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APPLICATION AND EFFECTIVENESS OF WATER-SAVING TECHNOLOGIES IN OUR COUNTRY

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Annotation: *The article studies irrigation regimes for apple orchards using drip irrigation technology and presents the results. It was found that improving irrigation system components led to increased yields and more efficient use of water resources. The implementation of drip irrigation technology in intensive orchards has been proven to save up to 48% of water resources, 50% of mineral fertilizers, and 30% of fuel and lubricants. Additionally, the irrigation regime matches the water needs of the plants, preventing excess water use, with moisture being concentrated near the plant root zone rather than spreading across the entire field.*

Keywords: *irrigation, drip irrigation, irrigation methods, groundwater, water resources, root, evaporation, water scarcity, water-saving technologies, irrigation rate, limited field moisture capacity (LFMC), salinity, irrigation equipment, vegetation period.*

In countries around the world, international organizations are developing and implementing necessary measures to prevent and mitigate water scarcity. By 2030, water shortage in Uzbekistan may reach up to 15 billion cubic meters. The majority of the water used in our country originates in neighboring states and flows into Uzbekistan. Only about 15–20% of the total water resources are formed within our borders, depending on annual precipitation levels. Unfortunately, in recent years, a

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decrease in rainfall across the region has led to reduced water flow in major river basins, as well as in smaller rivers and streams. While just a few years ago the annual water consumption in the country was 60–64 billion cubic meters, today the supply has decreased to 51–53 billion cubic meters. However, thanks to the wise policies of our national leadership in recent years, the situation is being alleviated. Transboundary water resource management among regional countries is now being conducted in a spirit of friendship, good neighborliness, and mutual respect. This approach has enabled the resolution of long-standing issues in the water sector. Uzbekistan continues to actively engage in bilateral and multilateral cooperation with neighboring countries to ensure the integrated management of shared water resources, including the joint use of transboundary water resources and interstate water infrastructure. Notably, several meetings were held last year, resulting in significant agreements.

In Uzbekistan, the annual volume of water used amounts to 52.0 billion cubic meters, of which 41.0 billion cubic meters are formed in neighboring countries, while 11.0 billion cubic meters are generated within the territory of Uzbekistan. When examining water usage across different sectors of the economy:

– 90% is used in agriculture,
– 4.5% in municipal services,
– 4.3% in industry and energy,
– and 1.2% in the fisheries sector.

According to Resolution No. PQ-5 of the President of the Republic of Uzbekistan dated January 5, 2024, key provisions have been outlined to promote the implementation of water-saving technologies. Notably, concessional loans with a reduced interest rate of 14% (instead of the previous 21%) will be allocated through the "suvkredit.uz" platform. For the Republic of Karakalpakstan and Khorezm region, the interest rate is set at 10%. Importantly, farmers will not be required to provide property collateral to obtain these loans. In terms of subsidies, full (100%) disbursement will be carried out within the same year. Previously, subsidies were paid in two installments—50% in the first year and the remaining 50% in the following year. Regarding construction quality, the aim is to enhance the quality of water-saving technology infrastructure. Contractors will be required to provide a 2-year warranty and ensure maintenance services for 5 years. Additionally, the activities of the "School of Irrigators" will be improved. Alongside water management personnel, district-level responsible leaders, staff, designers, and contractors will also undergo comprehensive training.

Between 2017 and 2024, water-saving irrigation technologies were introduced on a large scale in Uzbekistan: drip irrigation was implemented on 560,000 hectares, sprinkler irrigation on 90,000 hectares, and discrete and other advanced methods on 59,000 hectares. Additionally, 1.1 million hectares of land were leveled using laser equipment. According to analyses, the implementation of water-saving technologies has led to a 45–50% reduction in water resource usage, 25–35% savings in fuel, lubricants, and mineral fertilizers, and reduced mechanization service costs, while simultaneously increasing crop yields by 15–20%. By 2030, the country aims to concrete-line 46% of irrigation canals, equating to 13,200 kilometers, and expand the total area of agricultural land covered by water-saving technologies to 2 million hectares.

In 2024, based on allocated funding of 1.35 trillion UZS, the following construction and reconstruction works will be carried out:

– 586.5 kilometers of canals;
– 21 kilometers of flume (lotok) networks;
– 45.3 kilometers of closed irrigation pipelines;
– 167.9 kilometers of open collectors;
– 109.5 kilometers of closed-horizontal drainage networks;

Furthermore, 570.4 kilometers of main canals and 15,000 kilometers of on-farm irrigation networks will be converted to concrete lining. The coverage of water-saving technologies in agricultural lands will reach approximately 55%, or 2.4 million hectares. As a result, by the end of the year, the efficiency coefficient of the irrigation system and networks is expected to increase from 0.67 to 0.68, and 10 billion cubic meters of water will be saved in the agricultural sector.

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In the scientific research conducted on the efficient use of water resources, the positive effects of using drip irrigation technology in orchards were studied.

Calculation of water consumption using the drip irrigation system for irrigating apple trees. Determining the calculated water consumption using the drip irrigation method.

1. **Planting scheme:**

A) For a 2x3 meter orchard

2. **Type of drippers and water discharge rate:** 4.8 liters/hour
3. **Number of drippers:** 1 dripper per seedling
4. **Field slope:** 0.0033

The calculated water requirement for irrigating a 1-hectare orchard is determined.

We start by calculating the number of seedlings in a 1-hectare area.

$$N_{\text{Seedling}} = \frac{10000}{2x3} = 1666 \text{ sapling}$$

We will determine the calculated water consumption for irrigating one hectare of orchard

$$Q_{bur} = \frac{N_{\text{Seedling}} * q * n}{3600}$$

In this context:

Q_{bur}**-calculated water discharge per 1 hectare, in liters per second (l/s)**:

N_{Seedling} -number of saplings (seedlings)

q -water discharge of one dripper, in liters per hour (l/h)

n - number of drippers per sapling

3600 - conversion coefficient (to convert liters per hour to liters per second)

$$Q_{bur} = \frac{1666 * 4.8 * 1}{3600} = 2.3\ l/s$$

The minimum water discharge of the irrigation pipe is determined using the following formula.

$$q_{min} = \frac{N_{tom} * q}{3600} = \frac{100 * 4.8}{3600} = 0{,}13\ l/s$$

Here: N_{tom}- number of drippers in the irrigation pipe

N_{tom}-(L_m:B)*n

L_m- length of the irrigation pipe, in meters

B- distance between saplings, in meters

n- number of drippers between saplings

L_m-200 m; B-2 m; n-1 piece

N_{tom}-(200:2)*1=100

During the research years, scientific studies were conducted in experimental fields under **seven different irrigation variants**.

- In **Variant 1** (furrow irrigation of apples), the **seasonal irrigation norm** ranged from **3624 to 3884 m³/ha**, accounting for **85.9–86.4%** of the **total water consumption**, which averaged **4219–4495 m³/ha**.
- In **Variant 2** (drip irrigation of apples), the **seasonal irrigation norm** was **1582–2464 m³/ha**, which made up **69.4–79.9%** of the **total water consumption** (2278–3082 m³/ha).
- In **Variant 3** (drip irrigation), the **seasonal irrigation norm** was **1553–2389 m³/ha**, accounting for **72.4–77.5%** of the **total water consumption** (2145–3082 m³/ha).
- In **Variant 4** (drip irrigation), the seasonal irrigation norm was **1598–2480 m³/ha**, or **69.5–77.7%** of the total water consumption (2298–3193 m³/ha).
- In **Variant 5**, the seasonal irrigation norm ranged between **1546–2398 m³/ha**, accounting for **74.1–77.4%** of the total water consumption (2164–3096 m³/ha).
- In **Variant 6**, the seasonal irrigation norm was **1614–2496 m³/ha**, which constituted **69.9–77.7%** of the total water consumption (2308–3214 m³/ha).
- In **Variant 7**, the seasonal irrigation norm was **1562–2416 m³/ha**, equal to **71.8–77.6%** of the total water consumption (2174–3114 m³/ha).

Based on the **average results over three years of research**, in the **control variant** where the apple orchard was irrigated using **furrow irrigation**, irrigation was carried out **5 times** following a **1-3-1 scheme**. The **irrigation norms** ranged from **720 to 790 m³/ha**, and the **seasonal irrigation norm** was **3748 m³/ha**.

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In the experimental variant with **drip irrigation technology** using **200-meter-long irrigation pipes**, irrigation was conducted when the **pre-irrigation soil moisture** reached **70-80-65% of the field capacity (LFMC)**. In this control variant, irrigation was carried out **18 times** according to a **2-11-5 scheme**, with individual **irrigation norms** ranging from **87 to 145 m³/ha**, and a **seasonal irrigation norm** of **1940 m³/ha**.

In managing soil moisture, it is essential to adhere to the **target moisture levels based on the field capacity (LFMC)** as defined in the experimental system. It is also important to emphasize that, along with moisture, maintaining optimal levels of **nutrients, air, heat, and light** in the root zone is crucial for the healthy development of saplings.

Based on studies conducted in **Vobkent district of Bukhara region**, specific data on soil moisture management was obtained. All experimental variants in the field were conducted in accordance with the parameters established in the experimental system.

According to the findings, **soil moisture indicators** were measured on **lightly saline, medium loamy soils** at the **"Garden Buxoro Agrocluster" LLC**. In **Variant 1** (control), the soil moisture content ranged between **68.9–70.4%**.

In **Variants 2, 4, and 6**, where **drip irrigation technology** was applied, the pre-irrigation soil moisture was maintained at **70–75–60%** of LFMC. In **Variants 3, 5, and 7**, moisture was kept at **70–80–65%** of LFMC, and based on this, the irrigation rate for the **100 cm soil layer** was determined, effectively allowing water requirements of apple trees to be managed.

During the **pre-flowering and flowering-fruit setting stages**, the soil moisture was maintained at approximately **69.0–79.9%** of LFMC, while during the **fruit ripening stage**, it decreased to **64.5–66.4%**.

According to the results of scientific research conducted in the experimental plots, the pre-irrigation soil moisture consistently remained within ±2.0% of the target values. Based on these observations, it can be concluded that the **methodology**

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of field research was properly implemented in **Vobkent district of Bukhara region**.

Under the conditions of **meadow-alluvial, medium loamy soils** in **Bukhara region**, the **“Golden” variety apple orchards** irrigated using **drip irrigation technology** received irrigation **18 times per season**, with irrigation norms of **87–145 m³/ha** and a **seasonal irrigation norm** of **1940 m³/ha**. As a result, a **yield of 216 centners per hectare** was obtained.

Compared to the **control variant using furrow irrigation**, this method led to a **48% saving in water resources** and an **additional yield of 106 centners per hectare** of apples.

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