

Methods for supporting the process of diffusion and use of innovations in the agro-based industries

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ABSTRACT

In the modern context, one of the priority tasks for the agricultural development is to create conditions for the prompt transfer of the agro-industrial complex (AIC) to a new technological base. The purpose of this study is to substantiate the tools for assessing the innovative profile of animal husbandry, production and processing of fodder resources; study of means to support dairy farming to identify the impact of government regulation on the diffusion and use of innovations. The study forms the author's paradigm for assessing the innovative state of animal husbandry based on the theories of diffusion of innovations, the most important elements of which are technology transfer and knowledge spillover. The influence of the existing instruments of state support on the diffusion of innovations in dairy cattle operations by groups of regions in Russia is revealed. It is proposed to use indicators of the scale and intensity of innovative support for dairy farming, as well as the regional index of innovative support (RIIS). The findings revealed the priority role of innovative support in increasing the commodity resources of milk; appropriate models of state support were proposed for various groups of regions. To identify the impact of innovative support of dairy farming, an innovativeness matrix has been developed, which can be used to assess the innovation potential of milk production and processing, based on the innovative support resources used. Such methodological approach makes it possible to assess the level of sufficiency of innovative support resources for a fuller use of the industrial potential of both milk production and processing.

Keywords: Innovation process, Diffusion of innovations, Animal husbandry, Dairy farming, Support mechanisms, Innovation support.

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1. Introduction

The Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025 has identified as priority tasks the creation of conditions for the early transfer of the agro-industrial complex (AIC) to a new technological base, application of the results of scientific knowledge to the production process and its subsequent active use in the production process. Bringing the indicator of innovative activity in agriculture to 30% by 2025 is feasible provided that the innovative component of investments is strengthened, in connection with which it is necessary to implement measures to support the processes of modernisation and technical re-equipment of agricultural facilities [1-8]. Accordingly, the relevance of research in the field of assessing innovation potential, analysing the processes of diffusion of innovations, substantiating effective instruments of state support for transfer and the use of innovations in the agro-industrial complex is increasing.

Analysis of federal statistics data revealed a more active development of reconstruction and modernisation processes during the period 2005-2018 in organisations engaged in the production of food products. The innovative activity of agricultural organisations is lower than in manufacturing. An indicator such as the share

of costs for technological innovations in the total volume of goods shipped, work and services performed as of 2018 was also higher in food production, although interregional differences are noticeably traced (Table 1) [9-14].

Table 1. The share of costs for technological innovations in the total volume of goods shipped, work and services performed by certain types of activities (2018), %

Name of regions	Types of activity (Russian Classification of Economic Activities – OKVED 2)					
	Animal husbandry	Dairy cattle breeding, Milk production	Pig breeding	Agricultural poultry breeding	Food production	
Russian Federation	0.6	0.7	0.5	0.3	0.9	
Belgorod Oblast	0.3	<i>1.6</i>	0.2	0	<i>2.4</i>	
Vologda Oblast	<i>0.9</i>	<i>1.1</i>	0	0	0.1	
Kirov Oblast	0	0	0	0	<i>100</i>	
Kursk Oblast	0	0	0	0	25	
Leningrad Oblast	<i>1.2</i>	0.2	0	<i>1.6</i>	<i>1.4</i>	
Novgorod Oblast	<i>0.7</i>	2.3	0	0	0	
Tambov Oblast	0	0	0	<i>33.3</i>	<i>100</i>	
Republic of Udmurtia	0	0	0	<i>66.7</i>	0	

Notice. Indicator values that exceed the average level for Russia are italicised.

Thus, the dissemination of technological knowledge and the introduction of innovative technologies for certain types of activities in the agro-industrial complex are not sufficiently covered by incentive measures, which confirms the need to increase the innovative activity of regions [15-20]. Decree of the President of the Russian Federation of 07.05.2018 No. 204 “On national goals and strategic objectives of the development of the Russian Federation for the period up to 2024” provides for the stimulation of the use of innovations with such measures as strengthening tax incentives for research and development work (R&D); support of private tech firms [21-26]. According to a survey of heads of Russian enterprises in high-tech industries regarding the most demanded measures of state support of innovations, conducted by the Institute for Statistical Research and Economics of Knowledge of the National Research University “Higher School of Economics”, state support mechanisms are most actively used by large enterprises.

Throughout 2016-2018, 72% of this category of enterprises used at least one of the support instruments; for small and medium-sized enterprises, this indicator was 42% and 45%, respectively. Thus, in recent years, the share of enterprises using state support has increased: in 2015, in Russia as a whole, only 14.1% of all surveyed enterprises had access to state support (in the group of innovative companies this indicator was 44%) [27-31]. It should be noted that the most demanded measures in 2016-2018 were targeted subsidies for targeted innovation programs (they covered 25.7% of innovative enterprises). In second place is information and consulting support (23% of enterprises) [32-35].

The purpose of this study is to substantiate the methods for assessing the innovative profile of animal husbandry, production and processing of fodder resources; study of instruments to support dairy farming to identify the impact of government regulation on the diffusion and use of innovations.

2. Materials and methods

During the research, the following methods were used:

– monographic and abstract-logical: to investigate the problems of innovative development of the agro-industrial complex and mechanisms to support the diffusion of innovations. The compilation of theoretical and methodological approaches of Russian and foreign scientists has made it possible to develop the author's

paradigm for assessing the innovative state of animal husbandry based on the theory of diffusion of innovations based on technology transfer and knowledge spillover;

– analytical: to assess the forms of innovative state support used in dairy cattle breeding in Russia, identified according to the National Union of Milk Producers;

– analogies and comparisons: to compare the level of state support for milk, including innovation, at the interregional level for the selected groups of regions in Russia [36-39];

– computational and constructive: for calculating indicators of the innovative profile of animal husbandry and fodder production, which were calculated according to the EMISS Federal statistics. In order to identify the innovative component of state support for dairy cattle breeding, the author proposed indicators: the share of innovative support (%) and innovative support per cow, ths. RUB, which were calculated on the basis of statistics from the National Union of Milk Producers. It was determined that the first indicator characterises the scale of innovation support, and the second – the intensity of innovation support. The use of the above indicators makes it possible to characterise the state of innovation chains in the production of certain types of livestock products. Assessment of the process of diffusion of innovations was carried out on the basis of the previously published methodology of the author using the coefficient of innovation based on the standardisation of indicators of productivity of dairy cattle breeding. Using this technique, in this study, the author identified groups of regions in the Russian Federation with different levels of innovativeness in the dairy industry and investigated the impact of state support on the diffusion of innovations.

The study of the mechanisms for implementing the priorities for the development of the production potential of the agro-industrial complex and its industries was carried out using the regional index of innovative support (RIIS) substantiated by the author, the methodological basis for calculating which was the modernised integrated regional innovative index developed by the specialists of the Higher School of Economics. It is defined as the arithmetic mean of the normalised values of the indicators used, thereby smoothing the range of fluctuations within the regions and selected groups of regions. Its use made it possible to determine significant interregional differences in support for innovation and to reveal the relations with indicators of milk production.

Considering the variety of existing mechanisms of state support for innovation, on the one hand, and the limited scope of government regulation in the innovation sphere, on the other, it is of great importance to assess the overall effects of this kind of support. As practice shows, the support mechanisms used are not fully focused on achieving a high level of production innovation in various parts of the agro-industrial complex. The paradigm of innovative development is based on the mutual interest of participants in innovation chains in achieving the final result, which is largely predetermined by the socio-economic, informational, communication and institutional conditions of interaction between participants in the production process with scientific departments and government agencies. In the studies of Russian and foreign authors, the problems of innovative development of territorial economic systems, including the agro-industrial complex, are reflected. For example, the spatial distribution of innovative activity is present in the studies of P.C. Cheshire, E.J. Malecki, R. Crescenzi, A. Rodriguez-Pose, M. Storper [7]. The studies of M. Labianca, S. de Rubertis, A. Belliggiano and A. Salento noted the priority importance of technological and organisational innovations in the development of European rural areas [40; 41].

The issues of innovative development of the Russian agro-industrial complex and its branches have been reflected in numerous scientific papers. In particular, A.P. Potapov explores the resource potential of innovation in agricultural production; the system of measures proposed by him to expand innovative activity is based on the integration of science, education and production, designed to form an effective mechanism for the creation, development and dissemination of new technologies [42-46]. Using the knowledge economy methodology, E.A. Derunova proposed a system of indicators for assessing innovation potential in the context of digitalisation of the economy, and also substantiated the possibility of their adaptation to assess the scientific and intellectual potential of agriculture and the agri-food complex [47-53]. Studies of structural changes in the economy, leading to the development of new proportions in accordance with technological challenges, are widely represented, and the conceptual provisions of neoclassical theories of economic growth, which singled out scientific and technological progress as its most important source (S. Kuznets), are used as methodological tools [54], as well as providing a quantitative assessment of the contribution of innovation to the country's economic growth (W. Sockwell) [55-58].

There is no doubt that technological factors are most directly related to economic growth and increasing the efficiency of production potential of the agro-industrial complex, which is confirmed by numerous studies of

Russian scientists. With regard to the livestock sub-complex, scientific works that investigate the impact of innovative technology, resource-saving and digital technologies on the economic indicators of production [59-66] should be noted; a factor analysis of the reasons that hinder the use of technological innovations in dairy farming is carried out [67-70]. According to expert estimations, an increase in the efficiency of livestock production by 60-80% is determined by the impact of technical factors; climatic and soil conditions provide only up to 20% increase in efficiency [71].

In foreign studies, there are also papers aimed at investigating and substantiating the economic conditions for the introduction of innovations, including stimulating the introduction of innovations and initiating the process of their diffusion. This direction is reflected in the study of the diffusion of innovations by such foreign scientists as R. Andergassen, F. Nardini, M. Ricottilli [16]. The authors considered the mechanisms of spreading new technologies in a heterogeneous population of objects (clusters); They concluded that the presence of a significant technological gap impedes the diffusion of innovations and the achievement of economic growth, therefore, measures are necessary to reduce technological differentiation. A number of Russian scientists consider it expedient to apply the theory of diffusion of innovations in practice in the study of innovative development of various subsectors of the agro-industrial complex. Thus, V. Nechaev, I. Sandu, N. Ryzhenkova used the theory to assess the spread of innovations in the sugar beet subcomplex of Russia [17]; V.V. Kozlov and A.I. Ukolov - to assess the innovation potential of dairy farming [18].

It should be noted that in the activities of enterprises of the Russian agro-industrial complex the targets for development of a new technological core are not always present, according to M.E. Anokhina [19]. Therefore, in modern conditions, the most important direction in the development of the production potential of the agro-industrial complex is the formation of conditions for the early transition to a new technological base, which will significantly increase the competitiveness of the products of its main industries and accelerate the development of the export-oriented segment of the agro-industrial complex. The absence of their own research base in most of them is one of the significant disadvantages that hinder the more rapid implementation of innovations in agricultural organisations [72]. This emphasises the importance of creating a regional mechanism for managing innovation in the agro-industrial complex [73].

In previous studies of the author, significant regional differences in the scale of state support for dairy cattle breeding were identified, the need to strengthen the targeting of government measures, based on the criteria for the effectiveness of the use of innovative resources, taking into account the innovative activity of regions, was noted [74]. The author shares the standpoint regarding the need to supplement the mechanisms for the development and transfer of innovations included in the national project “Science” with indicators and tools to support the diffusion of innovations [75].

Some researchers identify two main mechanisms of innovation diffusion – technology transfer and knowledge spillover [24]. A number of papers by V.V. Kozlov and A.I. Ukolov, devoted to the study of the innovation potential of dairy cattle breeding with recommendations of the innovation transfer system mainly based on the use of the extension service system. The authors propose to assess the degree of innovation susceptibility of agricultural producers by integral indicators characterising the state of production and financial potential [76; 77].

3. Results and discussion

3.1. Features of innovative development of animal husbandry

The innovative profile of livestock production and processing of livestock fodder is characterised by corresponding indicators, which were calculated based on data on shipped innovative products for various types of livestock farming. Their ratio per unit of production or per head of livestock makes it possible to highlight the innovative profile of certain types of activity (Table 2) [78].

Table 2. Indicators of the innovative profile of animal husbandry and fodder production in Russia

Innovation profile indicators	Years	
	2017	2018
Innovative goods shipped, ths. RUB		
Innovative livestock products per tonne of meat, RUB	1144	1460.5
Innovative livestock products per head of livestock, RUB	428.6	565.8

Innovative products of dairy cattle breeding per head of cattle, RUB	106.6	113.1
Innovative pig products per head of pigs, RUB	207.3	438.2
Innovative poultry products per 1 bird, RUB	17.1	16.2
Innovative ready-made fodder per head of livestock, RUB	216.9	327.5
Innovative fodder protein per head of livestock, RUB	134.3	186.1

According to government statistics, in 2007-2016 the volume of innovative products in the direction of "Production of microbiological feed protein, premixes, feed vitamins, antibiotics, amino acids and enzymes" increased by 42.5%. The prospects of this type of activity are also confirmed by the higher share of costs for technological innovations (4.6% in 2018) in comparison with livestock products (0.6-1.2%). The Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025 notes that the use of innovative technologies for the production of high-quality feed and feed additives will reduce the import dependence of animal husbandry by 25%. The analysis of the indicators presented in Table 2 allows us to conclude about the multidirectional dynamics of shipped innovative goods of various types of activity. For example, according to data for 2017-2018 it can be stated that the indicator of shipped innovative ready-made fodder per head of livestock increased by 51%, and innovative fodder protein – by 38.6% [79-83].

Comparison per capita for certain areas of activity showed that the cost of innovative products in dairy farming increased by 6.1% over 2 years, in pig breeding – by 2 times, and in poultry farming – decreased by 5.3%. Taking into account the value of the previously calculated indicator of innovativeness of feed costs for the production of pig meat (90%), it can be concluded that the innovation cycle in the pork production chain is more complete. Turning to the issue of state support for innovative activities, we consider it expedient to state the author's hypothesis, according to which the innovative development of certain sectors of agriculture is to a certain extent dependent on the general level of innovative development of the regions, which is associated with state support for innovative projects, investment activity of business communities, the effectiveness of state mechanisms and private partnership, etc [84-89].

Table 3 presents a comparison of the index of innovative development of individual sectors of agriculture, calculated on the basis of standardising indicators of the productivity of milk and pig meat production in agricultural organisations according to statistical data for 2018 (average annual milk yield per 1 cow and average daily weight gain of pigs in growing and fattening), and integral innovation index of the region, calculated by scientists from the All-Russian Research Institute of Agricultural Economics, the Institute of Regional Studies and the Financial University under the Government of the Russian Federation [90-92].

Table 3. The ratio of innovative development of livestock industries and the general level of innovativeness of cluster groups of regions of the Russian Federation

Key features of clustering	Subjects of the Russian Federation – the cores of clusters according to the integral innovation index of regions	Indices of innovative development of individual livestock industries in cluster regions, %	
		dairy farming	pig breeding
1	2	4	5
1. High levels of the resulting indicators of innovative development, innovative development potential, innovative development environment.	Moscow	95.0	84.0
2. High levels of the resulting indicators of innovative development, innovative development environment; average level of potential for innovative development.	Omsk Oblast	55.0	51.0

Key features of clustering	Subjects of the Russian Federation – the cores of clusters according to the integral innovation index of regions	Indices of innovative development of individual livestock industries in cluster regions, %	
		dairy farming	pig breeding
3. High level of the resulting indicators of innovative development. Average levels of potential for innovative development, innovative development environment.	Smolensk Oblast	52.0	74.9
4. Average levels of the resulting indicators of innovative development, innovative development potential; high level of innovative development environment.	Tula Oblast	67.0	62.4
5. Average levels of the resulting indicators of innovative development, innovative development environment. High level of potential for innovative development.	Altai Krai	50.4	66.8
6. Average levels of the resulting indicators of innovative development, innovative development potential, innovative development environment.	Bryansk Oblast	46.3	87.1
7. Low level of the resulting indicators of innovative development. Average level of potential for innovative development. High level of innovative development environment.	Chukotka Autonomous Okrug	21.3	26.3
8. Low level of the resulting indicators of innovative development. High level of potential for innovative development. Average level of the environment for innovative development.	Republic of Dagestan	22.0	No data
9. Low level of the resulting indicators of innovative development. Average levels of potential for innovative development, innovative development environment.	Tyva Republic	8.8	4.6
10. Low levels of the resulting indicators of innovative development, innovative development potential, innovative development environment.	Chechen Republic	35.7	No data

Analysis of the data presented in Table 3 demonstrated a certain dependence of the innovative development of individual livestock industries on the level of innovative development of the region. For example, in cluster groups 2-6 with a high and medium level of the resulting indicator of innovative development, more than 70% of regions with a high level of milk productivity and over 80% are concentrated in pig meat. On the contrary, in groups 7-10 with low resulting indicators, there are also regions with low and medium levels of milk and pig meat productivity, which is logical to explain by the lack of innovation or their ineffective use. The

calculated pairwise correlation coefficients of the indices of innovative development of dairy cattle and pig breeding in the corresponding cluster groups of regions showed the highest closeness of communication both in the leading clusters (1st and 2nd) and in clusters with a low level of the resulting indicators of innovative development (7th, 8th, 10th). This circumstance can be explained by the difference in the conditions of the functioning of animal husbandry (for example, different effectiveness of state support; the presence of programs to stimulate innovation in the agro-industrial complex, etc [93-97]).

A more detailed study of methods to support the diffusion of innovations was carried out on the example of the development of dairy cattle breeding, as a continuation of the cycle of studies on the relevant topic.

3.2. Instruments for innovative government support in dairy farming

In recent years, there has been a significant increase in the technological level of milk production, which is confirmed by an increase in productivity, mainly in agricultural organisations. These processes are especially noticeable at the level of advanced farms in the regions of the Central Federal District of Russia, where the average annual milk yield in breeding farms reaches 11-12 ths. kg. (Kursk, Leningrad, Yaroslavl oblasts) [98]. Therefore, the criterion for identifying groups of regions by the level of innovativeness of milk production in 2018 was adjusted taking into account the noticeably increased threshold level of milk productivity in agricultural organisations (Figure 1).

The figure shows that in 2018 compared to 2016, the groups of regions-innovators and regions lagging behind have decreased (by 7 and 4 percentage points, respectively). At the same time, the composition of the groups of early adopters and the early majority expanded (by 6 and 4 percentage points), which characterises a certain reduction in differences in the technological level of milk production. It is worth mentioning the relatively stable composition of the group of innovators over a long period – Leningrad, Vladimir, Vologda, Kaluga oblasts.

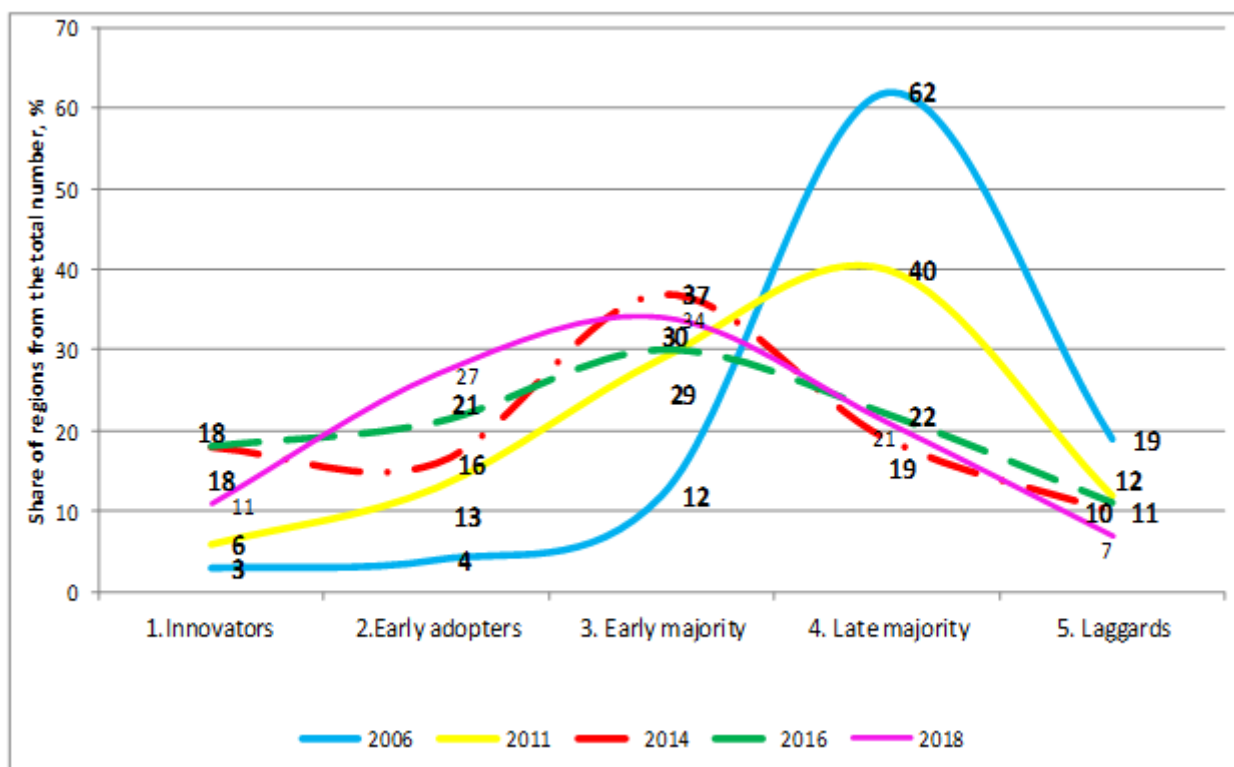


Figure 1. The quantitative composition of the groups of regions of the Russian Federation, specified in accordance with the theory of diffusion of innovations

To identify the impact of state support instruments on the diffusion of innovations, estimations were carried out for groups of regions differing in the level of innovativeness of milk production and specified in accordance with Rogers' theory of diffusion of innovations, which is presented in Figure 1. Given the availability of comparable statistical information on state support of dairy farming for limited period of time, the period 2016-2019 was chosen as the time period. Table 4 shows the estimated indicators of state support

(including innovation) for groups of regions of Russia, distinguished by the criterion of innovativeness of milk production. Groups of regions were singled out on the basis of rationing the indicator of milk productivity in agricultural organisations; the names of groups of regions are determined in accordance with the terminology used in the theory of diffusion of innovations by E. Rogers [99-102].

Table 4. Structure of state support (summarised data on allocations from the federal and regional budgets) for dairy cattle breeding, taking into account the innovation component (2019) [30; 31].

Groups of regions of the Russian Federation by the level of innovativeness of milk production	Structure of state support for the dairy industry, %				Subsidies per cow, ths. RUB			
	Subsidising the interest rate on investment loans	Reimbursement of modernisation costs	Support for breeding stock	Share of innovation support, %	Subsidising the interest rate on investment loans	Reimbursement of modernisation costs	Support for breeding stock	Innovation support per cow, ths. RUB
Russian Federation	16.6	13.9	19.0	32.9	2.0	1.7	2.3	4.0
Innovators (8 regions)	13.5	16.4	17.3	33.7	2.0	2.4	2.5	4.9
Early adopters (19 regions)	21.2	19.0	15.0	34.0	7.8	7.0	5.5	12.5
Early majority (24 regions)	16.2	9.1	23.2	32.3	1.5	0.8	2.1	2.9
Late majority (15 regions)	5.2	11.3	23.4	34.7	0.4	0.8	1.6	2.4
Laggards (5 regions)	0.1	8.4	34.4	42.8	0.1	0.3	1.4	1.7

The following indicators, calculated by the specialists of the National Union of Milk Producers, were used for the analysis as the main instruments of state support for dairy cattle breeding: subsidising the interest rate on investment loans; reimbursement of costs for the modernisation of dairy cattle breeding facilities; subsidies to support breeding stock. The last two instruments were classified by the author as innovative support, since they partly characterise the process of spreading technological innovations, and also allow analysing the provision of such an innovative resource as breeding stock.

The author believes that subsidising the interest rate on investment loans has an indirect effect on innovative development and to a greater extent characterises the possibilities of economic growth, including its innovative component. A more detailed analysis made it possible to establish that, in the group of innovators, the largest share of investment lending in 2019 fell on the Kaluga (17.8%), Vladimir (28.2%), Kaliningrad (47.6%) oblasts. However, on average for the group of innovators, the share of subsidies for innovative lending is lower than the average for Russia, which, with a certain convention, can be explained by the achieved “saturation” of investment resources, especially in such regions as Leningrad, Vladimir, Kaluga oblasts. In addition, one should take into account the presence of such positive factor as a favourable investment climate in a number of regions of the first three groups, which is confirmed by the corresponding data of the national rating of the investment climate for 2018 [103-108].

In the group of early adopters, it is necessary to note the highest share of investment lending in the Pskov, Tula and Tver oblasts (43.3%, 57.6% and 70.4%, respectively). In the group of the early majority in this regard, the Tambov Oblast dominates (48.6%); high rates are also in the Republic of Tatarstan (38.7%) and

Kursk Oblast (24.7%). In the late majority group, Primorsky Krai (29.4%) and the Republic of Buryatia (31.0%) are especially noteworthy. The relatively high level of investment activity of the above-mentioned late majority regions can be easily explained by the provision of additional support funds to these regions within the framework of the existing programs for the priority development of priority territories, including under the subprogram “Stimulating investment activities in the agro-industrial complex” [109].

In the structure of state support for the dairy industry, a significant share is accounted for by the costs of supporting breeding cattle for dairy production. Analysing the values of the average Russian indicator, we can talk about its comparability with the average data in most groups of regions. The greatest excess was observed in 2019 in the group of late majority (23.4%) and the group of laggards (34.4%). The share of subsidies for reimbursing modernisation costs, on the contrary, was higher than the average Russian level in the group of innovators (16.4%) and early adopters (19.0%).

It is necessary to note the persisting short-term trend of a “point” surge in modernisation, which is confirmed by the data of the National Union of Milk Producers. In particular, in the early majority group of 24 regions, in 2018 subsidies for modernisation were allocated only for six regions, and in 2019 – for ten. The highest rates of subsidising modernisation in the above-mentioned group were the Tomsk Oblast (the share of modernisation costs in the total amount of state support for milk – 27.5%), Kostroma Oblast (32.9%), Kursk Oblast (43.3%). In the group of laggards, subsidies for modernisation for the period 2016-2019 were carried out only in the Sakha Republic (Yakutia).

The use of the data from the rating of the subjects of the Russian Federation in terms of the quality of innovation policy for 2016 allowed us to draw certain conclusions about some dependence between the innovative development of dairy cattle breeding and the trend of the innovation policy of the region, which are relevant in modern conditions. For example, the Republic of Tatarstan, leading in the rating of the quality of innovation policy in 2016, received significant allocations from the consolidated budget for the purpose of innovative development of the region. In the Perm Krai during this period, there was a state program to support innovation. In the Sakha Republic, which occupied 13th place in the rating of the quality of innovation policy, the predominant share of funds from the federal budget was used for the development of innovation infrastructure, mainly for small and medium-sized businesses [110-115].

To identify the innovative dominant of state support for dairy cattle breeding, the author proposed such indicators as the share of innovative support and innovative support per cow, ths. RUB. The first indicator characterises the scale of innovation support, and the second – the intensity of innovation support. Comparison of the indicator values reflects the multidirectional trends in innovation support. In particular, the share of innovative support was higher for the late majority (34.7%) and laggards’ group (42.8%); innovative support per cow was higher in the group of innovators (4.9 thousand RUB) and the group of early adopters (12.5 thousand RUB). As has already been revealed, the structure of state support (including innovation) differs significantly across groups of regions, partly smoothing out territorial differences. Based on the foregoing, we consider it more appropriate to use the indicator of the innovative support intensity.

To determine the impact of innovative government support on the efficiency of milk production, the intensity indicator was compared with the growth rates of milk production and productivity in agricultural organisations for 2016-2018. (Picture 2).

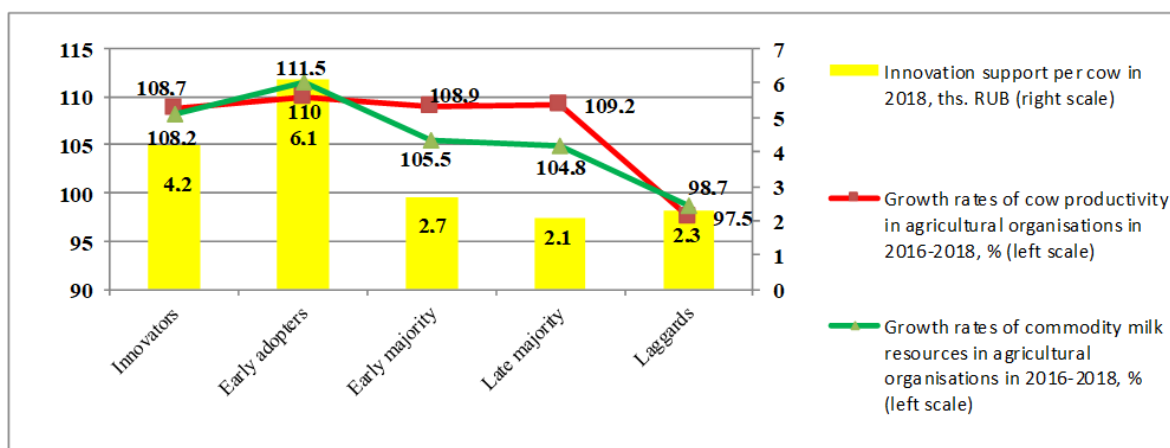


Figure 2. Impact of innovative government support on milk production efficiency

The results of the analysis indicated that innovative support had a greater impact on the growth rates of milk commodity resources. The increase in the average annual milk yield took place in the first four groups of regions, regardless of the level of innovation support. On the contrary, a closer relationship was observed between the level of government support and the rate of increase in milk commodity resources. Higher indicators of both innovation support and growth rates of milk commodity resources were achieved in the group of early adopters. According to preliminary data on cow productivity for 2019, this trend will continue in the coming years. A similar situation persisted in 2019. Some lag in innovators can be explained by the achievement of a certain threshold of saturation with investment and innovation resources, which does not require additional support. This statement acts as a hypothesis and needs more detailed justification.

The study of the mechanisms for implementing the priorities for the development of the production potential of the agro-industrial complex and its industries predetermines the need to assess the effectiveness of state support, including innovation. Using some methodological approaches to the determination of integral indices, generally accepted in world and Russian practice (for example, the Russian regional innovation index, developed by specialists of the Higher School of Economics), the author proposed to calculate the RIIS. It is defined as the arithmetic average of the normalised values of the indicators used, which makes it possible to somewhat smooth out the range of fluctuations within regions or by groups of regions. In our example, the index includes two indicators – reimbursement of costs for the modernisation of dairy cattle breeding facilities and support (subsidies) for the purchase of breeding cattle. Both figures are per cow. The values of the regional index of innovative support by groups of regions are presented in Figure 3.

According to the data obtained, there is a definite relationship between the level of innovative support and the innovativeness of milk production, and the gap between the group of leaders and those lagging behind is quite significant. The possibility of transforming the proposed index, taking into account the use of additional indicators of innovative support, including the processing industry is noteworthy. We believe that the aforementioned index can act as one of the tools for levelling the interregional differentiation of innovation support, taking into account indicators of the innovation potential of the industry (agricultural system, complex).

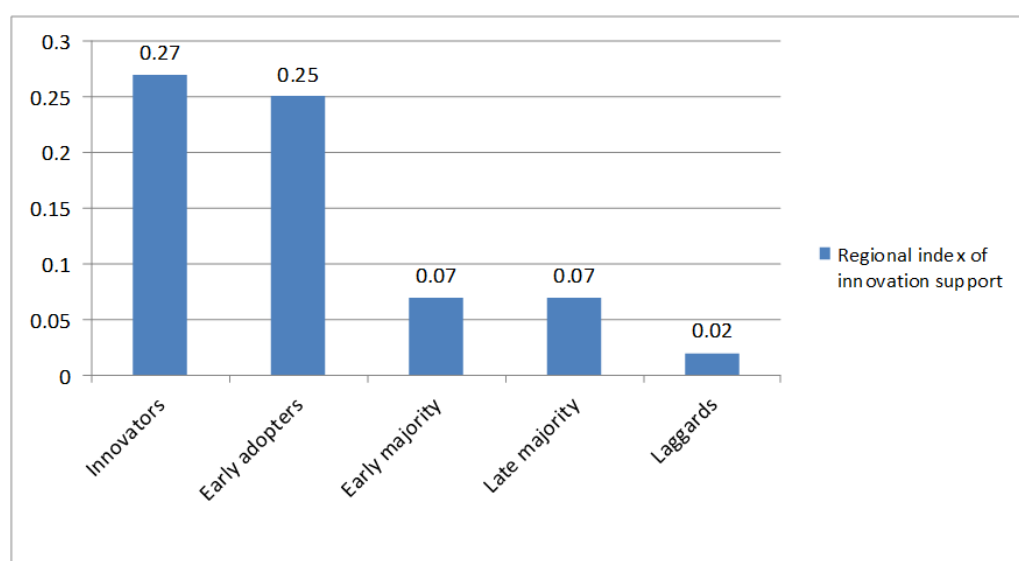


Figure 3. Regional index of innovative support for dairy farming by groups of regions (2018)

Given the lack of budgetary funds, the issue of the effectiveness of state support for the dissemination and use of innovations remains quite problematic. Support mechanisms should be aimed at stimulating innovation diffusion processes not only in industries, but also in product chains. This point of view was reflected in the papers by A. Troshin, I. Sandu, A. Doschanova, who propose to provide investment support along the entire chain of innovations [34]. This provision should be taken into account when developing strategies for regional development, since the concentration of state support in its various directions can be traced not only in specific regions (as shown by the author's study on dairy cattle breeding), but also in large holding-type farms, and often the implementation of projects in animal husbandry does not take into account regional and sectoral characteristics [116]. The limited use of such state support measures as capital investments (reimbursement of modernisation costs) and soft loans are confirmed by the data of the Union of Milk Producers for 2018-2019.

Thus, in 2018, 14 Russian regions did not receive subsidies for concessional lending (including Saratov, Volgograd, Kurgan oblasts, the Republic of Tatarstan). In 2019, 50 regions did not receive subsidies to reimburse part of direct costs for the creation and modernisation of dairy cattle breeding facilities, and subsidies for support of pedigree livestock – 18 regions. The problem of obtaining state support for small and medium agricultural enterprises remains.

It should be noted that since 2020, a new mechanism of state support has been in effect, based on the consolidation of funds in the context of compensating and stimulating subsidies in order to stimulate priority areas for the development of the agro-industrial complex and more fully utilise the advantages of the territorial-sectoral division of labour. Due to the short-term period of action, the assessment of the new mechanism was not included in the research objectives and will be considered in future studies. Improvement of methodological approaches to assessing the effectiveness of state support for dairy cattle breeding can be carried out using a more complete list of indicators of innovation potential. In addition to the indicators already used in this study, we can suggest the following:

- the ratio of the increase in gross milk production to the increase in livestock productivity;
- the ratio of the growth rate of breeding livestock to the growth rate of milk production;
- the ratio of the rates of commissioning of modernised facilities to the rates of production growth;
- ratio of livestock productivity by categories of farms;
- ratio of growth rates of commodity resources and production volumes.

It should be noted that the proposed list is not exhaustive; the given indicators are based on data from Rosstat, industry unions and associations. The possibility of using indicators of milk processing is not excluded, which is confirmed by the results of previous studies. To characterise the innovation potential, in addition to the productivity of cows and breeding livestock, in the previous studies, the author proposed to use the indicator of the depth of processing of livestock. The impact of innovative support for milk on innovation potential was reflected in the proposed author's matrix of innovativeness of milk production and processing [117] (Table 5).

Table 5. Matrix of innovativeness of milk production and processing by regions of the Russian Federation (2018)

Innovative support resources	Innovation potential		
	High level	Average level	Low level
High level	Belgorod, Voronezh, Perm Krai	Vologda, Leningrad oblasts	Kursk, Smolensk oblasts Republic of Khakassia
Average level	Vladimir, Ivanovo, Kirov, Moscow, Penza oblasts	Arkhangelsk, Kaluga, Ryazan, Tver, Tula, Yaroslavl oblasts, Republics: Mordovia, Tatarstan	Bryansk, Omsk, Tyumen oblasts
Low level	Kaliningrad, Sverdlovsk oblasts, Udmurt Republic	Pskov, Novgorod, Oryol, Rostov, Samara, Saratov, Tambov, Tomsk oblasts, Altai, Krasnodar, Stavropol Krai, Republics: Mari-El, Chuvash	Volgograd, Kostroma, Nizhny Astrakhan, Kemerovo, Kurgan, Novosibirsk, Orenburg, Novosibirsk, Chelyabinsk oblasts, Komi Republic, Primorsky, Khabarovsk Krai

Groups of regions were distinguished by innovative support resources and innovation potential of milk production and processing [118-121]. The innovation potential was defined as the sum of the ranked values of the level of milk productivity of cows, the share of breeding cattle and the depth of milk processing. The processing depth indicator was calculated as the share of cheese, butter and milk powder in the volume of products produced. Innovative support resources reflect the sum of the ranked values of subsidies to reimburse the costs of upgrading and supporting breeding stock. The author believes that such methodological approach, adjusted taking into account a more complete list of indicators of the innovative state of dairy farming, will

make it possible to identify the degree of sufficiency of innovative support resources to stimulate the process of diffusion and use of innovations in this sub-sector of the agro-industrial complex.

4. Conclusions

As a result of the study conducted, the impact of certain instruments of state support on the diffusion of innovations in dairy cattle breeding was revealed by groups of regions that differ in the level of innovativeness of milk production and are specified in accordance with Rogers' theory of diffusion of innovations. It was found that subsidising the interest rate on investment loans has an indirect effect on innovative development and largely characterises the possibilities of economic growth, including its innovative dominant. Calculations have confirmed that, on average for the group of innovators, the share of subsidies for innovative lending is lower than the average for Russia, which with a certain degree of probability can be explained by some "saturation" of investment resources, especially in regions such as Leningrad, Vladimir, Kaluga oblasts.

Significant interregional differences in the use of such innovative support tools as the costs of supporting dairy pedigree cattle and reimbursement of costs for the modernisation of dairy cattle breeding have been identified. The rather high level of subsidies for modernisation in the lower-level groups of regions is explained by a "point" surge in modernisation, especially in the group of lagging regions.

In order to identify the innovative dominant of state support for dairy cattle breeding, the author proposed the following indicators: the share of innovative support (%) and innovative support per cow, ths. RUB. The first indicator reflects the scale of innovation support, and the second – the intensity of innovation support. Comparison of the indicator values revealed multidirectional trends: the structure of state support (including innovation) differs significantly across groups of regions, partly smoothing out territorial differences. In this regard, we consider it more correct to use the indicator of the intensity of innovative support.

To determine the impact of innovative government support on the efficiency of milk production, the intensity indicator was compared with the growth rates of milk production and productivity in agricultural organisations for 2016-2018. The findings showed that innovative support has a greater impact on the growth rates of milk commodity resources. Higher indicators of both innovation support and growth rates of milk commodity resources were achieved in the group of early adopters. The lag of innovators can be explained by the achievement of a certain threshold of saturation with investment and innovation resources, which does not require additional support.

Using some methodological approaches to the determination of integral indices, generally accepted in the global and Russian practice, the author proposed to calculate the RIIS. It is determined on the basis of the modernised integrated regional innovation index, proposed by the specialists of the Higher School of Economics, as the arithmetic mean of the normalised values of the indicators used, which makes it possible to smooth out the range of fluctuations within regions (groups of regions). We believe that the proposed index can act as one of the tools for levelling the interregional differentiation of innovative support, taking into account the indicators of the innovation potential of the industry (agrosystem, complex). In general, according to the level of state support for dairy cattle breeding, the constituent entities of the Russian Federation are divided into two mega-groups. The first megagroup is formed by the regions that are classified as laggards, late majority, and early majority. The regions of these groups receive approximately the same support, but the growth in average milk yield in them is accompanied by lower rates of product sales. Therefore, it is quite reasonable that the support of the industry in these regions can be attributed to the supporting.

The second mega-group is formed by early adopters and innovators, the level of their support is about 2-3 times higher. At the same time, the growth rate of milk sales is also higher, which indicates the advisability of stimulating state support. The study shows the feasibility of using the economic mechanism of incentive support, depending on the level of innovativeness of the agro-industrial complex in a particular region.

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