



THE IMPACT OF RECLAMATION MEASURES ON SALINITY REGIMES OF SOLONCHAK AND HIGHLY SALINE GYPSIFEROUS SOILS

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Abstract

In order to improve the reclamation status of solonchak and highly compacted gypsiferous soils, the land was subjected to plowing to a depth of 30 cm, followed by deep loosening to a depth of 80 cm and slotting to a depth of 120 cm. Subsequently, a closed horizontal drainage system was installed at a depth of 120–150 cm, with spacing between drains of 30–35 m.

The prepared soil was leached in two stages. At the first stage, during the autumn–winter period, 10,000 m³/ha of water was applied, ensuring the removal of salts from the 50–70 cm soil layer. The second stage of leaching was continued through rice cultivation, with an additional application of 17,000 m³/ha of water, which reduced soil salinity from solonchak levels to slightly saline conditions.

The second experimental plot served as a control. Its soil, similar to that of the first plot, was also solonchak and highly saline; however, the depth of the horizontal drainage system was 3.0–3.5 m, with a spacing between drains of 70 m. In this variant, annual leaching was carried out during the autumn–winter period using



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4,000–4,500 m³/ha of water. However, no significant desalinization of the soil was observed.

Keywords: Solonchak, plowing, deep loosening, deep slotting of soil, leaching, rice cultivation, soil desalinization.

Introduction

According to the data of the Cadastral Agency of the Republic of Uzbekistan for 2024, the total area of irrigated saline lands amounts to 1,746 thousand hectares, of which 418 thousand hectares are classified as having unsatisfactory reclamation conditions.

The areas of strongly and very strongly saline irrigated lands are distributed as follows: in the Republic of Karakalpakstan— 97.8 thousand hectares, in Syrdarya Region — 51.4 thousand hectares, in Bukhara Region — 32.6 thousand hectares, in Kashkadarya Region — 16.5 thousand hectares, and in Surkhandarya Region — 13.9 thousand hectares.

Improving land reclamation in the Republic, particularly on highly saline and solonchak soils characterized by a high degree of compaction and the presence of impermeable gypsum layers at varying depths, remains an urgent task. Preventing secondary soil salinization, improving drainage systems, the widespread application of water-saving technologies in leaching practices, and the development and implementation of agrotechnologies for crop cultivation are of critical importance.

Materials and Methods

Two field experiments were conducted under conditions of light sierozem, solonchak, and highly saline gypsiferous soils in the Syrdarya Region.

At the first experimental site, for soil reclamation purposes, a closed horizontal drainage system was initially installed at a depth of 1.2 m with spacing between drains of 30–35 m. This was followed by deep loosening to a depth of 0.8 m and



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deep slotting to a depth of 1.2 m. The prepared soil was leached in two stages. During the first stage, in the autumn–winter period, 10,000 m³/ha of water was applied, which ensured the removal of salts from the 50–70 cm soil layer.

The second stage of leaching was continued from spring using rice cultivation, with an additional application of 17,000 m³/ha of water. This approach reduced soil salinity from solonchak levels to slightly saline conditions.

The second experimental plot served as a control. Its soil, similar to that of the first plot, was also solonchak and highly saline. However, the depth of the closed horizontal drainage system was 3.0–3.5 m, with spacing between drains of 70 m. At present, annual leaching is carried out during the autumn–winter period; however, the process of secondary salinization continues, and 4,000–4,500 m³/ha of water is used annually for salt leaching.

Soil salinity levels before reclamation in the experimental plots.

Prior to reclamation, the total salt content in the experimental plots ranged from 1.323% to 3.586%; chloride ions — 0.410–0.679%; sulfates — 0.475–1.545%; calcium — 0.145–0.209%; and sodium — 0.368–0.880%.

In the gypsum layer (dry residue), the total salt content ranged from 1.574% to 3.274%; chloride ions — 0.485–1.053%; sulfates — 0.347–0.970%; calcium — 0.213–0.325%; and sodium — 0.225–0.665%.

The presented data indicate that, according to the accepted classification, the salinity levels of the experimental plots correspond to solonchak soils. The salinity type is classified as chloride–sulfate based on anions and sodium–calcium based on cations.

Changes in soil salinity after land reclamation.

The results of long-term studies have shown that no significant changes in soil salinity were observed in the control variant. On the contrary, the majority of salts accumulated on the soil surface after leaching.

Over the past 40 years, in the upper soil layer (0–60 cm above the gypsum horizon), the dry residue content increased by 0.250%, chloride ions by 0.073%, sodium by



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0.173%, and calcium by 0.167%. In the gypsum layer (60–100 cm), these indicators increased by 0.093% and 0.073%, respectively. It was further established that the values reached 0.097%, 0.167%, and 0.114%, respectively. In this variant, a high level of salinity persisted throughout the entire one-meter soil layer. This is explained by the presence of a very dense gypsum horizon (1.70–1.75 g/cm³) at a depth of 60–100 cm, with a thickness of 30–55 cm and zero water permeability. As a result, water movement from the soil surface is impeded at the gypsum layer, and the applied irrigation water does not reach the closed subsurface drainage system (installed at a depth of 3.0–3.5 m) (Table 1).

Table-1 Changes in soil salinity in the control variant.

Soil layer name	Layer depth	Dry residue	HCO ₃	CL	SO ₄	Ca	Mg	Na+ K
Control variant (1985)								
Above the gypsum layer	0-60	1,323	0,010	0,485	0,475	0,145	0,024	0,368
Gypsum layer	60-100	1,574	0,015	0,347	0,570	0,213	0,026	0,225
2025.								
Above the gypsum layer	0-60	1,925	0,010	0,410	0,874	0,404	0,025	0,180
Gypsum layer	60-100	1,667	0,015	0,420	0,667	0,380	0,028	0,111
Difference								
Above the gypsum layer	0-60	+0.251	+0.005	--0,085	-0,095	+ 0,068	+0,006	- ,143
Gypsum layer	60-100	+0,093	0	+0,073	+0,097	+0,167	+0,002	-0,114

At the experimental site, for the reclamation of highly saline solonchak gypsiferous soils, a closed horizontal drainage system was installed with a length of 400 m, at a depth of 1.2–1.5 m, and with spacing between drains of 30–35 m. Plowing was carried out to a depth of 30–35 cm, followed by deep loosening to 70–80 cm, as well as slotting along the field at intervals of 1.2 m and a depth of 1.2 m.



Rice was cultivated during one season, and in subsequent years, cotton, winter wheat, and perennial crops were grown as the main crops.

As a result, salts within the one-meter soil profile were completely leached, and the salinity level decreased from solonchak and highly saline conditions to slightly saline conditions. In the 0–60 cm layer, the dry residue decreased by 2.347%, chloride ions by 0.664%, sulfates by 0.779%, calcium by 0.060%, and sodium by 0.859%. Complete leaching of salts was also observed in the gypsum layer (60–100 cm) (Table 2).

Table-2 Changes in soil salinity in the experimental variant.

Soil layer name	Layer depth	Dry residue	HCO ₃	CL	SO ₄	Ca	Mg	Na+ K
Control variant (1985)								
Above the gypsum layer	0-60	3,585	0,014	0,679	1,545	0,209	0,035	0,880
Gypsum layer	60-100	3,274	0,015	1,053	0,970	0,325	0,095	0,665
2025.								
Above the gypsum layer	0-60	1,238	0,008	0,015	0,766	0,269	0,030	0,021
Gypsum layer	60-100	1,233	0,013	0,022	0,774	0,266	0,036	0,014
Difference								
Above the gypsum layer	0,60	- 2,347	-0,006	-0,664	-0,779	+0.060	-0,005	-0,859
Gypsum layer	60-100	-2,041	-0,002	-1,031	-0,192	-0,059	-0,059	-0,651

Conclusions

1. Prior to reclamation, the salt content in the experimental plots ranged as follows: dry residue — 1.323–3.586%, chloride ions — 0.410–0.679%, and in the gypsum layer, dry residue — 1.574–3.274%, chloride ions — 0.485–1.053%. These data indicate that, according to the accepted classification, the soils of the experimental plots correspond to solonchak conditions. The salinity type is classified as chloride–sulfate based on anions and sodium–calcium based on cations.



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2. In the control variant, it was established that over a 40-year period, under the influence of irrigation and salt leaching associated with crop cultivation, up to the gypsum layer (0–60 cm depth), the dry residue content increased by 0.250% and chloride ions by 0.073%. In the gypsum layer, these indicators increased by 0.093% and 0.073%, respectively. In this variant, a high level of salinity was fully preserved within the one-meter soil layer.

3. In the experimental plot, salts were completely leached within the one-meter soil layer, resulting in a reduction of salinity from solonchak and highly saline levels to slightly saline conditions. In the 0–60 cm layer, dry residue decreased by 2.347%, chloride ions by 0.664%, sulfates by 0.779%, calcium by 0.060%, and sodium by 0.859%.

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