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Development of Digital Agriculture in Azerbaijan

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Abstract
The requirement for digitalization of the agro-modern complex is self-evident: the execution of the standards of the computerized economy will establish an institutional climate that will relate to the advanced real factors of innovation and, as a rule, will further develop creation proficiency. The article considers the experience of digitalization of agriculture in some developed and developing countries. The digital transformation of agriculture requires the application of digital technologies and platform solutions to ensure technological breakthroughs and increased productivity in this area. Given the trends of the modern world, the digitalization of agriculture has become a necessity for countries. In addition, this article shows the advantages and delays of digitalization in the agricultural sector. In recent years, much has been done in Azerbaijan in the field of digital transformation of agriculture. In particular, the Electronic Agricultural Information System (EAIS), Farmer Data Monitoring System, Electronic Price Information Portal, Geographic Information Systems and other applications can be mentioned. As a result, it should be noted that despite the great work done in the field of digital transformation of agriculture, much remains to be done.

I. Introduction

In modern conditions, the issue of the development of the digital economy is becoming very relevant, since it is it that radically transforms various spheres of human life. These include: infrastructure and communications, finance and trade, marketing and advertising, media and entertainment, government and society, security, education and personnel, and a number of others. “Without access to modern farming techniques or machinery, let alone science-based climate and weather data, farmers' livelihoods hinge precariously on a changing environment that they're struggling to understand” - was stating UN Agency for International Development. The digital economy, or Internet economy, refers to activities based on the use of digital technologies and closely related to e-business and e-commerce, as well as the digital goods and services they produce and sell. This activity is very multifaceted. Let's highlight the main advantages of the digital economy:

1. Optimization of production through the use of digital technologies, the use of which significantly improves the quality of the labor process.
2. An increase in labor productivity, that is, an increase in the efficiency of labor activity. One of the determinants of low labor productivity is the human factor, for example, poor health, low motivation, fatigue.

3. Lack of territorial attachment, in other words, going beyond national boundaries. It is the high level of mobility and globalization that blur the borders between countries, which has a positive effect on the development of the economy as a whole.
4. Large opportunities for management activities. Thanks to the digital economy, business development is possible anywhere in the country and even beyond its borders.
5. Minimization of threats to economic security.
6. A wide range of possibilities related to the storage and operational use of information.

However, the digital economy also has certain drawbacks:

1. The problem of ensuring information security in connection with the possibility of cyber-attacks.
2. Potential increase in unemployment (as a result of increased labor automation).
3. Limiting the ability of employees to materialize their competencies in order to develop the organization.
4. Decrease in the share of systems thinking due to the use of information technologies and, as a result, stagnation of the thinking processes of personnel.

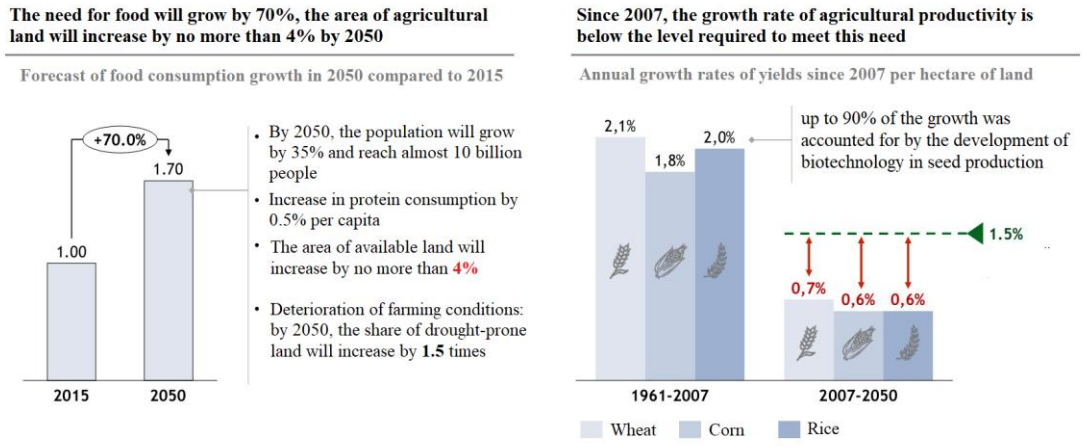
For the development of the digital technology segment, it is necessary to prepare a developed information and communication infrastructure. To solve the challenges facing the digital economy, we need appropriate knowledge bases, information resources and interactive communities, a wide network of integration business platforms, a digital environment and human resources that can work in new conditions. Such an integrated approach will create a digital ecosystem in which each participant will fulfill the dual role of a client and a data server. This will form the basis for subject-oriented clusters within which agrarian digital ecosystems function.

II. Results and Discussions

Digitalization of Agriculture in the World

Today, the use of IT in agriculture is not only about the use of computers. Digital technologies—including the Internet, mobile technologies and devices, data analytics, artificial intelligence, digitally-delivered services and apps—are changing agriculture and the food system [OECD, 2019]. Digital technologies allow you to control the full cycle of crop or livestock production - "smart" devices measure and transmit the parameters of soil, plants, microclimate, etc. All this data from sensors, drones and other equipment is analyzed by special programs. Mobile or online applications come to the aid of farmers and agronomists - to determine the right time for planting or harvesting, calculate the fertilization scheme, predict the harvest, and much more.

By 2050, the need for food in the world will grow by 70%, the current growth rates of agricultural productivity are not able to provide it. (Figure 1)



Source: Future of Agriculture and Food by Bayern AG, FAO, Goldman Sachs

Today, digital smart farming technologies have the potential to help end poverty and hunger faster, especially in developing countries, where most of them live from agriculture. In particular, the use of smartphones by farmers

to access real-time farm information could globally change the way they provide livelihoods and expand such communities.

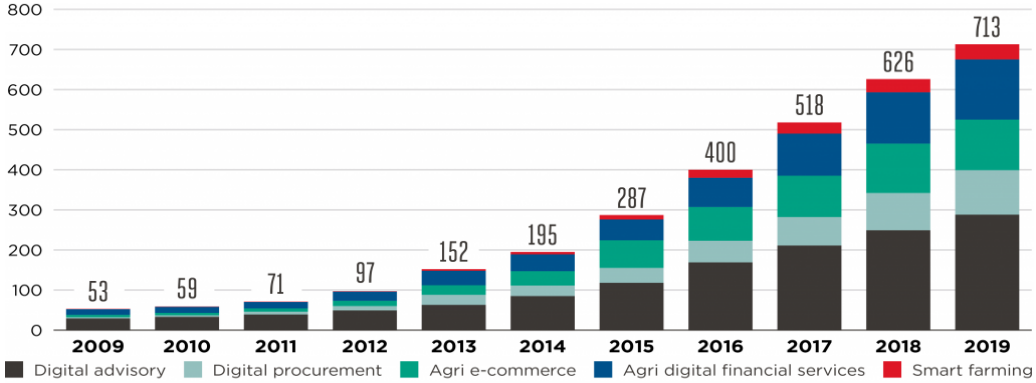
Thoughtful investment in situations where agricultural professionals are unable to visit farmers in person can propel the digitalization process forward and help narrow the income gaps that hamper rural development. A farmer with a smartphone can be considered sufficiently equipped to receive advice and support on smart farming in the form of audio and video messages via the Internet or even in the form of simple text SMS without it. For example, Africa and Latin America together account for less than 5% of the world's data centers. In addition, large differences in e-commerce readiness between and within countries increase the risk of unequal distribution of the benefits of e-commerce. In a number of countries, there are state programs for the implementation of AgTech. These are the examples of government initiatives to support the development of injections in the Agricultural Sector.

India*(Digital India Program).* A series of digital initiatives aimed at facilitating farmers' access to information on growing methods, weather, fertilizer and seed markets, and measures to keep crops from pests. Incl. PUSA KRISHI is an application that accelerates the adoption of modern technologies by Indian farmers. An application that helps farmers to find simple solutions to problems, receives information about the weather, and accordingly, takes measures to save the harvest. It also offers information regarding new crop varieties developed by the Indian Council for Agricultural Research (ICAR).

Kenya. The current arrangement of advances accessible to the Kenyan agrarian area is wide however has not yet crossed into standard use. High innovation costs, low advanced education, restricted foundation access, and a frail empowering strategy climate are the essential requirements to reception of computerized horticultural arrangements.

Versatile applications, information base frameworks, block chain, climate station advancements and monetary danger evaluation models and digitalized contracts are the most encouraging high-sway computerized answers for the difficulties confronting Kenyan agro-food partners.

Fig.2. Number of active digital agriculture services by use case, 2009–2019



Source: Introducing Digital Agriculture, a 2020 state of the sector report, Daniele Tricarico

Here is a dynamic view of the evolution of the sector. Digital advisory services first appeared in the late 1990s in response to the need to overcome the knowledge gaps limiting farmers' productivity. Since then, the range of digital agriculture solutions has evolved rapidly and the landscape has become increasingly sophisticated. Digital agriculture tools have become more widespread, from just 50 active services in 2009 to over 700 in 2019.

The economic geography of the digital economy does not reflect the traditional divide between North and South: it is consistently dominated by one developed country and one developing country, namely the United States and China. Thus, in addition to the dominance of the United States and China in the global digital platform landscape noted above, they account for 75% of all patents related to block chain technologies, 50% of global IoT spending, and more than 75% of the global public cloud computing market. Therefore, in many areas

of digital development, the rest of the world, especially Africa and Latin America, lags far behind the United States and China.

Studying the experience of digitalization of agriculture in developed countries, the United States should be highlighted with a high level of implementation of digital technologies in agriculture (almost half of the country's farms). The agricultural sector of the United States accounts for more than 40% of the world market for agricultural production. Such large agricultural companies as John Deere, Trimble, Iteris Inc, like many others, actively use various digital technologies, for example, crop mapping systems, unmanned aerial vehicles and airplanes, sensor sensors, etc. [Bauer, 2018].

Specifically, John Deere invested over $ 300 million in its 2017 Blue River technology, which integrates computer vision and learning technology to spray a variety of substances such as herbicides. Blue River has developed a special visual algorithm for distinguishing weeds. This contributed to a reduction in the amount of used herbicides and their application only on a point basis, optimizing the costs of farmers.

The Irish Government's Smart Farming program was launched in 2014. Individual entrepreneurs in a specific area of agricultural production are offered various options for using digital technologies and platforms that can reduce costs and emissions. Currently, 1,900 farms are working in the program. Savings in each of them averaged € 5,000 in 2017, and fuel consumption fell by 10% [Bauer, 2018].

An interesting project is being implemented in Switzerland, where the first (in Europe) demonstration of the farm took place, which was organized at the expense of the state budget. At this pilot enterprise, new approaches to the automation of agricultural management have been applied; the impact of new technologies on the labor economy, productivity and the environment has been studied. This experience helps determine which technologies are effective and can be applied in real agriculture, and which need to be improved.

III. Electronic Agricultural Information System (EAIS) in Azerbaijan

Digital transformation of the economy and society has become one of the priority issues facing the Republic of Azerbaijan in recent years. One of the important steps in this direction was the preparation of a Strategic Roadmap for the Development of Telecommunications and Information Technology. The Strategic Roadmap dated March 16, 2016 has been prepared by considering the challenges and opportunities that telecommunications sector is facing in order to enhance the development potential of the country's information and communication technology (ICT), improve ICT infrastructure to digitize economy, meet the demand for ICT services efficiently through domestic sources and increase productivity through implementing İCT technologies in government sector. (Strategic Roadmap for the Development of Telecommunications and Information Technology was prepared. The Strategic Roadmap, March 16, 2016)

Important work has been done in the country in the field of digitalization, information and communication technologies (ICT), construction of new infrastructure, application and modernization of modern technologies. Development of broadband Internet, which is the basis of ICT infrastructure to improve the efficiency of the economy and public administration, information security and living standards of citizens, "Government Cloud", "Big Data", "Smart City" (Smart City) and Smart Village. Consistent reforms are being carried out to turn Azerbaijan into a digital center in the region. (Announcement of the President of the Republic of Azerbaijan on further developing administration in the field of advanced change, 27.04.2021) One of the significant advances taken towards the improvement of the farming area and the digitalization of horticultural administrations is the making of the Electronic Agricultural Information System (EAIS). EAIS is a solitary framework that joins the fundamental standards of the Ministry of Agriculture of the Republic of Azerbaijan - closeness to ranchers, straightforward and effective administration and utilization of advancement, gives openings for combination homegrown and unfamiliar frameworks and makes a far reaching data set in agriculture. EAIS is, as a matter of first importance, a straightforward and functional administration instrument that accommodates the development of modules covering business processes identified with all phases of state support measures for farming makers.

Simultaneously, EAIS assumes the part of a significant data base in the agrarian area by extending incorporation with unfamiliar frameworks, covering all spaces of horticulture over the long run and all administrative help administration processes around there. Hence, EAIS can get ready insightful reports and fabricate models that

will assist with deciding and structure the reason for making arrangements for future turn of events, and the assortment and formation of Big Data, a vital necessity of current occasions. Because of this, it is feasible to build up a consistent association between all cycles identified with farming, to finish the cycles, to apply present day specialized arrangements, to lead complete investigates and to make precise estimates.

The primary objectives of EAIS are to make a solitary data set on ranchers and the assets they use, increment straightforwardness in the arrangement of appropriations from the state financial plan, work on the component for giving sponsorships, and give estimating, coordination and control openings for the Ministry of Agriculture.

As per the "Rules for Subsidizing Agricultural Production" supported by the Decree of the President of the Republic of Azerbaijan No. 759 dated June 27, 2019, beginning from 2020, appropriations are given to ranchers in the field of yield creation and domesticated animals just through EAIS. This takes into account chattier gritty data on ranchers to be acquired and arranged. Hence, the quantity of ranchers announcing their yields by locale and town, the proclaimed region, financial profile, just as data on harvest and animal endowments are organized and examined.

Data on rural business sectors is additionally significant as far as successful administration choices in the horticultural area. To utilize such data consistently and constantly, a value data entrance for agrarian items has been set up inside the undertaking carried out by the Ministry of Agriculture mutually with the Food and Agriculture Organization of the United Nations (FAO). Afterward, this gateway was improved by the Ministry and made www.aqrarbazar.az, an Electronic Price Information Portal for Agriculture. Electronic Price Information Portal gives discount, retail exchange of vegetables, potatoes and melons from fields and costs of their acquisition by handling undertakings, retail and discount costs for animals' items, just as retail costs for method for creation, etc. Prices for all item types or varieties are gathered on every day, week by week and month to month premise, and contingent upon the item, considering the low, medium and significant levels. Be that as it may, from 2020, to rapidly evaluate the impacts of the COVID-19 pandemic, information on discount and retail costs of horticultural items are gathered in the data set all week long. Based on this data, employable data notices "On changes in discount and retail costs of rural items" are ready consistently.

IV. Electronic Price Information Portal is available to general society

One of the principle models for the adequacy of agrarian arrangement in the nation is the effect of this strategy on the exercises of rural makers. The markers that portray this are a significant arrangement of pointers for evaluating the viability of the approach. In such manner, the Farmer Data Monitoring System (FDMS) was set up by the important choice of the European Commission. At the EU level, this framework, called the Farm Accountancy Data Network - FADN, is utilized in all part countries. Being a significant data base and one of the essential administration apparatuses for the dynamic interaction in the agrarian area, FDMS was set up in Azerbaijan without precedent for the CIS. To shape this data set, direct information is gathered yearly from 3-4 thousand ranchers occupied with farming in various locales of the country. One of the most significant and essential data sets in the field of agribusiness is the geological data set. Shaped by the Ministry of Agriculture and called Geographic Information Systems (GIS), this data set is a data framework that gives spatially planned assortment, handling, stockpiling, transmission, and cartographic and visual show.

The construction of this data set depends on the aftereffects of photointerpretation on orthophoto guides of the genuine utilization of agrarian grounds, just as data on different terrains, renamed lands, terrains of monetary and authoritative locale, managerial areas and regions, lasting yields and nurseries, all water bowls covers spatial and non-spatial information, just as orthophoto maps and advanced model of help and non-spatial information insights.

Coincidentally, following the freedom of our properties in 2020, a genuine guide of yields and enduring harvests on horticultural grounds in the Nagorno-Karabakh district was incorporated dependent on different satellite pictures as a component of the work to reestablish agribusiness in the Armenian-involved domains. A measurable report on the locales has been arranged. Likewise, the names, area and codes of the involved towns were explained, and the Electronic Agricultural Information System was updated.

In expansion, maps have been arranged to permit the Agrarian Insurance Fund to evaluate horticultural dangers based on help information (DEM model) for arranging protection chances on farming grounds in 2020, when the state-upheld agrarian protection component was formally dispatched in Azerbaijan.

By and large, as per the actions taken to further develop the agrarian protection instrument, the usefulness of the product of the Agrarian Insurance Information System will be expanded, and the inclusion of the data set will be extended.

Furthermore, the most common way of making new information bases in different fields has started. Consequently, the azaqroinvest.az gateway will be made as a point by point information base on venture open doors in agribusiness. Starter attainability examines on creation, handling, supply and acquisition of rural items will be directed, based on which model speculation activities will be ready and posted on this entryway. The entry in Azerbaijani and English will be routinely refreshed and introduced to nearby and unfamiliar investors.

In expansion, various measures are being taken to work on ranchers' admittance to data and counseling administrations utilizing new creative advancements. Accordingly, it is intended to make a versatile application stage that will cover countless ranchers with data and counseling administrations, which will guarantee that ranchers register in this application through EAIS. Hence, the instructive data will be accessible to all ranchers through the versatile application; ranchers will actually want to consistently get warnings about the dangers of infection transmission, counsel on agro-specialized administrations and other information. The work done inside the system of the "Computerized Agriculture" project executed by the Ministry of Agriculture is a reasonable illustration of this. The undertaking was dispatched as a pilot test in Guba, Gusar, Khachmaz and Shamakhi locales. Five environment stations covering around 60 towns have been dispatched in these districts. Environment stations are an advanced imaginative framework that permits you to screen the improvement period of illnesses and irritations during the time spent plant advancement, and, in like manner, ideal and precise gauging of field work. The sensors incorporated into this framework gather data on air temperature, dampness level, precipitation, leaf dampness and precipitation time, wind speed, which are investigated and shipped off ranchers. Ranchers additionally plan them neutralize plant sicknesses and vermin dependent on this data. Subsequently, the adequacy of infection and irritation control builds, crop creation increments, and ranchers can streamline costs. Thanks to this framework, the danger of water lack, which has turned into a worldwide issue as of late, has been killed somewhat. On account of this technique, ranchers know where and how much water to utilize and don't squander it. The undertaking is being extended to other financial districts.

Growing the arrangement of vital and quality data dependent on the utilization of computerized innovations is one of the fundamental needs of the "keen town" project, which is presently being carried out in our freed domains.

V. Agro-parks in Azerbaijan

One of the means of supporting digital transformation in the agricultural sector is the creation of agro-parks. Agroparks provide the use of digital technologies in agriculture.

Azerbaijan has contributed 1.4 billion USD (2.4 billion Azerbaijani Manats) in the development of agro parks, Azerbaijan State Ministry of Economy.

The investments to agricultural parks have been distributed through invest-promo documents and as well as in the form of private contributions.

The Entrepreneurship Development Fund (EDF) of the Ministry of Economy through promo documents has distributed 690 million USD (1.17 billion AZN) for the launching and improvement of 50 agro-parks in general.

The 25 agro-parks have been granted 19 million USD (32.8 million AZN) reductions to import machinery, tech equipment and other facilities.

Furthermore, the private sector has contributed 710 million USD (1.2 billion AZN) in the improvement of the agricultural parks in Azerbaijan.

The Ministry announced that the arrangement of 51 agro-parks and huge farms on 240,000 ha in 32 regions is underway. 35 of them are specialized in crop production, 14 in crop production and animal husbandry, 1 in

animal husbandry, and the other ones in sorting-packaging, processing and logistics. Some 43 agro-parks have already been launched, and design work is being carried out in others.
According to the Ministry, out of total 80.000 ha of watered land in 43 agricultural parks, 40.000 ha are watered by pivot, 31.000 ha by traditional methods, 2000 ha by sprinkler watering systems, and 7000 ha by drip watering.

Table 1: Methods of watering

Methods	**Amount of land (ha)**
By pivot	40 000
By traditional	31 000
By sprinkler	2 000
By drip watering	7 000
Total	**80 000**

Source: The Ministry of Agriculture of the Republic of Azerbaijan

In Azerbaijan, agro-parks carry a necessary responsibility in agriculture by boosting employment, as well. At present, 4750 permanents and more than 4800 temporary workers have been hired in agricultural parks and more than 4500 extra work places will be opened in the future.
In 2020, 18.500 tons of cotton, 64.600 tons of barley, 32.300 tons of alfalfa, 90.400 tons of sugar beet, 45.500 tons of corn for silage, 124.300 tons of wheat, 5.900 tons of soybeans, 121.600 tons of corn, 27.400 tons of milk and 3.300 tons of meat were produced in the agro parks.

Table 2: Production of various cultures in agro parks

Cultures	**Amount (thousand tons)**
Cotton	18.5
Barley	64.6
Alfalfa	32.3
Sugar Beet	90.4
Silage	45.5
Wheat	124.3
Soybeans	5.9
Corn	121.6
Milk	27.4
Meat	3.3

Source: The Ministry of Agriculture of the Republic of Azerbaijan

In 2017-2020, orchards with a total area of 7 500 ha were arranged in agro parks, 12 000 tons of which are apples, 393.5 tons are olives, 183 tons are almonds, 200.7 tons are pomegranates, 165.7 tons are grapes, that had been harvested.

Table 3: Amount of fruits harvested in agro parks

Fruits	**Amount (tons)**
Apples	12 000
Olives	395.5
Almonds	183
Pomegranates	200.7
Grapes	165.7

Source: The Ministry of Agriculture of the Republic of Azerbaijan

What will be the role of the digital system in the development of agriculture today, and to what extent are farmers ready for it?

The implementation of digital agricultural measures in the country is primarily aimed at strengthening relations, information base, substantiation of facts and operative implementation. It will be an indicator of how, in what form and when the work in one area is carried out. Today we live in the digital era, it is important to implement the information urgently, to eliminate the existing shortcomings in this area. The Ministry of Agriculture has been holding such events for a long time. In certain areas, these events have been held for several years for the development of animal husbandry, fruit growing and crop production. But it needs to be further developed and accelerated. In general, these measures are aimed at the development of agriculture in the country, and I think they will show positive results.

In my opinion, first of all, it is necessary to educate farmers, because today there are many farmers who work in an old, primitive way. They do not value the database well. I know a farmer who has a lot of opportunities to develop his field, for example, to develop livestock. There is enough pasture, including livestock. However, he is unaware of certain issues, measures taken, the importance of drugs and their use. Therefore, it happens that 50 animals of a farmer engaged in animal husbandry die suddenly. This is due to the fact that the animals were not informed in time and medical veterinary measures were not taken. That is why it is very important to educate farmers. Therefore, most farmers are unaware of certain technologies and innovations, so there are certain problems in animal husbandry, crop production and other areas. As a result, when problems arise, they blame it on the state, they consider it as carelessness. In fact, this is not the case. There are examples of foreign countries. For example, if a farmer is engaged in animal husbandry, he must work with a zoo-technician or a veterinarian, or there with an accountant to calculate these economic figures economically. Or several farmers take such specialists together. But we are lack of it. We have farmers who have been growing grain in the same place for 5 years. They do not know that if grain is planted in any field for 3 years continuously, there will be no productivity in that place. Or planting cotton on a regular basis can greatly reduce productivity. Today, the main task set by the President of Ministry of Agriculture, is to move to the crop rotation. Switching to the crop rotation is very important to increase productivity. Even in Soviet times, in case, when the land was cultivated for 1-2 years, it was left alone and provided with certain minerals in order to achieve future productivity. But now farmers and entrepreneurs often face certain difficulties because they do not know those issues, and also because they are not familiar with new technologies. Therefore, it is necessary to obtain this information first. They must refer to the specialists. Unfortunately, we still have problems in this area. If a farmer has a field, as the owner, he thinks that he can get a higher income if he'd take all the measures by himself. He is an accountant, agronomist, economist, veterinarian at the same time in there, and this is to some extent detrimental to all work.

Digital agriculture is a very important program for the development of agriculture in general. The entire information system is managed from a digital center, and this is a pretty working system. But the point is that it is necessary to create the first agricultural self-production. It's like we don't have a pine tree, but we buy lights and toys to decorate it. Because they need to spend money, and there is corruption here. This is concrete. "According to the expert, currently the country's agriculture is able to meet 40-45 percent of demand by 2020:" This means that we have not yet organized production. Some time ago, we installed refrigerators, buildings were built for 54 agricultural departments in the regions, and there are people working in those departments and receiving salaries. However, so far there has been no increase in agricultural production. Because our first task in the country is to revive agriculture, to tie farmers to the land, to have the desire to grow crops. That is, we must first build traditional agriculture, and then move to a digital system. Today, the farmer has no desire, ability or capital to produce. At best, they can produce cotton, because they provide funds and funds for cotton production. However, the country's farmer does not have the funds to develop other industries than cotton. It is a situation where it is not profitable for a farmer to produce. He uses the land in his hands as pasture, produces alfalfa or cotton. After all, today the country's demand is not only for cotton, alfalfa and grain. Who should meet these needs, and how long should we import these products? We must first build traditional agriculture, and then

move to a digital system. This is the demand of the time. However, the digital system is not based on ruins, but on production, which we do not have today.

VI. Conclusion

The complex application of digital technologies will make it possible to solve a number of existing problems and tasks of processing huge amounts of data and overcome most technological barriers. A roadmap for the digitalization of agriculture has been created, which displays the stages of project implementation by region. For developed countries, digital agriculture has already become commonplace, and in our country, despite the achievements of recent years, the share of digital technologies is still extremely small. That is why it is necessary to highlight the main reasons for the lag in the development of digital agriculture.

- Firstly, the low share of coverage of the territory of the regions with the Internet and communications
- Secondly, the lack of funding. These projects are very costly and, as a rule, are designed for a long payback period.
- Third, problems in the legal framework: lack of necessary legal mechanisms to regulate the use of digital technologies.
- Fourth, the lack of the necessary specialists

At the end of this research paper, the following recommendations are preferred:

1. It is necessary to create legal, organizational and technological conditions for the digital transformation of the agro-industrial complex. The necessary level of the nationwide information and communication environment must be provided. The support of the national market of digital technologies, the development of software, and computing and network infrastructure of the agro-industrial complex is required.
2. It is crucial to support the implementation of digital technologies in agriculture by personnel in order to provide a favorable environment for the formation and development of "smart" agriculture.
3. The introduction of digital technologies in related to the agricultural sector, the use of their potential for the implementation of digitalization, which are important for agriculture. These industries - industry, transport, trade, management, finance and banking, insurance - can have a transformative impact on agricultural enterprises.
4. Implementation of the concept of "digital agricultural company". A digital agricultural company is a company whose products and services, processes (both customer-oriented and internal) must be digitized and receives digital interfaces.

Summing up, we note that digital agriculture in our country is an important factor in the development of the national economy, which means that this direction requires special attention. The introduction of digital technologies in the agricultural sector makes it possible, on the one hand, to reduce the use of external resources, and on the other, to maximize the use of production factors of a local nature.

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