Approach to evaluation of the digitalization level in crop production of the Pskov region

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***Abstract*—Development and improvement of the State Science, Technology and Innovation policy, designed to accelerate the processes of digitalization, should be based on qualitative and quantitative evaluation of the current state of the regional and sectoral economy. The diversity of evaluation methods, which assume the usage of a wide range of statistics, reporting indicators and expert opinions, makes it difficult to make the necessary estimations. This process is even more complicated when it comes to evaluation of the digitalization level. The authors of this article propose an approach to evaluation of the digitalization level in crop production, which is about determining the strength of the factors of innovativeness changed by digitalization. It is suggested that the difference between growth factors of innovativeness (the share of costs for maintenance of capital assets and elite seeds in cost structure) and factors of decrease of innovativeness (the share of labor costs, electricity and petroleum products) should determine the digitalization level and the degree of innovative activity of production activity of agricultural enterprises. Only those agricultural producers who have a difference between growth factors and factors of decrease of innovativeness greater than zero should be called the innovation-active, and, therefore, having a potentially high digitalization level of business processes. Evaluation of the digitalization level on the basis of a limited amount of industry information – information about the cost structure of products – makes it highly probable to use the suggested approach in the practice of decision making on regional and sectoral levels.**

Keywords — digitalization, agriculture, cost structure, factors of innovativeness, activity rate

I. Introduction

New digital technologies are steadily penetrating all spheres of the economy. Traditional technologies of business activity are transforming and optimizing, saturated with information flow, specified and accelerated. The systemic use of innovative digital technologies and tools has already proven effective in some industries.

According to the Ministry of Agriculture of the Russian Federation, Russia ranks 15th in the world for digitalization level, only 10% of arable land in the country is cultivated using digital technologies [1]. In 2017 the amount of costs for information and communication technologies under the section "Agriculture, hunting and forestry", according to the Russian Federal State Statistics Service (Rosstat), amounted to 0.85 billion rubles, which was 0.2% of all investments in information and communication technologies in all sectors of the economy. This was the lowest rate in all industries, which indicates a low level of digitalization of the Russian agricultural sector. However, this figure shows that this industry has the greatest potential for investment in digitalization [2].

Development and improvement of the State Science, Technology and Innovation policy, designed to accelerate the introduction of information and communication technologies, should be based on qualitative and quantitative evaluation of the current state of the regional and sectoral economy [3]. This increases the relevance of the study and development of methodological foundations for evaluation of the digitalization level in the sectors of agriculture, the use of advanced information and communication technologies in which not only can increase labor productivity, but also reduce production costs.

The diversity of evaluation methods, which assume the usage of a wide range of statistics, reporting indicators and expert opinions, makes it difficult to make the necessary estimations. This process is even more complicated when it comes to evaluation of innovation processes, especially digitalization processes.

Comparative analysis of popular methods shows their diversity both in the methodological justification of the research system and in the method of assessing the innovation situation. Some researchers and experts prefer scorecard methods (mainly, expert methods) for evaluation of factors, others use statistical, quantitative data for this purpose. However, given that a number of factors characterizing innovation potential are not quantifiable, some methods use a mixed approach.

The situation with information sources, characterizing innovation processes, is more complicated in the agro-industrial complex than in industrial sector. There are no separate categories of "agro-industrial innovations" and "digitalization of agriculture" in official statistics. Periodic surveys conducted by statistical agencies provide a rather mixed picture of the innovation activity of agro-industrial enterprises [4]. Some information about the size and nature of digitalization can be obtained from the research of individual research groups [5].

II. Research Methods

The authors of this article propose an approach to evaluation of the digitalization level, which does not require a significant amount of initial information (in the context of

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the decision making on regional and sectoral levels) and complex economic and mathematical calculations.This approach is about determining the strength of the factors of innovativeness changed by digitalization and calculated on the basis of the cost structure of agricultural production.

The authors proceed from the following assumptions:

1. Introduction of digital technologies significantly changes the cost structure of agricultural production.

2. The digitalization level, and, consequently, the degree of innovative activity of the production activity of an agricultural enterprise are inversely proportional to the amount of costs for labor (with deductions), electricity and petroleum products in the cost structure, and are directly proportional to costs for maintenance of capital assets. A certain role in the digitalization level is played by the amount of costs for elite seeds in the cost structure.

At the first stage, it is planned to structure the costs of agricultural production. Further grouping of costs for labor, electricity, petroleum products, costs for maintenance of capital assets and costs for elite seeds allows us to determine the values of the factors of innovativeness of production activity. The subsequent determination of a difference between growth factors and factors of decrease of innovativeness reveals the digitalization level and the degree of innovation activity of agricultural enterprises.

III. FINDINGS

Agriculture of the Pskov region is one of the priority directions of the economic development of the region[6]. Crop production of the Pskov region is represented mainly by grains and oil-plants, vegetables and potatoes [7]. Despite the favorable natural and climatic conditions and large areas of agricultural land, in 2015 the Pskov region was ranked 46th among the regions of the Russian Federation for harvesting of winter and spring rye; 54th – for harvesting of oat; 55th – for harvesting of winter and spring wheat, winter and spring barley. In the same period, the Pskov region was ranked 50th in the rating of producer regions of potatoes for the volume of potatoes harvesting; 64th place in the rating – for the volume of production of open ground and protected ground vegetables, including: open ground vegetables - 67th, protected ground vegetables - 43rd. The main oil-plants cultivated in the Pskov region are winter and spring rape-plant (40th place) [8]. By the end of 2018, the situation in the crop production of the Pskov region has not changed significantly.

Using the suggested approach, we estimate the digitalization level of production activity of agricultural enterprises in the Pskov region (table I, II and III).

TABLE I. STRUCTURE OF PRODUCTION COSTS FOR AGRICULTURAL PRODUCTS IN THE DISTRICTS OF THE PSKOV REGION, %

District	Production costs				miscellaneous costs
	labor costs with deductions	*material costs:*	*maintenance of capital assets*	*totalproduction costs*	
Pushkinogorskij	19,1	51,86	27,9	98,7	1,28
Pechorskij	16,2	50,43	28,2	94,9	5,07
Novosokol'nicheskij	4,4	40,21	42,4	82,2	17,8
Ostrovskij	29,3	40,23	11,9	81,4	18,6
Kun'inskij	20,6	36,02	25,7	80,2	19,8
Strugokrasnenskij	9,06	51,89	23,7	77,5	22,5
Krasnogorodskij	18,1	45,54	14,1	75,4	24,6
Novorzhevskij	20,7	44,71	15,8	74,7	25,3
Palkinskij	11,3	39,64	22,7	71,7	28,3
Velikolukskij	16,0	29,28	25,1	70,2	29,8
Pustoshkinskij	19,9	23,32	25,3	68,5	31,6
Bezhanickij	7,43	30,46	23,8	61,7	38,3
Pskovskij	15,9	36,54	7,37	59,8	40,3
Nevel'skij	4,84	40,84	14,2	58,7	41,3
Opocheckij	37,7	16,24	4,60	58,5	41,5
Loknyanskij	37,2	18,2	1,64	57,0	43,0
Usvyatskij	12,8	34,41	9,92	56,8	43,2
Dedovichskij	16,1	32,26	5,56	54,0	46,1
Porhovskij	14,8	28,02	10,5	53,3	46,7
Sebezhskij	9,41	35,19	6,67	51,2	48,8
Pytalovskij	3,69	20,19	26,5	50,2	49,8
Gdovskij	9,97	26,21	11,8	47,8	52,2
Dnovskij	9,59	20,69	12,7	42,6	57,4

According to experts, a farmer has to make more than 40 different decisions in a limited period of time during one season. Many of these decisions, which directly affect the economy of agricultural production, are the objects of digitalization [2].

The introduction of digital technologies, ensuring monitoring of fields and data management, provides a reduction in the requirement for a large-scale use of manual labor. Labor costs with deductions, presented in table I, include only the costs for production workers of agricultural enterprises. Consequently, an increase in the digitalization level leads to a decrease in the share of this cost item in the cost structure.

TABLE II. STRUCTURE OF MATERIAL COSTS FOR AGRICULTURAL PRODUCTION IN THE DISTRICTS OF THE PSKOV REGION, %

District	seeds and planting material	including elite seeds	fertilizers		Chemical plant protection products	electricity	petroleum products
			mineral	*organic*			
Pushkinogorskij	14,1	0,05	4,28	0,60	9,88	1,05	21,9
Pechorskij	11,5	0,00	10,0	0,00	2,81	1,22	24,9
Novosokol'nicheskij	11,9	4,71	12,3	0,30	5,43	0,70	4,87
Ostrovskij	8,01	0,00	1,01	3,32	0,00	0,39	27,5
Kun'inskij	10,1	2,05	5,35	2,13	1,89	2,70	11,8
Strugokrasnenskij	10,3	7,10	12,6	0,08	13,0	0,97	7,84
Krasnogorodskij	16,0	2,26	2,64	0,00	0,04	0,00	24,6
Novorzhevskij	12,6	6,54	6,00	0,74	1,57	0,66	16,6
Palkinskij	7,85	1,84	5,49	5,45	2,63	1,88	14,5
Velikolukskij	4,83	0,00	2,02	7,31	0,00	1,52	13,6
Pustoshkinskij	4,82	0,00	5,82	0,00	0,68	0,00	12,0
Bezhanickij	8,10	0,00	0,00	9,06	0,00	0,00	13,3
Pskovskij	10,7	0,00	7,96	0,67	0,69	0,42	16,1
Nevel'skij	16,8	1,17	7,41	0,00	8,47	0,07	6,92
Opocheckij	2,01	0,00	0,37	0,46	0,00	0,00	13,4
Loknyanskij	0,00	0,00	0,00	0,00	0,00	0,00	18,2
Usvyatskij	9,59	0,30	6,73	2,15	1,48	0,86	13,3
Dedovichskij	11,1	0,00	0,00	3,66	0,00	0,40	17,1
Porhovskij	13,3	0,00	9,94	0,00	0,00	0,00	4,78
Sebezhskij	17,5	0,00	0,00	0,00	2,30	1,89	13,5
Pytalovskij	3,35	0,15	7,04	5,59	0,50	0,15	3,41
Gdovskij	7,78	0,14	3,75	3,28	0,60	0,46	10,2
Dnovskij	7,84	0,37	0,55	2,41	0,00	0,05	9,47

The introduction of digital technologies, ensuring accurate fertilization, precise seeding, accurate irrigation, monitoring of fields and data management, accurate spraying, etc., reduces the requirement for material costs (seeds, fertilizers, plant protection products, petroleum products and electricity).

Consequently, an increase in the digitalization level leads to a decrease in the share of material costs in the cost structure. Costs for elite seeds are the exception. The usage of elite seeds is the basis of innovative development of a modern enterprise specializing in crop production.

The digitalization level is inversely proportional to labor costs and material costs, but the digitalization level is directly proportional to costs for maintaining capital assets [9]. The introduction of digital technologies requires much lesser agricultural machinery and equipment, but the cost of such machinery and equipment is usually much higher.

TABLE III. VALUES OF THE FACTORS OF INNOVATIVENESS IN PRODUCTION ACTIVITY IN THE DISTRICTS OF THE PSKOV REGION

District	Factors of innovativeness, as % of cost structure		
	labor costs, energy costs, costs for petroleum products	*costs for the maintenance of capital assets*	*costs for elite seeds*
Pytalovskij	7,25	26,50	0,15
Novosokol'nicheskij	9,96	42,43	4,71
Nevel'skij	11,83	14,16	1,17
Strugokrasnenskij	17,87	23,65	7,10
Dnovskij	19,11	12,68	0,37
Porhovskij	19,60	10,54	0,00
Gdovskij	20,63	11,75	0,14
Bezhanickij	20,74	23,82	0,00
Sebezhskij	24,79	6,67	0,00
Usvyatskij	26,95	9,92	0,30
Palkinskij	27,57	22,68	1,84
Velikolukskij	30,91	25,14	0,00
Pustoshkinskij	31,84	25,29	0,00
Pskovskij	32,40	7,37	0,00
Dedovichskij	33,63	5,56	0,00
Kun'inskij	35,14	25,68	2,05
Novorzhevskij	37,96	15,77	6,54
Pushkinogorskij	42,01	27,89	0,05
Pechorskij	42,39	28,21	0,00
Krasnogorodskij	42,62	14,12	2,26
Opocheckij	51,03	4,60	0,00
Loknyanskij	55,33	1,64	0,00
Ostrovskij	57,17	11,92	0,00

It is suggested that the difference between growth factors of innovativeness (the share of costs for maintenance of capital assets and elite seeds in cost structure) and factors of decrease of innovativeness (the share of labor costs, electricity and petroleum products) should determine the digitalization level and the degree of innovative activity of production activity of agricultural enterprises (Fig. 1).

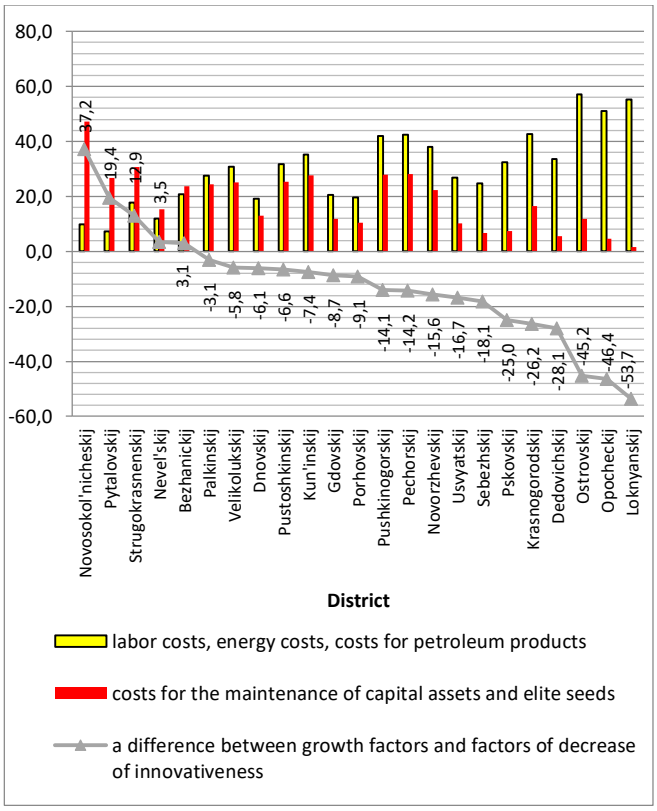

Fig. 1. Ranking of the administrative districts of the Pskov region by the digitalization level and the degree of innovativeness of production activity

It is obvious that of all the surveyed organizations, only those organizations who have a difference between growth factors of innovativeness (the share of costs for maintenance of capital assets and elite seeds in cost structure) and factors of decrease of innovativeness (the share of labor costs, electricity and petroleum products) greater than zero should be called the innovation-active (Fig. 2).

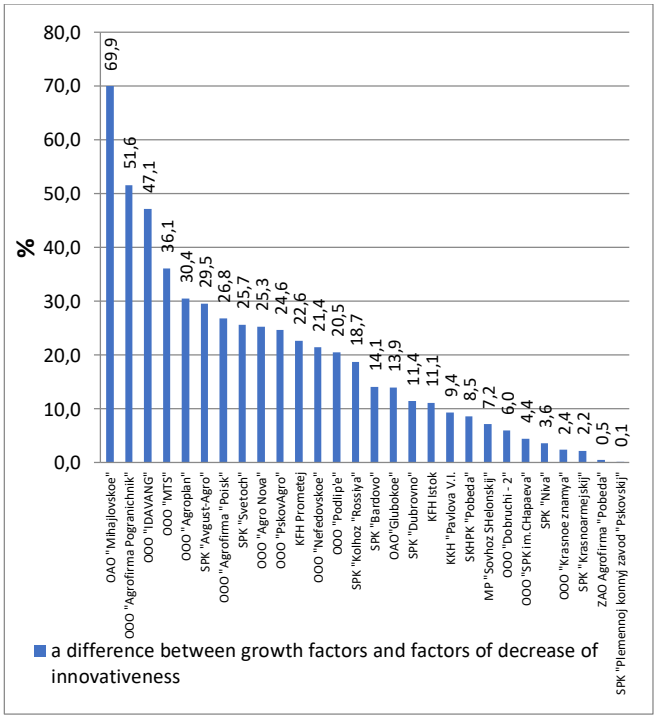

Fig. 2. Ranking of innovation-active agricultural enterprises by the digitalization level and the degree of innovative activity, relative units

29 enterprises of 144 surveyed agro-industrial enterprises of the Pskov region may be defined as innovation-active. The most innovation-active of the surveyed enterprises are: OAO "Mihajlovskoe" Loknyansky district, OOO "Agrofirma "Pogranichnik" Gdovsky district and OOO "IDAVANG" Ostrovsky district.

IV. Conclusion

The opportunities for digitalization of agriculture in the Russian Federation are enormous. They are conditioned by the need for ensuring food security and development of export potential [10]. However, the achievedlevel of introduction of information and communication technologies is a matter of serious concern.

Development and improvement of the State Science, Technology and Innovation policy, designed to accelerate the processes of digitalization, should be based on qualitative and quantitative evaluation of the current state of the regional and sectoral economy.

The existing diversity of popular approaches to evaluation of innovation processes, which assume the usage of a wide range of statistics, reporting indicators and expert opinions, makes it difficult to make the necessary estimations. This process is even more complicated when it comes to evaluation of the digitalization processes.

The authors of this article propose an approach to evaluation of the digitalization processes, which is about determining the strength of the factors of innovativeness changed by digitalization and calculated on the basis of the cost structure of agricultural production.

The evaluation of the digitalization level of production activity of agricultural enterprises in the Pskov region shows the following results: of all the surveyed 144 organizations only those 29 organizations, who have the difference between growth factors of innovativeness (the share of costs for maintenance of capital assets and elite seeds in cost structure) and factors of decrease of innovativeness (the share of labor costs, electricity and petroleum products) is greater than zero should be called the innovation-active.

Interpretation of the results of the presented evaluation can be quite broad. However, the evaluation of the digitalization processes on the basis of a limited amount of industry information – information about the cost structure of the products and the dynamics of technical resources –makes it highly probable to use the suggested approach in the practice of decision making on regional and sectoral levels.

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