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SOCIAL IMPLICATIONS OF IMPLEMENTING ARTIFICIAL INTELLIGENCE IN THE RUSSIAN AGRICULTURE

РЕСЕЙ АУЫЛ ШАРУАШЫЛЫҒЫНА ЖАСАНДЫ ИНТЕЛЛЕКТТІ ЕНГІЗУДІҢ ӘЛЕУМЕТТІК САЛДАРЫ

СОЦИАЛЬНЫЕ ПОСЛЕДСТВИЯ ВНЕДРЕНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В РОССИЙСКОМ СЕЛЬСКОМ ХОЗЯЙСТВЕ

Abstract. *The purpose of the study is to analyze the necessary conditions for the successful application of artificial intelligence in the digitalization of agriculture. On the example of the list of the most significant developments of artificial intelligence offered by the market in the industry, these conditions and the problems of their successful application are analyzed, since the intensity and coverage of the directions of development of technologies and methods of artificial intelligence turned out to be so great that the introduction of these technologies can radically change not only the economic, but also the social situation. The most important resource for these applications is data, so much attention is paid to the formation of a structured space for them. It is shown that Russian agriculture is not ready for a full-scale digital transformation due to the lack of necessary conditions for the introduction of innovations. For example, 90% of all data at Russian enterprises is recorded on paper or entered manually into Excel, it is impossible to use them for artificial intelligence technologies. It is shown that the solution to this problem can be the formation of a single digital platform for managing the economy, consisting of two specialized subplatforms: an aggregator subplatform for collecting and accumulating primary information and an applied subplatform for production management tasks. At the same time, the widespread introduction of a single digital control platform in any production leads to a more efficient system for applying artificial intelligence technologies. It is shown that the applications of these technologies must undergo integration transformations into the standards of the proposed unified digital platform for agricultural management, obtained by mathematical modeling. The used original model for the formation of a digital platform for agricultural management is based on the experience of informatization of agro-industrial enterprises of the Kuban with the introduction of artificial intelligence elements in the cultivation of tomatoes and sugar beets. This digital control platform will become an integrator of scientific and industrial information systems. And artificial intelligence technologies in this case will determine the structure of IT specialists, restructure education at universities, significantly increase the efficiency of digitalization of agriculture, and lead to a significant reduction in environmental hazards throughout the agro-industrial complex.*
Keywords: *Artificial intelligence; digital economy; agriculture; human capital, mathematical modeling.*

Аңдатпа. *Зерттеудің мақсаты – ауыл шаруашылығын цифрландыруда жасанды интеллектті сәтті қолдану үшін қажетті жағдайларға талдау жасау. Салада нарық ұсынатын жасанды интеллекттің ең маңызды әзірлемелерінің мысалында осы жағдайлар мен оларды сәтті қолдану мәселелері талданады, өйткені жасанды интеллекттің технологиялары мен әдістерін дамыту бағыттарының қарқындылығы мен қамтылуында интеллекттің рөлі соншалықты үлкен болып шықты, бұл технологияларды енгізу экономикалық жағдайды ғана емес, әлеуметтік жағдайды да түбегейлі өзгерте алады. Бұл қосымшалар үшін ең маңызды ресурс - бұл деректер, сондықтан олар үшін құрылымдық кеңістікті қалыптастыруға көп көңіл бөлінеді. Ресейлік ауыл шаруашылығы инновацияларды енгізу үшін қажетті жағдайлардың болмауына байланысты толық ауқымды цифрлық трансформацияға дайын емес екендігі көрсетілген. Мысалы, ресейлік кәсіпорындардағы барлық деректердің 90 %-ы қағазға жазылады немесе Excel-ге қолмен енгізі-*

леді, оларды жасанды интеллект технологиялары үшін пайдалану мүмкін емес. Бұл мәселенің шешімі екі мамандандырылған қосалқы платформадан тұратын экономиканы басқарудың бірыңғай цифрлық платформасын қалыптастыру болуы мүмкін екендігі көрсетілген: бастапқы ақпаратты жинауға және жинақтауға арналған агрегаторлық қосалқы платформа және өндірісті басқару міндеттері үшін қолданбалы қосалқы платформа. Сонымен қатар, кез келген өндірісте бірыңғай цифрлық басқару платформасын кеңінен енгізу жасанды интеллект технологияларын қолданудың тиімді жүйесіне әкеледі. Бұл технологиялардың қосымшалары математикалық модельдеу арқылы алынған ауыл шаруашылығын басқарудың бірыңғай цифрлық платформасының стандарттарына интеграциялық түрлендірулерден өтуі керек екендігі көрсетілген. Ауыл шаруашылығын басқарудың цифрлық платформасын қалыптастырудың пайдаланылған түпнұсқа моделі қызанақ пен қант қызылшасын өсіру кезінде жасанды интеллект элементтерін енгізе отырып, Кубаньнің агроөнеркәсіптік кәсіпорындарын ақпараттандыру тәжірибесіне негізделген. Бұл цифрлық басқару платформасы ғылыми және өндірістік ақпараттық жүйелердің интеграторы болады. Бұл жағдайда жасанды интеллект технологиялары АТ мамандарының құрылымын анықтайды, университеттерде білім беруді қалпына келтіреді, ауыл шаруашылығын цифрландырудың тиімділігін едәуір арттырады және барлық агроөнеркәсіптік кешендерде экологиялық қауіптің айтарлықтай төмендеуіне әкеледі.

Түйін сөздер. *Жасанды интеллект; цифрлық экономика; ауыл шаруашылығы; адами капитал, математикалық модельдеу.*

Аннотация. *Цель исследования – проанализировать необходимые условия для успешного применения искусственного интеллекта при цифровизации сельского хозяйства. На примере перечня наиболее значимых разработок искусственного интеллекта, предлагаемых рынком в отрасли, анализируются эти условия и проблемы их успешного применения, поскольку интенсивность и охват направлений развития технологий и методов искусственного интеллекта интеллект оказался настолько велик, что внедрение этих технологий может радикально изменить не только экономическую, но и социальную ситуацию. Важнейшим ресурсом для этих приложений являются данные, поэтому формированию структурированного пространства для них уделяется большое внимание. Показано, что российское сельское хозяйство не готово к полномасштабной цифровой трансформации из-за отсутствия необходимых условий для внедрения инноваций. Например, 90 % всех данных на российских предприятиях записываются на бумаге или вводятся вручную в Excel, использовать их для технологий искусственного интеллекта невозможно. Показано, что решением данной проблемы может стать формирование единой цифровой платформы управления экономикой, состоящей из двух специализированных субплатформ: агрегаторной субплатформы для сбора и накопления первичной информации и прикладной субплатформы для задач управления производством. При этом повсеместное внедрение единой цифровой платформы управления на любом производстве приводит к более эффективной системе применения технологий искусственного интеллекта. Показано, что приложения этих технологий должны пройти интеграционные преобразования в стандарты предлагаемой единой цифровой платформы управления сельским хозяйством, полученные путем математического моделирования. Используемая оригинальная модель формирования цифровой платформы управления сельским хозяйством основана на опыте информатизации агропромышленных предприятий Кубани с внедрением элементов искусственного интеллекта при выращивании томатов и сахарной свеклы. Эта цифровая платформа управления станет интегратором научных и промышленных информационных систем. А технологии искусственного интеллекта в этом случае определят структуру ИТ-специалистов, перестроят образование в университетах, существенно повысят эффективность цифровизации сельского хозяйства и приведут к существенному снижению экологической опасности во всем агропромышленным комплексам.*

Ключевые слова. *Искусственный интеллект; цифровая экономика; сельское хозяйство; человеческий капитал, математическое моделирование*

Introduction. Amid the ongoing digital transformation (DT), the world has recently seen a significant increase in the scientific and practical interest in the problems of human capital (HC). This interest is due to the understanding of its key role in the social and economic life and the society development with a drastic change in the technological patterns at all hierarchical levels: national, sectorial, regional, corporate, and individual.

However, digital economy (DE) requires pivotal modernization of production processes, personnel retraining, from workers to top managers, transition to modern management methods corresponding to new opportunities of information and communications technology (ICT). Such an economy needs highly qualified specialists who have necessary competencies and are able to invest their HC in the production and to develop themselves.

HC being realized as a key factor in the development of modern society has predictably set the task of assessing its transformation depending on the economy digitalization. Such an assessment, if based on a scientific integral approach, on sufficient and reliable information, allows for selecting the most effective ways to use this capital and the entire DE.

Serious research in the field was described in the paper by [1], which shows that the company's ICT economic efficiency hinges not only on investments in ICT, but on the so-called complementary changes driven by DT. According to the authors, complementary assets are those assets that should be developed together. Only well-coordinated changes in all production factors enable company to gain maximum profit. Later, this hypothesis was proved by other authors [2]. Thus, it was concluded that investment in ICT is more efficient with investment in other complementary assets: human and organizational capitals in certain proportions.

Therefore, this paper considers the dynamics of social transformation of human resources in the field of applying of artificial intelligence (AI) methods, the technology of which drastically influences the process of complementary changes in economy, as exemplified by the Russian agro-industrial complex (AIC).

Materials and methods of research. A huge attention gained by the DE program, that was adopted in 2017 in Russia, resembles the similar interest that arose during the approval of the Integrated Scientific and Engineering Program (ISEP) in 1985 by member countries of the Council for Mutual Economic Assistance (CMEA), a subprogram of which was electronification, namely, that of agriculture. Just as now, the national government have high hopes for electronification. By the moment of adopting the ISEP, the greatest problem in our country was its ineffective agriculture; therefore, considering electronification as one of the growth drivers, they established the Research Institute for Cybernetics in AIC (VNIIK) with a strong team of informatization experts (about 50 graduates of the Moscow Institute of Physics and Technology) engaged. VNIIK became the head organization in the task of "Electronification of Agriculture" in the CMEA.

In view of the expected growing numbers of personal computers, VNIIK faced an important scientific and engineering challenge: selecting an informatization strategy for the coming decades. For this purpose, the corresponding concept was developed. The concept involved informatization of the sector in the following closely interconnected areas: informatization of production (informatization of technological and managerial processes), education, social sphere in rural areas, and agricultural science. At the same time, informatization, like mechanization, chemicalization, etc., should become an integral part of agricultural production systems and, like other industries, should have its own scientific support, technical base, organizational infrastructure, and staff.

As a resource-saving strategy, VNIIK chose the path of comprehensive informatization of reference facilities in the Kuban and the Stavropol Territory with the development of standard information systems (IS) modules to be further replicated throughout the country. Such an approach would make it possible to transfer the existing spontaneous process of informatization into the monitored and regulated mode, to involve many farms on a single methodological basis, with uniform requirements for the composition of the hardware and software used, as well as for personnel. The experience of individual subsytems introduced into about 1,000 farms has proven this approach to be correct.

However, the informatization of technological processes was faced precisely with the limitations of complementary interdependencies of various assets. Thus, a farm head rejected the proposal to introduce unmanned technology using expert systems, being the prototype of modern

AI methods, for cultivation of sugar beet using precision seed drills, combine harvesters, new varieties of seeds placed in a shell of chemical plant protection products against diseases and pests, to be paid out of public funds, claiming that he had employed 700 women to thin and weed crops, so, with DT introduced, these workers would have no job to do. On the other hand, they could introduce this scheme for growing tomatoes in a farm covering 200 hectares. However, there were problems here, too. One of them was that the tomato farming technology presupposed their simultaneous ripening followed by harvesting using an appropriate combine harvester, unlike their manual harvesting as they ripen throughout the season. With simultaneous harvesting, neither the retail chain nor the processing factories were able to accept all the harvested products at the same time. Another problem was the lack of the necessary data for the reliable operation of the expert system and the ontological incompatibility and inconsistency of existing systems. Introducing a microclimate control system in a large pig farm could not be completed due to the need to reconstruct the premises, which required significant investment.

To develop standard IS modules and to solve the problem of ontological incompatibility of data circulating at reference facilities, a technology for the synthesis of optimal IS at farms was developed on the basis of the corresponding mathematical model [3]. Its deployment improved the IS quality and reliability, reduced their implementation cost, in particular, due to uniform training of specialists for their deployment. Based on calculation, ontological (conceptual) and logical models of technological databases (digital standards) were obtained and developed in 19 types of farms existing at reference facilities, that were common for all of them. In addition, for the same farms, management tasks were identified through ontological modeling with uniform agreed algorithms. These developments were implemented by a creative team from various leading sectorial research institutions and VNIIK on a single methodological basis.

The further development of the digitalization of agriculture has confirmed the correctness of this approach. The area of the most significant application of DE in agriculture is precision farming (PF), currently booming. It involves integrating the new agricultural technology and high-precision positioning based on remote sensing of the Earth (RSE), as well as differentiated, highly effective, and environmentally friendly agritech measures in the fields based on detailed information on the chemical and physical parameters of each land plot. Intensive research is underway around the world to improve this technology [4-13]. PF requires integrating a huge amount of information, which can only be processed by AI technology that requires a sufficient amount of structured and reliable data. Thus, among the AI-related problems, the lack of structured and reliable data was put in the first place by experts in this area [14].

Since almost all known technologies of precise farming cannot go without the use of AI applications, we will mention the most significant ones offered by the AI development market [15].

1. Machine learning in field monitoring. Taranis, an Israeli startup, provides accurate information on the state of plants, based on the readings of field sensors, weather stations, and aerial photography, which allows for timely identification of such negative factors as diseases and pests, nutrient deficiencies, followed by developing the recommendations for on-the-spot intervention.

The Watson Decision Platform for Agriculture by IBM provides advice concerning the doses, type of pesticides, and the optimal timing of their application in case of corn lesions risks, based on Earth remote sensing data (HD-NDVI index). Farmers get yield forecasts, etc.

Health Change Maps and Notifications, an AI platform, be Farmers Edge promptly informs the farmer on the efficiency of the equipment, the condition of plants, the appearance of pests or diseases, the lack of nutrients, etc.

The Field Manager mobile app from Bayer gives the user information on possible risks of crops and recommendations on how to prevent them based on the processing of Earth remote sensing data and a large amount of other data from the database.

The Hummingbird Technologies platform provides farmers with information on the current state and volume of plant mass, the presence of weeds, nitrogen deficiency in plants, etc. — not only based on the Earth remote sensing data but also due to the use of ground-based monitoring tools and UAV images.

2. AI technologies for weeding. Nowadays, the use of AI for weed and pest control experiences active development. Thus, Bayer and Bosh are developing a Smart Spraying technology, which will recognize a weed and determine the type and required amount of pesticide. The Weed Killer by EcoRobotix is capable of moving through the field independently, recognizing detected weeds, and applying treatment thereto. It is claimed that the technology will yield a 20-fold reduction in the use of herbicides. WeedSeeker, an autonomous system, by Trimble performs spot spraying of weeds. The system identifies weeds by using LEDs that scan the surface in the red and infrared range. The reflected light is analyzed automatically, and when a plant is detected, a signal is sent to the nozzle to trigger it exactly above the weed.

3. AI technologies for identifying plant diseases. AI is currently helping farmers to choose treatment methods with the calculation of economic indicators after identifying a plant disease. The process is based on photos of the affected part of the plant. A similar mobile app Plantix by Peat – Plantix – provides farmers with the ability to identify over 60 plant diseases. The app contains an extensive database of images with identification by plant varieties, types of bacteria, diseases, etc. Scouting, an application by Bayer-BASF, also helps to diagnose diseases, developmental disorders, and the degree of nitrogen availability for plants – through photo processing.

4. AI technologies in the digitalization of cattle breeding. Foreign experience in cattle breeding digitalization shows that almost all process operations are suitable for digital transformation using AI. Here are the main directions of this transformation.

– Improving the quality of animal housing conditions through smart control systems for light conditions, microclimate, feeding, and manure removal, since the comfort of animals affects their productivity.

– Breed selection. Selection will allow for accurate breeding according to the specified requirements and properties (lack of genetic predisposition to certain diseases, meat and dairy qualities, growth and maturation rate). Currently, great hopes are placed on AI methods, for example, on the development of methods for analyzing genomic information to assess the breeding value of an animal at an early age. Currently, research is being conducted on selecting the sex of the animal, milk productivity, and the thickness of a steak cut.

– Analysis of milk quality; diagnosis and prevention of animal diseases; compliance with sanitary and hygienic standards.

Results and discussion. The informatization experience at reference facilities made it possible to identify the following four evolutionary stages in the IS development, each of which was marked by significant transformation of data and software storage, transfer, processing, and integration methods. At the first IS development stage, almost all application software was usually developed by corporate specialists. It was focused either on the needs of a specific farm or those of a narrow group of similar farms, which required significant costs to support it. It was a traditional, the so-called task-oriented approach. At the second stage, with ICT improvement resulting in software standardization, cooperation, integration and lower cost, the functional capacities of systems were expanded. This process allowed to optimize managerial functions and information processing methods. The third stage was associated with the emergence of local area networks (LAN) and data base management system (DBMS). At this stage, placed at virtual computer nodes in a LAN, both software and data were physically and logically separated from specific computing facilities. The fourth IS evolution stage was about the digital era. Meanwhile, starting from the second stage, there was an economic expediency in replicating ISs to a certain group of farms; that is, the IS design space of each farm should be subjected to an important IS designing procedure – ontological modeling, in other words, the process of integrating heterogeneous data and knowledge of specialists from various businesses. As a result, international management standards – MRPII, ERP, CSRP – were developed to serve as a mere methodology for managing finance, material flows, production, projects, service, quality, and staff.

Introducing standards for information resources (IRs) was not that urgent, because, on the one hand, ISs could be comprehensively tailored to specific farms and, on the other hand, they were replicated to relatively homogeneous farms. However, standardization was necessary in the transition to the fourth IS evolution stage, when the Internet emerged, enabling an unlimited number of users to access various ISs. At the same time, it was possible to integrate various ISs and IRs not only in individual companies, but also across industries, countries, and across the world community. Under these conditions, accounting and monitoring of the maximum possible number of agricultural processes becomes the priority in developing a digitalization strategy for the largest agro-industrial firms worldwide. For instance, while in 2014, 190,000 measurements were made at smart farms to inform farmers, the number of measurements will grow to 4.1 million per day by 2050. It is almost impossible to independently navigate this information flow [15], and AI technology should help there, since one of the tasks of AI is generalizing, analyzing, processing data from various monitoring tools, and giving recommendations based on the same.

Since the transition to each next stage was accompanied by the growing number and complexity of automated tasks, there should be a change in both the organizational structure of IS development, implementation, and operation, the system for retraining AI app specialists and users and other DE tasks, as well as a change in the nomenclature of IT specialties, which needs subsequent restructuring of university education.

In this regard, it is of interest to consider a change in the composition of executors responsible for implementing ISs. At the second stage, due to the insolubility of the problem of ontological incompatibility of data and an increase in the number of automated tasks, software customization units were added to standard solutions for the needs of an individual user. Due to this fact, company managers, based on business considerations and the prospects of the new area, started sending their children to study at ICT departments to further develop and deploy software in their companies, which later made it difficult to switch to boxed solutions. At the third stage, boxed solutions became widespread, which, nevertheless, required competent implementation specialists due to the lack of standards for IRs and management functions. According to 1C managers, about 300,000 programmers are employed for implementing their accounting automation systems, which is due to the need to customize the software for a specific user. As a result, the accounting and reporting system in our country is unmanageable and expensive, which significantly increases the cost of accounting in Russia and, consequently, reduces business profitability. These trends are confirmed by the results of monitoring the informatization of 300 best agro-industrial businesses [16]: at the time of the study, mainly accounting software was being implemented; even these solutions were developed by several companies (23% by own efforts, 16% by 1C, 45% by a regional organization, 6% by a federal organization, 6% by an individual, 3% by a tax service); this software is informationally, ontologically, and ergonomically incompatible. Therefore, a task-oriented, original approach to the design and development of IS still prevails in Russia today. Although, before the DE era, it was still possible to put up with such a situation due to the low penetration of informatization into the business management system, haphazard implementation of ICT in the era of total economy digitalization will lead to huge expenses. Thus, following this approach, with the number of problems solved in crop production estimated as 150, the number of various process operations in the industry estimated as 20, the number of regions estimated as 80, and the number of crops estimated as 20, we get potentially 4,800,000 different versions of ISs. However, as stated above, most of the farms today still use solutions independently developed within a company; however, the lack of qualified specialists in data science and in the development and implementation of AI in rural areas leads to a shift in demand towards boxed solutions.

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In view of the above, the optimal IS synthesis model mentioned mentioned above was modified into a model for creating a digital platform (DP) to manage the AIC economy [17]. A digital platform is understood as a set of ordered digital data based on ontological modelling; mathematical algorithms, methods and models, software, and hardware tools for collecting, storing, processing and transmitting data and knowledge, optimally integrated into a single information and control system designed to manage the target subject area with the organization of rational digital interaction of stakeholders.

In this section, we present an abbreviated version of the core of the model so as not to go into the details of cluster analysis, semantic adjacency matrices, and the theory of automatic classification, which are required for the correct determination of optimum DP in the future. A digital platform is understood as a set of ordered digital data based on ontological modelling; mathematical algorithms, methods and models, software, and hardware tools for collecting, storing, processing and transmitting data and knowledge, optimally integrated into a single information and control system designed to manage the target subject area with the organization of rational digital interaction of stakeholders.

By the structure of a control system, we mean the organizational set of its interrelated elements that determine their place both in a purely physical and technological sense (the level and specific location of an element in space and the technological scheme of decision-making and information processing). The design of digital platforms' structure is understood as building relationships between the elements of the management structure under the specified performance criteria as a whole.

We consider a system consisting of a set of control nodes j (for example, a ministry, regional agricultural bodies, enterprises, departments), a set of tasks K associated with processing data located in data centres, situational centres, data clusters L, communication types R. The control process is assumed periodically with a period of T. All operations of calculations, data transmission, etc. averaged over time. We will assume that any task can be solved at any node, including breaking along these nodes. To solve the problems, some generalized technical means are used. The set of formalized model's parameters includes:

k – task number, $k \in K$;

l – group information item number, $l \in L$;

j – control unit number, $j \in J$;

f_{klj}^{e} – average characteristics (amount of information; time, frequency requirements, etc.) for the information of the l -th group, necessary for the task k , arising in the node j, $e \in E$;

$x_{jk} = 1$, if the task k is solved at node j, 0 – otherwise;

$\alpha_{klj} = 1$, if the l-th group arises at the j-th node for the task k , 0 – otherwise;

$y_{lj_1j_2r} = 1$, if information from the l-th group is transmitted from the j_1 -th node to the j_2 -th by the r-th means of communication;

d_{mjk} – necessary resources of the m-th type to solve the task k at the j-th node;

M_m – m-th equipment resources;

$s_{lj_1j_2r} = 1$, if the r-th link type is used to transfer the l-th group from the j_1-th to the j_2-th node;

G_r^e – communication characteristics; c_j^1 – the cost of a piece of equipment in the j-th node;

$c_{j_1j_2r}^2$ – the cost of the r-th means of communication when transferring information from j_1 to j_2; $c_{j_1j_2r}^3$ – the cost of transferring a unit of information from j_1 to j_2;

c_{mjk}^4 – the cost of the m-th resource for solving the task k in the j-th node; c_k^5 – generalized cost of the k-th task; c^0 – funds allocated for the development of a digital platform.

Restrictions on the placement of tasks by nodes and technical means:

$$\sum_j x_{jk} \geq 1, \quad k \in K^3 \in K, \tag{1}$$

that is, the k-th task must be solved at least in one node;

$$x_{jk} \geq 1, \ j \in J_1, \ k \in K^4 \in K, \tag{2}$$

i.e., some task from the set K must be solved at some nodes $j \in J_1$.

The conditions for transferring information from node j_1 to node j_2 are as follow:

$$\sum_r y_{lj_1j_2r} = \sum_k a_{klj_1} x_{j_2k}, \ j_1 \neq j_2. \tag{3}$$

Information is transferred from the node j_1 to the node j_2 when it occurs at the node j_1 and is used at the node j_2 for task k.

Equipment load limitations:

$$\sum_{jk} d_{mjk} x_{jk} \leq M_m. \tag{4}$$

Restrictions on communication channels:

$$\sum_{l,k} y_{lj_1j_2r} f_{klj_2}^e \leq G_r^e s_{j_1j_2r}. \tag{5}$$

Financial restrictions on investments:

$$\sum_{j,k} c_j^1 x_{jk} + \sum_{j_1,j_2,r} c_{j_1j_2r}^2 s_{j_1j_2r} + \sum_{j,k} c_k^5 x_{jk} \leq c^0. \tag{6}$$

Efficiency criterion:

$$\sum_{j,k} c_j^1 x_{jk} + \sum_{j_1,j_2,r} c_{j_1j_2r}^2 s_{j_1j_2r} + \sum_{j_1,j_2,r} c_{j_1j_2r}^3 f_{klj_2}^e y_{lj_1j_2r} + \sum_{m,j,k} c_{mjk}^4 d_{mjk} x_{jk} + \sum c_k^5 x_{jk} \to \min$$

The model made it possible to scale up the ontological and logical models of technological databases, as well as unified management tasks developed for reference facilities, to the entire AIC. In addition, this model allowed to develop another digital standard. It is an IR axis standard with far-reaching implications for the effective development of AI technology. All primary accounting information can be generated in a general form (standard): operation type, operation object, location, the person who conducted the operation, date, time interval, means of production involved, volume of operation, type of resource consumed, amount of resource consumed, operation quality.

Another important result of the synthesis of the optimal DP in AIC is a scientifically based calculation of the need for specialists necessary for DE. Let us describe the main groups of these specialists. Firstly, they include ontologists. Secondly, specialists in creating databases. Thirdly, specialists in the development of large IS architecture. Fourthly, programmers who are able to develop such ISs with various information processing modes. Fifthly, information security specialists. And, of course, the largest group is IS implementation and support specialists.

Based on the mathematical model and the available experience in implementing individual ISs in one thousand farms, let us present some data on specialists necessary for the development of DP for AIC management. In crop production, an ontological model was developed by a creative team of 10 people from various industry research institutes and VNIIK. The database project, architecture, and software were developed by a laboratory of 15 people. A similar work in animal husbandry was done by 10 specialists. The rest of the industries were computerized by a team of 12 people. The need for specialists in information security is estimated as three people. To deploy ISs, implementation centers were created in each region, similar to the once existing machine and tractor fleets. Currently, there are about 1,800 such regions in Russia. To update information support and train specialists, at least two IT specialists per farm are needed at the first stage. According to the 2016 agricultural census, there were 36,048 agricultural businesses in Russia. Let us assume that farmers and other small businesses will be served by regional implementation centers; then these centers need about 10 IS implementation and support specialists. Therefore, assuming that all businesses will use ISs (although this is far from reality), the need for specialists is as follows: 50 developers, 90,000 IS implementation and support specialists (about 18,000 people in regional implementation centers and about 72,000 people at farms).

As you can see, in our country, the concept of a single DP of economic management AIC, where AI technologies would work most effectively, was tested both theoretically and experimentally. However, the Ministry of Agriculture is in no hurry to develop this approach. Small farmers, who are the overwhelming majority in the market, lack financial resources, strategically minded specialists, and effective cases of a systematic approach. It is difficult for them to predict the trends of the digital transformation integration processes in the economy, since they are limited to only a small part of the global production chain. Therefore, they mainly use a task-oriented original approach to the design and development of digitalization systems, where the maximum possible digital transformation of the industry will not exceed 17%, according to mathematical modeling [18].

At the same time, in the agriculture of developed countries [19], two specialized similar platforms are gradually emerging: agrarian data aggregator platforms, otherwise, platforms for primary data collection and accumulation (IR in our understanding) and applied platforms (applications). These DPs are being gradually integrated with intensive mutual data exchange through the development of appropriate cloud platforms and services, because only this type of cloud technology makes them available to businesses of all sizes, not just for some of the largest farms.

J'son & Partners Consulting also believes that using the technology of two types of the above cloud platforms in the value added chain of agricultural products (wholesalers, logistics, retail chains) will enable transition to direct sales, where the farmer monitors the end consumer, the size and structure of the consumer's demand, and through the use of mathematical models, AI in particular, the farmer produces exactly those products that the consumer needs at the right time, whereas the product delivery is managed by the automatic exchange of information between participants in the supply chain through a cloud service with the minimum use of warehouse and logistics infrastructure of wholesale intermediaries. Such digitalization will make it possible to exclude the numerous unnecessary intermediaries from the chain, who now account for up to 80% of the value in the retail price of goods.

Conclusions. The paper shows that the main problem, without taking into account the economic and political, successful application of AI technologies and methods is the formation of a single digital platform for managing the economy, consisting of two specialized subplatforms: a subplatform-aggregator for collecting and accumulating primary information and an applied subplatform for production management tasks . In this case, the transition of any production to it allows you to move to a new type of production enterprises: from the quality control phase after the production phase to the principle of current control of all production operations, which should affect the entire economic and social system in the country. In addition, such a digital economic management platform will free up a large number of IT specialists from financial and accounting departments with their reorientation to the introduction of new digital technologies in the form of mathematical models, AI and will give an additional impetus to accelerating the digitalization of Russia.

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