

ADVANTAGES OF CULTIVATING SILAGE USING DOMESTIC WASTEWATER.

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Annotation: In the saline and degraded lands of the Bukhara region, maize was cultivated using domestic wastewater. The experimental study was conducted at the “*Muttaxarkhoja*” farm located in the Bukhara district. According to the experimental program, the composition of domestic wastewater was thoroughly analyzed, and the nutrient amount required for the selected crop type was determined. Two variants were chosen for silage cultivation: in the experimental variant — irrigation with domestic wastewater, and in the control variant — irrigation with canal water. In the control variant, an additional fertilizer norm was included in the plan. In both variants, the same amount of water — 3585 m³ per hectare — was applied.

Keywords: domestic wastewater, irrigated lands, nitrogen, phosphorus, maize, productivity, experimental and control variant, fertilizer, crop, irrigation rate.

Introduction.

By the year 2025, nearly 60% of the world’s population may suffer from water scarcity. Meanwhile, one of the major global issues is the increasing volume of wastewater discharge, which currently ranges from 400 billion to 5,500 billion cubic meters worldwide. Each year, China discharges 362 billion, the United States 216 billion, Brazil 95 billion, Russia 71 billion, Mexico 53 billion, India 30 billion, and the United Kingdom and France more than 20 billion cubic meters of drinking water as domestic wastewater.

In agriculture, due to the decreasing availability of fresh water for irrigation and the need to produce high and quality yields, the problem of water shortage has become increasingly acute. Therefore, to overcome water scarcity and to conserve drinking water resources, the efficient use of wastewater for irrigation—especially in water-deficient regions—plays an important role.

According to paragraph 3.3 of the Presidential Decree of the Republic of Uzbekistan No. PF–6024 dated July 10, 2020, “On the approval of the Concept for the Development of the Water Management Sector of the Republic of Uzbekistan for 2020–2030,” the following tasks have been set: “...to ensure the sustainable development of agricultural production, strengthen the country’s food security, expand the production of environmentally friendly products, and preserve drinking water through the introduction of modern water- and resource-saving agro-technologies.”

Based on these objectives, many practical measures have been implemented across the country. The majority of the territory of our region consists of degraded and water-deficient lands, with about 86% affected by varying degrees of salinity. The total irrigated land area in the region amounts to 275.1 thousand hectares. To preserve irrigated areas and meet the population’s growing demand for food, it is necessary to use agricultural land and water resources efficiently. Currently, our water resources are limited, and the reserves available for crop cultivation are insufficient. Therefore, the use of treated wastewater has become a necessity dictated by current

conditions. Analysis results have shown that, after purification, domestic wastewater generated by the population can be effectively used for irrigation purposes within the region.

Many scientists — such as S. Rizhov, N. Umarova, V. Baranov, L. Smirnova, and A. Norman — have conducted scientific research on the variation of soil moisture depending on its mechanical composition, density, and organic matter content.

The soil of the experimental plot is classified as alluvial-meadow soil, which has not been previously cultivated (non-reclaimed). It is characterized by a high degree of salinity, low fertility, and poor nutrient content.

The soil of the experimental area is unclaimed meadow-alluvial soil, where fine sand particles (0.1–0.05 mm) account for 27.9–34.67%, coarse silt fractions (0.05–0.01 mm) make up 28.9–30.7%, and clay particles (<0.001 mm) range from 6.50% to 10.27%. The soil profile consists not only of sandy, sandy loam, loam, and clay layers but also exhibits a highly complex stratified mechanical composition. From the surface downward, the soil layers may alternate between heavier and lighter textures, with rapid changes in sequence — for instance, sand–clay–loam or loam–sandy loam–gravelly clay formations can be observed.

In the experimental variant, only domestic wastewater was used for irrigation, and no additional fertilizers were applied. In the control variant, canal water was used for irrigation, and fertilizer norms were applied accordingly. For maize (silage), the mineral fertilizers were applied in pure form as follows: nitrogen – 250 kg/ha, phosphorus – 175 kg/ha, and potassium – 125 kg/ha.

Throughout the growing season, the irrigation rate was kept the same for both the experimental and control variants. The maize crop was irrigated six times according to a 2–4 irrigation schedule, with a total water consumption of 3,585 m³ per hectare. In the control variant, additional fertilizer was applied between irrigations.

Table 1

Nutrient composition of domestic wastewater during the 2022 growing season

Indicators	year	Month (mg/l)								total (mg/l)	in terms of kg/l
		March	April	May	June	July	August	September	October		
phosphate	2022	2,7	2,5	2,7	2,73	2,6	2,5	2,63	2,22	20,58	0,00002 058
Ammonium nitrogen		4,9	4,5	4,5	4,2	4,9	4,5	4,7	4,9	37,1	0,00003 71
nitrite		0,02 1	0,02 6	0,02 3	0,02 2	0,02 1	0,02 8	0,021	0,022	0,184	0,00000 018
nitrate		3,8	3,5	3,7	3,9	3,8	3,9	3,9	3,7	30,2	0,00003 02

During the experiment, phenological observations were conducted to monitor the growth and development of the crops. Field observations included measurements of the plants' leaves, stems, and height to assess their growth dynamics under the different irrigation conditions.

The results of the agro-technical measures carried out in the experimental plot are determined by crop yield. For harvesting corn for silage in both the control and experimental plots, Kemper Class Case (Belarus) forage harvesters were used. The corn hybrid “Uzbekistan–400 BL” was irrigated six times during the growing season, maintaining pre-irrigation soil moisture at 70–80% of the field capacity (FC). The seasonal irrigation rate was the same for both the experimental and control variants — 3585 m³/ha. The average yield in the control variant was 610.7 centners/ha, while in the experimental variant it was 21.8 centners/ha lower.

Table 2

Number and norms of seasonal irrigations for agricultural crops cultivated in the “Muttaharxo‘ja” farm, m³/ha

№	Variants	Number of irrigations						Seasonal irrigation rate, m³/ha	Irrigation scheme
		1	2	3	4	5	6		
Maize (for silage) crop, variety “Uzbekistan – 400 BL”									
1	Control	679	686	41	86	58	35	3585	2-4
2	Experiment	679	686	41	86	58	35	3585	

Note: In the experimental variant, higher productivity was achieved compared to the control variant by using domestic wastewater. The main reason for this is the presence of nitrogen, phosphorus, and other elements in the composition of domestic wastewater. During the season, when 3585 m³/ha of water was applied to the maize crop, 300.8532 kg of nitrogen and 140.1735 kg of phosphorus, dissolved in the water, entered the crop field.

Yield of agricultural crops cultivated in the “Muttaharxo‘ja” farm based on returns, c/ha

№	Variants	Varieties	Replication				Average yield, c/ha	Additional yield, c/ha
			1	2	3	4		
Maize (for silage)								
1	Control	“Uzbekistan – 400 BL”	610,2	611,5	610,8	610,5	610,7	-21.8
2	Experiment		589,5	588,9	588,4	588,7	588,9	

As a result, the yield increased. The superiority of the experimental variants can be determined through calculation. In cultivating the crops under study, all expenses were taken into account — including the purchase of seeds, soil treatment using machinery and manual labor (agrotechnical

measures), the purchase and application of fertilizers using mechanized equipment, leaching of salts, field preparation for sowing, irrigation operations, pest control treatments, harvesting, and other related activities.

In the experimental variant of maize (silage) cultivation using the “Uzbekistan – 400 BL” variety irrigated with domestic wastewater, the net profit amounted to 12,880,000 soums with a profitability rate of 269%. In contrast, in the control variant (fertilized and irrigated with river water), the net profit was 8,068,000 soums with a profitability rate of 79%, which is 190% lower compared to the experimental variant.

No fertilizer was applied in the experimental maize variant. Both the control and experimental variants were maintained under the same irrigation schedule and water norms. From this experiment, it can be concluded that under water scarcity conditions, irrigation with domestic wastewater at a rate of 3,585 m³/ha allows for significant savings in mineral fertilizers (for alfalfa: phosphorus – 150 kg/ha, potassium – 75 kg/ha; for maize: nitrogen – 250 kg/ha, phosphorus – 175 kg/ha, potassium – 125 kg/ha). (The economic efficiency of the farm is presented in Appendix 8.)

Table 3

Phosphorus and nitrogen content (kg/ha) in domestic wastewater supplied to crop fields during the irrigation season in 2022

Indicators	Maize (corn)		
	Seasonal irrigation rate, m ³ /ha	At the level of 70–80% of the Field Capacity (FC)	Seasonal irrigation norm, m ³ /ha
Phosphorus (kg/ha)	3357	46,71	3585
Nitrogen (kg/ha)		148,5	

Note: In Table 1, the content of domestic wastewater throughout the season, including ammonium nitrogen, nitrites, nitrates, and phosphorus, was calculated over three ears, and the fertilizer norms in the control variant were based on these data. In the experimental variant, the nutrients present in the domestic wastewater alone were sufficient. In 2022, the fertilizer levels in the domestic wastewater were compared, and in production trials, the effects of river water versus domestic wastewater along with fertilizer norms were repeatedly evaluated.

In Table 3, the nutrient content of domestic wastewater applied per hectare during the growing season is presented for each irrigation event. The main reason for the small difference in yield between the experimental and control variants is the presence of nitrogen, phosphorus, and other elements in the domestic wastewater. The fertilizer amount applied in the control variant, combined with the nutrients in the domestic wastewater, is sufficient for the growth and development of the crop. Therefore, when cultivating crops with domestic wastewater, the application of additional nutrients is not necessary.

Conclusion: An experimental trial was conducted in 2022 at the “Muttaharxo‘ja” farm in Bukhara district, Bukhara region. The results showed that for cultivating the maize (silage) variety “Uzbekistan – 400 BL,” 200 kg of seeds were sown, and the soil was irrigated six times according to a 2–4 irrigation system, maintaining pre-irrigation soil moisture at 70–80% of field

capacity. Both variants received 3,585 m³/ha of water. The yield reached 611 c/ha, which is 21.8 c/ha higher compared to the baseline. The net profit in the experimental variant amounted to 12,881,000 soums, with a profitability of 269%. No fertilizers were applied in the experimental variant for maize and alfalfa crops, resulting in savings of mineral fertilizers (N₂₅₀, P₁₇₅, K₁₂₅) and river water used for irrigation.

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