On the development of a system of palletizers for washing of saline and salty soil in Uzbekistan

M Kh Khajiev

Tashkent State Technical University Named After Islam Karimov, 100095, University str., 2, Tashkent, Uzbekistan

E-mail: khajiev@mail.ru

Abstract. The analysis of the work of farms, cultivated crops on irrigated lands confirmed by salinity, showed the impossibility of obtaining high yields on these lands without removing the excess of water-soluble salts from the root layer of the soil, which is achieved by washing against the background of drainage. The main method of flushing saline lands is flushing by flooding checks without passing water from check to check, and for this purpose, farms make pal (earthen rollers) palletizers. The analysis and experience of their use showed that the height (main parameter) of the pallet-"h" produced by the above-mentioned palletizers does not correspond to the modern requirements of agricultural technology, agromelioration and ecology, which leads to a decrease in yield and product quality. The author proposed a mathematical model for establishing the rational height of the log (check) "h", taking into account the total washing rate (Q), mechanical composition, physical, chemical and mechanical properties of the soil and the number of salt washing (multiplicity) of water supply (Z), etc. The use of a palletiser system for washing for lands with different conditions of salinity and saline soils, the parameters of which, selected according to the proposed model, provide an increase in productivity and a decrease in the cost of production of agricultural crops cultivated on these soils.

1. Introduction

It is impossible to obtain a high yield of cotton, grain, corn, potatoes, beets and other agricultural crops on irrigated lands confirmed by salinization without removing excess water-soluble salts from the root layer of the soil, which is achieved by washing against the background of drainage [1]. Currently, more than 50% of the irrigated lands of Uzbekistan are saline to some extent, which is one of the serious signs of their degradation and is a serious problem for the countries of Central Asia and in particular for Uzbekistan. To reduce the degree of salinization of the soil and maintain its suitability for agricultural production, land washing is widely used, which takes up to 25% of the water resources of the republic [2]. The drying up of the Aral Sea leads to further deterioration of the ecological situation in Central Asia and more intensive salinization of irrigated lands. The increasing rates of development of salinity of lands require large volumes of water resources, the reserves of which are very limited in the cotton zone, especially with the shortage of irrigation water and limited water resources of the republic and with the current climate change of the earth.
2. Materials and methods

Accordingly, one of the most important tasks is the systematic improvement of land reclamation, maintaining its economic efficiency and environmental condition at the necessary level, and these works on the reclamation of saline lands of the republic are continuing.

As a result of non-compliance by the performers of farms with agronomic, ameliorative and environmental requirements, norms and rules of washing, reduction in the volume and quality of washing, increase in the level and mineralization of groundwater, an increase in the area of saline irrigation lands of the republic is observed. At the same time, these processes lead to a decrease in the yield of cultivated crops, the quality and increase in the cost of their products in the country from year to year [3-16], which requires work to improve irrigated lands and increase the yield of cotton and other crops.

Long-term data of UzSRI (Uzbek Scientific Research Institute of Cotton Growing) show that the permissible salt content in the soil, which eliminates their negative impact on plants, in various soil-reclamation conditions of the irrigated zone of the republic depends on the salt composition of the soil and groundwater, mechanical composition, water-physical properties and qualities of irrigation water [1, 7].

The experiments conducted in serenno-meadow soils have shown that the yield of cotton, etc. An average of 48.4 c/ha for eight years was obtained with the content of salts (Na and Ca) in the upper meter layer of the soil. With an increase in the salt reserve, the yield of raw cotton decreases, and the decrease occurs both due to a decrease in the productivity of a single plant, and due to a reduced density of standing per 1 ha [1].

As numerous observations of the dynamics of the salt regime of soils have shown, the process of seasonal salt accumulation is always present in most of the republic, even with the use of a wash irrigation regime. It is known [1] that the intensity of salt accumulation increases in the period after the termination of vegetation irrigation, and in the soils of the desert zone (such is the part of the irrigation zone of the republic) both in the autumn-winter and spring periods. In this regard, the need for annual preventive flushing on irrigated lands confirmed for salinization does not cause any doubts. Also, their expediency is justified by the fact that only the upper meter layer of soil is settled during development washing, and in order to ensure a stable result of reclamation, it is necessary to achieve stratification of the entire aeration zone, as well as desalination of groundwater.

It was found [1, 5, 8] that in slightly saline soils, the yield of cotton decreases by 15-20%, in medium-saline soils by 30-40%, in highly saline soils by 70-80% and saline soils by 90% or more (Table 1). As a result of salinization of the soil, the germination of seedlings and the development of sprouted seedlings decreases, which leads to a decrease in yield and a deterioration in the quality of products (for example, for cotton - the quality of fiber; for wheat - the amount of gluten). This, in turn, has a negative impact on the development of the economy of farms and the economy of the republic as a whole [4-5, 8-9].

The most optimal way to obtain high yields of agricultural crops grown on saline and saline soils is to remove from the soil an excess of toxic salts for plants from the root-inhabited soil layer and increase the yield by annual preventive washing irrigation [6].

Currently, the main method of washing saline lands is washing checks by flooding without passing water from check to check [2, 5]. This method has been widely used in practice in Central Asia for many centuries, while the furrow and strip method is rarely used, due to low efficiency, and the washing method using biological products is still at the research level [7].

According to the method of washing land with flooding of checks without dumping water in order to wash off salts from the soil, first they are plowed, leveled, divided into small plots (checks), along their edges they are made with bollards (earth rollers) and temporary irrigation networks, windows are sealed and at the intersection of longitudinal and transverse bollards manually (there are no means of mechanization), then several times these plots are evenly filled with irrigation water before flooding [1, 10].
The washing of salts from the soil during washing depends on many factors: the initial degree of salinity and humidity, the chemical composition of salts, the mechanical composition and water-physical and physico-chemical properties of the soil, the timing of washing, the degree of artificial drainage, the method of preparing the soil for washing, etc.

The size of the check, depending on the water permeability of the soil, the slope and the planning of the field surface, ranges from 0.1 to 0.5 hectares. At the same time, the success of washing to a large extent depends on the size of the plots, given that the dyi of small plots requires excessive labor costs, while excessively large plots are difficult to water evenly. The studies of L. E. Legostaev and U. I. Isamkhano found that on highly permeable soils with a flat relief, plots should be 0.15-0.20 ha in size, and on the same soils, but with poorly leveled relief-0.1-0.15 ha [1].

According to [10] in the farms of the republic fallow cutting is carried out by palletizers KBN-0.35, KZU-0.3D, KZU-0.3E and PR-0.5A (for last 20 years palletizers of PR-0.5A type are not used in farms of the republic), produced by industrial enterprises of the republic. Analysis of the work and experience in the use of palletizers in the farms of the republic has shown that the height (the main parameter) of the fallow (roll) produced by the above palletizers does not meet the modern requirements of agricultural technology, agromelioration and ecology [1, 2, 9, 10], which leads to a decrease in yield, quality and increased cost of production.

3. Results and discussion

As a result of generalization of the results of multiple and long-term research works [1, 5, 7], it was revealed that the quality of washing of saline and saline irrigated soils mainly depends on the water norm used for current washing (Q = 3000...9000 m³), mechanical composition, water-physical and physico-chemical properties of the soil, the timing and number of washings or the water supply cycle (Z = 1...6), the method of preparing the soil for washing, etc. [1]. Taking into account the proposed mathematical model for determining the rational height of the fallow “h” required for washing saline and saline soils and taking into account the general washing rate (Q), mechanical composition, physical, chemical and mechanical properties of the soil and the number (multiplicity) of salt washings or the water supply cycle (Z), etc., we propose to determine by the following formula [17]:

\[ h = \left[ \frac{Q}{Z \cdot 100} + (a + b) \right] \cdot k_1 \cdot k_2 \cdot k_3, [cm] \tag{1} \]

Here Q - is the total flushing rate of 1 ha of saline soil, m³/ha;
Z - number (multiplicity) of salt flushes or water delivery cycle;
\( a \) - height of soil notch with ploughshare during fallow preparation, cm;
\( c \) - height of tent above water level, cm;
According to long-term data: \( a = 12-15 \) cm, \( c = 15-20 \) cm [17];
\( \kappa_1 \) - soil water absorption coefficient. It is established by numerous researches that washing out of salts from soil increases in the case if washing out is conducted on ploughed soil. Then taking into account mechanical composition and physical-mechanical properties of soil \( \kappa_1 = 1.1-1.3 \), if not ploughed before washing, \( \kappa_1 = 1.0 \);
\( \kappa_2 \) - coefficient of salinity of water used for washing. If the water used for brine washing is not mineralised, \( \kappa_2 = 1.0 \); if mineralised water is used for washing, \( \kappa_2 = 1.0-1.3 \).
\( \kappa_3 \) - coefficient indicating the need to increase tent height in sandy and loamy soils, due to their high water permeability; \( \kappa_3 = 1.1 - 1.2 \).

Depending on mechanical composition, character of structure and location of soil in aeration zone for washing of 1 ha of saline soil water consumption \( Q = 2000-9500 \) m³/ha, for current washing of saline soil it is necessary to conduct up to \( Z = 1-6 \) times [1, 3, 5, 9]. Only in this case farms can get guaranteed high volumes of harvest at their high quality, at low cost of crops production.

Studying and analyzing the above mathematical model (1) depending on washing rate (Q), mechanical composition, physical and chemical properties of soil in regions of Uzbekistan [6] we recommend the height of tent h (cm) as follows
- for washing of slightly saline soils - to h = 30 cm;
- for washing of medium saline soils up to h = 40-50 cm;
- for washing strongly saline soils up to h = 80 cm;
- for washing of solanaceous soils up to h = 100 cm;
- for capital levelling and for washing with increased washing rate (for liquidation of micro elevations and spots on the fields with medium and strong degree of salinization) up to h = 125 cm.

JSC "Chirchik Agricultural Machinery Plant" (JSC "ChAMP", former name of JSC "Chirchikselmash") produces and supplies to farms of the republic KBN-0.35 palletizers, which produces palletizers with height up to h = 30 cm, which are used by farms for washing of slightly saline soils. If these pallets are used for washing of moderately and strongly saline soils, salt washing is performed with deviations from established requirements, which will lead to significant reduction of crop yield, quality and production cost. This will lead to irrational use of irrigated lands of the republic.

Before 2000 JSC "Chirchikselmash" produced and exported KZU-0.3D and KZU-0.3E floor breakers to farms of the republic and abroad. At present they are produced by JSC "Urgenchkormash" and exported abroad, which produces fallow with height up to h = 40-50 cm respectively and is used by farms for washing of slightly saline and medium saline soils.

Due to the fact that needs of many farms are not fully satisfied in palodelers KZU-0.3D and KZU-0.3E for washing of medium saline soils, they use palomizers KBN-0.35 for palomizing. As the height of the fallow h = 30 cm performed by this tool does not provide flushing of toxic salts to the required level, does not meet the requirements of agricultural and agro-ameliorative norms, which is unacceptable and leads to significant crop losses and deterioration of quality indicators of produced products.

In farms producing agricultural products on highly saline and saline soils, due to the lack of palodelers, the production of fallen trees with a height of up to h = 80, 100 and 125 cm, respectively, is not produced at industrial enterprises of the republic. For this reason, the pal for washing the salts of plots is performed in four versions:

a) first, a saw with a height of 40-50 cm is produced by the palodelers KZU-0.3 D or KZU-0.3 E, and then the height of the saw is increased (raised) to h = 70-80 cm, respectively, manually, using manual labor of farm workers, etc. At the same time, taking into account the degree of salinity of the soil – the process of preparing the fallen is mechanized by about 50 %, the quality of the prepared fallen does not fully meet the established requirements and the costs for the production of the fallen are quite large;

b) first, a bollard with a height of 40-50 cm is produced by palodelers KZU-0.3 D or KZU-0.3 E, and then the height of the bollard is increased (raised) to h = 70-80 and 100 cm, respectively, with the help of graders and bulldozers with a straight shovel available on the farm, then the bollard is put in order manually. At the same time, taking into account the degree of salinity of the soil, the process of preparing the saw is mechanized by about 70-90%, the quality of the prepared saw meets the established requirements and the costs for the production of the saw are lower than those prepared manually;

c) produce bollards up to h = 40-50 cm, 70-80, 100 and 125 cm high, they are prepared with the help of graders and bulldozers with a straight shovel available on the farm. Then they are put in order manually, the windows are closed and the bollard is aligned in length and height. At the same time, taking into account the degree of salinity of the soil, the process of preparing the saw is mechanized by about 60-80%, manual labor is partially used, the quality of the prepared saw approximately meets the established requirements, and the costs for the production of saw are lower than options a and b.

d) in some farms, bulldozers with a straight shovel or with a shovel at an angle are used to forge a saw with a height of up to 40-50 cm. However, in this method, the saw is performed on relatively small fields, while the costs for preparing the saw by this method increases by 1.5-2 times and more than with the manual method, and the quality of the prepared saw does not meet the established requirements of agricultural technology and agro-reclamation. Performing the pala in this way, of
course, requires additional investments on the part of farms and, in turn, negatively affects the cost of production of the farm [15-17].

e) for washing the saw with a height up to \( h = 40-50, 75-80, 100 \) and \( 120 \) cm, they are prepared using homemade (non-standard) palodelateli, which are made in workshops of farms or MTP using outdated spare parts of bulldozers and agricultural machinery. However, because of this, the parameters and quality of the saw prepared by this method do not meet the established agrotechnical and agro-reclamation requirements, soil washing is not carried out qualitatively, and the yield and quality of products are reduced and the cost of production increases due to additional costs [1, 9, 15, 16, 17].

At the same time, the fallen prepared with such tools does not meet the requirements of agricultural technology, agro-reclamation and ecology, the prepared fallen is quickly destroyed by the pressure of irrigation water, passes from plot to plot, fertilizer solutions are washed off and sent to the collector. As a result, washing is performed poorly; crop yields and product quality are reduced, which negatively affects the economy of the farm [1, 9, 16].

### Table 1. Influence of soil salinity degree on crop yields, fallow height required for washing of saline and saline soil and for capital levelling, equipment used to carry them out

| Degree of soil salinity Soil | Reduced yields due to soil salinity, % | Height of the wings -h, cm | Make of palletizer used | Manufacturer |
|----------------------------|-------------------------------------|--------------------------|-----------------------|--------------|
| Weak                       | 15-20%, 30-40%                      | 30                       | KBN-0,35              | “ChFAM” JSC  |
| Medium                     | 30-40%                              | 40                       | KZU-0,3D              | “ChFAM” JSC  |
| Strongly                   | 70-80%                              | 50                       | KZU-0,3E              | “UrgKM” JSC  |
| Solonetz                   | 70-80%                              | 100                      | Not produced by       | Manufactured in farm workshops from old bulldozer work tools (nonstandard, non-factory made) |
| For capital planning and washing with an increased washing rate (for the elimination of micro-increases and spots on fields with a medium and strong degree of salinity) | 90% and above till 100% | 125                      | enterprises in the country |

The issue of washing highly saline and saline lands, for capital planning and for washing the increased washing rate (for the elimination of micro-increases and spots on fields with an average and strong degree of salinity) and transferring them to farms for restoration and use is provided for by the Decree of the President of the Republic of Uzbekistan dated June 19, 2019 "On measures for the effective use of land and water resources in agriculture". To wash these lands (in the Republic of Karakalpakstan, Khorezm, Bukhara, Jizzakh, Ferghana and Syrdarya regions), it is necessary to prepare a bollard with a height up to \( h = 75-80, 100 \) and \( 120 \) cm.

The equipment for the preparation of fallen, washing of saline soils of this size was used in the 60-90 - ies of the twentieth century of the newly developed lands of the PMK (mobile mechanized column). However, such equipment is now absent from farms and machine and tractor parks of the district. Therefore, for the washing of such lands and the forgery of the fallen is carried out by bulldozer equipment installed on tractors VT-100, VT-150D (3-4 classes) with a straight and inclined shovel [1, 9]. However, due to the low productivity of the MTA, the pal for washing is performed on relatively small fields, and the cost of preparing them increases by 1.5-2 or more times.

Some farms use self-made non-standard palodelateli, hung on tractors "Class Arion 6300" and "New Holland TS-130", made in workshops of farms or ICC of the district using old spare parts of
working bodies of bulldozer equipment, to forge a saw with a height of $h = 100$ and $120$ cm. The parameters and quality of the fallen prepared by these tools do not meet the established requirements of agricultural technology and agro-reclamation [1, 9], when washing, the fallen are destroyed, irrigation water is passed from plot to plot and mineral fertilizer solutions are washed off and sent to the drain.

For this reason, washing of highly saline and saline soils, capital planning and washing with an increased washing rate to eliminate micro-increases and spots on fields with an average and strong degree of salinity is performed poorly, which leads to a decrease in yield and product quality [2 -5, 8, 9, 11, 12]. This, of course, requires additional investments by farms and, in turn, has a negative impact on the cost of products.

4. Conclusion
1. For washing of slightly saline, medium saline and saline lands and for capital washing as well as for washing with increased washing rate for liquidation of micro elevations and spots on the fields of republic with regard to agrotechnical, agromeliorative and ecological requirements depending on degree of their salinization it is necessary to prepare height of tent - $h$ (cm) [17] in following dimensions
   - $h = 30$ cm for washing of slightly saline soils and irrigation of soil before sowing for overwatering;
   - $h = 40-50$ cm for washing medium saline soils;
   - $h = 75-80$ cm for washing highly saline soils;
   - $h = 100$ cm for washing of saline soils.
   - $h = 125$ cm for capital levelling and for washing with increased washing rate, for elimination of micro elevations and spots on the fields with medium and strong degree of salinity.

2. To flush slightly saline soils and to irrigate soil before sowing for overwatering [9] is made with serial palletizer KBN-0,35, this is serially produced at JSC «Chirchik factory of agricultural machinery (ChFAM)». We consider it expedient to carry out research and development works with KBN-0,35 palomelator to improve its design, quality and efficiency of work taking into account modern agrotechnical, agro-meliorative and ecological requirements.

3. For washing of soils with medium salinity is conducted by serial packer KZU-0,3D and KZU-0,3E [10], which are produced by JSC "Urgenchkormash (UrgKM)". We consider it advisable to conduct research and development work KZU-0,3E paloz, to improve the design and improve the quality and efficiency of work with modern agricultural, agro-meliorative and ecological requirements.

4. For flushing strongly saline and saline soils and for capital levelling and for flushing with increased flushing norm for liquidation of micro elevations and spots on fields of republic it is necessary to have a pallet with height up to $h = 75-80$, $100$ and $120$ cm accordingly [16-17]. However, absence of such palletizers of industrial production forces to use bulldozers with straight and sloping shovel, reclamation machines of different types, homemade (non-standard) palletizers made from spare parts of bulldozer equipment. For this reason, the soil washing pallet, which is forged by bulldozers with straight and sloping shovel, reclamation machines of different types, homemade (non-standard) palletizers, made from spare parts of bulldozer equipment do not meet the agrotechnical, agromeliorative and ecological requirements, at the same time, highly saline and saline soils, and for capital levelling.

References
[1] 2016 Cotton Handbook (Tashkent: "Science and Technology")
[2] Niyazmetov D, Rudenko I, Lamers Dj, Eshchanov R 2020 Innovations in agriculture of Uzbekistan Khorezmskiy (Uzbekistan: Urgench State University)
[3] 2016 Agro-ameliorative measures are the basis for a rich harvest. Recommendation. Journal of Agriculture of Uzbekistan, 1, 19-20.
[4] Azimov B 2015 The composition of salts in irrigated lands of Syrdarya region *Journal of Agro Science* 4 (36) 76-77
[5] Makhsadov H, Nosirov F 2016 The effect of saline washing norms and irrigation methods on soil fertility and cotton yield *Journal of Agro Science* 1 (39) 56-57
[6] Mamatqulov A V 2017 *Efficient use of irrigated saline lands in agriculture* (Tashkent).
[7] Khudoynazarov I A et al. 2018 Research of saline soils using the polymer composition "Bisolvent" *Universum: Chemistry and Biology* 6 (48)
[8] Rajabov T, Rajabova T 2015 Salinity and cotton yield *Journal of Agro Science* 1 (33) 18-19.
[9] Ministry of Agriculture and Water of Uzbekistan and others 2007 *Scientific and practical bases of increase of soil fertility* (Tashkent)
[10] Ministry of Agriculture and Water of Uzbekistan and others 2016 *Sample technology maps for crop care and cultivation. For 2016-2020. Part I and Part II.* (Tashkent)
[11] Petkovic M, Lukyanov A, Rudoy D, Miletic N, Safarov J 2021 Potato thin layer convective dehydration model and energy efficiency estimation *E3S Web of Conferences* 273 07028.
[12] Safarov J E, Sultanova Sh A, Dadayev G T, Zulpanov Sh U 2021 Influence of the structure of coolant flows on the temperature profile by phases in water heating dryer *IOP Conference Series: Materials Science and Engineering*, 1029(1), 012019.
[13] Sultanova S, Safarov J, Usenov A, Raxmanova T 2020 Definitions of useful energy and temperature at the outlet of solar collectors *E3S Web of Conferences* 216 01094
[14] Safarov J, Khujakulov A, Sultanova S, Khujakulov U, Verma S 2020 Research on energy efficient kinetics of drying raw material *E3S Web of Conferences* 216 01093
[15] Primkulov J, Khiziraliev N 2016 Modernization, technical and technological reequipment of agriculture *Journal of Agriculture of Uzbekistan* 2 41
[16] Khajiev M X, Mirmigmatov B T, Mukhamedov M A 2016 Problems of salinization of irrigated lands and measures to eliminate them *Prospects for the use of grain and medicinal plants to improve the reclamation of soil “Materials of the Republican scientific-practical conference: scientific collection Khorezm Mamun Academy – Khiva, May 13-14, pp. 108-112
[17] Khajiev M X, Mirmigmatov B T, Tashpulatov Q B 2017 Polishing equipment for washing saline soils *Journal of Agro Science* 3 (47) 97-98