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IMPORTANCE OF DRIP IRRIGATION TECHNOLOGIES ON FARMING: ANALYSIS AND RESULTS

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Abstract

Water scarcity and increasing global demand for food have made efficient irrigation systems a priority in modern agriculture. This study examines drip irrigation technology as a sustainable and highly efficient alternative to traditional flood and sprinkler irrigation methods. Based on field experiments and comparative analysis conducted in different farms and climatic conditions, water use efficiency, productivity, soil health, and economic indicators were evaluated.

The results show that drip irrigation reduces water consumption by 30–50% compared to traditional methods and simultaneously increases yields in vegetables, fruits and cereals by 20–40%. When used in combination with the fertigation method, weed growth, soil erosion and fertilizer leaching are significantly reduced. Economic evaluations show that although the initial installation costs are high, farmers recover their investment within 2–4 growing seasons due to reduced operating costs and higher quality products.

The study concludes that widespread implementation of drip irrigation technology is a promising solution for sustainable farm management, especially in arid and semi-arid regions facing water scarcity. Policy recommendations are also made for government support, farmer training programs, and infrastructure subsidies.

Keywords: Drip irrigation, water use efficiency, sustainable agriculture, productivity, fertigation, water scarcity, farm management

Introduction

Uzbekistan is located in the arid climate region of Central Asia, and the agricultural sector is the main branch of the economy in conditions of limited water resources. The area of irrigated land in the country is 4.3 million hectares, most of which is located in the Amu Darya and Syrdarya basins (Kholikov, 2020). The traditional flood

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irrigation method is still widely used, which leads to water waste, soil salinization, and reduced productivity.

The Decree of the President of the Republic of Uzbekistan No. PF-5742 dated June 17, 2019, includes increasing irrigation efficiency, widespread introduction of water-saving technologies, and increasing agricultural productivity as priority tasks (Decree of the President of the Republic of Uzbekistan, 2019). In this regard, the scientific study and implementation of drip irrigation technology is becoming an urgent issue.

Drip irrigation is a method of delivering water directly to the root zone of plants through networked pipes, which has been widely used worldwide since the 1960s (Toshmatov and Rakhimov, 2018). This technology not only saves water, but also allows for the direct delivery of fertilizers to the root zone (fertigation) and significantly increases productivity.The purpose of this study is to assess the practical effectiveness of implementing drip irrigation technology on farms in Uzbekistan based on quantitative indicators and to develop recommendations.

Methods

2.1. Research area and object

The study was conducted on 12 farms located in Fergana, Samarkand, and Kashkadarya regions during 2020–2023. The total experimental area was 480 hectares, and the crops included vegetables (tomatoes, cucumbers, peppers), fruit trees (apples, peaches), and grain crops (wheat, corn).

2.2. Research design

Farmers were divided into two groups:

- Control group (240 ha): traditional flood irrigation method
- Experimental group (240 ha): drip irrigation system (Israeli-made Netafim and local "Uzagrotekhnika" devices)

2.3. Measurement indicators

The following indicators were recorded during each growing season:

Indicator	Unit of measurement	Measurement method
Water consumption	m³/ha	Meter readings
Productivity	t/ha	Weighing
Soil moisture	%	Tensiometer
Fertilizer consumption	kg/ha	Settlement
Economic benefit	soum/ha	Accounting

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2.4. Statistical analysis

Data were processed using Microsoft Excel and Statistics 10.0 software. Differences between groups were tested using Student's t-test and analysis of variance (ANOVA) ($p < 0.05$).

Results

3.1. Water saving

The drip irrigation system significantly reduced water consumption compared to the traditional method. The following table shows the three-year averages:

Crop type	Flood irrigation (m³/ha)	Drip irrigation (m³/ha)	Savings (%)
Tomato	8,200	4 100	50.0%
Cucumber	7,600	3 950	48.0%
Apple orchard	9,500	5,700	40.0%
Wheat	5,400	3 510	35.0%
Corn	6 200	4,030	35.0%
Average	7 380	4 258	42.3%

Table 1. Comparative indicators of water consumption in irrigation methods (2020–2023)

In total, 3,499,200 m³ of water was saved in the experimental area over 3 years — equivalent to the annual water needs of approximately 3,500 families.

3.2. Productivity indicators

When drip irrigation and fertigation were used together, yields increased significantly in all crop types:

Crop type	Control group (t/ha)	Experimental group (t/ha)	Growth (%)
Tomato	42.3	61.8	+46.1%
Cucumber	38.5	54.2	+40.8%
Pepper	18.2	25.6	+40.7%
Apple	22.4	30.1	+34.4%
Wheat	4.8	6.1	+27.1%
Corn	7.2	9.4	+30.6%

Table 2. Yield indicators in crop types (t/ha)

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The highest yield increases were recorded in tomato and cucumber crops. These indicators are consistent with the results of a study conducted in Surkhandarya region by Mirzayev et al. (2021).

3.3. Reduction in fertilizer consumption (Fertigacy effect)

Since the drip irrigation system delivers fertilizers directly to the root zone, the following results were recorded:

- Nitrogen (N) consumption decreased by 32%
- Phosphorus (P_2O_5) consumption decreased by 28%
- Potassium (K_2O) consumption decreased by 25%
- Environmental damage due to soil erosion reduced by 45%

3.4. Economic efficiency

The cost of installing a drip irrigation system averaged 12–18 million soums per hectare (in 2023 prices):

Indicator	Control group	Experiment group
Annual income (tomatoes, soums/ha)	42,300,000	71,600,000
Water cost (sum/ha/year)	1,640,000	852,000
Fertilizer cost (sum/ha/year)	4,200,000	2,940,000
Net profit (sum/ha/year)	36,460,000	67,808,000
Investment payback period	—	2.1–2.8 years

Table 3. Comparative indicators of economic efficiency (tomatoes, soums/ha/year)

Calculations show that farmers fully recoup their initial investment in an average of 2.1–2.8 years.

3.5. Soil condition

During the three-year observation period, the following positive changes were noted in the experimental group farms:

- Soil salinity levels decreased by 18%
- The amount of organic matter in the soil increased by 12%.
- Soil compaction decreased by 22%
- Erosion cases have practically disappeared.

These results are consistent with data from the Uzbekistan Research Institute of Soil Science and Agrochemistry (2022).

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Conclusion

The results of this study clearly show that drip irrigation technology is the most economically and environmentally optimal irrigation solution for Uzbek farms. Key conclusions:

• Water savings: Drip irrigation provides an average of 42.3% water savings compared to traditional methods — which is strategically important for water-scarce regions like Uzbekistan.

• Productivity: Productivity increased by 27–46% across all crop types, nearly doubling farmers' incomes.

• Economic profitability: The initial investment is fully repaid within 2–3 years, and net profit increases significantly in the subsequent period.

• Environmental benefits: Soil salinization, erosion, and chemical leaching are reduced, which maintains soil fertility in the long term.

• Policy recommendations: Government subsidy and credit mechanisms, farmer training programs, local production development, and irrigation infrastructure modernization will accelerate widespread adoption.

The widespread introduction of drip irrigation technology into our country's agriculture can serve as one of the practical foundations of Uzbekistan's sustainable development strategy until 2030.

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