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# The current state of soil cover in Kazakhstan, problems and solution

Saparov A. [1,4], Pachikin K. [1,4], Mazhitovich M. B. [2,4], Schindler U.[3,4], Müller L.[3,4], Eulenstein F.[3,4]

## ZUSAMMENFASSUNG / SUMMARY

This paper presents the research material gained during implementation of the international project led by the International Center for Agricultural Research in Arid Areas (ICARDA) entitled “Sustainable management of land resources in arid regions of Central Asia and Caucasus”. This project focused primarily on irrigation and degraded pastures in south and southeast Kazakhstan. Soils and forage crops were studied using conventional, proven methodological approaches and agro-chemical methods. The subjects of the study were: terrains, soil, water, cultivated and pasture plants (rice, triticale and winter wheat, wormwood-ephemeral, grass-shrub and cereal-grass communities).
The following aspects were studied and evaluated: soil reclamation and the environmental condition of the soil surface of Shiely irrigation area, fertility levels, soil salinity chemistry and soil degradation under irrigation in the Kyzylorda region, as well as the degradation of pastures in the Sarysu district of the Zhambyl region. The current status of the soil surface of each study object was described. In addition, methods were devised to improve soil reclamation and environmental conditions and conservation, and to increase soil fertility and crop productivity in irrigated saline soils and pastures of the arid zone.

**SCHLÜSSELWORTE/ KEYWORTS:**
soil degradation, soil reclamation, Kazakhstan

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[1]U.U.Uspanov Kazakh Research Institute of Soil Science and Agrochemistry 75B, Al-Farabi ave., 050060, Almaty, Kazakhstan

[2]Kazakh Scientific and Research Institute of Forestry and Agroforestry Reclamation
021704 Akmolinskaya oblast. gorod Shuchinsk ul. Kirova 58.

[3]Leibniz Centre for Agricultural Landscape Research (ZALF) Müncheberg, Eberswalder Straße 84, D-15374 Müncheberg,
Email: feulenstein@zalf.de

[4]Mitscherlich Academy for Soil Fertility, Prof.-Mitscherlich-Allee 1, 14641 Paulinenaue, Germany

## EINLEITUNG / INTRODUCTION

Studies were conducted in areas of Kazakhstan focusing on the Shiely irrigation district. The objects of study were terrains, soils, water and plants. New varieties of plants, crop rotations and associations, and reinvented site-adapted natural species were tested. The plants involved were rice, triticale, winter wheat, *Artemísia*-ephemeral, grass-shrub and cereal-grass associations.
In order to achieve our objectives, we used very common, well-proven methodological approaches and methods to comprehensively study field soils: the comparative geographic method and the method of soil keys in studying the specifics of soil formation during the periodic flooding of soils, and morphological profiling. Saline soils were evaluated based on three main criteria: the chemistry (type) of salinity, the salinity rate, and the depth of the saline horizon. The chemistry of saline soils was determined by composing anions and cations. First of all, attention was paid to anions and the extent to which they correlated to water extracts from soils (Bazilevich and Pankov, 1968; Meirmanov et al., 1997; Zubairov, 2002; Otarov et al., 2007). The agrochemical soil survey was conducted

by conventional research using the following methods: humus using the Tyurin method, GOST 26213-91, easy hydrolysable nitrogen using the Cornfield method 1975 (Agrochemical methods, 1975), mobile phosphorus compounds and exchangeable potassium using the method of Machigin, GOST 26205-91, and pH-water extraction using GOST 17.5.4.01-84. The seasonal dynamics of salts was determined by conducting large-scale saline surveys (1:2000 scale). pH, $CO_3$, and $HCO_3$ were analysed by potentiometric, Cl and $SO_4$ by titration, Ca and Mg by atomic-absorption spectrometry, and K and Na using a flame photometer. Phenological observation of plant communities in rangelands was conducted according to Beideman's methodology (Beideman, 1974). All other field and agrochemical analyses were performed using standard methods (Dospechov, 1973; Agrochemical methods, 1983).

## EREBNISSE / RESULTS

The evaluation of the current soil reclamation status of the Shiely area revealed that all soils have a certain degree of salinity. At the same time, 998 ha (54 %) of the studied test site contain slightly saline rice-swamp soils and moderately and strongly saline soils. Saline soils and deep saline soils make up an insignificant area. Soils are mainly saline on the surface (88 %), the result of the irreversible secondary salinisation of soils, which is currently occurring. Concerning the extent and chemistry of soil salinity, it should be noted that the technical condition of the collector fails to meet design standards, resulting in an increase in groundwater level and soil salinity (Fig. 1). The results of the salinity survey and comparative analysis revealed that some freshening (flushing) or desalinisation occurs during the growing season. However, the intensity of the removal of salts from the root zone is insufficient. The yield of rice grown on weakly and moderately saline soils (in rotation with 3-year alfalfa) was 4.2 to 5.2 t/ha, and only 2.1 t/ha on strongly saline soils. The irrigation norm in a shorter irrigation regime was 24,200 $m^3$/ha, and 25,480 $m^3$/ha in a constant flooding regime. Since the productivity of crops grown on saline soils depends largely on soil fertility, the presence of organic matter in soils is one of the main aspects affecting the soil fertility of rice fields.

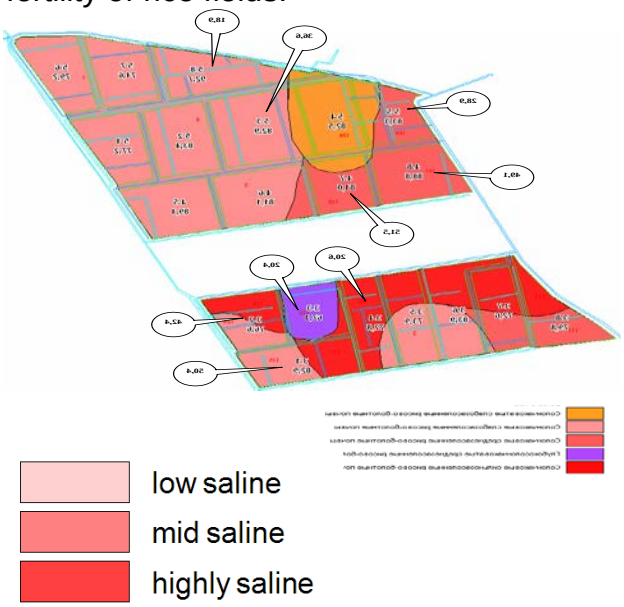


**Figure 1: Map of soil salinity and rice yield capacity**

The results of the variation-statistical analysis of the content of humus forms and nutrients in the soil revealed that soils from the test site in Shiely irrigation area have a very low content of common humus (1.1 ± 0.18 %). In this case, the mobile water-soluble form of humus averaged 0.004 ± 0.0005 %. The loss of humus in periodically flooded paddy soils is mainly due to mobile water-soluble forms.
An agrochemical survey was conducted to determine the content of total humus in soils at the experimental site and the extent to which they are supplied with the main nutrient elements at the test site (712 ha). Based on the data obtained, maps were created and the soils were classified into groups of humus content and nutrients, calculating the area of the respective groups. The studies revealed that the entire area under investigation contains groups of soils with a "very low" (95.8 %) and "low" (4.2 %) humus content, i.e. soils at the test site are degraded and

subject to the process of dehumification (Fig. 2).


**Figure 2: Map of humus content in soil**

Due to the deterioration of soil reclamation status and the intensive development of soil salinity, humus content in soils has decreased; the loss of the mobile water-soluble form of humus in one season was 12 to 36 % (Otarov et al., 2007). Soils in the surveyed territory are very diverse concerning the availability of mobile phosphorus, namely: very low, low, medium, increased, high and very high. In order to achieve a high yield, 45.2 % of the area requires phosphorus fertilisers. The content of exchangeable potassium was medium and high for over 90 % of the surveyed soils.

Studies on optimising the technology of rice cultivation based on raised bed and minimal-zero till technologies in combination with short or periodical irrigation show that the expenditure of irrigation water can be reduced by 30 to 40 %, leading to an improvement of the soil's reclamation status and a reduction in the amount of seeds, fuel and lubricants required. With raised bed seed sowing using specialised drills made in India and the equivalent rice yield capacity, the quantity of seeds saved ranged from 100 to 160 kg/ha.

In the Shiely area of irrigation, it was determined that it is possible to introduce a minimal-zero till technique for growing rice that produces the same yield but saves 100 kg/ha seeds compared with conventional rice cultivation techniques.

Based on the experimental studies, we designed soil and terrain maps of the study objects**.**

**Pasture and dryland improvement**

The productivity of pastures has decreased sharply in line with the intensive degradation of land. With this in mind, it is very important to develop activities to promote the rational use of land and the enhancement of pastures.

The results of studies on the development of systems to manage pastures, carried out on different soil types and climatic conditions of the Sarysu district of the Zhambyl region, highlighted the need to create sown pastures using plants of the arid zone and to cultivate alternative crops (Figs. 3 and 4).

Figure 4: Preliminary examination of the "Abylai" farm territory in the Sarysu district (Zhambyl region)

On light grey soils, where the pasture vegetation cover is 25 to 40 % and yields are 0.08 to 0.13 t/ha, the main species were Calligonum and Haloxylon, Krascheninnikovia ceratoides and Halothamnus. The plant height of Kochia prostrata was 23.6 cm and 19.5 cm in pure and mixed plantations, respectively, Krascheninnikovia ceratoides was 23.1 cm and 22.8 cm, Haloxylon 27 and 25.3 cm, Calligonum 43 cm and 39.2 cm, and Haloxylon 23.4 and 19.7 cm. In this case, all of the species featured well-developed lateral shoots and formed symmetrical crowns.

Drought periods in the spring in semi-bound sands with grass-shrub vegetation, with Artemisia-ephemeral groups, was reflected to some extent by the development of xerophytes. The height of young plants of Kochia prostrata, Atriplex and others, in particular triticale (variety Horde) and winter wheat (variety Vitreous 24), on ordinary grey soils revealed an advantage of triticale. Plant heights of 79.6 ± 0.9 cm and 62.6 ± 0.7 cm, respectively, and better tillering were observed. In this case, the biological productivity of triticale was 5.6 t/ha, and the yield of wheat 4.8 t/ha (Fig. 6).

The cultivation of cereal crops in rain-fed conditions Characteristics of wheat plants of the variety Vitreous 24 and triticale of the Horde variety

Figure 5: *Kochia* crops

Figure 6: Comparative indicators of tillering: 1. Winter wheat (variety Vitreous 24). 2. Triticale (variety Horde)

## SCHLUSSFOLGERUNGEN/ CONCLUSION

- Salinity is a major factor leading to a reduction in soil fertility and crop yield under irrigation conditions.
- The extent and chemistry of soil salinity are important. The salt regime of periodically flooded soils must be controlled by summer washing (when fields are flooded) and, in autumn, after the irrigation period.
- The reclamation and enhancement of the fertility of saline soils is essential for increasing the productivity of crops and land resource management in irrigated agriculture.
- The soil reclamation status should be assessed and soil fertility monitored periodically.
- Based on these survey maps and technology, action must be taken to enhance the fertility of saline soils.
- In order to achieve sustainable pasture management and to ensure fodder production in the arid zone, cultivated pastures must be created by planting natural forage plants and growing alternative crops, particularly triticale, in the ley.

## LITERATURE


Agrochemical methods, 1975. Methodological guidance on conducting the agrochemical survey of soils of agricultural land (Агрохимические методы исследования почв). “Nauka”, 23 p.

Agrochemical methods, 1983. Agrochemical methods of soil studies (Методические указания по проведению полевых опытов с кормовыми культурами). Moscow, “Nauka”. 656 p.

Bazilevich, N.I., Pankov, E. 1968. Experience in classifying salinity // Soil Science (Опыт классификации по засолению // Почвоведение). 1968. # 11, 76 p.

Beideman, I.N. 1974. Methodology for studying plant phenology and plant communities (Методика изучения фенологии растений и растительных сообществ). Novosibirsk, 154 p.

Dospechov, B.A. 1973. The field experiment method (Методика полевого опыта). Москва, 1973. 336 p.

Meirmanov, G.T., Dzhamantikov, H., Dzhamantikova, T.O., Bekbolat, S.J. 1997. Environmental impacts of anthropogenic changes in irrigated lands in the Aral Sea area (Экологические последствия антропогенных изменений орошаемых почв приаралья // Проблемы экологии АПК и охраны окружающей среды), Issues of ecology and agricultural environment. Almaty, 1997. p. 110-111.

Otarov, A., Ibraeva, M.A., Saparov, A.S. 2007. Degradation processes and current soil-ecological condition in rice areas of the Republic / Environmental bases of formation of soil surface in Kazakhstan in anthropogenesis and development of theoretical bases of reproduction of fertility (Деградационные процессы и современное почвенно-экологическое состояние рисовых массивов республики/ Экологические основы формирования почвенного покрова Казахстана в условиях антропогенеза и разработка теоретических основ воспроизводства плодородия). Almaty, 2007. 73-105.

Zubairov, O.Z. 2002. Reclamation status of irrigated land in the Kyzylorda region / System of agricultural production in the Kyzylorda region (Мелиоративное состояние орошаемых земель Кызылординской области / Система сельскохозяйственного производства Кызылординской области) Almaty. “Bastau” publishing house, 2002. p. 385-387.