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STRENGTHENING FOOD SECURITY THROUGH THE DEVELOPMENT OF DIGITAL AND SMART AGRICULTURE IN UZBEKISTAN

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Abstract:
The article focuses on strengthening of food security through development of digital and smart agriculture in Uzbekistan. In particular, aspects for assessing food security, the factors influencing the food security and sustainable agricultural development in the country were assessed. Attention is also paid to increasing the efficiency of land, water and other natural resources through the introduction of modern digital technologies.

Keywords: global pandemic; Sustainable Development Goals; food security; food supply chain; eliminate hunger; production potential of agriculture; digital transformation; digital technologies; agriculture-4.0; smart agriculture; smart garden, smart greenhouse, smart farm.

Introduction

In recent years, the level of hunger and poverty is increasing due to various crises, climate changes, political tensions and wars, pandemics, which have occurred in the world. According to joint research of the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD), the United Nations International Children's Fund (UNICEF), the World Food Program (WFP) and the World Health Organization (WHO): during 2015-2021 years, the number of people suffering from hunger worldwide increased from 8.0 to 9.8%. In 2021, from 702 to 828 million people could not eat enough. The number of people who faced a hunger and undernourishment during COVID-19 pandemic in 2019-2020 was 103 million, and in 2021 it was additionally increased to 46 million. Due to high cost of healthy food almost 3 billion people in the world with high poverty and income inequality will not be able to eat enough and 11.7% of the world's population may face food insecurity in the future (FAO, IFAD, UNICEF, WFP and WHO, 2022).

In this context, the importance of food supply and security around the world is growing. The United Nations General Assembly in 2015 has identified food security and sustainable agriculture as one of the 17 global objectives of the 2030 Agenda for Sustainable Development Goals: “Eliminate hunger, ensure food security, improve nutrition and promoting the sustainable development of agriculture” (United Nations, 2015). Therefore, agriculture and food production are becoming the most important issues today. According to the World Bank “agriculture is the largest sector of and the largest employer in Uzbekistan’s economy, and has a large role to play in reducing poverty and inequality through job creation” (World Bank, 2020).

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As noted by the President of the Republic of Uzbekistan Shavkat Mirziyoyev "in conditions of global crises and pandemic agriculture and food production are becoming the most pressing issue today" (Mirziyoyev Sh.M., 2020). The "Strategy of the development of agriculture of the Republic of Uzbekistan for 2020-2030", approved by the Decree of the President of the Republic of Uzbekistan dated from October 23, 2019 No PF-5853, provides the following tasks for the implementation: development of state policy on food security; development of food safety and improvement of consumer rations; improvement of mechanisms for production required amount of food; monitoring of food safety assessment system based on internationally recognized methodologies and best practices; creation of a favorable agribusiness environment and value chain involving the production of high value-added agricultural and food products.

The issue of ensuring global food supply and security is, first of all, inextricably linked with the modernization and digitalization of agricultural production, that is, with the introduction of the concepts of "Smart Agriculture" and "Agriculture 4.0". The article analyzes the issues of strengthening food security and reducing poverty through the digitalization of agriculture and the introduction of "smart agriculture".

Literature review

Research, conducted by Griggs D. and scientists group shows that "further human pressure risks causing widespread, abrupt and possibly irreversible changes to basic Earth-system processes. Water shortages, extreme weather, deteriorating conditions for food production, ecosystem loss, ocean acidification and sea-level rise are real dangers that could threaten development and trigger humanitarian crises across the globe. The growing affluence and the right to development among the world's poor demand that people of all nations make the transition to sustainable lifestyles (Griggs D. et al., (2013).

According to Robert K., Parris T. and Leiserowitz A. "a minimal sustainability transition would be one in which the world provides the energy, materials, and information to feed, nurture, house, educate, and employ the many more people of 2050 - while reducing hunger and poverty and preserving the basic life support systems of the planet" (Robert K., et al., 2005).

According to a group of Russian scientists led by Ushachev I., "food security" is a complex concept that includes food independence and access to food, physically and economically. "Food independence" is a concept determined by the country's self-sufficiency in food products, based on the level of normative and actual consumption, that is, the ratio of production in the country to total domestic consumption of all types (Ushachev I. et al., 2015).

As noted in the research of Russian scientists A.Tatarkin and S.Polbitsyn, the doctrine of food security of the countries reflects the level of quality and minimum provision of the population with the food they can buy. Thus, food security can be considered as the physical, economic and social provision of food products that meet the needs and preferences of consumers (Tatarkin A., Polibitsyn S., (2015).

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According to Future Market Insights analysts, the transition to "smart agriculture" in the world is happening slowly but surely. Most of the market (53%) is located in North America. This is due to the great interest of American farmers in smart innovations. IT-technologies are actively used on land plots, mainly for growing crops, and this is called "precision farming". In general, Goldman Sachs Group analysts note that many countries are actively developing their agriculture, moving from "analogue" to "smart". According to their forecast, with the introduction of new technological solutions by 2050, it is possible to achieve 70 percent growth in agriculture worldwide. It's almost $800 billion additional product (www.xabar.uz, 2021).

In the national literature of Uzbekistan we can highlight the researches of a number of scientists (Saidova D.N., Rustamova I.B., Tursunov Sh.A., 2016; Abulkosimov Kh.P., Rasulov T.S., 2015; Ilyina D.N., 2020; Sotvoldiev N.Yu., 2017; Isadjanov A.A., Kendjaboeva R.M., 2015).

Data and Methods

In preparing this article, materials and statistical data of the United Nations Organization (UN), Food and Agricultural Organization of the United Nations (FAO), the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan were widely used.

The results of scientific research of national and foreign scientists engaged in the analysis of global food security and digital agriculture served as a theoretical and methodological basis for this research. In the preparation of the article used abstract and analytical observation, analysis and synthesis, normative and positive analysis, comparative and factor analysis, multivariate correlation analysis, economic-statistical and other methods.

Discussions

A review of the scientific literature and other sources shows that "food security" concept was first introduced into consumption in the 1970s. Later, this concept expanded in meaning. According to the definition proposed by the World Bank at the 1996 World Summit on Food Security, "the ability of all people, both physically and economically, to obtain adequate, safe and nutritious food at all times to lead an active and healthy lifestyle - represents food safety" (World bank, 1986). Subsequently, the 2009 World Summit on Food Security identified the following 4 aspects of food security assessment (Table 1).

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Table 1. Food safety indicators, developed by the Food and Agriculture Organization of the United Nations (FAO)

Aspects	Explanation of concepts
Food availability	Physically, the availability of food depends on the volume of production, stocks and the balance of food exports / imports
Opportunity to obtain food	Physical and economic access to food. Economically - at the disposal of the population, with food prices and the level of social protection; Physically - it is determined by the availability of infrastructure to support the functioning of markets
Food consumption	Absorption of various nutrients present in food by the human body. Adequate consumption of nutrients and energy is ensured through the use of food preparation, diet and care methods, distribution of food within the household
Sustainability of food supply	The stability of the other three factors mentioned above over time. If a person from time to time has a risk of not getting enough food and quality (under the influence of unemployment, inflation and other factors), he is considered vulnerable in terms of food security

Source: www.fao.org

Producing enough food does not mean that food security has been ensured. The "Concept of Food Security" adopted by the UN Rome Declaration in 1996 sets out its basic principles: food security is not just self-sufficiency in food; if the country has comparative advantages, it should produce enough food for its own needs; if necessary, the country should be able to import the required amount of food to meet the needs of its citizens; the government must ensure that food is safe for its citizens, both physically and economically; it is necessary to take into account the growing and changing individual needs of the population in ensuring food security; the country can ensure food independence of the country regardless of external factors; food supply must be resistant to seasonal and climatic factors (World bank, 1986).

Global food supply and security issues have always been in the focus of the world community. In particular, the historic summit of the UN General Assembly in September 2015 adopted 17 global goals and 169 tasks "Sustainable Development Goals – SDG", which are to be implemented by 195 countries by 2030.

Sustainable development presupposes a path of development that meets the interests of present generations without compromising the needs of future generations. Such development reflects the aspirations of people around the world to work together for a sustainable, inclusive and bright future.

SDG's first goal is the "end all forms of poverty" worldwide by 2030. It is estimated that more than 780 million people on the planet still live in extreme poverty, and more than 70% of them earn less than $1.9 a day. In the richest countries of the world, more than 30% of children are forced to live in poverty. Almost 80 percent of the world's extreme poor live in rural areas where most are dependent on agriculture (United Nations, 2015).

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The second goal of the SDG is the "eliminate hunger, ensure food security, improve nutrition and promoting the sustainable development of agriculture". According to FAO's research: malnutrition exacts high economic and social costs on society; two billion people do not consume enough vitamins and minerals; one in three of the world's population cannot eat on a complete ration; 45% of all under-five deaths worldwide are due to malnutrition, and 3.1 million children die each year as a result. Sustainable development of agriculture will provide an opportunity to eliminate hunger in rural areas, feed families and live a decent life in exchange for adequate food production and job creation.

According to UN forecasts, the world's population could reach 10 billion by 2050, complicating the task of providing adequate and quality food to the world's population in the face of increasing degradation of agricultural land and declining water resources. At a time when 2.6 billion, or more than 33% of the world's population live in rural areas, 52% of agricultural land has been severely degraded, resulting in a significant decline in soil fertility. As a result of drought and desertification, 12 million hectares of land (23 hectares per minute) are out of use every year. However, these areas could produce up to 20 million tons of grain per year. Land degradation is negatively affecting the living standards of 74% of the world's poor population. At the same time, such drastic changes in the planet's climate, "global warming" and environmental pollution will have an impact on agricultural productivity (United Nations, (2015).

Analysis and Results

Food supply and security rely primarily on the potential of the agricultural sector. Although the share of gross agricultural output in the country's GDP fell from 34.4 to 27.1%, and the share of agriculture in the population employed in all sectors of the economy from 34.4 to 26.9% in 2000-2020, the agricultural sector still remains one of the largest sectors of economy of Uzbekistan (Table 2).

Table 2. Dynamics of key macroeconomic indicators of development of the agricultural sector in Uzbekistan1

Indicators	2000	2005	2010	2015	2020
The share of agriculture in GDP, in %	34.4	29.5	32.9	34.1	27.1
Annual growth rates of gross agricultural output, in % compared to the previous year	103.1	105.4	106.3	106.1	102.7
The share of agriculture in fixed capital investments, in %	5.7	4.4	3.5	3.3	7.0
The share of agriculture in the population employed in all sectors of the economy, in %	34.4	29.1	26.8	27.6	26.9

1including forest and fishing branches

Source: State Statistics Committee of the Republic of Uzbekistan. www.stat.uz

Certain results have been achieved in strengthening the production potential of agricultural sector of the Republic of Uzbekistan. As a result, the volume of production of basic agricultural products has increased significantly.

According to the State Statistics Committee of the Republic of Uzbekistan, despite the fact that, from 2000 to 2020 the permanent population of the country increased by 38.7% and the total area under crops decreased by 11.8%, per capita production of wheat was increased by 38.6%, vegetables by 181.3%, potatoes by 206.4%, melons by 237.7%, fruits by 153.6%, grapes by 83.8%, meat (live weight) by 115.8%, milk by 117.6% (Table 3).

Table 3. Dynamics of per capita production of basic types of agricultural food products in Uzbekistan, in kilograms

Indicators	2000	2005	2010	2015	2020	2020 to 2000, in %
Wheat	159.4	231.5	236.1	222.5	221.0	138.6
Vegetables	107.3	134.4	222.2	320.8	301.8	281.3
Potato	29.7	35.3	59.3	85.4	91.0	306.4
Melon crops	18.3	23.5	41.4	58.7	61.8	337.7
Fruits	32.1	36.3	59.9	87.0	81.4	253.6
Grapes	25.3	24.5	34.6	50.0	46.5	183.8
Meat (live weight)	34.1	40.6	51.3	61.4	73.6	215.8
Milk	147.4	174.1	216.0	288.4	320.7	217.6
Information for comparison:						
Permanent population, in thousand people	24 908 .2	26 312. 7	29 123. 4	31 575. 3	34 558 .9	138.7
Total crop area, in thousand ha	3 778.3	3 647.5	3 708. 4	3 694. 2	3 371.1	89.2

Source: State Statistics Committee of the Republic of Uzbekistan. www.stat.uz

Most importantly, this increase was not due to extensive factors, but to intensive factors such as productivity of resources, using modern technologies and etc. In particular, in the years of 2000-2020, cotton yield increased from 21.8 to 28.8 centners or 32.1%, wheat from 27.8 to 45.4 centners or 63.3%, potatoes from 129.3 to 213.4 centners or 65.0%, vegetables from 183.8 to 234.4 centners or 27.5%, vegetables from 132.4 to 168.3 centners or 27.1%, fruits and berries from 56.9 to 116.7 centners or 105.1%, grapes from 63.1 to 152.0 centners or 140.9% (Fig. 1).

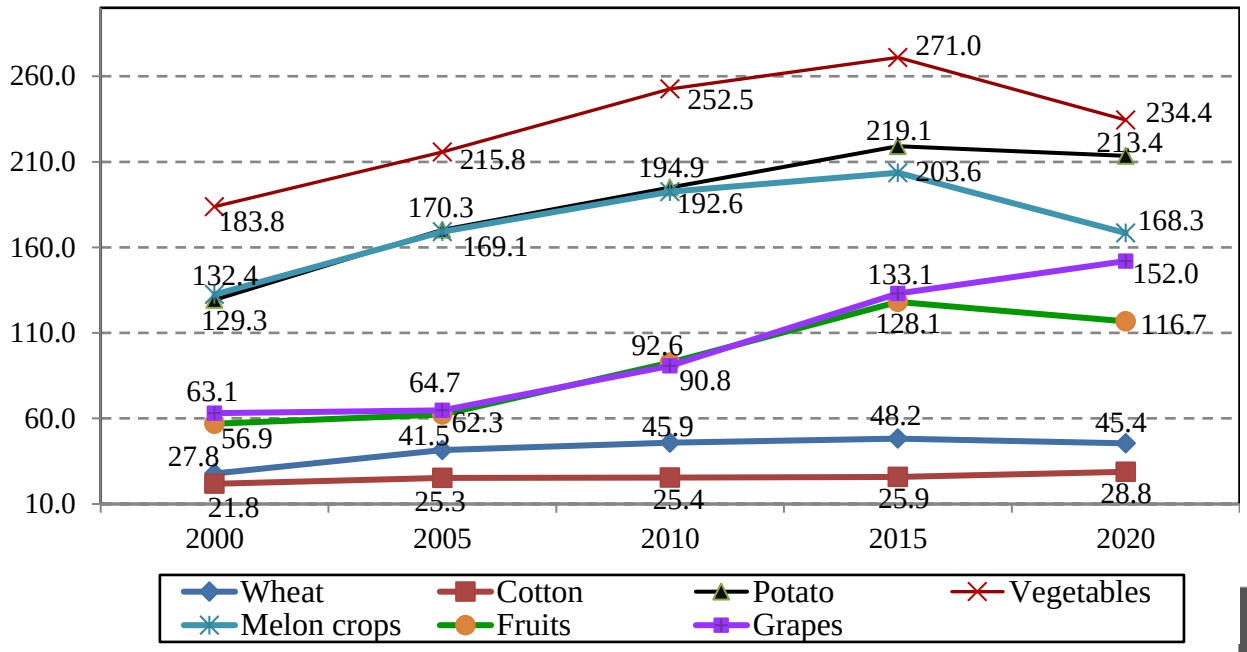

Figure 1. Dynamics of productivity of the main types of agricultural crops, centners/ha
Source: State Statistics Committee of the Republic of Uzbekistan. www.stat.uz

As a result of the implementation of measures to strengthen food security in the country, Uzbekistan has gradually improved its position from a score 24.3 to 5.9 (-18.4 p.p.) in Global Hunger Index (GHI) in 2000-2021 and in 2021 ranked 21st with low level of hunger (Global Hunger Index (GHI), 2022).

As confirmed a scientific research conducted by the author, a number of factors affect the sustainable development of agricultural sector. To determine the influence of various factors on the development of the agricultural sector for the period 2000-2016, the author used a multivariate econometric model. The model included the following factors: effective indicator - gross agricultural output in 2016 prices (Y) in billion sums; as factors influencing gross agricultural output - total area of agricultural crops, thousand hectares (X1); the value of investments in fixed assets attracted to the sector, billion sums (X2); the number of people employed in agriculture, thousand people (X3); the value of fixed assets of agriculture, billion sums (X4); the volume of mineral fertilizers applied to the sown area, thousand tons (X5); volume of water consumption in agriculture, mln.m3 (X6).

Calculations showed that there were the following interdependencies between the effective indicator (Y) and the factors influencing it: with the investments in fixed assets (X2) (0.9649) and the amount of fixed assets in agriculture (X4) (0.9912) were dense; with the amount of population engaged in agriculture (X3) (0.8567) was average; with the volume of agricultural crops area (X1) (0.5451) was weak and with the volume of water consumption in agriculture was very weak (0.1559).

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Based on the calculations made in the model, the average value of an increase in gross agricultural output (Y) as a result of changes in the influencing factors included in model was calculated:

$$y = 39662{,}6759 + 2{,}6723x_1 + 4{,}1361x_2 - 11{,}2902x_3 + 1{,}5466x_4 - 2{,}7368x_5 + 0{,}074x_6$$

(3,222) (0,788) (2,039) (-4,093) (8,338) (-0,424) (1,214)

According to this model (1), an increase in the value of fixed capital investment (X2) by one billion Uzbek soum may contribute to an increase in the value of gross agricultural output (Y) by 4.1346 billion soum; an increase in total crop area (X1) by 1,000 hectares to an increase by 2.6723 billion soum; an increase in the value of fixed assets (X4) by one billion soum to an increase by 1.5466 billion soum.

In this case: R2 = 0.9945, flattened R2 = 0.9911. Hence, the effective indicator is sufficiently closely related to the factors included in the model. That is, the change in the value of gross agricultural output depends on 99.45% of the factors included in the model, and the remaining 0.55% of factors not taken into account (Yusupov M., 2018).

From the above model, it is clear that one of the most influential factors in the growth of gross agricultural output is investment in fixed capital in the sector. But, the issue of attracting private investments to the agricultural sector is extremely limited due to low profitability in the sector and slow capital turnover, as well as the lack of pledge to attract loans from commercial banks and international financial institutions. In the period 2000-2020, the share of agriculture in fixed capital investment remained on average 4.6%.

In particular, from 2005 to 2015, 28.6 to 42.5% of total investments in fixed capital in agricultural sector were centralized public investments financed from the state budget, and only in 2020 this indicator decreased to 15.9%. During the 2005-2020 years the share of funds of enterprises and organizations in fixed capital investments decreased from 37.9 to 9.3%, while the share of foreign investments and loans increased from 15.1 to 41.4% (Table 4).

Table 4. Composition of investments in fixed capital of agriculture by sources of financing

Indicators	2005	2010	2015	2020
The share of agriculture in fixed capital investments of their total volume, in % to total	4.4	3.5	3.3	6.2
Distribution of investments in agriculture by sources of financing, in % to total				
Total, including	100	100	100	100
state budget allocations	28.6	32.9	42.5	15.9
funds of enterprises and organizations	37.9	17.3	31.8	9.3
bank loans and other borrowings	15.3	27.8	20.5	16.7
foreign investments and loans	15.1	7.1	4.7	41.4
other sources	3.1	14.9	0.5	16.7

Source: State Statistics Committee of the Republic of Uzbekistan. www.stat.uz

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It is known from the data given in Table 4, the share of state budget funds in total investments in agricultural sector is still remaining of a large amount, and the attraction of private sector funds remains low. Due to the absence of private ownership of land, as well as the frequent optimization of the land areas of farms conducted by the government from 2006 to 2020 several times (although the lease term for land plots by farmers is up to 50 years), it remains very difficult to attract private investors to the agricultural sector and the farmers have lost the confidence in the efficient use of these lands.

The issue of food security of the country depends primarily on the efficient use of agricultural arable land. Only 20.7% of the 20.2 million hectares of agricultural land are irrigated. Over the last 15 years, per capita irrigated land has decreased by 24% (from 0.23 to 0.16 hectares). This is due to population growth and the transfer of agricultural land to other land categories. Over the next 30 years, irrigated land is projected to reduce by another 20 to 25 percent (Yusupov M.S., 2020).

Most of the available arable land in the country is more or less saline due to the proximity of groundwater and other reasons. As January 1, 2020, the share of saline lands relative to total irrigated lands was 45.0% (Table 5).

Table 5. Dynamics of changes in the salinity of irrigated lands in the country in 2008-2020, in % to the total irrigated lands

Land types	2008	2010	2012	2014	2016	2018	2020	2020 to 2008, (+,–)
Unsalted lands	49,78	50,41	51,40	52,52	54,42	55,6	55,0	+ 5,22
Saline lands	50,22	49,59	48,6	47,48	45,58	45,4	45,0	– 5,22

Source: The Ministry of Agriculture of the Republic of Uzbekistan (2008-2016) and the Ministry of Water Resources (2018-2020)

High salinity of irrigated lands and low quality indicators (with a score of 55 on a 100-point scale) have a negative impact on crop yields, leading to significant additional costs associated with leaching of soil salinity and increasing soil fertility. According to the Ministry of Agriculture of the Republic of Uzbekistan, 18.0% of total irrigated lands belong to poor and below-average category lands with class I-IV, 53.0% to average category lands with class V-VI, 29.0% to good category lands with class VII-X. It can be seen that the share of poor, below-average and average lands is 71.0% of the total agricultural arable land area (Ministry of Agriculture of the Republic of Uzbekistan, 2020).

According to the Ministry of Water Resources, to improve the reclamation of irrigated lands in the country, the total length of 142.9 thousand km, as well as 172 reclamation pumping stations, 3,897 vertical drainage wells are used. During the period from 2008 to 2017, within the framework of the State Programs on Improvement of Irrigated Land

Reclamation and Rational Use of Water Resources, more than 3.2 trillion soums were allocated from the state budget for the building and reconstruction of irrigation systems. In addition, 2.5 trillion soums were allocated for the construction and repair of land reclamation facilities during this period. However, despite large expenditures from the state budget and the special funds, it has been possible to reduce the salinity of irrigated lands by 5.2% over the last 12 years and this problem remains relevant (Ministry of Water Resources of the Republic of Uzbekistan, 2020).

More than 91% of agricultural food products in Uzbekistan are grown on irrigated lands. However, given the fact that the country is located at the bottom of transboundary watercourses, and only 20.0% of water resources are formed in the country, the remaining 80.0% in neighboring Tajikistan and Kyrgyzstan, the problem of water supply for irrigation may be complicated in the future. Recently, the number of years of water shortage in the region has been increasing. If before 2000 the water shortage was repeated every 6-8 years, in recent years it has been observed every 3-4 years. It is obvious that the rational and efficient use of every drop of water is becoming one of the most urgent tasks not only in Uzbekistan but all over the world. The total water deficit in Uzbekistan until 2015 amounted to more than 3 billion cubic meters, by 2030 it may reach 7 billion cubic meters, and by 2050 – 15 billion cubic meters.

In recent years, the average annual volume of water resources used in Uzbekistan is 51-53 cubic kilometers, which indicates a significant reduction in total water intake (20%). 90% of water resources is consumed by agriculture. At the same time, the population of the country will increase by an average of 650-700 thousand people a year and reach 39 million by 2030, and it is expected, that their demand for quality water will increase from 2.3 billion cubic meters to 2.7-3.0 billion cubic meters (18-20%) for this time. This leads to an increase in the demand for water in the utilities sector from year to year. In recent years, industrial and energy sectors are actively developing, and their demand for water is growing every year. It is estimated that the total annual water consumption of these sectors will increase from 1.9 billion cubic meters to 3.5 billion cubic meters (1.8 times) by 2030.

Over the last 40 years, the population of Uzbekistan increased from 15 to 34 million. As a result of this per capita water consumption decreased from 4403 to 1600 cubic meters in 1980-2019. Nevertheless, per capita water consumption in Uzbekistan remains high compared to developed countries, such as: Switzerland - 1000 cubic meters, Turkey - 550 cubic meters, Germany - 460 cubic meters, in Israel - 300 cubic meters, Singapore - 45 cubic meters (Ministry of Water Resources of the Republic of Uzbekistan, 2020).

As a result of the disproportionate distribution of water resources and the uneven complex relief of irrigated lands, about 60% of irrigated lands are supplied with water by 1,687 pumping aggregates, with an annual electricity consumption of 8 billion kWh. In addition, a total of 155.2 thousand km of irrigation networks and more than 10,280 pumping aggregates are used by water consumers' associations, farms and clusters. The cost of water supply through the pumping aggregates is covered from the state budget of Uzbekistan and a large amount of money is spent for this direction each year.

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According to the Fund for State Support of Agriculture under the Ministry of Finance of the Republic of Uzbekistan in the framework of the implementation of the Decree of the President of the Republic of Uzbekistan dated February 28, 2018 No-3574 "On measures to significantly improve the financing system for the cotton and grain cultivation" 150.8 billion sums in 2019, and 344.6 billion sums in 2020 were allocated from the state budget to cover the cost of pumping aggregates, irrigation wells and electricity consumed for cultivation to support farmers (Ministry of Water Resources of the Republic of Uzbekistan, 2020).

The high demand for irrigation water due to the obsolescence of irrigation methods in the face of scarcity of surface and groundwater resources is another obstacle to strengthening food security. In recent years, drip irrigation has become important as one of the effective options to reduce soil salinity, increase soil fertility and crop yields (Table 6).

Table 6. Advantages of implementing of drip irrigation systems

Crop type	Water saving rate, in %	Labor cost savings, in %	Mineral fertilizer savings, in %	Productivity increase, in %
Cotton	30-40	50-60	Depending on the type of crop - until 50%	90-150 %
Gardens and vineyards	40-60	25-30		20-25 %
Vegetable and melon crops	50-55	50-60		55-65 %

Source: Ministry of Agriculture of the Republic of Uzbekistan

The advantage of the widespread introduction of drip irrigation is that this technology, on the one hand, eliminates soil salinity, on the other hand, helps to eliminate the problem of water scarcity. According to the Ministry of Agriculture of the Republic of Uzbekistan, drip irrigation of vegetables and melons in the country will reduce water consumption by 50-55, labor consumption by 50-60, mineral fertilizers by 50% and increase productivity by 55-65%.

In addition: soil erosion stops, groundwater level and soil salinity decreases; soil does not harden, inter-row cultivation and tillage are reduced; fertilizer is applied with water and its absorption rate increases; water evaporates less from the soil, so that water does not flow in vain; the root layer of the crops is constantly supplied with moisture, allowing it to absorb water and nutrients. In this case, the plant directs all its energy to increase the yield.

In recent years, the government of Uzbekistan has implemented the practice of providing below listed subsidies from the state budget and extra-budgetary funds for the introduction of drip irrigation technologies in irrigated areas: in the cultivation of raw cotton - in the amount of 8 million sums per hectare; in the creation of new vineyards - in the amount of 8 million sums per hectare; in the creation of new gardens

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and greenhouses - in the amount of not more than 6 million sums per hectare. Despite the large-scale measures taken in recent years, the introduction of drip irrigation and other modern water-saving technologies in the country remains low (in 2019 – 4 % of all irrigated crop lands). In the "Concept of Water Resources Development of the Republic of Uzbekistan for 2020-2030" it is planned to expand of modern water-saving irrigation technologies from 4,0 to 47.0%, and expansion of areas with drip irrigation technologies from 1,77 to 14.1% to total irrigated lands.

One of the important factors strongly influencing the efficiency of agricultural production is fixed assets. To increase the efficiency of production, agriculture needs modern high-performance machines and equipment. But from the data of the Ministry of Agriculture of the Republic of Uzbekistan it is clear that most of the agricultural tractors and machinery has a service life of more than 10 years and this negatively affects the performance of this agricultural machinery (Table 7).

Table 7. Distribution of the main types of agricultural tractors and machines in the agricultural sector of the Republic of Uzbekistan by service life, in % of total (2020)

Type of tractors and machines	Total	of which by service life						
		1-5 years	6-10 years	up to 10 years, total	11-15 years	16-20 years	more than 20 years	more than 11 years total
Land plowing tractor	100	32	23	55	16	13	16	45
Cultivation tractor	100	21	20	41	22	16	21	59
Grain harvesters (combine)	100	38	21	59	14	11	16	41
Forage harvesters (combine)	100	25	19	44	13	13	30	56
Cotton picking machine	100	84	7	91	0	3	6	9
Tractor trailer	100	15	13	28	19	17	36	72
Cotton seeder	100	27	20	47	15	13	25	53
Grain seeder	100	45	11	56	9	11	24	44
Cultivators	100	22	18	40	18	15	27	60
Chisel	100	8	11	19	18	20	43	81
Plow	100	27	20	47	15	15	23	53

Source: Based on the information of the Ministry of Agriculture of the Republic of Uzbekistan

According to the State Committee on Statistics of the Republic of Uzbekistan for 2005-2020, the degree of depreciation of fixed assets in agriculture decreased from 29.2 to 14.7% (-14.7 p.p.), the degree of renewal increased from 7.8 to 27.8% (20.0 p.p.) (Table 8).

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Table 8. The dynamics of changes in the fixed assets of the agricultural sector (including forestry and fisheries)1) (at current prices)

Indicators	2005	2010	2015	2020	2020 to 2000, p.p.
Fixed assets depreciation rate, in %	29,2	37,0	29,5	14,5	-14,7
Fixed assets renewal rate, in %	7,8	11,0	15,0	27,8	+20.0
Fixed assets disposal rate, in %	1,9	4,1	1,7	5.3	+3.4

1) without livestock
Source: Based on the information of the State Statistics Committee of the Republic of Uzbekistan. www.stat.uz

Despite the positive developments in this area, there is a shortage of tractors and agricultural machines during the preparation of land for sowing, vegetation and harvesting season.
According to research by the Food and Agriculture Organization of the United Nations (FAO UN), the digitalization of agricultural production or the introduction of "smart agriculture" in the pursuit of sustainable development goals will improve the production efficiency in the agricultural sector due to the optimization of resource use, expansion of communications and high inclusion, and renewal provides flexibility to market conditions (Trendov N., Varas S., Szen M., 2019).
But there are basic conditions for implementing digital transformation in agriculture, which can include:
- minimum conditions enabling the use of digital technologies: availability of digital technologies; opportunities to connect to them physically and financially; level of computer literacy of the population; level of education in the field of information and communication technologies; political measures in the field of digital technologies (e-government, etc.);
- conditions that support (satellite) digital technologies: the spread of the Internet, mobile communication and social networks and the possibilities of their use; digital technology skills; entrepreneurship and innovation support (business incubators, start-ups and other innovative programs).
Today, developed countries are entering the innovative phase of development "Agriculture - 4.0", introducing "smart agriculture" into agriculture based on digital technologies, in particular: broadband Internet, mobile communications, information technology (information data, artificial intelligence, automated control platform) , machinery and equipment (unmanned tractors and machines, unmanned drones, stamps, controllers, sensors, controls), advanced and efficient management methods such as "Digital technologies in the management of the agro-industrial complex", "Smart agriculture", "Smart field" , "Smart Garden", "Smart Greenhouse", "Smart Farm" and etc.

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In the context of digital transformation in the world, the Republic of Uzbekistan lags behind developed foreign countries in terms of the development of the agrarian sector: labor productivity and efficiency of agricultural production. In particular:

- if in developed countries the proportion of the employed population in agriculture is 1.3-5%, in Uzbekistan this figure is higher than 26%, which causes the country to be classified as a developing country;
- labor productivity in the branch ($2,247 per worker, in 2017) is several times lower than in developed countries ($95,243 in Israel; $49,475 in France, in 2017) ("BUYUK KELAJAK", 2019);
- the use of old traditional methods of irrigation leads to excessive consumption of water in conditions of water shortage, as a result of which more than 45 percent of irrigated arable land is saline and crop yields are reduced;
- the level of providing the branch with high-performance and resource-saving equipment and technologies (mechanization and automation) remains low (most of the agricultural machines and equipment used in agriculture have been in operation for more than 15 years, their degree of wear is high and the renewal rate is low);
- most agricultural producers do not have electronic platforms for agrochemical soil analysis, optimal placement of crops using satellite navigation systems, automatic feeding and control of plants during the growing season;
- most of the livestock work processes are performed manually, there is practically no use of advanced technologies that allow automatic feeding and control of livestock and other work processes.

Decree of the President of the Republic of Uzbekistan dated from October 5, 2020 No. PF-6079 "On the approval of the strategy "Digital Uzbekistan-2030" and measures for its effective implementation", Resolution of the Cabinet of Ministers of the Republic of Uzbekistan dated December 17, 2020 No. 794 "On Measures to Develop the Digitalization System in the Agro-industrial complex and Agriculture of the Republic of Uzbekistan", and other regulatory legal documents allow the use of modern methods of agricultural production based on the concept of "Smart Agriculture" and "Agriculture 4.0", aimed at the rational use of land, water and other natural resources, automation of agricultural production, the introduction of innovative ideas and technologies to ensure the food security of the country.

The introduction of the concept of "Smart Agriculture"" and "Agriculture 4.0" in the agricultural sector of our republic is just beginning. Development the "Strategy of Smart Agriculture", approved by the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 794 dated December 17, 2020 "On measures to develop the agro-industrial complex and the digitalization system in agriculture of the Republic of Uzbekistan", provides for the implementation of the following tasks:

- introduction of digital information technologies in the use of agricultural land;
- management and use of water resources using modern computer technologies;
- introduction of automated control technologies in the organization of intensive orchards and the cultivation of fruits and vegetables;

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- introduction of automated, computerized intelligent technologies in greenhouses;
- introduction of modern technologies in the processes of storage and processing of agricultural products, organization of logistics and shopping centers equipped with modern information and communication technologies;
- training of qualified personnel on “smart agriculture” technologies for all areas of agriculture and advanced training of personnel;
- formation of a regulatory framework for the implementation of “smart agriculture” technologies.

But analysis show that today the level of application of innovative technologies based on digital technologies in the agro-industrial complex of the Republic of Uzbekistan is very low yet, and therefore the goals and objectives set within the framework of the strategy “Digital Uzbekistan-2030” are only expanding and relatively new not only to the republic, but also on a global scale. Obtaining the necessary sources of information and other tools is difficult due to the limited opportunities for the introduction of digital technologies, which requires the use of complex IT technologies, artificial intelligence tools and highly qualified specialists. For example, the use of digital technologies depends mainly on the development of the Internet. But, “despite the fact that 4G is considered the main technology for connecting to the Internet today, and 90 percent of subscribers worldwide are able to connect using technology no less than 3G, but only one third of the rural population in less developed countries uses 3G technology in the network [Trendov N., Varas S., Szen M., 2019].

Conclusions

Based on the results of this research, we make the following recommendations for strengthening food security by the development of digital and smart agriculture in Uzbekistan:

- expansion of scientific research aimed at studying the theoretical and methodological foundations of the Conception of “Agriculture 4.0” and “Smart Agriculture” based on digital technologies;
- development of mechanisms for the introduction of innovative methods, such as: “Digital technologies in management of the agro-industrial complex”; “Precise farming”, “Smart garden”, “Smart greenhouse” and “Smart livestock farm” based on the use of automated digital technologies and assessment of their impact on the economic efficiency;
- based on the analysis of the current state of the digital agricultural technologies in Uzbekistan, to identify the existing problems in connection with this, the factors affecting them, and conduct research to find their solutions;
- creation and forecasting of balanced models of optimal placement of agricultural crops using digital technologies, forecasting the development trends of food and resource markets, taking into account long-term climate change;
- based on studying the experience of using the “Smart Agriculture” system and digital technologies in developed countries, choose the most suitable ones and develop

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recommendations for their adaptation in accordance with the conditions of the Republic of Uzbekistan;

- creation of practical recommendations for the development and implementation of software for neural networks in the development of intelligent solutions, such as: platforms for managing and monitoring modern intelligent technologies for the effective organization of agricultural production (self-propelled vehicles and vehicles without a driver; navigation drones equipped with cameras and sensors; sensors, monitoring the body of livestock and crops, soil moisture and microclimate; automated systems for managing livestock farms, data analysis);
- to develop a unified digital platform for monitoring the "value added chain" and reducing losses associated with the loss of products in the chain "production - storage - primary and deep processing - sales of agricultural products".

In our opinion, given the importance of water-saving technologies, it is necessary to implement targeted state programs aimed at the introduction of drip irrigation every 5 years until the necessary level to increase the efficiency of water use, and for this purpose regularly allocate centralized public investment from the state budget. In addition to the state budget for measures to improve the reclamation of irrigated lands, it is necessary to attract long-term (10-15 years) investment loans from commercial banks, apply a privileged payback period at least 5 years and introduce the practice of reimbursing at least 50% of loan interest payments to commercial banks from the state budget.

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