Research on the development of digital technologies and agriculture

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Abstract. The aim of the work is to study the coordination of the growth rates of the use of digital technologies in agricultural organizations and the efficiency of agricultural production in farms of all categories of the Russian Federation. Based on Rosstat data and our own calculations, the chain growth rates of indicators for 2019-2022 have been studied. With the growing number of organizations by type of activity, agriculture, forestry, hunting, fishing, fish farming in the Russian Federation, their costs for information and communication technologies, and for the purchase of telecommunications equipment are increasing, but they reduce the cost of purchasing software in the face of anti-Russian sanctions, a pandemic and shock effects. The instability of the development of organizations in the information infrastructure is associated with a decrease in the number of personal computers per 100 employees and the number of organizations using broadband Internet access. The coordination of the growth rate of potato, sugar beet, and sunflower seeds yields with the growth rate of organizations' costs for the purchase of telecommunications equipment has been established. The dynamics of vegetable yields is coordinated with the dynamics of organizations' expenditures on information and communication technologies.

1 Introduction

Important challenges for agriculture in modern conditions are the insufficient development of digital infrastructure, insufficient availability of the Internet, and a high level of differences in the development of infrastructure in the subjects of the Russian Federation [1].

The formation of digital infrastructure is one of the seven main directions of digital transformation of agriculture [2]. A.I. Altukhov et al. understand the digital transformation of the industry as “the transition of agriculture to a fundamentally new level of use of modern digital information technologies in combination with the latest achievements in the field of automation of agricultural production” [3, p. 85].

Digitalization contributes to changes in economic sectors by changing the trajectory through the introduction of new technologies, organizational innovations, and new business models [4].

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O.N. Vasyukov and others develop an interesting approach to coordinating the development of technical systems and business systems, which made it possible to identify common, in a certain sense, laws [5]. Thus, the authors formulated the law of “dynamics”, reflecting two major trends in the parallel development of technical and economic systems. Such trends include the development towards increased controllability and fragmentation of systems.

L.N. Usenko shows that trends in the development of agriculture are determined by the introduction of digitalization [6].

I.S. Sandu et al. It has been shown that to assess the development of information and communication infrastructure in the world, criteria such as the Network Readiness Index (Network Readiness Index) are used to assess countries on the use of information and communication technologies, the Inclusive Internet Index (Inclusive Internet Index) to analyze Internet use in regions, the Mobile Interaction Index (Mobile Interaction Index) for evaluating the effectiveness of user interaction with mobile devices [7]. The authors have developed a strategic map to define the goals, objectives and activities for the digital transformation of the industry.

To assess the digital potential of an agroindustrial complex subject, V.S. Pashhtetsky et al. proposed a system of indicators of its digital transformation (growth rates of income, investments, material costs, etc.) [8].

In the conditions of Buryatia, where there are no large agricultural producers, an assessment of the digital readiness of the population and digital maturity was carried out on the basis of a sociological survey [9].

In the work of N.A. Safiullin et al., a methodology for assessing digital maturity by groups of factors is proposed. DMPTSC analysis based on a survey of heads of large agricultural organizations [10].

The article by O.V. Vaganova et al. presents a methodological approach to assessing the transformation of the agricultural sector based on a data collection and processing scheme in an automated value chain from the beginning to the end of activity [11].

The model of integration of information technologies with agribusiness and government authorities was developed by Gorlov I.F. et al. [12].

To assess the effectiveness of digital innovations, a methodology based on the improved criterion “the difference in reduced costs” is proposed [13].

M. Oborin and M. Gorodilov have shown that the use of information technology contributes to increasing agricultural productivity and profitability, as well as reducing material costs [14].

However, digitalization of agriculture also creates negative effects. Thus, B.B. Slavin notes that in the process of digital transformation, enterprises begin to apply flexible management practices for innovative development, which does not always lead to increased efficiency [15].

Therefore, it is relevant to study the presence or absence of coordination of digitalization of agriculture and its effectiveness. The identification of such coordination will allow us to assess the impact of digitalization as a macroeconomic factor in the transformation of agriculture [16].

2 Materials and methods

The purpose of the work is to study the coordination of the growth rates of the use of digital technologies in agricultural organizations and the efficiency of agricultural production in farms of all categories of the Russian Federation. The information base is Rosstat's open data for the period 2019-2022 [17, 18]. The authors calculated the chain growth rates and
increments. Based on the methods of analysis and synthesis, statistical and monographic, conclusions are drawn.

3 Results and Discussion

The chain growth rates of the number of organizations and enterprises by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation are presented in 2019-2022 in Figure 1.

During the period under study, the growth rate of the number of organizations and enterprises in this industry has a linear upward trend. It is known that the period 2020-2022 for the Russian Federation is characterized by the effect of foreign economic sanctions, the spread of the coronavirus pandemic and other shock effects. However, all the shock effects did not affect the growth rate of the number of organizations and enterprises in agriculture.

![Fig. 1. Chain growth rates of the number of organizations and enterprises by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation (calculated by the authors according to [17]).](image)

At the same time, as shown in Figure 2, the chain growth rate of the number of personal computers per 100 employees in the Russian Federation is characterized by a linear downward trend.
Fig. 2. The chain growth rates of the number of personal computers per 100 employees in the surveyed organizations of the Russian Federation (calculated by the authors according to [17]).

Consequently, the availability of personal computers to organizations decreases during the period of shock effects. At the same time, the growth in the number of agricultural organizations and the number of personal computers per 100 employees has opposite trends.

The chain growth rates of organizations' costs for the introduction and use of digital technologies by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation have a sawtooth character (Fig. 3).

Fig. 3. Chain growth rates of organizations' costs for the introduction and use of digital technologies by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation (calculated by the authors according to [17]).

Thus, the highest growth rate of organizations' costs for the introduction and use of digital technologies is in 2021 (131.58%), and the lowest is in 2020 (64.41%). It can be assumed that in 2021, agricultural organizations adapted to the conditions of the pandemic and significantly increased their costs for digital technologies. However, in the next 2022, under the conditions of shock effects, this cost item also decreased significantly and amounted to 98.00%. Consequently, the costs of organizations in this industry are very sensitive to environmental shocks.

At the same time, there are multidirectional trends in the structure of costs for digital technologies in agricultural organizations (Fig. 4). The chain rates for the cost of purchasing telecommunications equipment in agricultural organizations are increasing. Whereas the
chain rates for software acquisition costs have been steadily decreasing over the period under review. Consequently, agricultural organizations in the period of shock effects show stability in terms of the cost of purchasing telecommunications equipment, but reduce the cost of purchasing software.

**Fig. 4.** The chain growth rates of organizations' costs for the purchase of telecommunications equipment and software by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation (calculated by the authors according to [17]).

Internet access is a necessary factor in agriculture for obtaining and transmitting the necessary data [19]. The dynamics of the provision of broadband Internet services to organizations in the Russian Federation is shown in Figure 5.

**Fig. 5.** The increase in the number of organizations using broadband Internet access in organizations by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation (calculated by the authors according to [17]).
The increase in the number of agricultural organizations using broadband Internet access was the lowest in 2020 (-26.8 percentage points). Whereas in 2021 this increase took a positive value (20.9 percentage points). However, in 2022 the increase in the number of agricultural organizations decreased again (-1.7 percentage points). Thus, it is possible to conclude that the use of broadband Internet access by agricultural organizations is more sensitive during the pandemic than in the year of shock effects.

Figure 6 shows the chain growth rates of crop yields with an upward trend for 2019-2022. The growth rate increases regardless of external shocks to the yield of potatoes, sugar beet and sunflower seeds. Comparison with the results of the analysis of information and communication technologies shows that an upward trend is characteristic of the costs of agricultural organizations for the purchase of telecommunications equipment. Consequently, there is a coordination of productivity growth and the costs of organizations for the purchase of telecommunications equipment.

![Fig. 6. The growth rate of crop yields with an upward trend in farms of all categories of the Russian Federation (calculated by the authors according to [18]).](image)

The dynamics of the chain growth rate of vegetable yields is nonlinear (sawtooth) in nature (Fig. 7). Thus, the chain rate for vegetable yields in 2020 was 97.61%, in 2021 – 98.78%, in 2022 - 89.26%. Similar dynamics of the chain rate took place for the expenses of organizations on information and communication technologies by type of activity agriculture, forestry, hunting, fishing, fish farming in the Russian Federation.
4 Conclusion

Based on the conducted research, the following conclusions can be drawn. Against the background of the growing number of organizations by type of activity, agriculture, forestry, hunting, fishing, fish farming in the Russian Federation, their costs for information and communication technologies are also increasing.

Over the period 2019-2022, agricultural organizations are showing resilience in terms of the cost of purchasing telecommunications equipment, but are reducing the cost of purchasing software in the face of anti-Russian sanctions, pandemics and shocks.

In the information infrastructure, the instability of the development of organizations is associated with a decrease in the number of personal computers per 100 employees and the number of organizations using broadband Internet access.

In organizations by type of activity, agriculture, forestry, hunting, fishing, and fish farming in the Russian Federation, there is coordination of the growth rate of potato, sugar beet, and sunflower seeds yields with the growth rate of organizations' costs for the purchase of telecommunications equipment. In addition, the dynamics of vegetable yields is coordinated with the dynamics of organizations' expenditures on information and communication technologies.

Thus, in agriculture, there is a coordination of the efficiency of agricultural production and the digitalization of the industry.

References

2. Digital transformation of agriculture in Russia: official publication (M.: FSBI "Rosinformagrotech", 2019)


16. N. Smelik, L. Vinnichek, Macroeconomic factors of structural changes in the agroindustrial complex, In Sat. AIP Conferens Proceeding, 020011 (2022)

