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PERSPECTIVES FOR WATER MANAGEMENT IN AGRICULTURE IN UZBEKISTAN

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Abstract: The article examines the current and forecast indicators of the socio-economic efficiency of water use in agriculture of Uzbekistan - the share of the gross domestic product produced in agriculture using irrigation technologies. The author has developed directions for increasing the economic efficiency of irrigation water use, suggestions for improving the organizational and economic mechanism of efficient use of water resources in Uzbekistan, and practical suggestions and recommendations for improving the information and analysis systems of irrigation water use management have been developed.

Keywords: water management, water scarcity, hydrological uncertainty, global climate change, agriculture, water resources.

1.Introduction

Agriculture continues to be a major consumer of global water with increasing demand in the sector due to increasing human population and extreme climate events (increasing temperature and severe drought) in most regions. [12]

Competition for water brought on by rising temperatures and urbanization poses a threat to intensive agriculture. On a global scale, the agriculture sector uses over half of all freshwater. Despite projections of agricultural production growth of roughly 70% by 2050, a large water share will need to be shifted away from agriculture to satisfy future demand in other sectors.

Already, this emphasizes the importance of sustainable water management in agriculture, with the protection of limited aquatic resources as a primary priority. The current paradigm of agriculture water management encourages sustainable agricultural practices, enhanced resource allocation efficiency, and ecosystem preservation. Therefore, the long-term success of agriculture relies on conformity with this paradigm. [8]

A rapidly growing world population will face a 40% shortfall between demand and available water supply by 2030, a 50% increase in agricultural production to feed 10 billion people by 2050 (which consumes 70% of the resource today), and water withdrawals It is predicted to require an increase of 15 percent. More than 40% of the world's population lives in water-scarce areas, and about ¼ of the world's GDP will be affected, and by 2040, one in four children is expected to live in areas with extreme water scarcity. Water resources management and water resources management is a big and often growing problem for many countries today. In addition, chronic water scarcity, hydrological uncertainty, and extreme weather events (floods and droughts) are considered to be among the greatest threats to global well-being and stability. Water shortages and droughts are fueling conflicts between countries. [1]

Groundwater, which accounts for nearly 99 percent of all liquid freshwater in the world, has the potential to provide enormous social, economic, and environmental benefits and opportunities to societies. Groundwater provides half of the world's domestic water use, including drinking water for the vast majority of rural residents who cannot access water through public or private supply systems, and approximately 25% of all water withdrawals are used for irrigation. Groundwater is being researched in areas such as combating poverty, ensuring food and water security, creating decent jobs, global climate change, socio-economic development, and ensuring the resilience of societies and economies to climate change.

2.Literature review

In the scientific works of foreign scientists, great attention was paid to the issues of researching the mechanisms of water resources management. In particular, the research works of foreign authors such as Briscoe S, Jones W, Repu S. are devoted to the issues of effective management of the use of water resources in agriculture. [2]

Management of the use of water resources and the problems of a systematic approach to it from the scientists of the CIS countries I.G., Pavtsov A.G., Semeniki V.A., Goncharenko I.Yu., Matyunina O.Yu., Gazimagamedova F.R., Demyanenko S.I., Dombrovsky S.F., Moroz O. , Maestra S.M. reflected in the research of scientists such as

The problems of forecasting during optimal management of water management and use of land and water resources in our country. Berkinov, M.N. Makhmudov, I. Akhmedov, T. Rizaev, A. M. Kadirov, R. Kh. Tashmatov, B. Khasanov, L. I. Abdurakhimov, Z. D. Khudoyberganov, and others were studied in scientific works.

3. Analysis and results

Approximately 70 per cent of global freshwater consumption is used in the agricultural sector, yet water use efficiency in many countries is below 50 per cent. Nuclear and isotopic techniques provide data on water use including losses through soil evaporation and help optimize irrigation scheduling and improve water use efficiency.

The FAO forecasts that by 2050 global water requirements for agriculture will increase by 50 per cent to meet the increased food demands of a growing population. Global freshwater is becoming increasingly scarce, due to improper management, indiscriminate use and a changing climate. Water scarcity and quality problems in many parts of the world are a serious challenge to future food security and environmental sustainability.

Addressing these issues requires an improved management of land and water. Jointly with the FAO, the IAEA helps Member States develop and adopt nuclear-based technologies to optimize agricultural water management practices that support the intensification of crop production and the preservation of natural resources.[9]

Analysis of socio-economic efficiency of water use in agriculture in Uzbekistan based on mathematical models using internationally comparable data and forecast of socio-economic efficiency of water use in agriculture in Uzbekistan using international database AQUASTAT (see paragraph 4.1) can be characterized by the following indicators:

1) Share of GDP produced in agriculture using irrigation technologies.

2) Values of United Nations Sustainable Development Goals indicators: 6.4.1 and 6.4.2.

Based on AQUASTAT data, the first of the above indicators can be calculated as a product of GDP share. created in agriculture ("Agriculture, value added (% GDP)"), farming using irrigation technologies as a share of gross value added created in agriculture ("percentage of agricultural GDP produced in irrigated agriculture").

The econometric models constructed for the regions of the Republic of Uzbekistan can be used both for forecasting purposes and for managing the efficiency of water consumption for agricultural production, taking into account the systemic effects described above.[10]

Using the results of a descriptive statistical analysis, the possibility of using the parameter $\boldsymbol{a_2}$ as an indicator of water consumption efficiency management in the region's agriculture was evaluated as part of econometric models. As presented above, this parameter describes the relationship between the change in water volume per hectare of land and the increase in agricultural production at relative prices. The value of parameter $\boldsymbol{a_2}$ is explained as follows: when the amount of water consumption changes per thousand cubic meters for 1 hectare of land, by how many percentage points does the production growth in the region's agriculture change.

The negative nature of the dynamics of the considered efficiency indicator confirms the need to develop indicators for monitoring and management of the impact of water use in agriculture on this situation using mathematical modeling methods.

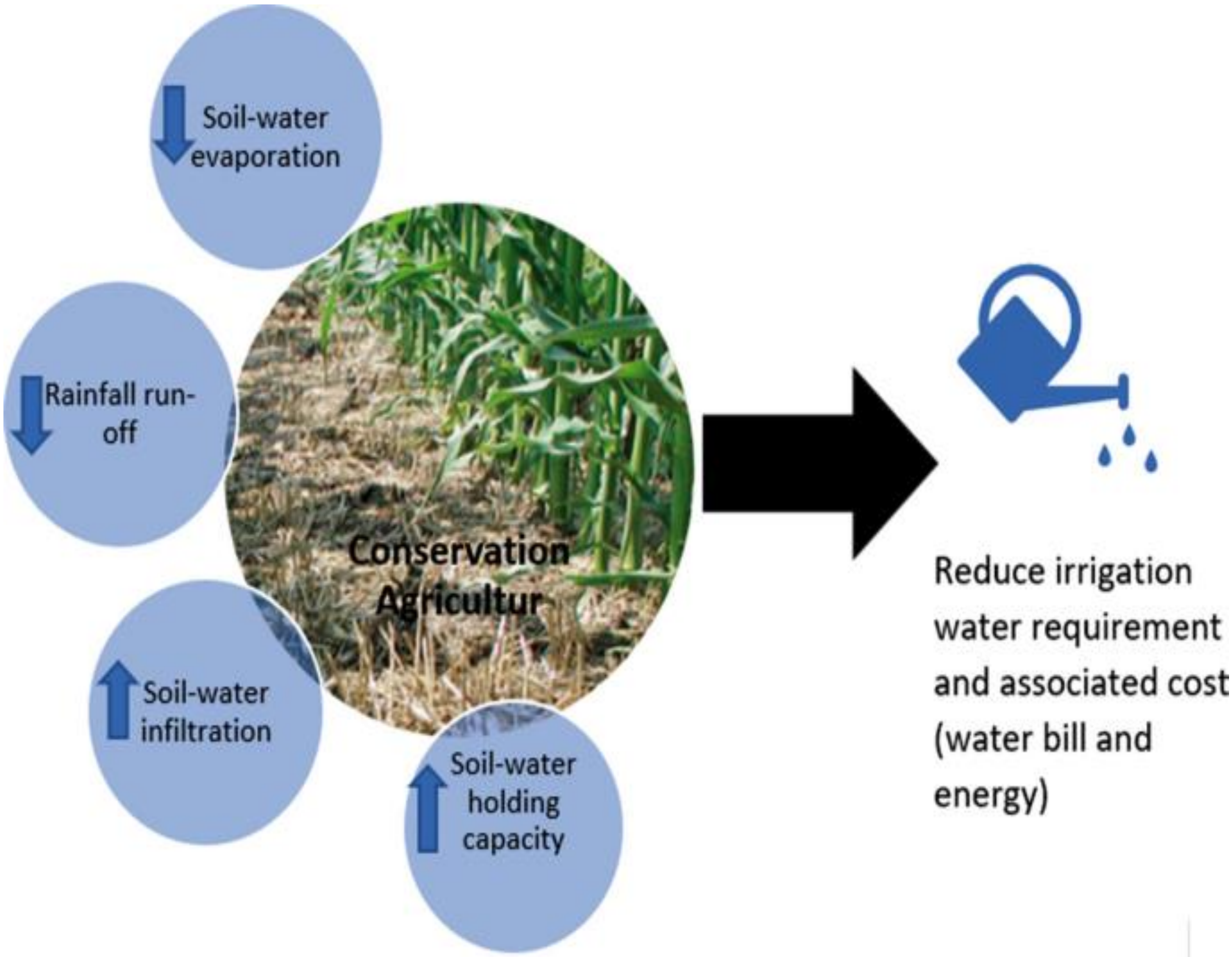

Fig.1.Innovations in Water Management: Agriculture [11]

The target indicators of modeling and analysis of socio-economic efficiency of water use in agriculture in Uzbekistan should include the indicators of achieving the UN Sustainable Development Goals presented in the AQUASTAT international database. in particular: 6.4.1 and 6.4.2.

The Sustainable Development Goals call on countries to “take action to end poverty, protect our planet, improve the quality of life and improve the prospects for all people around the world.

These 17 goals were adopted by all UN member states in 2015 as part of the 2030 agenda for sustainable development, and a 15-year plan was set to achieve them ".) indicates a slight decrease in the economic load on the water basin of the Republic of Uzbekistan; further stabilization of the indicator at this level is observed. [10]

Over the past 10 years, the pressure on the country's renewable freshwater resources has increased sharply (from 2014 to 2017), and then stabilized at this level.

Goal 6: Ensure availability and sustainable management of water and sanitation for all"

Goal 6: Ensure access to water and sanitation for all

A matrix of pairwise correlation coefficients describing the closeness of the relationship between the outcome and factor variables is presented in TVB.8. According to the data in this table, two effective (dependent) variables have statistically significant close relationships with the considered factor variables of agricultural irrigation equipment (Table 7):

1) SDG 6.4.1. Water use efficiency (Y1);

2) Share of GDP produced in agriculture using irrigation technologies (Y3).

Table 1. Characteristics of variables used in the construction of socio-economic efficiency models of water use in agriculture of the Republic of Uzbekistan.

Performance indicators	**Abr.**
SDG 6.4.1. Water use efficiency	Y1
SDG 6.4.2. Water stress level	Y2
Share of GDP produced in agriculture using irrigation technologies (%)	Y3
Factor indicators	
% of fully irrigated area actually irrigated	X1
% of the area equipped for irrigation with a mixture of surface and underground water	X2
% of area equipped for surface water irrigation	X3
% of dry area equipped for irrigation	X4
% of area equipped for irrigation with irrigation capacity	X5
% of irrigation potential equipped for irrigation	X6
% of actual irrigated area equipped for irrigation	X7
% of cultivated land equipped for irrigation	X8
% of total arable land dry	X9

Outcome variable Y_2 - SDG 6.4.2. The level of water stress (water stress) does not have statistically significant correlations with the considered factor indicators of agricultural land irrigation equipment. But this does not mean a real lack of communication. Based on the Pearson pairwise correlation coefficient, this result indicates the absence of a linear relationship. In this case, non-linear types of communication should be additionally tested.

$$\widehat{Y1} = -73{,}262 + 0{,}471\ X4 + 0{,}429\ X6 + 0{,}051\ X7$$

$$R^2 = 0{,}95$$

Water use efficiency - SDG indicator 6.4.1. (Y1-coefficient) increases by 0.471 in the annual dynamics in the Republic of Uzbekistan, by 1 percentage point (p.p.), 0.429 p.p. in dry areas equipped for irrigation (X4). With an increase of 1 p.p. irrigation capacity equipped for irrigation (X6) and 0.051 p.p. With an increase of 1 p.p. actually irrigated fields.

Table 2. Inertial version of forecasting SDG 6.4.1 target performance indicator values. "Water efficiency" is an inertial option

Inertia option	2022 y. Fact	Change from previous year (p.p.)			Forecast		
		2023 y.	2024 y.	2025 y.	2023 y.	2024 y.	2025 y.
% of areas equipped for irrigation, drained (X4)	69,968	0,006	0,012	0,018	1,3164	1,4461	1,5342
% of irrigation potential equipped for irrigation (X6)	87,09	-0,397	0	0,05			
% of areas equipped for irrigation that are actually irrigated (X7)	86,44	0,41	0,82	1,23			

The explanatory properties of the model are high (95%), which allows it to be used for forecasting.

On the basis of model (1), an inertial version of the forecast of SDG 6.4.1 target performance indicator values was obtained. "Water Use Efficiency". In its development (Appendix 5), it was taken into account that the annual rate of change of the factor indicators estimated above and presented in Table 5 will be maintained during the forecast three-year period.

However, as can be seen from the data in Figure 12, the inertial preservation of the existing relationship and dynamics of the factor indicators does not ensure the growth of the target indicator.

Increasing the target indicator is possible only in the innovative scenario, which implies a change in the current downward trend of the country's irrigation potential, equipped for irrigation, to increase by at least 0.5 percentage points.

Table 3. Inertial version of forecasting target performance indicator values SDG 6.4.1. Water efficiency is an innovative option

Innovative option	2022 y. Fact	Change from previous year (p.p.)			Forecast		
		2023 y.	2024 y.	2025 y.	2023 y.	2024 y.	2025 y.
% of areas equipped for irrigation, drained (X4)	69,968	0,006	0,012	0,018	1,7012	1,9395	2,1777
% of irrigation potential equipped for irrigation (X6)	87,09	0,5	1,0	1,5			
% of areas equipped for irrigation actually irrigated (X7)	86,44	0,41	0,82	1,23			

The year that can be achieved by solving the problems of technological modernization provided for in the concept of water management development of the Republic of Uzbekistan, introducing modern scientific and technical, organizational solutions, and introducing effective market mechanisms into the water use system. for 2020-2030.

Note: the red line represents the inertial version of the forecast, the green line the innovative one.

Model interpretation (2) $(Y_2)\hat{} = 0{,}1342t2 - 3{,}3986t + 164{,}65$

$R^2 = 0{,}7598$

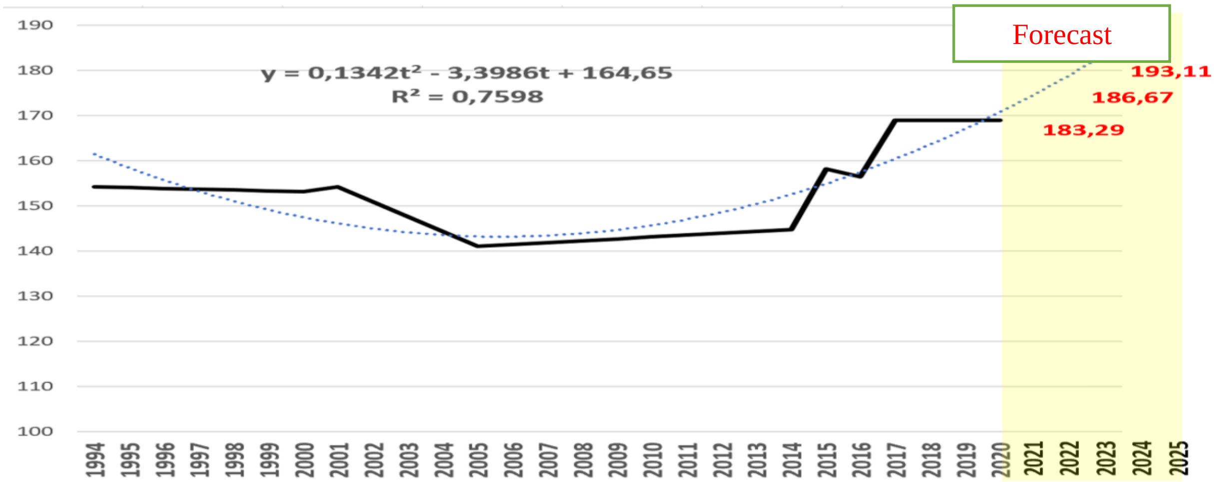

Figure 4. Actual and forecast values of the target indicator of socio-economic efficiency of water use in agriculture of Uzbekistan - SDG 6.4.2. Water Stress level.

According to the third target indicator - the share of GDP produced in agriculture using irrigation technologies (%) - a statistically reliable model (3) was obtained. The parameters of this model, as well as the calculation of the estimated values of the target variable based on it.

$$(Y_3)\hat{} = 225{,}552 - 2{,}091 * X8$$

$R^2 = 0{,}83$

According to the estimated parameters of this model, 1 p.p. with the increase. the share of areas equipped for irrigation, the share of the gross domestic product produced using irrigation technologies in agriculture decreased by 2,091 percentage points. This is due to the relatively larger share of intermediate consumption in the volume of agricultural output, compared to irrigated, dryland agricultural output. Improving the technological level of irrigation equipment, reducing material costs is a necessary measure to eliminate the negative relationship between the dynamics of the share of irrigated agricultural land and the share of added value created in agriculture using irrigation technologies. GDP. As shown in Table 5. The average annual growth rate of the area equipped for irrigation in the long-term period in the Republic of Uzbekistan is 0.435 percentage points.

4.Conclusions

Among other republics of Central Asia, the share of irrigated areas in the long-term annual growth of the main indicator of the country's economy - GDP has a restraining effect on the growth rate. The models created on the basis of data comparable to the countries of Central Asia made it possible to monitor the socio-economic efficiency of water use in the Republic of Uzbekistan and determine the regulatory indicators. It is a means of solving the concept established on the basis of the analysis of the predictive influence of the factor variables of agricultural land irrigation equipment on the target indicators of the socio-economic efficiency of water use in the agriculture of Uzbekistan and the developed mathematical models. The task of "improving the system of planning and managing the use of water resources, increasing the efficiency of water use, ensuring environmental protection and ecological stability" was set in the concept of water resources development.

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