Technologies to reduce water waste during land leaching and cultivation of industrial crops

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Abstract. More than half of Uzbekistan’s irrigated land is saline to some degree. The drying up of the Aral Sea has intensified this process. For many years, chronic salt storms in the northern part of the country have sprayed large quantities of salt onto agricultural land, leading to increased salinization. These processes cause the water required to flush saline soils year after year. The problem is exacerbated by water shortages worldwide, including in Central Asia. This requires the leaching of saline soils and a multiplication of the water used in crop cultivation. Therefore, alternative use of water resources in our country is one of the most important issues for agriculture. The introduction of salt leaching and cultivation in farms based on outdated technologies and the low efficiency of new technologies (biosolvent washing, etc.) in the production of new salt leaching and cultivation remain a negative obstacle for the economic development of farms and the country as a whole. The analysis shows that in our country, billions of cubic meters of water are used to flush saline soils and cultivate agricultural crops. Still, only 60% of this water reaches the fields where crops are grown, while the rest disappears into the irrigation systems and irrigation processes (canals, ditches, and branch lines). When providing water resources for soil salinization and cultivation using trapezoidal canals, part of the water flowing through them dissolves and filters the mineral and organic fertilizers in the soil due to air pressure and gravity; as a result, up to 30% of water is lost (wasted). In this paper, the water resources for soil washing and crop cultivation are replaced by a parabolic excavator with a trapezoidal boom, designed to save up to 30% of water resources.

1 Introduction

Over half of Uzbekistan’s irrigated land is saline to one degree or another [1]. With the drying up of the Aral Sea, this process is intensifying, as evidenced by a large number of salt storms in the country’s northern territories and the salt and sand...
2 Materials and methods

Fig. 1. Schematic diagram of KZU-0.3D ditch digger widely used in farms: 1 is support wheel; 2 is main frame; 3 is mouldboard; 4 is blade; 5 is skis (base, heel); 6 is holder; 7 is knife (lmemex); 8 is column (bracket).
Fig. 2. Trapezoidal arrow shape: 1 is field surface, 2 is cavalry, 3 is side ribs, 4 is lobes; a is length of top of cavalry, B is length of water level in channel, b is width of channel bottom, h is height of water level, h_d is distance to water level above cavalry.

Canals used for many years in agriculture of the republic for soil leaching and crop cultivation and irrigation are made in the form of trapezoid, mainly from KZU-0.3D, KZU-0.3E, KBN-0.35. Amenity canals prepared for this purpose have the following disadvantages: they require a high level of labor and skills, water consumption increases due to excessive water supply to the canal, the canal area becomes waterlogged, and soil erosion occurs. To eliminate these disadvantages, leveling works will be required. It will be difficult to flush the soil evenly with the saline solution and control the water distribution on uneven fields.

3 Results and discussion

Analysis shows that when saline soils are flushed with water using ditches prepared in this form, part of the water passing through the ditch is absorbed directly into the soil by dissolving mineral and organic fertilizers in the soil through air pressure and water gravity (gravity).

Some water flowing out of the ditches in stony and sandy soils joins the groundwater (drainage). This raises the water table, and in some cases, secondary salinisation occurs.
As a result of studies of soil moisture contours during water outflow from the trapezoidal boom in the cross-section, it was found that the wetting diagram of this type of ditch is circular (Fig. 3).

As a result of analysis of this method, it has been established that part of the water flowing out of existing trapezoidal ditch flows through capillaries in vertical directions under gravity and atmospheric pressure, dissolving mineral and organic fertilizers in the soil.

As a result, soil fertility significantly decreases, and by the results of research and practice, it has been established that water losses are up to 30%.

The long-term research, development, and patent studies and practical works carried out by the staff of Tashkent Institute of Irrigation and Agricultural Mechanization Engineers and Tashkent State Technical University and Tashkent State Technical University [6] on the study of salt leaching and irrigation methods used in crop cultivation have been analyzed. As a result, to eliminate drawbacks of the existing application of trapezoidal channels in agricultural and water leaching soils and crops, the section of channels was prepared as parabola 4 and its marking 3 and side 2.

It was proposed to mechanically add compaction (trampling) to it using mounted support wheels 5 (Fig. 4).

Fig. 4. The proposed cross-sectional profile is parabola-related. 1 is cavalry; 2 is lateral and 3 is birefringent; 4 is parabola; 5 is base wheel; 6 is parabola-shaped working part (lemex). To give the proposed transverse profile a parabolic geometric shape of the shaft, the blade tooling 6 must have the shape of the lower part of the parabola, and the rear part of the prepared shaft requires the installation of a rubber support wheel 5 with a parabolic cut surface (Fig. 4).

The equipment design proposed by the authors fully meets the requirements of agricultural engineering, agroamelioration, and ecology, the boom tip and the lateral part are mechanically compacted, the water flowing down from it is minimally infiltrated (filtered) into the soil, the cross-section is prepared by parabolic boom tip (Fig. 4).

The proposed profile is assumed to have an elongated oval shape of wetting epithelium when water passes through parabolic arrows (Fig. 3). In this method, the flow of water through the stem is accelerated, and efficiency is increased, water infiltration through the capillaries in the horizontal and vertical directions is minimized. Melting and infiltration of mineral and organic fertilizers into the soil are minimized, the area around the ditch is not swamped, and soil erosion is avoided.

As a result of research and practice, using parabolic booms in soil leaching and cultivation has shown that soil salinity and water loss during crop cultivation can be reduced by up to 30%.
4 Conclusion

1. Proposed use of a parabolic boom for washing soil salts and cultivating industrial crops; mechanical compaction of its shank and side using a rubber support wheel will reduce water losses up to 30%.

2. Improvement, preparation, and assimilation of KZU-0.3E, KBN-0.3, and other similar equipment, used in the farms of the republic for the production of parabolic profile booms, installation of rubber-armed support wheels for sealing the mark and side parts. Industrial enterprises of the republic do not need special technological equipment and mean to perform this work.

References


