Optimal solution leaching rates with a deficit of irrigation water

IOP Conf. Series: Materials Science and Engineering **883** (2020) 012091 doi:10.1088/1757-899X/883/1/012091

Optimal solution leaching rates with a deficit of irrigation water

A Khojiyev[1], T Khaydarov[1], N Rajabov[1] and J Pulatov[1]

Tashkent institute of irrigation and agricultural mechanization engineers. Tashkent, Uzbekistan

aliakbar-x@mail.ru

Abstract. The growing demand for water resources is associated with many natural and anthropogenic factors: diversification of the economy, growth of water supply and requirements, construction of hydropower complexes, problems with managing the transboundary rivers waters, restoration of the ecology of the Aral Sea region and others. Now, much attention is paid to the distribution of irrigation water during the growing season including the introduction of drip and spring irrigation systems, irrigation pipelines, etc. But, unfortunately, attention remains to the issues of effective salt leaching management the land to the extent of soil salinity, crop variety, the composition of salts, and salinity. In this paper, the authors attempt to solve this problem.

1. Introduction

Taking into account the zonal soil-climatic features of our Republic, special attention should be paid to the implementation of autumn-winter measures to improve the meliorative state of lands. To this end, it is necessary to carry out the following agrotechnical measures: plowing, leaching of saline lands, operational land planning, cutting of ridges, and deep tillage.

To increase the efficiency of irrigated lands and to obtain the planned harvest of agricultural crops in the Republic, 690 thousand of saline land should be washed annually using palovas (checks), including 141 000 hectares in the Republic of Karakalpakstan, 181 thousand hectares in the Bukhara region and the Kharezem region is 134 thousand hectares, etc [1, 2, 3].

According to the data, 45% of the lands on the territory of Uzbekistan are saline to some extent. 34% of them are saline, which is 8%. The remaining lands are saline and highly saline. Usually in 100 grams of soil contains 0.3% chlorine of the ion, if the salts are not used 0,01 means the land is not saline, if the salt concentration exceeds 1%, chlorine ion 0.1-0.15% is considered highly saline. From previous experiments, it is known that when salinization of the land the yield decreases by 10-15% for slightly saline soils, 30-35% for saline lands, 65-75% for highly saline soils, and further the yield decreases. Accordingly, the quality of agricultural products also decreases [5, 6].

Without reducing salinity in the root zone of the soil, a good harvest of cotton and other crops can not be achieved. This can be achieved by leaching the land. The rate of irrigation is not continuous, if it is supplied in part, then the effectiveness of reducing the degree of salinization of land will increase. Therefore, when flushing land, especially if washed with large norms, after each water supply, it is necessary to take a break. The duration of the break varies from the connection of the soil texture and the filtration rate, respectively, in light soils water permeability is 2-3 days, medium soils 5-6 days, and heavy soils 7-8 days [7, 8, 9, 10].

It is possible to choose ways of leaching according to the degree of soil salinity, the physical properties of the soil, and the relief of the field: by flooding, by furrows, by strips. The main method of land leaching is flooding with water, leaching is carried out by not passing water from one floor to another. At present, in the period of irrigation water shortage, the scientific justification of land leaching and ways of leaching to improve the efficiency of reducing the salinization of irrigated land becomes an urgent task. To do this, it is important to determine the degree of soil salinity in the wash area, the name, and grade of the plant, the composition of the salts, and the change in crop yields after leaching operations. As a consequence, analyzing the change in crop yields, the optimal solution for land leaching is selected. The optimal solution for land leaching is determined by the formula of Volobuyev [11, 12, 13, 14].

$$N = \frac{lgC_0}{lgC_r} + \frac{a}{\mu}h \qquad (1)$$

Here:

C_0, C_r are the content of salts before leaching and the permissible norms, relative to gravity in % ratio.

α is the coefficient of free salt supply.

h is the depth of the washed soil layer, m

μ is the coefficient associated with the rate of removal of saline water.

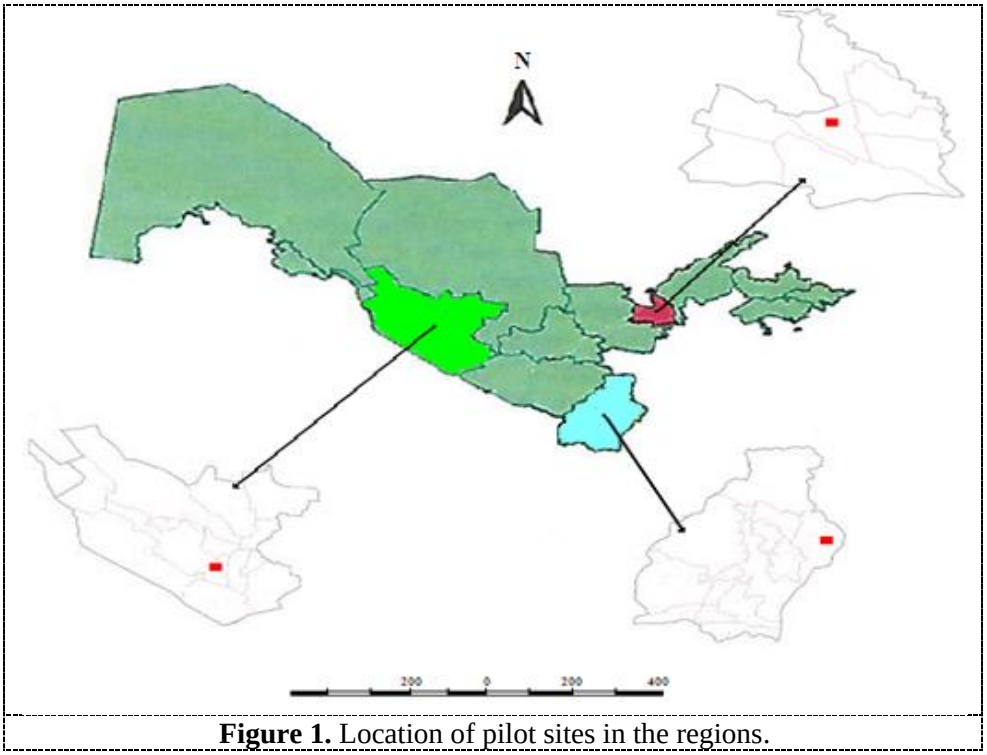

Figure 1. Location of pilot sites in the regions.

2. Methods

Experiments were conducted in the Syrdarya, Surkhandarya, and Bukhara regions in farms specializing in cotton-growing (Figure 1). The soils in the experimental plots are mainly of a much more moderate degree of solidity, medium, and light loam, mainly soils contain *Cl, K, Na*, and *Mg* salts. The middle-silt soils are 0.01÷0.04 percent chlorine, the light loam is 0.04÷0.0, 10 percent chlorine ion [15, 16, 17, 18].

Here, according to Volobuyev's formula, areas with the same fertility and area are selected, but with different degrees of salinity.

To carry out the experiment, the mechanical composition of the soil, the relief, the meliorative state, the types of soil, and the hydro module areas in these areas should be appropriate. At the same time, a soil map with a scale of 1: 10000 should be used to correctly evaluate the experimental plot. In the absence of a soil map, 2-3 pits are excavated for the morphological determination of the genetic layer. Together with this, simultaneous 5-fold analysis of nitrogen, phosphorus, potassium, and humus at a depth of 100-150 m

Here, the wash area of the degree of salinity *(S)* is determined before and after leaching using the Progress-1T device. The degree of salinity before flushing is determined by *(S)* FAO-16 Ese, dS/m, the depth of leaching *(h)* is 1 m, the salt supply index *(a)* is 0.97 ha, the indicator of used leaching water is assumed to be constant (H_{wat}) [19, 20].

3. Results and Discussions

A field experiment was conducted in 2012-2016 on the territory of the farm "Azamat tazhribakor" of Mirzaabad district of the Syrdarya region. The territory of the farm with an area of 39.5 hectares (cotton -26 hectares and corn 13.5 hectares) was divided into 5 sites for salt leaching operations with different leaching norms. As a reference option, the existing approach was chosen, in which the leaching rate is accepted the same, regardless of the type and crop resistance to salinization, the fields consist of soil with light loam.

The results of land fertility, salinity degree, plant species during the leaching of the experimental plot are shown in Fig. 2.

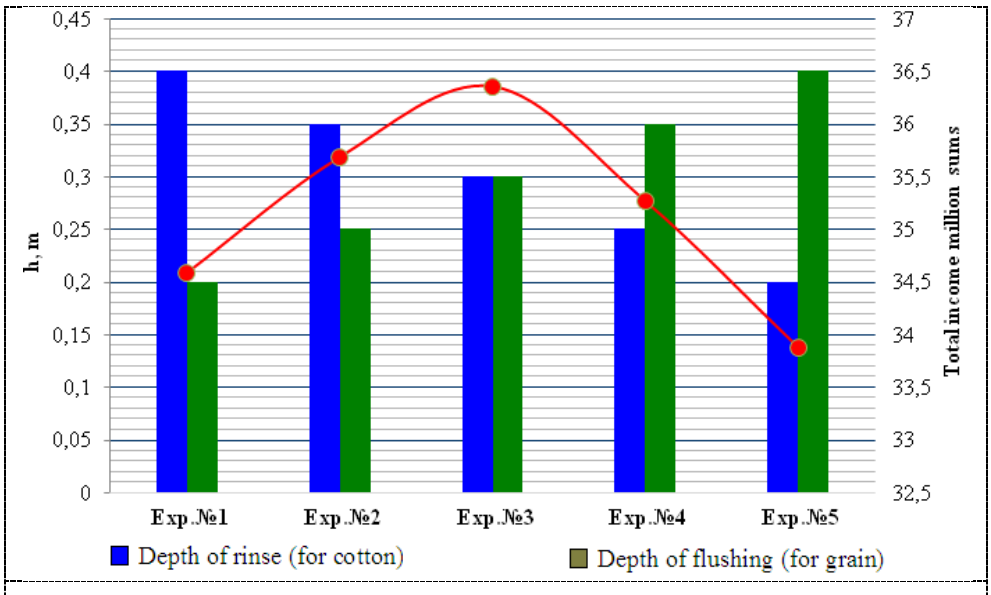

Figure 2. The effect of leaching land with light loam on the degree of salinity and land fertility.

It can be seen from figure 2 that if the leaching norm is used taking into account the plant species, i.e. for the sowing of cotton, the flow of water is 4000 m^3/ha and for corn 2000 m^3/ha, in this case, the yield of crops is not high. But, if you do not change the water consumption for land leaching in these areas, i.e. For the field with cotton planting to use 3000 m^3/ha and for corn 3000 m^3/ha, the relatively average crop yields increase.

The second experiment was conducted in the Surkhandarya region of the Kumkurgan district on the farm "Saodat". Here fields were chosen with a sowing area of cotton 10.8 hectares and corn in 13.2 hectares mainly the fields consist of soil with heavy loam figure 3.

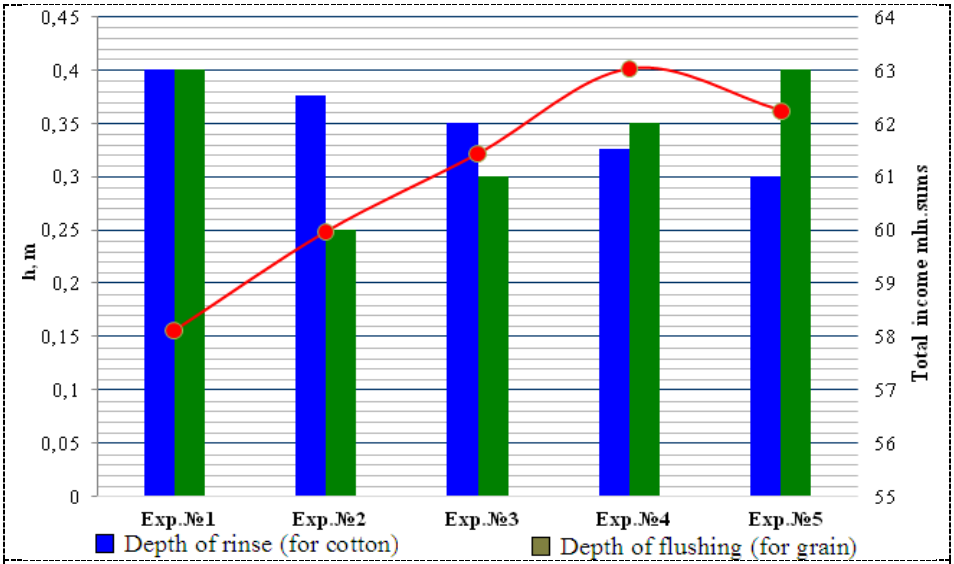

Figure 3. Impact of leaching land with heavy loam on the degree of salinity and land fertility.

Here, too, if we analyze the results when using the leaching norm, taking into account the plant species, i.e. For the sowing of cotton, the water discharge is 4000 m^3/ha and for corn 2000 m^3/ha, then the yield of crops is not high. But, if you do not change the water consumption for land leaching in these areas, i.e. For the field with cotton planting to use 3250 m^3/ha, and for corn 3500 m^3/ha, it is possible to achieve relatively positive crop yields.

The third experimental site was located in the Bukhara region in the Karakul district in the farm Chashma. Here the selected plot consisted of loam, the area of irrigated land for cotton is 8.8 hectares, for corn 3.6 hectares figure 3.

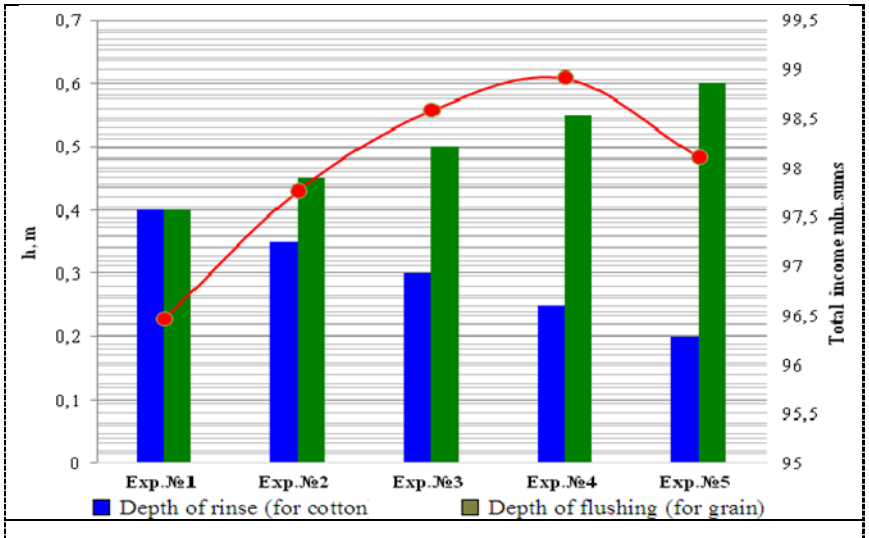

Figure 4. Impact of leaching land with loam on the degree of salinity and land fertility.

It can be seen from Fig. 4 that if the leaching norm is used taking into account the plant species, i.e. For the sowing of cotton, the flow of water is 4000 m^3/ha and for corn 2000 m^3/ha, in this case, the yield of crops is not high. But, if you do not change the water consumption for land leaching in these

areas, i.e. For the field with cotton planting to use 2500 m3/ha and for corn 5500 m3/ha, the relatively average crop yields increase.

Table 1 shows the influence of a variety of soils during leaching operations on yield and an increase in total income.

Table 1. Influence of the change in leaching norm on the yield of agricultural cultures**.**

An experience	Type of soil	Irrigated area, ha		The optimum leaching rate, m^3/ha		Yield, centner/ha				Total revenue (thousand sum)
						Calculated		actual		
		cotton	corn			cotton	corn	cotton	corn	
Syrdarya region Mirzaabad district farm «Azamat tajribakor»										
Recommended method	Light loam	5.2	2.7	3000	3000	29.4	47.5	27.2	43.4	36354
Control		5.2	5.2	4000	2000	30	27.8	27.2	43.4	34587
Surkhandarya region of the Kumkurgan district farm «Saodat»										
Recommended method	Heavy loam	10.8	13.2	3250	3750	30	70.5	28.5	61.6	63028
Control		10.8	13.2	4000	4000	30	53.3	28.5	61.6	58113
Bukhara region Karakul district farm «Chashma»										
Recommended method	Loam	8.8	3.6	2500	5500	30	63.1	28.8	56.3	98912
Control		8.8	3.6	4000	2000	30	42.8	28.8	56.3	96460

Together with this, the leaching starts from the central strip of the reservoir, the is approached, together with this the leaching begins from the beginning of the field part and ends in a decrease.

4. Conclusions

Besides, when calculating the technology of the leaching regime and the technology of their conduct, it is necessary to take into account the unevenness of the relief of saline lands. Such land should be washed with a high leaching rate.

In conclusion, the following can be cited:

- in the future, leaching on saline lands should be carried out taking into account the variety and name of plants;
- to reduce the volume of water during leaching operations, temporarily design and use drainage systems;
- uniform use of irrigation water from water intake facilities, the supply of measuring devices, prevention, and use of water-saving technologies in the AWS and farms.
- use strictly according to agrotechnical rules in the permissible periods of plowing and deep loosening of the soil, leaching the land, watering, and moistening the soil.

5. Acknowledgments

The authors are grateful to farmers from the Sirdarya Region, Tohir Z. Sultanov, Vice-Rector on Research at Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, and Professor Muhammadhon Hamidov.

References

[1] Khamidov M Shukullaev H Mamataliev A 2009 Agricultural hydraulic reclamation Tashkent *Publishing house Shark* pp 56-59
[2] Kostyakov A N 1960 Fundamentals of Land Reclamation Moscow *Publishing house Selkhozgiz* pp 212-214
[3] Abutaliev F B Baklushin M B 2002 On the issue of moisture transfer in the irrigation period *The Herald* **11** (116) pp 56-58

[4] Averyanov C F 1972 Isothermal movement of moisture in the aeration zone Lenigrad *Publishing house Gidromethioizdat* 162p
[5] Volobuev V R 1959 About leaching norms for reclamation of saline soils *Journal of Hydrotechnics and land reclamation* **12** (244) pp 19-21
[6] Konstantinov V K 1966 To the determination of moisture reserves in the soil by the depth of standing of groundwater *Journal "Soil Science"* **2** (22) pp 58-66
[7] Makhmudov I E 2012 Hydraulic model of convective moisture absorption in soils during irrigation of crops *Journal "Problems of mechanics"* **1** pp 33-36
[8] Khudaykulov S I Kalandarov A D 2017 Mathematical modeling of the dynamics of drainages and drainage systems Bukhara pp 125
[9] Shumakov B 1977 Mathematical modeling of programmed crop yield on irrigated lands *West s -kh Science* **6** (133) pp 115-122
[10] Muradov R A 2010 Water use in conditions of shortage of irrigation water *Journal "Bulletin of Tashkent State Technical University"* **1**(2) pp 164-168
[11] Muradov R A Khojiev A A 2017 The optimal solution of leaching rates with a deficit of irrigation water *Journal "Agro Ilm"* **5** (49) pp 83-84
[12] Ampofo E A Tanton T W A 2014 Theoretical Study of Subsurface Drainage Model Simulation of Drainage Flow and Leaching in Salt Affected Irrigated Fields West African *Journal of Applied Ecology* vol. 22(**1**) pp59–76
[13] Curry R B Chen L H 2007 Dynamic simulation of plant growth Pt II Incorporation of actual daily weather and portioning of net photosyntate *Trans ASAE* vol. **14** # 6 pp 1170—1174
[14] Mirkhosilova Z 2018 Ways to improve the water availability of irrigated lands European science review №7-8 july-august
[15] Khojiev A A Muradov R A 2018 Moisture and salt transfer in the initial period of plant development *The path of science International Journal* **8** (54) pp 50-56
[16] Muradov R A Khojiev A A 2018 Modeling moisture and salt transfer in the initial period of plant development *Journal "Agro Ilm"* **6** (56) pp 44-45
[17] Muradov R A 2014Some issues of efficient use of land in WUAs with a shortage of water resources *Journal "Agro Ilm"* **18** (29) pp 27-30
[18] Khojiyev A Muradov R 2018 Moisture and salt transfer in the initial period of plant development *The Way of Science* **8** (54) 50 p
[19] Murodov R Khojiev A 2016 The optimal solution to salt leaching standards for water shortage *Journal "Agro Ilm"* **6** (50) pp 74-75
[20] Khojiyev A Muradov R Khaydarov T Rajabov N Utepov B 2019Some results of moisture and salt transfer in the initial period of plant development *International Journal of Engineering and Advanced Technology (IJEAT)* Volume-**9** pp 6907-6911