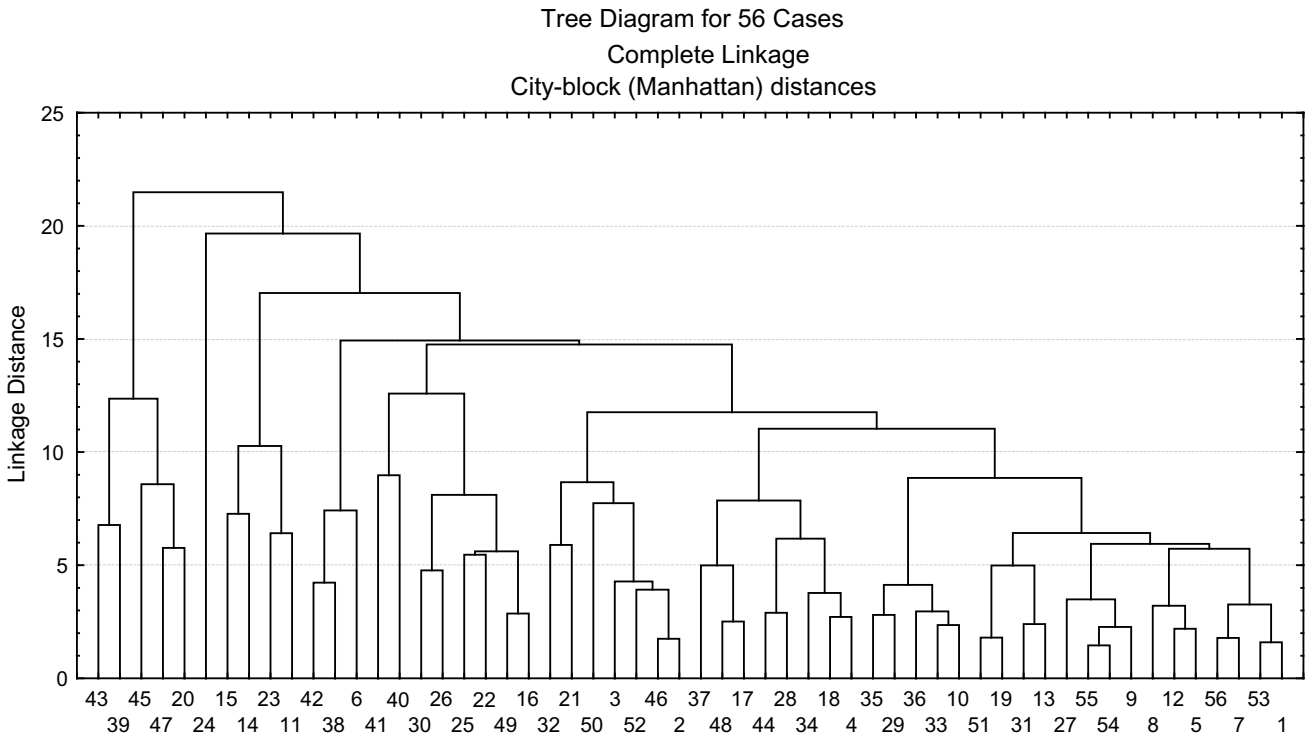


**Fig. 1** Tree diagram of regions by resource endowment indicators. *Source* Compiled by the authors

and materialized in the new technologies and developments being introduced. The regions of the first, second, and fourth clusters have the lowest indicators of agricultural production efficiency. The reasons for this are different for the regions of each cluster. For the regions of the first cluster, the reason is a lack of resources and a large territory. The average level of resource provision in the third cluster leads to average aggregate production performance indicators.

A cluster analysis procedure was carried out in the next step. The set of regions of the studied European part of the Russian Federation was divided into several clusters according to the second group of indicators characterizing the performance of agricultural enterprises. The association tree diagram is shown in Fig. 2.

Cluster I included 18 regions (32.1% of the studied population), cluster II included 5 regions (8.9% of the studied population), cluster III included 5 regions (8.9% of the studied population), cluster IV included 2 regions (3.6% of the studied population), cluster V included 16 regions (28.6% of the studied population), and cluster VI included 10 regions (17.9% of the studied population).

The regions of the third, fourth, and sixth clusters are characterized by a more compact location in the considered area. The compositions of other clusters are characterized by dispersion over the territory. This indicates the influence of a large variety of causes on the results and the process of selling products, the distribution of the created product, pricing, etc. The composition of clusters in the second grouping has undergone significant changes compared to the first grouping. The average values of the indicators were analyzed, on the basis of which a multidimensional grouping was carried out. This made it possible to identify the main problems of agricultural enterprises, in general, agricultural production, develop recommendations, and create a concept for further development.

The largest number of regions is observed in the first and sixth clusters. However, the indicators characterizing the performance of the regions of the first cluster do not reach high values. The regions in the fifth and sixth clusters have the best performance. They are the most well resourced and show the highest efficiency of agricultural production. The regions of these clusters stand apart. The regions of the third and fourth clusters are not far behind. They are also characterized by high indicators. However, the development of the livestock industry requires special attention. It is necessary to increase the profitability of the livestock industry. The state of this industry prevents the regions of the third cluster from reaching the leading level. The territories of the cluster V are mainly located in the western part of the location of the studied set of regions. They are located in close proximity to major cities (e.g., the city of St. Petersburg, Moscow, Krasnodar, etc.). The development of agriculture in these regions is greatly influenced by urbanization, the development of agglomerations, a large market for

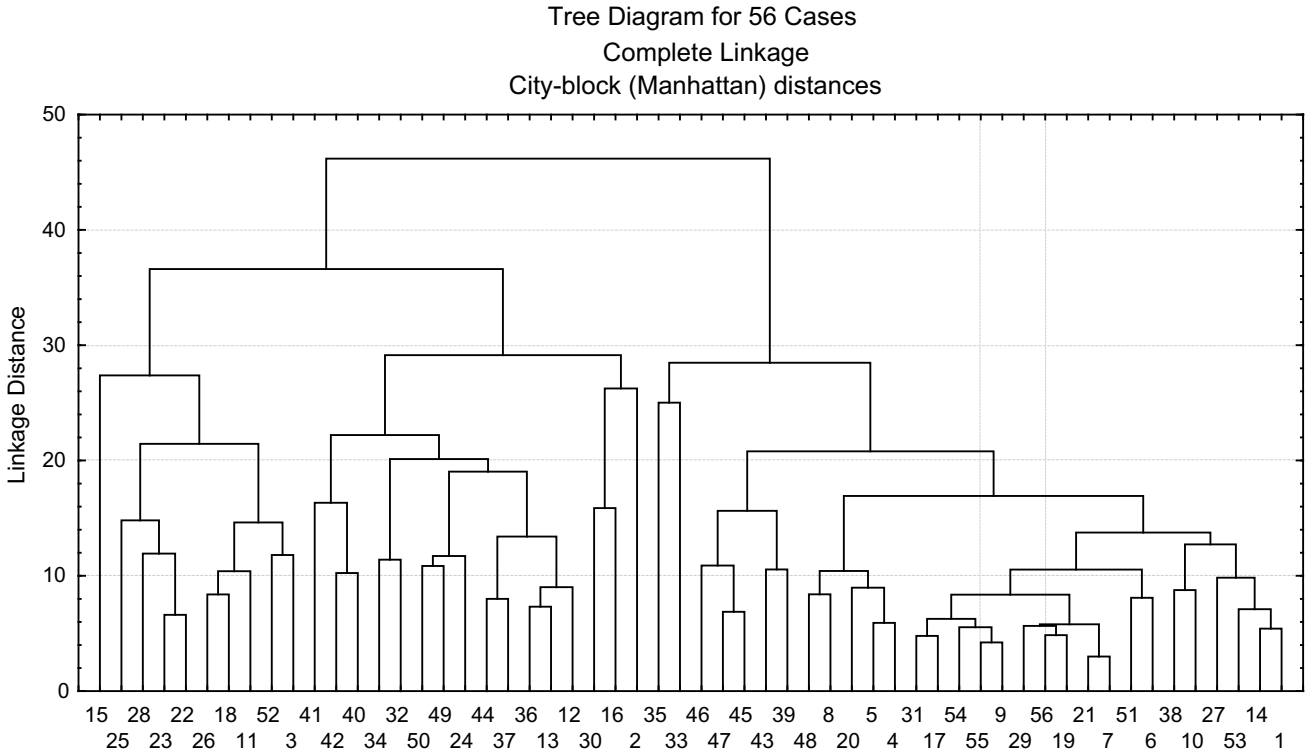


**Fig. 2** Tree diagram of regions by economic efficiency of enterprises. *Source* Compiled by the authors

agricultural products, and compact territories. This allows to improve the organization of agricultural production, improves and develops the methods, principles and structure of production management. Despite the favorable conditions and developed infrastructure, these regions have reserves for improving the efficiency of agricultural production (in particular, increasing the return on assets). The regions of the third cluster can be singled out. Their territorial location makes adjustments in the development of agriculture and its efficiency (they have not been able to achieve profitable production in either livestock or crop production). The most critical negative values of indicators were formed in the regions of the cluster I and cluster II. The territories of the first cluster are significantly less well-resourced. Simultaneously, the efficiency of their use is comparable with the regions of the better clusters. This is where the lowest cost of investment is observed. An increase in this indicator can lead to increased efficiency and leading positions. Remoteness from major cities prevents them from developing markets and investment attractiveness. The low endowment and armament of fixed assets can be defined as the main deterrent to production development in these regions. The regions of the cluster II have a higher supply of agricultural production with resources than the regions of the cluster I. Nevertheless, their production efficiency is lower, which may indicate insufficient organization and inefficient management. The natural and climatic conditions of these regions are favorable for agriculture. This allows to achieve better results even at the existing level of security.

## 4 Discussion

Our results are largely consistent with world studies. Let us note some directions. C. Castillo et al. state that some rural areas have lower availability of services, and people there have to travel long distances to get to a service area or facility. Considering future technological changes, integrated sustainable territorial development is necessary (Castillo et al., 2022). We also believe that a multi-level system of regional governance is needed to enable the involvement of local, regional, and national authorities in creating effective systems for monitoring and evaluating the development of territories, supporting the development of a coordinated strategy, and ensuring long-term planning across territorial boundaries (Castillo et al., 2022). The conclusion is made about the importance of management organization for the sustainable development of agricultural production. These conclusions are confirmed by the findings and results of other scientists. C. Castillo et al. note the importance of applying analytical and predictive methods to assess the problems facing agricultural production effectively (Castillo

et al., 2022). We develop a method of analysis and apply a multidimensional approach to the analysis of the resource endowment and development of agricultural production. The need for a whole system of indicators for the development of agricultural production and the solution of emerging problems, substantiated in this research, is also confirmed by scientists. During the allocation of clusters, we noted that the availability and provision of agricultural production and rural areas with resources, as well as their rational use, is a determining factor for the effective development of agricultural production and, therefore, for the territory's welfare. We also agree that the allocation of clusters and their analysis makes it possible to create a scientifically sound policy for developing production and regions. A development for our research is that the indicators can be presented in a more extended form, with a rationale for their application in international studies.

S. K. Kulshrestha notes that an integrated, collaborative, and proactive approach to regional spatial planning is needed that promotes sustainable, inclusive, and resilient development that can adapt to technological innovation and climate change (Kulshrestha, 2022). K. Jozsef and H. Patricia point out that intelligent rural development requires a coherent policy that is markedly capable of promoting innovation, learning, and knowledge in rural areas (Jozsef & Patricia, 2019). We assume that investments in agriculture will help improve the efficiency of agricultural production and the prosperity of rural areas, increase labor productivity in agriculture, and the development of related industries and food processing.

A special place in this research was given to the indicators of technical equipment of the industry. In this regard, E. Ernawati et al. note that the optimization of use cases, interactions, combination of resources, and technological solutions for agricultural development provides great opportunities for enterprises to increase the efficiency of production, management, and marketing of products (Ernawati et al., 2021). S. Baharudin and H. N. Waked add that inability to meet domestic demand, inefficient use of machinery, mismanagement, and technical inefficiency are major problems of the agricultural sector in various countries. Inadequate planning and management of agricultural activities lead to poor land conditions, inadequate water supplies, difficulties in disease control, and machinery maintenance. This leads to additional costs and reduced profits and jeopardizes the financial situation of agricultural producers (Baharudin & Waked, 2021).

N. Golikova et al. note that the significant influence of the state, governing bodies, the structure of the economy of a large space, the low level of development of the business climate, business conjuncture are the main characteristics of modern cluster policy in the Russian Federation (Golikova et al., 2019). Therefore, the conclusions and results of this study are of scientific novelty and are practically significant.

The allocation of clusters and their analysis makes it possible to conduct a scientifically sound policy for the development of production and the regions as a whole. In this research, we expand the research object, the methodology, and the nature of applying multivariate grouping methods (Salimova et al., 2021, 2022). During the research, we were interested in how the region ended up in the group, what were the dynamics of indicators that led to a certain place in the cluster, what is the forecast of indicators and scenarios for this cluster distribution, and what will be the reason for the transition of the region from one cluster to another in the dynamics. These challenges broaden the scope of our anticipated research and will lead to meaningful results.

## 5 Conclusion

The initially developed system of indicators is consistent with the results obtained in the process of cluster analysis. Taking into account the selected groups of indicators, it was decided to analyze the provision and efficiency of agricultural production in the regions. The cluster analysis method was used. The territories of the European part of the Russian Federation were divided into several clusters according to the first group of indicators characterizing the resource endowment of agricultural enterprises. The dependence of performance indicators on resource provision is revealed.

Further research will deepen the dynamic analysis of the causes of problems in the resource provision of agricultural production, the construction of scenarios for their solutions, and forecasts of agricultural development. During the research, the authors were also interested in how the region ended up in a particular cluster, what indicators and factors were decisive in uniting the regions, what is the forecast of indicators and development scenarios for this cluster distribution, and what will be the reason for the transition of the region from one cluster to another in the dynamics. These research questions are in the field of systems analysis. These challenges broaden the scope of our anticipated research and will lead to meaningful results.

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# Assessment of Consumer Demand for Organic Products in the Moscow Region

Viktoriya V. Rakhaeva and Vera V. Mizyureva

**Abstract**

The research aims to determine the factors influencing the demand and consumption of organic products in the Moscow Region. To achieve the research goal, the authors surveyed residents of the Moscow Region. The survey analysis results allowed the authors to conclude that people who consciously consume organic products do not always belong to the category of people with high incomes. They are people with a particular set of values and lifestyles. The main factors of demand for food products are the quality of products, their composition, and price. As indicated by the survey, 70.4% of respondents are interested in consuming organic products; 32% do not correctly perceive the concept of organic products, often substituting it with farm products. Less than 8% of respondents ask for its certificate when buying organic products; pseudo-labeling of producers often misleads consumers. The survey results revealed the problem of low awareness among the population about the quality, useful properties, and peculiarities of organic production and consumer incompetence. Proposals to increase demand for organic products include the following: (1) strengthening the promotion of healthy lifestyles and the need to address environmental issues; (2) increasing public awareness of organic products; (3) development of marketing of organic products; (4) expansion of the national system of standardization, certification, and control of organic products, equivalent to international norms and regulations; (5) state support for organic producers through subsidies and the introduction of reduced prices for organic products.

**Keywords**

Organic products • Organic farming • Farm products • Demand factors • Organic market • Certification of organic products • State support

**JEL Classifications**

L15 • Q13 • Q18

## 1 Introduction

The problem of an effective compromise between economic development, meeting the needs of a growing world population, and respect for nature is particularly relevant in today's world. In an attempt to solve this problem, more countries have started advocating a green economy. Organic farming is one of the most important areas of the green economy. Organic products are produced without harming the environment; their consumption positively affects the nation's health.

Although Russia occupies the largest area in the world and has enough arable land, its share in the world market of organic products is only 0.2%. The main reasons are insufficient knowledge of organic farming technologies, a lack of sustainable released plant varieties, and a significant difference between the natural and climatic conditions of the regions and their capacity to produce organic products.

Organic production is carried out in 46 subjects of the Russian Federation. The area of land occupied by certified producers of agricultural products is 655.5 thousand hectares. The land area under organic food forest resources is 801.7 thousand hectares (Besshaposhnyy et al., 2023).

The Russian market of organic products is dominated by the share of imported products certified abroad (63%), while the share of domestic products is only 37%.

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The volume of organic products produced by Russian producers in 2022 amounted to 12.8 billion rubles.

The volume of imported products certified abroad amounted to 15.3 billion rubles, which is four times higher than the volume of exported products (3.7 billion rubles).

Currently, there are 111 producers of organic products in Russia. All producers have a Russian organic certificate, 20 companies have double certification (Russian and foreign certificates), and 62 producers and exporters have only foreign organic certificates (i.e., they have the right to export products recognized as organic in importing countries).

The most important problem constraining the development of organic agriculture in Russia is the high cost of certification entry to the market (300–800 thousand rubles per year), which is an unaffordable amount for most agricultural producers.

About 50 organizations are at the stage of transition to organic production. However, they have not yet received the relevant certificate.

The transition to organic production has a rather long character (Blace et al., 2020). On average, for cropped areas, the transition takes about two years. In fact, it takes about five years or more to clear fields of weeds without using chemicals.

The share of organic products in the Russian food market is only 0.13% (Rakhaeva, 2021).

The differentiation of incomes of the population by regions, low level of disposable income, and the high cost of organic products explain the lack of mass demand for these products in Russia. These are important factors constraining the development of organic agriculture in Russia (Khoruzhy et al., 2019).

The authors studied and generalized normative-legal acts and scientific and professional literature. The legal framework regulating the organization and implementation of organic agricultural production in Russia is represented by the Doctrine of food security of Russia (Presidential Executive Office, 2020), the Federal law "On organic products" (Federation, 2018), interstate standard on organic products (Rosstandart., 2016a), national standards on organic products (Rosstandart., 2016b), and international and interstate acts on organic agriculture (JFOAM, FiBL, Codex Alimentarius Commission, and EAEU and CIS regulations) (Pivovarov et al., 2021). Without a comprehensive study of the listed legislative acts, it is incorrect to assess organic agriculture in Russia and the market of organic products, as well as to give recommendations for its development in regions and the country. Proposals must not conflict with applicable regulations. The study of scientific approaches and practical analysis was based on the publications of Russian scientists-economists, including Nikodimov et al. (2022), Nikonova and Nikonov (2021), Zaruk et al. (2021, 2022), Pivovarov et al. (2021), and others.

The main directions of recent scientific research in the field of organic agriculture (legal regulation of production and marketing of organic products, certification of products, increasing the economic efficiency of organic production, marketing of organic products, etc.) contribute to the sustainable development of organic production. According to the authors, the issues related to consumer behavior and the formation of demand for organic products are insufficiently studied.

Consumer behavior patterns are unique, depending on many factors, including gender, age, social status, region of residence, religion, lifestyle, value attitudes, income level, and others (Hansmann et al., 2020).

The authors believe that consumer demand has its own specifics in each region of Russia. The impact on demand and the formation of correct consumer behavior can contribute to the sustainable development of organic production in Russia.

This research analyzes price and non-price determinants of demand for organic products in the Moscow Region.

## 2 Materials and Methods

This research aims to determine the impact of various factors on the demand and consumption of organic products in the Moscow Region of the Russian Federation. The choice of the research object is determined by the following reasons: high population density, multi-nationality, different religions, different life values, reference points and attitudes, one of the highest levels of income per capita among Russian regions, and a high degree of awareness of the population about world trends in various areas of social life.

The research objectives are as follows:

1. To consider the main parameters of the organic products market in Russia in 2021–2022;
2. To assess organic agriculture in Russia;
3. To identify the reasons constraining the development of organic agriculture;
4. To identify the impact of various factors on the demand and consumption of organic products in the Moscow Region of the Russian Federation;
5. To provide recommendations on developing the organic market in the studied region of Russia.

The monographic method allowed the authors to identify trends in developing the organic market in Russia and assess the potential application of various measures for introducing and expanding organic production in Russia. The authors propose the following:

- To improve the regulatory and legal framework for organic production (Khoruzhy et al., 2023; Nikodimov et al., 2022; Nikonova & Nikonov, 2021; Pivovarov et al., 2021) under the influence of the political and social situation in the country;
- To introduce previously retired agricultural land into the turnover (Nikonova & Nikonov, 2021);
- To create a database to calculate a system of indicators of conditions of production and consumption of organic products, selected by experts, characterizing the regions by the potential of socio-economic development; the state of agriculture, climatic, and environmental conditions; and the standard of living of the population, which forms the demand for organic products (Zaruk et al., 2022);
- To create international specialized electronic trading platforms for organic exports (Zaruk & Miziureva, 2021);
- To introduce reduced rates of insurance premiums for certified agricultural producers of organic products (Shelemekh et al., 2021).

The authors apply system analysis because a comprehensive analysis of organizational, production, economic, legal, social, environmental, and other aspects of organic agriculture is required to develop rational proposals to increase organic production.

A survey by questionnaire was used for data collection. The survey involved residents of the Moscow Region and the region's guests. The survey covered 300 respondents of different ages, gender groups, and income levels. For the survey, the authors prepared questions divided into the following blocks:

- Information on the respondent's age and income;
- The main factors influencing the purchase of food;
- Awareness of organic products and their benefits;
- Assessment of organic purchase under the influence of various factors, organic market assessment, and key challenges;
- Possible measures to expand organic production in Russia.

Respondents were offered answer options and given the opportunity to indicate their own opinion.

The collected data were processed by graphical method. The respondents were grouped by the share of family spending on organic products, in % of per capita family income, which made it possible to conclude the dependence of consumption of organic products on income and age. The comparative analysis made it possible to conclude the preservation of the global trend in the consumption of individual groups of organic products, considering regional characteristics.

The application of these techniques and methods allowed the authors to obtain original data and assess the demand for environmentally friendly products in the regional market.

## 3 Results and Discussion

During the survey, residents and guests of the Moscow Region gave the following answers to the question "What is the most important factor when purchasing food products?" (in % of the total number of respondents):

- Product quality—85.2%;
- Product composition—53.7%;
- Price—47.2%;
- Recommendations from friends and acquaintances—15.7%;
- Ease of purchase—13%;
- Organic production—13%;
- Brand—8.3%;
- Package—5.6%;
- Taste—0.9%.

Based on the survey, the authors conclude that quality, composition, and price are the main determining factors when buying food products in the Moscow Region. Consumers tend to evaluate the quality of products by their composition, not paying due attention to the production conditions. Meanwhile, the composition of products, their useful properties, and their quality depend to a large extent on the production conditions. Agricultural producers use fertilizers, growth regulators, and pesticides to increase intensity and efficiency (Khoruzhy et al., 2019). This simplifies and cheapens the production process. However, the use of substances indicated above and food additives by food industry enterprises negatively affects the beneficial properties of products, the region's ecological situation, and the nation's health.

The world is trending toward a healthy lifestyle, which can be achieved through the introduction and expansion of organic production. This is facilitated by forming a regulatory framework for organic products, certification of agricultural producers according to international and national standards, and creating the Union of Organic Agriculture. Thanks to these measures, 68% of respondents have heard about organic products and correctly understand that this category should include only a part of agricultural products and food, namely products produced in an environmentally friendly environment (Fig. 1).

According to Fig. 1, a significant proportion of respondents believe that any farm produce is organic, substituting these concepts for each other.

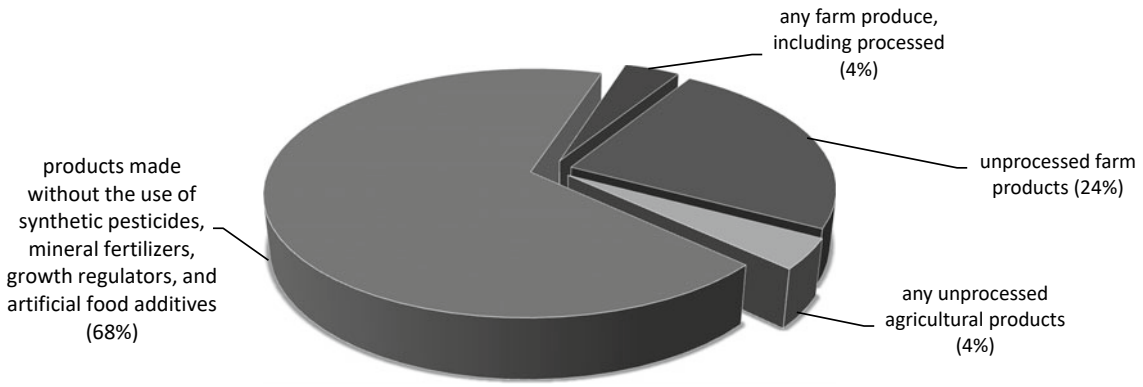


**Fig. 1** Results of answers to the question "Organic produce is ….". *Source* Developed by the authors based on the conducted survey

A survey showed that 70.4% are interested in consuming environmentally friendly products. Some people consider it harmless, while others consider it more useful for health and superior in taste. Many respondents (29.6%) do not attach importance to the peculiarities of the production and composition of food products. Some people do not see any advantages in organically produced products (3.6%) or are unsure if the production is organic.

Most respondents (33%) purchase organic products several times a week, choosing mainly vegetables, fruits, milk and dairy products, and meat products. Only 3% of respondents purchase organic products daily.

The survey showed that age and income are not determinants of demand for organic products (Table 1).

The main reason for the choice is health benefits. Most respondents spend from 6 to 10% of per capita family income on purchases. Most respondents have a level of income per family member up to 100,000 rubles. Studies have shown that income level is not a determinant in the decision to buy organic products: 24% of respondents with income over 100,001 rubles per person are not ready to spend even 5% of per capita family income. Half of the respondents with income less than minimum wage spend up to 20% of their income. They buy organic products at the market several times a week, scrutinizing the product's composition, noting the high price but better quality.

The analysis showed that income affects the place of purchase of organic products. People with high incomes often buy farm products at special sites; people with average incomes prefer supermarkets, online stores, and health food stores.

To ensure the products are organic, 59.4% study the label and the product's composition or buy from trusted sellers. Only 7.8% check organic certificates. The majority of respondents would like to buy organic products more often. However, they highlight certain problems and want to see appropriate changes (Table 2).

Respondents highlight the following obstacles in solving these problems and implementing changes:

- High costs of organic production—70.7%;
- Insufficient customer demand—38.7%;
- Insufficient number of qualified specialists in this field—36.8%;
- Problems with certification and quality control—25.5%.

According to the population, the indicated obstacles to the expansion of organic production can be overcome using the following measures:

- Subsidizing the production of organic products—41.9%;
- Training of farmers and producers in organic production methods—19%;
- Creation of specialized markets to sell organic products—16.2%;
- Raising consumer awareness of the benefits of organic products—21.9%;
- Limiting non-organic food production—1%.

The authors highlight the general trends and regional features by comparing the structure of organic food consumption globally and in the Moscow Region (Fig. 2).

Fruits, vegetables, and dairy products occupy the leading positions in the organic consumer basket. However, the population of the Moscow Region is oriented toward purchasing healthier food. Thus, the share of semi-finished products is much lower than the world value. Simultaneously, the share of purchased fruits and vegetables is 2.3 times higher, and meat and dairy products—2.4 times higher.

**Table 1** Grouping of respondents by share of family spending on organic products, in % of per capita family income

| No. | Indicator | Amount spent on purchasing organic products, as a % of per capita family income | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0% | < 1% | 1–5% | 6–10% | 11–15% | 16–20% | 21–30% | > 31% |
| 1 | % of respondents | 9.6 | 9.6 | 24 | 20.2 | 6.7 | 13.5 | 10.6 | 5.8 |
| 2 | Age: | | | | | | | | |
| | Up to 25 | 3 | 3 | 9 | 0 | 3 | 12 | 3 | 3 |
| | 25–35 | 3 | 3 | 18 | 12 | 9 | 9 | 15 | 3 |
| | 35–45 | 15 | 12 | 30 | 21 | 0 | 9 | 12 | 3 |
| | 45–60 | 9 | 12 | 15 | 9 | 6 | 12 | 3 | 6 |
| | Over 60 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 3 |
| 3 | Income level per family member: | | | | | | | | |
| | Less than the minimum wage (RUB) | 6 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| | 16,242–25,000 RUB | 0 | 3 | 24 | 9 | 0 | 0 | 0 | 6 |
| | 25,001–45,000 RUB | 9 | 9 | 12 | 9 | 3 | 12 | 0 | 3 |
| | 45,001–100,000 RUB | 9 | 12 | 27 | 39 | 18 | 18 | 24 | 3 |
| | > 100,001 RUB | 6 | 6 | 12 | 6 | 0 | 6 | 9 | 6 |
| 4 | Organic products are purchased: | | | | | | | | |
| | Daily | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 |
| | Several times a week | 0 | 6 | 9 | 21 | 9 | 24 | 24 | 9 |
| | once a week | 0 | 0 | 24 | 27 | 9 | 12 | 3 | 6 |
| | Less than once a week | 0 | 21 | 39 | 15 | 3 | 6 | 3 | 0 |
| | Never | 24 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

*Source* Developed by the authors based on the conducted survey

**Table 2** Problems and desirable changes highlighted by respondents, in %

| Problems | | Desired changes | |
|---|---|---|---|
| Type of problem | Responses | Wishes | Responses |
| High price | 39.3 | Lower prices for organic products | 61.0 |
| Insufficient number of products on the market | 28.0 | More available products on the market | 67.6 |
| Insufficient consumer awareness of the benefits of organic products | 21.5 | More information about the benefits of organic products | 24.8 |
| Problems with certification and quality control | 9.3 | Improved product quality | 31.4 |

*Source* Developed by the authors based on the conducted survey

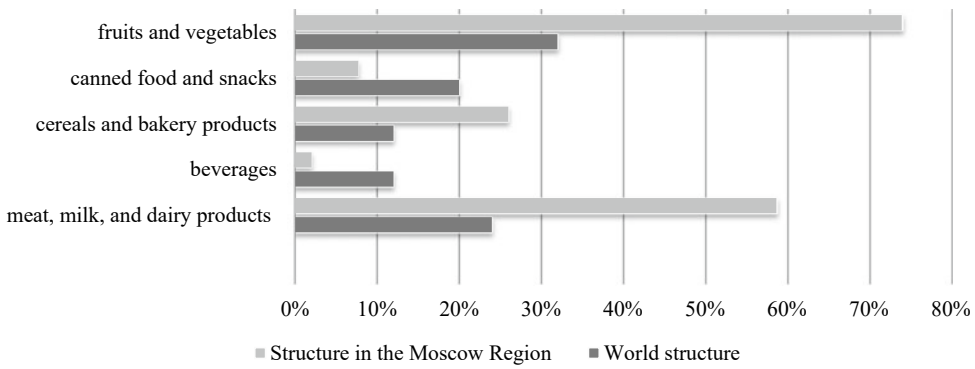


**Fig. 2** Consumption patterns of organic products in the world and in the Moscow Region. *Source* Developed by the authors based on a survey conducted in the Moscow Region and (Darnhofer et al., 2019)

## 4 Conclusion

The conducted research revealed that people who consciously consume organic products are found in different categories: high-, middle-, and low-income categories. The determining factor of demand is not income but lifestyle and way of thinking. Consumers are willing to pay more for products that are good for the body and less harmful to the environment. It seems appropriate to strengthen the promotion of healthy lifestyles and the need to address environmental issues. For this purpose, it is possible to use various channels of communication. Informing the population about the properties, quality, and conditions of production of organic products will significantly expand the number of consumers, which will include people who care about their health, have indications for the consumption of these products for health reasons, athletes, the elderly, and other categories.

To increase the loyalty of customers to the producers of organic products, it is advisable to design their own brand and trademark. Further expansion of the national system of standardization, certification, and control of organic products, equivalent to international norms and rules, will protect the rights and interests of producers and consumers of organic products. The identified problem of insufficient public awareness of certification can be solved by establishing a single sign of organic products and a certificate with its application on the packaging.

During the transition to organic production, agricultural organizations face the need to incur additional costs of production without the use of fertilizers and plant protection products. An effective measure of support for them can be the application of a single agricultural tax rate of 1%. Such a rate should be applied when confirming the inclusion of organizations in the register of organizations switching to organic production. Agricultural producers include high costs of obtaining an organic certificate in the expenses for accounting and tax accounting purposes. However, they increase the cost of production, and, as a consequence, prices for consumers increase. Targeted subsidization will eliminate the increase in producers' costs and consumer prices. The government thus partially realizes the issues of food security and the green agenda. To incentivize agricultural producers to switch to organic production, it is recommended to introduce a reduced rate of 7.6% on insurance contributions from the remuneration of employees based on inclusion in the unified register of organic producers.

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# Relationship of Vegetation Indices of Winter Wheat Determined by Digital Device on Different Agricultural Backgrounds in the Chernozem Zone of Stavropol

Elena V. Pismennaya, Alexander N. Esaulko, Alena Yu. Ozheredova, and Evgeny V. Golosnoy

**Abstract**

The research was conducted in 2020–2022 on the territory of the Agricultural Company "Kolos" JSC, located in the Stavropol Territory. The soil of the experimental plot is represented mainly by common chernozem. Studies were conducted to determine the relationship of pigment indices (PSSRAa and PSSRb) in crops of soft winter wheat (variety Grom) and in the models "PSSRAa, PSSRb – VOG1" and "PSSRAa, PSSRb – SIPI" on different agricultural backgrounds in the unstable moisture zone. The study showed that chlorophyll indices (PSSRAa and PSSRb) are high in the seedling phase and markedly high in the tillering phase in all agricultural backgrounds. The models "PSSRAa, PSSRb – VOG1" and "PSSRAa, PSSRb – SIPI" showed high regression dependence of the variables in the seedling phase. Simultaneously, the model "PSSRAa, PSSRb – SIPI" is inversely proportional. During the tillering phase of "PSSRAa, PSSRb – VOG1" and "PSSRAa, PSSRb – SIPI," the relationship between the variables decreased. However, the correlation in the "PSSRAa, PSSRb – SIPI" model improves, probably due to increased chlorophyll concentration (PSSRb). Consequently, the established relationship of the indices makes it possible to fix the vegetative phase of the development of winter wheat plants and display the state of the cultivated crop.

**Keywords**

Winter wheat • Vegetation index • Chlorophyll • Vegetation phase • Experiment option • Agricultural background

**JEL Classification**

Q22

## 1 Introduction

In accordance with the Food Security Doctrine of the Russian Federation, the main direction of the country's national security in the medium term is to ensure the country's food security, regardless of changes in external and internal conditions. To reduce the lag of production by yield, gross yield, and other indicators in Russian crop production from countries with traditionally developed agriculture, the Ministry of Agriculture of the Russian Federation has paid attention to the development of measures to stimulate the implementation of digital technologies and platform solutions in the agricultural sector through the project "Digital agriculture."

The use of IT technology in agriculture makes it possible to control the full cycle of plant development through the use of smart devices that allow agronomists to determine the best time for planting and harvesting, calculate fertilizer patterns, predict the productivity of cultivated crops, etc. About 70% of farms abroad use smart technology for farming. Russian farmers are far from such figures. Nevertheless, the demand for digital solutions is growing.

For the first time in the territory of the South of Russia at different agricultural backgrounds, the authors provide scientific substantiation of model application of hyperspectral results of the study to determine the physiological state of plants of soft winter wheat and adjust the implementation of agricultural and technical operations if necessary.

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## 2 Materials and Method

Digital crop production is explored by Bogdanchikov et al. (2019), Kivarina et al. (2022), Pookalchik et al. (2018), Savinykh and Cheryomushkina (2015), Smirnov (2022), Vasileva and Vyshegurov (2022), and others.

Baret and Guyot (1991), Cherepanov and Druzhinina (2009), Clevers and Gitelson (2013), Gitelson (2004), Hardisky et al. (1983), Hill (2013), Huan and Tang (2007), Huete et al. (1997), Jordan (1963), Kalichkin et al. (2019), Kurbanov et al. (2022), Rouse et al. (1973); and others pay particular attention to the use of vegetation indices.

Despite the interest in the research topic, the problem of applying vegetation indices in crop production in the conditions of digital agriculture and the prospects of future production advantages are studied insufficiently. The study uses correlation and regression analysis to determine the nature of the influence of the indices on the physiological state of winter wheat plants.

The studied winter wheat variety (Grom) is cultivated in the territory of the Agricultural Company "Kolos" JSC. The territory is located in a zone of temperate continental climate. The average annual air temperature is 9.5 °C. The average annual precipitation is 579.3 mm, of which 75% falls in the period with temperatures above + 10 °C.

Annual average air temperature and precipitation data that support the findings are available at https://figshare.com/ with the identifier https://doi.org/ https://doi.org/10.6084/m9.figshare.22737098.

The distribution of precipitation during the growing season of winter wheat is extremely uneven. In this regard, optimal crop rotation, a rational fertilizer system, a flexible crop set, and other agricultural technologies will help smooth the negative impact.

Intense dry winds recur five times a year. In summer, there are 50–60 days with dry winds, the probability of occurrence of which is 69%.

The soil cover of the land used is predominantly common carbonate thick low-humus chernozem.

The research uses a spectroradiometer (PSI PolyPen RP-410 NIR, Czech Republic), which makes it possible to functionally diagnose the physiological state of winter wheat through the vegetation indices by the reflectivity of the plants' leaf surfaces. The indices are determined in the seedling and tillering phase in different agricultural backgrounds:

- Control (without fertilizer);
- For the planned yield—7.5 t/ha ($N_{161}P_{74}K_{54}$);
- For the planned yield—10.0 t/ha ($N_{211}P_{100}K_{71}$);
- Recommended (existing in the Agricultural Company "Kolos" JSC) ($N_{118}P_{52}$).

To determine the vegetation indices, a spectral analysis of plants is conducted, which is calculated using the following formulas:

- Chlorophyll a—$PSSRA_a = R_{790}/R_{675}$, where R is the wavelength (Blackburn, 1998);
- Chlorophyll b—$PSSR_b = (1/R_{510}) - (1/R_{550})$ (Gitelson et al., 2006);
- Nitrogen—$N550 = R_{550}$ (López-López et al., 2016);
- Vogelman index—$VOG1 = R_{740}/R_{720}$ (Gurova et al., 2019);
- SIPI index—$SIPI = (R_{800} - R_{445})/(R_{800} - R_{680})$ (Sentinel-Hub Service, 2020).

The statistical significance of the results presented in Tables 1 and 2 is 0.95%. The tightness of the correlation relationship of the indices is characterized as follows:

- 0.1–0.3—weak;
- 0.3–0.5—moderate;
- 0.5–0.7—noticeable;
- 0.7–0.9—high;
- $\geq$ 0.9—very high.

It can also be positive or negative/inverse (with a minus sign). Statistical processing of the results was performed using Statistics 17.0.

## 3 Results

The photosynthetic work of plants is important for programming winter wheat productivity. The photosynthetic productivity of a crop depends on the state of the photosynthetic apparatus, which functions throughout the growing season of plants.

Regression analysis in the seedling phase for all agricultural backgrounds showed a very high degree of relationship between chlorophyll a (PSSRAa) and chlorophyll b (PSSRb) in different backgrounds of mineral nutrition—from 0.99472479 to 0.99840087. The correlation of the indices is also very high—from 0.994725 to 0.998401 (Table 1).

In the tillering phase, the regression analysis of the dependence of the indices (PSSRb on PSSRAa) decreases significantly. The minimum value is noted at the planned yield of 10 tons and is 0.16217152. The maximum value is at the recommended agronomic background—0.92723809. The correlation of the indices is 0.162172 and 0.927238, respectively.

Thus, during the transition from the seedling phase to the tillering phase, the plant organism changes the direction of

**Table 1** Relationship of vegetation indices by development phases of winter wheat

| Agricultural background | Phase | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Seedling | | | | Tillering | | | |
| Recommended | Regression results for the dependent variable: PSSRb<br>$R$ = 0.95848431 $R^2$ = 0.91869216 | | | | Regression results for the dependent variable: PSSRb<br>$R$ = 0.732185621 $R^2$ = 0.53609578 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.996028 | 0.901172 | PSSRAa | 1.000000 | 0.996028 | − 0.593124 |
| | PSSRb | 0.996028 | 1.000000 | 0.926662 | PSSRb | 0.996028 | 1.000000 | − 0.591773 |
| | VOG1 | 0.901172 | 0.926662 | 1.000000 | SIPI | − 0.593124 | − 0.591773 | 1.000000 |
| Planned yield of 7.5 tons | Regression results for the dependent variable: VOG1<br>$R$ = 0.91958225, $R^2$ = 0.84563152 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.85120642, $R^2$ = 0.72455236 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.994807 | 0.859502 | PSSRAa | 1.000000 | 0.994807 | − 0.831174 |
| | PSSRb | 0.994807 | 1.000000 | 0.888313 | PSSRb | 0.994807 | 1.000000 | − 0.845542 |
| | VOG1 | 0.859502 | 0.888313 | 1.000000 | SIPI | − 0.831174 | − 0.845542 | 1.000000 |
| Planned yield of 10.5 tons | Regression results for the dependent variable: VOG1<br>$R$ = 0.95344839, $R^2$ = 0.90906384 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.82752264, $R^2$ = 0.68479371 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.998401 | 0.900461 | PSSRAa | 1.000000 | 0.998401 | – 0.544887 |
| | PSSRb | 0.998401 | 1.000000 | 0.916607 | PSSRb | 0.998401 | 1.000000 | – 0.550807 |
| | VOG1 | 0.900461 | 0.916607 | 1.000000 | SIPI | − 0.544887 | – 0.550807 | 1.000000 |
| Control (without fertilizer) | Regression results for the dependent variable: VOG1<br>$R$ = 0.98297266, $R^2$ = 0.96623525 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.83428375, $R^2$ = 0.69602937 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRa | 1.000000 | 0.997604 | 0.945682 | PSSRa | 1.000000 | 0.997604 | − 0.712934 |
| | PSSRb | 0.997604 | 1.000000 | 0.961968 | PSSRb | 0.997604 | 1.000000 | − 0.712518 |
| | VOG1 | 0.945682 | 0.961968 | 1.000000 | SIPI | − 0.712934 | − 0.712518 | 1.000000 |

*Source* Compiled by the authors

physiological and biochemical reactions associated with the restructuring of the leaf pigment complex. Changes in the chlorophyll ratio (PSSRAa and PSSRb) reflect the dynamics of plant ontogenesis against the background of changing weather and climatic conditions.

Studying the effect of chlorophyll concentration in leaves and water content through the index VOG1 showed that the variables' regression dependence is high in all agricultural backgrounds in the seedling phase (from 0.91958225 to 0.98297266), as well as a high correlation relationship in the model "PSSRAa, PSSRb – VOG1." Apparently, the high combined effect of chlorophyll concentration and moisture content in plant leaves reflects their optimal ratio (Table 2).

In the seedling phase, the ratio of indices (PSSRAa, PSSRb – SIPI) is negative, indicating their inverse proportionality and manifested through the effect of carotenoid volume on chlorophyll concentration. There is a high correlation of indices in the model "PSSRAa, PSSRb – SIPI" (0.732185621–0.82752264) for all agricultural backgrounds. However, this relationship is reversed, as evidenced by the negative correlation.

During the tillering phase in the model "PSSRAa, PSSRb – VOG1," regression dependence of indices decreases (0.63145206–0.89613274) for all agricultural backgrounds.

Data on the relationship of vegetation indices in the tillering phase, which support the research findings, are

**Table 2** Relationship of vegetation indices in the seedling phase

| Agricultural background | PSSRAa, PSSRb, and VOG1 | | | | PSSRAa, PSSRb, and SIPI | | | |
|---|---|---|---|---|---|---|---|---|
| Recommended | Regression results for the dependent variable: VOG1<br>$R$ = 0.95848431, $R^2$ = 0.91869216 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.732185621 ,$R^2$ = 0.53609578 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.996028 | 0.901172 | PSSRAa | 1.000000 | 0.996028 | – 0.593124 |
| | PSSRb | 0.996028 | 1.000000 | 0.926662 | PSSRb | 0.996028 | 1.000000 | – 0.591773 |
| | VOG1 | 0.901172 | 0.926662 | 1.000000 | SIPI | − 0.593124 | − 0.591773 | 1.000000 |
| Planned yield of 7.5 tons | Regression results for the dependent variable: VOG1<br>$R$ = 0.91958225, $R^2$ = 0.84563152 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.85120642, $R^2$ = 0.72455236 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.994807 | 0.859502 | PSSRAa | 1.000000 | 0.994807 | –0.831174 |
| | PSSRb | 0.994807 | 1.000000 | 0.888313 | PSSRb | 0.994807 | 1.000000 | –0.845542 |
| | VOG1 | 0.859502 | 0.888313 | 1.000000 | SIPI | –0.831174 | –0.845542 | 1.000000 |
| Planned yield of 10.5 tons | Regression results for the dependent variable: VOG1<br>$R$ = 0.95344839, $R^2$ = 0.90906384 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.82752264, $R^2$ = 0.68479371 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRAa | 1.000000 | 0.998401 | 0.900461 | PSSRAa | 1.000000 | 0.998401 | – 0.544887 |
| | PSSRb | 0.998401 | 1.000000 | 0.916607 | PSSRb | 0.998401 | 1.000000 | – 0.550807 |
| | VOG1 | 0.900461 | 0.916607 | 1.000000 | SIPI | − 0.544887 | − 0.550807 | 1.000000 |
| Control (without fertilizer) | Regression results for the dependent variable: VOG1<br>$R$ = 0.98297266, $R^2$ = 0.96623525 | | | | Regression results for the dependent variable: SIPI<br>$R$ = 0.83428375, $R^2$ = 0.69602937 | | | |
| | Correlation | | | | | | | |
| | Variable | PSSRAa | PSSRb | VOG1 | Variable | PSSRAa | PSSRb | SIPI |
| | PSSRa | 1.000000 | 0.997604 | 0.945682 | PSSRa | 1.000000 | 0.997604 | – 0.712934 |
| | PSSRb | 0.997604 | 1.000000 | 0.961968 | PSSRb | 0.997604 | 1.000000 | – 0.712518 |
| | VOG1 | 0.945682 | 0.961968 | 1.000000 | SIPI | − 0.712934 | − 0.712518 | 1.000000 |

*Source* Compiled by the authors

available at https://figshare.com/ with the identifier https://doi.org/ https://doi.org/10.6084/m9.figshare.22737428.

Simultaneously, there is a decrease in the relationship in the model "PSSRAa, PSSRb – SIPI" (from 0.32721009 to 0.14446776) and an increase in the positive correlation between the indices (in the recommended scheme and control). This effect is probably due to increased chlorophyll (PSSRb), NPK ratio, and active air temperatures.

## 4 Conclusion

New knowledge about the productivity of winter wheat plants cultivated in the Chernozem zone of the Stavropol Territory was obtained. The effectiveness of using the models of interrelation between the indices "PSSRAa, PSSRb – VOG1" and "PSSRAa, PSSRb – SIPI" obtained by a digital device was shown.

This approach made it possible to objectively assess the chlorophyll indices (PSSRAa and PSSRb), determined as high mainly in the seedling phase and markedly high in the tillering phase (except for the scheme for the planned yield of 10 tons) for all agricultural backgrounds.

The models "PSSRAa, PSSRb – VOG1" and "PSSRAa, PSSRb – SIPI" reflected high rates of regression dependence of the variables during the seedling phase. However, the model "PSSRAa, PSSRb – SIPI" showed that their relationship is inversely proportional.

During the tillering phase, models "PSSRAa, PSSRb – VOG1" and "PSSRAa PSSRb – SIPI" reflected a decrease in

the correlation of variables (especially in relation to the SIPI index). Simultaneously, the model "PSSRAa, PSSRb – SIPI" reflected the fact that when the concentration of chlorophyll (PSSRb) increases, the correlation improves.

Thus, the data obtained makes it possible to fix the vegetative phase of plant development, establish the relationship of indices, and display the crop's physiological state.

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# Physical Condition of Soil in Sorghum Seeds Depending on Forecrop and Yield in Arid Zone Conditions

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**Abstract**

The research describes the results of studying the effect of grain sorghum forecrop on the agrophysical properties of the soil and their impact on fertility in the arid zone of the Stavropol Territory. The research was conducted on the crops of grain sorghum cultivated on such forecrop as winter wheat, silage corn, and sorghum in 2021–2022. The authors investigated such agrophysical properties of soils as productive moisture supply, water stability, structural and aggregate composition and density. The research object was grain sorghum "Zersta 97," cultivated on winter wheat "Knyaginya Olga," silage corn of "Krasnodar 291" hybrid, and sorghum "Zersta 97." Grain sorghum "Zersta 97" is referred to as a variety of Kaffir sorghum. Its best qualities are that the yield can reach up to 8.0 t/ha and the leaf mass can be up to 30 t/ha. The purpose of the variety is to produce grain that goes for forage, alcohol, and starch production. The variety shows increased performance in production and has a high workability of cultivation. Studies were conducted in the arid zone on dark-chestnut soils (Esaulko et al. in Agriculture 13:55, 2023; Volters et al. in IOP Conf Ser Earth Environ Sci 1076, 2022). The correct selection of a forecrop plays a significant role in improving soil fertility (Dorozhko et al. in Influence of winter wheat forecrop cultivated in the zone of sufficient moisture on productive moisture supply. In A. Yu. Krylovsky (Ed.), Youth agrarian science: Status, problems, and prospects of development: Collection of scientific works of Stavropol State Agrarian University, All-Russian Council of Young Scientists and Specialists of Agrarian Educational, and scientific organizations of Southern Federal district (pp. 66–70). Stavropol, Russia: Agrus.; Volters and Zhuravleva in Biological activity of soil depending on forecrop and main tillage in the zone of sufficient moisture. In Current issues of ecology and environmental management (Vol. 2) (pp. 160–162). Stavropol, Russia: Agrus.; Volters and Zhuravleva in Influence of forecrop and main tillage on the chernozem structure. In Current issues of ecology and nature management. International scientific and practical conference (pp. 497–499). Moscow, Russia: RUDN University). Studies were conducted at all stages of the growth and development of grain sorghum. According to the results, in the phase of spring tillering, there is a maximum reserve of productive moisture in winter wheat as a forecrop; this indicator reaches 25 mm in the arable layer and 135 mm in the meter layer. The maximum number of agronomically valuable aggregates was also determined in the tillering phase of winter wheat (76.4%).

**Keywords**

Predecessor • Winter wheat • Productive moisture reserve • Structural and aggregate composition • Water stability

**JEL Classifications**

R01 • F22 • F63 • J15 • J61 • O15

## 1 Introduction

The physical state of the soil is an important factor in reproducing soil fertility. It is determined by various properties such as structure, density, and water stability. These properties play a vital role in the soil's ability to hold water, nutrients, and air, which are essential for plant growth and development.

The farmer's task is to preserve and improve soil fertility. The soil's suitability to satisfy agricultural plants in the

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earthly factors of life is also related to this. Soil is the conduit for the supply of air, water, and nutrients to plants. The degree to which plants are provided with plant life factors is determined by soil regimes and soil properties. Thus, soil fertility is an integral indicator that reflects the soil processes occurring in the soil (Esaulko et al., 2016; Perederieva et al., 2017; Pismennaya et al., 2019; Volters & Tivikov, 2005; Volters et al., 2018).

Yield is an indicator of effective fertility. If rainfall in some years is much lower than normal during the growing season, yields are greatly reduced. In this case, to maintain the gross yields at the proper level, it is necessary to have an insurance crop in the crops.

This crop must have a yield not lower than that of corn, and preferably much better in terms of drought tolerance. In this case, we can talk about sorghum.

In bad growing years for winter wheat, and even its deaths in some cases, sorghum can be an insurance crop for reseeding areas occupied by winter wheat. Seeding sorghum is economically advantageous over other insurance crops, such as rape and sunflowers (Kapustin et al., 2022).

## 2 Methodology

The research aims to study the effect of different forecrop of grain sorghum on agrophysical properties of the soil and their impact on fertility in the arid zone of the Stavropol Territory.

For this purpose, such forecrop of grain sorghum as winter wheat, silage corn, and sorghum were selected.

The main objectives of this research are to study the reserve of productive moisture, structural-aggregate composition, soil pedality, and the number of water-stable aggregates as factors of soil fertility in sorghum crops.

The research was conducted on chestnut soils located in an arid zone.

The set problems were solved using the following methods:

- Determination of soil aggregate composition by dry sieving method, GOST 51232-98;
- Determination of water stability of soil structure by P. I. Andrianov's method, GOST 12232-89;
- Determination of soil moisture, maximum hygroscopicity, and productive moisture by weight method in meter layer, GOST 28268-89 (Dospekhov et al., 1987).

## 3 Results

Studies on the impact of sorghum forecrop on agrophysical factors of soil fertility were conducted in different phases of growth and development of sorghum in the arid zone on chestnut soils in 2020–2022.

The reserve of productive moisture required by plants directly depends on biological characteristics, weather conditions, soil and climatic conditions, and cultivation technology. Different crops require different growing conditions. Forecrop leave behind different amounts of moisture, physical soil conditions, and nutrients. Great importance is given to the choice of the main method of tillage, which directly affects the moisture-holding capacity of the soil.

Before sowing sorghum, the reserve of productive moisture in the 0.2 m layer of soil for winter wheat as a forecrop has a value of 22.8 mm, more than values for silage corn and grain sorghum by 2.8 mm and 3.4 mm, respectively (Table 1).

In the meter layer, the reserve of productive moisture also takes the highest values for winter wheat as a forecrop, corresponding to 132.2 mm. By the tillering phase of grain sorghum, there is the largest reserve of productive moisture, corresponding to 25.6 mm. By the phase of full ripeness, the reserve of productive moisture slightly decreases in all available forecrop; it is in the range from 10.4 to 13.3 mm in the arable layer; in the meter layer, there is a similar picture. The highest result of 105 mm was recorded for winter wheat.

Thus, higher rates are noted during the tillering phase in the arable and in the meter layer in all forecrop of grain sorghum.

The tillering phase provides the highest values of productive moisture in all forecrop of grain sorghum and in the arable and meter layers.

One of the most important factors of soil fertility is the soil structure (i.e., bonded aggregates that differ in size and qualitative composition, the ability of which to disintegrate is called soil pedality). The physical properties of the soil, such as water–air regime and tillage conditions, depend on soil structure, which, in turn, affects soil fertility.

Since soil structure is a dynamic indicator, it is capable of destruction and restoration under the influence of various factors. To keep the soil in a structural state and maintain it, it is necessary to know how to manage it. The size, porosity, mechanical strength, and water stability determine the structure's qualitative assessment.

Winter plants have a well-developed root system and can retain the soil from precipitation and meltwater in the fall and spring; they have a longer period.

Thus, cereal crops have a greater ability to form aggregated soil. Such soil prevents erosion and produces higher yields.

Factors such as wetting and drying, as well as thawing, shrinkage, root penetration into the soil, optimally moist soil, and tillage, affect soil structure.

According to the research results, before sowing grain sorghum, the number of agronomically valuable aggregates

**Table 1** Effect of grain sorghum forecrop on productive moisture supply in the arid zone (2020–2022), mm

| Growth phases | Layers (m) | Predecessor | | |
|---|---|---|---|---|
| | | Winter wheat | Silage corn | Sorghum |
| Before sowing | 0–0.20 | 22.8 | 20.0 | 19.4 |
| | 0–1.0 | 123.2 | 112.0 | 106.8 |
| Tillering | 0–0.20 | 25.6 | 22.3 | 20.1 |
| | 0–1.0 | 135.3 | 126.0 | 115.0 |
| Full ripeness | 0–0.20 | 13.3 | 11.6 | 10.4 |
| | 0–1.0 | 105.0 | 98.0 | 94.0 |

*Source* Calculated and built by the authors

**Table 2** Influence of sorghum forecrop on structure-aggregate composition in the arid zone in different phases of growth and development (2020–2022), mm

| Growth phases | Size of soil deposits (%) | Predecessor | | |
|---|---|---|---|---|
| | | Sorghum | Sorghum | Sorghum |
| Before sowing | 10 and more | 28.2 | 33.5 | 36.1 |
| | 10–0.25 | 66.8 | 62.9 | 58.9 |
| | < 0.25 | 5.0 | 3.6 | 5.0 |
| Coefficient of soil pedality | | 2.0 | 1.7 | 1.4 |
| Tillering | 10 and more | 18.8 | 22.5 | 25.5 |
| | 10–0.25 | 76.4 | 72.6 | 68.8 |
| | < 0.25 | 4.8 | 4.9 | 5.7 |
| Coefficient of soil pedality | | 3.2 | 2.6 | 2.2 |
| Full ripeness | 10 and more | 21.0 | 30.2 | 27.0 |
| | 10–0.25 | 74.2 | 69.8 | 68.2 |
| | < 0.25 | 4.8 | 5.2 | 4.8 |
| Coefficient of soil pedality | | 2.9 | 2.0 | 2.1 |

*Source* Calculated and built by the authors

has the greatest values for such a predecessor as winter wheat. It equals 66.8%, which is 3.9% more than for silage corn and 7.9% more than for sorghum as a predecessor (Table 2).

The clump fraction ranges from 28.2% to 36.1%. It is predominant in sorghum as a forecrop. The coefficient of soil pedality has a greater value for winter wheat as a forecrop, being equal to 2.0. It has values of 1.7 and 1.4 for such forecrop as silage corn and sorghum, respectively.

The number of agronomically valuable aggregates in the phase of spring tillering changes upward for all forecrop; the highest value of 76.4% corresponds to winter wheat as a predecessor, which is 3.8% and 7.6% more than for silage corn and sorghum as forecrop.

The clump fraction decreases; the highest value of 25.5% is noted for sorghum as a forecrop. The coefficient of soil pedality is in the range of 2.2–3.2. Greater importance is noted for winter wheat as a forecrop.

In the phase of full ripeness, the number of agronomically valuable aggregates decreases in relation to the tillering phase and ranges between 68.2 and 74.2%, with the highest value of 74.22% for winter wheat.

The amount of megastructure takes higher values. The maximum value is noted for silage corn as a forecrop (30.2%).

The coefficient of soil pedality becomes less in relation to the tillering phase and ranges between 2.1 and 2.9, with the highest value of 2.9 for winter wheat as a forecrop.

The water stability of soil aggregates is an important indicator for determining the soil's structural condition and its quality.

An important indicator of qualitative assessment of the structure is its size, porosity, mechanical strength, and water stability. Macroaggregates ranging in size from 0.25 to 10 mm are agronomically valuable.

Similar importance is given to the qualitative assessment of the structure, which is determined by its size, porosity, mechanical strength, and water stability (i.e., the soil's ability to resist the destructive action of water). The macrostructure (aggregates ranging in size from 0.25 to 10 mm) is the most agronomically valuable.

Before sowing sorghum on such a forecrop as winter wheat in all phases of growth and development of sorghum, higher rates of water-stable aggregates are registered, ranging from 72.2 to 80.1%.

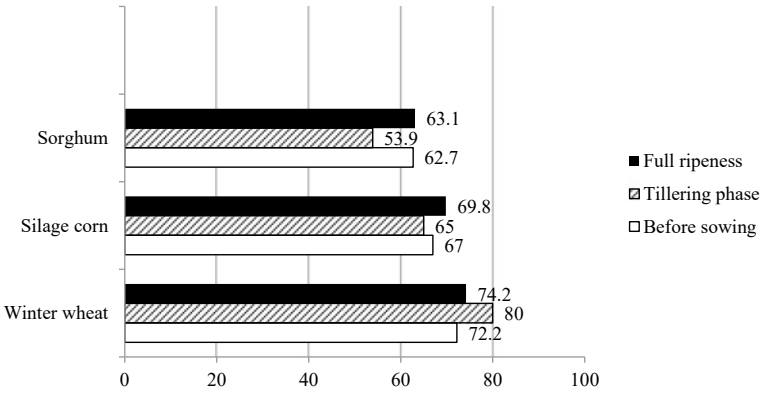


**Fig. 1** Percentage of water-stable aggregates depending on sorghum forecrop. *Source* Calculated and built by the authors

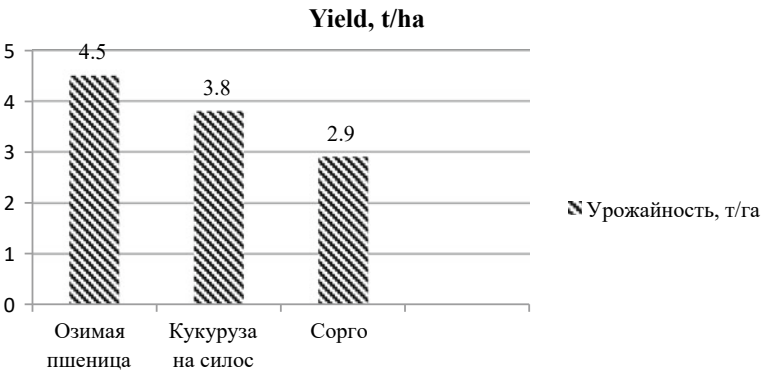


**Fig. 2** Yields of grain sorghum depending on forecrop. *Source* Calculated and built by the authors

Silage corn and grain sorghum as a forecrop show lower values than for winter wheat.

If silage corn was used as a forecrop, the number of water-stable aggregates was in the range 65.0–69.8%, which corresponds to a good watertight structure, and for sorghum as a forecrop in the range 53.9–63.1%.

Before sowing sorghum, the number of water-stable aggregates corresponds to 62.7%, which is good water stability. In the tillering phase, the number of water-stable aggregates decreases and becomes 53.9%, which is consistent with a satisfactory structure. To the phase of full ripeness, the number of water-stable aggregates reaches 63.1%, which corresponds to good water stability (Fig. 1).

Winter wheat as a forecrop gives the highest number of water-stable aggregates in the tillering phase, ranging from 77.2 to 80.0%, which corresponds to excellent water stability. In all phases of growth and development of winter wheat, the number of water-stable aggregates corresponds to the excellent water stability of the structure, with the greatest number of water-stable aggregates in the phase of spring tillering.

As calculations show, forecrop influence the yield of the crop and the efficiency of its cultivation on several evaluation indicators.

To reduce production costs and obtain the highest yield of field crops, it is necessary to combine deep and conventional mouldboard correctly and rationally. The right forecrop plays a significant role. Thus, its selection should be of great importance.

Forecrop can change the physical and chemical properties, as well as moisture, which affects the acceleration of soil microbiological processes and the mobilization of nutrients that can significantly increase yields.

The highest yield was obtained for such a forecrop as winter wheat (4.5 t/ha). Silage corn and sorghum showed lower rates of 3.8 t/ha and 2.9 t/ha.

$HCP_{05}$ is 0.6. The difference between the yield of sorghum for such a predecessor as winter wheat is 4.5 t/ha, which is 0.7 more than for silage corn and 1.6 t/ha more than for sorghum as a predecessor. The difference is greater than 0.6. Thus, the difference between the options is significant.

The physical condition of the soil plays a crucial role in determining the yield of grain sorghum in arid zones. The use of different forecrop can affect the physical condition of the soil and, consequently, its yields (Fig. 2).

## 4 Conclusion

We studied the soil condition in sorghum crops depending on the forecrop and its yields. The research was conducted in the conditions of the arid zone on dark-chestnut soils.

Analyzing the results, we can conclude that grain sorghum in the arid zone is recommended to cultivate on such forecrop as winter wheat and corn for silage. The reserve of productive moisture in the arable and in the meter layers on this forecrop in all phases of growth and development of sorghum gave higher results. The prevailing number of agronomically valuable aggregates was also observed on this forecrop. Sorghum yields were also higher for winter wheat and silage corn in these crops.

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# Factors and Conditions for Ensuring the Sustainable Development of Viticulture and Winemaking in Russia

Maria N. Tatarinova, Marina V. Feskova, Vladimir G. Shirobokov, Natalia N. Volkova, and Tamara I. Logvinova

**Abstract**

The research aims to identify the conditions and factors that determine the sustainable development of viticulture and winemaking in Russia. The authors use general scientific methods, including analysis, synthesis, comparison, analogy, and generalization. Sustainability plays a key role in viticulture and winemaking, as evidenced by the current attention to this issue. Nevertheless, the sustainable development principle is widely debated; it has a substantial impact on the elements and circumstances influencing the industry's development. The subject area of this research is the current state of the industry of viticulture and winemaking. The research deals with the priority components of sustainable development based on the optimization of production processes and the search for optimal conditions of economic management, labor, economic support, consulting, and information support. During the research, the authors identified several problems currently faced by producers of grapes and winemaking products. For solving the problems indicated, the authors suggest monitoring the efficiency of grant project implementation through a unified reporting format, while also streamlining reporting processes to encompass a single comprehensive report on the fulfillment of financial obligations across all regulatory bodies within the digital economy context. The formation of a closed production cycle requires the creation of production and marketing cooperatives.

**Keywords**

Entrepreneurship • Viticulture • Winemaking • Sustainable development • Conditions and factors • Food security

**JEL Classifications**

E23 • H25 • Q14 • Q18 • O25

## 1 Introduction

The key issue facing any country is ensuring food security. The wine industry is a promising area of economic activity for Russia. The Russian wine market is far from saturation and is actively developing. An acute shortage of raw materials and government subsidies create the preconditions for establishing new vineyards. Hence, this research aims to determine the factors and conditions contributing to the enduring growth of viticulture and winemaking in Russia.

The formulated goal of scientific research has defined the following tasks:

- To determine the directions for the advancement of viticulture and winemaking;
- To study possible forms of state support of the industry;
- To study contemporary methods of farming, increasing investment, etc.

Scientists around the world are concerned with sustainable development issues. A considerable number of scientific works are devoted to solving this issue (Abdikerimova & Moldabekov, 2021; Cherdantsev & Robinson, 2009; Gizatullin & Troitsky, 1998; Meadows et al., 1972; Pavliashvili, 2014; Zhou et al., 2021).

In 2015, countries participants to UN engaged in discussions about sustainable development objectives until

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E. G. Popkova et al. (eds.), *Sustainable Development of the Agrarian Economy Based on Digital Technologies and Smart Innovations*, Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-031-51272-8_45

2030. They embraced 17 Sustainable Development Goals (SDGs) and formulated a 15-year strategy to realize them. One SDG has to do with food security and the elimination of hunger. The achievement of this SDG is intricately linked to the advancement of sustainable agriculture. Russia has endorsed the Strategy for Sustainable Development of Rural Areas of the Russian Federation until 2030 (Government of the Russian Federation, 2015).

S. Ohmart gives an insight into the concept of sustainability in farming, "Sustainability includes everything we do on the farm, including the economy, the environmental impact of everything we do, and all aspects of human resources, including not only us and our families but also our employees and the surrounding community" (Egorov et al., 2020).

The development of viticulture and winemaking became the basis for the works of famous academic economists (Galitskaya & Martynova, 2006; Kulik, 2017; Kulov & Khairbekov, 2011; Muduev & Melkhashev, 2012; Nasibov, 2018; Tolmacheva et al., 2021).

E. J. Dolan, D. Lindsay, R. Damari, and A. Hosking (Abdikerimova & Moldabekov, 2021; Egorov et al., 2020; Pavliashvili, 2014; Zhou et al., 2021) considered the problems related to the development of the agro-industrial complex (AIC) and winemaking.

The exploration of issues concerning the advancement of viticulture and winemaking industry has always remained relevant and important for the global economy and Russia. The current state of food security requires the development of concepts of a complex interaction between the state and agricultural companies.

## 2 Materials and Methods

In the contemporary agricultural policy of the Russian Federation, the model of support and development of commodity producers is based on incentivizing agricultural production. It aims to achieve indicators set by the Doctrine of Food Security of the Russian Federation (Approved by Presidential Decree of January 21, 2020 No. 20) (Presidential Executive Office, 2020).

Viticulture and wine products are particularly important to society under conditions of intensive economic development. This underscores the necessity of finding a strategic direction for fostering competitive development of the viticulture and winemaking (commodity) market of the AIC.

The research materials encompass findings from statistical studies of the Federal State Statistics Service of the Russian Federation and an expert assessment of organizations that lead the winemaking and viticulture industry. In today's conditions, the developed theoretical and methodological sustainable development concepts made it possible to identify factors and conditions for developing viticulture and winemaking, considering the industry's characteristics.

The research uses general scientific methods, including analysis, synthesis, comparison, analogy, and generalization.

## 3 Results

In accordance with the Food Security Doctrine of the Russian Federation, ensuring food security stands as a fundamental pillar within the realm of long-term national security (Presidential Executive Office, 2020).

To successfully implement the chosen strategy, the government actively supports the priority areas of AIC and small-scale farming. The subjects of the Russian Federation receive subsidies for creating a system to support farmers, develop rural cooperation, and provide reimbursement to producers for part of the expenses incurred in purchasing feed for dairy cattle, the production and sale of crops, etc.

State support regulates stable expansion in the key sectors of the country's food security and aids in reaching set benchmarks to fulfill the population's requirements (Fig. 1).

From 2019 to 2021, there was an increase in the production of certain agricultural products: fruits and berries—by 13.9%, grapes—by 10.8%, livestock and poultry for slaughter—by 3.7%, milk—by 3.1%, cereals and leguminous crops—by 0.2%. Concurrently, there is a decline in the cultivation of sugar beet, potatoes, vegetables, and flax fiber, primarily attributed to unfavorable weather conditions. In general, the achieved indicators of agricultural production make it possible to conclude that most of the domestic needs for food are ensured.

Viticulture and winemaking stand out as one of the most profitable and intensively developing sectors of the AIC. To fulfill these objectives, the Government of the Russian Federation endorsed the "Long-term program (road map) for the development of viticulture and winemaking in the Russian Federation" (Government of the Russian Federation, 2022).

The priority direction of the road map is to ensure the stable operation of entities encompassing the entire production cycle, from harvesting, storage, and transportation to trade in the final products—wines and cognacs.

Each production cycle has a strictly defined function and is technologically, organizationally, and economically interconnected with the other. The presence of well-established relationships ensures the stable operation of the entire system. The system should be based on the following postulates: protection of nature and the environment, reduction of food waste, sustainable management of production processes, and regulation of trade flows.

The Ministry of Agriculture of Russia developed the Federal project "Stimulation of viticulture and winemaking,"

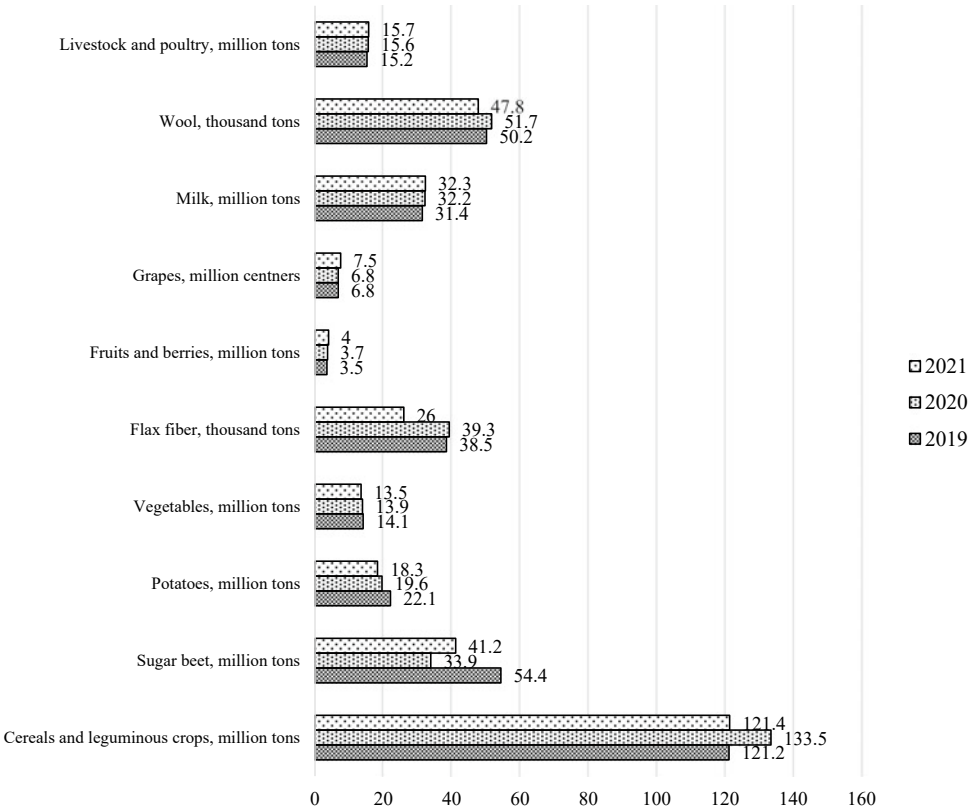


**Fig. 1** Increase in the output of specific categories of agricultural goods. *Source* Compiled by the authors based on Federal State Statistics Service of the Russian Federation (2022)

which has been implemented since 2022. The implementation of this project will increase the area of vineyards of fruit-bearing age by 35% by 2030. For this purpose, the government plans to provide support of 26.4 billion rubles. In 2023, the funding will reach 3.5 billion rubles, 46% more than in 2022. Additionally, the department is currently compiling a federal register of viticultural land, which is necessary to assess and analyze the potential of viticulture development.

The result of the decisions taken can be already observed. Between January and October of 2022, wine production surged to 27 million decaliters (an increase of 9%); sparkling wine saw an increase to 11.7 million decaliters (an increase of 26.7%); and cognac production increased to 7.2 million decaliters (an increase of 14.7%). The primary volume of production is targeted for the domestic market. In this regard, special attention is now paid to developing a wine consumption culture. The Southern Federal District retains its position as the top wine producer, with the North Caucasus Federal District ranking second.

The analysis of the development of viticulture and winemaking indicates the intrinsic potential for developing this area. Simultaneously, there remains a question related to reorienting the existing principles of doing business to meet current conditions of digitalization, greening, and technical re-equipment. The progressive development of winemaking organizations faces several challenges. The global challenges are as follows:

1. The lack of domestic raw materials. The production of wine in Russia primarily relies on imported wine materials. The problem of meeting domestic needs for grapes and wine in Russia remains urgent. The annual consumption of fresh grapes in Russia amounts to 400–430 thousand tons, of which only 65–75 thousand tons are produced in Russia; the rest has to be imported. The government has taken measures to expand the area under vineyards. Nonetheless, the challenge of insufficient funds and a shortage of high-quality planting materials still persists. To solve the identified problem, a subprogram "Development of viticulture, including nursery production" was adopted. The subprogram's objectives are to improve grape assortment and the use of virus-free planting material for planting and new highly effective technologies of grape cultivation, given environmental conditions of growth. The program aims to increase the production of planting material of grape plants by 15 million pieces by 2025.
2. Difficulties with financial support. The procedure for obtaining a soft loan is long, and reporting requirements are complex. The investment cycle in viticulture is characterized by a significant duration. It takes at least 8–

10 years to get the first results from a project. Determining the feasibility of state support of the industry for such a timeframe is not always possible. An important issue is the monitoring of the effectiveness of grant projects, which is advisable to implement with a single reporting form—Grantee Passport. This document could be generated on the grantor's portal in an online format. To reduce the administrative burden in a digital economy, it is also possible to fill out a Single Grantee Report to monitor the performance of funding commitments.

3. Excise tax rates are increased for certain types of alcoholic beverages. Excisable products include wine materials (excise tax rate—31 rubles/l in 2020, 32 rubles/l in 2021, and 33 rubles/l in 2022) and grapes (excise tax rate—30 rubles/t in 2021 and 32 rubles/t in 2022). The taxpayer is entitled to tax deductions in the case of proper use of excisable raw materials. It was decided to reduce the VAT rate on operations with grapes from 20 to 10%.
4. The lack of infrastructure for marketing, production, and storage of viticulture products. This problem can be largely solved by developing the activities of production and marketing cooperatives. In this case, we need a well-developed regulatory component of agricultural cooperation, which will save the added value of the products produced rather than giving it to the intermediary.

The sustainable development of the viticulture and winemaking industry depends on external and internal conditions and factors. It is provided through the development and interaction on various aspects of activities, ranging from organizational, managerial, technological, and marketing to financial and investment (Fig. 2).

Having analyzed the approaches to the sustainable development concept of viticulture and winemaking, the authors come to the conclusion that the development would

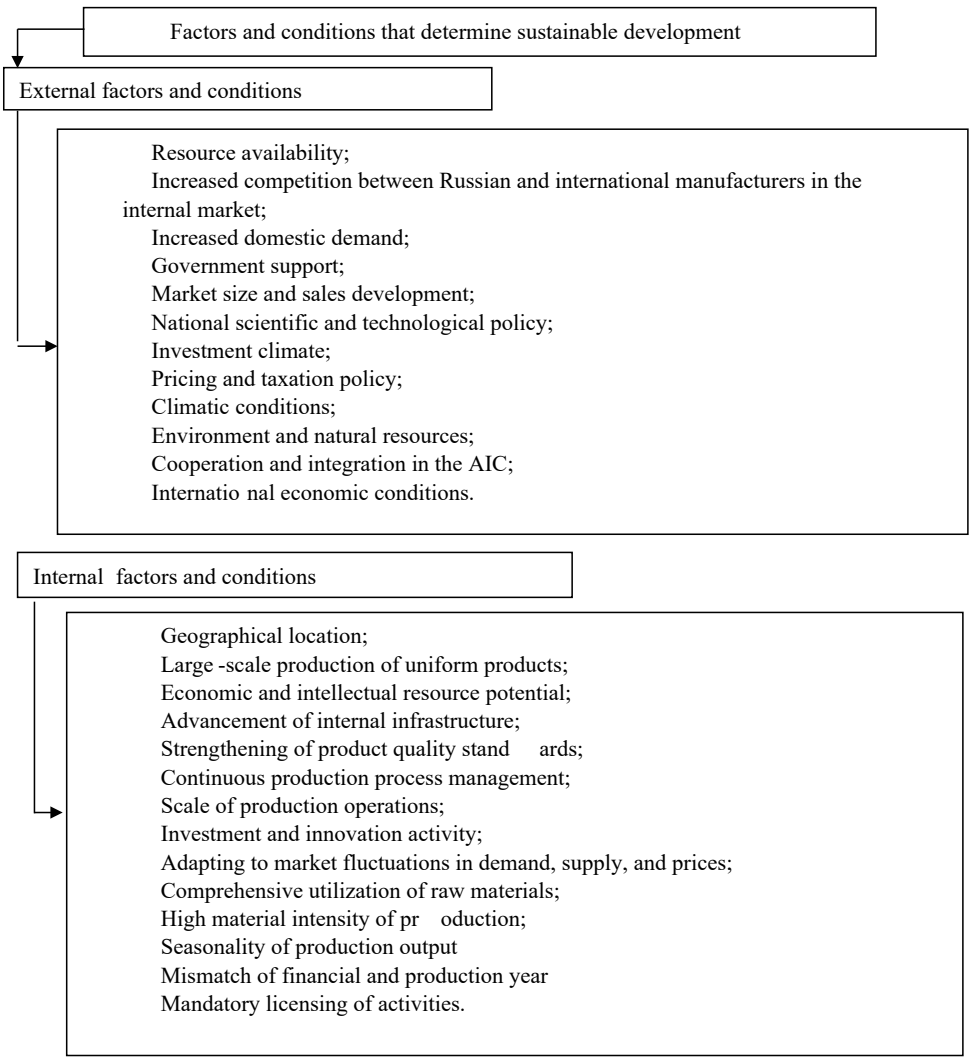


**Fig. 2** Factors and conditions for the sustainable growth of entrepreneurial activity in viticulture and winemaking. *Source* Compiled by the authors

be considered sustainable in the case of intensive methods of expanded reproduction. This is the approach that will satisfy business owners and consumers.

## 4 Discussion

During the research, the authors analyzed and systematized factors and conditions to ensure the sustainable development of entrepreneurial activity in viticulture and winemaking. The proposed directions for enhancing efficiency focus on ensuring an optimal balance between the economic interests of all stakeholders and improving the efficiency of production and sales of viticulture and winemaking products.

Sustainable development of viticulture and winemaking is related to the effectiveness of state support, the analysis of development parameters, and administrative burden. The research identified several problems faced by producers of grapes and winemaking products at the current stage, including the lack of domestic raw materials associated with a shortage of high-quality planting material, difficulties with financial support and reporting, increased rates of excise tax on wine and wine materials, and the lack of infrastructure for marketing, production, and storage of wine products.

This determines the main points of this research.

Monitoring the efficacy of grant projects should involve employing a unified reporting format—the Grantee Passport, which could be generated in an online format on the grantor's portal. This approach will offer a comprehensive analysis of the progress of each project, along with a statistical evaluation of outcomes (regionally and nationally). As a result, the reduction of cases of inefficient use of grant funds, theft, and fraud is expected.

To reduce the administrative burden, we recommend reducing the number of reporting forms to one report on the execution of funding obligations for all regulatory agencies. In a digital business environment, the Single Grantee Report can consider all needs of regulatory bodies and can be transmitted automatically with the electronic signature of the entrepreneur.

A closed cycle of production activities is necessary for entrepreneurship in viticulture and winemaking to compete and develop. Production and marketing cooperatives can solve this problem. This form of integration will make it possible to independently form added value, set procurement prices, and increase the capacity of production processes and product quality.

The authors concluded that Russia has significant prospects for developing viticulture and winemaking. There is a need for quality and environmentally friendly products. Moreover, there is a desire of businesses to produce these products. Regions should be given the right to determine their priorities and direct funds to where there is production efficiency.

## 5 Conclusion

The search for sustainable development of viticulture and winemaking must begin with the regions. Creating a flexible financing system, reducing the administrative burden, and developing the cooperative movement are the main conditions for development in this direction. Changing the agricultural and industrial course to the intensive development of entrepreneurship in viticulture and winemaking will solve the need for high-quality and healthy food and ensure national food security in the near and distant future.

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# Using Visual-Block Programming Environments to Create Robotic Systems

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**Abstract**

The research aims to substantiate the use of a visual block programming environment to prepare future teachers using robotic systems. Education faces the challenge of keeping up with the widespread introduction of robots and digital technologies into industry and everyday life. Robotics and robotic systems are becoming part of today's technological culture and human activity. This requires new approaches to learning at all levels of education. A school is a high-tech educational complex in which advanced technical teaching aids are introduced and used. In accordance with the fundamental concept of the content and structure of general education, technical teaching aids must be combined with new technologies for teaching academic disciplines. Robotics and robotic systems are becoming a new and important element of the content of today's education. In this regard, it is necessary to provide future teachers with the necessary knowledge about intelligent robotic systems and the possibility of their application in the educational process. The research analyzes the existing popular visual-block programming environments in the field of programming and robotics. Using the Tinkercad visual-block environment in the educational process is justified for teaching schoolchildren and training students in pedagogical specialties.

**Keywords**

Robotics • Robotic systems • Robotic kits • Visual blocks • Programming

**JEL Classification**

I230

## 1 Introduction

The first programming languages appeared in the 1860s. Working with computers required special complex skills to control them through programming languages. By the time the first personal computers appeared, there were many programming languages, they were different, and it took a long time to learn how to use them. Programming languages were studied in higher educational institutions in the relevant specialties. Since 1985, the subject "Informatics" has been introduced into the set of school subjects for high school students. The first programming language that was then studied was Basic. In subsequent years, the following programming languages were studied in the school course with varying success: algorithmic language (Ershova), Pascal, C/C++, and Python. The basics of programming were studied in grades 7–9; an in-depth programming course was taught in grades 10–11. The biggest problem in learning various programming languages was the correct syntactic writing of the program (Abaidullin & Abaidullin, 2019; Filippov, 2021).

In recent years, there has been a tendency to move to an earlier study of the basics of programming due to the emergence of such a subject as "Robotics" and the development of robotization in modern industries. The main emphasis in the application of programming is placed on the practical component—writing programs to control a robot or process. During training, students have to write programs of varying complexity and in fairly large numbers. In this regard, syntactically correct writing of program text becomes very important for young programmers (Blockly.Ru., n.d.; Romanovskaya et al., 2022).

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## 2 Methodology

Any robotic kit makes creating structures of various types and complexity possible. Students of all ages can create such structures. Programming a robot is a difficult task because, in addition to programming specific movements, it is necessary to use the power of the motors on the ports and the readings of the sensors. Therefore, robotic designers based on environments that use visual components are especially popular. This simplifies the robot programming process; even preschoolers can work with visual blocks (Golikov, 2017; Sorokin & Soldatenko, 2017).

Visual block programming is one of the latest developments in facilitating robot programming. Visual-block programming resembles the game "erector." Each separate block is a "piece" of the finished code, which has its own name and meaning and gives a certain property or function to the future program. A workable program is obtained if these blocks are assembled correctly (Gornov, 2021; Volkova et al., 2023).

This approach can be used to control a character on a computer screen, program robots, create 3D models, and develop virtual rooms.

Nowadays, most robotics software developers use scratch-like visual-block programming languages.

The most common robotics kits in schools are as follows:

- Lego Education WeDo 2.0;
- Lego Education Mindstorms EV3;
- Lego Education SPIKE Prime;
- VEX IQ;
- Educational set "Quantum";
- Electronic designer Evolvector;
- Arduino.

These kits are designed for different age groups of students and have their own programming environments. In recent versions, they all switched to Scratch-like visual-block programming environments. Figure 1 shows examples of such programming languages.

Visual-block programming environments are especially popular in the early stages of learning programming. A good visual-block programming environment can completely eliminate syntax errors at this stage of learning. However, with large amounts of block code, it becomes difficult to control the project visually. Additionally, visual block programming is limited in the blocks that the user can use. To create complex projects, the user will have to learn a programming language (Litvinov, 2012; Polyakov, 2021).

Let us consider the most popular visual-block programming environments: Scratch, Google Blockly, EduBlocks, and Tinkercad.

Scratch (n.d.) is a visual programming environment based on actions (events) on objects. It is focused on teaching programming to primary and secondary school students, developing creative abilities, and increasing logical thinking. Created as an extension of the Logo language and Lego, this environment allows users (mostly aged 8–16) to learn computer programming by working on meaningful projects such as animated stories and games. A key design goal of Scratch is to support self-directed learning through work and collaboration with peers. After the project is created in Scratch, it can be placed on the official website. Some robotic designers can use this programming environment as a way to control objects on the screen using sensors and motors on the assembled robot via Bluetooth. There is an online version.

Google Blockly (n.d.) is a visual-block programming language editor developed by Google. It allows users to create programs using only a set of typical logical blocks. It can be used to create block visual programming languages and custom editors. The advantage of Google Blockly is its availability over the Internet. Program development is performed directly in the browser. During the creation of a program in blocks, intermediate results are automatically written in one of the five built-in languages. The program can be saved and reloaded in JavaScript, Python, PHP, Lua, and Dart format. It is possible to use the Russian language in the description of the blocks. Based on this programming environment, one can create an environment to control a specific robot.

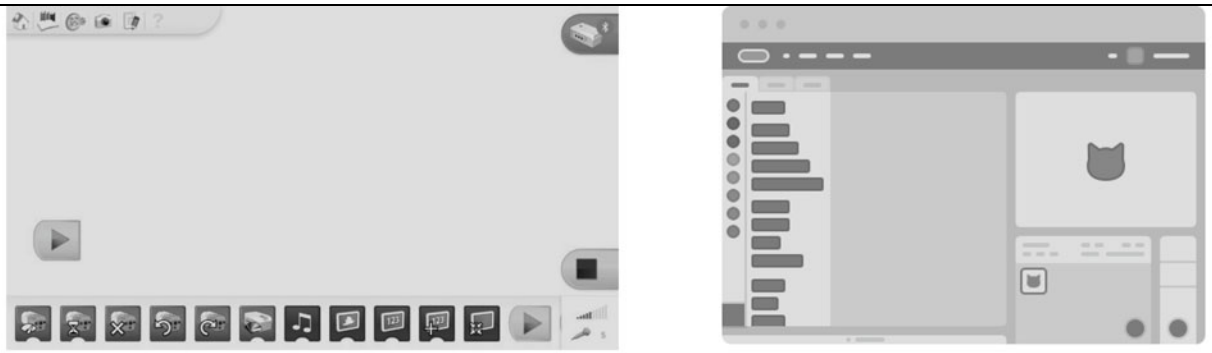
EduBlocks (n.d.) is an online educational platform, a free tool that helps users learn how to write programs in text-based languages such as Python or HTML using a block-based algorithm-building system (like in Scratch). The website has free access to methodological developments for lessons created on this platform. All materials are presented in English. It is possible to install the environment on a computer.

Tinkercad (n.d.) is a web application for 3D design, working with electronic devices and writing code. Tinkercad allows users to create and modify 3D design shapes using block code, create and program electronic circuits using a block programming language or C/C++, and emulate the operation of fairly complex projects without physically connecting electronic circuits.

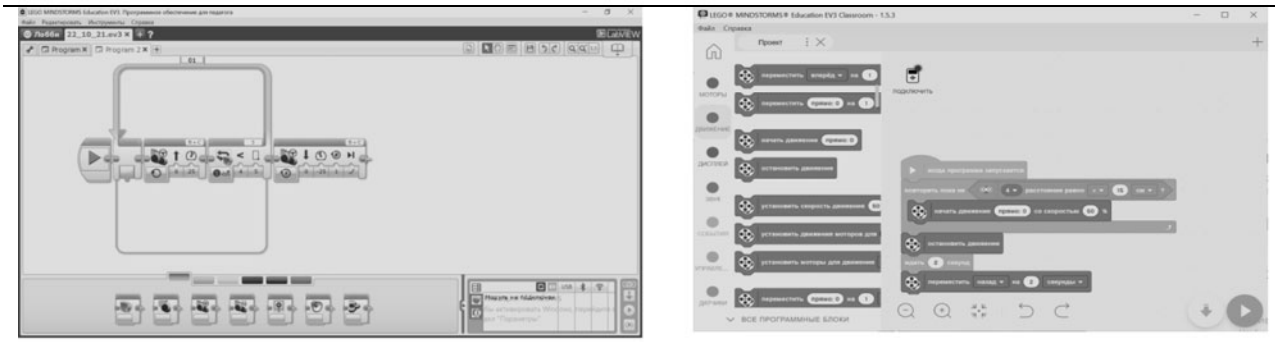
Table 1 compares visual-block programming environments for various constructors.

Scratch is designed to teach the basics of programming to younger students. It can connect motors and sensors to program an object on the screen. EduBlocks, Google Blockly, and Tinkercad can be used for students at the initial stage of learning to program, with a transition to a text-based programming language at later stages of learning.

Lego Education WeDo 2.0



Lego Education Mindstorms EV3



VEX IQ

**Fig. 1** Comparison of changes in visual-block programming environments for various designers. *Source* Compiled by the authors

Among the presented visual-block programming environments, we highlight the Tinkercad environment. This environment can be used at different stages of learning. First, the "3D Project" section can be used to teach students how to create 3D models with further prototyping on a 3D printer as one of the blocks of learning the basics of robotics. The same block can also be used when studying the course "Computer modeling" in the section "Construction of computer graphic models." In practice, this section is often used to build three-dimensional images in the "Computer graphics" section of the "Multimedia technologies" course for students of various specialties, as a free graphics editor that does not require the installation of a program on a computer. The section "3D-project" is used to create 3D models during the course "Designing robotics" by students with a specialty in "Technology." Second, using the "Code blocks" section, a user can create dynamic, parametric, and adaptive projects. Working with such projects can be used to teach initial programming and algorithmization. Later, it can be used to develop VR projects. In practice, this section was used in the course "Modern information technologies" for the initial training of students of the specialty "Russian language and literature" in the basics of creating three-dimensional dynamic scenes. Third, the "Circuits section" can be used to study electronics, programming, and process simulation. Moreover, users can start programming even if they do not know programming languages at all because it is possible to program in blocks at the initial stage of training. In this

**Table 1** Comparative table of visual-block programming environments for various constructors

| | Lego Education WeDo 2.0 | Lego Education Mindstorms EV3 | Lego Education SPIKE Prime | VEX IQ | Quantum | Evolvector | Arduino |
|---|---|---|---|---|---|---|---|
| Programming environment | Scratch 3.0 | EV3 Classroom | SPIKE App | VEXcode IQ | Scratch 2.0 | Studio Evolvector | TinkerCAD |
| Price | Free software (there is an online version) | Free software | Free software (there is a web application) | Free software (there is an online version) | Free software (there is an online version) | Comes with a set (there is an online version) | Online environment |
| Developer | The Lifelong Kindergarten Group at the Massachusetts Institute of Technology | Group LEGO | Group LEGO | VEX Robotics | The Lifelong Kindergarten Group at the Massachusetts Institute of Technology | "Evolvector" company | Autodesk |
| Block groups | Movement, appearance, sound, events, controls, sensors, operators, variables, and other blocks | Motors, movement, displays, sound, events, controls, sensors, operators, variables, and my blocks | Motors, motion, lighting, sound, events, controls, sensors, operators, variables, and my blocks | Display, sounds, events, control, measurement, operators, variables, my blocks, and comments | Movement, appearance, sound, pen, data and blocks, events, control, sensors, operators, and robot | Logic, loops, math, variables, text, arrays, and functions | Output, input, control, material data, variables, comments, forms, data, markup, and editing |
| Ability to create your own character | Yes | No | No | No | Yes | No | Yes |
| The presence of the "Help" or "Help" section | There is a help section in English | There is a help section in English | There is a help section in English | There is a help section in English | Detailed manual in Russian | Detailed manual in Russian | There is a help section in English. One can use a web page translator |
| Age category | 1–4 grade | 5–7 grade | 5–8 grade | 7–9 grade | 4 grade + | 8 grade + | 8 grade + |
| Ability to switch to a text-based programming language | No | MicroPython | Python | C++, Python | No | Prescribed in parallel in C++ | One can write in blocks and see the result in C++. One can write in C++ |

*Source* Compiled by the authors

section, the environment makes it possible to check the actions of robotic systems using the example of working with the Arduino microcontroller (2023). This section is widely used in the courses of "Robotics," "Robotic systems," "Automation and robotics," and "Modeling of processes and systems" for future teachers of mathematics, computer science, physics, and technology.

The main features of the Tinkercad simulator for the development of robotic systems on the Arduino board are as follows (n.d.):

- Online platform;
- Convenient graphics editor for visual construction of electronic circuits with a parallel rendering of the circuit diagram;
- Pre-installed set of models of most popular electronic components;
- Emulator of electronic circuits;
- Simulators of operation of sensors and instruments of external influence; if one changes the readings of the sensors, it is possible to track how the system reacts to them;
- Built-in editor Arduino IDE, the possibility of step-by-step debugging of the program;
- Visual-block code editor Arduino;
- The possibility of programming in blocks, with viewing the text version of the program;
- Ready-made Arduino projects with diagrams and code;
- The ability to integrate with the rest of the functionality of Tinkercad;
- Built-in tutorials, a collection of ready-made projects.

This environment can be used in distance learning, which is especially important in today's education.

After developing and testing a robotic system created in the Tinkercad environment, it can be implemented on a real Arduino board. Even if the program was written using blocks, in the Tinkercad environment, the program is written in parallel in a text programming language. This text code can be copied into the Arduino IDE and uploaded to a real Arduino board. To do this, it is enough to assemble the corresponding real model, copy the text code of the program, and load it into the microcontroller. After a little debugging, the robotic system will be ready for operation. Debugging is usually associated with a variety of Arduino boards.

## 3 Results

Using the Tinkercad visual-block environment in the educational process in training future teachers is preferable compared to other environments. This is especially true for future teachers of a technical orientation—computer science, technology, and physics. For future teachers of other specialties, this environment can be used as an environment for teaching the basics of algorithmization and 3D modeling as part of a general course of new information technologies and as an environment for getting to know the basics of VR and AR technologies. The environment can be used for distance learning.

## 4 Conclusion

The Tinkercad visual-block environment can become a motivator for students to create and put into practice interesting educational robotic systems based on the Arduino microcontroller. It can be the first step in creating virtual environments using block programming. The ability to use the environment remotely and showcase projects is an added bonus.

Each of Tinkercad's features individually is perhaps better implemented in other services. Taken together, they make Tinkercad useful for teaching robotics and robotic systems.

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# Methodological Basis for Assessing Negative Factors of Mineral Extraction on Beds of Rivers and Watercourses

Nurlanbek A. Kaldybaev, Nematilla A. Sopubekov, Aliima T. Mamatkasymova, Guldana N. Ramankulova, and Guljan Sh. Toktomuratova

**Abstract**

The research focuses on the methodological basis for assessing the negative factors of the extraction of sand and gravel mixture on the beds of rivers and watercourses to take prompt measures to minimize their impact on the environment. The research objectives are as follows: (1) to identify possible negative consequences of intensive extraction of sand and gravel material from the bed of rivers and watercourses; (2) to develop a methodology for assessing the technogenic impact of the extraction of sand and gravel mixture on the floodplain of the Kugart River; (3) and to develop a working algorithm to minimize the negative aspects of mining in the coastal zones of rivers using digital methods of information processing. Analytical and field-expedition methods, GIS technologies, and mathematical modeling methods were used to solve the research problems. The authors compiled a research algorithm to study the negative effects of mining sand and gravel on the Kugart River bed. The authors developed an ecological and economic model to monitor the balance of positive and negative impacts of mining on floodplains. The used model showed that the main threat lies in destroying the previously built bank protection dams, leading to flooding and waterlogging of settlements and territories. Calculations proved that further continuation of mining operations would cause multimillion-dollar environmental damage to the economy. The research results can be used to improve environmental management mechanisms and prevent emergencies in the coastal zones of rivers and watercourses.

**Keywords**

Mining • Geoecology • Methodology for assessing negative factors • Sand and gravel mixture • Disturbance of streambeds • Prevention of emergencies

**JEL Classifications**

Q01 • Q55 • Q56 • R15

## 1 Introduction

The existence of humankind has been closely linked to the consumption of natural resources, including the extraction of various minerals. Mining has gradually emerged as one of the most important sectors of the economy that has the most direct and visible impact on nature. Mining alters the land cover and natural ecosystems surrounding mining sites (Gassler et al., 2018; Wang et al., 2020). Mining poses serious and highly specific threats to biodiversity (Sonter et al., 2018). Increased mining is exacerbating climate change and pollution. There are many examples of resource extraction projects around the world that have been a disaster for the environment in the absence of proper management (Bebbington et al., 2018; Garcia et al., 2017; Schwarz-Herion & Omran, 2020). The analysis of risks in the mining industry and economic aspects of the development of small and technogenic deposits in the Kyrgyz Republic was considered by Kaldybaev et al. (2022).

The extraction of minerals in the immediate area of water bodies is of particular concern. Sand and gravel mix (SGM), which is a good construction material, is mainly mined at the bottom of water bodies. SGM geologically accumulates precisely in mountain vegetation and marine and lake–river sediments, being sedimentary rocks of water-glacial and lake-alluvial origin. The mining of SGM results in a significant transformation of channel cross-sectional shape and channel topography during irretrievable soil removal and

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depth erosion. The cause of the channel transformation that accompanies SGM mining is also the disturbance of sediment runoff. The quarrying process intercepts a significant proportion of channel sediment runoff, resulting in downstream erosion of the bed and the development of erosion upstream of the quarry as local gradient and flow velocity increase due to changes in topography. With the increasing anthropogenic load on the environment, the mutual influence of people and nature on each other increases. Excessive anthropogenic load and constantly dangerous natural processes eventually create an emergency situation threatening human life and health and the integrity of the surrounding infrastructure and territories. Uncontrolled mining in river beds and floodplains negatively affects the environment, creating the risk of emergencies such as flooding, waterlogging, and the destruction of the banks of water structures.

The conducted literature review shows that various approaches and methods have been tried in world practice to regulate conflict situations in mining. The term responsible mining was introduced due to increasing conflicts between local communities and mining companies. This term means a so-called social license to mine (Sairinen et al., 2012). This tool calls for the exploration and development of subsoil resources in a socially and environmentally responsible manner. The meaning of the social license is that mining companies should make every effort to ensure their operations are supported by the public and local communities. In response to the negative impacts of mining, global initiatives such as the "Extractive Industries Transparency Initiative," the World Bank's "Extractive Industries Overview," and the "Mining, Minerals, and Sustainable Development" have emerged. These initiatives have raised awareness of negative practices in the extractive industries; many governments have followed suit and started implementing good governance practices (Corrigan, 2017; David-Barrett & Okamura, 2016; Sabyrbekov & Overland, 2022). Simultaneously, the part of the problem related to the mining ecosystem in floodplains remains unresolved because, in this case, the conflict situation covers a wide range of issues closely interconnected with the environmental components.

One example of a negative impact on the aquatic ecosystem is the situation in the Jalal-Abad Region of the Kyrgyz Republic, where erosion has intensified in the floodplains of the Kugart and Kara-Unkur rivers due to intensive extraction of SGM. Dozens of quarries are engaged in spontaneous extraction of SGM without proper geological substantiation of reserves on the floodplains of the two rivers. In such conditions, pursuing economic profit without considering risks and threats can lead to environmentally catastrophic consequences. Consequently, the study of negative factors associated with the extraction of SGM in the zone of watercourses is an urgent problem that contributes to the prevention and prophylaxis of emergencies.

This research aims to generalize the methodological basis for assessing the negative factors of mineral extraction on river beds and watercourses to improve the mechanisms of environmental management and prevention of emergencies in the Kyrgyz Republic. The research objectives are as follows:

- To identify possible negative consequences of the intensive withdrawal of SGM from river beds and watercourses.
- To develop a methodology for assessing the anthropogenic impact of SGM mining on the floodplain of the Kugart River.
- To develop an algorithm of works on minimizing negative aspects of mining in the coastal zones of rivers through digital methods of information processing.

## 2 Materials and Methods

Informative data from the Ministry of Emergency Situations of the Kyrgyz Republic on the forecast of development of dangerous natural processes on the territory of the Jalal-Abad Region and the summary of the Hydrometeorological Center of the Kyrgyz Republic on water flow in the Kugart River in the flood period for hydrological monitoring were used to identify negative factors that have an impact as a result of SGM extraction in the coastal zones of rivers. To develop a methodological framework for the integrated assessment of the impact of SGM mining, the authors used analytical and theoretical methods of summarizing information, including literature sources (Gudkova, 2020; Parfenov & Sivkov, 2015; Savichev, 2016; Werner et al., 2019). To visually assess and model anthropogenic and geo-ecological processes by the method of field-expedition studies, a trip was made to the locations of sinkholes in the Kugart, Kara-Unkur, and Kara-Darya rivers located on the territory of the Kyrgyz Republic.

## 3 Results

Analysis of specialized literature on the considered issue has revealed that the ecosystem of rivers in Kyrgyzstan is affected by three main groups of negative impact factors: activation of dangerous geodynamic processes, geochemical pollution, and high anthropogenic load. The last process is caused by the extraction of SGM at unauthorized quarries. In the Kyrgyz Republic, a considerable number of deposits of SGM with total reserves of 491.6 million $m^3$ have been explored for the needs of the construction industry. Currently, 86 large deposits of SGM are known, most of which are located on terraces and floodplains of rivers. With the

approval of the regulation on the state registration of rights for the extraction of sand and gravel mixture and loam based on the Resolution of the Government of the Kyrgyz Republic No. 43 (February 5, 2019), the authority on the issues related to subsoil use for these types of minerals were transferred to local governments. Unfortunately, district administrations often lack competent experts in assessing exogenous geological processes (EGP). Consequently, licenses are issued to developers without considering anthropogenic and natural factors. Uncontrolled mining in river beds and floodplains negatively affects the environment, creating the risk of emergencies such as flooding, waterlogging, and destruction of the banks of water structures.

The main types of negative environmental impacts of quarrying in floodplains are as follows:

- Uncontrolled withdrawal of natural resources (SGM reserves are temporary; depending on climatic and hydrometeorological conditions, they may be replenished by sediment transport).
- Pollution of the air basin by gaseous and suspended matter emissions.
- Chemical pollution of water, causing damage to agricultural land.
- Changes in the territory's relief, hydrogeological conditions of the construction site, and adjacent territory.
- Endangering the vital activity of the population and the territory's integrity (e.g., erosion, floods, mudflows, landslides, and rockslides).
- Destruction of existing coastal protection structures.
- Changes in the social conditions of the population.

It is necessary to calculate and forecast channel deformations and water levels resulting from the organization of quarries in river channels and floodplains, as well as to plan a set of engineering measures to eliminate or significantly limit the negative impacts of quarries, especially on the environment.

Based on the results of the generalization of methodological recommendations for assessing the impact of quarries on the river ecosystem, it is advisable to be guided by the following algorithm of action:

- To study the hydrological characterization of the river (hydrological monitoring).
- To conduct a reconnaissance survey of river floodplains to study anthropogenic load on water bodies and aerial photographic surveys, including drone (UAV) overflights.
- To conduct an instrumental assessment of channel deformations (toposiometry of disturbed coastal areas).
- To calculate, model, and forecast erosion processes.
- To conduct digitization of information and mapping.
- To develop measures to reduce negative consequences.

Various geo-information technologies are widely available for predicting and assessing the environmental impact of mining operations. Figure 1 presents a map-scheme of a survey of the Kugart River section in the zone of intensive SGM mining as a methodological example. The survey was compiled by the authors using the ArcGIS program.

To make operational management decisions on the rational use of water resources, the following parameters characterizing the river state can be entered into the database for detailed hydrological monitoring purposes:

1. River length ($L$), m.
2. Average width ($b\ av$), m.
3. Coefficient of river narrowing – from top to bottom ($K_{nar}$), by sections.
4. Area of the river basin ($F$), $km^2$.
5. Weighted average absolute height ($H_{av}$), m.
6. River gradient coefficient ($C_{gr}$), %.
7. Glaciation, in %.
8. Type of river feeding (snow or glacial).
9. Multiyear average total discharge of the river ($Q$), $m^3\backslash s$.
10. Maximum discharge during the flood period, ($Q_{max}$), $m^3\backslash s$.
11. Water turbidity (maximum and average) ($S_{av}$ *and* $S_{max}$), $kg\backslash m^3$.
12. Average multiyear sediment load, tons/year.
13. Total length of bank protection structures (dams), km.
14. Observation period, years.

In such maps, the degree of danger and boundaries of erosion processes can be marked with different colors or dotted lines. It is advisable to process satellite images of the area to determine the boundaries of quarry impact. For convenience, the most acceptable satellite map is Google Earth, which provides adjustments and changes in decimal degrees.

The most crucial aspect of the methodological aspect of assessing the negative impact of construction materials extraction on floodplains is to justify management decisions. Theoretically, based on the results of monitoring and assessment of river channel deformations, two options can be adopted: implementation of engineering and technical measures for channel regulation or prohibition of mineral extraction. Many factors can play in favor of the first option, including the organization of SGM extraction in a special gentle regime or in specially designated areas. Despite the simplicity of the solution, the second option may create a

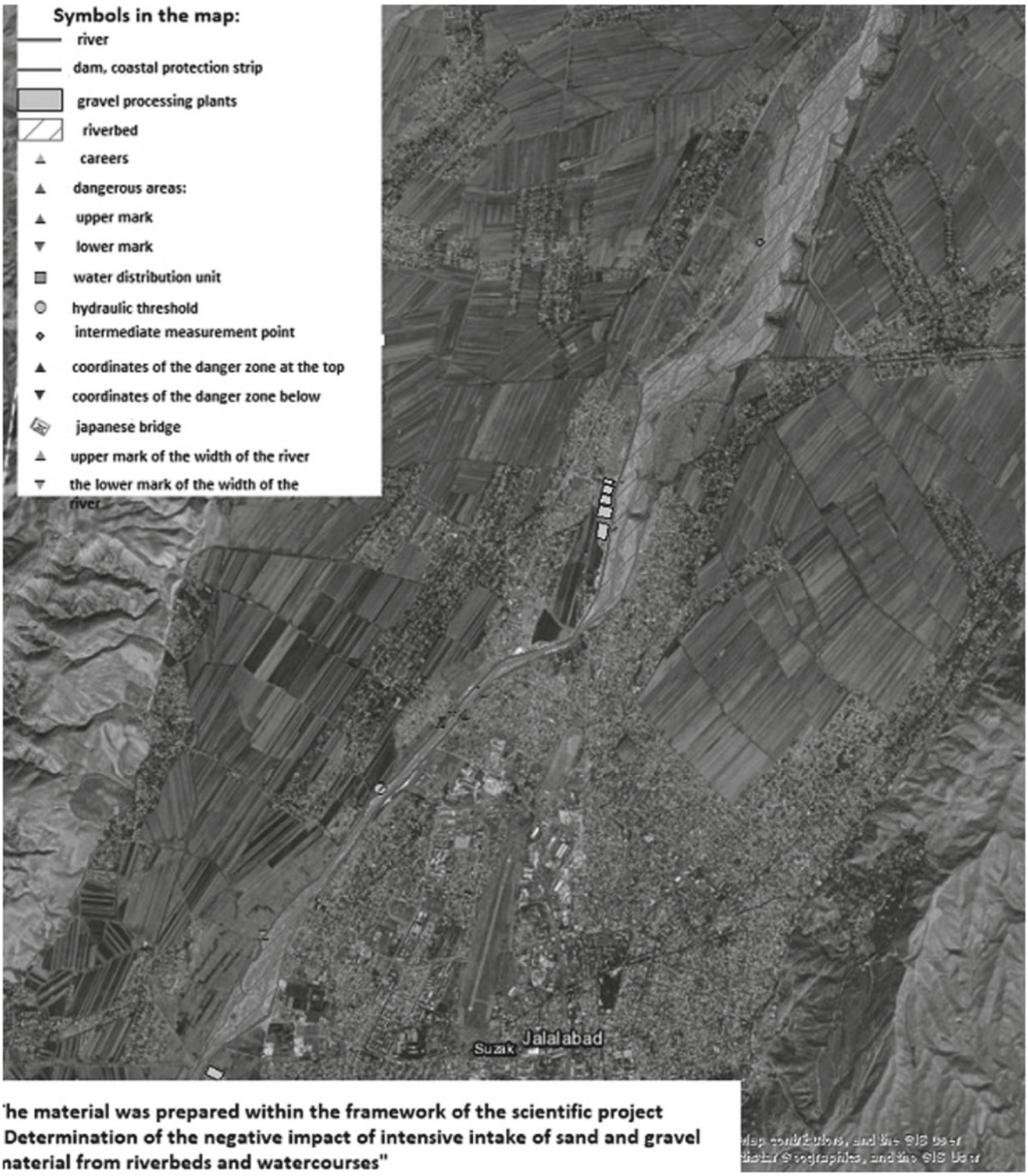


**Fig. 1** Map-scheme of reconnaissance survey of the Kugart River section in the zone of intensive SGM mining. *Source* Developed by the authors

conflict of interest. To optimally address this issue, the authors propose an ecological and economical method built in the principles of equilibrium, like lever weights (Fig. 2). According to this model, one side of the scale includes the factors proving the economic benefits of mining, and the other side includes the factors emphasizing the environmental harms. If the environmental factors are outweighed, the decision to ban mining is made accordingly.

The constituent factors of both components can be compared by two types of independent criteria: socio-political and material. To evaluate the first of them, experts may be involved. They establish the value and weight of each component using the ranking method.

Depending on the considered situation, the single assessment criteria can be supplemented and improved. Quantitative data on revenues and amounts of environmental damage should be collected to compare material criteria.

## 4 Discussion

Despite the abundance of literature sources, solving methodological issues of studying the impact of SGM quarry development on floodplains has been difficult because the task covers socio-political and socio-economic aspects of the issue along with the usual engineering methodology. The following points can be outlined as disadvantages of the known methodologies for estimating channel deformations:

- The labor intensity of hydrological studies, which makes it difficult to obtain information in the time allotted.
- The need for a multi-temporal channel survey.
- High uncertainty in measuring or calculating parameters used in indirect methods of assessing and predicting channel deformations.

The proposed methodology emphasizes GIS technology and remote sensing. Processing of satellite images significantly accelerates analytical work. According to the proposed methodology, an electronic cadastre of the aquatic ecosystem can be created based on the collected research materials, allowing users of different levels to make operational management decisions.

As an example of the realization of the developed methodology in the part of the ecological-economic model, let us consider the assessment of the impact of SGM mining processes on the floodplain of the Kugart River (Fig. 1). During the reconnaissance visit, the authors found out that there are five quarries for extracting SGM on the sections of the river flowing through the city of Jalal-Abad; there are processing enterprises (crushing and sorting units and even an asphalt plant) in the embankment zone. The annual capacity of one quarry averages 10 thousand $m^3$. According to the annual reporting standards of the State Committee of Geology (Goskomgeologiya), the average total annual income of such a quarry ranges from 1.5 to 5 million soms.

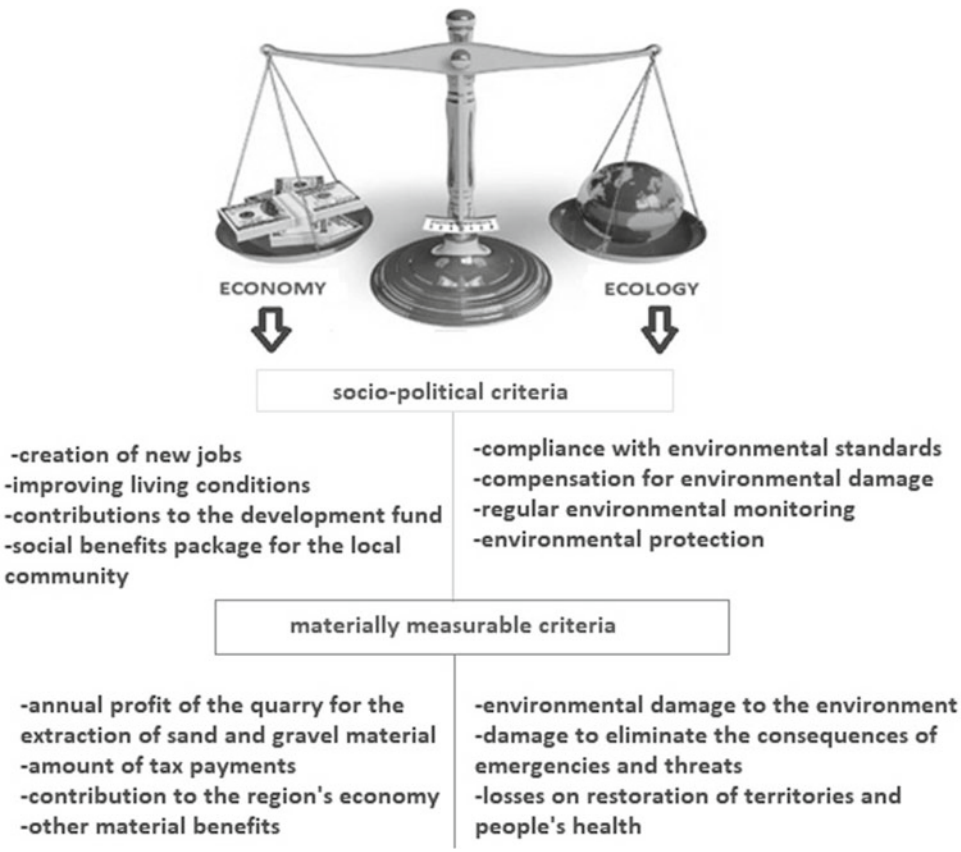


**Fig. 2** Simplified ecological and economic model for assessing the environmental impact of mining operations. *Source* Developed by the authors

The authors put this information into the left side of the model, to the "economy" item. On the right-hand side, under the item "ecology," the authors summarize the ecological damage caused by mining operations by carriers. Due to the quarrying of SGM, the bed of the Kugart River in the section with a length of more than 14,500 m is subject to bottom erosion, which led to the lowering of the river bed by 3–4 m. As a result, the bases (aprons) of bank protection dams have been destroyed in some places, which threatens the stability of structures subordinated to the service "Selvodzaschita" under the Ministry of Emergency Situations of the Kyrgyz Republic. The bank protection dams, totaling 33,836 m, have a book value of 214.4 million soms and protect 3239 households and 852 ha. of agricultural land from the harmful impact of mudflows and floods. According to preliminary calculations, the amount of expected damage is 2.1 billion soms. It is apparent that the model tipped the scales in favor of preserving the "ecology" balance, which leads to the conclusion that it is expedient to stop the extraction of SGM or implement regulatory measures for rational extraction.

## 5 Conclusion

Based on the generalization and systematization of existing methods for assessing the impact of mining on the aquatic ecosystem, the research algorithm is compiled, and an ecological and economic model of the mining process in river channels is developed. Using the model, analysis of SGM extraction indicators on the floodplain of the Kugart River showed that the ecological load on the river is exceeded, creating a threat of emergencies. The main threat is the destruction of the previously built bank protection dam, leading to flooding and waterlogging of settlements and territories. Calculations have proven that further continuation of mining operations will cause multimillion-dollar environmental damage to the economy. The Ministry of Emergency Situations is currently carrying out preventive works to prevent an emergency situation by constructing a hydraulic sill in the areas of bottom erosion activation. It is necessary to conduct further scientific research to develop technological recommendations for the rational development of quarries, considering the geological peculiarities of sand and gravel deposits. One of the promising ways to minimize the consequences of SGM extraction on the floodplains of rivers is the construction of special sediment traps and flow velocity dampeners at the headwaters of rivers, considering the area's geomorphology and topography.

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# Development of Land Surveying Science and Education as Factors of Reliable Provision of the Country's Food Security

Timur V. Papaskiri and Stanislav A. Lipski

**Abstract**

The research analyzes the state institutional component of contemporary agricultural and land relations. Based on the analysis results, the research reveals several problems that emerged during this period: unclaimed land shares, cessation of cultivation of previously developed agricultural lands, and concentration of agricultural lands in large agricultural farms. The prolonged effects of these processes are still underestimated. The authors point out that proper land management is a prerequisite for successfully resolving these problems. Considering the history of domestic land use planning and the factors affecting it, the key factors at this stage of land management in Russia are its proper legal support and the improvement of relevant education and objective processes in the system of agricultural land use. Digitalization is universal, affecting land management, education, and all other sectors. Taking these factors into account will make it possible to realize the land potential more effectively and reliably to ensure the country's food security.

**Keywords**

Food security • Agricultural land • Privatization • Unclaimed land shares • Abandoned land • Agricultural holdings • Land surveying • Digitalization

**JEL Classifications**

O13 • Q24 • Q56 • Q57 • R14

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## 1 Introduction

Sustainable development of the agro-industrial complex (AIC) lies at the heart of reliable food security in the country. In modern Russia, a special doctrine has been approved (Presidential Executive Office, 2020). It determines that factors to ensure this are resource and institutional conditions. Simultaneously, land suitable for agricultural production is the key agricultural resource (Goncharov & Rau, 2018).

According to the UN FAO, the area of agricultural land is less than 5 billion hectares globally, out of which 1.4 billion hectares is arable land. Additionally, less than 0.5 billion hectares can be developed for agricultural production. However, the use of this potentially usable 10% is very problematic due to unfavorable climatic conditions, topography, and insufficient water supply (Kireycheva, 2018; Loiko, 2009). The world's population continues to grow; according to some sources, the world's already-developed land resources will be sufficient to provide food for no more than 12 billion people (Pitersky, 1999). In this regard, the land factor (land availability, rationality of land use, and reclamation of abandoned lands) becomes a key factor in terms of ensuring food security and the country's competitiveness in the global market of agricultural products and food. Post-Soviet Russia, with 122 million hectares of arable land, is among the top four countries in terms of arable land reserves (Loiko, 2009).

Moreover, the land suitable for agricultural use is located unevenly. In fact, most of them are a belt covering regions in the southwestern part of Russia (Fig. 1). Therefore, decisions made in the land sphere have clearly expressed regional specificity and require proper land planning support. These factors (current problems) predetermine a significant increase in the role of land management. In some ways, it even makes the current situation similar to the Stolypin agrarian reform a little more than 100 years ago.



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**Fig. 1** Share of agricultural land in the total area of the regions. *Source* Compiled by the authors based on (Volkova, 2018)

## 2 Methodology

The research uses the following materials:

- Acts of authorized structures (Government of the Russian Federation, 2021; Presidential Executive Office, 2020).
- Their reports on the topic under study.
- Scientific publications on the studied problem, including the works of Goncharov and Rau (2018), Khlystun et al. (2020), Ksenofontov et al. (2019), Lerman and Shagaida (2007), Loiko (2009) and Wegren (2012).

In processing the selected materials, the authors used abstract-logical, statistical, historical, and graphical methods.

## 3 Results

If we analyze the state-wide institutional component of contemporary agricultural and land relations, we should note several problems that emerged during this period:

- The problem of unclaimed land shares formed during the privatization of agricultural lands in the early 1990s. It was assumed that some part of the privatized farmland would not be claimed (not everyone was endowed with commercial abilities, but the entire rural population was endowed with shares, the mechanism of their distribution was not quite fair in some respects, and the rules for making transactions with them were complicated and not based on the rules of law for the first ten years). However, if the non-claiming of 5–7% of shares was predictable, then the status of every third share (34 million hectares out of 114 million hectares (Khlystun et al., 2020)) was certainly not assumed. These shares, both claimed (having a specific owner) and unclaimed (currently transferred to municipalities), are to be allocated into plots in the near future. Along with the "big" privatization of land, by dividing most of the country's agricultural holdings into shares and distributing such shares to their employees, other mechanisms of changing the institutional component of agricultural land use were applied. Additionally, the delimitation of non-privatized lands between different levels of public ownership began (and still continues) (Lerman & Shagaida, 2007; Prishchepov et al., 2013; Wegren, 2012). The options for land privatization and the current results of this delimitation are shown in Fig. 2. Most of the land was transferred into private ownership back in the 1990s. By 2002, 129 million hectares (7.6% of the country's land fund) were transferred into the ownership of citizens and legal entities. By 2022, the corresponding figures increased insignificantly—133 million hectares (7.8%). Moreover, most of the land was transferred into private ownership due to such privatization methods as the formation of shares, a significant part of which remained unclaimed. Various legal measures are used to resolve the situation with unclaimed shares. However, they cannot have the required effect without proper land surveying.
- The problem of abandoned land within agricultural plots granted to (or even purchased by) certain private individuals. The government was forced to adopt a state program (Government of the Russian Federation, 2021) to re-develop about 13 million hectares of such lands. In this case, there is a high probability of errors without land management. First, (1) there is a risk of simply not identifying the lands to be involved in the program, as there is still no reliable information about agricultural lands and their rights holders. The reporting systems of the Ministry of Agriculture of Russia, Rosreestr, and regional bodies do not coincide in many respects. Moreover, they have never coincided with the results of agricultural censuses conducted in the current century.

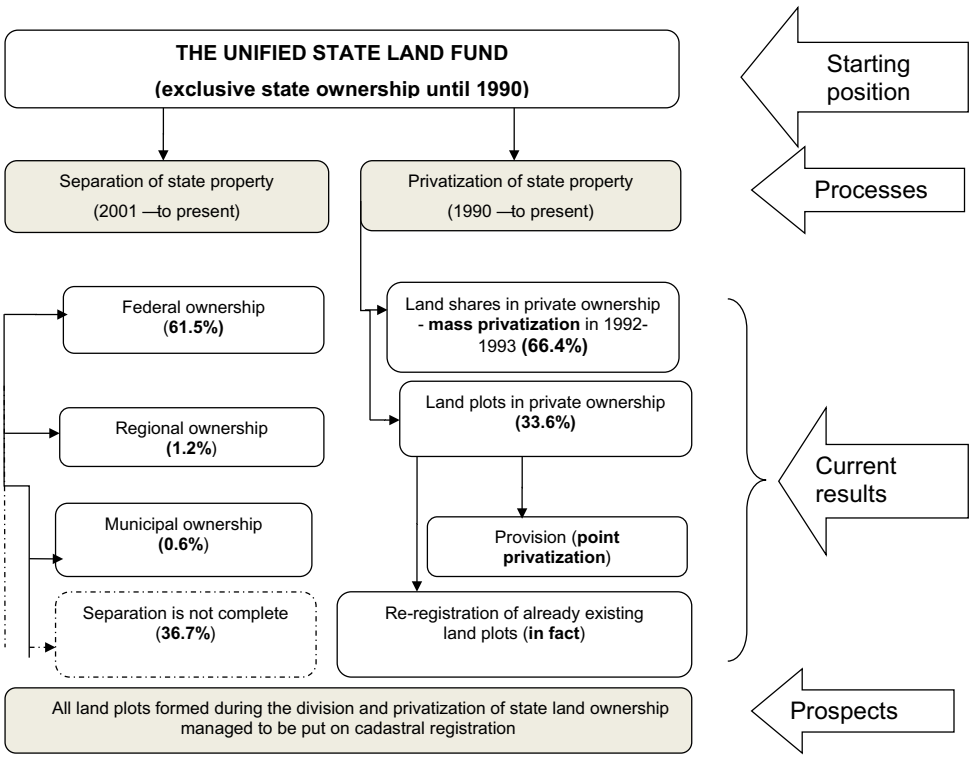


**Fig. 2** Options of institutional transformation in the land sphere of post-Soviet Russia. *Source* Compiled by the authors

Second, it is quite possible that the courts may refuse to satisfy claims for the seizure of abandoned land. Third, new owners, to whom the seized plots will be transferred as a result of tenders, may also repeat the previous negative experience of inefficient use of acquired lands.

- The problem of concentration of agricultural land in large agricultural enterprises (e.g., Miratorg, Prodimex, Rusagro, etc.). This process is assessed ambiguously (Khlystun et al., 2020; Ksenofontov et al., 2019; Polunin, 2016). In our view, such an assessment should be based on a comparison of the rationality of land use and farming efficiency before and after such concentration.

The emergence of these problems was, to some extent, the result of the state policy in the agricultural and land sectors pursued during the 1990s. In general, it turned out to be quite effective (in terms of implementing specific tasks—to privatize agricultural land, reorganize agricultural farms, develop farming, increase land plots for gardens and subsidiary farms of citizens, etc.). Simultaneously, implementing these decisions was contradictory, not always consistent, and partly erroneous. The reason for this is seen in the fact that for most of the post-Soviet period, managerial decisions in the agricultural and land sectors were focused on current goals, with no consideration of the prolonged consequences entailed by the mechanisms for achieving these goals. Most importantly, they were not supported by land surveying developments (except for the very early period of reforms, in which land surveying organizations were involved rather "out of inertia").

That is, the peculiarities of farmland privatization in post-Soviet Russia (its order, terms, conditions, range of participants, and inconsistency of state policy), the established rules and concepts of agricultural turnover, and not the most successful ways of solving the problems mentioned above have led to the emergence of prolonged institutional factors directly affecting food security and international trade (not so apparently) in agricultural products. For example, Russian agrarians are currently facing the task of increasing export supplies. Nevertheless, this task requires additional resources, including land; it is not always easy to seize abandoned land from a private owner.

A prerequisite for the successful resolution of these problems is proper land management.

The history of land management in the Russian Empire and the USSR, as well as its role in today's Russia, differs in many respects from European countries. This fact is due to the vast expanse of Russia compared to other countries and the lower population density. After all, even with the current level of technological sophistication (e.g., aerospace survey methods, artificial intelligence, digitization of land data, and various possibilities to modify this data), the available data on lands and plots and its accuracy is still not comparable to countries in densely populated Europe. Accordingly, the

legal acts determining the procedure of land surveying (until the early twentieth century—land measuring) were of a public-law nature.

The Stolypin reform of the early twentieth century was a turning point in the centuries-long development of Russian land management. The result of that reform was a qualitatively new, more multidimensional composition of formerly purely technical land surveying and accounting works—they were supplemented with qualitatively new content (organizational, managerial, and economic aspects). A new role was legally enshrined in a special law "On land management" (1911).

The final understanding of the essence and content of land management in Russia, its role and place in the system of land relations, and regulation on land management was formed after the nationalization of all lands of the Soviet period. It turned out that during the Soviet period, almost all land use regulators that were used then (and are still used now in a slightly modified form) either became part of land management or were carried out to ensure it. Moreover, Soviet land management was identified with the general state management system of land use. It is not accidental that the adoption of the law on land management (in 2001) occurred even earlier than the adoption of the Land Code of the Russian Federation and other federal laws regulating the land sector.

However, in post-Soviet conditions, new factors and circumstances have emerged.

The first of them was the agricultural and land reform of the early 1990s. On the one hand, land management provided for the reform (special funds were formed, and the land was transferred from agricultural farms to local authorities and the population). On the other hand, the reform reduced the ability of the government and agricultural farms to finance land surveying works (and their demand). Thus, the performance of such traditional types of work as the development of on-farm and inter-farm land management projects practically ceased. Land surveyors focused on land acquisition (mainly for plots for collective gardening). The role of land management as an instrument of state land management was forgotten.

The second factor was the introduction of a new cadastre in 2008—real estate, the provision of which (formation of plots) was transferred from land surveyors to cadastral engineers.

Finally, the third, purely legal, factor included the following:

1. In what conditions and how the law on land management was adopted: cardinal updating of the entire array of land law norms in the very beginning of the 1990s, replaced by the lacunae of the specified legal sphere in the second half of the same decade (Lerman & Shagaida, 2007), and significant update of almost all key institutions of land law in the last 5–7 years (except for land management).
2. How this law was then transformed (the current version is 13). The point is that almost all changes made to it are the exclusion from its text of such objects and types of works that traditionally were in the sphere of land management. Some of the excluded works were transferred to cadastral engineers. For other works, it became unclear who should do them (e.g., to determine the boundaries of various zones).

Additionally, in the nearly quarter of a century that has passed since the adoption of this law, completely new circumstances have arisen that were not considered in their original form. Thus, it was only in 2003 that the turnover of agricultural land was finally legalized in Russia; the status of land shares, formed in the 1990s, which account for almost half of agricultural land, was defined by law. Since 2011, work requiring land surveying has been underway to identify unclaimed shares and transfer them to municipalities (with subsequent allocation into plots). A special state program for the re-development of abandoned agricultural lands has been implemented since 2021 (their presence has been a prolonged problem of the last decades) (Khlystun et al., 2020; Volkova, 2018).

Therefore, the key factor that will determine the prospects of Russian land management becomes just the improvement of its legal support. It has been five years since a new version of this law was drafted (on behalf of the federal government). There are several variations of it now. Their key differences are as follows:

1. Understanding the essence of land management—as a service (similar to cadastral engineers) or the participation of society and the state in managing the land fund.
2. The degree of continuity with respect to the previous practice of Russian land management.
3. The volume of borrowing of foreign experience (mainly Western European experience, which is criticized by authoritative experts).
4. Emphasis on different problems in land use, particularly in agricultural land use.

The first versions initiated by the Ministry of Economic Development were critically received by the professional community. The fact that there are several variants of the new version of the law, on the one hand, expands the possibilities to update the entire system of legislative regulation of land management in the shortest time possible. On the other hand, the competition of these variants (and their developers) hinders this process. The adoption (albeit

belated) of this law will predetermine the subsequent development of Russian land management for many years to come.

Another important factor (vector) in the development of land management is the actively developing process of improving the relevant education, largely due to the prospects of the Federal State Educational Institution of Higher Education "State University of Land Use Planning," which provides 25 directions of training, including 9 bachelor's, 1 specialist, 6 master's, and 9 postgraduate courses. The structure of the university includes 6 faculties, 2 institutes, 26 departments, and 14 specialized laboratories.

The strategic goal of further development of the University is the earliest possible entry into the group of system-forming sectoral universities—world leaders in training personnel for land management and cadastres. To achieve this goal, the following programmatic measures have been outlined:

- To increase the number of undergraduate and graduate students studying at the university up to 5.5 thousand, open new profiles and areas of training (including "Digital technologies in geoecology and land resources management," "Protected soil engineer," "Regulation of land surveying and cadastral activity," "Digital support of spatial development," "Forensic land surveying expertise," "Cadastral activity," and "Registration of real estate and rights"), and create basic departments at enterprises and research institutes.
- To integrate university science and education (e.g., launching a satellite with remote sensing equipment).
- To implement several strategic university projects at once, including the following:

1. The development and implementation of a hardware-software complex of geoinformation support "Digital planet."
2. The creation of a set of land surveying and architectural planning solutions for the AIC and rural areas—the "Village—2030" project.
3. The development of fundamentally new approaches to planning and development of territories to achieve their climate neutrality—Carbon Land Management project.
4. The proposal to develop vertical farms that ensure the independence of agricultural production from sunlight and natural climate and make it possible to control yields all year round (with the introduction of appropriate technologies into the educational process).
5. The project "Sustainable spatial development" makes it possible to ensure safety and favorable conditions for human life and rational land use.

Finally, the digital transformation of all university processes, which is now relevant for any Russian university, will be realized, which will make it possible to create a local digital system in the university and introduce a digital corporate culture, which will make it possible to create a university digital ecosystem and introduce a digital corporate culture.

## 4 Conclusion

The authors identify the following key factors redefining the development of land management in Russia at the current stage:

1. Objective processes in the system of agricultural land use (insufficient land surveying support of which became one of the reasons for the problems arising).
2. Improving the legislative regulation of land management (this work intensified in 2019–2020 but has clearly slowed down recently).
3. New opportunities in the system of land surveying education (some of them are universal for all agricultural universities, the others are purely specific, corresponding to the peculiarities of the university).
4. There is another important factor—digitalization, the impact of which on the organization of land surveying activities (very positive) requires other research methods and is not analyzed in this research.

Considering the influence of these factors and building the trajectory of land management in accordance with them will make it possible to avoid very likely consequences of negative processes of institutional nature in agricultural land use. In the next few years, the situation in this sector will change more than in the period of reforms of the 1990s. Moreover, it will be not so much about its property-legal (as in the case of land shares formation) but clearly land-productive aspects (allocation of specific land plots on account of unclaimed shares).

Land management adapted to today's conditions (and better—to tomorrow) is also a guarantee of effective realization of land potential as a factor in developing the AIC in Russia.

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# Structural Transformation of Accumulation and Consumption in Agricultural Production as the Basis of Its New Industrialization

Vasily I. Nechaev and Aleksandr V. Semenov

**Abstract**

The article justifies the need to accumulate capital while ensuring a proportionate growth in final consumption for the development of the economy. The new industrialization of the agricultural sector implies the rearmament of its material and technical base. The main problem causing such low investment credit indicators in Russia is that banks are only engaged in making profits and are not interested in developing the real economy. Monetary policy needs to be regulated to ensure accessibility to an investment loan, increase business interest in domestic achievements of scientific and technological progress. The organization of expanded reproduction of fixed capital will make it possible to overcome the import dependence of the country's agricultural sector on knowledge-intensive means of production. In order to neo-industrialize the country's agricultural sector, the Russian government should increase the efficiency of state investment investments, reduce dependence on critical imports, eliminate the disparity in prices for industrial and agricultural products, and develop debt financing mechanisms.

**Keywords**

Industrialization • Investments • Agricultural sector • Capital accumulation and consumption

**JEL Classifications**

E22 • O14 • Q14

## 1 Introduction

Speaking in the State Duma with the annual report on the activities of the Government of the Russian Federation (March 23, 2023), Prime Minister M. Mishustin said: "A sanctions blow was inflicted on Russia, which was not equal in force in recent history" (State Duma, 2023). Unfortunately, in his speech, the Prime Minister did not focus on the acute points in the agricultural sector. And there are quite a few problems in the agriculture, which were discussed at the AKKOR reporting congress (Government report in the State Duma, 2023): This is overproduction of unrealized grain; monopolization of the energy industry, which causes an unreasonably high cost of electricity in agricultural production, which is several times higher than tariffs in industry; rising taxes and fees; problem of agricultural insurance with state support; high prices for public services; artificial "winding" of profitability; and other negative aspects (Government report in the State Duma, 2023). The issue of import substitution of agricultural machinery, capacities for refinement of seeds (seed lines, factories), special equipment for the selection and seed sector, the production of chemicals, feed additives and veterinary preparations is especially acute. All this requires a new industrialization in the country's agricultural production. But in order for this process to follow the path of development and growth, it is necessary to solve the problem of fixed capital's accumulation, which is a fundamental indicator of the economy, as well as to carry out a structural transformation of accumulation and consumption in the industry.

The problem of investment development of the country's economy and individual industries is paid great attention. The task of accelerating this process and raising the rate of

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capital accumulation to 25% of gross domestic product by 2024 was set by the President of the Russian Federation (Website of the President of Russia, 2020). The owned and attracted funds of agricultural producers are the main sources of investment in the agricultural sector. At the same time, own funds are formed both due to profit and depreciation. Raised funds—at the expense of budget funds, bank loans, borrowed funds and other resources.

The main investment problems in the agricultural sector of the country include:

- negative impact on the investment climate in Russia of sanctions of unfriendly states;
- unsustainable dynamics of investments in agricultural fixed assets;
- mismatch of investment to meet the challenges facing the country's food security industry;
- low innovation focus of investments;
- insufficient government support for investment in the industry;
- low investment efficiency;
- accelerated price growth for industrial products, especially agricultural machinery and other industries.

If we talk about the restart of the investment cycle in the Russian economy, this is possible with increasing investment in fixed assets in the production sector. The fact is that the share of industry in Russia in creating GDP is about 30%, in the United States and Europe—about 20 and 25%, respectively. In developing industrial countries such as China, Brazil, Mexico, investment in fixed assets is the main driver of growth, which in this process reaches 60%.

As Academician of the Russian Academy of Sciences A. Aganbegyan noted: "The main question that all economists are now asking is how the economic bloc of the Russian government intends to support growth rates and restart the investment cycle. Indeed, without this, the national economy risks again falling into a state of stagnation, in which, according to some scientists-economists, it has been since 2009, and today it has lagged behind other countries even more than in the 'stagnant' years in the USSR" (Lesnykh, 2021).

It should be noted that in developed countries, economic growth is mainly associated not with investment in fixed assets, but with a creative economy (knowledge economy), which is an integral part of human capital. Thus, according to the IMF, purchasing power parity in China reached $998.0 billion. The United States or 4.2% of the country's GDP, in Russia these indicators amounted to $104.6 billion. United States or 2.4%, respectively (Trends, 2019).

Economic growth in developed countries is associated with the sale of goods and services resulting from intellectual property in such innovative areas as: education, science, R&D, information technologies, biotechnology, robotization of production processes, digitalization, on the basis of which high-tech production is developing, which is called Industry 4.0. This is when components interact with production equipment on their own, order repairs or purchase new materials if necessary—when people, machines, and production processes are combined into an intelligent network (Industry, 2023). In developed countries the agricultural sector is not growing due to the saturation of the market with agricultural products. The domestic agricultural sector has room to grow, especially in terms of labour productivity. And as Academician of the Russian Academy of Sciences A. Aganbegyan rightly notes: "The implementation of potential growth depends on the share of investments in fixed assets in the structure of GDP. If this share approaches the lower bar of 17–20%, then the country cannot even completely update outdated equipment, and with each goal its share will increase, and itself will more often stand idle and demand more and more money for repairs" (Lesnykh, 2021). In addition, such equipment is impossible to reduce electricity consumption in agricultural organizations, increase production efficiency and produce high-quality products, which requires a new industrialization of the agricultural sector, as a result of which the advanced level of labour productivity in the industry and the quality of life in the countryside will be achieved. It is necessary to organize expanded reproduction of fixed capital in order to overcome the import dependence of the country's agricultural sector on knowledge-intensive means of production, and above all, agricultural machinery, technologies, seeds of a number of crops, breeding material, plant protection products, feed additives and veterinary products, which determines the relevance of the study.

## 2 Materials and Methods

In the process of research, a wide range of methods was used, among which the abstract-logical, monographic, analytical and some others should be emphasized, which are based on a dialectical approach to the study of socio-economic phenomena in agricultural production.

## 3 Results

In the Decree of the President of Russia "On the National Development Goals of the Russian Federation for the Period up to 2030" (Official Publication of Legal Acts, 2020), one of the main goals is to ensure "decent, effective work and successful entrepreneurship." Within the framework of this goal, it is planned to increase the country' GDP above the

world average and a steady increase in household incomes based on an increase by 2030, real investment growth in fixed assets at least 70%, real growth in exports of non-primary non-energy goods at least 70%, an increase in the number of employees in small and medium-sized businesses to 25 million people, which is extremely important, bearing in mind the fact that we still have an extremely low share of small and medium-sized enterprises in GDP—in 2020 it was only about 20%.

The increase in the agricultural sector production is associated with an increase in capital accumulation and an increase in its share in gross domestic product (industry) while increasing consumption per inhabitant of the country. In this regard, when starting a new industrialization in the agricultural sector, it is important to regulate the process of managing fundamental reproducible proportions—accumulation and final consumption.

Another limitation in the industrialization of the agricultural sector of the country's economy is the shortage of personnel in the domestic industry. Thus, according to the latest estimates, (Lugacheva & Musatova, 2021) the share of open vacancies in mechanical engineering and metalworking increased from 2 to 3.6%, which amounted to about 60 thousand positions for skilled workers.

One of the possible solutions is the introduction of robots and robotic complexes to those areas where possible. In other words, the question is about replacing labour with capital. Since labour is scarce, reindustrialization and real import substitution require accelerated investments in automated production systems that can be serviced by a minimum number of workers. The question of the comparative costs of various methods of production is relevant (more work and less capital or vice versa). In Russia, the cost of labour remains at a low level, and the cost of capital (new investments) is at a high level due to the high interest rate of the Central Bank, which slows down the replacement of labour with capital. At the same time, as some authors' note (Amirkhanova & Tenyakov, 2023), due to the action of objective Russian factors (climate, territory, the gap between the deployment of resources, production and consumption), the cost of labour is higher than in China and a number of Asian countries. Therefore, it turns out to be difficult to compete with them by reducing the cost of labour. To stimulate technological industrialization, it is necessary not to reduce, but on the contrary, to increase the cost of labour and reduce the price of capital (interest rate), while blocking the possibility of redirecting capital to the foreign exchange and financial market in order to quickly extract easy profits. However, the pursued policy of the Central Bank remains in the same direction ("inflation targeting at any cost"), which does not contribute to either modernization or industrialization of the country. As Academician of the Russian Academy of Sciences S. Yu. Glazyev notes, lending to the Russian economy is growing at an insufficient pace to ensure investment demand, while a significant part of loans falls on the consumer sector and mortgages (International Federation of Robotics, 2022).

In modern geopolitical conditions, despite the indicated goals, there has been significant stagnation in investment development. "If we want to develop normally, providing at least three per cent of growth per year, in an industrial country the share of investments in fixed assets should be at least 22%. And if we want to develop sustainably, moving to an innovative path of development, then investment in the structure of GDP should occupy 25%. «The current situation can be described as a chronic lack of investment—the deficit is 5–6 trillion roubles per year (Lesnykh, 2021). According to Rosstat (EMISS State Statistics, 2023) for the period from 2010 to 2020, investments in the country's economy increased in fixed assets by 24%, in agriculture and forestry by 19%, in the food industry by 29%. In the total volume of investments in fixed assets, the share of agriculture is about 3%.; the share of the food industry does not exceed 1.5% or two times lower. It is important to understand that the investment deficit is not a lack of activity in the stock market, but an insufficient contribution to the material, technical and intellectual potential of the country's agricultural sector.

Most of the investments in fixed assets in agriculture were directed to the purchase of machinery and equipment—41%, buildings account for 31% and structures 12% (Federal State Statistics Service, 2023).

According to Interfax (Interfax, 2018), the change in investment rates among agricultural producers of various forms of ownership and management in 2014–2020. It is associated with an increase in political tension, which increased in 2022. For this reason, in 2014, the decline in Russian agriculture investments amounted to 7.3%, in 2015—12.6%, in 2019–2020. Up to 6.7% per year in comparable prices.

At the same time, according to Rosstat for the first three quarters of 2022, the industry is experiencing an increase in fixed assets investments (Table 1).

The dynamics of investments in 2021–2022 (Table 2) are characterized by a positive trend compared to the same period in 2021. In the first quarter of 2022, the volume of budget funds increased 2.8 times, in the first half of the year—1.7, in 9 months—1.4 times.

The decrease in investments from the budgets of the constituent entities in the first quarter of 2022 was compensated by a quadruple increase in funds from the federal budget, as well as from the local budget, in subsequent periods, financing of investments increased with the funds of the regions.

The lag in the growth rate of investments in the period January–June 2022 and in the first quarter due to attracted

**Table 1** Dynamics of budget investments in fixed assets in Activity 01 "Crop and livestock production, hunting and provision of relevant services in these areas" (cumulative), RUB million

| Budgetary funds | 2021 | | | | 2022 | | |
|---|---|---|---|---|---|---|---|
| | January-March | January-June | January–September | January-December | January-March | January-June | January–September |
| In total: | 466.4 | 2119.6 | 4431.8 | 10,867.5 | 1233.8 | 3695.8 | 6258.5 |
| including: From the budgets of the constituent entities | 220.1 | 471.0 | 887.3 | 2070.4 | 177.9 | 694.7 | 1062.0 |
| From the federal budget | 190.1 | 852.9 | 3019.4 | 7505.4 | 892.8 | 2472.4 | 4260.9 |
| Local budget | 56.2 | 795.7 | 525.1 | 1291.7 | 252.1 | 528.7 | 935.6 |

*Source* Compiled by the authors on the basis of EMISS state statistics (2023)

**Table 2** Fixed asset investment dynamics by source in Activity 01 "Crop and livestock production, hunting and provision of relevant services in these areas" (cumulative), RUB million

| Funds | 2021 | | | | 2022 | | |
|---|---|---|---|---|---|---|---|
| | January–March | January–June | January–September | January–December | January–March | January–June | January–September |
| Owner's equity | 56,065 | 144,332 | 228,405 | 323,706 | 63,199 | 152,205 | 245,158 |
| Engages funds | 36,395 | 88,041 | 139,008 | 216,586 | 31,619 | 81,319 | 125,042 |
| Including: | | | | | | | |
| bank loans | 33,180 | 77,529 | 120,759 | 185,929 | 25,926 | 66,498 | 102,457 |

*Source* Compiled by the authors on the basis of EMISS state statistics (2023)

sources is associated with a reducing the rate of loans issued by banks to agricultural producers due to economic sanctions of unfriendly states. In subsequent periods, credit institutions of Russia were adapted and despite the sanctions of Western states were expanded, lending to the agricultural sector in 2022 decreased by only 15.1%, which was partially (by 7.9%) compensated by own funds. A particularly significant increase (by 12.7%) in the own funds of agricultural producers was observed in the first quarter of 2022, due to the acquisition of the remaining means of production in warehouses for the harvest of 2023, in connection with the departure of foreign companies from the country.

We consider it appropriate to point out the unexpected growth in investments in 2022, which in the Expert magazine was called an "investment miracle." In 2022, the investments in fixed assets in the country's economy exceeded 30 trillion roubles, an increase of 5.5 trillion over the year. But in relation to GDP, the accumulation rate was only 21% instead of 25%, which are necessary for an investment breakthrough. However, as A. Shirov notes, the main increase was achieved due to construction and installation work, and not the purchase of machinery and equipment. The share of the latter for the year decreased immediately by 4 percentage points (from 39.5 to 35.5%), and as rightly noted, this trend will continue in 2023 (Ivanter, 2023).

The growth phenomenon of fixed assets investments is associated with investment-intensive import substitution in the country, the speed of restructuring of logistics channels and settlement schemes in foreign economic activity, which was demonstrated by Russian business, thereby activating import substitution. The Cabinet of Ministers of the Russian Federation has developed annual import substitution indicators for critical types of products. To achieve the goals set by Russian President V. Putin back in December 2022, it is planned to develop new and/or expand existing support measures.

In the agricultural sector of the country, the share of own funds in investments was constantly higher than the share of funds raised. So, according to Maslova (2021), the period 1995–2005 was especially negative, when it was extremely difficult to attract external financing in agriculture, and most of the attracted resources came from budgetary support. According to her, in 2010 the ratio of attracted funds and own funds almost equalled (51:49), in 2015, due to difficulties with external borrowing, most of the investments in agriculture again began to form at the expense of their own sources (60:40). In 2020, the situation worsened due to the coronavirus pandemic. It is planned to increase the project "Stimulating investment activities in the agro-industrial complex" in 2023 by 47.263 billion roubles, in 2024 by 15.5764 billion roubles. In 2025, the amount of financing may be reduced compared to the budget forecast by 11.4316 billion roubles due to the redistribution of budget allocations from concessional lending to higher priority areas of the agro-industrial complex (Budget, 2022).

Only appropriate investment investments, at a rate of at least 5–6% per year, can provide target production growth rates. Unfortunately, in the agro-industrial industry as a whole, there are still no changes in investment activity.

The growth rate of investments in fixed assets in domestic agriculture from 2013 to 2021 was 1.7 times less than in the economy as a whole (Maslova, 2022).

The given analysis of the ratio of sources of investment financing made it possible to establish that the investment attractiveness of agricultural production depends a lot on the agricultural policy pursued by the state and the level of state support for this industry. At the same time, investments in construction and various infrastructure (road network, cellular communications, Internet, etc.) will have a significant positive effect on economic growth in the agricultural sector only when new enterprises for the production and processing of agricultural products equipped with modern high-performance equipment are created with them. In this case, infrastructure projects will contribute to the development of districts and settlements of rural areas of the country. So far, we see that the role of the state has grown in the investment structure and the importance of private business has sharply decreased. Therefore, it is necessary to move on to stimulating investment activity of business in the countryside. It may be necessary to use borrowed financing, as well as other institutions of the financial system, for example, to create a Fund for the neo-industrialization of agriculture under the Ministry of Agriculture of Russia (by analogy with the existing Industrial Development Fund under the Ministry of Industry and Trade of Russia). The purpose of the fund is to support applied research on the development of technical means, including robotics and their saturation of the country's agricultural sector. In parallel, it is necessary to structurally change the content of investment activities, increasing the efficiency of investments, supporting mainly such projects that increase the potential for economic growth in the agricultural sector, and most importantly its effectiveness. The issue of the effectiveness of capital investments in modern geopolitical conditions is key.

The next term for restarting the investment cycle in agricultural production is human potential, which, together with reproducible fixed assets, interact and complement each other. Scientific and technological progress is a synthesis of this interaction. At the same time, countries lagging behind in technological development will inevitably have to increase the volume of production of high-tech products, means of production, which will create an opportunity for the formation of a new industrial and technological structure.

## 4 Discussion

Talking about the new industrialization of the country's agricultural sector, a number of questions arise. Is it enough to restart the investment cycle in the agricultural sector only for the technical re-equipment of enterprises? And who will work on this equipment? To answer these questions, it is necessary to clearly understand that in order to transition to sustainable economic growth, investments in human capital —knowledge and skills of employees—are necessary. So, the field of knowledge economics is the main component of human capital. Investments in fixed and human capital are inextricable concepts. If we want to carry out a new industrialization, then behind the machines with numerical programme control should be people who can interact with such an interface and use it competently. Without creating jobs, it will not be possible to carry out neo-industrialization in the country's economy. According to Academician of the Russian Academy of Sciences A. Aganbegyan, the sphere of knowledge economics in Russia's GDP is only 14%—half as much as in Europe, and almost three times as in the United States. Even in China, this figure is one and a half times lower (Lesnykh, 2021).

The new industrialization of the agricultural sector implies the rearmament of its material and technical base. In agriculture the degree of depreciation of fixed assets is about 40%, in the food industry is 48%. Fully worn-out fixed assets in agriculture—9.4%, in the food industry—12% (Maslova, 2021). In the Russian economy, 23% of all machinery and equipment work in excess of depreciation period. The average service life of domestic equipment in Russia is fifteen years, while in many other countries it is ten years. In the United States, equipment is being culled in five to seven years. Almost all countries have accelerated depreciation periods, which are the main source of investment and make up the depreciation fund. Moreover, enterprises in this process have no more than 20–30% of their own investments, and all the rest are attracted, including state ones. In Russia, organizations' own investment funds account for 55% on average in the country's economy, and investment credit accounts for only 8%. In the United States and Western Europe, this figure ranges from 30 to 50%. In developing countries, including China, it is 20–30% (Lesnykh, 2021).

The main problem causing such low investment credit indicators in Russia is that banks are only engaged in making profits and are not interested in developing the real sector. Mobilizing financial resources in the "mobilization economy" requires mobilizing financial resources, turning the banking system to long-term investment lending with long-term money of the country's agricultural sector, given its biological component. For thirty-two years of the new Russia, we have not been able to create a "financial engine of the economy"—a developed capital market and a competitive environment. And as Academician of the Russian Academy of Sciences A. Aganbegyan rightly notes: "Because of this, over 30 years our economy has grown by only 15%, despite the fact that the developed countries of Europe and the United States have doubled, developing countries led by China - five times" (Lesnykh, 2021).

The next problem is that the profit made in the real sector goes to dividends—not for development, but for self-enrichment of their owners. Moreover, it often goes to accounts in foreign banks. Boston Consulting Group, which has been engaged in offshore companies in different countries for many years, estimates offshore companies of Russian organizations at about $400 billion. The United States, and more than half of this amount, has been accumulated during the period of stagnation and economic crisis. So, only in 2018–2019 the profit of Russian enterprises increased by 72%, and investments during this period increased by only 6%, salaries—by 10%. The rest of the money went to accounts and to the purchase of securities, including foreign ones. Thus, the business shows that it is unprofitable for it to invest in its development. Therefore, it is necessary to interest shareholders, stimulate enterprises and make investments in fixed assets attractive (Lesnykh, 2021). For these purposes, it is necessary: to exempt from taxes that part of the profit that is directed to investments in the enterprises development; to reduce the depreciation period by at least one and a half times; to carry out mass culling of old (worn-out) equipment in organizations of the agricultural sector, which is no longer unprofitable to keep on the balance sheet.

Growth in gross accumulation in the agricultural sector Russia accordingly reduces final consumption and will require an increase in imports of machinery and equipment from friendly states. This will increase domestic market capacity for domestic producers' equipment. To expand it, the growth of capital accumulation must be accompanied by development of industrial production. It is necessary to change the structure of the use of available resources—to increase the scale of capital accumulation, which will contribute to the growth of domestic agricultural engineering. On April 19, 2023, at a meeting held by President of the Russian Federation V. Putin, Minister of Agriculture D. Patrushev noted that we continue to operate state support mechanisms to update the fleet of equipment: "The Ministry of Industry and Trade has subsidies to manufacturers of domestic equipment. The key instrument of the Ministry of Agriculture is Rosagroleasing's preferential programmes, including without a down payment and with a significant deferral of the payment of the principal debt. Thanks to the support of the Government in 2022, the company delivered 12.7 thousand units machinery and equipment to agrarians. The 2023 plan is 13 thousand units. Of these, the supply of six thousand has already been organized" (Website of the President of Russia, 2023).

Currently, the state segment is growing in investments, and private investment continues to decline, and so it will be in the flesh until the country's economy enters the trajectory of sustainable growth (Ivanter, 2023). Only an active stimulating policy of the state can radically change the situation in the economy, but for its implementation there must be confidence that the resources spent will be used with the necessary level of efficiency, and for this it is necessary that the agricultural sector finally adapts to new geopolitical conditions.

What threatens the domestic economy to maintain a shortage of investments in fixed assets of enterprises? Academician of the Russian Academy of Sciences A. Aganbegyan gave the most detailed answer to this question: "In this case, we will return to stagnation. And our pace of economic development will not be able to reach the 3% per year that the Ministry of Economic Development dreams of" (Lesnykh, 2021). Stagnation carries a lot of negative trends: an increasing in the volume of capital outflows; reducing financial capabilities not only for growth, but at least to preserve investment in human capital; the income gap between the poor and the rich will grow. So, according to the Gini coefficient, Russia is 2 times behind developed countries: "This led to the most destructive negative trend - a demographic catastrophe with a record increase in mortality in 2020–2021 total of 750 thousand people, which is the highest indicator per thousand people of the population among large countries of the world" (see ibid. On page 53).

The pace of development of the agricultural sector is a function of the growth rate of population and fixed capital. Only in the absence of innovative development and investment in fixed assets, it is determined by the rate of population growth. Moreover, in this case it is not rural, since the main factories for the production of agricultural machinery and chemicals are located in cities.

In fact, as I. Pogosov and E. Sokolovskaya noted back in 2014: "Two opposite processes will take place. An increase in production really requires an increase in the number of workers. New industrialization, the growth of the technological level of enterprises means an increase in labour productivity and labour savings while increasing the requirements for their qualifications" (Pogosov & Sokolovskaya, 2014). The question is how these two trends in the production of machinery and chemical means for agricultural production are balanced.

To curb stagnation, the Ministry of Economic Development believes that it is necessary to increase investments by 6% per year, but at such a pace, according to Academician of the Russian Academy of Sciences A. Aganbegyan:… "we will only come to the beginning of the third decade to the indicator from which economic growth can begin" (Lesnykh, 2021). Therefore, the task is that in modern geopolitical conditions the period of structural adaptation of the country's agricultural sector does not drag on and is limited to two to three years.

## 5 Conclusion

The main task of the Russian economy in modern geopolitical conditions is to accumulate capital while ensuring a proportionate growth in final consumption. This requires a correction of monetary policy in order to ensure accessibility to an investment loan, as well as increase business interest in domestic achievements of scientific and technological progress. It is necessary to establish an optimal ratio between the growth of capital accumulation and final consumption and create an increase in capital accumulation per capita comparable to developed countries. It is necessary to organize expanded reproduction of fixed capital in order to overcome the import dependence of the country's agricultural sector on knowledge-intensive means of production.

In order to neo-industrialize the country's agricultural sector, the Russian government should increase the efficiency of state investment investments, reduce dependence on critical imports, eliminate the disparity in prices for industrial and agricultural products, and develop debt financing mechanisms. The regulation of prices and tariffs for the products of energy companies, railway transport services, as well as the timely implementation of procurement interventions on agricultural products by the state in the harvest years, can play an important role in this process. Along with the development of production infrastructure, it is necessary to promote the improvement of institutional—consulting, marketing, project financing, information systems based on progressive IT technologies.

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# Directions for Increasing Rice Yield and Its Predicting

Tatiana N. Polutina and Sofia Yu. Gubieva

**Abstract**

The research focuses on the peculiarities of rice production and directions for increasing its efficiency. Rice production continues to grow due to increased yields of the crop and the expansion of rice applications. Among grains, rice is characterized by high yield, product quality, stability, and guaranteed yields. The share of the Krasnodar Territory in rice production among the regions of the Russian Federation in 2022 amounted to 63.11%. In Russia, 41 agricultural organizations specialize in the type of activity 01.12 "Rice cultivation." The indicators of the financial condition of these rice farms are satisfactory. The largest rice farms in the country are Kuban Agro-Industrial Company LLC, with a revenue of 1076 million rubles in 2022, and Chernoerkovskoye LLC, with a revenue of 857 million rubles. Yield is one of the main efficiency indicators. When predicting rice yield, the authors used the method of average characteristics (absolute growth and growth rate) and trend models of various types (linear and polynomial). Forecasts gave approximately the same values of rice yield—55–57 centners per hectare for the next three years.

**Keywords**

Rice • Yield • Trend • Forecast • Efficiency

**JEL Classifications**

C22 • O13 • Q13

## 1 Introduction

Rice production continues to grow due to the increase in the yield of this crop and the expansion of rice applications. Among grains, rice is characterized by high yield, product quality, stability, and guaranteed yields.

The features of rice production are determined by the features of rice as an agricultural crop (reaction to external climatic conditions—daily air temperature in the growth phase, the duration of the light period, precipitation, and air humidity) and cultivation technologies (the presence of special irrigation systems and cleaning equipment capable of working in aggressive conditions, freshwater quality, chemical treatment of crops, etc.).

Russian authors consider priority directions for developing subsidence: breeding (Goncharov & Goncharova, 2019), improving the soil cultivation system, optimizing the application of fertilizers, applying an effective water regime, and building rice crop rotations (Chebotaryov & Dyachenko, 2019) to improve soil fertility and increase the efficiency of subsidence farms (Polutina & Gubieva, 2022; Tyupakov et al., 2019).

The efficiency of rice production largely depends on the efficient use of water and land resources. The Krasnodar Territory was chosen as the research object due to the region's leading position in rice production and the most intensive use of water resources in the Lower Kuban subsidence zone. This exacerbates the problems of declining soil fertility, the need for rational use of natural resources and environmental protection, and reducing the costs of agricultural producers at the stage of industrial production of rice.

The rice variety becomes a competitive advantage for agricultural producers and an object of capital investment. Goncharov and Goncharova (2019) proposed assessing breeding progress by the relative increase in sown areas and yield over a relatively long period.

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Rice production growth exacerbates the problem of recycling rice straw because the existing technique does not provide rapid and high-quality grinding of rice stems after threshing the grain. Burning straw creates environmental tension and causes a negative reaction in the population (Zelensky et al., 2021).

Among the areas of innovative development of rice production, Yu. I. Bershitsky and P. G. Zelensky highlight the creation of new high-yielding rice varieties, the active introduction of resource-saving and nature-saving technologies, and the renewal and modernization of the machine and tractor fleet (Bershitsky & Zelensky, 2019).

Innovative areas of development of rice production include the following:

- The use of a biological method for cleaning rice checks (water bodies) from blossoming based on the use of chlorella algae (Melikhov et al., 2016);
- Optimization of rice mineral nutrition due to the use of liquid nitrogen fertilizers and new micro fertilization on rice crops (Zelensky, 2016);
- Cultivation of intermediate crops for green fodder and side rates in the occupied fallow of rice crop rotation (rape, red, and white mustard) (Maslivets & Zdesenko, 2008).

To improve the efficiency of rice, the authors propose the following:

- Optimizing the technology of the rice production process;
- Using innovative approaches in the growing technology while providing strict compliance with the adopted irrigation regime;
- Using new plant and mineral protection products to reduce the detrimental effects of chemicals in the subsidence area (Polutina & Gubieva, 2022).

## 2 Materials and Method

Yield forecasting is a justification of agricultural crop productivity for the future, considering factors of influence or identifying trends. Stepovoy and Slastukhin (2009) predicted rice yield based on the consideration of the influence of the following technological factors:

- Natural conditions of cultivation, design, and technological features of the irrigation system;
- The time of the main tillage (fall or spring);
- Plant nutrient supply (NPK);
- Adherence to rice cultivation technology;
- Clogging of crops.

The coefficients of influence of factors on the rice yield in the prediction equation depending on the soil, agrochemical, and design-technological conditions of the rice engineering system are based on earlier studies by Stepovoy and Polyakov (1984).

A similar approach to predicting rice yield, considering the density of rice plants standing during various periods of vegetation, weed vegetation, and water regime, is presented by Sereda et al. (2006).

A promising direction for predicting rice yield is the use of remote sensing data based on regression analysis between indicators obtained from satellite data and official statistics (Wit, 2007), mathematical modeling of agricultural plant growth (Royer & Genovese, 2004), and rice crop development models using MODIS satellite data and meteorological information (Savin & Isaev, 2010). According to I. Yu. Savin and V. A. Isaev, "the effectiveness of such approaches to predict yield does not yet exceed the effectiveness of approaches based on regression analysis" (Savin & Isaev, 2010, p. 24). Therefore, the authors used statistical forecasting methods to predict rice yield, which are more accessible and easier to use.

The research applied a wide range of methods, including abstract-logical, monographic, analytical, and other methods. When predicting the rice yield, the method of average characteristics and MS Excel tools for trend models of various types are used.

The analysis of agricultural organizations specialized in the type of activity 01.12 "Rice cultivation" was carried out using the database of statistical and accounting reports of TestFirm (n.d.).

## 3 Results

The share of the Krasnodar Territory in rice production among the regions of the Russian Federation amounted to 63.11% in 2022, which is 10.94% lower than in 2017. The share of rice production in the Republic of Dagestan increased by 5.67% and by 0.82% in the Rostov Region. For rice production, the Krasnodar Territory uses swampy, saline, and flooded lands unsuitable for other crops (Fig. 1).

Rapan (25%), Polevik (15%), and Favorite (7%) varieties prevailed in rice crops in the Krasnodar Territory in 2020. These most common varieties occupied 59.6 thousand hectares in 2020, which is 47% of the total rice sowing area. There is a gradual replacement of foreign varieties of rice with varieties of Russian selection. Kuban breeders have created new varieties of rice, including Azovsky, Zlata, Nautilus, Cossack-4, Yakhont, Yubileiny 85, Patriot, Appolon, Veles, Rapan-2, and Alliance varieties that are distinguished by high yield and improved technological qualities of grain (Polutina & Gubieva, 2021).

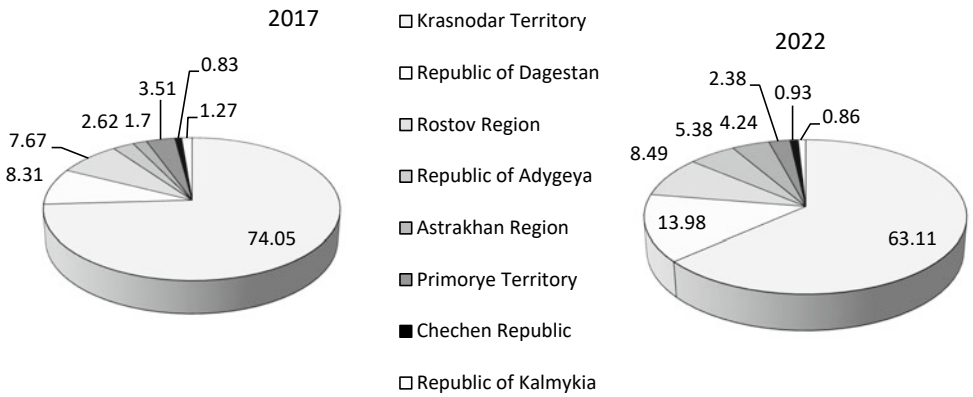


**Fig. 1** Share of regions of the Russian Federation in rice production. *Source* Calculated by the authors according to "Gross harvest and crop yield in the Russian Federation in 2022" (Federal State Statistics Service of the Russian Federation, 2023)

In general, 41 agricultural organizations specialize in the type of activity 01.12 "Rice cultivation," of which 11 are located in the Krasnodar Territory. The largest rice farms in the country are Kuban Agro-Industrial Company LLC, with a revenue of 1076 million rubles in 2022, and Chernoerkovskoye LLC, with a revenue of 857 million rubles.

The financial condition of 41 agricultural rice farms is satisfactory (Table 1).

According to the financial condition, agricultural organizations by type of activity 01.12 "Rice cultivation" are independent of borrowed sources of financing (autonomy coefficient 0.71, which is higher than the regulatory value). They have enough funds to finance current activities (investment coverage ratio 0.8). Moreover, these organizations have no difficulties in repaying current liabilities (liquidity ratio 2.8) and no risk of insolvency (fast and absolute liquidity ratios above normal).

The relatively low level of profitability of rice production prevents agricultural organizations from performing extended reproduction and ensuring sufficient investments from organizations' funds, which is a deterrent to the development of rice production.

Rice yield in Russia is characterized by progressive growth (Fig. 2).

The trend of yield change with a high confidence level $R^2 = 0.883$ is described by the equations linear and polynomial functions. Rice yields are predicted to increase in both functions.

Let us forecast rice yield using average characteristics (by average value, average absolute growth, and average growth rate) for 1990–2022. Table 2 shows the results of calculating the forecast of rice yield.

Forecast 1—by average absolute growth—is determined by the following formula:

$$\text{Forecast } 1 = y_n + \overline{\Delta y} \cdot n_p, \tag{1}$$

where

$y_n$—the actual rice yield for the last year of the analyzed period;

$\overline{\Delta y}$—the average absolute growth in rice yield over the analyzed period;

$n_p$—the number of years in the forecast.

$$\overline{\Delta y} = \frac{y_n - y_1}{n - 1}, \tag{2}$$

where

$y_i$—yield for the $i$-th year;

$n$—the number of years of the analyzed period.

**Table 1** Main financial indicators of agricultural organizations by type of activity 01.12 "Rice cultivation" for 2021

| Indicator | Measure value | Normative |
|---|---|---|
| Coefficient of autonomy (financial independence) | 0.71 | $\geq$ 0.5 |
| Coefficient of provision with own working capital | 0.6 | Not less than 0.1 |
| Investment coverage ratio | 0.8 | $\geq$ 1 (Not less than 0.7–0.8) |
| Current liquidity ratio | 2.8 | $\geq$ 2 |
| Fast liquidity ratio | 1.3 | $\geq$ 1 |
| Absolute liquidity ratio | 0.4 | $\geq$ 0.2 |
| Return on sales,% | 17 | Greater than 0 |
| Net profit rate,% | 16.5 | Greater than 0 |
| Return on assets,% | 9 | Greater than 0 |

*Source* Calculated by the authors based on (TextFirm, n.d.)

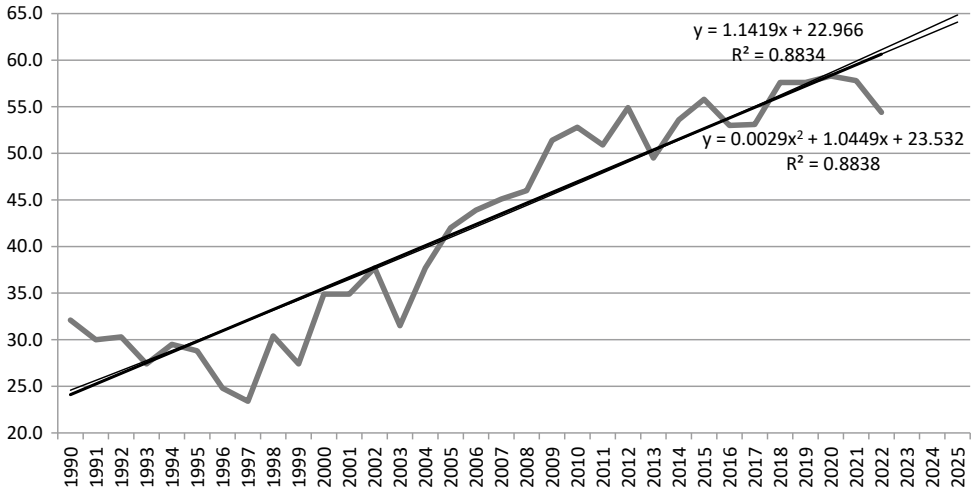


**Fig. 2** Dynamics of rice yield in the Russian Federation. *Source* Calculated by the authors based on "Gross harvest and crop yield in the Russian Federation in 2022" (Federal State Statistics Service of the Russian Federation, 2023)

**Table 2** Forecast rice yield, centners per hectare

| Indicator | Rice yield, c/ha | |
|---|---|---|
| Average for 1990–2022 | 42.7 | |
| Average absolute gain for 1990–2022 | 0.68 | |
| Average growth rate for 1990–2022 | 1.02 | |
| | Forecast 1—by average absolute growth | Forecast 2—by average growth rate |
| 2023 | 55.08 | 55.30 |
| 2024 | 55.75 | 56.21 |
| 2025 | 56.43 | 57.14 |

*Source* Calculated by the authors

Forecast 2—by average growth rate—is determined by the following formula:

$$\text{Forecast } 2 = y_n \overline{T}^{n_p}, \tag{3}$$

where $\overline{T}$—average growth rate in rice yield over the analyzed period.

$$\overline{T} = \sqrt[n-1]{\frac{y_n}{y_1}}. \tag{4}$$

Both forecasts gave approximately the same values of rice yield—55–57 centners per hectare (c/ha).

The obtained forecast value of rice yield is almost two times lower than the potential yield of 110–130 c/ha according to breeding programs for the prospect of creating rice varieties. In today's economic conditions, characterized by weak material, technical, and financial support for rice production, such potential yields cannot be achieved because rice varieties specially bred for industrial agriculture require additional costs for which they are designed. The use of low-cost technologies and corresponding varieties of rice is relevant.

To achieve the potential yield of rice, it is necessary to introduce technological innovations in its production. The development of rice production is facilitated by state support measures, particularly the provision of preferential loans and subsidies to purchase elite seeds and reimburse part of the costs of reclamation activities.

## 4 Conclusion

A review of existing approaches to predicting rice yield showed that researchers use statistical forecasting methods and regression models, considering the influence of predominantly technological factors, mathematical modeling methods, and remote sensing data. Some researchers note the same effectiveness of the approaches used. Therefore, the authors applied the method of statistical forecasting to predict rice yield, which is more accessible and easier to use.

Based on the data for 1990–2022, the authors made a forecast of rice yield using the methods of calculating the average growth and average growth rate, as well as Excel

trends. Both forecasts gave approximately the same values of rice yield—55–57 c/ha.

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# Conclusion

As this book demonstrates, sustainable agrarian economies based on digital technologies and smart innovation are the key to ensuring food security and combating global hunger. The scientific knowledge collected in this book makes it possible to conclude that the issues of state regulation of the agrarian economy, organization and management of agricultural organizations, and socio-legal and technological support for their implementation of digital technologies and smart innovations are closely interrelated and need systemic solutions, which are proposed in this book.

It is important to consider the specific context of the Decade of Action. On the one hand, the Fourth Industrial Revolution makes it possible to expect the creation of more digital technologies and smart innovations that will require ground breaking scientific and practical solutions. It is appropriate to devote future research to their development in the sequel to this book. Particularly, the creation of fully robotized smart vertical farms similar to smart industrial enterprises needs in-depth elaboration from the socio-legal and organizational-technical points of view.

In future research, it is also worth paying attention to the scientific study of the impact of the transformation of international supply and distribution chains, the processes of which have already begun but not yet taken their final shape. Overall, the future architecture of world food markets is uncertain and, therefore, emerges as a promising area for further research in the sequel to this book.

The global food crisis, exacerbated in 2022–2023, is another promising area of research based on the findings in this book. As the current food crisis and its future manifestations threaten to exacerbate global hunger, it needs crisis management. This will require the implementation of supranational initiatives to regulate world food markets, which will have to be developed by science in the coming years.



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