

Digital Transformations in Agriculture as a Factor of Sustainable Rural Development



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Abstract In the modern, dynamically changing world, the development of information technologies plays an increasingly important role in the technological and economic development of all countries. The transformation of the Fourth industrial revolution, “Industry 4.0,” which is based on digital production, has affected almost all sectors of the economy. The creation of conditions for increasing the efficiency of the agro-industrial complex and sustainable development of rural areas will be possible through the implementation of the digital agenda. It is not limited only to the use of information and communication technologies but also involves the use of new business processes, digital models, and the creation of digital assets.

Keywords Rural areas · Sustainable development · Agricultural producers · Digital economy · Intelligent agriculture

1 Introduction

In recent decades, sustainable development has been considered one of the conditions for solving the global problems of modern society. On September 25, 2015, the UN Member States adopted the 2030 Agenda for Sustainable Development, which contained several goals for conserving the planet’s resources, eliminating poverty, and ensuring prosperity for all.

The achievement of these goals should be facilitated by the implementation of strategies conducive to economic growth and aimed at meeting the social needs of society. The increasing influence of international economic relations on national economies requires the independence and food security of Russia and the stabilization and growth of its agricultural production.

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2 Materials and Methods

The study is based on the data of regulatory legal acts and materials of state statistics. During the study, methods such as induction, deduction, analysis, synthesis, etc. were used.

3 Results

Depending on the specific area of scientific research, geopolitical relations, as well as the versatility and complexity of the support process, the term “sustainable development” is interpreted in different ways. However, the main idea, ultimately, is to ensure the possibility of survival and long-term existence for an indefinite period of civilization with a high level of security of the nature-man-society system (Table 1).

In Russia, rural areas are one of the most valuable resources with a rapidly growing role. These are the territories of rural settlements and the corresponding inter-settlement territories where business activities, mainly related to the production and processing of agricultural products, are carried out.

Table 1 Some characteristics of the concept of “sustainable development.”

Source	Definition
World Conservation Strategy (International Union for Conservation of Nature and Natural Resources, 1978)	Sustainable development is a modification of the biosphere and the use of human, financial, living, and non-living resources for meeting human needs and improving the quality of life
Town Planning Code of the Russian Federation [15]	Sustainable development of territories implies ensuring safety and favorable conditions for human life during urban development, limiting the negative impact of economic and other activities on the environment, and ensuring the protection and rational use of natural resources in the interests of present and future generations
Model Law on Strategic Forecasting and Planning for Socio-Economic Development [6]	Sustainable safe development – the development of a process that meets the criteria of efficiency, effectiveness, and optimality, ensures the achievement of goals, eliminating negative direct and side effects in the present and future for participants of this process and the environment; sustainable state development implies an objective interconnection and interdependence of socio-economic and biosphere-ecological development

(continued)

Table 1 (continued)

Source	Definition
MES Dictionary	Sustainable development is a controlled, programmatic development taking place under conditions of equilibrium interaction between the biosphere and humanity (regulated by an index of development sustainability less than one) and an internally harmonious society ecological socialism, capable of establishing harmonious interaction of all three spheres of human activity (the sphere of global ecology, society, and economy), to ensure the flourishing of the human person
Kakutich, E. Yu. [7]	Sustainable development is a development that guarantees decent, equal (as much as possible) starting conditions for the representatives of current and next generations to manifest their abilities and meet life needs. Sustainable development is based on an economy that combines the principles of environmental security and social justice in a democratic society that respects human rights
Popov, L. A. [12]	Sustainable development is a strategy of social and natural development. It guarantees the survival and constant progress of society and does not destroy the natural environment, especially the biosphere, in any way
Yashalova, N. N. [20]	Sustainable development is the ability of stable economic development with the creation of conditions and factors for improving the quality of life while ensuring the ecological balance in the environment

Source: Compiled by the authors

We believe that the sustainable development of rural areas should contribute to the preservation of territorial integrity and labor resources in the countryside, and, on this basis, to the achievement of the food security of states in the long term.

The sustainable development of rural areas is defined as a targeted process of economic and social changes that ensure the reproduction and further development of the natural resource potential of rural areas in the interests of future generations based on several factors. These factors are the rational use of land, coordination of growth parameters of production volumes, increasing the efficiency of agricultural production, investment areas (including investments in human capital), the formation of the labor resource potential of these areas, and the achievement of full employment of the rural population, as well as improving the level and quality of the life of the rural population [16].

It is indisputable that the sustainable development of rural territories should be based on a stable, balanced pace of continuous development and sustainable growth of both the national economy of the country as a whole and the agro-industrial complex in particular.

According to UN estimates, in the coming decades, the world's population will reach almost 10 billion people. Therefore, food production will have to be increased by 70% in order to avoid hunger (Food and Agriculture Organization, n.d.). Accordingly, the issue of agricultural modernization is shifting from a purely economic sphere to the social one. Its importance will increase even more with time.

Agriculture has always been considered one of the main sectors of the Russian economy, and nowadays, the agro-industrial complex remains the most vulnerable and significant economic and social component of the country's national economic system.

Negative processes taking place over decades in the agricultural sector of Russia have led to the abandonment of agriculturally productive land from circulation; a significant gap in the level and quality of life in rural areas compared with urban areas; a significant decrease in the level of comfort in rural areas; reduction and shredding of the rural settlement structure; reduction of the personnel potential of the rural areas; depopulation and neglect of rural areas, etc. [17].

In order to solve the problems that arose in this sector of the economy as a result of market transformations, the "State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials, and Food Markets for 2008–2012" was developed and implemented. The basis for this five-year program was the priority national project "Development of the agro-industrial complex." Currently, the "State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials, and Food Markets for 2013–2020" is being implemented in the Russian Federation.

The results of the federal and regional state programs were the growth of agricultural production and the emerging positive dynamics in agriculture. Thus, the index of agricultural production increased by 14.0%, food products, by 19.0% over five years (from 2013 to 2017). The average annual growth rate of agricultural production amounted to 103.3% from 2013 to 2017 [11].

The implementation of state programs for the development of agriculture in 2008–2012 and 2013–2020 significantly increased the flow of financial resources to the development of rural areas. Positive changes were noted in creating comfortable living conditions in rural areas, stimulating investment in the agricultural sector, and creating new jobs through the formation of infrastructural conditions, as well as a positive attitude towards the rural way of life.

Trying to increase production efficiency, agricultural producers are looking for reserves to reduce production costs and increase productivity per unit of expended resources.

The achievement of these goals is facilitated by the use of productive plant varieties and animal breeds, economic agricultural machines, plant protection products, effective fertilizers, and the improvement of production technologies.

We believe that in current conditions—taking into account the global challenges of the digital transformation of society—a further search for ways to increase the efficiency of the agricultural business necessitates the introduction of elements of the digital economy, allowing for cost reduction based on the technical and technological renewal of production.

4 Discussion

The transition to a new level of economic, technological, and social development in rural areas involves the conduct of “intelligent agriculture.” In particular, it includes the use of the following automated decision-making systems:

- In crop production: global positioning technologies (GPS), geographic information systems (GIS), yield monitor technologies, variable rate technology, and remote sensing of the Earth
- In animal husbandry: electronic herd control systems (EHCS), a system for preparing and distributing feeds, a Smaxtec system allowing the monitoring of animals’ health status, etc.

According to the Analytical Center of the Ministry of Agriculture of Russia, the implementation of digital economy technologies provides positive economic effects and reduces costs by at least 23% when implementing an integrated approach (Ministry of Agriculture of Russia, n.d.).

For example, the development of computer technology, satellite navigation, and space monitoring of Earth contributes to more efficient use of technical means and an increase in the technological level of agriculture. This high-tech agriculture is called precision (Table 2).

Farmers from the Kursk region were among the first in Russia to use precision agriculture. Thus, the following systems are used in the agricultural holding *Garant*:

- the system of satellite equipment monitoring “Agrocontrol”;
- “Trimble Autopilot” auto-driving with the accuracy of 3.8 cm;
- the system of automatic material control “Trimble Field IQ”;
- the technology of soil sampling and differential fertilizer application [1].

The “AgroControl” system, which allows monitoring of equipment and land on the entire farm, and the automatic driving system “Autopilot” is used by the largest meat producer – *Miratorg*.

Another large agricultural holding company, *Rusagro*, has also been applying precision agriculture for several years now. In addition to the “AgroControl” system, the company is introducing such precision farming technology as a differential fertilizer application. The organization pays special attention to the control of fuel on agricultural machinery (IDK.[4].

However, it should be noted that, in Russia, only about 7% of the total number of agricultural producers use electronic systems in the agricultural sector, and even fewer

Table 2 Precision farming technologies

Technology	Obtained effect
Mapping	An electronic field map is created
Parallel driving	Saving time and fuel, increasing productivity, working with maximum accuracy and a minimum of superfluous movements. The ability to process the field at night with the same efficiency and accuracy as during the day
Differentiated sowing	Increased productivity due to better seed density and distribution, lower seed costs, lower fertilizer costs
Differentiated spraying of weeds based on the map; differentiated fertilizing	The application of the optimal amount of fertilizers and herbicides per square meter. Saving herbicides, fertilizers. Time-saving; yield increase
Differentiated irrigation	Saving water and nutrients
Differentiated tillage according to soil maps	Yield increase; energy saving; time-saving; improving machine performance
Measurement of chlorophyll in crops before harvesting	Improving product quality; an optimal period for the start of harvesting; improving grain quality with optimal moisture content
Automatic shutdown of agricultural equipment on floors	Saving seeds, products for plant protection, and fertilizers

Source: Compiled by the authors

directly implement precision farming technologies. For comparison, in European countries, electronic systems are used by approximately 47–69% of agrarians [8].

Studies show that, nowadays, systems for remote monitoring of equipment, controlling fuel drains, stopping machines, deviating from routes, and unloading crops are the most widely used systems in Russia. Also, technologies for the differential use of fertilizers are considered to be quite popular. A transition to differentiated plant protection is expected soon; this will save costs without reducing the quality of the crop [8].

According to the Center for Forecasting and Monitoring of the Kuban State Agrarian University, the elements of precision agriculture are actively used by agrarians of the Lipetsk, Samara, and Oryol regions, which, respectively, are 812 (2352 thousand ha), 108 (704 thousand ha), and 75 (684 thousand ha) farms (Geometer [3]).

Modern technologies are also being introduced in the livestock industry. According to the studies of the Kuban State Agrarian University, in 2017, new technologies were applied in business entities in the following regions: Leningrad (46 farms), Lipetsk (51), Kostroma (24), Ivanovo (16), and Tomsk (13).

More than 60 modern livestock breeding complexes for milk production are currently operating in the Kaluga region. There are 57 milking parlors; more than 130 milking robots are used.

In Russia, computerization and automation of animal husbandry mean the use of an electronic herd control system. Each milking parlor and robot-milker has a software system to control the herd, track the movement of animals through the barn, set the parameters of feeding and milking, and monitor the health of the cows, the optimal time for insemination, etc. An electronic herd control system is multi-unit, consisting of various programs aimed at solving the specific problems of agricultural producers. Accordingly, it can be used by both agricultural organizations and farmers.

Technology makes it possible to reduce the number of farmworkers, which is especially important under the current conditions of the labor force in rural areas. These software tools contribute to improving milk quality, reducing the incidence of unhealthy animals, using feed more rationally, and minimizing the impact of the human factor.

However, the introduction of digital technologies in production requires farmers to make substantial investments in equipment. Therefore, at present, only large agricultural holdings can afford the digitalization of technological processes. Digital technologies are generally not available to small-scale agricultural organizations and farmers. There is no provision for subsidizing the costs of introducing elements of the digital economy among the measures of state support for small and medium-sized agricultural producers. Moreover, not every rural area is covered by data transmission networks, respectively. For the further broad development of the digital economy in Russian agriculture, it is necessary to create a single information Internet space for agricultural knowledge. There is also a need for training of skilled workers, as well as government support, to stimulate the use of modern technologies in medium-sized agricultural organizations and peasant farms.

5 Conclusion

Ensuring the accelerated implementation of digital technologies in the economy is designated as one of the national priorities of the Russian Federation for the period until 2024 (President of the Russian Federation, 2018).

In 2018, the IT market in Russian agriculture reached 360 billion rubles; by 2026, this amount, according to estimates of the Informatization Department of the Ministry of Agriculture of the Russian Federation, should increase five or more times [14].

The transition to a new technological and economic structure through the further introduction of digital technologies, involving not only the use of information and communication technologies but also new business processes, digital models, and the creation of digital assets, in our opinion, will enhance the competitiveness of agribusiness entities; cooperation of business entities based on end-to-end digital processes; the emergence of sustainable digital ecosystems for business entities; and, ultimately, the creation of conditions for the sustainable development of rural areas.

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