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# THE IMPACT OF LEACHING AND IRRIGATION TECHNOLOGY ON THE SALT BALANCE OF STRONGLY SALINIZED SOILS IN THE BUKHARA REGION

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**Abstract**
This article presents the results of field experiments on salt leaching and water-saving irrigation technology for cotton in the heavily saline, heavy loam soils of the long-irrigated alluvial meadows of Bukhara region. The study evaluates salt balance, with results showing that salt content decreased by 3.3 t ha-1 in the second variant and by 7 t ha-1 in the third variant compared to the control.

**Keywords**: Saline soils, deep loosening, perforated drainage, vegetation period, salt balance, salt leaching, cotton irrigation.

## Introduction

In irrigated agriculture, soil compaction is primarily attributed to improper management of agronomic and irrigation practices on irrigated land. This leads to compaction (hard layers) and gypsum formation, causing saline buildup and a higher bulk density in these soils compared to others. Consequently, such soils are difficult to reclaim and have low fertility.

Saline soils pose significant challenges in agriculture, as salinization markedly reduces soil productivity. Soil salinization refers to the accumulation of high concentrations of salts within the soil. This condition inhibits plant growth and development by hindering water and nutrient uptake. Salt leaching is one of the key processes used to address such issues, aiming to flush out salts from the soil using water.

**The purpose of the study.** The objective of this study is to enhance the efficiency of salt leaching through deep loosening and the creation of perforated drainage channels in the heavily saline, difficult-to-reclaim heavy loam soils of the Bukhara region. Additionally, it aims to develop a scientifically based irrigation regime using water-saving technology for irrigating the “Bukhara-8” cotton variety in saline soils.

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**The object of the study.** The research focuses on the heavily saline, difficult-to-reclaim heavy loam soils of the Bukhara region. This includes evaluating the effectiveness of salt leaching through deep loosening and perforated drainage channels, as well as applying an innovative water-saving irrigation technology for cultivating the “Bukhara-8” cotton variety.

**Research methods.** The study utilizes field and laboratory experiments, agrochemical analyses, biometric measurements, phenological observations, and statistical analysis. These methods are based on the "Field Experiment Techniques" outlined by the Institute of Cotton Breeding, Seed Production, and Agro-Technology Research (UzPITI, 2007). The accuracy and reliability of the data obtained were assessed using B.A. Dospekhov's multivariate methodology, along with mathematical-statistical analysis conducted with the SPSS (Statistical Package for Social Science) software.

**Results and analysis.** Over the years, heavy machinery use, excessive irrigation bringing in salts, and improper agronomic practices have compacted the lower soil layers in the experimental field, negatively impacting water permeability, porosity, bulk density, and fertility. This has reduced the efficiency of salt leaching and adversely affected plant growth and development. Therefore, additional agronomic practices, such as deep loosening and the creation of perforated drainage channels, are essential measures for such soils.

In the first variant of the experimental field, traditional salt leaching was performed with plowing at a depth of 35-40 cm. In the second variant, the field was loosened to a depth of 0.8 meters, then plowed at 35-40 cm before leaching. In the third variant, perforated drainage channels were created at a depth of 0.5 meters, followed by plowing to 35-40 cm before leaching.

In agricultural crop production, salt balance significantly affects plant growth and productivity. Excess salt in the soil can cause plant stress or death. Experiments were conducted on salt balance in the experimental field to understand how soil and plants interact with salts and to determine the impact of innovative salt leaching and irrigation technology on salt balance. The formulas developed by V.A. Kovda and data collected from the experimental field were used for this purpose.

To assess the effect of innovative salt leaching and irrigation technology on salt balance, the incoming components of salt balance included salt in water used for seasonal salt leaching and irrigation, salt brought by groundwater, and salts accumulated during the fertilization process. In the outgoing components, salts were calculated as those removed by drainage and those absorbed by the plant body and yield. For irrigation and salt leaching, water from the Amu-Bukhara Machine Channel was used, which had a mineralization level of 0.9-1.1 g/l throughout the year.

Examining the three-year average (2021-2024) of salt balance in the experimental field, the incoming salt in the control variant (1st variant) included 10.5 t $ha^{-1}$ from water used for seasonal salt leaching and irrigation, 14.3 t $ha^{-1}$ from groundwater, and 1 t $ha^{-1}$ from fertilizers, totaling 25.8 t $ha^{-1}$. In the outgoing components, 13.2 t $ha^{-1}$ was removed through drainage water, and 0.2 t $ha^{-1}$ was removed with the plant body and yield, totaling 13.4 t $ha^{-1}$. This left a balance of 12.4 t $ha^{-1}$ retained in the soil.

In the second variant, 7.6 t $ha^{-1}$ of salt entered through irrigation and leaching water, 13.5 t $ha^{-1}$ from groundwater, and 1 t $ha^{-1}$ from fertilizers, totaling 22.0 t $ha^{-1}$. The outgoing components

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showed 12.7 t $ha^{-1}$ removed through drainage and 0.2 t $ha^{-1}$ a removed with plant material, totaling 12.9 t $ha^{-1}$. Thus, 9.1 t $ha^{-1}$ of salt remained in the soil.

In the third variant, incoming salt included 7.6 t $ha^{-1}$ from irrigation and leaching water, 12.9 t $ha^{-1}$ from groundwater, and 1 t $ha^{-1}$ from fertilizers, totaling 21.5 t $ha^{-1}$. The outgoing components showed 15.9 t $ha^{-1}$ removed through drainage and 0.2 t $ha^{-1}$ removed with plant material, totaling 16.1 t $ha^{-1}$. This left a balance of 5.4 t $ha^{-1}$ of salt retained in the soil.

## Conclusion

From the information provided above, it can be concluded that field experiments conducted on salt leaching and water-saving irrigation technology for cotton in the heavily saline, heavy loam, long-irrigated alluvial meadow soils of the Bukhara region demonstrated a reduction in salt balance compared to the control. Specifically, salt content decreased by 3.3 t $ha^{-1}$ in the second variant and by 7 t $ha^{-1}$ in the third variant.

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