

## WORLD EXPERIENCE AND APPLICATION OF DRIP IRRIGATION TECHNOLOGIES IN UZBEKISTAN

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### Abstract

The article is devoted to research on drip irrigation and other irrigation methods in countries such as the USA, Germany, Russia, Australia, Israel, etc. The experience of using drip irrigation in Uzbekistan is considered, taking into account soil properties and with the use of a controlled automatic electronic drip irrigation system.

**Keywords:** Water-saving technologies, drip irrigation, furrow irrigation, sprinkling, subsurface irrigation, water-use coefficient, soil fertility, automatic electronic drip irrigation system.

### Introduction

The idea of micro-dosed local soil moistening first arose in Germany. In 1880 experiments were carried out there with the first drip system, which consisted of short ceramic pipes with branches.

In the 1930s this idea was developed by Simcha Blass, whom some scholars consider the founder of drip irrigation. He proposed the first dripper design, but failed to bring it into production and to extend his experiments.

Wide use of irrigation tape began after the end of World War II, when industrial production of low- and high-pressure polyethylene became possible. A patent for the first drip-irrigation system was issued in Israel in 1963. Almost simultaneously similar developments were under way in the USA. Since then agricultural land irrigated by micro-dosed local irrigation has grown steadily.

At present more than 5 million ha worldwide are irrigated by this method. It is most widespread in countries with arid climates—Australia, Israel, Egypt—as well as in countries with highly profitable agriculture such as New Zealand, Austria, France and Germany.

The main purpose of irrigation is to obtain guaranteed yields of agricultural crops by controlling the water regime and associated air, heat, salt, microbiological and nutrient regimes in the soil. The irrigation method is characterised by the contacts of water with the plant, soil and ground-level air layer, the physical processes that take place, and the duration and intensity of their effect on the plant and the environment. According to A. N. Kostyakov, irrigation methods are divided into the traditional periodic and the “continuous”. The first group includes the widely used strip and furrow methods, as well as sprinkling, where the intensity of artificial water supply is 100–1000 times higher

than the intensity of water consumption, and the duration of the impact is short-term. "Continuous" methods (drip irrigation, synchronous-pulse sprinkling) are based on low-intensity water supply comparable to the intensity of water consumption throughout the growing season.

The main irrigation methods include: surface irrigation by furrows and strips; sprinkling, where artificially created rain with drops of 0.5–2.0 mm diameter moistens the above-ground part of plants and the surface layer of air; aerosol humidification (fine sprinkling); subsurface irrigation, where water is distributed over the entire irrigated area or over a local zone through porous (perforated) tubular moistening devices or mole channels directly in the arable (sub-arable) soil layer, moistening it under the action of capillary forces; subirrigation, where the groundwater level is artificially raised and the root zone is moistened due to capillary rise of moisture; surface drip irrigation, where water is supplied as individual drops of 1–2 mm diameter or jets directly to a local portion of the field surface. Economical use of irrigation water while maintaining crop yields is the main problem of irrigated agriculture. Besides progressive agrotechnical measures, the development of new irrigation techniques and methods, one of which is drip irrigation, is of primary importance.

Drip irrigation was first used in England in 1948 in greenhouses to grow vegetables. In 1962 one of the pioneers of this method moved to Israel and expanded it to industrial scale. By 1968 drip irrigation had reached 800 ha [3]. In subsequent years its use quickly spread to many other countries. In 1970 it covered 4.2 thousand ha, in 1975 – 110 thousand ha, and in 1980 – 350 thousand ha, of which 172 thousand ha were in the USA.

The advantage of the new irrigation equipment and technology is that when water is supplied in accordance with crop needs, conditions are created for uniform distribution of moisture over the entire irrigated area, local centres of moistening are formed for more intensive plant development and crop yields increase significantly. Drip irrigation reduces irrigation water consumption by 2.0–2.5 times and increases yields by 1.3–1.5 times. Therefore, in the most developed countries, such as the USA, France, Germany, Australia, Israel, Russia, etc., drip irrigation is widely used. For example, 100 % of the irrigated area in Israel is under drip irrigation, in Germany – 96 %, in France – 85 %, in the USA – 35 %, etc. Drip irrigation is widespread abroad (Israel, Germany, USA, etc.) and in some republics of the former USSR, especially in Moldova, Russia and Ukraine.

Research results show that the highest yields are obtained under drip irrigation. This is because drip irrigation delivers water from a point source directly to the plant root system and prevents runoff. In furrow irrigation it is almost impossible to provide the daily rate over a long period, as water is applied in large doses. The high intensity of application causes uneven soil moisture, which negatively affects crop productivity. Drip irrigation makes it possible to maintain soil moisture at an optimal level to promote growth and development.

Since the early 1960s Netafim (Israel) has carried out research on fruit trees and vineyards using drip irrigation. The efficiency of drip irrigation is higher than other methods; in Israel drip irrigation of vineyards has completely replaced all other methods. Studies in the USA, Israel and Australia on vineyards, apple and pear orchards have demonstrated that the highest yields are achieved in drip-irrigated vineyards. Particularly noteworthy are experiments in Australia: although almost the same amount of water was applied by furrow and drip methods, yields were 25 t/ha and 44 t/ha respectively. This is because under furrow irrigation only 340 mm of the supplied 1030 mm (33 %) was used productively, whereas under drip irrigation 1150–1170 mm, i.e. 98 % of the water, was used. Thus, plants under drip irrigation use water three times more efficiently. Greater and more productive water use under drip irrigation results in the highest yields of various crops.

The main advantage of drip irrigation is saving irrigation water through local soil moistening and increasing crop yields.

Irrational use of water resources is one of the main reasons hindering sustainable development of irrigated agriculture in Uzbekistan. One way to solve the problem is to introduce drip-irrigation systems, that is, technologies for the economical use of water resources.

Water shortage is becoming a global problem. Priority is therefore given to conserving and efficiently using available water, introducing modern irrigation technologies and scientific achievements. Uzbekistan has already done much in this direction. The transition to market relations in production and the widespread development of farming in Uzbekistan have significantly increased interest in agriculture and in the economical use of water and mineral resources.

Uzbekistan is unique in its natural conditions: rich meadows and large glaciers, juniper forests and orchards, magnificent spring and autumn pastures of low mountains and foothills, fertile irrigated lands of river valleys, large “sai” (seasonal watercourses) and hilly plains, boundless steppes gradually merging into deserts.

Important factors determining human comfort and many aspects of activity are relief and climate. Relief determines groundwater formation, mineral content, and irrigation characteristics; climate influences vegetation, the possibility of cultivation and irrigation frequency.

The lands and resources of Uzbekistan have been used since Neanderthal times. Over time significant changes have occurred in composition and relief. Groundwater formation, depth and mineralisation markedly influence soil types and fertility, which in turn determine the required irrigation regime. Why can the same plants develop differently under cultivation? In a market economy the use of land and its resources requires special scientific knowledge.

The most important soil characteristic is fertility; it provides plants with nutrients, water, air and heat. Land is the main means of agricultural production. Its efficient and rational use ensures a prosperous present and future. The republic has 28 soil types, of which 22 are intensively used and six are rarely used.

Agricultural products are grown by moistening cultivated fields through irrigation. Such farming is practiced in the valleys of the Norin, Syr Darya, Kara Darya, Kashka Darya and Surkhandarya rivers.

Soil moisture and its control are of great importance when water resources are limited. Worldwide research is under way in drip irrigation. For normal plant growth the moisture level is achieved using digital automatic control of the irrigation process. The Presidential Decree of 10 July 2020 “On Approval of the Concept for the Development of Water Management in the Republic of Uzbekistan for 2020–2030” defined the further expansion of water-saving irrigation technologies and water-use efficiency, and the development of a system of state support and incentives for agricultural producers who introduce such technologies. The Concept provides for increasing the area under water-saving technologies from 175 thousand ha to 1 million ha by 2025 and to 2 million ha by 2030, including drip irrigation from 77.4 thousand ha to 300 thousand ha by 2025 and to 600 thousand ha by 2030. These measures aim to meet the tasks facing producers: economical use of all energy resources and labour, which in turn requires a scientific and analytical approach.

The “New Uzbekistan Development Strategy for 2022–2026”, approved by the Presidential Decree of 28 January 2022, and the State Programme for its implementation set specific tasks for radical reform of water-resources management and water savings. Goal 31 provides for saving at least 7 billion m<sup>3</sup> of water through efficient use of resources.

Although many processes of water supply to plants are similar in different climatic zones, there are major differences in methods of conserving and replenishing soil moisture depending on soil properties.

Under drip irrigation, to save water it is important to measure soil moisture and monitor it continuously. Therefore, modern methods for measuring or assessing soil moisture must be developed.

The controlled automatic electronic drip-irrigation system created helps to solve the following tasks:

- When water is scarce and delivery is difficult on farms and dehqan holdings, drip irrigation can be used in the plant root zone.
- For a specific soil type and crop the drip-irrigation system operates with due regard to soil moisture.
- The system automatically controls root-zone moisture according to time of day (air-temperature changes).
- Saving water for normal growth, the system supplies water and mineral fertilisers directly to the root zone.
- With such a system water-use efficiency is dozens of times higher than with above-ground drip irrigation.
- Relay control of water supply from the source is used.
- Electrical energy is also saved

Moisture in the root zone is measured by special sensors inserted directly under the root and powered by a direct-current source (battery cell). Electrical conductivity between the electrodes depends on soil moisture (water content by mass). Resistance is measured under laboratory and field conditions.

In soil surveys the use of field electrophysical methods (measuring soil conductivity with a two-electrode moisture sensor) allows them to be carried out at a new scientific, technical and technological level, providing more objective and representative information compared with classical methods and reducing costs severalfold. The controlled water-supply system significantly saves water and electricity, which in turn reduces the cost of growing crops in all regions of Uzbekistan.

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