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Analysis and forecasting of the availability of sufficient personnel complexities of the digital economy mechanisms in the agrarian sector of the Stavropol territory

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Analysis and forecasting of the availability of sufficient personnel complexities of the digital economy mechanisms in the agrarian sector of the Stavropol territory

R V Kron, T A Gulay, A F Dolgopolova and V V Zakharov

Stavropol State Agrarian University, Stavropol, 355012, Russia

Abstract. The need to transfer agricultural production to the digital economy is obvious. One of the main factors constraining the mechanisms for introducing digital technologies into agricultural production is the insufficient availability of specialists with the necessary qualifications in the IT sphere in the area of processes and production. The main, in our opinion, criteria that allow us to predict the demand for labour resources with the necessary qualifications have been considered; typical problems of training in the framework of the current education system, associated with insufficient from the point of view of the digital economy, elaboration and specification of Educational Standards and qualification requirements for graduates who were educated by the time of transition to digital production mechanisms have been identified. The possible difficulties of the state of the labour market associated with the reduction of jobs as a result of the intensification and automation of a number of industries using the digital economy and buffer measures of pension legislation have been noted. Options for mitigating the effects of the problems presented by creating a specialized educational structure based on short-term, highly specialized courses, allowing in a short time, depending on the existing skill level of the worker, to bring his knowledge, skills, abilities and competencies in line with the level required for successful work in the framework of digital economy mechanisms have been offered.

1. Introduction
Since July 2017, the Russian economy has been applying digital technologies. The results of the impact of the order No. 1632-p [Lin 1] have not yet changed the economic, production, cultural-social and other spheres, but, according to the opinions of a large number of experts, they should do it within the stated time frame. The transfer to digital economy should affect all areas of business and the life of the Russian population, and within this article we have analyzed a number of points related to the implementation of order No. 1632-p in the agricultural sector of production using the Stavropol Territory as an example. According to Igor Kozubenko, Director of the Department of Development and Management of State Information Resources of the Agricultural Sector of the Ministry of Agriculture of Russia [1], the ICT market in agriculture is projected to increase at least three times, which will help to reduce production costs by about 23% by optimizing production and storage. On the other hand, almost all experts are forced to immediately note a number of negative factors that thwart, and often block, the victorious step of the digital economy in the agricultural sector. This and the lack of ready-made integrated solutions that would provide automation and transparency of all processes, the lack of technical solutions and Russian-manufactured products, the poor state of the infrastructure for storage and data exchange, and much more. Some of the main negative unconditionally recognized factors are the low level of preparation for the use of IC technologies by final users and the extremely low saturation of the labour

market in the agricultural sector by IT specialists. According to the estimates of the authors, there is only one IT specialist per thousand specialists employed in the agro-industrial sector, and a total of 12 thousand IT specialists work in the industry [1]. Thus, we are forced to return to the issues of agricultural sector personnel availability as an issue of implementing the objectives of the Government order No. 1632-p in the direction of personnel and education, such as:

- creation of key conditions for digital economy personnel training;
- improvement of the education system, which should provide the digital economy with competent personnel;
- labour market that should rely on the demands of the digital economy;
- creation of the motivation system for the development of necessary competencies and participation of personnel in the development of the digital economy of Russia.

2. Task
A number of publications analyzed the state, complexity and prospects for the preparation and accumulation of human resources in general [2] and in relation to the IT sector of the economy, production, services and education [3]. All authors drew attention to Russia's significant potential in terms of educating the intellectual elite, but they also noticed the various difficulties and shortcomings of the existing education system. There are some especially noted:

- low share of IT specialists in the total number of trained specialists;
- limited list of areas of IT training for all levels of education;
- presence of deliberately outdated among the training directions;
- lack of training directions aimed directly at ensuring the digital economy in general and in the agricultural sector in particular.

**Table 1.** ICT specialists engaged in the economy by 2016 [4]

	Thousands of people	As percentage of total
Total	1050	100
Specialists of the highest level of qualification	829	79.0
Software and application developers and analytics	603	57.4
Database and network specialists	226	21.6
Specialists of the middle level of qualification	221	21.0
ICT service technicians and ICT user support specialists	145	13.8
Telecommunications and broadcasting technicians	76	7.2
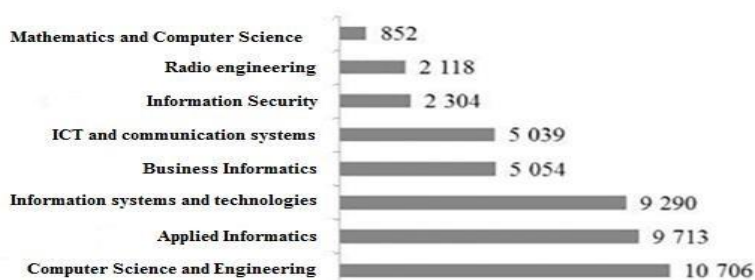
Figure 1. Graduates of the main areas of training and specialties in the field of ICT in 2016, pers.

This is not a complete list of problematic issues; some of them have also been touched on during the consideration of the problem. The typical picture developed in the ICT specialists training system at the end of the period preceding the "transition to the digit" is most clearly demonstrated by the statistical materials presented by the Higher School of Economics [4]:

At the same time, the share of Bachelors, Masters and Specialists does not exceed 4% of the total number of graduates, and mid-level specialists 6.6% [3]. The same authors proposed a mechanism to ensure the compliance of scientific personnel with the needs of the digital economy.
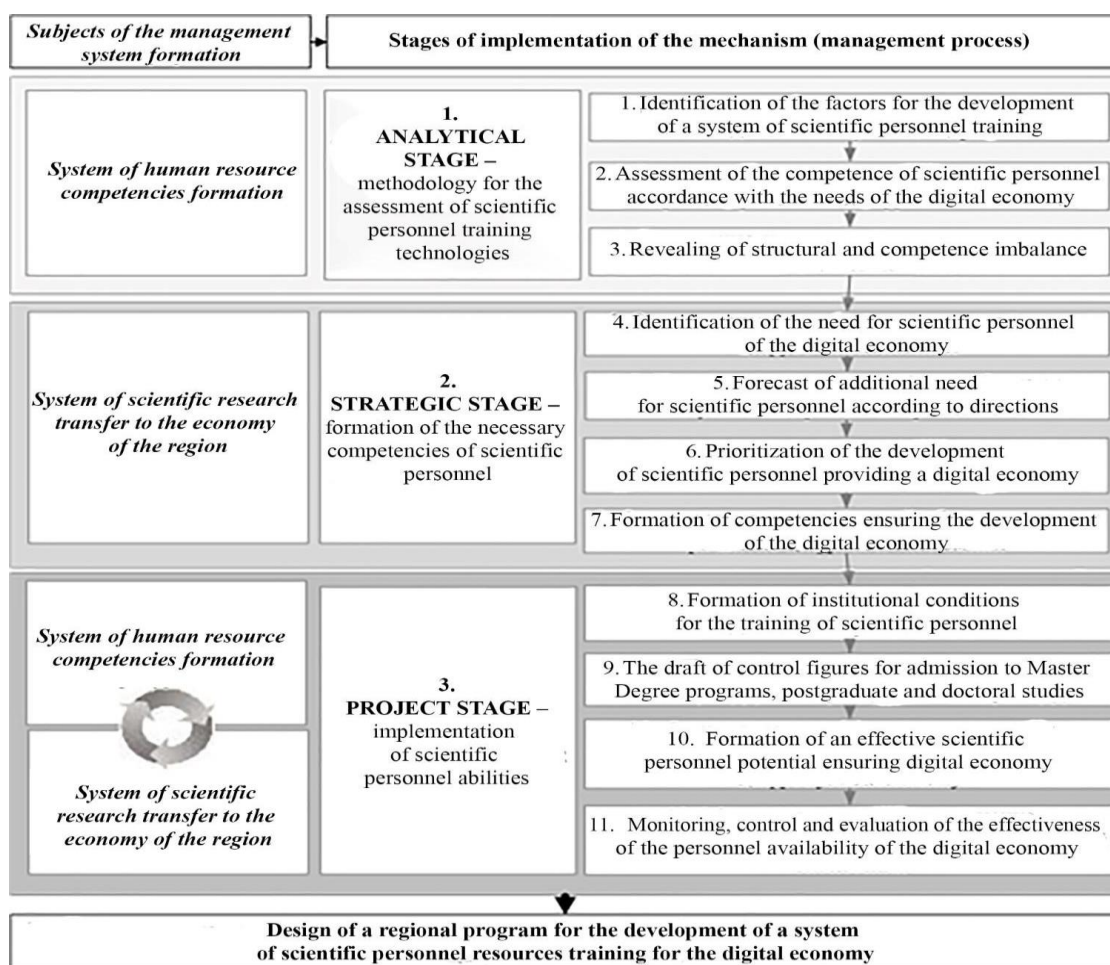
Figure 2. Mechanism to ensure that scientific personnel's training meets the needs of the digital economy [4].

The mechanism is undoubtedly viable and meets the tasks assigned to it, but its implementation is recurrent and designed for a long period of implementation and adaptation. The agricultural sector, as the least saturated with ICT specialists, requires personnel not sometime in the future, but now.

Unfortunately, the new realities of the demand of specialists do not allow to fully use the statistically accumulated experience in the formation, rotation and recruitment of personnel in agricultural production, which does not allow building a correct model for providing the digital economy with personnel for the digital agro-industrial complex without additional research, but it is possible to identify the key points on which the prognostic analysis of the demand for personnel in the agro-industrial sector should be based in the short, medium and long term.

3. Development of methodology

The current and prospective assessment of the demand for IT specialists in the agricultural production of the Stavropol Territory has been carried out. According to S.D. Ridny, Deputy Minister of Agriculture of the Stavropol Territory, expressed during the report at the plenary session of the 1st International Scientific and Practical Conference "Digital Technologies in Agriculture: Current State and Development Prospects" [5], the current employment of ICT specialists at workplaces in the agricultural production of the region even within the framework of already implemented and ongoing projects of the digital economy does not exceed 60%. A similar situation is observed in other regions of Russia: at the moment, about 113 thousand IT specialists are involved in the digital economy, and the current shortage is more than 90 thousand people.

What are the future needs of the region in the relevant personnel and the possibility of using the existing personnel reserve? Agrarians of the Stavropol Territory see the mechanisms of precision farming as the main (but not the only) area of implementation of digital mechanisms in agricultural production. According to expert estimates, the mechanisms already implemented with full-scale implementation and support will increase economic efficiency and reduce costs and losses from 20 to 40%, which is applicable, for example, to the cost of cereal production, it will be possible to achieve a decrease of about 1,500 roubles per ton: from 6,580 roubles per ton to 5,060 roubles per ton in current prices of 2018. Each of the mechanisms of precision farming requires its own specialists, but the relative need is on average the same, so it suffices to consider only the most obvious needs in order to assess the prospects as a whole.

The park of tractors and combine harvesters for various purposes in the Stavropol Territory is approximately 26 thousand units of equipment. Moreover, the equipment to be replaced or upgraded (major repair), i.e. at the age of more than 10 years, about 50% for tractors and 33% for combine harvesters. The ministry accepted the planned annual renewal of the park of vehicles at the level of 2,000 tractors and 667 combine harvesters for various purposes. All new tractors and combine harvesters are equipped with the default equipment used in the implementation of precision farming mechanisms and, as a result, require a trained operator with the basic knowledge in the IT field. In other words, only in this segment more than 2.5 thousand specialists with updated ICT knowledge are required. The situation is similar in the system of land use, cadastral registration and monitoring of land, agro biology and plant protection. Thus, the annual required inflow of specialists is approximately estimated at 3–3.6 thousand people. What is the existing workforce capacity in the framework of the existing specialists of the agricultural sector of the Stavropol Territory? It can be estimated approximately, analyzing the age characteristics of workers. The figure shows a diagram representing the gradation of workers by age in the context of the administrative units of the Stavropol Territory [5]:
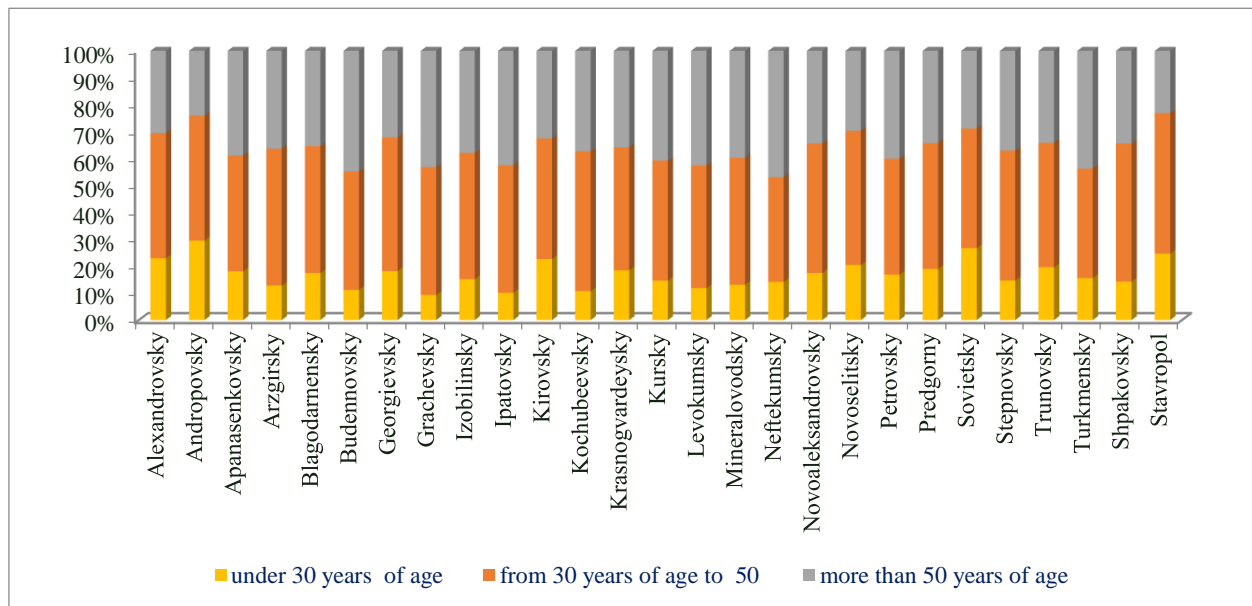
Figure 3. The age of people allowed driving self-propelled machines [5].

Obviously, within the framework of an even distribution in each of the age categories, those of workers over the age of 35 are about 55-57%. Why was this age chosen as liminal? There are several reasons:

- completion of training in the specialty before 2003-2005, i.e. lack of necessary ICT disciplines in educational programs;
- obsolescence of acquired knowledge and skills;
- psychological reluctance of changes in working activities.

Thus, in an optimistic forecast, only a little more than 40% of the specialists involved are ready to immediately start implementing the mechanisms of digital production with minimal labour and time. But, it is this contingent that is currently used to work on modern equipment and cannot be taken into account in the long-term planning of the improvement of personnel in any significant amount.

The main alma mater of the agrarian sector in the region and nearby territories is Stavropol State Agrarian University. It has been preparing graduates in all the required areas of implementation of the mechanisms of the digital agrarian economy: agro engineers, maintenance and cadastre specialists, ecologists, agrobiologists, livestock specialists, veterinarians, specialists in the production of various types of agricultural products. Separately, it is worth noting the presence of areas of training more widely demanded in the framework of the digital economy: Business Informatics, Applied Informatics, Information Systems and Technologies, Economic Security. Since 2008, due to the implementation of the national project "Education", laboratories have been deployed on the basis of Stavropol State Agrarian University, covering the whole range of mechanisms for precision farming, monitoring territories, chemical and biological plant protection. Graduates have the necessary skills, knowledge, and competencies demanded in the framework of digital production. Would it seem that the issue is resolved? The average number of graduates in all designated areas each year does not exceed 500 people in all forms of education. Even if 100% of graduates are employed by the received specialty within the region, the stated need for specialists will be covered by no more than 20%.

The availability of specialized laboratories allowed Stavropol State Agrarian University to maximally adapt curricula and programs in all directions of training to the needs of the digital economy and significantly improve both the quality of graduate training and their demand in the labour market. And what would the situation look like with a standard approach to training in these directions within the framework of the Educational Standards of the 3 and 3+ generations?

4. Analysis of some Educational Standards of the 2, 3, 3+ and 3 ++ generations on the graduate's readiness to implement the mechanisms of the digital economy

We will conduct the simplest semantic and meaningful comparative analysis of Educational Standards of different generations on the example of the speciality / direction of training "Agro engineering".

Table 2. Comparison of Educational Standards by generation.

State Educational Standard of Higher Professional Education (Specialist's Degree Program)	Federal State Educational Standard of Higher Professional Education (Bachelor's Degree Program – Standards of 3d generation)	Federal State Educational Standard of Higher Education (Bachelor's Degree Program – Standards of 3+)	Federal State Educational Standard of Higher Education (Bachelor's Degree Program – Standards of 3++)
Requirements for mandatory minimum content			
yes	yes	No, except for 4 disciplines. Determined by competencies.	No, except for 4 disciplines. Determined by competencies.
Total academic hours of theoretical training			
8262	190-215 credit points (6840 – 7740 academic hours)	201 – 207 credit points (7236 – 7452 academic hours)	Not less than 183 credit points (6583 academic hours)
Requirements for graduate professional training			
embodied	Within the competences of the Standard	Within the competences of the Standard	Within Professional Standards
Qualification requirements (applicable to digital economy mechanisms)			
To solve professional problems an engineer: • develops and participates in the implementation of measures to improve production efficiency, to reduce the consumption of material resources, to reduce labour intensity and energy intensity, increase • productivity; • develops and applies methods and means of technical diagnostics of machines and equipment; • considers rationalization proposals on the improvement of technologies for the production, storage and primary processing of agricultural products and gives conclusions on the • appropriateness of their use;	by type of activity: *industrial and technological activities*: • able to use modern methods of installation, commissioning of machines and installations, maintaining the operating modes of electrified and automated technological processes directly related to biological objects; • able to use technical means to determine the parameters of technological processes and product quality; *organizational and management activities*: • able to analyze the process as an object of control and management; • ready to systematize and summarize information on the formation and use of enterprise resources;	by type of activity: *research activities*: • ready to study and use scientific and technical information, domestic and foreign experience on research topics (PC • (professional competence) -1); • ready to participate in the research of workers and technological processes of machines (PC -2); • ready to process experimental data • (PC -3); *project activity*: • capable of collecting and analyzing source data for the calculation and design (PC -4); • ready to participate in the design of technical means and technological processes of production, electrification systems and automation of agricultural objects (PC -5);	• Planning, organization and control of the operation of agricultural machinery • Planning of mechanized agricultural work, maintenance and repair of agricultural machinery • Organization of operation of agricultural machinery • Organization of work to improve the efficiency of operation of agricultural machinery
• participates in scientific research or technical development; • designs testing facilities and conducts benchmark trials and field tests of machines and equipment in terms of reliability, environmental and technical safety;	*research activities:* • ready to study and use scientific and technical information, domestic and foreign • experience on research topics; • ready to process experimental data; *project activity*:	• able to use information technology in the design of machines and the organization of their work (PC -6); • ready to participate in the design of new equipment and technology • (PC -7); *industrial and technological activities*: • able to use modern methods of installation, commissioning of	

• participates in the implementation of the developed technical solutions and projects;
• studies special literature and other scientific and technical information, achievements of domestic and foreign science and technology in the field of agro engineering;
• studies and analyzes the technical data, indicators and results of the work of electrified and automated equipment;
• carries out calculations to determine the optimal modes of agricultural technological processes;

• capable of collecting and analyzing source data for the calculation and design;
• ready to participate in the design of technical means and technological processes of production, electrification systems and automation of agricultural objects;
• able to use information technology in the design of machines and the organization of their work;
• ready to participate in the design of new equipment and technology.

machines and installations, maintaining the operating modes of electrified and automated technological processes directly related to biological objects (PC 10);
• able to use technical means to determine the parameters of technological processes and
• product quality (PC -11);
organizational and management activities:
• able to analyze the process and evaluate the results of the work (PC - 13);
• ready to systematize and summarize information on the formation and use of enterprise resources (PC -15).

The presented set of qualifying requirements presents requirements that, with appropriate interpretation, can be considered the basis for admission to the work of a specialist in the framework of narrow-profile tasks of the digital economy. For comparison, no qualification requirements were used to ensure an adequate level of knowledge, skills, abilities and competencies for the performance of current professional duties within the framework of qualification. Conspicuously, none of the generations of Educational Standards in this area is focused on the training of specialists who meet the requirements of the digital economy. The disparate qualification requirements are not able to provide high-quality training for an integral, versatile specialist who can accompany a digital project from the design stage to the practical implementation, accumulation and analysis of results, summarizing the experience gained and optimizing the business process.

The vague wording of professional competencies, on the one hand, leaves creative scope for the educational activities of curriculum and disciplines' teaching materials to developers, and on the other hand, they make students hostages of a personified vision of filling the discipline with a specific teacher.

Separately, it should be noted that to date, about half of the Professional Standards of the 3 ++ generation have not yet been approved and it's at least premature to talk about their content and compliance with the principles of the digital economy. The same Professional Standards that have passed the approval procedure were developed almost simultaneously with the legal development of the concept of the digital economy and also cannot be fully oriented towards the optimal preparation of a digital specialist.

5. Number of jobs, pension reform and optimization of cadre personnel

Many experts analyzing trends in the development of robotics, automated control systems and production, continuous upward intensification of processes, unanimously agree that the mechanisms of the digital economy and general production trends in agriculture will inevitably lead to a global reduction in jobs [6]. Even taking into account the fact that Russia is far from being a leader in the processes of intensification and automation of agricultural production, over the past 10-12 years, the number of workers involved in agricultural production has decreased by more than 2 times without a significant decrease in the volume of production. According to the same source, it is theoretically possible to replace about 58% of the people working in the agrarian industry with corresponding robotized complexes. The only exceptions are jobs with a creative component and managerial positions, implying the possibility of a quick response to non-standard situations.

Another unpleasant nuance for the process of saturating agriculture with highly skilled personnel with training for functioning within the digital economy is, oddly enough, an increase in the retirement

age and a moratorium on the dismissal of employees of pre-retirement age under the threat of criminal prosecution of business leaders. Fixed, and as noted above, it is possible that a decreasing number of jobs along with pension reform may become a barrier to the employment of young professionals for the next 4-6 years.

6. Results
Evaluating the above, several conclusions can be drawn:

- accelerated introduction of digital economy mechanisms is currently not provided with personnel;
- most of the specialists working in agriculture do not have a sufficient level of training in the IT field to function effectively within the digital economy;
- the total number of IT specialists in the agricultural sector is clearly not enough;
- classic forms of training specialists of the agricultural sector are not able to saturate the labour market in the short term;
- no statistical material has been developed that allows to correct the content and teaching methods in order to qualitatively improve the training of graduates in the digital economy;
- active development of new mechanisms, business processes and algorithms of the digital economy will constantly update the requirements of both content and level of training of specialists.

7. Discussion
How do we see the solution to the situation? The most easily implemented we see the creation of a system of advanced training (72 academic hours), additional training (up to 200 academic hours) or retraining (from 648 academic hours) of specialists already involved in the system of agricultural production. It is these highly specialized courses, selected according to previously existing qualifications that in their spare time from seasonal work are capable of:

- in a short time to saturate agriculture with necessary personnel;
- test and optimize the content and methods of teaching disciplines that lead students to meet the requirements of workplaces within the framework of digital production;
- ensure the continuity of the educational process and increase the adaptablity of the specialist in the context of improving business processes without interrupting their core business;
- ensure the demand for professionals who have lost their jobs as a result of the reduction or reorganization of production;
- give time for the adaptation of curricula, teaching materials for disciplines of the state educational system in accordance with the requirements of the order of the Government of the Russian Federation No. 1632-p; □ give time to create an integrated system of functioning of the digital economy in the agricultural sector.

8. Conclusion
Effective management methods based on consolidated access and processing of global data sets with the goal of total optimization of all existing production, work and performance management mechanisms is the main goal of digitization of the economy in the agricultural sector. Obviously, there will always be a real, rather than a digital product, but it is digital technologies implemented and used by high-class specialists that will ensure the food security of our country, transfer agriculture to the rails of the most profitable industries, and ensure the attractiveness of labour in the agrarian sphere to young professionals.

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