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Abstract. Beginning with the existing irrigation technique used in cotton farming, this paper aims to compare the outcomes of using drip irrigation with traditional irrigation. There are drip irrigation advantages for the cotton field aimed at saving water and other resources, which is demonstrated by the example of decreasing the percent of losses and increasing the outputs and crop yields. Such irrigation conditions allowed collecting and saving water resources per hectare and increasing productivity, decreasing water consumption of surface irrigation thanks to wear-resistant cast iron parts that extended equipment life.

1. Introduction

The President and the government of the Republic of Uzbekistan have been focused on the problem of saving water resources for sufficient irrigation of crops in the arid regions of the country during dry seasons of the year.

The Republic of Uzbekistan's Concept of Water Resources Development for 2020–2030 was created on July 10, 2020. The Republic of Uzbekistan's Concept of Water Resources Development for 2020–2030 states that drip irrigation will be used on 600,000 ha of the 2 million hectares that would be covered by water-saving technologies. The expected annual water savings of 35–40% (3.5–4 billion m3) is 298 thousand hectares. It is conceivable to remodel some land that cannot be currently used [1].

Analytical predictions state that out of the 7.5 billion people living in the globe now, about 1.1 billion experience water shortages. As a result of the population migration to the arid regions of the country, there is an increasing need for and focus on the widespread usage of drip irrigation systems in the countries applying water-saving irrigation technologies, including Uzbekistan as the largest cotton producer [2].

The country needs for water resources are vast to satisfy the agricultural requirements for field irrigation throughout Uzbekistan, having scarce water sources despite growing population and acute necessity to provide high crop yields [3]. Cotton manufacture is provided with 60% of water while the rest of the moisture is lost, which makes the task of water saving as one of the crucial for the Ministry of Water Resources, especially in the cotton farming, entailing resorting to salinization, conservation, groundwater control techniques, involving the application of automation, processing, technical means to obtain high crop yields in Uzbekistan throughout a year [4].

M. Khamidov, K. Isabaev, U. Norkulov, and I. Abdullayev in their works have analyzed the negative influence and consequences related to the lack of water for the entire agriculture of Uzbekistan. J. Kazbekov, M. Bekchanov, A. Isashev, B. Sh. Matyakubov, S. X. Isaev, A. Muratov, I. Abdullayev, J. Kazbekov, D. Molden, J. Lamers, C. Martius, and Goldhamer have shared their experience of water-saving technologies wide spread abroad. J. Baker, D. Gitz, J. Stout, R. Lascano, and M. Junna have made great contribution in the in-depth investigation of the innovative drip-irrigation technologies developed in the world nowadays [5–15].

In Uzbekistan 4.2–4.6 billion m^3 of river water is used for desalinization allowing 1.9–2.2 billion m^3 of groundwater to get lost through collectors and drainage networks, increasing soil salinization [16].

Being part of the subtropical desert province and sandwiched between the Kyzylkum and Karakum deserts, the Bukhara area includes the fields along the banks of the Zarafshan River up to the Bukhara and Karakul oasis with irrigated plains in the southern Kyzylkum desert.

In view of the varying depth of groundwater occurrence in the Bukhara province, its level changes vastly, taking into account mercury mineralization of 0–1 g/l in 1.3 thousand hectares and 1–3 g/l in 178.2 thousand hectares [17–21].

The objectives of the work involve considering the meadow at the “Said Imam Tilav” farm in the Vabkent district of the Bukhara area with its alluvial medium-sized sandy soil, groundwater levels between 2.0 and 2.5 metres and mineralization of 2.0 to 3.0 g/l; enhancing drip irrigation recommendations to improve cotton yield production.

The purpose of the work is to specify hydrogeological and reclamation conditions of experimental fields, cotton irrigation regime and its influence on alluvial, weakly saline soils, and soil conditions experimental fields [22–24].

2. Materials and Methods

During the study the following research methods were used: field, lab, and phenological observations; field experiments; agrochemical and agrophysical research in irrigated cotton areas to analyze the agrophysical, agrochemical, and microbiological properties of soils in cotton fields, mathematical-statistical analysis to determine the accuracy and dependability of the collected data.

Scientifically supported cotton irrigation in the grassland-alluvial, weakly saline soils of the Bukhara province can be scheduled basing on drip irrigation influence on growth, development, production, and quality of cotton fibre allowing for the level and mineralization of groundwater, leading to reducing river water consumption by introducing drip irrigation. In this way, consuming economically 1 m3 of water increases agricultural yields of irrigated areas, meeting the food needs thus ensuring the nation's food security.

The “Said Imam Tilav” farm's meadows rich in alluvial, medium-sandy soils with a mechanical composition of 2.0–2.5 m, groundwater mineralization of 2.0–3.0 g/l were studied in the Vobkent district of the Bukhara province where drip irrigation promotes the growth, development, and productivity of cotton, using field trials to schedule irrigation, mechanical soil elements, and moisture levels (above-ground and drip), whose field system is shown in Table 1.

The soil in the testing field is a medium sand type with a medium-fibre cotton variety “Bukhara-8” and the space between cotton rows of 60 cm.

Table 1. Field experimental system performed in 4 replicates.

No.	Soil moisture before irrigation, % of ultimate field moisture capacity (UFMC)	Irrigation method	Irrigation rate, m^3 / ha
1.	Production control	Surface irrigation method	Actual measurements
2.	70–80–65	Drip irrigation	0–50 cm and 0–70 cm with moisture

deficiency

* 70–80–65% (before flowering of cotton: from flowering to ripening: percentage of moisture retention after ripening relative to the limit humidity).

Several investigations demonstrate that the soil's moisture content and its water-physical characteristics were computed based on techniques used in the lab and the field.

Under drip irrigation, the experimental field soil moisture was 60 cm compared to 100 cm in the traditional irrigation field, regulating the depth-dependent soil moisture, determining the timing of cotton irrigation by a soil moisture tensiometer (irrometer) to analyze cotton's water requirements and the best alternatives for traditional and drip irrigation techniques.

3. Results and Discussion

Table 2 provides the information on the findings on traditional (above ground) and drip irrigation for cotton.

Table 2. Cotton irrigation method.

Moon	Surface irrigation method		Drip irrigation	
	Irrigation norm, m^3/ha	Number of irrigations	Irrigation norm, m^3/ ha	Number of irrigations
June	1100	1	830	4
July	2320	2	1870	7
August	1830	2	970	4
Total:	**5250**	**5**	**3670**	**15**

According to irrigation standards (1250-1350 m3/ha) (first variant), cotton was irrigated five times in accordance with the scheme 1-3-1 during the growing season under production control, with intervals of 21–26 days between irrigations. Irrigation conditions and norms required the cotton variety “Bukhara-8” to be irrigated five times with optional irrigation in the first option, receiving between 70 and 80 and 65 percent more water compared to UFMC. The average irrigation rate is 1006 m3 per hectare, with a 21–25-day irrigation interval. The average annual m3/ha of irrigation was 5250.

Option 2 provides for 15 time-drip irrigation, following schemes 4-7-4, when the cotton variety “Bukhara-8” was irrigated in the range of 70-80-65%, according to irrigation time norms at an average irrigation rate of 292 m3 per hectare and the irrigation interval of 5–14 days, with each acre typically receiving 3670 m3 of irrigation every season, reducing water by 31% compared to drip irrigation and saving 5250 m3 in total.

Table 3. Irrigation technique dependence on water productivity.

Irrigation strategy	**Normal irrigation, m^3/ha**	**Cotton harvest, t/ha**	**Water output, t/m^3**	**Margin, + t/m^3**
Surface irrigation method	5250	3.4	0.65	–
Drip irrigation	3670	4.2	1.14	0.49

The drip irrigation technique increased water productivity, yielding 0.49 tonnes more for every 1000 m3 of used water, according to an analysis of the trial data. Drip irrigation saved water resources and increased the raw cotton yield by 24% compared to earlier measurements, produced 89.000

seedlings per hectare and an average cotton output of 4.2 tonnes per hectare. 62.000 seedlings were thick under irrigation, and 3.4 tonnes of cotton were produced on average per hectare. Even soil wetting of the plant's segmented root system, cotton feeding efficiency improvement supplied mineral fertilisers to the root system.

The net profit and level of profitability of the cotton tillage and drip irrigation technologies were estimated based on the cotton yield, including the used irrigation system cost, based on 2021 estimates as a reference point and the real cost of cotton in 2021 in the Vobkent district of the "Said Imam Tilav" province of Bukhara.

The sale proceeds were found when dividing the yield by the purchase price, whose cost was subtracted from the sale revenues to determine the conditional profit that was multiplied by the overall cost by 100 to determine the profitability, shown by Table 4 for cotton using various irrigation technologies.

Table 4. Comparative indicators of the costs of the farm "Said Imam Tilav" for the production of raw cotton by the method of traditional and drip irrigation.

No.	Indicators	Measurement scale	Surface irrigation method		Irrigation via dripping		Margin "+", "–"	
1.	Crop field	hectare	1.0	12.0	1.0	12.0	0	0
2.	The yield	centner per hectare	34	408	42	504	8	96
3.	Gross yield	ton per hectare	3.4	40.8	4.2	50.4	0.8	9.6
4.	Total expenses	thousand soums	15850	190200	18917	227004	–3067	–36804
5.	Total revenue	thousand soums	21250	255000	26250	315000	5000	60000

21250 thousand dollars were gained for the cotton cultivated on a hectare of land using conventional irrigation, with a total of 15.850.000 dollars per ha, ranking profitability at 34% and 5400 thousand sums/ha as opposed to conditional irrigation profit, while drip irrigation allowed gaining 26.250.000 dollars per ha with total production expenses of 18.917.000 dollars/ha, conditional profit of 7.333.000 dollars/ha, and 39% profitability.

4. Conclusion

Drip irrigation allowed watering the cotton variety Bukhara-8 15 times using the 4-7-4 irrigation method, sustaining 70-80-65% of the border steppe's moisture capacity, whose average irrigation rate guarantees 292 m3/ha for a period of 5 to 14 days, with 3670 m3 of water per ha throughout the season, using 31% less water per acre compared to drip irrigation and the standard irrigation technique (control option). Drip irrigation reduced water wastage, increased the raw cotton production volume by 24%, estimated to be 4.2 tonnes per hectare on average, with 89.000 seedlings per ha, which proved to be more profitable than traditional, yielding conditional profits of 7333 thousand dollars per ha and profitability rates of 39%.

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