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# FORMATION OF THE PERSONNEL POTENTIAL OF THE DIGITAL TRANSFORMATION OF THE AGRICULTURE IN RUSSIA

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***Abstract***

*Currently, real competitive advantages in the market are acquired by agricultural enterprises that introduce and develop modern digital technologies. At the same time, for the effective implementation of the digitalization process, it is necessary to complete the staff of enterprises with the appropriate number of specialists. The theoretical foundations of training and employment of IT specialists, as well as methods of managing IT personnel in the agro-industrial complex are considered. The current state of the training of information technology specialists in Russia is analyzed. The situation with the training of students in leading universities is considered in detail. The regularities reflecting the annual volatility of the number of applicants with a general trend of moderate growth are revealed, the forecast of preservation of the corresponding parameters of human capital development is made, the attractiveness of vacancies in the agricultural sector is determined on the basis of a retrospective analysis of indicators characterizing the formation of personnel potential in the IT sphere. A set of measures to improve the provision of the agricultural sector with highly qualified IT specialists is proposed.*

***Key words***: *digitalization, agriculture, personnel training, Russia*

## INTRODUCTION

At the present stage of the development of the world economy, those agricultural companies have significant advantages in which modern technologies are fully applied, and not only production, but also business management. The stability of the company and high competitiveness today are possible only under the condition of the active use of innovations, digital tools and technologies that ensure the constant relevance of information about the status of all processes and allow making effective management decisions when planning and organizing activities, monitoring performance, analyzing the results [25]. In the near future, companies that integrate their business into a single system based on a digital platform will take the leading positions in the market.

For these reasons, digital management systems are already becoming more and more popular, which belong to a special class of industry software products focused on working in agribusiness [7]. The head of the agricultural enterprise has a real opportunity to control the entire production cycle in the crop and livestock sectors through the use of smart devices that transmit and process operational information about the current parameters of each object (equipment and sensors that determine the state of soil, plants, animals, microclimate), as well as seamless channels communication between them and external partners [21]. Incorporation of objects into a single network, dispatching and aggregation of data streams based on the Internet of Things, the increased productive capacity of computers, improvement of software and cloud platforms make it possible to design and automate accurate business processes by developing a digital model of the entire production cycle and interconnected links in the value chain, with mathematical accuracy to plan a work schedule, emergency measures to prevent losses in the event of an identified threat, to predict the result [12]. Most of these digital control systems are browser-based or cross-platform applications installed on computers or mobile devices. As a result, their use presupposes the presence of personnel with relevant knowledge in the field of Big Data, Data Science, mathematics, analytics, robotics and skills in working with digital devices.

The study of modern processes of digitalization of the economy and the integration of information technologies with real processes in it scientists began in the mid-90s of the last century. Don Tapscott [31] was the author of the first cited work in 1994, which interprets the term “digital economy”. Neal Lane, exploring various aspects of the formation of the digital economy, focuses on e-commerce and the impact of information technology on privacy, standards, innovation and the digital divide [17]. Collaboration of Eric Brynjolfsson and Brian Kahin led to the publication of their joint work, in which the authors noted that the term "digital economy" is applicable only to the currently observed transformation of various sectors of the economy based on the intellectualization of processes through the spread of IT technologies [6]. The key components of the digital economy were first identified by Lynn Margherio [18], which served as the foundation for further research, which resulted in the publication of a joint work by Rob Kling and Roberta Lamb [13]. The authors defined the digital economy as a combination of four components: “Digital products and services. Mixed digital products and services. Services and production of IT-dependent goods. A segment of the IT industry that serves the three segments of the digital economy under consideration. " In turn, Thomas Mesenbourg talks about the bifurcation of the digital economy to the products of IT infrastructure and the use of information technology in order to implement business processes [20].

Currently, world scientists continue to work on the study and improvement of the digitalization mechanism of various branches of the agro-industrial complex, investigate the role of science and obstacles in the development of digital agriculture [30], new methods of managing the agro-industrial complex in the context of digitalization [22], interaction between the state and business during digital transformation [11] and digitalization as a tool to overcome the consequences of the pandemic [29]. In addition, specific digitalization tools are considered: the creation of a single digital platform in the agro-industrial complex [19], the introduction of fuzzy logic in vegetable growing [4], cloud systems [3], digitalization of various food regimes [28], the design of digital tools [23], UAV in agriculture [14, 32], digital grain platforms [5], monitoring and feedback of agricultural projects [9]. At the same time, active research is underway on the issues of training specialists in digital agriculture [1, 2] and digitalization of educational processes [15, 24].

These initiatives are being actively implemented in practice. A number of recommendations for the development of digitalization were developed by the Food and Agriculture Organization of the United Nations (FAO UN) [8]. Currently, a number of state projects in the field of digitalization of the economy are being implemented in Russia: The Strategy for the Development of the Information Society in the Russian Federation for 2017-2030, the Strategy for Scientific and Technological Development of the Russian Federation, the National Program "Digital Economy of the Russian Federation", the National Technology Initiative (NTI) and the National Science Project. In the field of the agro-industrial complex, the Ministry of Agriculture has been implementing the Departmental Project "Digital Agriculture" [10] since 2020, which includes the following areas:

(1)Creation of a national platform for digital public administration of agriculture "Digital Agriculture" (DSA) (effective hectare, smart contracts, agro-export "from field to port");

(2)Implementation of the "Agro-solutions" module of the national platform of digital public administration to improve the efficiency of the activities of commodity

producers (smart: farm, field, herd, greenhouse, processing, warehouse, agro-office);
(3)Creation of a system of continuous training of specialists of agricultural enterprises in order to form their competencies in the field of the digital economy ("Land of Knowledge" = 55th digital agricultural university).
Thus, it can be noted that a unified approach to understanding the term "digitalization of agriculture" has not yet been formed. For the most part, the digitalization of agribusiness is the result of the inclusion of digital technologies (including the use of local subsystems for managing technological operations) in various elements of the activities of an agricultural organization (production, processing, sale, supply and service) to create consumer value of products, ranging from planning, organization and implementation of the production cycle, and ending with the satisfaction of consumer demand. Also important are the issues of digitalization of public administration processes in all areas of the agro-industrial complex at the state and regional levels [26], [27]. At the same time, effective implementation of new technologies requires an increase in the staff of both developers of "hard" and "soft" products, as well as qualified users and maintenance personnel of the IT infrastructure.

## MATERIALS AND METHODS

In preparing the article, data from the Ministries of Economic Development, Agriculture, Science and Higher Education of the Russian Federation, and the Federal State Statistics Service of Russia were used. Information of higher educational institutions and scientific institutes of the federal and regional level. Works of Russian and foreign scientists on the digitalization of various sectors of the economy and the training of highly qualified personnel, materials of research organizations from around the world. In the study of theoretical and methodological aspects of various organizational and economic aspects of digitalization of enterprises, monographic and logical methods were used. The study of the current state of training of specialists in information technology direction was carried out on the basis of statistical and economic analysis, as well as the method of comparative analysis. The definition of directions for the development of staffing for the digital transformation of the activities of agro-industrial enterprises in Russia was carried out using abstract-logical and computational-constructive methods.

## RESULTS AND DISCUSSIONS

Today, a high level of shortage of IT specialists is recorded in the industry labor market. According to the Ministry of Agriculture, there are half of them in Russia than in other countries with a traditionally developed agricultural sector. The Russian agrarian sector, according to experts, needs about 90 thousand IT specialists [16]. Note that the degree of staff “hunger” does not differ significantly across regions. This is the most important obstacle to the implementation of modern digital solutions in agricultural enterprises, since without experience working with IT technologies it is impossible to fully use the software product, comprehensively revealing its potential, and, therefore, to obtain the expected economic effect. Therefore, modern companies are even forced to attract specialists from related industries who do not have experience in agriculture.
Thus, the transfer to a new technological paradigm associated with the active use of digital technologies inspires the need to solve a whole range of problems in matters of staffing. In particular, universities are faced with the task of training personnel with competencies that are not currently articulated in the current federal educational standards for the areas of training specialists in the agricultural sector. For example, there is no doubt that in the coming years there will be a growing trend in demand for multidisciplinary specialists in the integration of intelligent solutions in agriculture, possessing knowledge in the field of agronomy, fleet management, as well as IT technologies in a broad sense (software developers , specialists in the deployment of hardware, local networks and databases of farms with a mandatory

knowledge of the principles of satellite navigation, data transmission networks, telemetry and the principles of agricultural machines). However, there is still a low adaptive potential of educational programs to the requirements of real production and the peculiarities of the formation of modern professional competencies in the agricultural sector. The process of developing educational standards is quite lengthy and often demonstrates significant inertia against the background of permanently changing economic requirements. As a result, most agricultural universities today lack areas of training related to IT technologies. The situation noted is also determined by the sequestered capabilities of universities due to the lack of the necessary material base and teaching staff. As a result, enterprises are forced to retrain graduates or entice specialists from competitors.

In the last decade, many scientific publications have been devoted to various aspects of the digital transformation of the economy in general and individual industries in particular. However, to date, the prospects of digitalization in the regional agricultural sector have not been studied from the point of view of the correspondence of the existing personnel potential to the necessary. In addition, the data on the number of students in training areas related to the use of information technologies, the prospects for their employment and the eventuality of work in agricultural organizations have not been systematized and studied.

For several years in Russia, the reform of education and the transition to a two-tier Bologna system - bachelor's degree (first 4 years) and master's degree (next additional 2 years) have been progressing, but at the same time, in some areas, the traditional option remains - specialty (5 years). A similar situation is typical for IT specialties, which are gaining popularity every year (Table 1).

If in 2013, 416.6 thousand applications were submitted for these areas of training, then in 2020 it is already 85% more - 770.2 thousand. The competition has grown almost one and a half times, but the total number of students in 7 years has increased only by 2.6%.

This table took into account various areas of student training, in particular, the following areas of undergraduate and graduate programs: applied mathematics and computer science; mathematics and computer science; fundamental informatics and information technology; software and administration of information systems; cartography and geoinformatics; informatics and computer technology; information systems and technologies; Applied Informatics; Information Security; infocommunication technologies and communication systems; mechatronics and robotics; business informatics, etc. Specialty programs: computer security; information security of telecommunication systems; information security of automated systems; information and analytical security systems; infocommunication technologies of a special communication system, etc. To study in detail the situation with the preparation of students, it is necessary to consider the indicators of specific universities. For example, in one of the typical agrarian regions of Russia - the Saratov region - there are a large number of educational institutions and a developed labor market in the information technology and agricultural sectors.

In the Saratov region, specialists in the field of IT technologies are graduated from 2 universities: "Saratov State Technical University named after Y. Gagarin" and "Saratov National Research State University named after N.G. Chernyshevsky ". It should be emphasized that “Saratov State Agrarian University named after N.I. Vavilov”, which is one of the largest higher educational institutions of the country and trains specialists for the agro-industrial complex of the Volga region, does not prepare students for work in the field of IT-format technologies.

Faculty of Computer Science and Information Technologies, SSU n. a. N.G. Chernyshevsky trains programmers capable of working in the field of information security of an agricultural enterprise (creation of a system for protecting information, including personal data of employees, its support and development of measures to prevent the occurrence of information risks associated with information leakage, hacker attacks, etc.), in the field programming (full support of software performance, creation and maintenance of enterprise databases, creation of web sites in the format of trading platforms for the sale of agricultural products), as well as in the direction of system analytics.

Table 1. Indicators of training specialists in higher educational institutions of Russia in IT specialties in 2013–2019

| Years | Indicators | Qualification types | | | Total |
|---|---|---|---|---|---|
| | | Bachelor degree | Specialty | Master's degree | |
| 2013 | Applications submitted | 377,836 | 24,442 | 14,384 | 416,662 |
| | Applications accepted | 66,548 | 2,780 | 9,156 | 78,484 |
| | Competition, people for one place | 5.68 | 8.79 | 1.57 | 5.31 |
| | Number of students in all courses | 191,049 | 92,397 | 13,568 | 297,014 |
| 2014 | Applications submitted | 351,373 | 21,351 | 16,523 | 389,247 |
| | Applications accepted | 61,367 | 2,651 | 8,900 | 72,918 |
| | Competition, people for one place | 5.73 | 8.05 | 1.86 | 5.34 |
| | Number of students in all courses | 221,001 | 38,144 | 16,331 | 275,476 |
| 2015 | Applications submitted | 327,682 | 22,434 | 37,763 | 387,879 |
| | Applications accepted | 60,974 | 2,908 | 15,523 | 79,405 |
| | Competition, people for one place | 5.37 | 7.71 | 2.43 | 4.88 |
| | Number of students in all courses | 222,067 | 19,457 | 23,617 | 265,141 |
| 2016 | Applications submitted | 356,024 | 25,312 | 50,157 | 431,493 |
| | Applications accepted | 56,886 | 3,057 | 17,543 | 77,486 |
| | Competition, people for one place | 6.26 | 8.28 | 2.86 | 5.57 |
| | Number of students in all courses | 214,251 | 12,535 | 31,885 | 258,671 |
| 2017 | Applications submitted | 392,168 | 77,642 | 51,245 | 521,055 |
| | Applications accepted | 59,554 | 21,746 | 18,220 | 99,520 |
| | Competition, people for one place | 6.59 | 3.57 | 2.81 | 5.24 |
| | Number of students in all courses | 209,435 | 14,685 | 35,463 | 259,583 |
| 2018 | Applications submitted | 475,300 | 28,583 | 58,774 | 562,657 |
| | Applications accepted | 66,131 | 3,930 | 18,917 | 88,978 |
| | Competition, people for one place | 7.19 | 7.27 | 3.11 | 6.32 |
| | Number of students in all courses | 215,955 | 15,662 | 37,528 | 269,145 |
| 2019 | Applications submitted | 539,834 | 24,374 | 49,245 | 613,453 |
| | Applications accepted | 71,775 | 4,154 | 15,769 | 91,698 |
| | Competition, people for one place | 7.52 | 5.87 | 3.12 | 6.69 |
| | Number of students in all courses | 227,690 | 16,613 | 38,024 | 282,327 |
| 2020 | Applications submitted | 658,144 | 46,176 | 65,878 | 770,198 |
| | Applications accepted | 76,650 | 4,733 | 18,899 | 100,282 |
| | Competition, people for one place | 8.59 | 9.76 | 3.49 | 7.68 |
| | Number of students in all courses | 247,844 | 18,313 | 38,437 | 304,594 |

Source: Compiled by the authors based on the data of the Ministry of Science and Higher Education of the Russian Federation.

Graduates of the Faculty of Mechanics and Mathematics solve similar problems (audit and monitoring, analysis of information risks). The only exception is the development of an information security system.

After completing their studies at the Faculty of Geography, graduates effectively work with maps (update them via satellites, track the directions of land use, the proportion of abandoned lands, etc.).

SSTU named after Gagarin Yu.A. carries out training of specialists in the field of automated control systems capable of servicing any control system in an agricultural organization (an on-board computer in a tractor, automated feeding, milking, watering, etc.) in terms of functioning, as well as analyzing information from sensors.

The number of students studying at SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. in the above areas of training related to the use of information technology, in dynamics does not decrease (Figure 1).

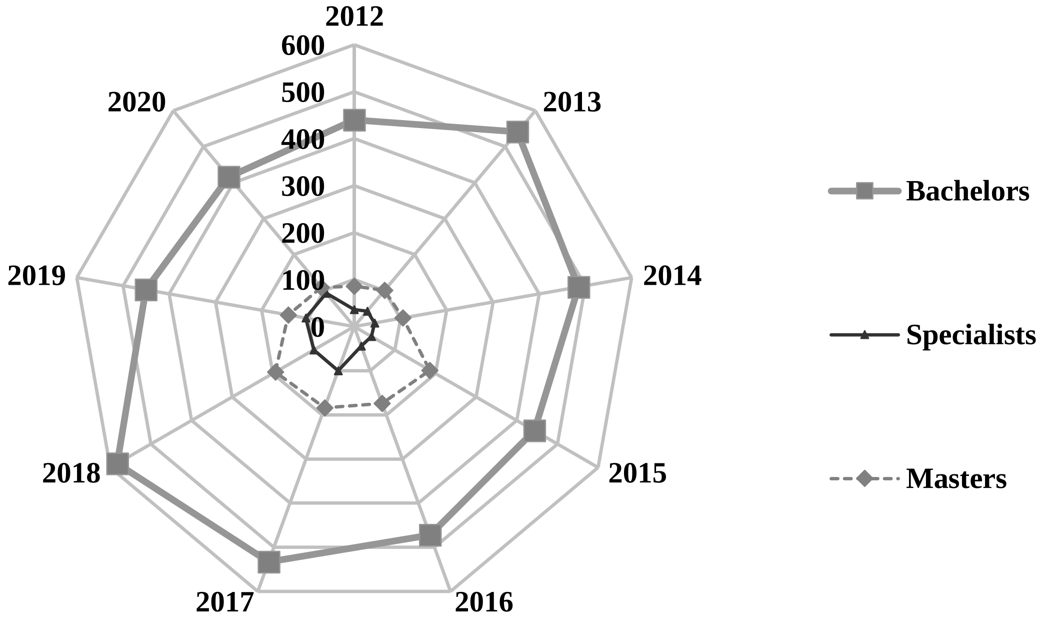


Fig. 1. Dynamics of the number of students of SSU named after N.G. Chernyshevsky and SSTU named after Yu.A. Gagarin, enrolled in areas of training related to the use of information technology, in 2012–2020.
Source: Compiled by the authors based on university data.

The radial diagram shows data grouped by years in the context of higher education levels (bachelors, specialists, masters), which spectacularly indicate a significant fluctuation in the number of students in the areas under consideration over the past 9 years, however, on average, there is a growth trend in the studied indicator.

It should be noted that the insignificant enrollment of students for a specialty in recent years compared to bachelor's and master's degrees was inspired by the transition to a three-level education system. At the moment, the specialty has remained only in those areas of training for which the bachelor's format is impossible.

In addition, in the learning process, some groups of students are subject to unification or, on the contrary, separation. Therefore, in the future, when constructing a model, we will consider the number of young specialists who entered the labor market as a whole, without differentiating them by levels of education and areas of training.

The study made it possible to build an economic and mathematical model in the form of a regression equation, reflecting the forecast of the number of students who will be enrolled in the considered areas of training. Forecast calculations were carried out by the method of mathematical extrapolation of the general development curve (trend), which consists in the continuation of the curve characterizing the previous changes in the economic indicator over time. This allows you to build all kinds of mathematical forecast models presented in Table 2.

Table 2. Simulation of the dynamics of the numerical series of the number of applicants for the IT specialty in Saratov

| Model type | Model equation | Approximation coefficient ($R^2$) |
|---|---|---|
| Linear | $Y = 14.933x + 620$ | $R^2 = 0.1768$ |
| Exponential | $Y = 618.97e^{0.0214x}$ | $R^2 = 0.1858$ |
| Logarithmic | $Y = 72.23\ln(x) + 591{,}93$ | $R^2 = 0.2873$ |
| Polynomial | $Y = -0.9738x^4 + 16.299x^3 - 91.56x^2 + 232.5x + 423.33$ | $R^2 = 0.8906$ |
| Raised to degree | $Y = 593x^{0.1054}$ | $R^2 = 0.3106$ |

Source: Calculated by the authors based on university data.

The main indicator of the quality of the model is the coefficient of determination (R2), which characterizes by what percentage the constructed regression model explains the variation in the values of the resultant variable relative to its average level. Thus, the higher the coefficient of determination, the higher the quality of the model. In this case, the polynomial model of the fourth degree of the form $y = -0.9738x^4 + 16.299x^3 - 91.56x^2 + 232.5x + 423.33$ has the highest quality. Its coefficient of determination is $R^2 = 0.8906$. It was this model that served as the basis for predicting the dynamics of the investigated time series (Figure 2).

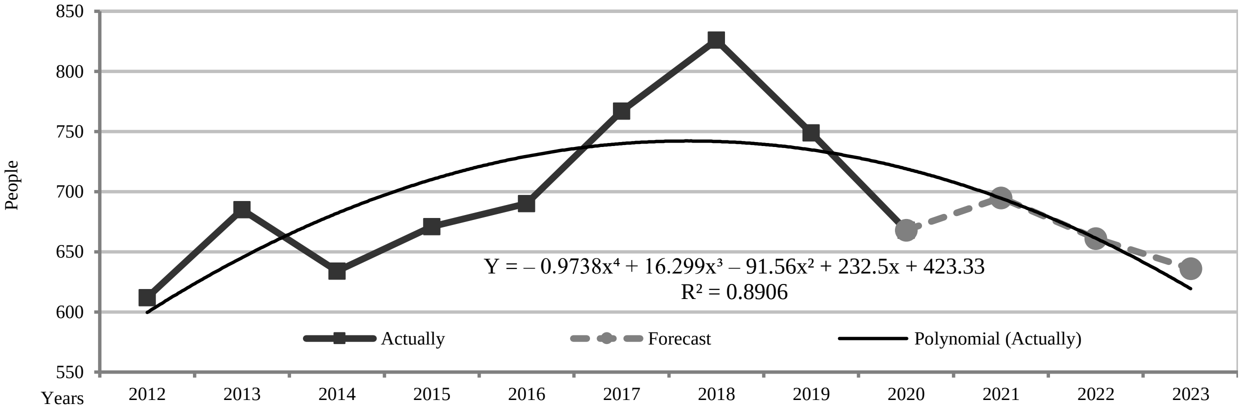


Fig. 2. Dynamics of the actual and projected number of students enrolled in SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. for areas of training related to the use of information technology in 2012–2023
Source: Calculated by the authors based on university data.

According to calculations, the number of students enrolled in the areas of study we are interested in within the framework of this study, in the next 3 years will average from 600 to 660 people per year. A significant increase in this indicator in the near future is not expected, since the number of budget places in such popular and demanded areas, unfortunately, is decreasing, and the curriculum consists of disciplines that can only be mastered by students with a high level of basic training. At the same time, admission to a university on the basis of an agreement on full reimbursement of training costs requires significant financial resources, and therefore is not available to everyone.

Practice shows that boys predominate in the composition of students enrolled in IT-areas (Figure 3).

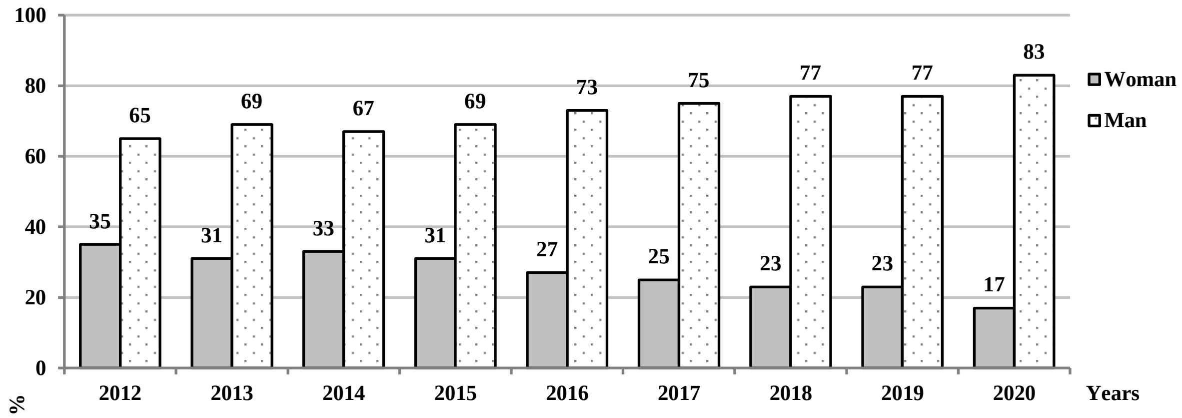


Fig. 3. The structure of students enrolled in SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. in 2012–2020 on the areas of training related to the use of information technology, in the context of sex
Source: Calculated by the authors based on university data.

A particularly noticeable difference is observed in YA Gagarin SSTU: the proportion of girls is from 17 to 24%, depending on the direction. At SSU named after N.G. Chernyshevsky, this figure varies from 42 to 67%.

Analysis of the composition of students who have successfully completed their studies in the areas under consideration, in terms of gender, shows that the proportion of girls in the total number does not practically differ from the same indicator calculated for enrolled students. Therefore, they are successful in their studies (Figure 4). In particular, in 2012, girls accounted for 35 % of the total number of students enrolled and 29 % of the total number of graduates; in 2020, these figures were 17 % and 31 %, respectively. Thus, more boys were expelled during the period of study, which led to an increase in the percentage of girls.

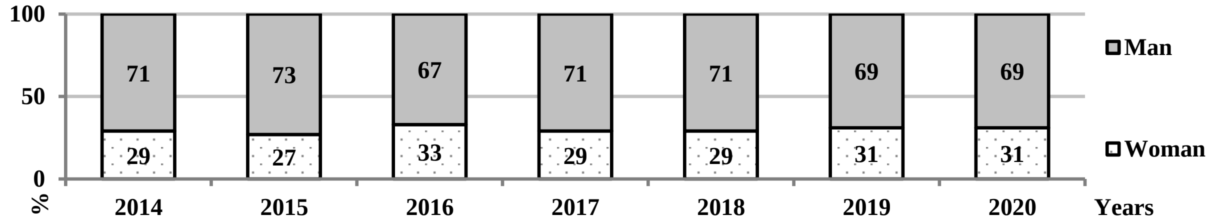


Fig. 4. The structure of students who graduated from SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. in 2015–2020 in areas of training related to the use of information technology, in the context of sex
Source: Calculated by the authors based on university data.

It is also important to note that, according to the results of data analysis, only 71% of the total number of enrolled students successfully complete their studies in the areas of interest (Figure 5).

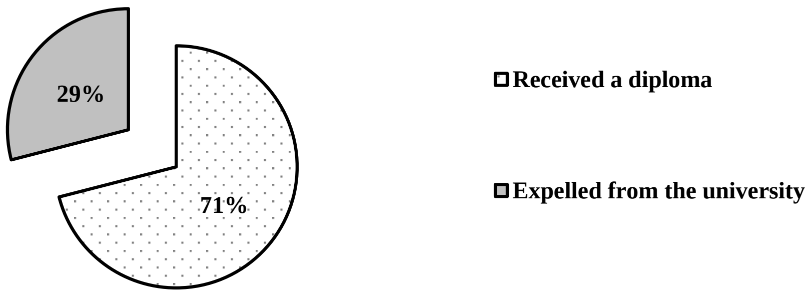


Fig. 5. The share of students who successfully completed their studies at SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. in areas of training related to the use of information technology, on average for 2016-2020
Source: Calculated by the authors based on university data.

The availability of actual data on the number of students enrolled in the studied universities in the period 2017–2020 suggests that about 1,200 people will enter the market of young IT specialists in the next 2–3 years. Already now, they need to be interested in possible employment in the agricultural sector.

Similarly to the predictive model of the number of students who will be enrolled in the IT-areas of training at SSU named after N.G. Chernyshevsky and SSTU named after Y. Gagarin, various models are being built to predict the number of graduates and their assessment (Table 3).

Calculations have shown that the highest quality is also possessed by the polynomial model of the fourth degree of the form $y = -5.9242x^4 + 90.732x^3 - 463.75x^2 + 945.16x - 95.857$. Its coefficient of determination is $R^2 = 0.9583$. The forecast of the number of graduates based on this model is graphically presented in Figure 6.

All specialists in the field of information technology graduating from Saratov universities are in high demand in the market. Most of them find a job while still studying at the university. Unfortunately, they do not consider the agricultural sector of the economy to be a promising area of application of professional competencies acquired during training.

Table 3. Modeling the dynamics of the numerical series of the number of young IT specialists in the city of Saratov

| Model type | Model equation | Approximation coefficient ($R^2$) |
|---|---|---|
| Linear | Y = 45.321x + 433.14 | $R^2 = 0.7162$ |
| Exponential | $Y = 449.49e^{0.0743x}$ | $R^2 = 0.7255$ |
| Logarithmic | Y = 137.31ln(x) + 447.2 | $R^2 = 0.6606$ |
| Polynomial | $Y = – 5,9242x^4 + 90.732x^3 – 463.75x^2 + 945.16x – 95.857$ | $R^2 = 0.9583$ |
| Raised to degree | $Y = 458.34x^{0.2281}$ | $R^2 = 0.6866$ |

Source: Calculated by the authors based on university data.

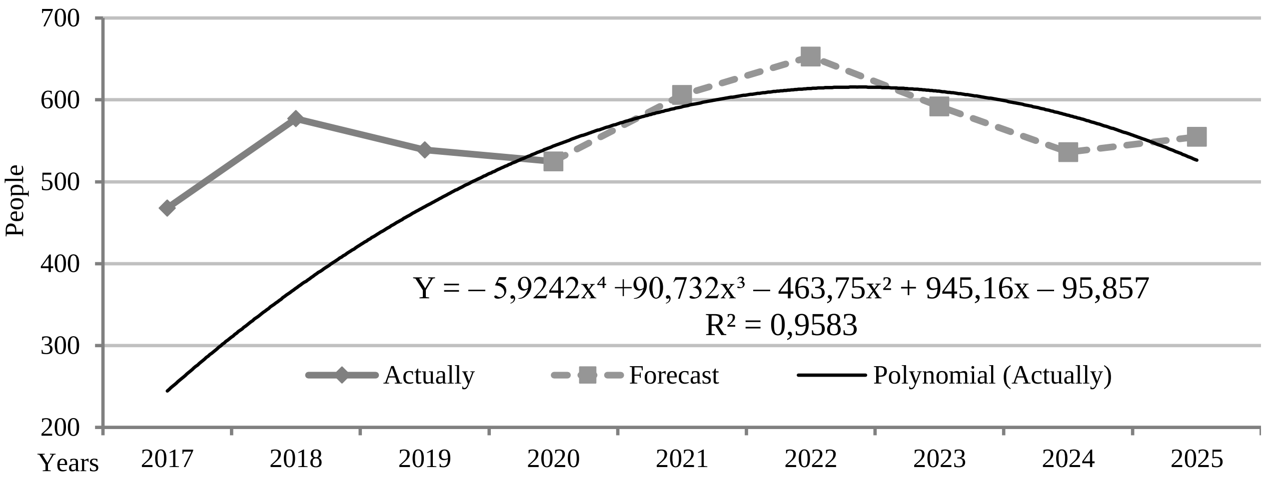


Fig. 6. Dynamics of the actual and projected number of students who successfully graduate from SSU named after N.G. Chernyshevsky and SSTU named after Gagarin Yu.A. in the areas of training related to the use of information technology in 2017-2025
Source: Calculated by the authors based on university data.

Traditionally, energy, raw materials, IT companies, research centers, business structures (banks), security services, government structures have the characteristics that graduates are guided by, namely: stability, predictability of career and professional development, high wages ...

In modern conditions, the task of attracting highly qualified IT specialists to agriculture can be solved by increasing the prestige of labor in the countryside, creating financial conditions and formatting the attitude of the population to this area as a non-technological sector of the economy.

Undoubtedly, male graduates at this stage are more in demand in the agro-industrial complex, since many works are associated with the use of agricultural machinery, GIS technologies, control of fuel consumption, etc. about modern technologies used in this area, directions of their development at the present stage. Their involvement in agriculture is possible at the stage of their coursework or diploma work by setting practice-oriented tasks. According to the results of 2-3 years of study at the university, students are able to create program code, websites, form databases, work with quadrocopters (calculate their trajectory, the weight they can lift, for example, seeds or fertilizers, etc.).

An effective measure of attracting students to the agricultural sector can be their employment on a part-time basis. As a result, agricultural enterprises should establish effective strategic partnerships with universities in terms of:

– resource support of universities (provision of equipment, specialized software);

– creation of joint scientific, educational and innovative structures (scientific and educational laboratories, training centers, basic departments and branches of departments);
– conducting classes at the university by leading specialists of enterprises (reading special courses and electives, consulting in the preparation of course and diploma projects);
– participation in the work of state certification commissions,
– organization of educational, research, industrial, including pre-diploma practice, internships;
– holding various kinds of competitions of student works;
– participation in design and research activities.

A very effective form of cooperation between the university and an agricultural enterprise is the organization of additional targeted training of students, the selection of which takes place on a competitive basis following the results of two to three years of study. Students who have passed the selection procedure are registered as employees of the enterprise. Their task is to study in the afternoon specific disciplines included in a specially formed program. At the same time, students are not exempt from the main educational program of study.

At the same time, female students cannot be ignored. The persisting low level of wages in the countryside and the lack of infrastructure make this area unattractive for the employment of young specialists in the field of IT-technologies. Meanwhile, girls with a higher education in computer science and information technology, but who are on maternity leave or parental leave, can be attracted by this employment option if it involves performing a number of jobs remotely (in particular, creating a database or updating website of the organization).

It should be noted that another possible solution to the personnel issue in the countryside is the development of outsourcing. One IT specialist will perform work for several enterprises, while the management does not need to register an employee on the staff, which will reduce costs and costs.

Among the measures to increase the human resources of agriculture in the context of the digital transformation of the industry, it is also necessary to indicate:
– training of employees of agricultural enterprises on the job (both full-time and remote format in the form of online webinars).
In the educational process, situations that employees regularly encounter in practice are considered and analyzed, which makes it possible to provide an understanding of the essence of the processes;
– the creation of advanced training and professional retraining courses at agricultural universities, within which cycles of seminars and webinars for employees of agricultural organizations on the implementation of digital technologies can be held.

In both cases, it is possible to attract specialists from companies developing industry digital products, which can significantly increase the efficiency of training due to a detailed consideration of the features of a software product or technology.

## CONCLUSIONS

As a result, it can be noted that currently in Russia there are active processes of digitalization of various sectors of the economy. The agro-industrial complex does not lag behind other industries, where projects for the development of information technology have been developed and are being implemented in recent years.

However, today the level of use of information technologies in agriculture in Russia is very low and is mainly reduced to the use of computers and general-purpose software for accounting and fixing commercial transactions. Some commodity producers use digital technologies, but mainly for monitoring the condition of fields, crops and animals. With the help of special software, control over some links of the agricultural process is carried out. Long production cycle, exposure to natural risks, seasonality of work, crop losses during harvesting and storage largely predetermined the restrained, but much needed progress in increasing labor productivity and introducing innovations. There is an urgent need for digitalization of all areas of activity of agricultural enterprises, which is due not only to the need to improve the quality and efficiency of production management, but also to increase investment attractiveness. At the same time, one of the obstacles to the widespread use of IT in agriculture is the lack of qualified personnel, the main reason for which is the low attractiveness of working in the countryside.

At the same time, the country is witnessing an increase in the popularity of professions in the IT field, as evidenced by the rates of enrollment in universities. Over the past 7 years, the competition for IT specialties has significantly increased, while the number of training places is almost not growing. The considered experience of work of 2 largest universities of one of the leading agricultural regions of the country - the Saratov region - testifies to the preservation of all-Russian trends at the regional level. From year to year, there are fluctuations in the number of students in information technology areas of training with a general trend of slight growth.

At the same time, measures are required to develop the involvement of specialists in the agricultural sector and to popularize work in the countryside. The main objectives of the training should be the formation and development of users' technical skills for working with the interface of an agricultural digital system, a detailed study of related applied specific technologies (for example, determining the size of a land plot and classifying crops in the context of agricultural crops using drones and computer vision, differentiated seed application and fertilizers, installation of sensors for measuring moisture and temperature of soil and air, the level of solar insolation, the amount of precipitation). In agricultural universities, which almost never train IT specialists, it is necessary to work towards the technological updating of educational programs in specialized disciplines. It is also possible to ensure that lectures and practical classes on digital agricultural technologies are included in the educational programs of other specialties, which will make it possible to form the necessary set of modern competencies among potential agribusiness workers even in the process of university studies. In order to ensure the visibility of all the processes under study, it would be advisable to use real functioning IT systems deployed in educational and experimental facilities of universities.

Thus, it is necessary to establish effective cooperation between the methodological councils of universities and the management of large industrial enterprises in the process of forming a register of relevant professional competencies in order to adjust student training programs in accordance with the needs of enterprises. In addition, it is advisable to carry out regular monitoring of the needs of the regional economy in industry specialists who possess digital technologies.

The implementation of these measures, ultimately, will allow attracting the necessary number of specialists to the agricultural sector of the regions for the development, implementation and operation of digital production and management systems. And the development of digitalization of all spheres of activity of agricultural enterprises will create the preconditions for increasing efficiency and competitiveness in the international market of Russian agricultural and food products.

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