Scientific and practical basis of assessing the impact of water-saving technologies on crop productivity and product quality

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Abstract. The purpose of this article is to develop suggestions and recommendations aimed at the effective use of water resources, taking into account the water shortage not only in Uzbekistan, but also in the world in the context of global climate change and water scarcity. Logical thinking, comparative and comparative analysis methods were used to explain the topic, and it was highlighted that the state's support and encouragement in the use of water-saving technologies leads to rational and economical use of water. Research conducted by foreign scientists on how irrigation technology affects the yield of agricultural products the results obtained based on this were studied by the authors and suggestions were made.

1 Introduction

In the context of global climate changes, expanding the use of water-efficient irrigation systems is a very important and urgent issue.

The increase in the number of the world's population, the desire to improve the quality of life, first of all, leads to an extensive increase in the volume of water consumed. Since 1980, the level of water use in the world has increased by an average of 1% per year, and this trend is expected to maintain an average growth pattern until 2050, which means 20-30% more than the current situation.

The issue of using water resources is one of the urgent issues facing not only our republic, but the entire world community.

Currently, Uzbekistan's water industry is facing new threats related to water and food security. These are: climate change, increased demand for food due to population growth and real incomes, industrial and urban development that require additional water resources.

Today, especially in the hot season of the year, the climate changes observed in the increase of the environmental temperature, the increase of the years with little water, the arrival of floods and torrential waters as a result of the acceleration of precipitation in certain periods of the year, and other natural phenomena are the main threats.

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2 Materials and methods

Some issues of effective use of water resources in Uzbekistan R.A. Abdullahonov, V.A. Dukhovnyi, S.D. Jalolov, B.J. Jorakulov, M.V. Kim, M.M. Matkarimov, O.M. Murtazaev, O.O. Olimjonov, O'.P. Umurzokov, U.R. Sangirova, M.O'. Umbetaev, T. Farmonov, N. Khushmatov, P.Z. Khojalepesov, Q.A. Choriev, A.S. Chertovitsky, It was studied by G.H. Kudratov, B.U. Hasanov, and others. In these studies, great attention is paid to the issues of the water management complex, the effectiveness of water saving and protection technologies and their management, improvement of the water management system, and the development of the activities of water consumer associations.

Research methodology and empirical analysis. In writing the article, the Law of the Republic of Uzbekistan "On Water and Water Use", Decrees and Decisions of the President of the Republic of Uzbekistan, decisions of the Cabinet of Ministers of the Republic of Uzbekistan, as well as researches of Uzbek scientists and foreign experiences were used. Logical thinking, comparative and comparative analysis methods are used to explain the topic, and positive opinions and suggestions are given by the authors.

3 Results and Discussion

Water shortages, global climate change, and the waste of water from sources to farm fields in the coming years require the transition to an innovative way of using water. That is, the state's support and encouragement in the use of water-saving technologies leads to rational and economical use of water.

The negative side of the issue of water use is that the wastage, especially in agriculture, is several times higher than the average unavoidable water costs in the world. For example, in our country, 12-14 thousand m^3 is spent on cultivating one hectare of land and washing salt. However, in Israel, only 5,000 m^3 of water is used per hectare, and the cotton yield is 50 centners. In the agriculture of our country, the average yield is only 23-25 centners. Therefore, the need for farmers and peasants of our country to learn the culture of rational use of water is becoming an urgent issue today. We will consider the results of the research conducted by foreign scientists on how irrigation technologies affect the productivity of agricultural products and reflect them in the table below.

The results of long-term experiments conducted by foreign and domestic scientists on the effect of irrigation methods on the productivity of agricultural products show that the use of water-saving methods of irrigation is more efficient than conventional irrigation. According to the research conducted at the farm "Saidakhmad Nabirasi Anvar" in Karshi district of Kashkadarya region, 35-40% saving of water consumption was achieved when cotton is irrigated by drip irrigation method. Also, according to the data of 2009-2011, the total expenditure on 1 hectare of cotton area was 1309-1702 thousand soums, and the income from the sale of cotton was 1812-2579 thousand soums. The profit of the farm from cotton cultivation was 502.6-876.6 thousand soums per 1, and the profitability index was equal to 38.4-51.5%.

In irrigated agriculture, irrigation water has some influence on soil, vegetation, agrotechnical methods and macroclimate. When irrigation methods are chosen correctly and the duration and number of irrigations are optimal, as well as when irrigation techniques are implemented correctly, the positive effects of irrigation water increase, and the type and amount of negative situations increase when the irrigation regime and techniques are violated. In particular, there are a number of negative consequences, such as the rise of soil, secondary salinization of land, swamping, soil compaction, soil erosion, deterioration of the ecological environment of its water-nutrition regimes and zoofauna and microflora, as well as erosion of the fertile layer due to irrigation erosion of the soil. For

example, irrigation erosion is a detrimental effect on soil fertility. Therefore, all agrotechnics and irrigation erosion measures used in irrigated agriculture should be remedial in nature and should be aimed at protecting the soil.

Table 1. The scientific basis of the influence of irrigation methods on the yield of agricultural products.

No.	The results of research conducted by foreign and republican scientists	Suggested irrigation methods	Water consumption, m^3/ha	Productivity of agricultural products, ts/ha
1	A.S. Ovchinnikov, B.S. Bocharnikova, I.I. Azareva1	Drip irrigation	190 m^3/ha (5600 m^3/ha)	Tomato yield increased by 10 ts/h (95-96 t/ha)
2	I.M. Jidkov, V.V. Zakharov	Drip irrigation	1500 m^3/ha (5450 m^3/ha) 20 m^3 of water is saved for 1 ton.	Potato productivity increased by 9-10 ts/(74 t/ha)
3	L.Kh.Shezdukova	Drip irrigation	2400-2500 m^3/ha (5500-6000 m^3/ha) 11.3 t/ha yield was obtained for 1000 m^3 of water	Cotton yield increased by 5.7 ts/h
4	A.S.Shamsiev, Sh. Nizomov, M. Ziyatov	Irrigate between rows of cotton with a film	Irrigation water is saved by 25-30%	otton yield increased by 5-6 ts/h
5	M.Kh. Khamidov, S.I. Isaev	Subirrigation irrigation method	Flow water is 900-1900 m^3/ha saved	Cotton yield increased by 1.5-7 ts/ha
6	B.F. Kambarov and others	Drip irrigation method	Irrigation water standard 2744-3497 m^3/ha	Cotton yield increased by 1.5-3.6 ts/ha
7	S.B. Gulyamov	drip irrigation method	Irrigation water standard 2170 m^3/ha	"Golden" variety apple productivity 33-75 ts/ha
8	B.U. Suvanov	subirrigation irrigation method	Irrigation water standard 2488-2535 m^3/ha The period bet- ween waterings is 23-28 days	Winter wheat yield increased by 3-6 ts/ha
9	Z.S. Shokhujaeva	Drip irrigation method	Irrigation water standard 2250-2300 m3/ha	Cotton yield productivity increases by 8-10 ts/ha, Fruit yield productivity. It leads to an increase of 40-80 ts/ha

Research shows that one of the main ways to protect soil from erosion when watering plants is to use optimal watering rates. According to the observations, in most cases, irrigation at optimal rates is not taken into account. For example, when irrigating cotton, the irrigators carry out irrigation in large quantities and prefer to irrigate, as a result, they release a large part of the water (30-40% or more) into the drain. Tons of muddy soil particles are also washed away with the wastewater. Therefore, irrigation of cotton at optimal rates, without discharge of water, is an effective way to stop irrigation erosion.

The use of progressive irrigation methods is becoming more and more popular in modern irrigation, that is, subsoil irrigation, sprinkler, drip, film, and sprinkler irrigation methods are widely used, in which no soil erosion is allowed.

In order to determine the advantages and disadvantages of drip irrigation technology, we will make a comparative analysis in comparison with the traditional irrigation method. For example, if 6600 m^3 of water, 60 kg of seeds, 300 liters of fuel, 750 kg of mineral fertilizers are used per hectare in the traditional method, in the drip irrigation method, 3300 m3 per hectare or 3300 m3 less water than in the traditional method, 35 kg/ha or 25 kg in

comparison to the traditional method less seed, 78 liters or 222 liters less fuel compared to the traditional method and 450 or 300 kg less mineral fertilizer compared to the traditional method (Table 2).

Table 2. Comparative analysis of the resources used to grow cotton on 1 hectare using traditional and drip irrigation methods.

Annual resources	Unit of measure	Indicator results				Amount to be saved, thousand soums
		Traditional drip irrigation method		Drip irrigation method		
		Resource consumption	Total amount, soums	Resource consumption	Total amount, soums	
Water consumption	m^3/ha	6600*	439 362	3300	219 681	219.0
Seed consumption (seed)	kg/ha	60	88000	35	43 840	44.0
Fuel consumption	l/ha	300	600 000	78	156 000	444.0
Consumption of mineral fertilizer	kg/ha	750	432 152	450	259 291	172.8
Electricity consumption	kW/ha	-	-	1092	131 040	-131.0
Film	kg/ha	-	-	93	418 000	-418.0
Drip irrigation hose	m/ha	-	-	12000	570 240	-570.0
Total			1 559 514	-	1 798 092	-238.0

Note: * only water supplied during the growing season was taken into account

However, compared to conventional irrigation method, drip irrigation has 1092 sq/ha of electricity consumption, 93 kg/ha of film and 12000 meters of drip irrigation hoses. The difference between the two irrigation methods is 238,000 soums more per hectare in the drip irrigation method compared to the traditional irrigation method.

In the Kashkadarya region, where we are conducting research, water saving as a result of the use of water-saving technologies was analyzed based on the econometric model (Table 3).

Table 3. Area and volume of water saved using water-saving technologies in Kashkadarya region in 2013-2021.

Watering methods	Volume of water saved when using WST, mln. m^3	Total WST applied area, ha	Drip irrigation (ha)	Pipeline irrigation (ha)	Irrigation by laying a film on the lawn (ha)	Sprinkler irrigation (ha)
Years	Y	X	X1	X2	X3	X4
2013	9.7	824	560	114	150	-
2014	13.8	2894	737	918	1239	-
2015	18.3	3488	858	1020	1610	-
2016	23.4	15550	943	12000	2607	-
2017	27.1	9625	966	4800	3859	-
2018	47.5	16499	1876	13020	1603	-
2019	20.9	3795	1752	-	2043	-
2020	49.4	15470	3393	10015	2062	6
2021	93	28931	15666	10080	3185	298.5

Table 4. Correlation matrix between the volume of water saved when using WSTand water saving technologies that affect its increase.

Covariance Analysis: Ordinary					
Date: 03/29/23 Time: 09:16					
Sample: 2020 2022					
Included observations: 3					
Balanced sample (listwise missing value deletion)					
Covariance					
Correlation					
t-Statistic					
Probability	Y	X1	X2	X3	X4
Y	35448.76				
Correlation	1.000000				
t-Statistic	-----				
Probability	-----				
X1	-154286.1	26791706			
Correlation	-0.158316	1.000000			
t-Statistic	-0.160339	-----			
Probability	0.8988	-----			
X2	94352.47	-517646.7	251572.2		
Correlation	0.999129	-0.199389	1.000000		
t-Statistic	23.93855	-0.203475	-----		
Probability	0.0266	0.8722	-----		
X3	85606.06	1760386.	219117.2	380910.9	
Correlation	0.736703	0.551056	0.707837	1.000000	
t-Statistic	1.089448	0.660369	1.002070	-----	
Probability	0.4728	0.6284	0.4993	-----	
X4	70130.06	127026.4	184891.7	204657.0	145895.2
Correlation	0.975176	0.064250	0.965085	0.868149	1.000000
t-Statistic	4.404013	0.064383	3.684412	1.749231	-----
Probability	0.1421	0.9591	0.1687	0.3306	-----

Table 5. The results of the built econometric model between water-saving technologies affecting the amount of water saved and its increase when using water-saving technologies.

Dependent Variable: Y				
Method: Least Squares				
Date: 03/29/23 Time: 09:26				
Sample: 2013 2022				
Included observations: 9				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	0.710084	0.300312	2.364490	0.0644
X2	0.110703	0.338261	0.327272	0.7567
X3	0.121614	0.515278	0.236015	0.8228
C	-3.505306	2.462505	-1.423472	0.2139
R-squared	0.750064	Mean dependent var		3.633271
Adjusted R-squared	0.600103	S.D. dependent var		1.172949
S.E. of regression	0.741743	Akaike info criterion		2.541473
Sum squared resid	2.750910	Schwarz criterion		2.629128
Log likelihood	-7.436629	Hannan-Quinn criter.		2.352313
F-statistic	5.001714	Durbin-Watson stat		2.145768
Prob(F-statistic)	0.057633			

An overview of the constructed econometric model between the volume of water saved when using WST and the water-saving technologies affecting its increase was as follows:

$$\begin{matrix} Y = 0.03 * x_1^{0.71} * x_2^{0.11} * x_3^{0.12} \\ t \quad (-1.42)\ (2.36)\ \ (0.33)\ \ (0.24) \end{matrix} \quad (1)$$

The result of the econometric model built through the factors affecting the increase in the amount of water saved as a result of the introduction and use of water-saving technologies on the irrigated land areas in the agriculture of Kashkadarya region showed that an increase in the introduction of drip irrigation technologies on the irrigated land areas by 1%, the water volume is 0.71 while increasing the pipe irrigation system by 1% will save the volume of water by 0.11%, while increasing the irrigation by laying a film on the edge by 1% will save the volume of water by 0.12%.

So, it showed that the effectiveness of drip irrigation technology is higher than water saving technologies. That is, when 100 percent of water was given in the normal irrigation method, 71 percent of water was saved in drip irrigation.

As a result of the analysis, it can be seen that the drip irrigation method does not save financial resources due to the consumption of resources. Therefore, the land user will be able to achieve a financial advantage only due to the increase in productivity.

4 Conclusion

Therefore, the following conclusion can be reached regarding the studied cases in assessing the impact of water-saving technologies on crop yield and product quality:

- Carrying out propaganda work on water shortage and its prevention in our country.
- Encouraging other farms to use water-saving technologies by encouraging farms that use water-saving technologies.
- Strengthening the activity of infrastructure services in the promotion of water-saving technologies.
- To help farmers and peasants to introduce water-saving technologies by experts of regional agricultural departments and district departments.
- Preparation of methodological manuals containing instructions on the technical and technological processes of water-saving technologies and expressing their effectiveness and delivering them to farmers.
- To establish a system of incentives for farms using water-saving technologies by regional agricultural departments.

Also, the result of the econometric model built through the factors affecting the increase in the amount of water saved as a result of the introduction and use of water-saving technologies showed that the effectiveness of the drip irrigation method is high, that is, when 100 percent of water is given in the normal irrigation method, 71 percent of the water in drip irrigation saving was observed.

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