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INFORMATION TECHNOLOGIES AS AN INCENTIVE FOR RUSSIAN AGRICULTURE

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Abstract

This article presents the findings of evaluating the level of ICT (*information and* communication *technology) advancement in the agricultural production of the Russian Federation. The primary goal of this paper is to identify priority areas for intensifying agriculture using information and communication technologies for the ICT advancement in agricultural production. The study is based on application of theoretical and general scientific research methods, as well as comparative analysis of statistical data reflecting the development of information and communication technologies in rural areas of the Russian Federation. Analysis of the current state of informatization of the agricultural industry in the Russian Federation allows to draw a conclusion that information systems enabling automatization of the processes to ensure national food security in state authorities have been established in the country by now. At the same time, the information resources required by agricultural producers are rather scattered and poorly systematized. Evaluation of the ICT utilization in agricultural production of the Russian Federation reveals that the state of the information infrastructure and the advancement of information technologies among rural population are much inferior to similar indicators in urban areas. A positive trend should be noted: ICTs are increasingly spreading in rural areas, and differences between the city and the countryside are fading. The author agrees with the opinion of experts who claim that the task of information technologies is to maximize automation of all stages of the production cycle to reduce losses, increase business productivity and optimize resource management. In the author's opinion, two key areas of the agricultural production intensification with the use of information technologies can be identified: creation of a unified information base on resources for agricultural producers and introduction of the Internet of things (IoT), and digitalization of agricultural production in the Russian Federation.*

Key words: *information technologies, agricultural industry, agriculture, ICT, informatization, mobile technologies, digitalization, internet of things*

INTRODUCTION

The demand for food is expected to increase by 60% over the next 35 years, since the world's population is estimated to reach 9.2 Billion people by 2050 [14]. Agriculture is a vital sector for the survival of mankind and a driver of international trade. If this production problem cannot be solved, food shortages may occur, which would entail social and political instability, and the global security may be threatened.

Agricultural production is currently developing under the conditions of stagnating expansion of arable land, lack of water resources, environmental degradation, negative effects of climate change, rapid urbanization, and reduction in agricultural labor.

Coordinated and concerted efforts are required from all stakeholders, including the public and private sectors, in order to solve the problem of food security. Achieving improved and sustainable agricultural

production and productivity growth largely depends on the advancement of agricultural research and its efficient application in farmer fields through the transfer of technology and innovation.

FAO (Food and Agriculture Organization) estimates that 91% of the global food production will increase until 2050; one should proceed from the increasing yield of existing arable land through the promotion of agricultural research, as well as its application and transfer to farmers through efficient research links. ICTs, geoinformation systems, remote probing, precise agriculture and many other technologies or processes have an enormous potential in the development of agriculture and advancement of the national food security [13].

Mobile technologies will efficiently improve the transfer of agricultural research findings for use in farmer fields [16]. Timely reporting of transboundary animal diseases using mobile technology will save lives of a large number of animals and minimize financial losses [30].

At the same time, the ICT utilization in agricultural production is significantly lower than in other branches of the economy and is constrained by a number of problems, including insufficient technological and intellectual training of employees at agricultural enterprises.

Creation of a system of state information resources that support electronic accounting in the agricultural sector remains among the topical issues.

The goal of this paper is to evaluate the intensity of the information and computer technologies application in the agricultural sector of the Russian Federation and define the priorities for the ICT development in agricultural production.

Literature review

The review of international practices on the ICT usage in agriculture of various countries indicates that the scope of its application is quite extensive [20].

ICTs in agriculture are used for [1]:

(i)Promoting multiple innovations.

As the innovation activity in agribusiness intensifies, the role of information and communication services increases, since information and knowledge act as the most important production resources for shaping sustainable agriculture [15].

An innovative approach to agriculture development requires creation of a strong favorable environment (supporting and efficient legal, tax and political regimes) and adequate infrastructure systems (roads, transport, telephones, means of storage, processing and marketing, as well as information systems) [26].

(ii)Obtaining pricing information and analysis of prices for commodities and stock markets.

Not only information on agricultural marketing available to farmers helps them sell their products at more favorable prices, but also provides reliable information about prices for products to policymakers in order to prevent price volatility and speculation. This contributes to improving food security [35].

(iii)Collecting meteorological data.

Regular monitoring of global food reserves, including mapping of agricultural production and areas where food shortages exist, is the first step towards ensuring food security [36]. Information and communication technologies (ICTs) are primary tools for monitoring the environment and climate and predicting climate change at the global level [2].

(iv)Providing farmers with consulting services relating to agricultural production expansion.

Consulting services are arranged and provided via various information channels, of which the Internet and mobile telephony are most often used [25]. However, the development of ICT infrastructure – especially access to the Internet, and hence access to the necessary and timely information, – remains challenging in rural areas [6].

(v)Establishing an early warning system for disaster prevention and control;

(vi)Collecting statistical data in agriculture, etc.

Farms, which form the basis of agricultural production (AG) worldwide, are the key factor for the industry development. To meet the growing demand for food, small farmers need to achieve critical success in managing tasks, create an efficient system for monitoring crops and livestock breeding, and

move on to efficient agricultural practices [37].

ICTs will play a critical role in achieving the goals set by providing integrated and available cyber physical systems (CPS) that are able to measure, analyze and control AG operations [32].

Contemporary studies note that ICTs include hardware, software and applications for creating, managing and presenting digital content (for a user), knowledge management and shared use, as well as aspects of institutional management and organizational structures associated with information, data and knowledge sharing [33].

This set of technologies and processes is called the Information and Communication Management (ICM) [22, 23].

Challenges of ICM of agricultural production in developing countries are reviewed in the papers of Chalemba, L. [5], Nelcon, R. and Coe, R. (2016), Jukan A., Masip-Bruin X. and Amla, N. [17], Cáceres R., Pol E., Narváez L. [4] and others.

Impact of ICT on knowledge management processes in the agricultural sector attracts particular attention of modern researchers [34].

Rizvi, S.M.H., Dearden, A. note that advances in the field of ICTs and their application in the fields of development have significantly improved the prospects for human development [29].

Kelly N., Bennett J.M., Starasts A. theoretically justified the adoption of the network paradigm of training agricultural producers, which connects farmers at different distances for constructivist training [18].

Modern information technologies allow solving problems of soil fertility management [27], creation of intelligent irrigation systems [12], etc. The world practice indicates that introduction and development of ICTs in agriculture has an efficient impact on the increase in productivity, income of agricultural producers, food security and employment in the sector [19].

However, lack of integrated approach, basic principles and tools for the ICT usage in agricultural services at the national level leads to inefficient use of resources [7].

As such, the agribusiness sector should start using public networks and advances in communication and information technologies to be able to develop business ponentially [8, 31].

MATERIALS AND METHODS

The primary goal of this study is to identify promising areas for improving the efficiency of agricultural production using information technologies.

The study solves a number of problems to achieve this goal:

-Evaluate the intensity of ICT usage in agricultural production in the Russian Federation;

-Identify priority areas for intensification using ICTs.

Academic publications of Russian and foreign experts on the development of the agricultural sector and the problems of introducing information technologies in agricultural production served as the theoretical basis of the study.

The study uses methods of analyzing the results of observations, dynamic and comparative analysis of statistics provided by Rosstat, the Ministry of Agriculture of the Russian Federation, the Ministry of Communications and Mass Media of the Russian Federation, etc.

RESULTS AND DICUSSIONS

Informatization of agricultural industry as a priority of the Russian National Policy

Agriculture is the most important sector of the Russian economy, since food security is among the key national priorities. The state supports agricultural producers with subsidies, grants and concessional lending. This situation has led to an increase in investment in the development of large-scale projects in the agricultural industry [3].

At the same time, sanctions against Russia helped accelerate import substitution, while retaliatory measures aimed at restricting the import of certain types of food from the European Union, the US, Australia, Canada and Norway to Russia provided a "window of

opportunities" for domestic producers and gave positive impetus to the industry.

As such, due to a set of measures in the field of import substitution, agricultural production has grown by 11% over 3 years, while imports of food have almost halved over 3 years: from $43 bln to $25 bln in 2016. Positive results were noted in most agribusiness branches. For example, gross harvest of grain has increased by 14.2% over 2014-2016, production of livestock meat and poultry has increased by 9.1%, catch of aquatic biological resources has increased by 5%. Sugar beet and oil crops are leading in the production of vegetables, demonstrating an increase of 53.3% and 26.4% respectively at the year-end.

Fundamental indicators of the Russian agricultural industry for 2014-2016 are presented in Table 1.

Table 1. Fundamental indicators of the Russian agricultural industry for 2014-2016

Indicator	2014	2015	2016	Change, 2016/2014	
				+/-	%
Agricultural production, bln. rub.	4,319.1	5,165.7	5,626.0	1,306.9	130.3%
including crop farming	2,222.5	2,791.4	3,170.5	948.0	142.7%
including livestock breeding	2,096.6	2,374.3	2,455.5	358.9	117.1%
Crop acreage, thous. ha	78,525	79,319	79,993	1,468.0	101.9%
Gross yield of grain, thous. tons	105,315	104,786	120,672	15,356.7	114.6%
Gross yield of sugar beet, thous. tons	33,513	39,031	51,367	17,853.5	153.3%
Gross yield of oil crops	12,859	13,837	16,258	3,399.1	126.4%
Production of meat and poultry, thous. tons	9,070.3	9,565.2	9,899.2	828.9	109.1%
Field vegetables and vegetables under glass	15,458	16,111	16,283	825.5	105.3%

Source: Federal State Statistic Service of Russian Federation http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/efficiency/#)

Imports/exports balance for individual products has also improved. Russia approached the positive balance of exports/imports of food in some months of 2016. This situation is observed for the first time in recent history.

Informatization of the industry is among priority areas for the development of modern agriculture. The key provisions of information support for agriculture are reflected in Federal Law No. 264-FZ "On the development of agriculture" [24].

The procedure for creating and maintaining the system of state information support in agriculture is established in the Regulation approved by the Government of the Russian Federation in 2008 [28].

Establishment of state information resources is among key dimensions of the State program for the development of agriculture and regulation of markets for agricultural products, raw materials and food for 2013-2020 [28]. Under Russian law, the Ministry of Agriculture of Russia is granted the functions of the state information system operator.

At the moment, the Ministry of Agriculture has introduced and improved information systems that automate technological processes in the established area of activities for such government agencies as FGIS USMT, AIS NSI, PK "Elektronnye gosuslugi", SM PB, IS PK GP, AIS "Subsidii APK". Following the results of 2016, state information resources in the field of ensuring food security are used by 98.4% of regional and 62.6% of administrative bodies of agribusiness.

The Foundation of Agriculture Promotion carries out consistent work on informatization of Russian agricultural producers. "Farmer's Workstation "ZARYA" became the first hardware and software package successfully tested by farmers in four pilot regions.

The Foundation launched the all-Russia information and maintenance service "AgroContactCenter" in early March 2017, which solves many problems of agricultural producers with the sale of agricultural products, with the development of agricultural cooperatives, with a lack of information, with a deficit of literate specialists in the countryside, etc.

Evaluating the intensity of ICT usage in agricultural production in the Russian Federation

Statistical indicators of the ICT industry advancement and the results of monitoring the economic situation and public health [11] reveal that the information infrastructure of rural areas is not sufficiently developed.

The telephone density per 100 people of the rural population amounted to 10.97, which is significantly lower than in urban areas (27.92). The volumes of commissioning of rural PBXs decreased by one third compared to 2010 and amounted to 389.3 thous. numbers by late 2015. The number of public telephones, including payphones, fell by 17% over five years [21].

The telephone network in rural areas is compressed more rapidly than in urban areas, but due to the decrease in the number of rural population, the gap in the provision of townspeople and villagers (per 100 people) with public telephones remains wide: 2.6 times by general provision; 2.1 times by home devices (2.3 in 2010).

Percentage of settlements with a telephone line in rural areas decreased from 89.1% in 2014 to 88.2% of the total number of rural settlements over three years. 11.8% of villages do not have access to landline telephone network.

Reduction in the landline telephone network in rural areas is largely due to the development of mobile telephony and the Internet.

Information technologies are increasingly being introduced in rural areas. Following the results of 2016, 61.4% of rural households have PCs, 63.5% have access to the Internet, 56.2% of rural families have broadband Internet access (Figure 1).

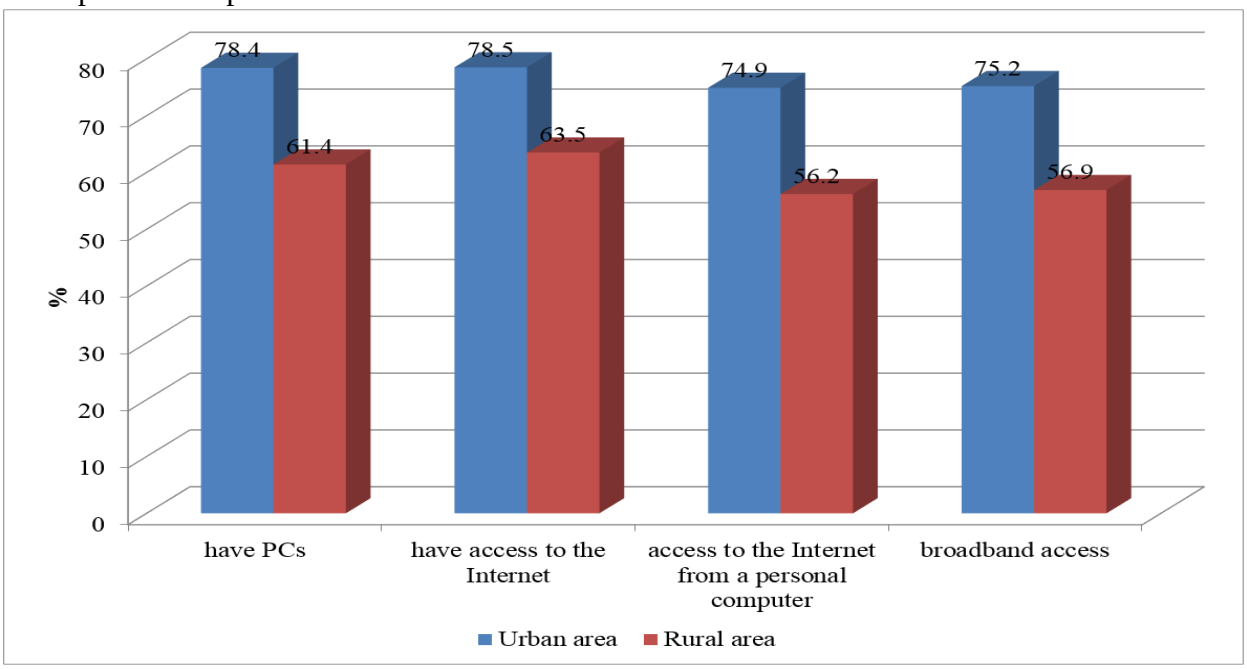


Fig. 1. Availability of PCs and access to the Internet following the results of 2016. Sources: compiled by authors on the base of statistical data [11, 21]

Rural households still lag far behind urban ones by computerization and access to the Internet, but these differences rapidly fade.

The ratio of rural and urban areas by the availability of PCs was 78.2% in 2014, while this figure was 75.2% in 2015.

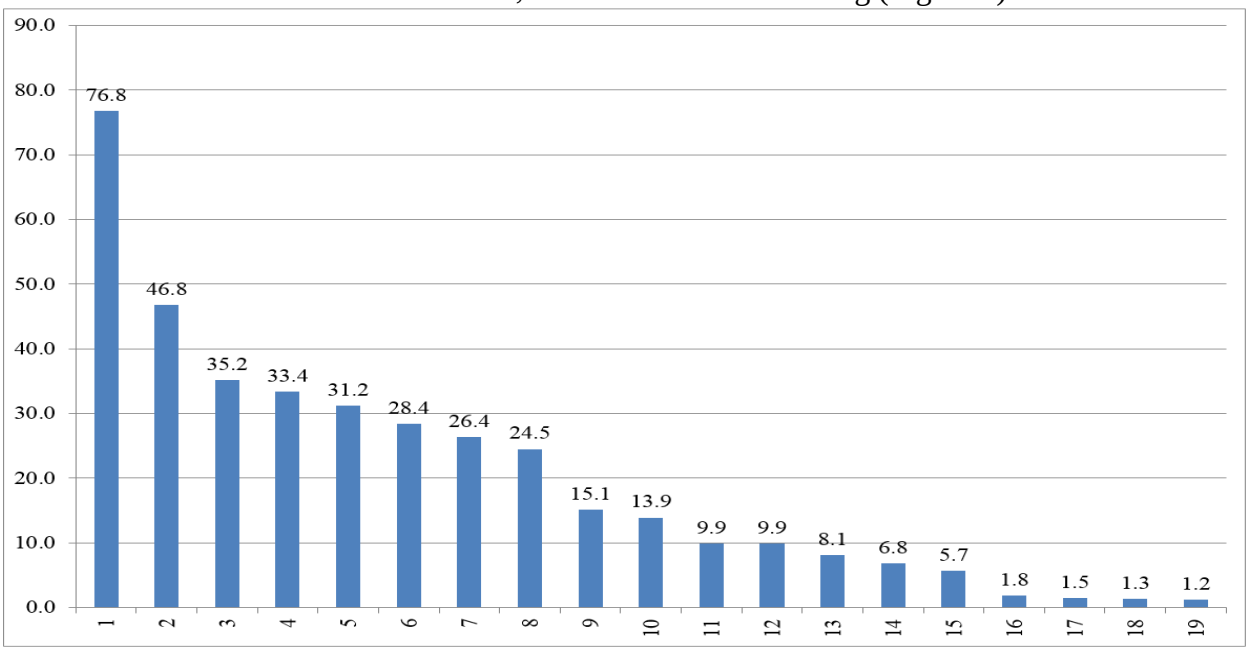
At the same time, the availability of mobile phones is 1.2 times higher than the urban level (Table 2).

Table 2. Availability of ICT equipment in rural and urban households in 2015, pcs per 100 households

Name	Village	City	Village to City, %
Personal computer	49	65	75.4
Portable computer (laptop, tablet, iPad)	41	71	57.7
Mobile phone	214	182	117.6
Smartphone, iPhone	36	75	48.0
TV (all kinds)	157	186	84.4
Radio (wired and wireless)	14	16	87.5

Source: Federal State Statistic Service of Russian Federation (http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/efficiency/#)

It must be noted that only 26.4% of rural residents use the Internet to send emails, 8.1% use it to look for a job and only 1.8% for distance learning (Figure 2).



Legend:
1 - participating in social networks (for example, Vkontakte, Odnoklassniki, Facebook, etc.)
2 - downloading movies, images, music; watching videos; listening to music or radio
3 - voice calls or video calls over the Internet (using, for example, Skype or other apps)
4 - searching for information about goods and services
5 - gaining knowledge and information on any topic using Wikipedia, online encyclopedias, etc.
6 - playing video or computer games/games for mobile phones or downloading them
7 - sending or receiving emails
8 - uploading personal files (books/articles/magazines, photos, music, videos, programs, etc.) to websites, social networks, cloud storage for public access
9 - conducting financial transactions
10 - reading or downloading online newspapers or magazines, e-books
11 - communicating via instant messaging systems (chats, ICQ, QIP, etc.)
12 - selling/buying goods and services (including via online auction sites)
13 - looking for a job
14 - searching for information about education, training courses, workshops, etc.
15 - downloading software (other than computer games)
16 - distance learning
17 - participating in online voting or consultations on public and political issues (urban planning issues, signing petitions and appeals)
18 - participating in professional networks (for example, Linkedin, Xing, E-xecutive.ru, etc.)
19 - posting opinions on public and political issues via websites, participating in forums

Fig. 2. Purposes of Internet usage by rural population, % of respondents. Sources: compiled by authors on the base of statistical data [11, 21]

According to the results of statistical observation on the ICT usage by the population, about 36.5% of rural residents do not have access to the Internet from their home computer. As a result, villagers (including farmers) can check email about once a month, when they go to the district center.

The main reason for this is lack of the need or desire to use this information source. Another reason constraining the Internet usage in rural areas is the high cost of its connection (Figure 3).

26.7% of rural residents cite the lack of web browsing skills. 8.6% cited the lack of a technical ability to connect to the Internet.

The advanced growth of agriculture is of critical importance for the economy and food security of Russia. However, agriculture will have to deal with two major challenges.

The first is the loss of arable land for non-agricultural uses due to industrialization and urbanization. The second is soil erosion due to intensive farming and environmental degradation.

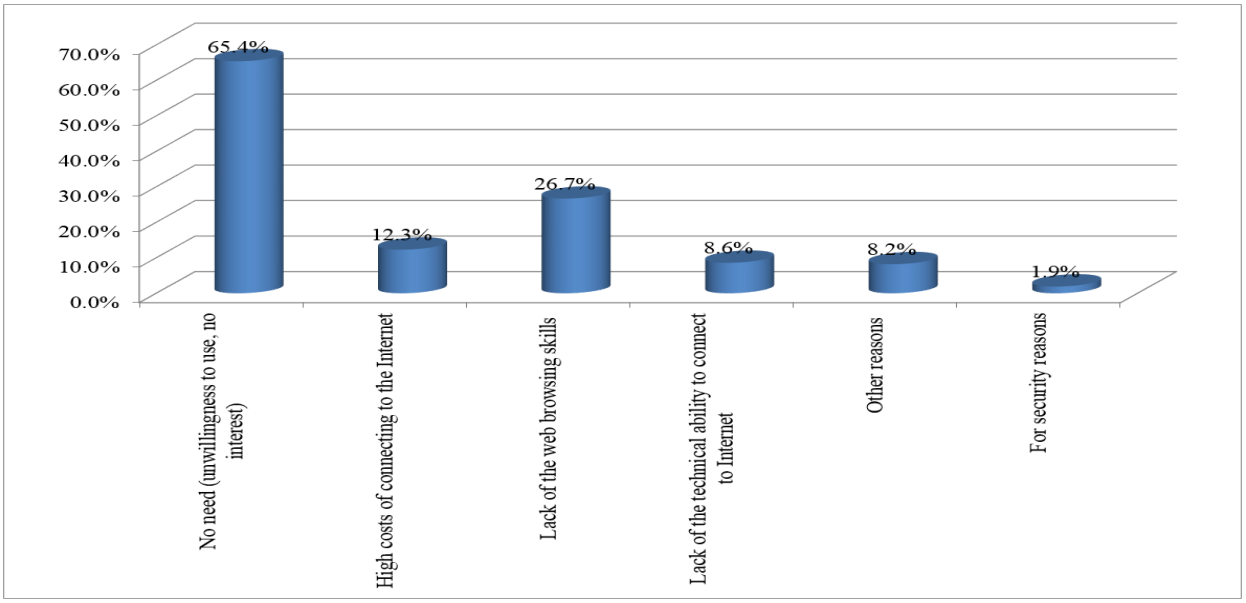


Fig. 3. Reasons for non-use of the Internet by rural residents. Sources: compiled by authors on the base of statistical data [11, 21]

The experts widely recognize that increasing agricultural productivity is critical to maintaining high growth of the national economy and reducing poverty.

The study of expert opinions allowed to determine the perspective areas for development of information technologies in Russian agriculture:

(i)Creating a unified information base on resources for agricultural producers

(ii)Introducing the Internet of things (IoT) and digitalization of agricultural production

Creating a unified information base on resources for agricultural producers

At present, the information resources required by agricultural producers are quite scattered and poorly systematized.

It is required to integrate the resources needed by agrarians into a unified information base that will accumulate all the information required by rural entrepreneurs about machinery, goods and services in one place. The Foundation of Agriculture Promotion proceeded to the implementation of this project in 2017. Undoubted advantage of the information base is that the information collected in it will be available in both "online" and "offline" modes. This will allow to cover most of the interested audience.

According to experts, the creation of such a database is a necessary step to agriculture intensification and optimization of the costs of agricultural production.

Introducing the IoT and digitalization of agricultural production

Productivity of agriculture is an indicator reflecting the volume of output per employee and describing the level of living labor costs in production, labor intensity of production and, ultimately, its competitiveness.

The resulting indicator of productivity is the yield of crop farming (or livestock breeding productivity), as well as the maximum utilization of resources (each ha of area, each unit of equipment, kg of fertilizer, agrochemistry, ruble invested, etc.).

Russia has at least a three-fold reserve of increase in the yield of grain crops in comparison with the US and Germany.

The lag by labor productivity in agriculture in general is 3 times compared to Germany and more than 20 times compared to the US. For example, following the results of 2015, the gross value of agricultural products in Russia per employee was $8 thous. dollars, while in the USA it was $195 thous. [10].

One of the relevant tasks of Russian agriculture is the accelerated narrowing of the technological gap with developed countries, increase in agricultural productivity due to the use of precision farming technologies, improvement of instruments for collecting and analyzing data and automation of agricultural processes.

The analog period in agriculture is over; the industry has entered the digital age. Investment bank Goldman Sachs predicts that the application of next generation technologies is able to increase the productivity of global agriculture by 70% by 2050 [9].

Experts estimate that due to precision farming technologies based on the IoT, there can be such a surge in yields which humanity has not seen even at the time of emergence of tractors, invention of herbicides and genetically modified seeds.

Realization of the IoT projects in agriculture shapes the partner ecosystem. There is interaction between the members within this system, where cooperation is much more beneficial than competition with each other.

Members of this ecosystem can use the common infrastructure and the IT platform interface to introduce innovations and create new products that they could never create on their own and that will be made available to general consumers. Within such cooperation, each ecosystem member promotes a common solution, achieving positive result for all members. Required members of IoT projects are device suppliers, telecom operators, IoT platforms, system integrators, app developers and customers.

Experts estimate that such a model of creating added value, based on the IoT technology and integrated automation of production business processes in agricultural production will allow to:

-Approximately halve the price level for basic food products in Russia, while improving their quality. This can be achieved through a 3-5-fold increase in labor productivity in agriculture, resulting from a reduction in the mark-up in the wholesale and retail chain. The volume of the food and agricultural products market is expected to increase by 1.5 times, and the annual increase in net profit may reach 200 bln rubles.

-Significantly improve the level of automation of the key production and business processes of rural households.

According to preliminary estimates, this will increase the consumption of information technologies by agricultural producers by 156 bln rubles (+22% to the current volume of the IT market in Russia) and data transmission services by 11 bln rubles annually (+19% to the current volume of data transmission by the corporate sector in Russia).

-Increase availability of borrowed resources for agricultural producers. Switch to integrated automated supply chains for agricultural products will ensure transparency of this process for banks and reduce lending risks, which in turn will increase the volume of lending to agricultural producers by 500 bln rubles.

-Create skilled jobs in the village with a higher level of wages.

According to experts from J'son & Partners Consulting, the total economic impact of the introduction of the rural production business model based on the IoT and digitalization can reach more than 4.8 trln rubles per year, or 5.6% of Russian GDP growth (relative to 2016 figures), while the possible increase in the volume of consumption of information technologies in Russia can amount to +22% due to the digitization of only one industry – agriculture.

CONCLUSIONS

Results of the conducted study lead to the following conclusions:

-Information systems are currently introduced in Russia that allow to automate the processes to ensure the national food security in state authorities. State information resources are used by 98.4% of regional and 62.6% of municipal administrative bodies of agribusiness.

-The information infrastructure in rural areas is not sufficiently developed compared with the urban area. However, the results of the conducted study indicate that information technologies are becoming more widespread in rural areas. More than 60% of rural households have PCs and Internet access.

-According to many experts, modernization of production systems and application of modern information and digital technologies are drivers for increasing agricultural productivity and intensifying the agricultural sector.

Having reviewed the expert opinions, the

author outlined two key areas of agricultural production intensification using information technologies: creating a unified information base on resources for agricultural producers and introducing the IoT, and digitalization of agricultural production in the Russian Federation.

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