MINISTRY OF AGRICULTURE AND ENVIRONMENTAL PROTECTION of TURKMENISTAN

TURKMEN AGRICULTURAL UNIVERSITY NAMED AFTER S.A.NIYAZOV

TURKMEN AGRICULTURAL INSTITUTE

MANUAL FOR ANALYSIS OF THE MELIORATIVE CONDITION OF IRRIGATED LANDS

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In the manual the recommendations on improving the reclamation status of irrigated lands, monitoring the level and salinity of groundwater, determining the salinity and density of soil, assessing the reclamation status of irrigated lands are provided.

The manual is for landowners, farmers and tenants, and for agricultural specialists.

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INTRODUCTION

In the prosperous period of our sovereign state, under the wise leadership of our esteemed President, the agriculture of our country is developing at a rapid pace.

At the first meeting of the People's Council of Turkmenistan on September 25, 2018, on the proposal of the President, a number of important issues related to the improvement of agricultural reforms were considered and historic decisions were made. The implementation of those decisions and solutions will improve the efficiency of agricultural production in our country, strengthen food security, and further improve the standard of living of the rural population.

Effective use of irrigated farmland, improving the ameliorative situation, increasing its fertility and introducing scientifically based crop rotation are of great importance in increasing the production of agricultural products in our country.

In irrigated agriculture, it is of great importance to monitor and evaluate the agrophysical and agrochemical properties of the agricultural lands, the ameliorative condition of the agricultural lands in the scientific development of the farm, as the scientific approach is based on numerical results of control and evaluation. The legal basis for these cases is determined by the legislation of Turkmenistan.

According to Article 52 of the Water Code of Turkmenistan, the monitoring and evaluation of the ameliorative condition of fields is transferred to the State Budget of Turkmenistan by the authorized bodies. In the Article 60 (2) of this code it is determined that the monitoring and the ameliorative condition of irrigated lands and the technical condition of irrigation systems belong to the using of hydro ameliorative systems. In the Article of 11 of the “Ground Code” it is determined, that the authorized state enterprise in regarding the management of resources will conduct the monitoring. Recently, due to climate change on Earth, the importance of monitoring and assessing the reclamation of land has been increasing.

Turkmenistan attaches great importance to climate change and adopted the “National Climate Change Strategy of Turkmenistan” approved by the President of Turkmenistan in 2012 [6] . This document reflects our country's national views on climate change and serves as the basis for the formation and successful implementation of a state policy on climate change in Turkmenistan, its impact. The main goal of the national strategy is to is to ensure sustainable development that helps.

The task of the national strategy is to improve the economic, food, water and ecological security of the state by preparing measures to respond to the effects of climate change in our country.

The national strategy states that water resources in Central Asia will be reduced due to rising temperatures. Due to climate change, the water demand of crops is increasing and water vaporization over the soil is increasing. Such conditions affect the ameliorative condition of irrigated lands and the yield of agricultural crops. Given these effects, the development of appropriate adaptation measures in agriculture is an important issue today.

The national strategy envisages active cooperation with international organizations in the development and implementation of climate change response [6]. Several international projects are being implemented in Turkmenistan in this regard. The international community sees the increase in knowledge of local professionals in this area as one of the key measures to respond to climate change. In this regard, we hope that the manual you have will help agricultural and water workers, environmentalists, students and other interested parties to plan and carry out their work.

The results of monitoring and evaluation in agricultural fields serve as a basis for the adoption of programs to improve the land reclamation situation. According to world experience, two approaches are used to control land reclamation. The first of these is the monitoring of land reclamation by a specialized government agency. The results of such surveys are widely used in determining the direction of financing irrigation and reclamation measures in the country [4]. The second approach is to monitor land reclamation by land users at the economic level. The purpose of this survey is to determine the set of agro-ameliorative measures to be taken on the farm (catching wastewater, deep dredging, creation of protected forest zones, drainage system cleaning, etc.). That is, clarifying issues such as the catchment of wastewater in some areas, the softening of the condensed layer under the slurry layer, the creation of forest zones, and where the drainage system is cleaned.

To date, agricultural science is carried out in accordance with Article 16 of the Law of Turkmenistan "On Farmers' Associations" with the help of relevant ministries and research institutes. It requires a new approach to the scientific development of irrigated agriculture. In this regard, landowners have to deal with most of the agricultural issues. To do this, they will need scientific-practical and production manuals written in plain language.

1. Harmful effects of saline soils and salts on agricultural crops

Saline soils refer to soils that contain a toxic amount of salts that are easily soluble in water for plants as part of their vertical section. Such salts include sodium carbonate (Na_2CO_3), sodium chloride and sulfur ($Na\,CI$; Na_2SO_4), sometimes nitrates, alkaline bases (carbon magnesium-$Mg\,CO_3$), Mg and Ca bicarbonates [$Mg\,(HCO_3)_2$, $Ca\,(HCO_3)_2$], their chloride ($Mg\,CI_2$, $CACI_2$), sulphuric acid Let soluble salt of the medium - gypsum ($Cason_4 \cdot 2H_2O$) incarnate.

The degree to which these salts have a harmful effect on crops is indicated by their water-soluble dry weight and the percentage of chlorine ion. The farms are provided with this information by the agro-chemical laboratories in the provinces as a result of their field and soil surveys.

Soil is divided into saline: non-saline, weak, medium and strongly saline, and very strongly saline groups *(Table 4)*.

The adverse effects of soil-soluble salts on soil and their ions on individual crops include:

When the amount of salts in the soil solution increases by more than 5 grams per 1 liter of it, the water-absorbing power (osmotic pressure) of this solution increases than that of the plant, increasing its ability not to give moisture to the crop. As a result, there is a "physiological drought" in the soil;

- the sodium in the soil , chlorine, and magnesium ions *(Table 6)* dilute the starch in it when water is excessively exposed to the leaf, slowing down the passage of photosynthesis, and under the influence of chlorides, the cell walls of the plants are also disrupted. As a result, the mineral and water nutrition of crops is disturbed, in which the metabolism is disturbed;

- Sodium cation dissolves its aggregation when aggregated in the soil. Under the influence of this element, the mobility of organic matter in the soil is also enhanced. When it enters the soil suction system, moist soil swells, then shrinks and hardens when the soil dries. Thus, the other parts of the continually moist soil are disintegrated and become a whole. This makes it difficult for water, air, and heat to pass to the lower strata;

- In saline soils, the number of small-bodied individuals is reduced and the activity of the rest is reduced.

The average effect of saline soils on concentrated crop yields is shown in Diagram 1. It can be seen that in non-saline soils, higher yields can be obtained if the crop is well cared for. With an increase in harmful salts in the soil, yields are reduced by 15, 35, 65%, respectively, when weak, medium and strong salinization occurs. In soils where the wastewater has been transferred and the salts have not been washed, no yield can be obtained.

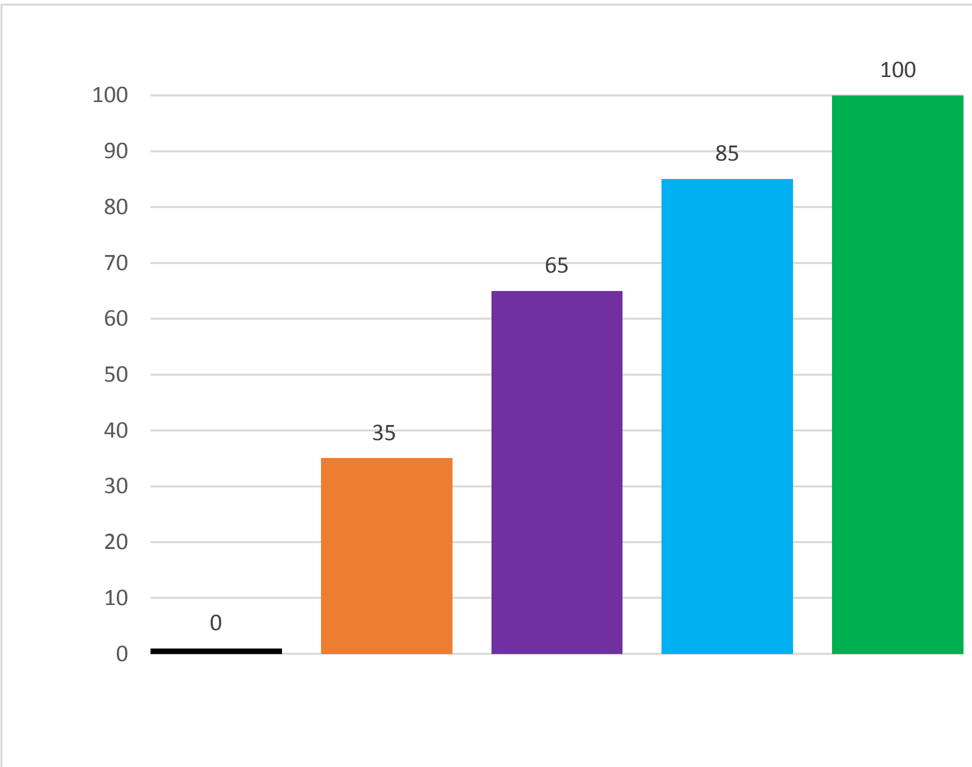

Diagram 1. Effect of soil salinity on crop yields:
In 1-very strong, 2-strong, 3-medium, 4-weak and 5-saline soils.

2. What to understand as a reclamation condition of irrigated lands?

In irrigated agriculture, it is not possible to run a household without affecting the environment. Although the culture of agriculture is high, the water-physical properties, mechanical composition, soil moisture and other properties of the soil change as a result of long-term irrigation. The water from the rivers contains a small amount of salt, albeit a small amount. They are also able to accumulate in the soil for many years [5]. Heavy-duty tractors operate in slightly damp soils that cause soil compaction. As a result, soil compaction reduces its water absorption, air and heat retention, and the activity of beneficial microorganisms.

In areas where scientifically based crop rotation is disrupted, the quantitative balance of nutrients and living microorganisms in the soil is not maintained favorably for crops. Failure to comply with irrigation rules or improper watering methods in crop irrigation alters the agrophysical and agrochemical properties of the soil.

For these reasons, the soil degrades the ability to escape from the soil if the proper measures are not taken to prevent the adverse effects on irrigated agriculture in a timely manner. One of the most important of these measures is to improve the reclamation of irrigated lands.

Let us now try to study the concept of reclamation of irrigated lands in more detail. In our view, this concept will serve as a tool for land users to improve land reclamation.

Melioration the word means from Latin translation “to improve” [2]. If anything needs to be improved from its previous state, then it must first monitor its current state and assess the situation as a result of control. Only then can a decision be made to improve the situation. Even when working with soil, one has to follow this principle.

Is it necessary and possible to improve the integrity of the land from its previous form? By what means, if it is possible? Here, to answer these questions, the reclamation status of irrigated lands is monitored and evaluated. Monitoring the reclamation status of irrigated lands is a very complex and important task.

The ameliorative condition of irrigated lands is determined by the level of groundwater, their salinity, the salinity of the soil, the presence or absence of a compacted layer with low water absorption in the active layer of the soil, and the degree of crop yield [2]. Reclamation is considered a technical concept. Its indicators are expressed in certain numbers, referring to regulatory legal acts [7]. The decision-making process is scientifically grounded and referred to the regulatory legal acts approved by the relevant authorities.

Indicators determining ameliorative status should be measured in accordance with approved regulations. It is urgent to re-approve such regulations and regulatory legal acts in line with modern requirements, taking into account the latest achievements of science and technology.

In order to regulate the indicators that determine the reclamation status of lands, it is necessary to clarify the conditions that affect each of them [8]. Let's take a brief look at each of them in order to meet this need.

Groundwater level is defined as the distance from the surface of the water to the surface of the land. If monitoring wells are installed in the field, the level of groundwater can be easily determined. If the adverse effects of these factors are not eliminated, it is not possible to reduce the level of groundwater and improve the reclamation status of lands only through the drainage system. Because it doesn't make sense to deal with the consequences of it without eliminating the causes of the bad situation. Unfortunately, the main reason for the loss of land in all regions of the country is due to the inadequate functioning of the drainage system and the inadequate implementation of agro-technical measures taken during the cultivation of agricultural crops.

Affecting ***groundwater salinity*** is considered a very difficult issue. Its harmful effects on plants can be regulated by regular irrigation of crops, by preventing irrigation water from leaking down from the active layer of the soil, or by keeping the level of groundwater at a level that is harmless to crops. If wastewater is caught where drains are not working properly, then the salts washed from the top layers of the soil will move to the lower layers and some of them will be added to groundwater to further increase its salinity.

The salinity of the soil is mainly affected by the depth and salinity of the groundwater, the ***level*** of the land, the observance of irrigation rules, and the salinity of irrigation water. Soil salinity can be regulated by catching wastewater, switching to scientifically based crop management, creating protected forest areas, and improving the quality of agro-technical work.

The formation of a ***compacted layer*** (a high density layer) ***below the soil layer*** leads to a decrease in soil moisture absorption and the loss of its active layer. Inspections under the project revealed that the compacted layer of the soil is usually 45-55 cm deep. Its thickness is up to 8-15 cm. Soil compaction can also be caused by a decrease in the amount of rot in the soil and an increase in the amount of gypsum. Figure 1 below shows the cross-section of the crop area.

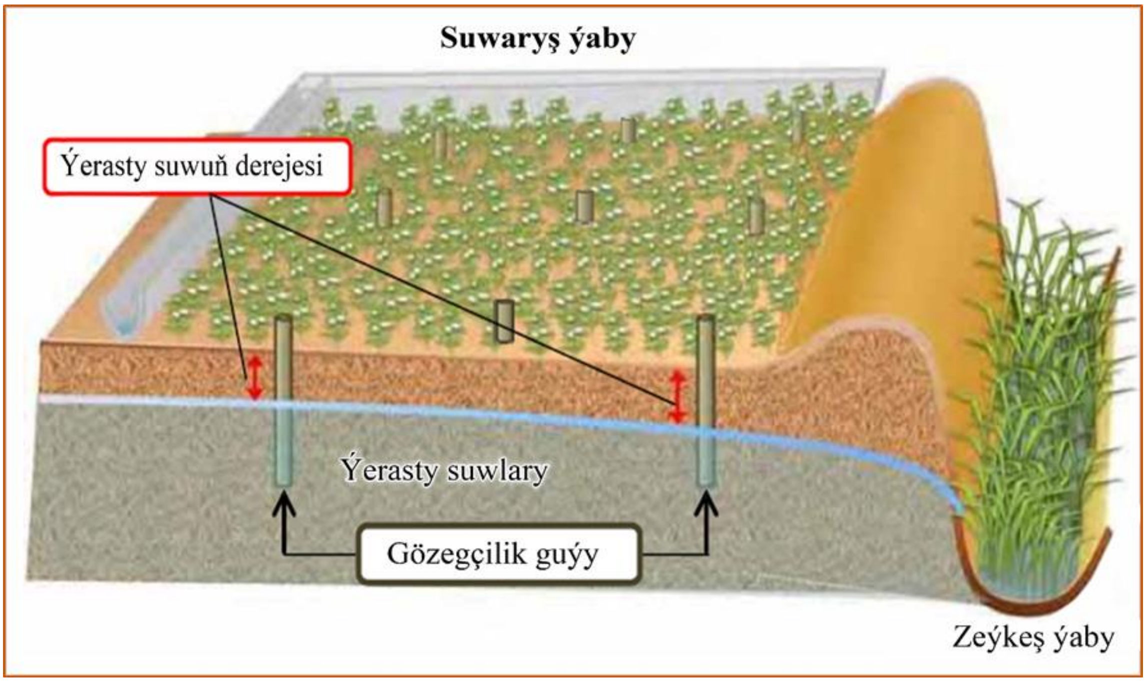

Figure 1. **Cross section of the field.**

Irrigation dams are often built on the high side of the farm and drains on the low side. Actions such as barriers to drains, construction of passages through drains by burying pipes, pouring wastewater into drains, and the use of drains as armor to discharge excess wastewater lead to deterioration of irrigated lands. Farms should have regular monitoring of groundwater levels and salinity, soil salinity, and water permeability to monitor and evaluate the reclamation status of irrigated lands. We will discuss in the next sections of the manual how to set up and carry out that work.

3. Monitoring the level and salinity of groundwater

It will be useful to get acquainted with the movement of salts in the soil and changes in its quantity before proceeding to the method of monitoring the level and salinity of groundwater. In arid regions, including agricultural lands of Turkmenistan, irrigation water, soil and groundwater contain certain salts that are harmful to plants, in some cases; they are added to groundwater *(Figure 2).*

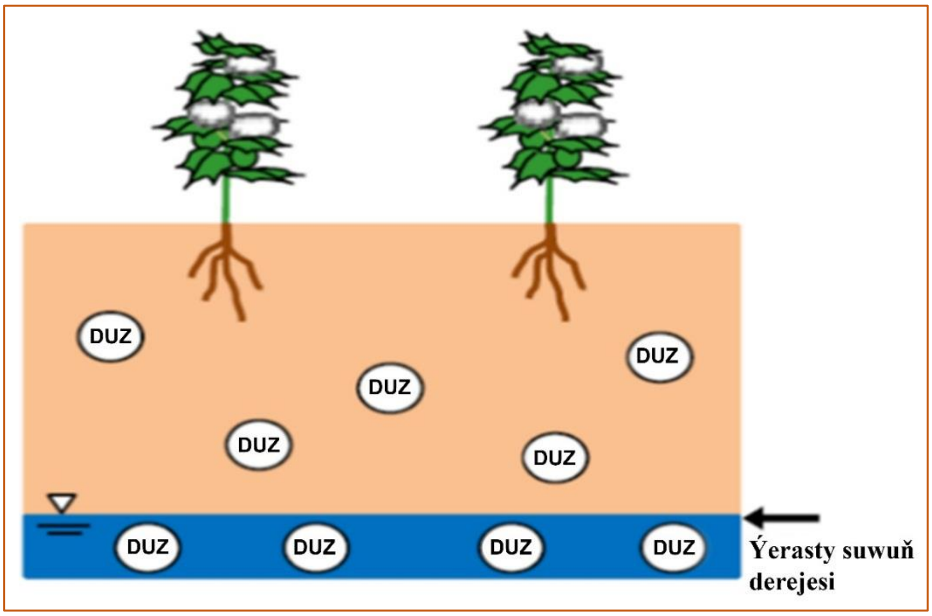

Figure 2. **Movement of salts in the soil**

The soil can retain a certain amount of water in a moist form. If water is supplied to the bottom layer of the soil, which can fully moisturize the active layer of the soil during water retention, the water does not filter into the lower layers of the soil and the groundwater level does not rise. However, the excess water supplied to the crops is added to the groundwater with the salts washed from the soil, increasing their level and salinity *(Fig. 3).*

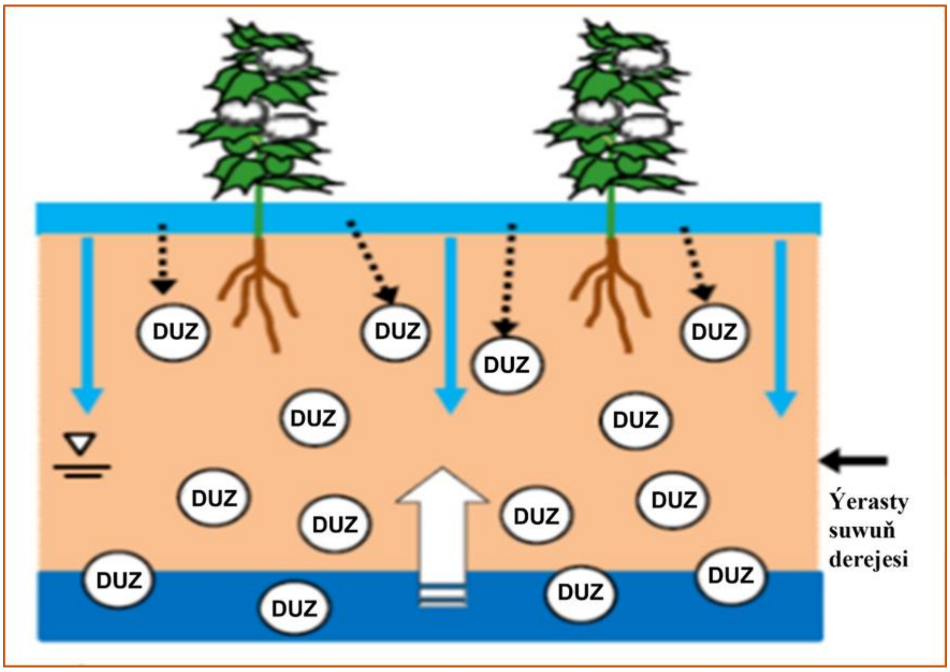

Figure 3. **Increasing groundwater's salinity**

The sun heats the top layer of the soil much lower than the lower layers. This increases the rate of evaporation of water from moist soil.

Seeking to compensate for the evaporated water, the groundwater saline near the surface rises through the soil capillaries and penetrates into the active layer of the soil. This situation leads to secondary salinization of the soil. This phenomenon is shown in Figure 4 below.

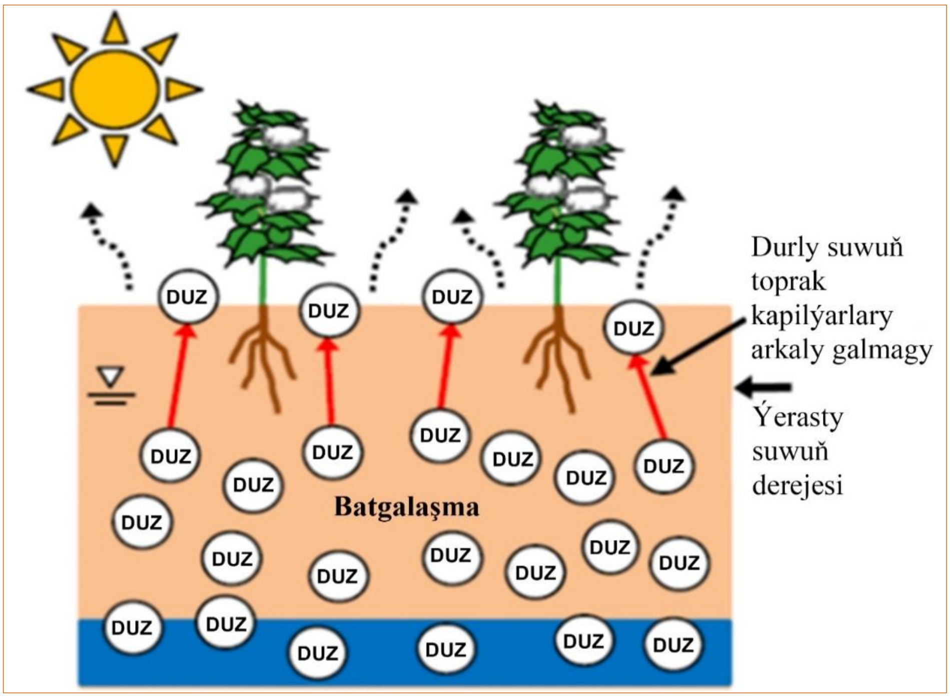

Figure 4. **The phenomenon accumulation of salt**

Thus, in irrigated agriculture, second salinization of the soil is mainly due to the proximity of the groundwater to the surface of the salt. Let's answer the questions. «At what depth of soil wills the underground saline water be stored and will it not cause second salinization of the soil, and what does that depth depend on?"

Let’s turn to simple experience to answer these questions. Let's take three identical pieces of soil that are about the size of a chicken egg. Let the first be of light clay, the second of medium quality, and the third of snow clay. Immerse all three strands in equal amounts. Observe the increase in moisture in the particles. As a result of the monitoring, we find that the moisture content in the strains does not increase. This means that the rise of groundwater through the veins in the soil depends on its mechanical composition.

According to the results of many years of research in Turkmenistan, the not harmful level of the depth of the groundwater to crops, depending on the mechanical composition of the soil and the salinity of groundwater is determined *according to Table 1* below.

Table 1

Determination of the level of the depth of groundwater harmless to crops

Location of arable lands	**Groundwater salinity, g/l**	**Mechanical composition of the soil and its subsoil**		
		sandy	**medium**	**clay**
Middle stream of the river Amyderya, Lebap Province	<3	1.5 - 1.7	1.6 - 1.8	1.8 - 1.9
	3 - 5	1.7 - 1.8	1.8 - 1.9	1.9 - 2.0
	> 5	1.8 - 1.9	1.9 - 2.0	
Downstream of the Amu darya, Dashoguz Province	<3	1.5 - 1.7	1.7 - 1.8	1.8 - 2.0
	3 - 5	1.7 - 1.8	1.8 - 1.9	1.9 - 2.2
	> 5	1.8 - 1.9	1.9 - 2.0	
Murgap oasis, Mary Province	<5	1.8 - 2.0	1.8 - 2.0	2.0 - 2.2
	> 5	1.9 - 2.2	2.0 - 2.2	2.2 - 2.5
Hanhowuz plain, Mary Province	<5	1.8 - 2.0	2.0 - 2.2	2.2 - 2.5
	> 5	2.0 - 2.2	2.2 - 2.5	2.5 - 2.7
Tejen oasis, Ahal province	<5	1.8 - 2.0	2.0 - 2.2	2.2 - 2.5
	> 5	2.0 - 2.2	2.2 - 2.5	2.5 - 2.7
Kopetdag foothills, Ahal province	<5	1.8 - 2.0	1.8 - 2.0	2.0 - 2.2
	> 5	2.0 - 2.2	2.0 - 2.2	2.2 - 2.5

Special monitoring wells are being set up on farms to monitor the depth and salinity of groundwater levels (*Figure 5)*. It is enough if the depth of the wells is 5 meters.

Wells can be drilled with soil drilling. The wells should be drilled with holes such as the eye of the needle in the lower 1 meter section (end) of the plastic pipes with a diameter of 32 mm. The perforated part of the pipe should be provided with a filter. The surface of the well should be fitted with concrete using a metal pipe. The well should be locked so that no one else can open it and hand over its key to an ameliorator or land user.

To monitor the reclamation status of irrigated lands at the economic level, monitoring wells should be set up at characteristic points of arable land. Surveillance wells should be installed 20m from the drains, 40m from small drains (drains), 120m from inter-farm irrigation canals and drains, and 200m from large watercourses (*Figure 6)*.

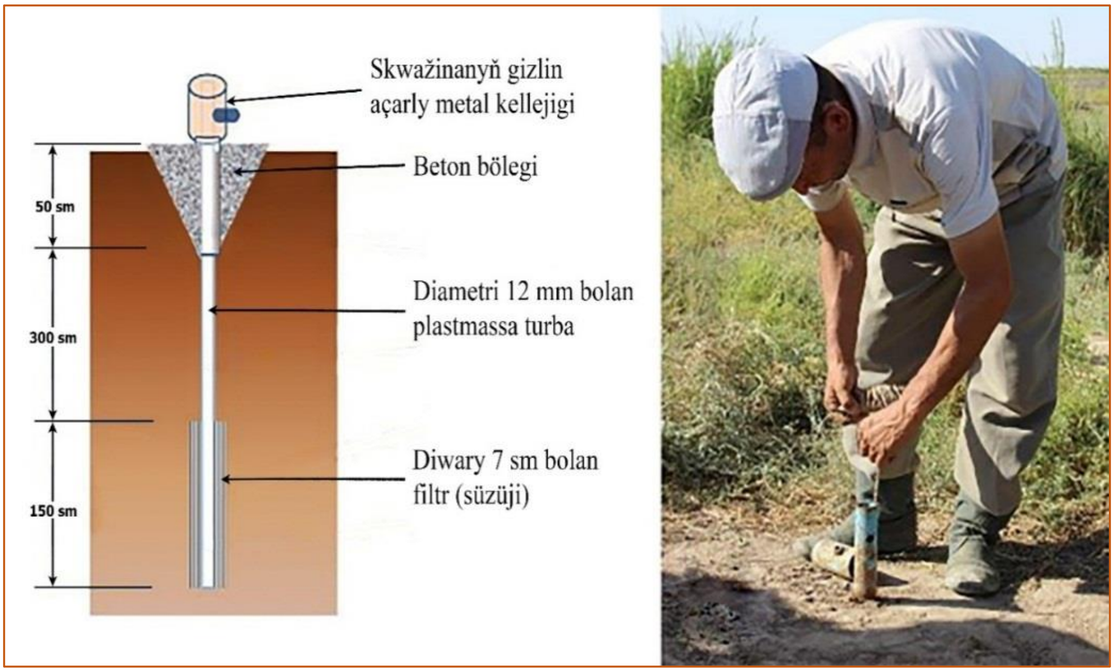

Figure 5. **Digging of monitoring wells**

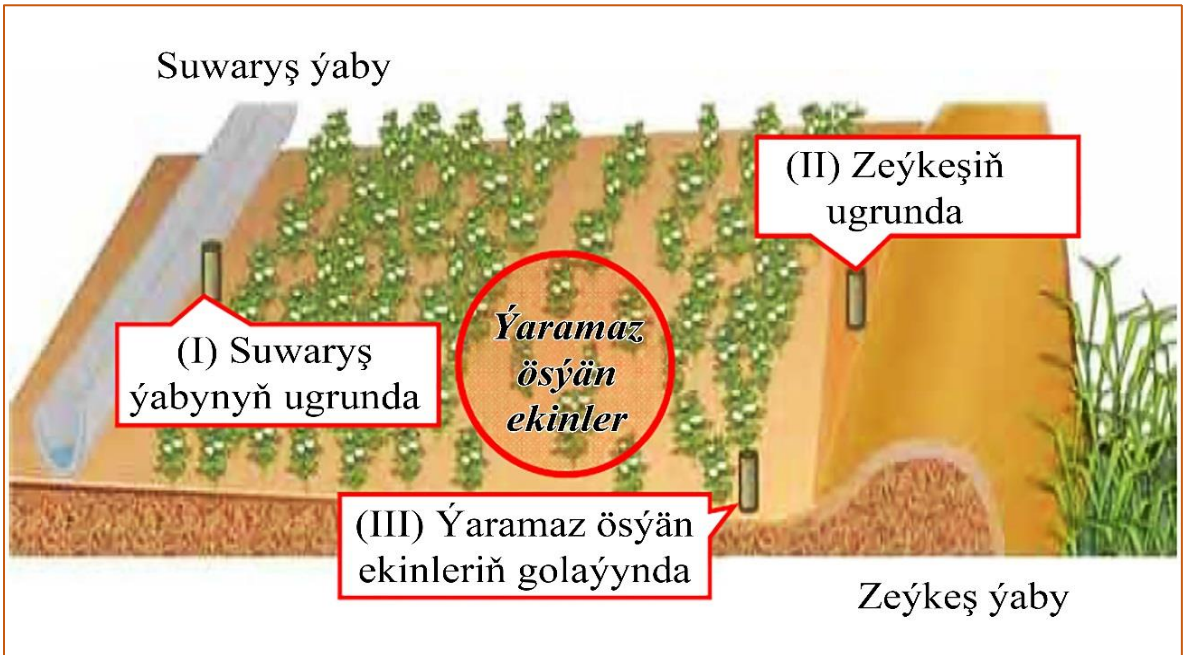

Figure 6. **Placement of control wells in arable lands.**

In monitoring wells, a special device that measures the level of groundwater with sound and light is used to measure groundwater levels. A *conduct meter is* used to determine the salinity, conductivity, and ions of the water sample. There are many types of conduct meters.

All of them are based on the electrical conductivity of the workers. Conduct meter is also widely used in determining soil salinity.

A special methodology approved by the Ministry of Agriculture and Water Resources of Turkmenistan is used to monitor the reclamation of irrigated lands by government agencies.

It is recommended that groundwater and their salinity be monitored at least once a month by experts from the relevant state body, the farm, the farmers' association, or the landowners themselves. If the reclamation situation of irrigated lands is more complicated, it is necessary to conduct monitoring every fifteen days to establish specific measures. The supervisors are introduced to the methodology for conducting this work.

The project once monitored groundwater levels and salinity. Its results are shown in Table 2 below.

Using the table, the average value is taken together, which takes into account the parameters of the level and salinity of groundwater during the development of crops.

2-nji tablisa

Topragyň şorlulyk derejesiniň barlagynyň netijeleri

Gözegçilik edilen ýerler	Toprak nusgalarynyň belgisi	Görogly etrabynyňiki daýhan birleşiginde ýerasty suwlarynyň çägi we olaryň minerallaşma derejesi (2018-nji ýyl)																	
		Ýanwar		Fewral		Mart		Aprel		Maý		Iýun		Iýul		Awgust		Sentýabr	
		ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS	ÝSÇ	mS
Daşoguz welaýatynyň Görogly etrabynyň “Ýagtylyk” daýhan birleşigi	1	166	1,643	167	1,453	145	1,57	125	1,468	82	1,48	133	1,36	129	1,77	150	2,22	83	2,11
	2	102	2,05	117	2,08	69	1,96	86	1,843	95	2,11	110	1,96	85	2,6	107	2,69	64	2,64
	3	166	3,77	166	3,89	134	3,85	139	4,01	151	4,3	163	4,33	157	4,35	165	4,6	87	4,5
	4	133	1,880	134	2,24	49	2,38	90	2,2	114	2,14	131	2,08	111	2,76	110	2,79	92	2,58
	5	79	2,01	126	1,695	95	1,50	96	1,402	93	1,38	126	1,38	115	2,05	117	2,35	100	2,57
	6	261	3,73	241	3,55	209	3,61	222	3,53	223	3,2	225	4,3	212	4,72	192	4,57	173	4,94
	7	161	1,606	112	1,404	98	1,67	125	1,955	111	2,23	147	2,55	135	2,75	137	3,26	88	3,36
	8	96	2,17	98	2,03	74	2,65	88	3,9	104	3,07	105	3,3	-	-	84	4,87	-8	4,57
	9	143	9,6	136	11,95	54	9,78	117	12,07	132	17,4	135	14,16	110	11,8	141	9,99	119	9,31
	10	-	-	205	2,8	122	2,7	159	2,77	154	2,93	172	2,21	-	-	164	2,99	146	1,1
Daşoguz welaýatynyň Görogly etrabynyň “Garagum” maldarçylyk hojalygy	1	164	1,784	155	2,07	130	2,17	141	2,17	145	1,69	154	1,62	104	1,90	148	2,42	140	2,18
	2	179	5,22	167	3,35	131	3,21	141	4,52	161	3,46	160	2,55	-	-	124	2,56	108	2,42
	3	40	5,76	15	5,91	51	5,7	-	-	110	4,78	110	2,78	111	6,2	38	4,44	42	1,09
	4	190	1,616	182	1,590	155	1,61	168	1,542	180	2,93	175	1,97	127	2,09	103	2,12	81	2,35
	5	199	1,584	202	1,545	63	1,88	60	1,845	159	1,56	169	1,64	142	2,18	164	2,27	97	2,17
	6	126	1,593	139	1,603	111	1,41	114	1,732	113	1,4	125	1,44	-	-	-	-	-	-
	7	164	1,282	168	1,185	132	1,31	112	1,425	132	1,29	149	1,07	112	1,04	81	1,02	48	1,24
	8	136	3,01	150	3,89	88	2,6	1128	3,15	138	2,12	135	2,14	120	2,66	86	2,87	1	2,95
	9	110	3,05	123	3,01	95	2,54	102	2,87	110	2,58	117	2,64	-20	3,65	0	3,28	-25	3,35
	10	193	2,45	208	2,09	208	2,05	84	2,07	202	2,06	200	2,57	182	2,81	148	3,03	182	2,74

4. Determination of soil salinity

Currently, most of Turkmenistan's irrigated land and water resources are used in agriculture. Declining water resources due to climate change, reduced rainfall, increased water demand for crops, and salinization of farmland reduce the amount and quality of products produced from the sector, leading to a gradual decline in agricultural production. land reclamation and soil consolidation are considered important issues.

Soil salinization is said to be the accumulation of harmful salts that are mainly soluble in water in the active layer of the active, plant roots [2] . The harmful effects of the same amount of salts on the plant are not the same. Sodium salts, in particular, have a stronger adverse effect on the plant. If the high level of harmful effects of sodium salts is considered to be 10 points (value) , then the levels of their harmful effects can be placed in a sequence as shown in Table 3 below.

Table 3

The degree of adverse effects of sodium salts

Sodium salts	**Na_2CO_3**	**NaCl**	**$NaHCO_3$**	**In_2SO_4**
Harmful effect level (in score)	10	3	3	1

All salts of sodium and chlorine are also harmful to the plant. Calcium carbonate and calcium sulfate are not harmful to plants. In general, according to B.A.Kovdan’s information the degree of harmful effects of easily soluble salts on plants is reduced in the following order [11] :

$$\mathbf{Na_2CO_3 > NaHCO_3 > Mg(HCO_3)_2 > NaCl > CaCl_2 > Na_2SO_4 > MgCl_2 > MgSO_4}$$

It is necessary to correctly determine the type of soil salinity and the degree of salinity in order to develop measures aimed at preventing soil salinity, cleaning saline soils from plant-harmful salts, and effective use of mineral fertilizers in saline soils.

Y.I. Pankova and others (2006) divide the salinity of soils into groups such as non-saline, weakly saline, moderately saline, strongly saline,very strongly saline, depending on the retention (%) of all salts and harmful salts in their composition *(Table 4).*

Table 4

Grouping of soils by salinity levels

(Y.I.Pankova and others, 1996)

Soil salinity	Types of salinity of ionic quantities, mmol-equiv / 100 g of soil					
	neutral (neutral) salinization			**alkaline salinity**		**carbonate-alkali salting**
	chlorine, sulfate-chlorine	chloride-sulfate	sulfate	soda, chlorine-soda and soda-chlorine	sulfate-sodium and sodium-sulfate	sulfate-chloride-carbonate
Not salted	$\frac{< 0,1}{< 0,05}$	$\frac{< 0,2}{< 0,1}$	$\frac{< 0,3(1,0)}{< 0,15}$	$\frac{< 0,1}{< 0,05}$	$\frac{< 0,15}{< 0,15}$	$\frac{< 0,2}{< 0,15}$
Weakly salted	$\frac{0,1 - 0,2}{0,05 - 0,12}$	$\frac{0,2 - 0,4(0,6)}{0,1 - 0,25}$	$\frac{0,3(1,0) - 0,6(1,2)}{0,15 - 0,3}$	$\frac{0,1 - 0,2}{0,05 - 0,15}$	$\frac{0,15 - 0,25}{0,15 - 0,25}$	$\frac{0,2 - 0,4}{0,15 - 0,3}$
Medium salty	$\frac{0,2 - 0,4}{0,12 - 0,35}$	$\frac{0,4(0,6) - 0,6(0,9)}{0,25 - 0,5}$	$\frac{0,6(1,2) - 0,8(1,5)}{0,3 - 0,6}$	$\frac{0,2 - 0,3}{0,15 - 0,3}$	$\frac{0,25 - 0,4}{0,25 - 0,4}$	$\frac{0,.4 - 0,5}{0,3 - 0,5}$
Strongly salted	$\frac{0,4 - 0,8}{0,35 - 0,7}$	$\frac{0,6(0,9) - 1,0(1,4)}{0,5 - 1,0}$	$\frac{0,8(1,5) - 1,5(2,0)}{0,6 - 1,5}$	$\frac{0,3 - 0,5}{0,3 - 0,5}$	$\frac{0,4 - 0,6}{0,4 - 0,6}$	not meet
Very salty	$\frac{> 0,8}{> 0,7}$	$\frac{> 1,0(1,4)}{> 1,0}$	$\frac{> 1,5(2,0)}{> 1,5}$	$\frac{> 0,5}{> 0,5}$	$\frac{> 0,6}{> 0,6}$	not meet

Notes:

1. Total amount of indicator salts on top of the fraction, total amount of toxic salts below (soil solution in 1: 5 ratio),%.
2. Indicators in the bow refer to soils that contain gypsum.
3. Neutral (neutral) saline mixed with soda is valued as alkaline saline.

Y.I. Pankova and others (2006), it is recommended to determine the type of salinity in terms of the quantitative ratio of ions of easily dissolved salts in water using the following table 5 on anions:

Table 5

Determination of the type of soil salinity by anions

(According to Y.I. Pankova and others.)

Neutral salinity pH <8.5		**Alkaline salinity pH> 8.5**	
Type of salinity	**Cl / SO_4**	**Don't get me wrong type**	**HCO_3 > total anions * 0.2**
Hlorly	> 2.0	Soda	HCO3> Cl and HCO3> SO_4
Sulfate-chloride	2.0 - 1.0	Chlorine - soda	HCO_3 > Cl; SO_4 <0.2 * Σ□anion
Chloride-sulfate	1.0 - 0.5	Sulfate - soda	HCO3> SO_4; Cl <0.2 * Σ□anion
Sulfate	<0.5	Soda - chlorine	HCO3 <Cl; SO4 <0.2 * Σ□anion
		Soda - sulfate	HCO3 <SO4; Cl <0.2 * Σ□anion

Till today the hydrogen index of the soil has not been taken into account in the research carried out to determine the level of soil salinity in Turkmenistan. This is probably due to the fact that in the past, alkaline salinity was not widespread in Turkmenistan's agricultural fields and a limited level of soil analysis. Nowadays, with the change of climate, the symptoms of alkaline salinity in the agricultural fields of the provinces of the country are becoming more pronounced. According to the results of the research carried out in the framework of the project, the lands exposed to alkaline salinity were most common in Lebap province. Due to the presence of a certain amount of gypsum in the soil of the agricultural lands of Dashoguz province, it can be explained that alkaline salinity is rare in this region. Because, the gypsum neutralizes algae.

For example, consider the data on the level and types of salinization of agricultural lands in some districts of Dashoguz and Lebap provinces *(Table 6).*

Table 6

Types and levels of salinization of agricultural lands in the research districts of Dashoguz and Lebap provinces

Areas of soil sampling	No of the sample	In dry soil samples, the amount of ions in water-soluble salts, mmol / 100 g									
		HCO_3	CL	SO_4	Ca	Mg	K	Na	Total	CL	Types of soline
Yagtylyk collective farm of Gorogly District, Dashoguz Province	1	1,5	1,49	16,42	13,4	1,5	0,13	4,38	1,33	0,09	sulphate
	2	1,5	1,39	8,88	6,2	2,1	0,14	3,33	0,8	0,16	sulphate
	3	1,7	3,18	11	2	4,1	0,15	9,64	1,06	0,26	sulphate
Yagtylyk collective farm of Gorogly District, Dashoguz Province	4	1,5	1,79	8,64	6,6	1,9	0,2	3,23	0,8	0,21	sulphate
	5	1,5	1,49	6,97	5,3	1,4	0,19	3,07	0,68	0,21	sulphate
	6	1,5	0,9	1,69	0,7	1,4	0,1	1,88	0,28	0,53	Chiorine- sulphate
Yagtylyk collective farm of Gorogly District, Dashoguz Province	7	1,3	2,89	2,87	1,3	2,9	0,13	2,73	0,45	1,01	Chiorine- sulphate
	8	1,4	1,99	8,06	5	2,5	0,14	3,81	0,77	0,25	sulphate
	9	1,6	1,99	9,86	6,4	2,5	0,13	4,43	0,91	0,20	sulphate
Yagtylyk collective farm of Gorogly District, Dashoguz Province	10	1,6	5,17	7,73	3,1	4,3	0,21	6,89	0,93	0,67	Chiorine- sulphate
	11	1,6	1,09	5,17	2	3,5	0,14	2,22	0,52	0,21	Chiorine- sulphate
	12	1,3	1,09	2,9	1,4	2,4	0,1	1,39	0,35	0,38	sulphate
Yagtylyk collective farm of Gorogly District, Dashoguz Province	13	0,5	1,19	3,24	2,3	1,2	0,09	1,34	0,34	0,37	sulphate
	14	1,3	0,6	4,61	2,8	1,8	0,09	1,82	0,45	0,13	sulphate
	15	1,3	0,6	6,93	3,2	2,4	0,08	3,15	0,6	0,09	sulphate
Parahat collective farm of Danev district of Lebap province	16	1,2	0,36	0,59	1,3	0,5	0,1	0,24	0,16	0,61	Chiorine- sulphate
	17	0,95	0,23	0,59	0,7	0,7	0,12	0,35	0,13	0,39	sulphate
	18	0,7	0,2	0,64	0,7	0,6	0,14	0,31	0,12	0,31	sulphate
Parahat collective farm of Danev district of Lebap province	19	0,7	5,84	19,11	11,5	5,75	0,26	8,14	1,66	0,31	sulphate
	20	0,6	0,33	2,09	1,7	0,8	0,12	0,41	0,21	0,16	sulphate
	21	0,9	0,43	1,13	1,2	0,8	0,04	0,42	0,17	0,38	sulphate
Watan collective farm of Danev district of Lebap province	22	0,9	0,74	1,12	1	0,6	0,1	1,06	0,19	0,66	Chiorine- sulphate
	23	0,8	0,41	0,71	0,8	0,8	0,08	0,44	0,14	0,58	Chiorine- sulphate
	24	0,85	0,41	0,76	0,9	0,5	0,03	0,69	0,15	0,54	Chiorine- sulphate
	25	0,9	14,72	11,86	9	5,25	0,15	13,08	1,7	1,24	Chiorine- sulphate
	26	0,9	3,3	1,95	1,7	1,9	0,09	2,46	0,38	1,69	Chiorine- sulphate

There are several ways to determine the level of soil salinity. Among them, it is more convenient to determine the salinity of the soil by soil solution. Using this method, a special device- *conduct meter is* used to determine the salinity of the soil solution. There are many types of conduct meters. All of them are based on the electrical conductivity of the soil solution.

The work of determining the salinity of the fields with the help of a conduct meter should be carried out in late August - early September. During this period, with the completion of irrigation and the reduction of irrigation water and the cooling of the air, the level of groundwater begins to decrease, the accumulation of salts in the upper layer of the soil slows down, and therefore the rate of salinity also decreases.

The number of soil samples to be taken from each hectare of farmland is determined according to its salinity and based on the data of preliminary surveys. Land use maps, land use maps, or space photos from previous years can also be used. It will also be possible to go around the fields before harvesting with the land user and estimate the salinity of the soil according to the condition of the crop. If the soil of the field is considered to be unsalted, it is sufficient to take a sample of every 15 hectares. A sample of every 10 hectares of slightly saline land should be taken. If the lands are considered to be moderately or strongly saline, it is necessary to take at least 1-2 specimens per hectare. The location of the arable land should also be taken into account. If the user is working in more than one area of the field, more copies must be obtained from all of them. The location of the soil sample taken from the fields should be marked, and their coordinates should be determined by the help of the JPS equipment and recorded in a special notebook. In determining the salinity of cotton fields, it is recommended to use the data shown in Table 7 below.

The agronomy of the farm must be consulted when deciding on the level of salinity and salinity of farmland. This is because there may be other reasons for the low yield.

If the soil is sown in the field where the soil samples are to be taken, then the soil should be counted from the top of the ridge and sampled from three layers with soil depth of 0-30, 30-70, 70-100 cm. A special device - a drill - is used to sample from different depths of the soil. The most advanced version of such a device was used in the design work.

Table 7

Determination of soil salinity on the basis of monitoring

No	Condition of medium-stable crops (cotton)	The condition of the topsoil	Soil salinity
1.	Regular germination, high yield (40-50s / ha), good crop condition	No salt spots are visible on the soil	We didn't get tired
2.	Crops have mild to severe symptoms, yields are reduced by about l0% (35-45 s / ha).	On the ridge, white salt stains are visible on the tops	Poorly salted
3.	In some parts of the area, the crop was not green, the plants were short, the yield was reduced by 20-50% (25 - 35 s / ha).	White salts are clearly visible on the ridge. Such areas cover 20% of the area.	Medium salty
4.	Crops are low (50%), weed plants, yields are reduced to 50-80% (10 - 25 s / ha)	About 50% of the land is covered with white salts	Strongly salted

After drilling the sampled land , it is necessary to determine the mechanical composition of the soil with an eye on the layers of the soil and make a note in the notebook. If there is a compacted layer under the slurry layer, its depth should also be noted in the notebook.

The resulting soil sample should be written in a square shape on a flat surface of polyethylene film, and the plant residues and other mixtures in it should be manually selected. Each specimen should weigh about 150-200 grams on average. The samples should then be collected by placing them in a special paper or cloth bag, providing a label.

The salinity level of the soil is determined by determining the electrical conductivity of the samples. As a unit of electrical conductivity, the **decimeter (dc / m) in meters is** internationally accepted. As ions serve as electrical conductors in solutions, if the amount of ions in the solution is higher, so the electrical conductivity becomes higher.

The electrical conductivity of soil samples can also be determined in field conditions when it needs. However, in this case, each time you need to clean the suspension glasses and the electrode thoroughly with distilled water, or you need to carry a large number of glasses with you. It is also necessary to repeat each measurement three times to ensure the accuracy of field tests. It is advisable to collect soil samples and conduct their analysis in the laboratory or in the house for this purpose.

To determine the specific electrical conductivity of a sample, it is first necessary to prepare a water-soil suspension. To do this, you must first dry the soil samples brought from the field, without falling into sunlight at home, and then place them in a special container and grind well with a fork. Then, first, pour 30 ml of distilled water into a 100 ml bulgur (glass), add 30 g of well-crushed soil samples (about one teaspoon) and mix well until completely dissolved. When the soil-water mixture (suspension) is ready, insert the guide electrode to a depth of about 1-2 cm and press the device button to activate it. After 2-3 minutes, the device will show the conductivity of the suspension. It must be saved in the device memory or copied to a laptop. At the end of the work, rinse the electrodes and bulbs (glasses) and collect with distilled water.

The electrical conductivity of soil-water contamination (suspension) is determined by **EG** $_{1:1}$. To evaluate the salinity of the land using the **EG** $_{1:1}$ indicator, it must be converted to electrical conductivity of the soil sample (extract).

Soil that has a moisture content equal to the total area water capacity is called soil extract. To better understand the meaning of soil extract, let’s look at the phenomenon of water absorption into the soil.

There are small empty cells inside the soil. The sum of the volumes of these empty cells is called the total soil moisture or cellularity. At a depth below the water table, all cells in the soil are filled with water, that is, the soil is filled to its full capacity. However, even after the cells in the active soil layer are filled with water immediately after watering the crops, the water cannot stay in the cells for long. Farmers refer to this phenomenon as “water uptake by the soil”. The reason water seeps into the lower soil layers are because its gravity is greater than the capillary forces trying to hold onto the water. As water is absorbed, the gravity of the unabsorbed water decreases, when it becomes equal to the capillary forces that try to hold water in the active layer of the soil, water absorption stops, and some water stops. The amount of stored water is also equal to the total soil area. This amount of water gradually evaporates from the soil and is used for crops.

The electrical conductivity of the soil depends on the humidity, temperature of the soil, the type of ions it contains. In field conditions, soil moisture varies very rapidly. At the same time, the electrical conductivity will change. The electrical conductivity of the soil extract is taken into account in this study so that these changes do not affect the determination of soil salinity.

There is a direct connection between the electrical conductivity of the soil-water suspension and the electrical conductivity of the soil extract. As a result of research abroad and correlation analysis, it has been found that the equation of this connection is **y = kx** . The **k-**coefficient in this equation depends on the quantitative ratio of the ions in the soil. It is necessary to conduct special research to determine the coefficient.

Such studies have been carried out sufficiently in the Republic of Uzbekistan. However, no such work has been done in Turkmenistan yet, but it is planned to work with local experts in the future phases of the project.

If the agrochemical properties of a certain part of the agricultural lands of the Republic of Uzbekistan and Turkmenistan are similar (for example, in Bukhara and Lebap, Khorezm and in Dashoguz provinces), then the coefficient can be used as **k = 3.5** for preliminary calculations.

Thus, the electrical conductivity of the soil extract can be determined by multiplying the electrical conductivity of the soil-water suspension determined by a conductor to 3.5. It will not be the same at different points in the field and in different layers of soil. In order to make a final decision on the salinity of the soil, it is necessary to determine their average arithmetic value.

As is well known, the soils are subdivided into the following groups according to their salinity levels based on the electrical conductivity characteristics of the UN Food and Agriculture Organization (FAO) classification *(Table 8).*

Using the above table for the average electrical conductivity of soil extract, the salinity level of the soil is determined. The index, defined in this way, meets international standards and is clear to experts in any country in the world.

Table 8

According to electrical conductivity of the soil extract, saline soils and their division into groups

EG, ds / m	Soil salinity	EG $_{1:1}$ (k = 3.5) ds / m
0-2	Not salted	0.0 - 0.60
2-4	Poorly salted	0.61 - 1.15
4-8	Medium salty	1.16 - 2.30
8-16	Strongly salted	2.31- 4.70
> 16	Salts	> 4.70

5. Assessment of soil density in the active part of the roots

It receives plant water and water-soluble nutrients through its roots. The thicker and softer the active layer of the soil, the higher the water supply and nutrients of the plant. If the thinner and denser the active layer of the soil is high, the more the sunlight warms and dries the soil, resulting in more frequent watering to the crop. The free spread of the roots to the lower layers in the soil also depends on the density of the soil.

Soil density is the mass of a unit of volume of fully (absolute) dry soil that has not been disturbed by its natural structure. It is characterized by the location of the small particles of the soil and the interdependence of the cell. This density of soil affects the moisture absorption of the plant, gas exchange, heat retention, root growth and the intensity of microbiological phenomena in the soil. According to scientific data, the optimal soil density should be between 1.25-1.30 g / cm ^{3} for the normal growth of most crops . Excessive soil density has a detrimental effect on crop yields.

As a result of many years of soil treatment, crop rotation, changes in water retention methods, and the use of mineral and organic fertilizers, the density of the soil changes.

Over the years, irrigation has shown that under the influence of agricultural machinery, a layer that is condensed under the slurry and low in water permeability is formed.

In recent years, the depth of autumn (main) plowing has also been reduced to 30-35 centimeters due to the use of wheeled heavy tractors instead of chain plowing tractors. When water is caught in flawed areas, not all of its land is equal. In this case, the operation of the treatment tractors becomes difficult, and as a result of treatment in some high-humidity soils, a denser layer is formed or thickened if it already exists. Inspections carried out during the project revealed that in the Dashoguz province, the densified layer of the soil is often located at a depth of 45-55 cm. The thickness of the compacted layer is about 8-15 cm.

The presence or absence of a condensed layer can be ascertained in three ways. The first of these is drilling the soil (Figure *7)*. When the tip of the drill reaches the condensed layer, the drill gives a sensitive weight.

Figure 7. **Sampling of soil samples**

At that point the depth should be noted. Then, as the drill goes down the condensed layer, it again defeats the drill and stops its sensitive weight. At this point, too, depth should be measured. The difference in the depths of the two moments indicates the thickness of the compacted layer.

The second way to determine the presence of a condensed layer is by digging a pit in the field. Dig a hole in the sun so that it can be exposed to the sun. The pit should be dug with an elephant - 50x50 cm in width, 70 - 80 cm in depth and the side where the sun will set. If there is a condensed layer, it will make it visible. Its thickness and depth of soil can be measured. If accurate data are needed, samples should be taken every 10 cm with a certain volume of cylinders without disturbing the natural state of the soil. It is necessary to weigh the exact samples taken by layers, to determine the full dry weight by hygroscopic humidity. According to this data, the density of each layer can be accurately determined and accurately estimated.

It is also convenient to use the method of determining the density of the soil by the movement of water when the crops are irrigated. To use this method, you need to select a straight and flat cache from the caches where it is suspected that there is a condensed layer. You have to dig a hole every 20 meters from the beginning of the cache. That cache should let the water flow in a constant stream and mark the time when the water reaches every gas. If the flow of water passes between the pits at the same time, i.e. the water moves in a balanced way, then it is assumed that there is a condensed layer. If there is no condensed layer, the flow rate decreases as it moves away from the top of the cache.

6. Assessment of reclamation status of irrigated lands

To the ameliorative condition of irrigated lands, *"Ameliorative* condition is good*."* *The ameliorative condition* is assessed as *“satisfactory”* and *“the ameliorative condition is unsatisfactory”.* Based on the results of the evaluation is as follows:

Underground water levels below the water table, which are neither saline nor saline, provide high crop yields that are rated as **“reclamation”.** This can happen in areas where natural or artificial drainage is in good working order and has a high level of water supply.

Underground water levels are considered to be «satisfactory »for agricultural lands located at a depth not harmful to crops, soil or medium saline, which ensures moderate crop yields .

Underground waters, which are above the level of the depth of reuse of crops, soil, moderate, or strong lands, crops in the fields of farming cannot provide the normal yield **"satisfactory reclamation status"** as the assessment.

In recent years, due to reasons such as climate change, changes in applied technologies, inadequate drainage systems, and the analysis of the data collected, there have also been cases where the farmland does not meet the above three indicators. That is, in some cases, even when irrigated areas are right on three indicators, they may have an unsatisfactory rating on other indicators. For example, in non-saline soils, crops can yield high yields despite the fact that groundwater is located at a depth that is harmful to crops, i.e., close to the ground. This is due to the fact that groundwater salinity is weak, when the requirements for water **retention are** met, and the catchment water **retention norm** (soil washing rate from harmful salts) is enforced. Conversely, if the soil is saline, the reclamation condition of the cropland may be unsatisfactory, even if the groundwater is low (harmless).

Achieving full compliance with **water retention norm** is of great importance in improving the reclamation status of farmland. But what should be understood as the norm of irrigation? Where and under what conditions is it used? To answer these questions, let’s recall the content of the irrigation rules. Irrigation regulations are a document that specifies which crop, at what time, and how much to irrigate according to weather - soil and other natural - economic conditions. It is developed and approved by the authorized state body.

Up to now, the level of salinization of soils ignores the rules developed irrigation and soil moisture to improve only aimed at. The agro-autumn-winter months in accordance with the requirements of growing of crops are grown, and the earth from harmful salt water flushing clean shall be deemed discharged through the drainage. However, at present, does not want to clog the drains and due to lack of water everywhere, washing is not possible to transfer the waters of the highest quality. Thus, the full implementation of yield is not exceeding irrigation flushing. We recommend designing the rules to further areas in the salinity of irrigation for agriculture, its consideration of soil salinity options.

As the moisture content in the saline soils decreases, the soil moisture content decreases, the adverse effects on the soil of the toxic salts in the soil intensify. According to scientific data, cotton loses 15% in lightly saline soils, 30 - 40% in moderately saline soils, and 60 - 80% in strongly saline soils. If the conditions limiting the yield on farms are saline, then all agro-technical measures should be determined according to the expected yield. This will allow for more efficient and cost-effective use of the resources used in the agricultural sector, especially mineral fertilizers.

7. Adopting of Decree to improve the ameliorative condition of irrigated lands

Adopting of Decree on improving the reclamation status of irrigated lands should begin with the elimination of the reasons for the decline in agricultural productivity. Because fighting the consequences of this situation is ineffective. It only leads to unnecessary costs and the complexity of the environmental conditions. For example, an attempt to improve the reclamation conditions of irrigated lands by cleaning or re-drilling drains can be a clear example of how to deal with the consequences of adverse conditions. It should be borne in mind that improving the reclamation status of irrigated lands may have a number of causes other than poor drainage. These reasons apply to the priorities of adaptation measures in climate change.

In many cases, the deterioration of land reclamation is caused by an increase in groundwater levels. Below are some of the conditions that cause groundwater levels to rise:

Failure to comply with irrigation regulations. This is due to the fact that the crops are irrigated with excess water. This situation occurs when a water-based economic plan for water use is not scientifically substantiated, taking into account local soil and climatic conditions, and not measuring and reporting water use. The domestic water use plan is an integral part of the water user's contract with the state water authority. Violation of this agreement by any of the parties does not ensure the fairness, reliability, flexibility and scale of water services. As a result, the land reclamation situation is deteriorating with the loss of crops.

Uneven of irrigated lands. Some farmers pretext of shortage of bulldozers, in irrigated region, and so they use water from underground water level 2-3 norms themselves have raised higher. Low water shall arranged in the water here, here in the great arises out of the water. As a result, the advantage of a glitch and somewhere is else it cannot lack of opportunity due to the transfer of agro-technical activities. And this is a substantial loss of fertility. So, the great surpluses spent tackling verdict in the water here. This is the result of the rise of the groundwater level. Due to the transfer in the areas of agro-technical measures do not tan in uneven places equal quality is poor. These are the proper places according to evidence-leveling is one of the most important reclamation measures. Should ensure that the work of leveling the land, dryness out evenly. As a result of dryness plant roots out evenly in the lower layers of the earth, extend water draining layer of soil. Stipulated in the field of rational water are used economically. Here, because of the whole field covered with the patch, used in flat places is increasing as well as the coefficient of irrigation to extend the opportunity to water retention. If this happens, carrying out repair work agronomist and increases the efficiency of the agricultural machinery business.

Incorrect selection of water retention techniques. The technique of water retention, i.e. the method of watering the crops, refers to a set of indicators that determine the amount of water released to the field per unit time, the length of the caches, the size of the field, and the time to catch water. These parameters are determined by the slope of the soil, the mechanical composition of the soil, the presence or absence of a compacted layer beneath the slurry layer. To better understand the importance of water retention techniques, let’s look at the movement of water on the ground when water is caught.

Flooding means turning the running water in the dam into a wetland. The water moves in a two-dimensional space at the mouth. At the same time, it moves forward and sinks into the ground. If the water flows at a high speed, the water will absorb less into the lower layers, but it will quickly reach the end of the cache and the water may press down on the cache. As can be seen from Figure 8 below, the active layer of roots at the end of the cache will remain completely unchanged.

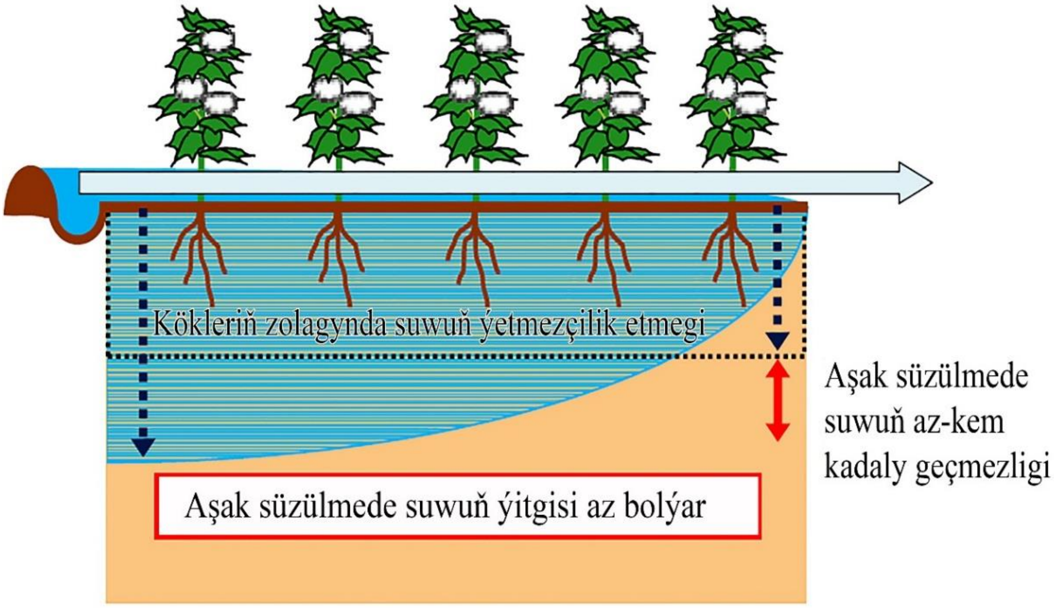

Figure 8. **The condition when cotton is watered by a strong current**

If the water flows at a low flow, i.e. at a low velocity, the caches will be fully moistened throughout the length, but at the beginning of the cache a lot of water will be uselessly absorbed into the bottom and raise the level of groundwater (Figure *9).*

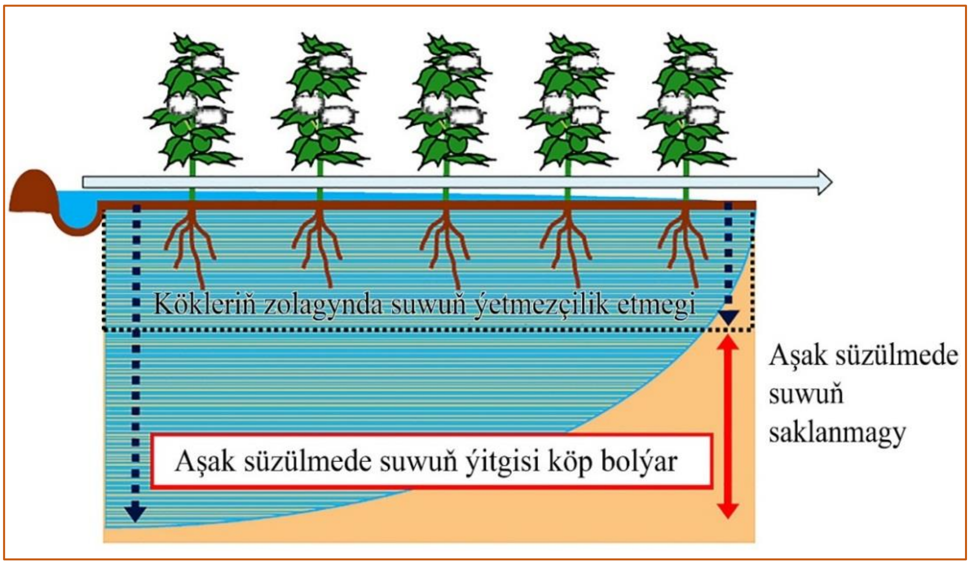

Figure 9. **This is the case when water is caught with a low flow of cotton.**

Therefore, there is a need to select and use scientifically based techniques for crop irrigation.

Low level of organizational activities. Organizational activities should be organized in accordance with the economic plan of water use and the agro technological map of crop cultivation. In accordance with these documents, the scheme of water retention of crops and the order of water management are determined.

It was a matter of catching water - the order in which the fields were to be watered, when, and in what quantity. It is configured individually for each lane. According to the water catchment schedule, the days when the watermen have to go to work are set. The divers have to work day and night. Melorator's assessment of the quality of its work improves the effectiveness of its organizational activities.

Water management is of great importance in the efficient use of water resources. Its main purpose is to drain it from a stream with a large flow to reduce water losses. The water catch line should be drawn up according to the water management schedule.

Dissatisfaction with the technical condition of the irrigation system. The irrigation system must be able to deliver the required amount of water to the required place without loss of time in order to irrigate the crops. Of course, in open irrigation it is not possible to completely eliminate water loss. But it is possible to reduce water losses to the lowest level if appropriate measures are taken. If the dimensions of the cross-section of the irrigation ditches do not correspond to the amount of water to flow from the dam, its water permeability will decrease and water losses will increase. Factors such as high levels of water leaks in the layers, the use of water tanks, the lack of water regulators and water meters are needed to create additional water losses and raise groundwater levels.

Dissatisfaction with the technical condition of the drainage system. In fact, the drainage system is designed to remove salty sewage from irrigated areas when washing wastewater is caught. During non-catchment periods, an average of 0.3 liters of drainage water per hectare should be released per second. This means that the farmer to get about 2600 m ^{2} of water per day from 100 hectares of farmland . If the water comes out more than that, it is a sign that irrigation water is being used in vain.

Drainage needs to be cleaned and deepened at least once every five years to ensure proper use. On average, the depths of the drains should not be more than 3 meters. Drains are not allowed to be blocked or piped through. The use of drains as water tanks and the use of land within 20 m of them for household purposes are prohibited.

Thus, the landlords should analyze the data collected as a result of the surveys and clarify which of the above conditions led to the deterioration of the ameliorative condition of the irrigated lands attached to them , as well as the appropriate organizational, technical, hydraulic, agro-technical, agro-technical measures.

8. Transfer of wastewater in saline soils

8.1. Transfering of wastewater in the saline areas of cotton and spring crops

Irrigated soils with saline soils are kept in good condition with wastewater for next year's harvest. The amount of wastewater depends on the salinity of the soil, its mechanical composition, and the depth of the groundwater [10] .

When groundwater is not flowing naturally or where drainage is not being carried out, it is only temporary when the wastewater is being pumped or the soil is re-salted. Washing water should therefore be carried out in the presence of drains that operate normally.

In ***low-saline and moderately saline*** soils with light soils, to save irrigation water, wastewater is combined with early spring water. In areas with moderate to heavy salinity, winter wastewater is specially administered *(Table 9).*

The amount of wastewater that should be allocated at each time should be 1,500-1700 cubic meters per hectare and the distance should be 8-10 days.

The areas with ***low-slope*** light soils are divided into ditches so that they are 0.15-0.25 hectares in size and 0.25-0.35 hectares in medium and heavy soils, and irrigation is carried out on these fields separately. When irrigating pellets and temporary sidewalls, each irrigation horse is made to irrigate separately. Irrigation water should not be flushed from one to another to increase its efficiency *(Fig. 10).* Therefore, the pallets that are transferred to the vertical of the area should be alternated with temporary inserts.

Figure 10. **Detention of washing and throne water in slopes**

It is wrong to pass wastewater through large sewers, as this leads to excessive consumption of good water, high groundwater levels, and deteriorating amelioration.

In large slopes, washing water is carried out in caches *(Figure 11)*. In light soils, the distance between the rows should be 60 cm , the length of the caches should be 100-150 m, and in medium and heavy soils it should be 150-250 m. When the row spacing is 90 cm, the recommended length of the caches is increased by 1.2-1.5 times.

The requirements for the proper conduct of wastewater in sloping areas are:

- the ground should be well leveled before the cache is drawn.
- the height of the cache should be the same everywhere.
- The soil of the caches should not be washed with irrigation.
- In order for water to penetrate the soil, the caches should be irrigated with a stronger current at the beginning of irrigation and less at the end.

Table 9

Recommended quantities (in terms of thousand m ^{3} / day of irrigation) **and timing for next year's harvest in light and moderately saline areas**

(O.Rejepov and others, 2001)

<table>
<tr><th rowspan="4">Mechanical composition of the soil</th><th colspan="6">In less saline soils</th><th colspan="6">In moderately saline soils</th></tr>
<tr><th colspan="12">Groundwater Depth (SES)</th></tr>
<tr><th colspan="2">(SES)> 3m</th><th colspan="2">(SES) = 2-3m</th><th colspan="2">(SES) <2m</th><th colspan="2">(SES)> 3m</th><th colspan="2">(SES) = 2-3m</th><th colspan="2">(SES) <2m</th></tr>
<tr><th>deadlines</th><th>amount</th><th>deadlines</th><th>amount</th><th>deadlines</th><th>amount</th><th>deadlines</th><th>amount</th><th>deadlines</th><th>amount</th><th>deadlines</th><th>amount</th></tr>
<tr><td rowspan="2">Easy</td><td colspan="6">In early spring it is held in conjunction with throne water</td><td colspan="6">In early spring it is held in conjunction with throne water</td></tr>
<tr><td>1.03-31.03</td><td>1.75</td><td>1.03-31.03</td><td>1.5</td><td>21.02-31.03</td><td>1.3</td><td>21.02-31.03</td><td>2.5</td><td>21.02-31.03</td><td>2.25</td><td>21.02-31.03</td><td>2.0</td></tr>
<tr><td rowspan="4">Medium</td><td colspan="6" rowspan="3">In early spring it is held in conjunction with throne water</td><td colspan="6">It is held in the form of special washing water</td></tr>
<tr><td>11.01-28.02</td><td>2.5</td><td>21.01-28.02</td><td>2.25</td><td>01.02-28.02</td><td>1.75</td></tr>
<tr><td colspan="6">In early spring it is held in conjunction with throne water</td></tr>
<tr><td>1.03-31.03</td><td>1.75</td><td>1.03-31.03</td><td>1.5</td><td>21.02-31.03</td><td>1.3</td><td>1.03-31.03</td><td>1.2</td><td>1.03-31.03</td><td>1.2</td><td>1.03-31.03</td><td>1.2</td></tr>
<tr><td rowspan="4">hard</td><td colspan="6" rowspan="3">In early spring it is held in conjunction with throne water</td><td colspan="6">It is held in the form of special washing water</td></tr>
<tr><td>01.01-28.02</td><td>3.0</td><td>11.01-28.02</td><td>2.5</td><td>21.01-28.0.2</td><td>2.0</td></tr>
<tr><td colspan="6">In early spring it is held in conjunction with throne water</td></tr>
<tr><td>21.02-31.03</td><td>2.00</td><td>21.02-31.03</td><td>1.75</td><td>21.02-31.03</td><td>1.5</td><td>01.03-31.03</td><td>1.2</td><td>01.03-31.03</td><td>1.2</td><td>01.03-31.03</td><td>1.2</td></tr>
</table>

Washing water in light, medium, strong, very saline soils with the participation of the Honored Worker of Agriculture of Turkmenistan, Doctor of Agricultural Sciences O. Rejepov, Doctors of Agricultural Sciences O. Garahanov, D. Babayev and others (O. Rejepov et al., 2001) The application of the developed transfer tips *(Tables 9 and 10 of the manual) in* production will help make the wastewater more efficient. In these tables, the quantities and timing of wastewater transfer are given in relation to the salinity of the soil, the level of groundwater, and the mechanical composition of the soil.

Figure 11. **Detention of washing and throne water in sloping areas**

The agronomy conducts the plan of wastewater treatment at least one month before the start of the household to ensure that the wastewater is properly organized. This work requires maps and maps of the salinity, mechanical composition, depth of groundwater of the lands used by the farmers' association. As a result of conducting almost all of these land surveys, the ‘’Turkmenyertaslama’’ State Design Institute has set up a survey of relevant farms and provides them with land use projects. The agronomist of the farm uses this information and Tables 9 and 10 of the manual to draw up a plan to carry out wastewater treatment for each planting area using Annex 1, which is provided separately.

Table 10

Recommended deadlines and amounts of groundwater **reclamation in the reclamation area, thousand m ^{3} / ha** (O.Rejepov and others, 2001)

Depth of groundwater, m	**In a strongly saline field (chlorine 0.07-0.14%)**			**In a very strong saline area (chlorine 0.14% and above)**		
	conduct thorough washing water					
	deadlines	**amount**	**the amount of wastewater**	**deadlines**	**amount**	**the amount of wastewater**
In areas with light soils (sandy and light clay)						
> 3.0	21.01-31.03	4.5-5.0	3	01.01-31.03	> 5.0	3 and more
2.0-3.0	21.01-31.03	4.5-5.0	3	01.01-31.03	> 5.0	3 and more
1.0-2.0	21.01-31.03	4.5-5.0	3	01.01-31.03	> 5.0	3 and more
In areas with medium soil (medium clay)						
> 3.0	21.01-31.03	5.5-6.0	4	01.12-31.03	> 6.0	4 and more
2.0-3.0	21.01-31.03	5.5-6.0	4	01.12-31.03	> 6.0	4 and more
1.0-2.0	21.01-31.03	5.0-5.5	4	01.12-31.03	> 5.5	4 and more
In areas with heavy soil (heavy clay, clay)						
> 3.0	01.12-31.03	8.0-10.0	6	20.11-31.03	> 10.0	6 and more
2.0-3.0	01.12-31.03	7.0-8.0	5	20.11-31.03	> 8.0	5 and more
1.0-2.0	01.12-31.03	6.0-7.0	5	20.11-31.03	> 7.0	5 and more

Significant wastewater is used ***to wash the saltier and stronger saline areas***. Such areas are common among newly developed, as well as irrigated lands. It is not agronomically and economically feasible to transfer wastewater without splitting the area into large maps, as excess water is wasted and leads to an increase in groundwater levels .

If stronger and more strongly saline soils are located between farmland areas, efforts are being made to improve the reclamation conditions of the soil. When the scale of these works is large, it is advisable to leave the *area* for sowing for a certain period of time as a *"reclamation area"* and to have a good plan of major hydro and reclamation works, including the construction of drains, leveling works, thorough washing of the lands and so on. In these areas, it is not possible to carry out serious wastewater treatment at a rate of more than 6,000 cubic meters per hectare in one season. It is therefore performed during the two autumn and winter seasons, and mandatory *cultivation crops* are planted between the periods during which the wastewater is supplied. The best of these crops are considered Sudanese grass, jowl, corn and others. These crops also improve yields when grown under normal agro technics and also increase the efficiency of wastewater.

When sowing crops are planted, the irrigation rates of their growth period are regulated so that the soil layer is always washed away, so the irrigation rate should be 10-15% higher.

When the total amount of wastewater does not exceed 5-6 thousand cubic meters, it is given several times, just as the annual wastewater catchment *(Table 10).* It is proposed to provide 70-75% of its total amount during the fall and winter period and the remaining 25-30% during the period of throne water transfer. After March 1, it will not be given more than 2.0 thousand cubic meters per hectare.

If the above recommendations are not followed, the soil maturation period is disrupted, the sowing time of cotton and other crops is also delayed, the efficiency of wastewater is reduced, and the barrier to the production of good quality crops is increased *(Table 11).* Also, if the above-mentioned wastewater transfer technology is not implemented, they will not ensure the reduction of toxic salts in the edible layer of the roots of the crop. Soil salts have a detrimental effect on the germination of agricultural crops, their density and growth.

Table 11

Activities related to the washing of saline lands in the agriculture of Turkmenistan in 2004 (I.M.Stanchin, 2006)

N	Types of work	Unit of measure	Volume
1.	The length of the drainage should be on each hectare of irrigated land The actual length of the drain Drainage supply	step meter step meter %	45 16.65 37
2.	The near-surface area of saline groundwater Areas of reclamation activities Wastewater catchment areas A real catchment area Normally 1 hectare of wastewater should be consumed What was given to him was real	% % % % m^3 m^3 %	14 73 53 22.7 3706 1048 28.3
3.	Due to the lack of washing water in the saline soils and the lack of drainage, the amount of uncultivated cotton crop	thousand tons	250

The "Turkmenyertaslama" State Project Institute itself and its regional enterprises carry out inspections of changes in salts that are harmful to the crops in the soil every 4-5 years.

Innovative irrigation technologies, including drip irrigation, need to be widely used to improve soil reclamation.

It is recommended to carry out washing water from the *end of November to the beginning* of *March in* order to complete the field work on the preparation of cotton fields for sowing without delay within the stipulated time. In areas where wastewater is combined with throne water, throne water should be transferred from March 1 to April 5. In light soils, water should be given 10-15 days before planting, and 15-20 days before medium and heavy soils. If the last throne water is to delay the sowing period, its yield can be reduced to 1,200-1400 cubic meters per hectare. In sloping areas, wash and board water in a 60 cm row with a flow rate of 0.5-0.7 *l / sec* and a flow rate of 1.0-1.5 *l / sec at* 90 cm.

It is important to ensure that agro-technical work is carried out in a timely manner on the bed of the introduction of good quality and high-yielding varieties of crops in order to ensure the transfer of wastewater in a convenient and more efficient time.

8.2. Conducting wastewater treatment in saline areas where winter crops will be planted

Even in the saline soils where winter crops are planted, the amount of wastewater transfer is similar to that of cotton and other spring crops (G. Goshayev et al., 2018). But in contrast, the catchment of wastewater in these crops has to be completed in the southern districts of the country from August 15 to November 20, and in the northern districts from August 1 to October 15. Appendices 1 and 2 of the manual are also used in the preparation of the wastewater treatment plan in the fall.

Results and suggestions

1. The so-called "ameliorative condition of irrigated lands" means the level of groundwater in agricultural lands, their salinity, the degree of salinization of the soil, the type (type) of its salinization, the presence or absence of a compacted layer in the active layer of the soil, as well as the ability to provide or exceed the fertility of the land. It must be to understand the sum of indicators such as the ability to know.
2. Land users need to improve their land and improve their land reclamation, improve their land yields, and at the same time develop and implement irrigation measures to improve the local ecological situation. This work can be done mainly by land users themselves.
3. To monitor the reclamation status of irrigated lands at the economic level, monitoring wells should be set up at the characteristic points of the cultivated areas. Surveillance wells should be installed 20 m from the canals, 40 m from small drains (drains), 120 m from inter-farm irrigation ditches and drains, and 200 m from large watercourses (canals). These wells need to be operated on a regular basis.
4. Land users should take a multifaceted and thoughtful approach to improving the reclamation status of low-irrigated irrigated lands as a result of regular assessments. In the first place, it is

necessary to pay attention to the organizational and agro-technical measures, the standard use and reporting of irrigation water, which require low costs when growing crops. Transition from technical and agricultural measures to scientifically based crop rotation, agro-technical measures *(proper leveling of lands, deep plowing, breaking of the compacted layer of soil, water retention norms, more water retention and soil composting, water retention rules).* Great attention should be paid to timely and high-quality transfer, efficient use of organic and mineral fertilizers, and creation of protected forest areas in agricultural lands. The technical condition of the drainage system should also be taken into account in the reconstruction or reconstruction of drainage systems.

5. In order for water drainage and irrigation canals to have high water permeability, they must be regularly cleaned of weeds.

6. In order to reduce the leakage of irrigation water to the lower layers of the soil, to prevent the rise of groundwater to a certain extent, water dams should be covered (reinforced) with waterproofing materials as much as possible.

7. In order to make efficient use of irrigation water, to prevent its incorporation into groundwater, and to fight salinity more effectively, modern advanced irrigation technologies, including drip method, and artificial use of air-cooled crops, have been introduced into production.

8. When placing agricultural crops in saline areas, their salt tolerance should also be taken into account.

9. It should be noted that scientifically based alfalfa crop rotation, the use of favorable water norms in combination with fertilizers is of great importance in reducing the consumption of irrigation water per unit of yield.

10. In order to ensure the proper conduct of wastewater in cotton fields, one of the most priority and widely cultivated crops in the country, it is necessary to start the preparation of wastewater from crops, including cotton, from early November.

11. Given the changing climate and the high cost of early harvesting, early planting, high-quality and high-yielding varieties of crops should be created and produced for production in order to save time on the foundation of next year's harvest, including the amount of wastewater.

12. Phosphorus fertilizers should be used in scientifically based quantities and timelines.

13. Efforts should be made to reduce the level of groundwater, first of all, to clean up the drainage system in its areas close to the soil, and to build them in areas where there is no drainage.

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APPENDIX

1. Development of a plan to carry out wastewater treatment in saline soils of the farm

Of arable land order number	Mechanical composition of the soil	In low saline soils						In moderately saline soils					
		SES> 3m		SES = 2-3m		<eSÇ <2m		SES> 3m		SES = 2-3m		<eSÇ <2m	
		conduction of wastewater when available											
		deadline	amount, m^3/ha	deadline	amount, m^3/ha	deadline	amount, m^3/ha	deadline	amount, m^3/ha	deadline	amount, m^3/ha	deadline	amount, m^3/ha
1	Easy	1.03-31.03	1.75										
7	Hard			21.02-31.03	1.75								
17	Medium											01.02-28.02	1.75
												01.03-31.03	1.2

<table>
<tr><th rowspan="4">Crop area sequence number</th><th rowspan="4">Mechanical composition of the soil</th><th colspan="6">In strongly saline soils (chlorine 0.007-0.14%)</th><th colspan="6">In very strongly saline soils (chlorine> 14%)</th></tr>
<tr><th colspan="2">SEAS> 3m</th><th colspan="2">SES = 2-3m</th><th colspan="2">=eSÇ = 1-2m</th><th colspan="2">SEAS> 3m</th><th colspan="2">SES = 2-3m</th><th colspan="2">=eSÇ = 1-2m</th></tr>
<tr><th colspan="12">conduction of wastewater when available</th></tr>
<tr><th>deadline</th><th>amount, m^3 /ha</th><th>deadline</th><th>amount, m^3/ha</th><th>deadline</th><th>amount, m^3/ha</th><th>deadline</th><th>amount, m^3/ha</th><th>deadline</th><th>amount, m^3/ha</th><th>deadline</th><th>amount, m^3/ha</th></tr>
<tr><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td></tr>
<tr><td rowspan="2">21</td><td rowspan="2">Medium</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">21.01-31.03</td><td>5.5-6.0</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>4</td></tr>
<tr><td rowspan="2">25</td><td rowspan="2">hard</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">20.11-31.03</td><td>> 7</td></tr>
<tr><td>5 and more</td></tr>
</table>

Note: This appendix is based on the indicators in Tables 9 and 10 of the manual.

The actual flow of wastewater in the saline soils of the farm

Array number of the field	In low saline soils						In moderately saline soils					
	SES> 3m		SES = 2-3m		<eSÇ <2m		SES> 3m		SES = 2-3m		<eSÇ <2m	
	conduction of wastewater when available											
	deadline	amount, m^3 / ha	deadline	amount, m^3 / ha	deadline	amount, m^3 / ha	deadline	amount, m^3 / ha	deadline	amount, m^3 / ha	deadline	amount, m^3 / ha
1												
7												
17												

Crop area sequence number	In strongly saline soils (chlorine 0.007-0.14%)						In very strongly saline soils (chlorine> 14%)					
	SEAS> 3m		SES = 2-3m		=eSÇ = 1-2m		SEAS> 3m		SES = 2-3m		=eSÇ = 1-2m	
	conduction of wastewater when available											
	deadline	amount, m^3/ ha	deadline	amount, m^3/ ha	deadline	amount, m^3/ ha	deadline	amount, m^3/ ha	deadline	amount, m^3/ ha	deadline	amount, m^3/ ha
21												
25												

CONTENT