Innovation as a Factor in Sustainable Development of Russia's Agriculture

Nadezhda N. Semenova*, Irina A. Ivanova and Svetlana G. Busalova

Faculty of Economics, Ogarev Mordovia State University, Saransk, Russia

Abstract: Sustainable agriculture is an integral aspect of the sustainable development of a socio-economic system. In this regard, innovation is considered to be one of the leading factors ensuring the development of sustainable agricultural since it increases the efficiency and competitiveness of the industry in the domestic and foreign markets. This study presents a system of recursive equations characterizing the innovations occurring within agricultural organizations in the regions of the Russian Federation. Additionally, the study assesses the sustainability of agricultural development in Russia by calculating the integrated index of five components: economic, innovative, social, ecological, and institutional. Also, the authors built a regression model that estimates the influence of innovation on the sustainability of agricultural development in Russia.

Keywords: Sustainable development, sustainable agriculture, innovation, innovative development.

INTRODUCTION

Russia's agricultural sector is the main producer of vital agricultural products, and any agricultural sector plays a crucial role in ensuring the food security and food independence of a country (Pargaru, Stancioiu, Ladaru, and Teodor, 2019; Krylatykh and Mazloeva, 2016; Kormishkina, Semenova, Krutova, and Sausheva, 2013). According to some scholars, in the near future we can expect a higher demand for food accompanied by aggravated environmental problems due to intensive farming (Skaf, Buonocore, Dumontet, Capone, and Franzese, 2019; Czyzewski, Matuszczak, and Muntean, 2018; Caraka, Chen, Toharudin, Pardamean, Yasin, and Wu, 2019; Ivlev, Ivleva, and Ivleva, 2019; Ivleva, Yablochkina, Kornilova, Ludvig, and Vasyakin, 2016). Thus, the greatest global challenges faced by humankind are ensuring food security and reducing the risks and threats to sustainable agricultural development around the world (Borzykh, 2019; Czyżewski, Matuszczak, and Muntean, 2019; Serova, 2017; Spicka, Hlavsa, Soukupova, and Stolbova, 2019).

Currently, the main imperatives for the sustainable development of agriculture include: a) increasing human and social capital of rural territories; b) stimulating innovation and technological modernization of the industry; c) conserving natural resources and preserving them for future generations (Caraka, Lee, Kurniawan, Herliansyah, Kaban, Nasution, Gio, Chen, Toharudin, and Pardamean, 2020; Caraka, Tahmid, Putra, Iskandar, Mauludin, Hermansah, Goldameir, Rohayani, and Pardamean, 2018; Caraka, Bakar, Tahmid, Yasin, and Kurniawan, 2019).

Sustainable agricultural development requires innovations that increase the efficiency and competitiveness of the industry in the domestic and global markets (Sinha, 2019; Kheyfets and Chernova, 2019; Voronin, Chupina, Voronina, and Chupin, 2019; Kantemirova, Kuchieva, and Balikoev, 2016; Kharitonov, 2016a, 2016b; Adenle, Wedig, and Azadi, 2019; de Gennaro and Forleo, 2019; Nikolaeva, 2014; Markova, 2013; Brinza, Ilyichev, Ugarova, and Loginova, 2015; Fedorenko, Persteneva, Konovalova, and Tokarev, 2016). Major innovations in agriculture will lead to: an increase in crop yields and livestock productivity; the growth in labor productivity and agricultural production; saving material, labor, and financial resources (Surya, Syafri, Abubakar, Sahban, and Sakti, 2020; Ponkratov, Karaev, Silvestrov, Kuznetsov, Smirnov, and Kotova, 2019). At present, innovation is of paramount importance for the sustainable development of agriculture.

Sustainable agricultural development through innovation is among the top priorities of the Russian Federation (Osipov, Ponkratov, Karepova, Volkova, Karaev, and Kuznetsov, 2020). For instance, in August 2017, the country adopted the Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025, which implies the transition of the industry to an innovative path of development, increasing export potential and reducing its dependence on imported technology.

LITERATURE REVIEW

Sustainable agriculture is an integral element of the sustainable development of the global economy (Aziz,

*Address correspondence to this author at the Ogarev Mordovia State University, 68 Bolshevistskaya St., Saransk, 430005, Russia;
E-mail: nadezhda_semenova_1980@bk.ru

E-ISSN: 1929-4409/20

Muhammad, Ghazali, Talaat, and Saputra, 2019). For the first time, the issues of sustainable development were actively discussed worldwide in the 1960-1970s when humanity faced some risks and threats: namely, the depletion of natural capital, the lack of mineral resources and energy, ecosystem degradation, lower regenerative ability of the biosphere, food crisis, and alleviated poverty (Caraka, Hafianti, Hidayati, Wilie, and Muztahid, 2019; Toharudin, Caraka, Darmawan, Iskandar, Somantri, Arnita, Soebagyo, Goldameir, and Asmawati, 2018). In 1987, the UN International Commission on Environment and Development published a report "Our Common Future." This document claimed that the equal coexistence of society and the world, in which environmental safety will be an integral part of sustainable development, is the prime goal in the development of the global economy. Sustainable development was defined as "the development that contributes to meeting the needs of the current generation without reducing the ability of future generations to satisfy their needs" (Brundtland, 1987).

In 1992, the United Nations held a conference on the environment and adopted the document "Agenda 21," which presents 27 fundamental principles of sustainable development (Food and Agriculture Organization of the United Nations, 1996). In other words, the global community formed a new economic paradigm: the concept of sustainable development based on the harmonization and optimal combination of economic, social, and environmental advances, as well as consideration of the interests of present and future generations.

Currently, within the triune concept of sustainable development embracing the economic, social, and environmental components, some scientists (Goryunova, 2015; Reshetnikova, 2017) identify a fourth subsystem—the institutional one. They single out the institutional component, as there is a need for creating a regulatory framework in regard to the modern information system and other institutions that would ensure the sustainable development of countries and regions.

The concept of "sustainable development of agriculture" was first defined at a 1996 session of the UN Food and Agriculture Organization (FAO). According to the FAO, sustainable development of agriculture ensures the conservation and preservation of soil fertility, the rational use and protection of water resources, and preservation and accumulation, within reasonable limits, of plant and animal genetic potential. The main objective of sustainable agricultural development is to increase the production of high-quality and safe food and to ensure food security (Food and Agriculture Organization of the United Nations, 1996). This aim can be achieved by creating and using intensive resource-saving technologies, creating favorable conditions for the development of all forms of management, increasing the income of agricultural producers and social protection of the rural population, as well as natural resource management and environmental protection (Kharitonov, 2016a, 2016b; Altukhov, 2017).

According to Askarov and Askarova (2012), agriculture is sustainable as long as the reproduction of its resource potential—the natural environment, means of production, and human resources—may continue for unlimited time. Russian academic Petrikov (2009) defines sustainable rural development as "stable development that increases the efficiency of the rural economy, the level and quality of life of the rural population, maintains ecological balance, and preserves and improves the rural landscape." Sustainable agricultural development entails maintaining an economic, social, and environmental balance that ensures the congruence of interests within the trinity of "nature – society – people" (Kazannikov, 2015).

Against this background, the main criteria for the sustainable development of agriculture are: 1) economic: the growth in food production and the economic efficiency of agricultural production; 2) social: higher level and better quality of life, as well as improved demographic and migration situation in rural areas; 3) environmental: the stability of agricultural systems, better environmental quality and conservation of natural resources; 4) institutional: legislation, regulatory, and control institutions, as well as the institutions of social and economic development.

Innovation plays a leading role among the factors of sustainable agricultural development (Nikitin and Kuzicheva, 2019; Lukhmanova, Baisholanova, Shiganbayeva, Sambetbayeva, Abenov, and Gussenov, 2019; Mazur, Barmuta, Demin, Tikhomirov, and Bykovskiy, 2016; Akhmetshin, Vasilev, Mironov, Yumashev, Puryaev, and Lvov, 2018). According to some researchers, the latest technology and innovation in agriculture reduce the complexity of production and labor costs by 47.1-87.0% (Derevyankin, 2014). At the same time, the potential for introducing innovation in their activities is not the same for all agricultural producers (Chekunov, 2019). For instance, large agricultural holdings and agro-industrial clusters (except for organic and waste-free agriculture) have the greatest potential for introducing modern innovative technologies. Farms are most interested in organic farming technologies, loose livestock, circular agriculture, and drip irrigation (Asylbaev, Nigmatzyanov, Khabirov, Sergeev, and Kurmasheva, 2020).

Innovation in agriculture has certain specifics: firstly, the introduction of innovations should provide not only economic benefits, but also maintain consumers' health; secondly, the development and implementation of innovations takes quite a long time; thirdly, the industry is influenced by the climatic conditions (Minina, 2019; Podkolzina and Pavlyuk, 2018).

In modern conditions, the innovative development of the industry involves not only the active use of the technologies created in the times of the "green revolution" (reclamation, mechanization, chemization, best advances of selective breeding, etc.), but also post-industrial agriculture technologies (for example, digitalization) (Petrikov, 2018; Aitkhozhin, Balkibayeva, Ramazanova, Yermekov, and Karsybayeva, 2019). The introduction of innovations in agriculture aimed at its sustainable development should take the following directions: a) the development of human capital; b) the development of biological resources; c) increasing the technical and technological potential (Podkolzina and Pavlyuk, 2018; Dedeeva and Lapaeva, 2015).

MATERIALS AND METHODS

In this study we used the following methods and tools:

1. Factor and correlation analysis, as well as analysis of variance to identify and verify the results of a regression system and to test the statistical hypotheses according to the F-test and Student's t-test.

2. The method of multicriteria integral assessment of the sustainability of agricultural development. We used two approaches as integrated assessment tools:

The first was a transformed polygon (stability radar) constructed on the basis of five local criteria: economy (17 indicators), innovation (44 indicators), social sphere (16 indicators), ecology, and institutions (15 indicators).

In this case, the stability index was calculated by the formula:

$$I_{sus1} = \frac{S_i}{S} \tag{1}$$

where Si is the polygon area for the *i*-th region of the Russian Federation;

S is the total area of the attribute space (the polygon of the "reference" region whose ranks have the maximum possible value.

The second is the stability index, which can be calculated by the formula:

$$I_{sus2} = \frac{x_i - x_{i\ \min}}{x_{i\ \max} - x_{i\ \min}} \tag{2}$$

where x_i is the value of the *i*-th indicator,

$x_{i\ \max}$ and $x_{i\ \min}$ are the maximum and minimum values of the *i*-th indicator.

To calculate the integral index of sustainable agricultural development, we used the formula:

$$I_{sus} = \frac{I_{sus1} + I_{sus2}}{2} \tag{3}$$

3. Regression modeling of the impact of innovation on sustainable agricultural development based on the generalized least squares method.

RESEARCH RESULTS

According to the Federal State Statistics Service of the Russian Federation, innovation activity in agriculture has been decreasing over the past decade. For instance, in 2018, the share of innovative goods in agriculture amounted to only 1.9% of the total volume of production; the share of organizations implementing technological innovations decreased from 9.5 in 2008 to 3.1% in 2018.

To assess innovation activity in Russian agriculture, we used a recursive system of econometric equations, which take the following form:

$$\begin{cases} Y_1 = \sum_{j=1}^{m} a_{1j} \cdot X_j + \varepsilon_1 \\ Y_2 = b_{21} \cdot Y1 + \sum_{j=1}^{m} a_{2j} \cdot X_j + \varepsilon_2 \\ Y_3 = b_{31} \cdot Y_1 + b_{32} \cdot Y_2 + \sum_{j=1}^{m} a_{3j} \cdot X_j + \varepsilon_3 \end{cases} \tag{4}$$

where the endogenous variables of model (1) are explained below.

Y_1 is the internal expenditure on research and development in agricultural organizations (RUB million),

Y_2 refers to the advanced production technologies used in agricultural organizations (RUB million), and

Y_3 is the value of the combined volume of innovative goods, work, and services in agriculture (RUB million).

Each endogenous indicator is influenced by numerous socio-economic factors $X_j (j = 1,\ldots, m)$. The exogenous variables were represented by 44 indicators that affect the development of innovation activity and are relevant to Russia's regions. Sequential stepwise addition was used to construct multiple regression equations depending on the given factors, excluding those responsible for multicollinearity as well as factors deemed as statistically insignificant by Student's t-test.

The system of the constructed recursive equations describing the innovation activity in agricultural organizations in Russia takes the following form:

$$\begin{cases} Y_1 = -19.62273 + 0.00011X_5 + 0.00180X_8 + 0.00129X_{21} + 0.01614X_{35} + \varepsilon_1; F_1(4;77) = 43.27; R_1^2 = 0.69 \\ \qquad (4.761) \quad (4.616) \quad (4.227) \quad (9.337) \\ Y_2 = 489.77753 + 3.19469Y_1 - 0.65171X_3 + 0.00305X_6 + 0.06056X_{24} + 0.08068X_{27} + 23.95891X_{37} + \varepsilon_2; F_2(6;75) = 24.59; R_2^2 = 0.66 \\ \qquad (4.129) \quad (-2.891) \quad (3.354) \quad (3.279) \quad (2.226) \quad (3.035) \\ Y_3 = -74124.298 + 1.40529Y_1 + 12.10204Y_2 + 0.02886X_5 + 5607.44314X_{15} - 0.5570X_{26} + 4726.53916X_{39} + 4960.13594X_{43} + \varepsilon_3; F_3(7;74) = 29.68; R_3^2 = 0.74 \\ \qquad (2.149) \quad (3.712) \quad (2.829) \quad (3740) \quad (-4.181) \quad (2.904) \quad (2.095) \end{cases} \tag{5}$$

The regression equations of system (5) and their parameters were reliable according to the F-test and Student's t-test (significance level α = 0.05) since

$$F_i > F_{cri}, |t_{aj}| > t_{cri} \tag{6}$$

where

$$F_{cr1}(0.05;4;77) = 2.49; F_{cr2}(0.05;6;75) = 2.22; F_{cr3}(0.05;7;74) = 2.14 \tag{7}$$

$$t_{cr1}(0.05;77) = 1.991; t_{cr2}(0.05;75) = 1.992; t_{cr3}(0.05;74) = 1.993 \tag{8}$$

The system of recursive equations (5) can be used to predict the innovation activity in agricultural organizations in Russia.

As part of our study, we analyzed sustainable development in agriculture in the Volga Federal District of the Russian Federation according to the calculated integral index. The calculations of the local and integral indices of sustainable agricultural development in the Volga Federal District are presented in Table **1**.

Table **2** presents the interpretation of the agricultural sustainability index in the regions of the Volga Federal District of Russia.

To assess the influence of innovations on the sustainable development of agriculture in the regions of the Volga Federal District, we constructed regression (9), as follows:

$$I_{sus} = -0.617 + 2.267 \cdot I_{RRII} + \varepsilon; F(1,12) = 38.96; R^2 = 0.77 \tag{9}$$
$$(6.242)$$

where I_{RRII} is the index of Russia's Regional innovative development calculated for the regions of the Volga Federal District as an integral indicator using the above multicriteria methodology, which is based on five local criteria (Table **3** and Figure **1**).

The constructed regression equation (9) was statistically significant $(\alpha = 0.000044, (F_{cr}(0.000044;1;12) = 38.78, F > F_{cr})$, thus confirming the high correlation of agricultural stability in the regions of the Volga Federal District (I_{sus}) with the innovation activity of the constituent entities of the Russian Federation (I_{RRII}) (correlation coefficient *R*=0.87). Simultaneously, the regression coefficient $\alpha_1 (= 2.267)$ was reliable according to Student's *t*-test $(\alpha = 0.000044)$. Therefore, we can draw highly reliable conclusions confirming the significance of innovation on the sustainability of agricultural development.

DISCUSSION

Having analyzed the system of recursive equations to describe the innovation activity of agricultural organizations in the regions of the Russian Federation, we can draw the following conclusions:

– The volume of gross regional product per capita, agricultural production, investment in fixed assets of agricultural enterprises, and number of staff employed in research and development

Table 1: Local and Integrated Indices of Agricultural Development in the Regions of the Volga Federal District

No	Region	Local criteria					I_{sus1}	I_{sus2}	$I_{sus} = \frac{I_{sus1} + I_{sus2}}{2}$	Rank
		Economy	Innovation	Social sphere	Ecology	Institutions				
1	Republic of Tatarstan	0.552	0.537	0.838	0.218	0.870	0.470	1.000	0.735	1
2	Nizhny Novgorod Region	0.434	0.496	0.375	0.212	0.687	0.272	0.445	0.358	4
3	Samara Region	0.478	0.417	0.460	0.267	0.661	0.296	0.502	0.399	2
4	Republic of Bashkortostan	0.411	0.412	0.551	0.285	0.586	0.282	0.473	0.378	3
5	Perm Region	0.380	0.397	0.322	0.571	0.484	0.271	0.417	0.344	5
6	The Republic of Mordovia	0.319	0.385	0.195	0.515	0.444	0.196	0.213	0.205	8
7	Ulyanovsk Region	0.332	0.385	0.255	0.235	0.467	0.162	0.093	0.127	11
8	Penza Region	0.375	0.382	0.369	0.212	0.431	0.181	0.156	0.168	10
9	Chuvash Republic	0.367	0.375	0.257	0.383	0.409	0.188	0.171	0.180	9
10	Saratov Region	0.407	0.357	0.275	0.325	0.481	0.201	0.209	0.205	7
11	Mari El Republic	0.388	0.328	0.178	0.309	0.402	0.153	0.050	0.102	13
12	Udmurt Republic	0.378	0.320	0.151	0.358	0.423	0.157	0.066	0.112	12
13	Kirov Region	0.313	0.317	0.141	0.627	0.467	0.197	0.217	0.207	6
14	Orenburg Region	0.368	0.289	0.212	0.257	0.402	0.139	0.000	0.070	14

Table 2: The Interpretation of the Values of the Agricultural Sustainability Index in the Regions of the Volga Federal District of the Russian Federation

Sustainability area	Index interval boundaries	Degree of system sustainability	Regions
1	$0.7 < I_{sus} \leq 1$	Highly sustainable development	Republic of Tatarstan
2	$0.5 < I_{sus} \leq 0.7$	Sustainable development	
	$0.3 < I_{sus} \leq 0.5$	Development close to sustainable	Nizhny Novgorod Region Samara Region Republic of Bashkortostan Perm Region
3	$0.1 < I_{sus} \leq 0.3$	Development with some features of unsustainability	The Republic of Mordovia Ulyanovsk Region Penza Region Chuvash Republic Saratov Region Mari El Republic Udmurt Republic Kirov Region
	$0.01 < I_{sus} \leq 0.01$	Unsustainable development	Orenburg Region

Table 3: The Influence of Innovations on the Sustainable Development of Agriculture in the Regions of the Volga Federal District

Region	Russia's Regional innovation index I_{RRII}		Index of socio-economic conditions of innovation		Index of scientific and technical potential		Innovation index		Index of export activity		Index of the quality of innovation policy	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Republic of Tatarstan	0.537	2	0.523	2	0.475	13	0.570	1	0.461	9	0.642	1
Nizhny Novgorod Region	0.496	5	0.397	34	0.56	4	0.470	8	0.533	3	0.557	6
Samara Region	0.417	11	0.490	5	0.383	37	0.268	39	0.375	25	0.518	10
Republic of Bashkortostan	0.412	13	0.427	17	0.486	12	0.286	36	0.372	26	0.46	15
Perm Region	0.397	17	0.384	45	0.420	20	0.334	23	0.398	21	0.447	17
The Republic of Mordovia	0.385	22	0.324	70	0.341	58	0.500	5	0.191	65	0.539	8
Ulyanovsk Region	0.385	20	0.334	68	0.594	2	0.241	42	0.313	39	0.422	20
Penza Region	0.382	23	0.377	48	0.354	51	0.481	6	0.247	53	0.423	19
Chuvash Republic	0.375	24	0.377	49	0.35	52	0.544	2	0.156	71	0.399	24
Saratov Region	0.357	32	0.406	25	0.384	36	0.223	48	0.314	38	0.419	21
Mari El Republic	0.328	46	0.390	42	0.460	15	0.288	35	0.241	55	0.211	64
Udmurt Republic	0.320	52	0.374	50	0.328	65	0.292	32	0.199	64	0.351	35
Kirov Region	0.317	54	0.314	76	0.387	35	0.301	31	0.327	35	0.256	55
Orenburg Region	0.289	63	0.364	53	0.309	73	0.239	45	0.363	30	0.164	74

have a significant impact on the growth of research and development in the regions and agricultural organizations.

– The use of advanced production technologies in agricultural organizations depends on the level of research and development costs, number of innovative production technologies developed, investment in fixed assets, and retail and wholesale turnovers.

– The production of innovative goods, work, and services in agriculture depends on the costs of research and development, advanced production technologies used in agricultural organizations, volume of gross regional product per capita, innovation activity of agricultural organizations, development of wholesale trade, use of special software for scientific research, and number of higher education institutions and scientific organizations.

The calculated indices of the sustainability of agricultural development in the regions of the Volga Federal District of the Russian Federation indicate the following:

– In terms of the local criterion of “Economy,” the Republic of Tatarstan was the only region to demonstrate sustainable development. The development was close to sustainable for all the other regions of the Russian Federation.

– In terms of the local criterion “Innovation,” the Republic of Tatarstan was the only region to demonstrate sustainable development; all other constituent entities of the Russian Federation, with the exception of the Orenburg

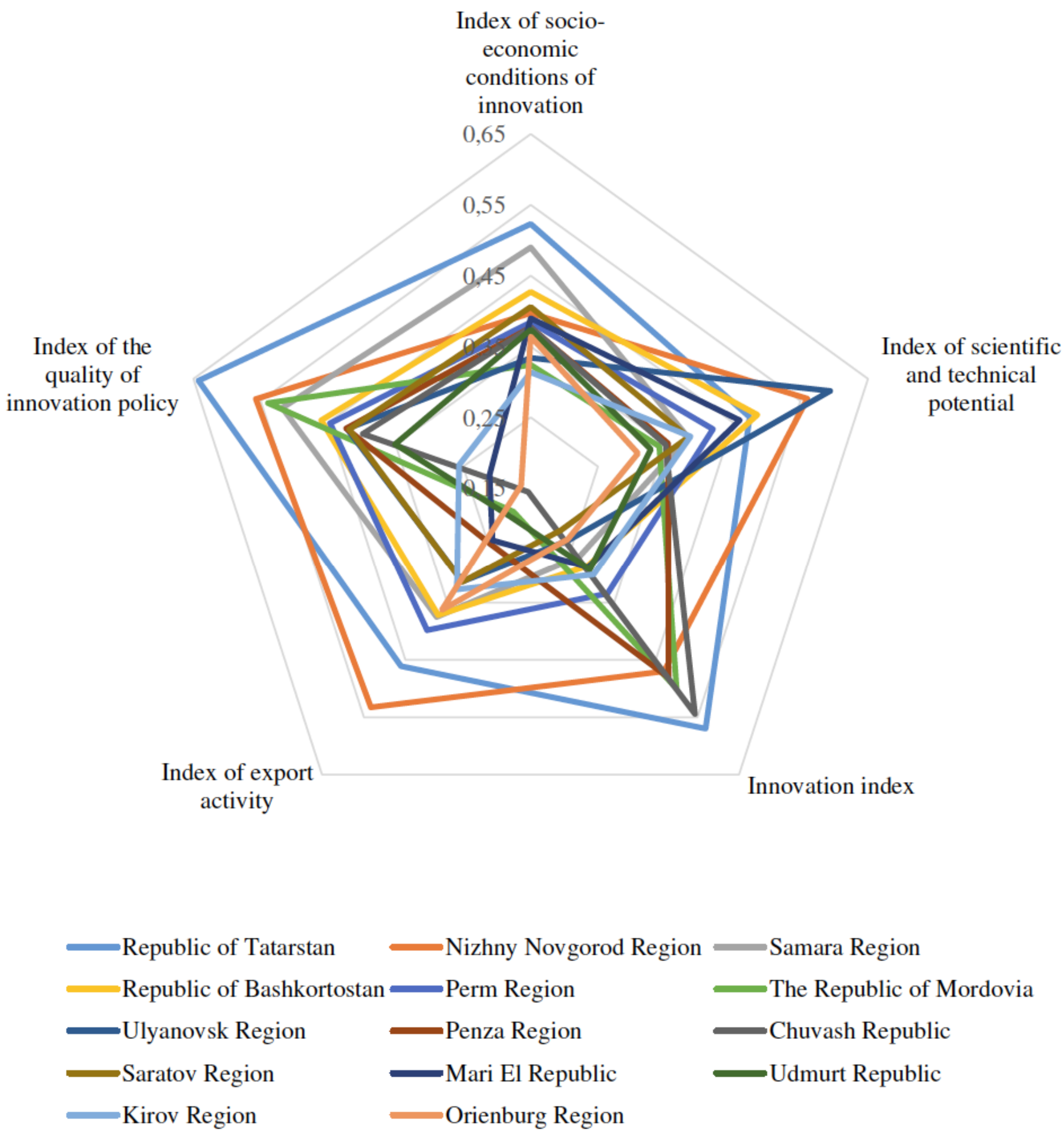

Figure 1: The ranking of the regions of the Volga Federal District by Russia's Regional Innovation Index in 2018.

Region, exhibited development that was close to sustainable.

– In terms of the local criterion "Social sphere," high sustainability was observed in the Republic of Tatarstan. The Republic of Bashkortostan showed sustainable development, while the Nizhny Novgorod, Samara, Penza, and Perm Regions demonstrated development that was close to sustainable. Unsustainable development was a characteristic of the Republics of Mordovia, Mari El, Chuvash, and Udmurt as well as the Ulyanovsk, Saratov, Kirov, and Orenburg Regions.

– In terms of the local criterion "Ecology," the Kirov and Perm Regions as well as the Republic of Mordovia showed sustainable development. The Republics of Chuvash, Mari El, and Udmurt as well as the Saratov Region exhibited development that was close to sustainable. All the other constituent entities of the Russian Federation showed unsustainable development.

– In terms of the local criterion "Institutions," practically all regions of the Volga Federal District showed sustainable or close to sustainable agricultural development.

The constructed regression equation could assess the influences of innovations on the sustainable development of agriculture in the regions of the Volga Federal District. The results confirmed a high correlation (R = 0.87).

CONCLUSION

Agriculture is one of the key sectors of the Russian economy. The sustainable development of this industry is the most important strategic priority of Russia's socio-economic policy. Simultaneously, the country cannot ensure sustainable development of its industry without promoting innovation. The active introduction of innovation helps increase the efficiency and competitiveness of agriculture in the domestic and global markets. Successful innovative development of the industry requires comprehensive measures aimed at stimulating the supply of innovations and increasing the demand for innovative products, services, and technologies.

ACKNOWLEDGEMENTS

This article was supported by the Russian Foundation for Basic Research (Project No. 19-05-00066 A: "Spatial-Temporal Patterns of Innovative Development of Agriculture in Russian Regions").

REFERENCES

Adenle, A. A., Wedig, K., & Azadi, H. (2019). Sustainable agriculture and food security in Africa: The role of innovative technologies and international organizations. *Technology in Society*, 58, 101143. https://doi.org/10.1016/j.techsoc.2019.05.007

Aitkhozhin, S. K., Balkibayeva, A. M., Ramazanova, R. H., Yermekov, F. K., & Karsybayeva, K. A. (2019). Economic assessment of precision agriculture project in Kazakhstan. *Periódico Tchê Química,* 16(33), 304-314. http://www.deboni.he.com.br/arquivos_jornal/2019/33/319_Periodico33.pdf

Akhmetshin, E. M., Vasilev, V. L., Mironov, D. S., Yumashev, A. V., Puryaev, A. S., & Lvov, V. V. (2018). Innovation process and control function in management. *European Research Studies Journal,* 21(1), 663-674. https://doi.org/10.35808/ersj/978

Altukhov, A. I. (2017). *Substantiation of Directions of Sustainable Innovative Development of Agriculture.* Kursk: Publishing House of Kursk State Agricultural Academy.

Askarov, A. A., & Askarova, A. A. (2012). Sustainable agriculture: The nature and prerequisites for its formation. *Management of Economic Systems: An Electronic Scientific Journal*, 6(42), 31. http://uecs.ru/otraslevaya-ekonomika/item/1378-2012-06-01-12-28-17

Asylbaev, I., Nigmatzyanov, A., Khabirov, I., Sergeev, V., & Kurmasheva, N. (2020). Composition, properties, and use of secondary resources as organic soil fertilizers. *Periódico Tchê Química,* 17(35), 259-268. http://www.deboni.he.com.br/arquivos_jornal/2020/35/23_ASYLBAEV_pgs_259_268.pdf

Aziz, N., Muhammad, Z., Ghazali, F., Talaat, W. I. A. W., & Saputra, J. (2019). Marine spatial planning: The way forward for sustainable development of Central Terengganu, Malaysia. *Journal of Southwest Jiaotong University,* 54(4). https://doi.org/10.35741/issn.0258-2724.54.4.9

Borzykh, O. V. (2019). Environmental risks of sustainable agricultural development. *Science and Education*, 3, 7.

Brinza, V. V., Ilyichev, I. P., Ugarova, O. A., & Loginova, V. V. (2015). Prognostic simulation of external economic activity for an industrial company. *CIS Iron and Steel Review,* 10, 27-39. https://doi.org/10.17580/cisisr.2015.01.06

Brundtland, G. H. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. New York: Oxford University Press. https://sustainable-development.un.org/content/documents/5987our-common-future.pdf

Caraka, R. E., Bakar, S. A., Tahmid, M., Yasin, H., & Kurniawan, I. D. (2019). Neurocomputing fundamental climate analysis. *TELKOMNIKA Indonesian Journal of Electrical Engineering,* 17(4), 1818-1827. https://doi.org/10.12928/telkomnika.v17i4.11788

Caraka, R. E., Chen, R. C., Toharudin, T., Pardamean, B., Yasin, H., & Wu, S. H. (2019). Prediction of status particulate matter 2.5 using state Markov chain stochastic process and Hybrid VAR-NN-PSO. *IEEE Access,* 7, 161654-161665. https://doi.org/10.1109/ACCESS.2019.2950439

Caraka, R. E., Hafianti, S., Hidayati, S., Wilie, B., & Muztahid, M. R. (2019). *Identifying Indicators of Household Indebtedness by Provinces*. https://doi.org/10.13140/RG.2.2.17238.19528

Caraka, R. E., Tahmid, M., Putra, R. M., Iskandar, A., Mauludin, M. A., Hermansah, Goldameir, N. E., Rohayani, H., & Pardamean, B. (2018). Analysis of plant pattern using water balance and cimogram based on oldeman climate type. *IOP Conference Series: Earth and Environmental Science,* 195, 012001. https://doi.org/10.1088/1755-1315/195/1/012001

Caraka, R., Lee, Y., Kurniawan, R., Herliansyah, R., Kaban, P., Nasution, B., Gio, P., Chen, R., Toharudin, T., & Pardamean, B. (2020). Impact of COVID-19 large scale restriction on environment and economy in Indonesia. *Global Journal of Environmental Science and Management,* 6(Special Issue (COVID-19)), 65-84. https://doi.org/10.22034/GJESM.2019.06.SI.07

Chekunov, A. S. (2019). Technological modernization of agricultural production: condition, forms, methods and directions of innovations support. *Bulletin of the Voronezh State University of Engineering Technology*, 81-1(79), 373-379. https://doi.org/10.20914/2310-1202-2019-1-373-379

Czyzewski, B., Matuszczak, A., & Muntean, A. (2018). Influence of agricultural policy on the environmental sustainability of European farming. *Journal of Environmental Protection and Ecology*, 19(1), 426-434. https://www.researchgate.net/profile/Bazyli_Czyzewski/publication/324561757_Influence_of_agricultural_policy_on_the_environmental_sustainability_of_European_farming/links/5ad5ad18a6fdcc293580e0b5/Influence-of-agricultural-policy-on-the-environmental-sustainability-of-European-farming.pdf

Czyżewski, B., Matuszczak, A., & Muntean, A. (2019). Approaching environmental sustainability of agriculture: Environmental burden, eco-efficiency or eco-effectiveness. *Agricultural Economics (Czech Republic),* 65(7), 299-306. https://doi.org/10.17221/290/2018-AGRICECON

Dedeeva, S. A., & Lapaeva, O. A. (2015). Innovation as the main factor in the development of agriculture in the region. *Bulletin of Orenburg State University,* 4(179), 266-270. http://vestnik.osu.ru/doc/1033/article/8347/lang/0

de Gennaro, B. C., & Forleo, M. B. (2019). Sustainability perspectives in agricultural economics research and policy agenda. *Agricultural and Food Economics*, 7(1), 17. https://doi.org/10.1186/s40100-019-0134-8

Derevyankin, A. V. (2014). The stimulation of transition to the progressive technical-technological level in the main branches of agriculture in Siberia. *Bulletin of the Krasnoyarsk State Agrarian University*, 12, 3-7. http://www.kgau.ru/vestnik/content/2014/12.pdf

Fedorenko, R. V., Persteneva, N. P., Konovalova, M. E., & Tokarev, Y. A. (2016). Research of the regional service market in terms of international economic activity's customs registration. *International Journal of Economics and Financial Issues,* 6(5), 136-144. http://www.econjournals.com/index.php/ijefi/article/download/2878/pdf

Food and Agriculture Organization of the United Nations. (1996). *Promotion of Sustainable Agriculture and Rural Development: Agenda 21.* http://www.fao.org/3/x5559e/x5559e07.htm

Goryunova, L. A. (2015). Innovative institutional environment as a factor in the sustainability of territorial development. *Bulletin of the Buryat State University*, 2a, 21-25. https://cyberleninka.ru/article/n/innovatsionnaya-institutsionalnaya-sreda-kak-faktor-ustoychivosti-territorialnogo-razvitiya

Ivlev, V. Y., Ivleva, M. I., & Ivleva, M. L. (2019). Ecological regulation of economy as a concept of social philosophy. *Voprosy Filosofii,* 2019(7), 111-121. https://doi.org/10.31857/S004287440005737-5

Ivleva, M. I., Yablochkina, I. V., Kornilova, I. M., Ludvig, S. D., & Vasyakin, B. S. (2016). Ecological aspect of investment projects for the development of specially protected nature territories (by the example of the Sochi national park). *Research Journal of Pharmaceutical, Biological and Chemical Sciences,* 7(4), 1293-1303. https://www.rjpbcs.com/pdf/2016_7(4)/%5B165%5D.pdf

Kantemirova, M. A., Kuchieva, M. V., & Balikoev, V. T. (2016). Innovations as a factor of import substitution in agricultural complex of the region. *Fundamental Research*, 4(2), 392-396. https://fundamental-research.ru/en/article/view?id=40187

Kazannikov, A. A. (2015). Sustainable development of the agri-food system as a social and market imperative. *Bulletin of the Institute of Economics of the Russian Academy of Sciences*, 2, 87-94. https://inecon.org/images/stories/publicacii/vesnik-ran/2015/VIE_RAS_2_2015.pdf

Kharitonov, A. V. (2016a). Innovations as factor of the sustainable development of agriculture of the region. *Fundamental Research,* 3(3), 648-652. https://fundamental-research.ru/en/article/view?id=40115

Kharitonov, A. V. (2016b). *Sustainable Development of Agriculture in the Region: Theoretical and Applied Aspects.* Tomsk: Publishing House of Tomsk University.

Kheyfets, B. A., & Chernova, V. Y. (2019). Sustainable agriculture in Russia: Research on the dynamics of innovation activity and labor productivity. *Entrepreneurship and Sustainability Issues*, 7(2), 814-824. https://doi.org/10.9770/jesi.2019.7.2(2)

Kormishkina, L. A., Semenova, N. N., Krutova, I. N., & Sausheva, O. S. (2013). Food security in the system of relations of the standard and quality of life. *World Applied Sciences Journal*, 25(11), 1536-1541. https://doi.org/10.5829/idosi.wasj.2013.25.11.13456

Krylatykh, E. N., & Mazloeva, V. Z. (eds.) (2016). *National Economy: Food Security in the Context of Integration and Globalization.* Moscow: Infra-M.

Lukhmanova, G., Baisholanova, K., Shiganbayeva, N., Sambetbayeva, A., Abenov, B., & Gussenov, B. S. (2019). Innovative development of the agricultural sector of the Republic of Kazakhstan. *Espacios,* 40(32), 6. https://www.revistaespacios.com/a19v40n32/19403206.html

Markova, V. (2013). Marketing in innovation: the classification of the tasks and tools. *Journal of Contemporary Economics Issues,* 4. https://doi.org/10.24194/41312

Mazur, V. V., Barmuta, K. A., Demin, S. S., Tikhomirov, E. A., & Bykovskiy, M. A. (2016). Innovation clusters: Advantages and disadvantages. *International Journal of Economics and Financial Issues,* 6(1S), 270-274. https://econjournals.com/index.php/ijefi/article/view/2397

Minina, N. N. (2019). Innovation as a direction of increasing the sustainability of crop production in the Republic of Belarus. *Bulletin of the Belarusian State Agricultural Academy*, 4, 24-28. http://elc.baa.by/vestnik/vestnik2019-4.pdf

Nikitin, A., & Kuzicheva, N. (2019). Innovative technologies in agriculture. *International Journal of Recent Technology and Engineering,* 8(4), 3802-3807. https://doi.org/10.35940/ijrte.D8173.118419

Nikolaeva, I. (2014). Marketing aspects of innovative development of priority traditional industries of agribusiness of Republic of Sakha (Yakutia). *Journal of Contemporary Economics Issues,* 3. https://doi.org/10.24194/31402

Osipov, G. V., Ponkratov, V. V., Karepova, S. G., Volkova, M. V., Karaev, A. K., & Kuznetsov, N. V. (2020). Economic and mathematical modeling of the shocks impact on the Russian economy stability. *Montenegrin Journal of Economics,* 16(2), 101-116. https://doi.org/10.14254/1800-5845/2020.16-2.8

Pargaru, I., Stancioiu, F., Ladaru, R. G., & Teodor, C. (2019). Sustainable development in agriculture at the level of Romania and the European Union. *Quality – Access to Success*, 20(S2), 446-450.

Petrikov, A. (2009). Rural territories – sustainable development. *Agricultural Economics of Russia*, 7, 39-47.

Petrikov, A. (2018). Use of innovative technologies in various categories of farms and improvement of scientific and technological policy in agriculture. *AIC: Economics and Management*, 9, 4-11. https://doi.org/10.33305/189-4

Podkolzina, I. M., & Pavlyuk, A. V. (2018). The sustainable development of the rural economy in the framework of the innovative approach. *Economics Problems and Legal Practice*, 1, 23-27. https://urvak.org/articles/probl-vypusk-1-obespechenie-ustoychivogo-razvitiya/

Ponkratov, V. V., Karaev, A. K., Silvestrov, S. N., Kuznetsov, N. V., Smirnov, D. A., & Kotova, N. E. (2019). Graphical analysis of the growth rate of national economies by considering the supply chain strategy in 25 countries over the period from 2000 to 2016. *International Journal of Supply Chain Management,* 8(6), 1027-1034. https://ojs.excelingtech.co.uk/index.php/IJSCM/article/view/4052

Reshetnikova, E. G. (2017). Priority directions for the development of the institutional environment of the agri-food complex in the face of global challenges.

Serova, E. V. (2017). Sustainable development of the agri-food sector: challenges for the world and Russia. *Sustainable Economic Growth: Political and Social Background*, 1, 16-20.

Sinha, J. K. (2019). Influence of technologies on the growth rate of GDP from agriculture: A case study of sustaining economic growth of the agriculture sector in Bihar. *Statistical Journal of the IAOS*, 35(2), 277-287. https://doi.org/10.3233/SJI-180436

Skaf, L., Buonocore, E., Dumontet, S., Capone, R., & Franzese, P. P. (2019). Food security and sustainable agriculture in Lebanon: An environmental accounting framework. *Journal of Cleaner Production*, 209, 1025-1032. https://doi.org/10.1016/j.jclepro.2018.10.301

Spicka, J., Hlavsa, T., Soukupova, K., & Stolbova, M. (2019). Approaches to estimation the farm-level economic viability and sustainability in agriculture: A literature review. *Agricultural Economics (Czech Republic),* 65(6), 289-297. https://doi.org/10.17221/269/2018-AGRICECON

Surya, B., Syafri, Abubakar, H., Sahban, H., & Sakti, H. H. (2020). Spatial transformation of new city area: economic, social, and environmental sustainability perspective of Makassar

City, Indonesia. *Journal of Southwest Jiaotong University,* 55(3). http://jsju.org/index.php/journal/article/view/620

Toharudin, T., Caraka, R. E., Darmawan, G., Iskandar, A., Somantri, O., Arnita, Soebagyo, J., Goldameir, N. E., & Asmawati, S. (2018). Ensemble time series modified generalized regression neural network rainfall forecasting. In: *Proceedings of the 2nd Borneo International Conference on Applied Mathematics and Engineering* (pp. 280-285). Piscataway, New Jersey: Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/BICAME45512.2018.1570505191

Voronin, B. A., Chupina, I. P., Voronina, Y. V., & Chupin, Yu. N. (2019). Innovative activity in agriculture as a factor in increasing the competitiveness of the industry. *Agricultural Education and Science*, 1, 9. http://aon.urgau.ru/en/issues/36/articles/866

Received on 12-10-2020 Accepted on 14-11-2020 Published on 20-11-2020

DOI: https://doi.org/10.6000/1929-4409.2020.09.145