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ADVANTAGES OF PIPELINE IRRIGATION TECHNOLOGY

Abstract

The article outlines that the irrigation equipment and technology we recommend for use in complex relief foothill areas is based on the principle of "Distributed Water Discharge." From this, it can be concluded that the use of the "Distributed Water Discharge" technology allows for a reduction in irrigation duration and improvement in moisture quality compared to traditional furrow irrigation methods. Ultimately, this leads to significant water savings and reductions in capital construction costs.

Keywords:

Distributed water supply, furrow Irrigation, irrigation efficiency, water use coefficient, moisture distribution, complex terrain irrigation, short-interval water distribution, soil conservation

In Andijan region, there are more than 53,520 hectares of nine foothill massifs. These sloped lands, composed of loess-like loamy soil layers of varying thickness, cannot be clearly categorized into a specific natural-climatic zone. The annual precipitation does not exceed 220–250 mm, and most of this precipitation falls during the non-growing season.

Considering the demographic situation in the region, high population density, and the growing demand for land across various sectors of social life, the development of previously considered completely unsuitable sloped foothill lands for agricultural production has rapidly progressed. In these areas, traditional furrow irrigation techniques, technologies, and practices from flatlands were replicated. As a result, the ecological condition of the foothill and pre-foothill zones has significantly deteriorated. The degradation of the ecological state manifested in the rise of groundwater levels, waterlogging, salinization, intensified irrigation erosion, landslides and ravine formation in sloped areas, and the emergence of malaria mosquitoes due to poor drainage conditions.

Improper organization of irrigation, neglect of the technical condition of networks, and the lack of timely repair and restoration work have led to the annual washing away of 80 to 100 tons of top fertile soil layer per hectare. Soil suffosion — the formation of large cavities in the subsoil — and waterlogging of the adjacent flatlands have also emerged as other serious consequences. In recent years, the issue of water scarcity in our region threatens the stability of agricultural production on lands that were reclaimed with decades of effort.

It is worth noting that the main drawbacks of traditional furrow irrigation are the uneven distribution of moisture along the furrow length and the enormous loss of water (60–65%) due to surface runoff and infiltration. The problems of furrow irrigation and water resource shortages cannot be solved merely by identifying and selecting optimal variants of irrigation equipment parameters. Through large-scale reforms currently being carried out across the country, it is possible to meet agricultural production demands during non-growing periods with the available accumulated water resources by improving water distribution and using modern, water-saving technologies.

Along with the agronomic advantages of traditionally regarded conservative furrow irrigation, the principle of distributed water discharge, which achieves efficiency comparable to the most advanced water-saving equipment, has the following theoretical basis. The numerical analysis of the following formula, recommended by academician A.N. Kostyakov for solving the balance equation of water flow movement in a furrow, shows that:

$$X = \frac{q_э t^{\alpha}}{\chi n v_0}$$

The relationship between the water discharges supplied to the furrow and the distances they travel can be expressed by the following inequality:

$q_1 > q_2$ in the case of: $q_2 / q_1 < \ell_2 / \ell_1$

Where:

q_1 – water discharge supplied to the furrow, in liters per second (l/s);

q_2 – distributed water discharge, in liters per second (l/s);

ℓ_1, ℓ_2 - distances that the water discharges flow through during the same period of time, in meters (m).

Experimental data collected under field conditions over a period of 1.0 to 5.0 hours showed that when the ratio of water discharges was q_2/q_1=0.008…0.8, the corresponding ratio ℓ_2/ℓ_1 ranged from 0.038 to 0.9. This confirms the validity of the above-mentioned relationship.

If $q_1 = j \cdot q_2$, that is, if the water discharge q_1 is distributed from *j* different points:

$$\frac{j \cdot q_2}{q_1} \angle \frac{j \cdot \ell_2}{\ell_1}$$

An inequality emerges, showing that the distance traveled by the flow with discharge q_1 over a given period is always less than the total distance covered when the same amount of water is distributed from several points. From this, it can be concluded that the "Distributed Water Supply" technology reduces the irrigation duration and improves moisture distribution quality compared to conventional furrow irrigation methods.

For application on complex hilly terrains, the irrigation equipment and technology we recommend are based on the "Distributed Water Supply" principle. Irrigation is carried out by distributing an equal amount of water at very short intervals (1.5–4.0 meters) along furrows dug between plant rows, from the beginning to the end.

The recommended irrigation technology and system have the following advantages:

- Maintains soil structure without erosion or slope collapse;
- Completely prevents runoff and significantly reduces seepage losses below the active root zone, increasing water use efficiency up to 0.98;
- Saves 2,000–2,500 cubic meters of water per hectare compared to existing irrigation systems;
- Increases labor productivity of irrigators by 10–12 times;
- Requires lower capital investment per hectare compared to modern drip irrigation systems;
- Due to low sensitivity to water turbidity, there is no need for additional sedimentation or filtration facilities;
- Ensures a moisture distribution coefficient of no less than 0.95 along the length of the plant rows;
- The design of the irrigation network is simple and easy to understand, and it can be constructed using existing polyethylene pipes in local farm workshops;
- Since the system consists of pipeline networks, it enables automation of the irrigation process and ensures accurate and consistent water accounting — a critical requirement in today’s conditions.

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