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Potentials of the use of IoT-technologies in agricultural sector

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***Abstract*—The agro-industrial complex at its up-to-date stage of development is an important sphere for massive introduction of IoT-technologies, which are able to change traditional approaches to the use of agriculturally used areas, to the growing of cultures and providing the population with safe and cheap products greatly. Digitalization of the agricultural sector takes place with the application of digital technologies in different spheres of activity, which allows passing adaptation procedure faster and getting positive results. Introduction of IoT – technologies into agricultural sector means constant exchange of data between various inner and outer Internet-resources at any time from any place, which is an important factor for taking decisions, providing the efficiency of agricultural organization as well as decreasing risks of untimely response to the happening changes. The theoretical basis of this work is statistical data of the Federal State Statistics Service of the RF, publications on the theme of the study in the Internet. As a methodological basis general scientific methods of the study have been used. As a result the background of the introduction of IoT-technologies in the agricultural sector has been described, main purpose indicators of digital technologies in the RF are specified, solved tasks and tools on their solution are formulated.**

Keywords—IoT-technologies, agricultural sector, digitalization, agricultural industry, «smart farm enterprise», digitalizing of agricultural sector.

I. INTRODUCTION

Nowadays information as one of the most significant factor of the production is becoming mega important active of any sphere of activity. This is conditioned by alternative value significance of information resource while using in new business processes and for realization of new business ideas. In connection with this the Internet of things gets quite an important value [1].

The Internet of things (Eng.: Internet of Things, IoT) is a concept of computer network of physical objects («things»), equipped with embedded technologies for interaction with each other or with the environment, this concept considers organization of such nets as a phenomenon, able change economic and social processes, excluding the necessity of man's participation from some parts of actions and operations [2].

Under current conditions in the agricultural sector of economics nowadays there is a necessity to introduce labour-saving technologies, the main among them are intellectual, digital, IoT-technologies and robot automation. The thing that unites all the above-mentioned technologies is intellectual background, which is based on fast obtain of initial information about the state of the object, factual data of outer processes, happening, and produced agricultural products (performed work, provided services of agricultural designation) to increase speed, efficiency and subsequent realization of managing decisions in agricultural sphere.

II. MAIN POINTS

In the understanding, close to the up-to-date conditions of economic development, IoT-technologies are considered as dynamic global net infrastructure with the independent control of possibilities on the basis of standard and compatible communication protocols, where physical and virtual "things" have identifying codes, physical attributes and virtual personalias, use intellectual interfaces and are easily integrated into the information network [3].

The gradual transition of the agricultural sector to "digital rails" with the use of IoT-technologies is reasoned by the following changes that are in progress:

- the growth of production rate, conditioned by correctly-chosen tools of the Internet of things, as the production rate increases by several times in this;
- the growth of the quality of agricultural production due to the decrease of the role of the «human factor», able to reduce mistakes and the possibility of their repetition in the process of growing, processing and storing agricultural production to a minimum;
- the growth of labour safety together with its comfort improvement, which is based on the exclusion of a man's participation in the conditions «hazardous» industry.

IoT-technologies has obtained a wide circulation almost in all the spheres of production and commercial activities, which is connected with getting practical results of the use of the most effective tool in the reach of a high level of business-project digitalization. The agrarian business is not an exception

According to the data of the explanatory notes to the proposal on the realization of a new program area «Digital economy of the Russian Federation» [4], the following targets for the agricultural field are indicated (Fig. 1).

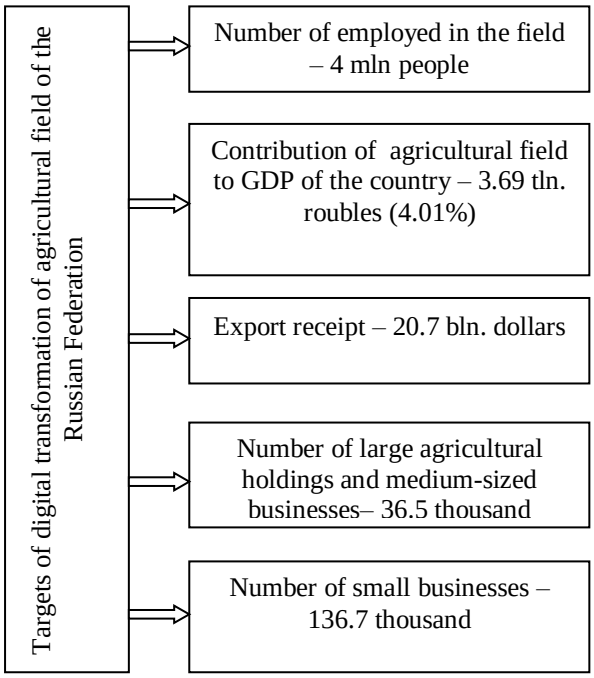

Fig. 1. Targets of digital transformation of agricultural field of the Russian Federation

Agriculture, being an integral part of the agrarian industrial complex of the Russian Federation, is a participant od the program «Digital economy of the Russian Federation», signed by the regulation of the Government of the Russian Federation dated 28 July 2017 № 1632-p.

To get the set targets, it is proposed to simplify the algorithm of the process of the construction of the necessary communication objects on the lands of agricultural designation at the legislation level as well as develop the system of activities, contributing to encouraging and financial support of the enterprises and of the agrarian sector, including the process of introducing IoT-technological tools. This mechanism is prescribed in «roadmap time line» on the development of the digital economy of the RF, where it is offered to decrease income tax rate for the enterprises of the agricultural sector by setting off expenses, necessary to IoT-technologies. At the same time it is suggested to assign farm businesses radio frequencies to use one of the most effective IoT-tool – pilotless aircrafts (drones) and provide maximum simplified access of the subjects of the agro-industrial complex to the system of space monitoring of the data for the most accurate and operational use of the cartographical and meteorological information with the aims of observation, analysis and control of the process of growing yield.

In November 2018 the Ministry of the agricultural development of Russia presented departmental project «Digital agriculture», within its frame target goals are indicated for the period of 2018-2021 (table 1) [5].

TABLE I. TARGET GOALS OF DEPARTMENTAL PROJECT «DIGITAL AGRICULTURE»

Target goals	**Years**			
	2018	***2019***	***2020***	***2021***
Resource ratio in Big Data, (%)				
- land	75	100	100	100
- cattle	1	25	50	100
- technical equipment	50	75	100	100
Ratio of SMART-contracts with subsidy recipients, %	0	10	50	100
Coefficient of expense decrease	0	0,05	0,15	0,20
Ratio of material expenses in prime cost of agricultural production, %	65	60	55	50
Growth of production rate, %	0	105	150	200
Investment ratio into digital technologies (as well as production of Russia), %	0,5 (0.1)	1 (0.5)	3 (1,5)	7 (5)

In the same project the roadmap time line of its realization is presented, which includes five directions of realization of the proposed project [5]:

- effective hectare. This direction provides for the creation of federal digital platform of the agro-industrial complex in 2019, in 2010 – the organization of integral processes with the database of the Russian meteorological service, which will allow making careful crop forecast and times of gathering cultivated plants, in 2011 году – introduction of intellectual field planning. The following regions will be involved into this direction: Tambov, Belgorod, Samara, Kemerovo, the Republics of Bashkortostan, Tatarstan, Mordovia and others. The organization, guaranteeing the realization of the direction, are Rostelecom, Roscosmos and Rosreestr;
- smart contracts. In 2019 it is suggested to create intellectual system of the state support measures together with the creation of the personal cabinet of the subject of the agro-industrial complex – subsidy recipient, investment loans and so on. In 2020 there is a beginning of work of the operator company of the created system. By 2021 it is planned to conclude 100% of smart contracts with subsidy recipients. The involved regions are the same as according to the first direction. The organization, guaranteeing the realization of the direction, are Rosselhozbank, the Federal Tax Service of the RF, the Ministry of Finance of the RF;

For the first two directions the realization resources will be: facilities of the State program of the agro-industrial complex, budgets of the subjects of the RF, facilities of the National program of Digital economy of the RF;

- agro-export from the field to the port. In 2019 they model export flows on the basis of « effective hectare». In 2020 – coordination of forecast harvest quantity with the rolling stock of the Russian Railways. In 2021 – accompanying export products of agricultural designation with the help of electronic intellectual system «from the field to the port». The regions involved into the direction realization are: Altai territory, Novosibirsk region and Krasnodar territory. The realization of the direction is due to the ports of the cities of Vladivostok, Novorossiysk as well as logistic centres and marketplaces. The resources on the realization: facilities of the State program of the agro-industrial complex, facilities of high volume exporters of agricultural raw materials, facilities of port operators, facilities of marketplaces;
- agro-solutions for agro-business. 2019 – accumulation of Russian information products and technologies for the agro-industrial complex: «Smart farm», «Smart field», « Smart herd», « Smart greenhouse», « Smart processing», « Smart storage», « Smart agro-office». In 2020 – approbation of the above mentioned products and technologies at the enterprises of the agro-industrial

complex, receive of ecomonic justification of introduction efficiency. 2021 – procedure of transferring of digital agro-solutions. The following will join in the organization of the direction: the Fund of industry development, SkolTech, Bortnik fund, RUSNANO, Geoscan, Scanex, Centre of Program System, ICT-business, agro-business. The resources on the realization will be grants and preferential loans;

- electronic educational system «Knowledge land». 2019 – the creation of quasi-corporate electronic educational system (EES) « Knowledge land ». 2020 – development of the content for EES, introduction of technologies of chatbots and on-line consultants. 2021 – the education of 55 thousand specialists in the sphere of digital economy in the agro-industrial complex with the help of « Knowledge land». The realization of the direction will be allotted to Stavropol state agrarian university, Kemerovo state agricultural institute, Kuban state agrarian university and other agricultural higher institutions of the RF, as well as to agro-business. The resources of the direction realization will be facilities of the universities and facilities of the State program of the agro-industrial complex.

Having digital competences is becoming a necessity for the effective work of the agricultural sector in the process of reaching target goals, as during the seasonal period of activity, the farmer must take a great number of managerial decisions in limited amount of time, and the part of these decisions is the objects of digitalization.

In Fig. 2 there is information of approximate procurement of IoT-equipment for the agricultural sector of the economics for the period from 2015 to 2020.

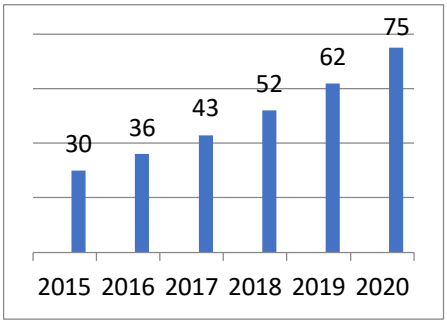

Fig. 2. Approximate procurement of IoT-equipment for the agricultural sector of the economics, mln pcs [6]

Quite a wide application of digital technologies in all the spheres of economics allows using the following autonomous electronic devices in the agricultural sphere as well for carrying out different monitoring-processes:

- on the main parameters of soil layer: the control of humidity and acidity levels, fertilizer content and temperature regime etc.;
- on the main vital parameters of farm livestock: temperature, location , diseases and etc.;
- on the parameters of growth and development of agricultural plants: the control of supply of bio-mineral fertilizers, parameters of growth and development of plants, the control of terms of ripening, having weeds and their timely extraction and etc.;
- on the parameters of agricultural production origin and methods of its production (growing), etc.

The application of IoT-technologies in the agricultural sector will allow solving the following tasks:

- decrease of prime cost of growing production with the aim of increasing its competitive ability in domestic and foreign markets;
- reduction of operating costs;
- assurance of efficiency of application of resource-saving technologies;
- yield enhancement and quality improvement of the grown cultures;
- analysis of land plots and identification of problem areas of land-use;
- decrease of climate risk level;
- assurance of eco-balance in the use of organic mineral fertilizers while growing cultivated plants;
- decrease of human factor influence and etc.

To solve all the above mentioned tasks the tools of IoT-technologies have a lot of technical, information and telemetric systems such as:

- pilotless aircrafts (drones). According to the data of analytical research of consultant company Research and Markets the volume of the world-market of drones for fulfilling agricultural problems 2022 will have reached 3.69 bln dollars [7]. GC «Cognitive technologies» together with the domestic producer of agricultural engineering «Rostselmash» and agro-holding «Soyuz-Agro» are promoting pilotless agricultural engineering in Russia. In 2016 there were the first tests of the tractor with the system of computer vision C-Pilot [8];

- network of the Internet of things. The projected growth of the world market of IoT-technologies comprises 23% yearly[1]. «Smart decisions» are introduced into all the spheres of activities, including agricultural sector, which allows providing large-scale monitoring of the launched systems;

- satellite technologies. GLONASS/GPS – technologies are used at all the stages of the growth of cultivated plants. The system ensures constant control of special-purpose machines: allows carrying out monitoring of the route of advance, making it optimal and not omitting cultivated land plots; it helps to save fuels and lubricants, to reduce production expenses in the part of the use of seeds and fertilizers; it will provide the work of the dripping system of the wetting and irrigation, conducting side-dressing and cultural treatment of the plants; preserve the quality of the performed work at the periods of darkness and in the conditions of poor visibility, minimize, and as a consequence, exclude non-effective and illegal exploitation of agricultural engineering. The system also allows realizing the procedure of monitoring and analysis of crop acreage to develop digital location map and to conduct coordinate analysis of arable resources;

- self-guided special-purpose machines. Self-guided technologies, according to the words of Cory Reed, vice-president of the group of intellectual solutions of company John Deere, began to change agriculture in America and abroad, John Deere sells the systems of self-piloting and other self-guided technologies in more than 100 countries of

the world [9]. Nowadays specialists of different companies work on the creation and adaptation of self-guided machines, for example the specialists of CNH Industrial, developed the system NH Drive, which turns ordinary agricultural engineering into a robot, the work of which is based on speed and accuracy. Digital intelligence of the system and developed special applications for a usual PC, tablets and mobile phones let the farmer control the process of traveling of automated (robotized) vehicles or the fulfillment of the set tasks. For this the farmer has to conduct «training» for the machines in the part of charting peculiarities of local area on the map so that if the obstacle is met while moving, the vehicles will be able to inform the farmer about it, who will in his turn either choose one of the proposed variants of work continuation or offer his own variant, which can be «remembered» and in future used by machine-robot in the same situation. This approach will allow reducing expenses of human labour greatly, especially during peak period of seasonal work, as well as will ensure round-the-clock work with maximum comfort and flexibility in the managerial process. Accounting on the year of 2017 robotechnics is used in 28 regions of the Russian Federation in 103 agricultural institutions [8]. In Fig. 3 the dynamics of robotechnics introduction in the agricultural sector of the Russifn Federation is presented for the period from 2006 to 2016 [8].

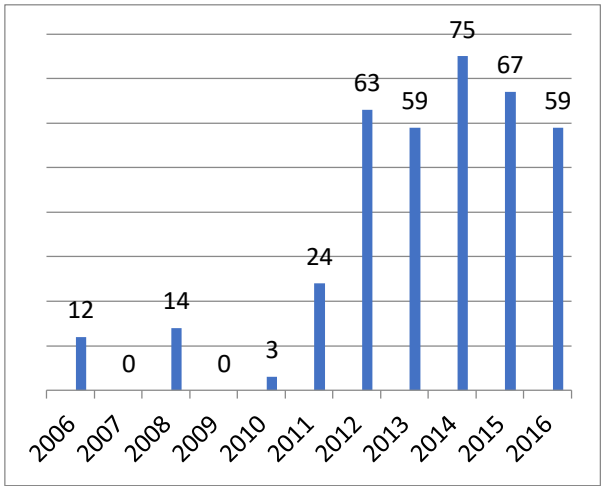

Fig. 3. Dynamics of robotechnics introduction in the agricultural sector of the Russian Federation, thousand pcs. [8]

-telematic resources. Under telematic resources communication support between the equipment and transducers, providing the process of automation (robotization) is meant. The peculiarity of the agricultural industry in the Russian Federation gives the right to say that the potential of the development of the market of «smart farm business» is quite huge. The application of IoT-technologies in foreign farm businesses is able to reduce the major expense items by 10-20% and at the same time to increase production rate. According to the calculations of analysts of Grand View Research, in 2017 the market of smart farming in Russia comprised 221.8 mln dollars (a little more than 1.2% in the world market). The potential volume of it is just great. In the country there is a minimum of three-fold reserve for the growth of grain yields in relation to leading countries. The lag in the production rate in the industry is estimated as three times of the one in Germany and 20 times of the one in the USA [9].

For the moment the greatest representatives of the agricultural sector of economics have started to introduce IoT-technologies into their business, as they are absolutely sure that the innovations of such kind will have short payback period and increase yield significantly. But to spread IoT-technologies everywhere, it is necessary to create corresponding infrastructure, and it is not less important to ensure seamless access to it by small and midsized agro-businesses. The basis of the infrastructure of IoT-technologies must compose unique standards of data exchange which will allow uniting agricultural enterprises of different legal organizational forms into single information system, encouraging transition to the next more qualitative level of analysis and estimation of digital data. In this connection it is possible to state that IoT-technologies in agro-sphere are introduced in complex only in some parts and only by the greatest subjects of the agricultural market, oriented towards the breakthrough completion in the industry and possible transition onto a higher level of business struggle, and small and midsized subjects use the above mentioned tools of the Internet of things only with the aim of reducing production expenses. The main barrier, interfering into the speed of IoT-technology introduction into the agro-sphere is a weak link cover of agricultural farmlands, which makes it difficult to transmit information, collected by drones, quickly and reliably for timely managerial decisions. Especially this barrier decrease the efficiency of work of electronic devices while using pilotless aircraft to control the accuracy of sowing seeds and their further treatment by protection means from diseases and pests. The way out of the situation is the use of services of satellite connection, as while working through GSM there is no robust network signal. This kind of service needs extra investment, which small and midsized agro-businesses cannot cope with. So the solution of the present situation is in the attraction of investment resources into the creation of the necessary infrastructure on the part of telecom-operators.

III. Conclusion

Digitalization of the agricultural sector of economics will definitely allow satisfying consumer needs due to the increase of the quality of agricultural production. Mobile IoT-systems will be created as well, which participants will exchange information over the Internet, which will lead to the growth of the production rate and efficiency of all kinds of labour and will reduce expenses at all the stages of the process.

The introduction of IoT-technologies, as the best tool of digitalization of the agriculture, from our point of view, is totally conditioned by the present background in the economic sphere, as the existing and potential information systems are able to analyze a great number of digital data and by this it is possible to increase the efficiency of the agricultural business significantly. The significant growth of the number of agricultural enterprises of different legal organizational forms intensifies competitive struggle among them and as a consequence, the participants face the problems of providing minimum prime cost of the manufactured production, profit increase from the realization thanks to the growth of production volume and sale while preserving and improving the quality of the

manufactured production. That is why the use of IoT-technologies in the agricultural sphere will be able to make all the process of production and realization completely controlled and transparent thanks to the creation of unique information space by the subjects of agro-business. A wide range of digital technologies and tools, tested in different sphere of economic activity, adapted for the agricultural sector, will allow getting multiplicative effect with the high expense at the introduction, but this effect may overreach expenses significantly thanks to the economy of technical maintenance of agricultural engineering, reduction of the number and terms of conduct of repair works of production actives of the agricultural enterprise, growth of energy efficiency of the main production funds, will allow making transport routes and logistic chain optimal, which in the end will result in the increase of the efficiency of activity of the enterprises of the agricultural sector and will ensure them competitive advantages of a high level in domestic and foreign markets.

REFERENCES

[1] A. D. *Fedorov, Information agency «Svetich» Magazine «Russian fields» №5 (160), 2018* M. S. Tokareva. K. O. Vishnevskiy, and L. P. Chikhun "The influence of technologies of the Internet of things on the economics," Business information technologies, №3 (45), pp. 62-78, 2018.

[2] "The Internet of things," Wikipedia. The date of update: 05.03.2019. URL: https://ru.wikipedia.org/?oldid=98468544

[3] Li Da Xu, Wu He, and Shancang Li, "«Internet of things» in the industry: the review of key technologies and trends," Control Engineering Russia, II T, pp. 13-18, 2017.

[4] The program «Digital economy of the Russian Federation» signed by the order of the Government of the RF dated 28.07.2017. №1635-p

[5] Departmental project «Digital agriculture». Resource - http://www.dairynews.ru/news-image/2018/December/20181203/tsifr_s_hozyaystvo.pdf

[6] Why IoT and accurate arable farming agriculture are the future of agriculture. Resource https://aggeek.net/ru-blog/pochemu-iot-i-tochnoe-zemledelie-eto-buduschee-selskogo-hozyajstva

[7] V. Moiseev, "The main forecasts for the Internet of things. – Resource," https://iot.ru/promyshlennost/glavnye-prognozy-dlya-interneta-veshchey

[8] E. A. Skvortsov, E. G. Skvortsova, I. S. Sandu, and G. A. Iovlev, "Transition of agriculture to digital, intellectual and robotized technologies," Economy of the region., 2018, T. 14, Issue. 3, pp. 1014-1028, 2018.

[9] «Smart farming»: The review of leading producers and technologies, Resource: http://geoline-tech.com/smartfarm/