MINISTRY OF AGRICULTURE AND ENVIRONMENTAL PROTECTION OF TURKMENISTAN

TURKMEN AGRICULTURAL UNIVERSITY NAMED AFTER S.A. NIYAZOV

TURKMEN AGRICULTURAL INSTITUTE

MANUAL ON EFFECTIVE APPLICATION IN COTTON GROWING OF MINERAL FERTILIZERS

Ashgabat-2019

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The scientific and production manual provides a methodology for determining the rules for the use of mineral fertilizers when growing cotton, depending on the strength and salinity of the soil, the amount of the planned harvest, the rules for using these soil-agrochemical maps on the ground with specific examples. The manual also provides tips and tricks for the correct use of mineral fertilizers when growing cotton.

The manual is intended for landowners, farmers and tenants, as well as agricultural professionals.

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INTRODUCTION

Cotton is one of the most important branches of our national economy. It creates favorable conditions for solving the socio-economic problems of rural development. In this regard, with the aim of developing the cotton industry, they are of great scientific, industrial and economic importance on important issues, such as the creation of high-yielding varieties of cotton, the improvement of seed production, as well as the improvement of cultivation technology.

The Program of Socio-Economic Development of the President of Turkmenistan for 2019-2025 provides for the production of cotton in our country in the amount of 1,050,000 tons in 2019 and 1,250,000 tons annually from 2020 to 2025. To achieve these heights, it is required to carry out more useful research work in the field of scientific development of cotton growing, the introduction of the achievements of science, technology and advanced world experience into production [2].

In this regard, the creation of varieties that are resistant to environmental conditions, capable of increasing yields, as a result of scientific and practical research, fully satisfying the ecological requirements of the plant to ensure the correct growth and productivity of the plant is one of the urgent problems of the industry. The development of a fertilizer regime that ensures high crop yields and the use of fertilizers on a scientific basis are at the heart of innovative cotton growing technology.

Therefore, it is important for land users to learn how to effectively use mineral fertilizers when growing cotton in accordance with local climatic conditions in the current changing climate.

This manual pays great attention to the problems of cotton nutrition with mineral fertilizers on the multifaceted meaning and function of fertilizers *(Fig. 1).* In our opinion, henceforth, there is a need to teach farmers the nutritional method in what volume, what fertilizer and when to feed cotton, and not with general recommendations on how to determine the need for cotton, when, how many fertilizers given in the cotton recommendations.

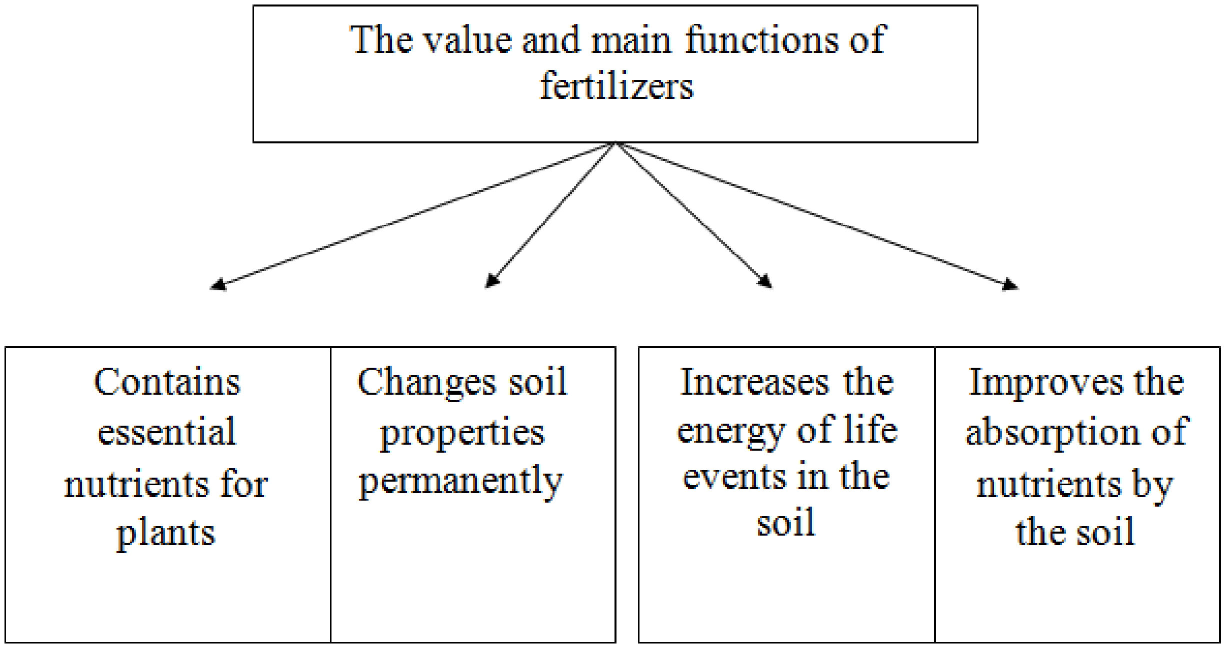


Figure 1. **The value and main functions of fertilizers in agriculture**

Scientific and Technical Council of the Ministry of Agriculture and Water Resources of Turkmenistan, approved and published January 24, 2018, "In the manual on the cultivation of cotton," gave an accurate determine,*that the total number of available nutrients in the soil as determined by the total amount of nutrients available in the soil* The manual also reported , *"Data about soil and agrochemical maps should be used to improve productivity and economic efficiency of mineral fertilizers"* [5]. Taking advantage of this advice requires appropriate knowledge and hard work of land users. We decided to show in this manual how to use these soil-agrochemical maps in a language that farmers understand through specific examples.

The manual focuses on determining the rules for the use of mineral fertilizers in cotton growing, depending on the fertility and salinity of the soil, as well as the volume of the planned harvest [5]. This is due to the fact that the use of mineral fertilizers in excessive rates worsens the physical, chemical and ecological properties of the soil, negatively affects the life of beneficial microorganisms in the soil and does not allow obtaining the expected yield from agricultural crops, but also the quality of products are reduced.

Requirements for the use of mineral fertilizers

Cotton is a crop that requires mineral fertilizers. According to scientific data, without the use of mineral fertilizers and crop rotation, 8-12 metric centner of cotton can be harvested from each hectare of cotton on the soils of Central Asia. If it is planned to harvest more crops, then it needs the obliged using of mineral fertilizers. The area used for growing cotton is productive. Just as it is impossible to use for a long time without the maintenance of a tractor or machine, it is also effective to use mineral fertilizers in agriculture, taking into account the specifics. The use of mineral fertilizers should solve three problems. That is, the use of fertilizers should be economically profitable, environmentally friendly and support sustainable development of the village.

The joint solution of these three tasks is impossible without the use of scientifically based approaches. Given that the problem is currently global in nature, the International Institute of Plant Nutrition of the Russian Federation is conducting research in countries around the world. The purpose of this institute is to collect and disseminate scientific information on responsible plant nutrition management for the benefit of humanity. The Institute was founded in 2007 on the basis of the Institute of Potassium and Phosphorus, created in the 30s of the last century. (http://eeca-ru.ipni.net/). The main idea of this international organization is to follow four directions to solve three problems. That is, in order to effectively use of mineral fertilizers, it is necessary to determine which fertilizer to apply, how much, when and by what means, depending on local soil conditions.

Currently, seminars in the regions of the country recommend the use of mineral fertilizers in the same amount for everyone when consulting on the norms and timing of agro technical measures for growing cotton. At the same time, soil-agrochemical analyzes carried out at the expense of farmers' associations provide other proposals for the use of mineral fertilizers based on soil indicators. When distributing fertilizers, references are made to general figures and calculations. This, on the one hand, causes the farmer to mistrust the calculations, and on the other hand, it reduces the efficiency of the use of fertilizers. The International Plant Nutrition Institute has done a lot of research in India to thoroughly investigate this issue. As a result of the research, the yield obtained on the basis of the recommendations for soil crops was 25% higher than the norms used by farmers in their work practices (*Figure 2).*

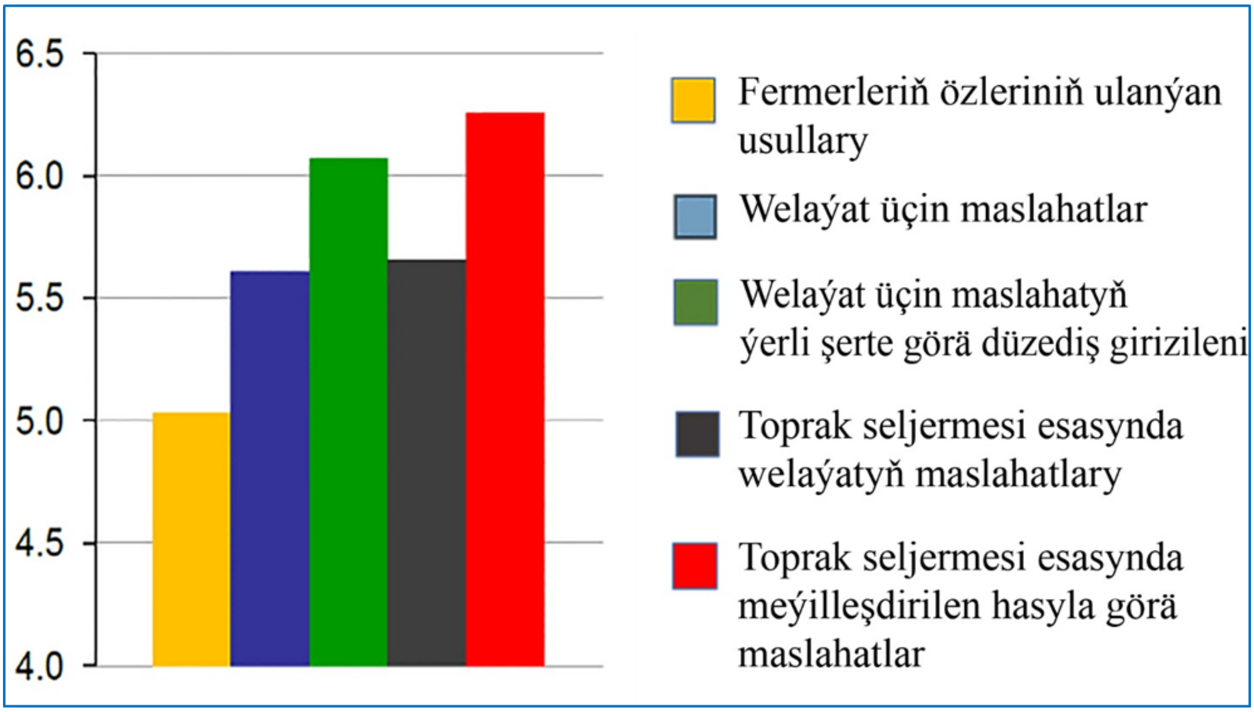


Figure 2. **Yield of winter wheat, t/ha, depending on the consulting system**

The following conditions affect the absorption of nutrients by cotton:

- the amount of nutrients available in the soil and their ratio;
- the amount of moisture in the soil;
- air supply to the soil;
- soil heat;
- acidity or alkalinity of the soil;
- lighting of plants.

Some of these conditions can be adjusted with the help of agro technical measures, but some of them are associated with the introduction of innovative technologies in production [8]. Four principles which were put by the International Institute of Plant Nutrition about **time, place and an amount of fertilizer** should be made in accordance with the local soil and climatic conditions, aimed at regulating the combination of the above conditions. For example, farmers are interested in questions when to use nitrogen fertilizers or ammonium nitrate. To answer it, we summarize the experiments of scientists from the neighboring Republic of Uzbekistan, which are close to our conditions and the United States. The results of studies on irrigated soils in California, USA, close to our climatic conditions, are as follows. This type of nitrogen, in particular, leads to the multiplication of bacteria belonging to the Pseudomonas species. However, in this case, the absorption of nitrogen by plants is normal at an air temperature of 18-25 ^{o}C. If the air temperature is above 30-35 ^{o} C, absorption leads to a decrease in absorption.

Ammonium nitrogen accumulated in bacteria is completely dissolved during soil irrigation, which leads to nitrogen poisoning of plants. Therefore, it is very effective when sowing area or at the initial stage of plant growth, i.e. when 3-5 true leaves are formed at the rate of 150-200 kg / ha. When using carbamate in the last fertilizing, the absorption of ammonium nitrogen (NH_4^{+}) by the plant in the absorbing complex of the soil is exceeded. On the other hand, ammonium nitrate increases the activity of beneficial microorganisms in the soil, since it contains ammonium and nitrate nitrogen. The proliferation of small fungi in the soil not only regulates nitrogen absorption, but also helps maintain the necessary moisture, creating favorable conditions for plant growth. The use of ammonium nitrate is very effective during the growing season when more fertilizer is required for growth. Even with irrigation of the soil, the presence of anions and cations in it has a detrimental effect on the plant. Due to the dry and hot climate of our soil, the use of urea is limited due to the rapid drying out of the soil. On the other hand, ammonium nitrate has a good effect on production [4, 9].

The amount of fertilizers used is determined by the planned yield depending on the fertility of the soil. The spill time is set according to the plant's nutrient requirements suitable for the growing season. Filling methods are made depending on technological capabilities.

Ecological demand for cotton

The most widespread type of cotton in Turkmenistan is considered to be *Gossypiumhirzutum* L. (medium staple cotton) [9]. His homeland is Mexico. Cultural trends of this species are small shrubs with their sympodial and intermediate branches. Crop branches belong to I, II, III subspecies. If the distance between the joints in the branch is up to 5 cm, it belongs to the I subtype, if the joint is 6-10 cm

- to the II subtype, and at 11-15 cm it belongs to the subtype III. It takes about 100-150 days from sowing to ripening.

The root shaft refers to the root system. It reaches a length of 2-2.5 meters. In the upper layer of the earth, the first lateral root is separated to a depth of 8-10 cm. It has active and transient roots. The active roots are located on the lateral roots, they are soft and white. Perimeter roots are covered with a crust. It mainly consists of old cells, the outside of which is brown in color. The main root also refers to the conductive roots. Cotton requires a lot of light, heat, water and nutrients. Its seeds begin to germinate at 10–12 ^{0}C. But it germinates better at 25 ^{0}C. The best temperature for cotton during growth is 25–30 ^{0}C.

The total amount of active heat required for a cotton harvest is 3000 ^{0} C for early-ripening varieties, 3400 ^{0} C for mid-ripening varieties and 4000 ^{0}C for late-ripening varieties.

Scientists have determined that the assimilation of the nutritional elements of cotton is an active physiological phenomenon, which is inextricably linked with such important events as the development of the root system, activity, metabolism, respiration and photosynthesis [6, 10-11]. The normal nutritional view of cotton is shown in Figure 3.

Figure 3. **Regularly feeding of cotton** (according to K.I.Semergey)

Depending on the biological properties of cotton, soil properties depend on the volume of: soil strength, storage of organic matter, mineral component, storage level, moisture content, mechanical composition, heat, air exchange, solution concentration, solubility, reaction, light. For example, the assimilation of potassium, calcium and phosphorus at night decreases by 1.5-2.3 times. This is influenced not only by light, but also by heat, climate change, decreased transpiration, and lack of photosynthesis [10-11].

During cotton development, nutrient intake varies at different levels. During their slow growth, nutrients are poorly absorbed. As cotton flesh formation, growth and yields increase and growth rate accelerates; nutrient intake is further enhanced and increased. It is possible to distinguish between the dangerous and the maximum period of intake of nutrients by cotton.

Dangerous period of intake of nutrients - the lack of nutrients during this period has a very negative effect on its development and future harvest. The most dangerous period of nutrient deficiency is the moment when on the cotton begins to germinate 4–5 true leaves. During this period, it is necessary to provide a sufficient amount of nitrogen and phosphorus fertilizers. If there is a shortage of nitrogen and phosphorus during a dangerous period, the benefits of recently spilled fertilizers are small. This is due to the fact that cotton cannot grow well, and fruitful flesh (bud, flower, and boll) does not develop enough. Therefore, nitrogen and phosphorus in the soil should be enough for a young age of cotton. During this period, potassium deficiency in the soil is also detrimental; therefore it is also important to know that the soil is supplied with this element.

During the high level of the feeding period the amount of food consumed per day and night reaches the (maximum) level. This period mainly coincides with the period of flowering and harvesting of cotton. When it begins to bloom, it absorbs 80–90% of its nutrients *(Table 1).* But the periods of mass flowering and budding of cotton are considered the time when the crop needs the most nutrients. During this time, cotton gets stronger and grows rapidly, and the plant accumulates a lot of organic matter.

After germination of cotton with a lack of **nitrogen,** there are few productive branches, and growth branches are large. This is also one of the main reasons for the decrease in yields in the absence of nitrogen during the dangerous period. Potassium is the most necessary period for the formation and maturation of cotton beans, which increases the need for plants.

Table 1

Accumulation of dry matter and nutrients during cotton development (in % amount)

Periods of development	Dry matter	Nitrogen(N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Budding phase	2	3-5	3-5	2-3
Flowering phase	12	25-30	15-20	15-20
Full ripening period	30	50	36	55
Ripening period	100	100	100	100

In connection with the frequency of feeding cotton, it is necessary to distinguish between the main sowing and fertilization during the growing season after sowing. With late application of nitrogen fertilizers, especially in large doses, the formation of yield samples slows down, the growth of the stem and monopodial (straight) branches increases. The flowering of cotton, the formation and maturation of cocoons occurs in the second half of development. With late sowing of cotton, most of the cotton crop is harvested after the cold. As a result, the quantity and quality of the crop are reduced.

Harmful to cotton, if it is not enough fertilized with nitrogen fertilizer. With its lack, the development of the plant is slow. The twigs and stems of cotton are thin, and the leaves are small and thin. The leaves turn yellow. This sign indicates a decrease in the formation of chlorophyll in the leaves *(Fig. 4)*.

As noted, **phosphate** fertilizers are less active. Therefore, most of them are poured out before sowing, and also poured 20–40 kg / ha at sowing. According to research, phosphorus has a strong effect on soil activity and plant nutrition, which increases the growth of the cotton root system.

Where nitrogen fertilizers delay the flowering and ripening of cotton when used improperly, phosphorus fertilizers accelerate them. Phosphorus deficiency is most often severe in young plants *(Fig. 5)*.Plant growth slows down. The leaves are small, and the budding and flowering phases are delayed. Phosphate fertilizers play an important role in the formation and improvement of the yielding flesh of cotton. Therefore, numerous scientific experiments show that it is very important to apply 30–40 kg of phosphorus per hectare when cotton begins to bloom.

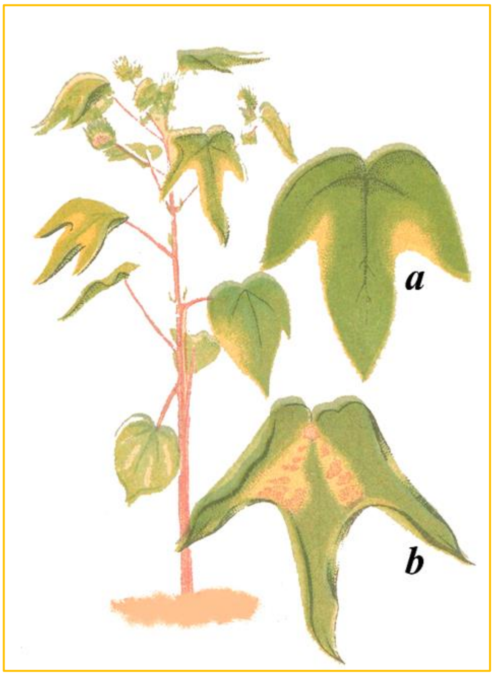


Figure 4. **Cotton with nitrogen deficiency: a-leaf of cotton, lack of nitrogen fertilizer in small quantities b-leaf cotton, lack of nitrogen in large quantities**

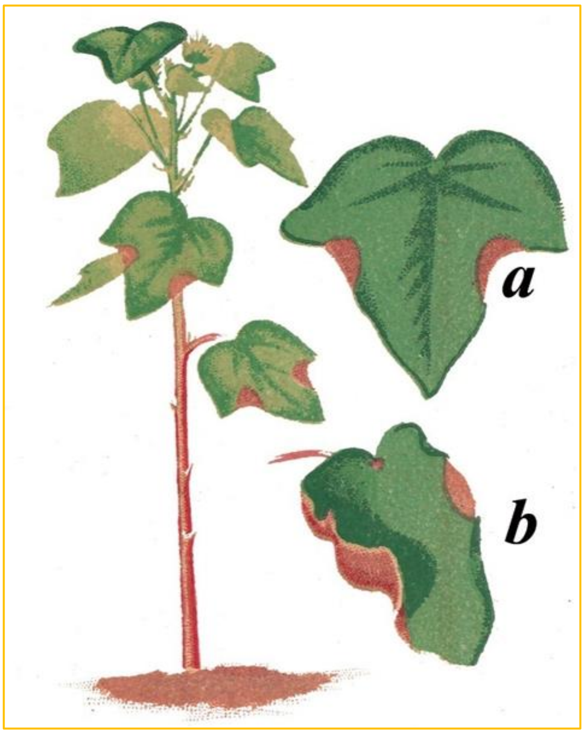


Figure 5. **Cotton with a phosphorus deficiency supplied with nitrogen nutrition: a cotton leaf with a phosphorus deficiency in a small amount, b- cotton leaf, with a deficit of a large amount of food**

Timely supply of a sufficient amount of mineral fertilizers during the development period ensures a strong growth of cotton, the formation of productive flesh is sufficient and high yields.

In the absence of potassium, the color of the edges of the leaves and the ends of the cotton first turns yellow, on which blue spots are formed. The tips of the aging leaves of the plant turn yellow, and then the edges and roots of the plant turn yellow *(Fig. 6).* The leaves are wrinkled. These symptoms are more pronounced with potassium deficiency during the period of strong cotton growth.

Although potassium is sufficient in clay and loamy soils, there is a need to use potash fertilizers on light soils in areas with a mechanical structure where cotton is grown in large quantities.

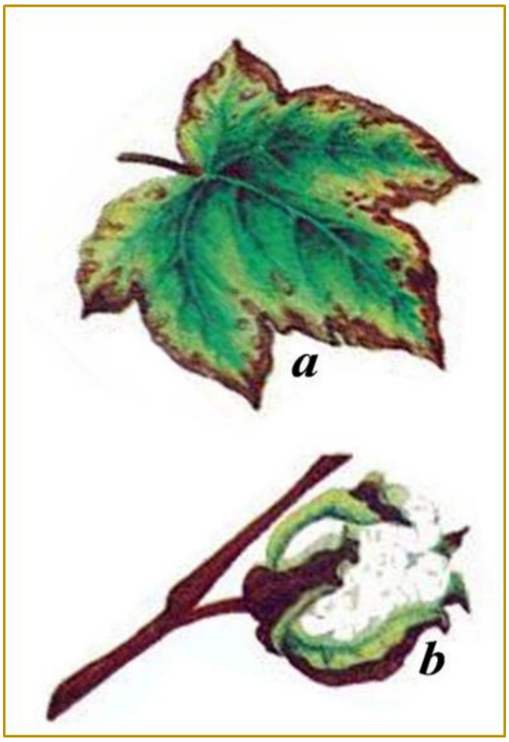


*Figure 6.***External symptoms of potassium deficiency in cotton: a-In a list, b-in a box Accounting for soil salinity and alkalinity**

According to the laws of agriculture, the decrease in yield is caused by the minimum number of conditions that makes it up. For example, the more mineral fertilizers or nutrients in the soil, the lack of water (moisture) crop plants and the lack of water (moisture) and production support, at least in accordance with the conditions for the formation of the crop. This is called the smallest crop limiting condition. The content of this law is clearly shown in Figure 7.

As you can see from the picture, the amount of water in the bucket indicates the yield. The vertical planks that make up the bucket of water create conditions for growing crops.

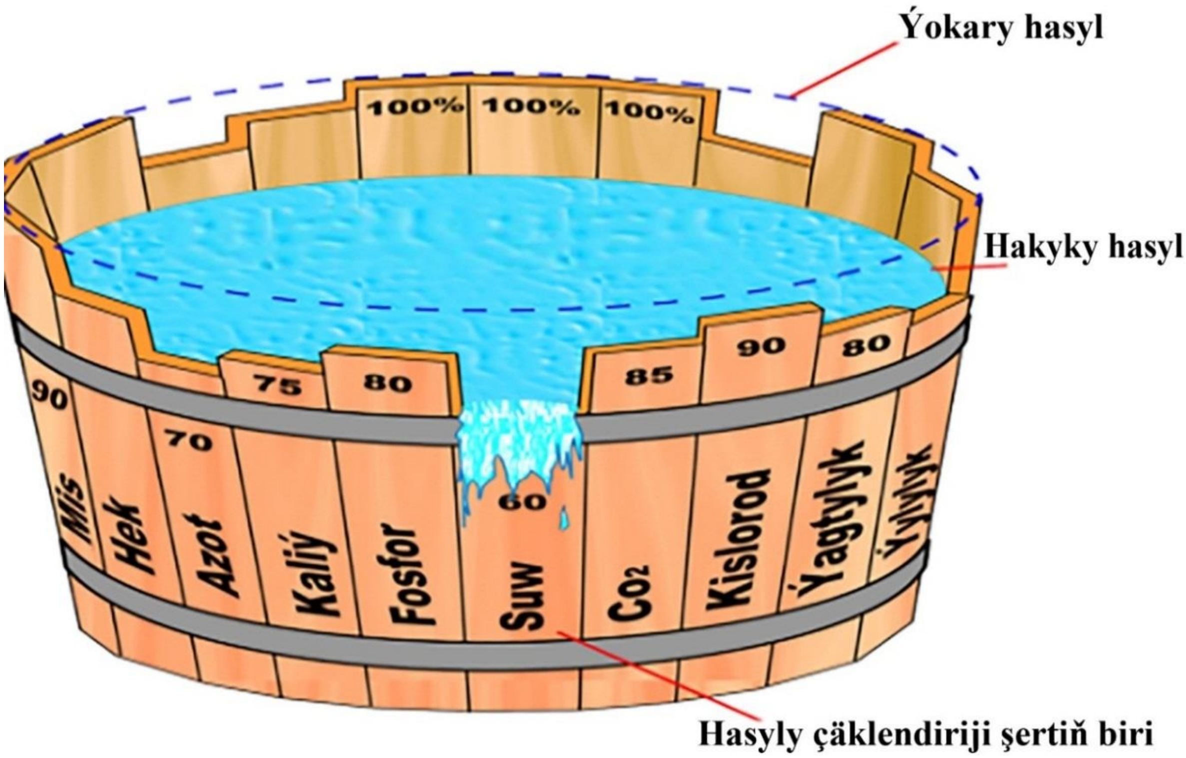


Figure 7. **Law of low yield**

In changing climates, in arid regions, conditions that limit crop yield often remain salinization or water supply. This is due to the fact that other conditions can be adjusted to a certain extent with the help of agro technical measures. To determine the planned yield, it is very important to clarify the conditions limiting the yield, since the calculation of the rate of mineral fertilizers is carried out according to the planned yield.

The accumulation of salts harmful to agricultural crops in the soil is called salinization. Salinity refers to conditions that limit yield. In saline soils it is difficult to assimilate nutrients and absorb water through the roots. Both of these methods are available to the farmer and do not require complex laboratory analyzes. A farmer who is really interested in this matter can learn it very quickly.

This is done in a simple and inexpensive way using these methods. There are a lot of species. As an example, below we describe the device in Figure8.

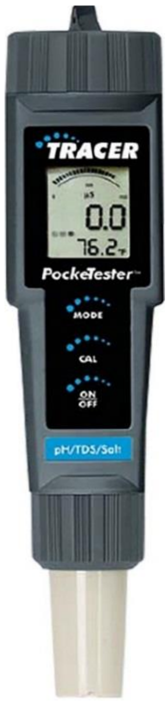
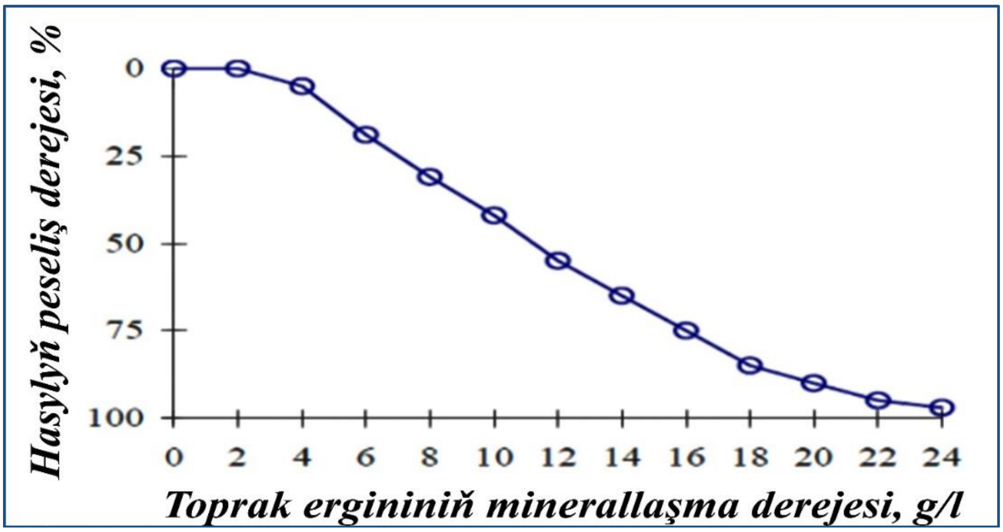


Figure8. **Equipment for determining soil salinity,electrical conductivity and alkalinity**

This instrument can be used to determine soil salinity (mg / l), electrical conductivity (m C) and alkalinity in the field. The first work is carried out to determine the salinity of the soil solution. During irrigation, some of the water seeps in and is absorbed by the lower layers of the soil, while the rest remains in the soil as moisture. And this water, accumulated in the soil, interacts with soil particles, forming a solution. It is compressed (compressed) to the level of soil moisture and measured by equipment.

Depending on the salinity of the soil solution of cotton as a result of many years of research carried out by scientists in Central Asia (Ryzhov, Kovda, Radachev, Minashina, Stroganov, Morozov, Usmanov, etc.), it is shown in Fig.1 [7, 9, 10, and 12].



1 graph. **The dependence of cotton yield to the soil salinity**
(Comparative decrease in cotton yield at different concentrations of soil solution)

As you can see from this figure, the soil solution does not lose cotton yield when it is about 2-4 g/l. However, when this figure is 22-24 g/l, cotton does not produce a crop. When the salinity of the soil solution is 10-12 g/l, half of the cotton crop is lost. Local air is determined based on the highest cotton yields that can be obtained, depending on soil conditions and varieties (Table *2)*.

Table 2

Characteristics of cotton varieties grown in the Dashoguz region

Indicators	Measure	Cotton varieties			
		Dashoguz-120	149-F	S-4727	serdar
The height of the cotton	cm	120	110	110	100
The ripening period	day	110	115	115	122
Cotton harvest	S/ha	46,5	39,9	45,2	42,8
Weight of cotton in a box	h	6,8	6,5	6,0	6,2
Fiber output	%	37,7	35,6	35,0	37,0
Harvest	s/ha	17,5	14,2	15,8	16,9
Length	mm	36	35	33	35
Strength	g	4,6	4,3	4,5	4,8
Fineness	m	5905	5393	5600	6000
Break length	km	27,2	23,0	25,8	28,8
Type	one	V	V	V	V
1000 The weight of the seed	h	113	120	125	122
Degree of disease	%	12,0	26,8	21,0	1,0

A second method for determining the expected yield in relation to soil salinity has been proposed by the Food and Agriculture Organization of the United Nations (FAO) [13]. This method determines the yield loss by the electrical conductivity of a specially prepared soil solution. Soil samples obtained from three areas of the active layer of roots are first dried, then crushed and sieved. Remove 50 g of a sieved soil sample, mix with 250 mm of distilled water in a ratio of 1: 5 and shake for 5 minutes. Then all salts dissolve that dissolve in water. Then, after the soil particles have crumbled a little, the suspended solution must be filtered in order to measure its electrical conductivity. In Figure 9, the procedure is clearly visible.

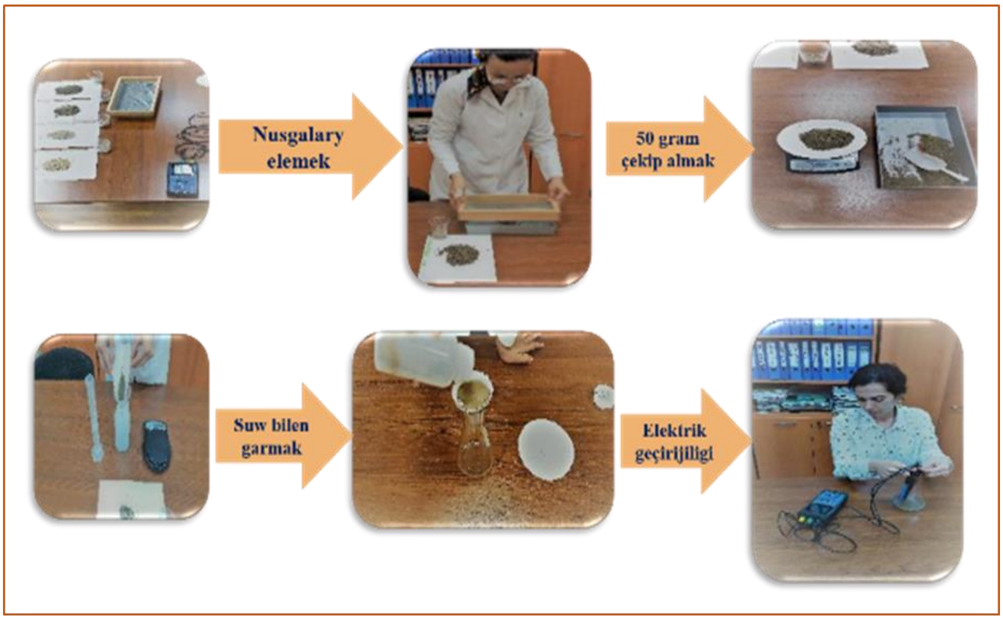


Figure 9. **Sequence for determining soil salinity**

Depending on the electrical conductivity of the soil solution, the decrease in cotton yield can be determined using *Table 3* .

Table 3

Decrease in cotton yield by electrical conductivity of soil solution,%

	Parts of the electrical conductivity of the soil solution									
mS	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2	100%	98%	96%	94%	92%	90%	88%	86%	84%	82%
3	80%	78%	76%	74%	72%	70%	68%	66%	64%	62%
4	60%	58%	56%	54%	52%	50%	48%	46%	44%	42%
5	40%	38%	36%	34%	32%	30%	28%	26%	24%	22%
6	20%	18%	16%	14%	12%	10%	8%	6%	4%	2%

As a result of research activities carried out within the framework of the project, it was found that the two methods give indicators that are close to each other. In addition, the same device can measure soil salinity and electrical conductivity. The farmers themselves can verify this.

Let's look at an example of how to determine the planned yield in brine so that farmers understand this. For example, a farmer determined the salinity of the soil solution and the average value of the electrical conductivity at several points before sowing at the cotton planting site. These indicators were 8 g / l and 3.4 mC, respectively. Then we will see that when using the 1st line, the cotton yield in saline areas will decrease by 28%. At the same time, we will find that the yield on the electrical conductivity of the soil solution *(Table 3)* will be reduced by 28%. This means that our planned harvest of - of the salinity of the soil of the earth, in comparison with non-saline soil is reduced by 28% If it is put cotton farm in Dashoguz -120 *(Table 2),* saline soil of 33.5 c / ha crop can mature (46.5 centners / ha x 0.72). When calculating the rates of fertilizers, the planned yield should be considered 33.5 c / ha. In recent years, due to climate change, weakly alkaline and alkaline soils began to appear [3]. Such lands are widespread in the Dashoguz region. Changes in soil response affect the ability of plants to assimilate nutrients [7]. Some nutrients are harder to absorb and some are easier to absorb. This situation must be taken into account when adopting a fertilizer rate.

The dependence of nutrient absorption on the pH of the soil solution (pH) is shown in Figure 10.

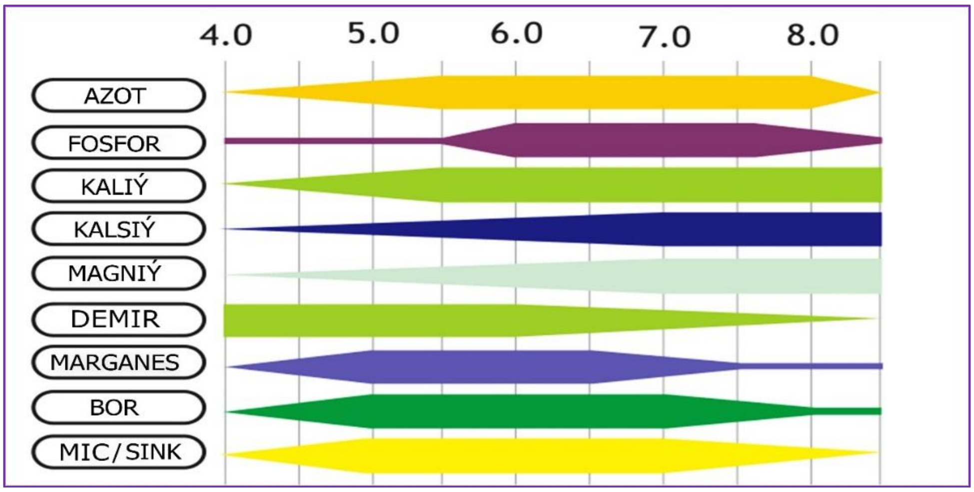


Figure 10. **PH effect of soil solution**

As can be seen from the figure, with an increase in soil alkalinity by 7.0 degrees, the assimilation of phosphorus, iron, manganese, boron, copper and zinc begins to become difficult.

When the pH of the cotton soil solution is between 7 and 8, it grows normally and gives good yields. If the pH value is higher, it is recommended to take agro-reclamation measures to reduce it.

Depending on the level of alkalinity of the soil, the absorption of nutrients by plants in the soil is not the same. As shown in Figure 10, elements such as potassium, calcium and magnesium in alkaline soils are easily absorbed by plants, but the intake of elements such as phosphorus, nitrogen, iron, manganese, boron, copper and zinc is degraded.

It is revealed by the influence of various compounds on the composition of the alkaline earth (soil and water) composition. These include: carbonates, alkaline hydrocarbons, silicates, aluminates, sodium and others. An alkaline environment can also occur when weak acid salts formed from strong bases migrate from the solid to the soil solution to form basic properties.

When the soil interacts with carbon dioxide, an exchange reaction occurs with the sodium carbonate absorbed in it, soda is formed and the soil solution is purified:

$$[TST^{2-}]2Na^{+}+H_2CO_3=[TST^{2-}]2H^{+}+Na_2CO_3$$

The strong alkaline effect is very harmful to plants and has a detrimental effect on the physical and chemical properties of the soil.

As the alkalinity of the soil increases (pH above 7.5), the topsoil hardens and conducts water very slowly, which has side effects such as loss of structure when it dries. To remove the alkalinity of the soil, it is necessary to replace the substituted Na^{+} with calcium and neutralize the free soda. As a result, sodium sulfur (sodium sulfate) must be washed out and removed from the soil by flushing. Studies carried out in agricultural fields with elevated and alkaline- sandy groundwater with a texture have established that soil fertility decreases and cotton yield improves as a result of improved soil reclamation. Such an agrochemical study was carried out in a field experiment in various saline soils with a predominance of sodium cation in cotton fields of the S.A. Rozmetov Joint stock breeding of the district named after S.A. Niyazov of the Dashoguz region. The use of a chemical ameliorant has resulted in a significant reduction in the amount of water-soluble salts present in the soil. That is, the amount of substituted sodium was reduced by 8-10%, the amount of salt by 50-60%, the physical and chemical properties of the soil were improved to some extent, and its biological properties were shown to be active. Thus, fertilizer ameliorant showed its high agrochemical efficiency in saline soils. The amount of ameliorants to be given depends on the alkalinity and salinity of the soil.

The use of an ameliorant for the cultivation of soils, wheat, cotton, beets and other crops, to a certain extent saline, in need of land reclamation, and sandy areas with a high level of groundwater in the USA, Australia, India, the Republic of Kazakhstan, the Republic of Kyrgyzstan are widely used in foreign countries the world. The increased alkalinity in the soil has a direct effect on the physiological properties of the culture, that is, it slows down the growth of roots and the ability to freely penetrate into deeper layers of the soil, reduces the supply of nutrients by the roots and seriously disrupts metabolism. With a partial effect, soil fertility decreases, and the lack of calcium and magnesium dissolved in it leads to a significant deterioration in the agrophysical and physicochemical properties of the soil. The main reason for the change in the soil environment is the decrease as a result of the release of calcium and magnesium along with the harvest and their large washout.

$$[TST^{2-}]2Na^{+} + CaSO_4 = [TST^{2-}]Ca + Na_2SO_4$$
$$Na_2CO_3 + CaSO_4 = CaCO_3 + Na_2SO_4$$
$$Na_2CO_3 + H_2SO_4 = Na_2SO_4 + H_2O + CO_2$$

Sulfuric calcium is formed by pouring gypsum (sulfuric acid, ferrous sulfate, pyrite, or sulfur pyrite) into the ash zones. It reacts with the Na^{+} absorbed in the soil, causing harmful salting of soda, while the soda is acidified with sulfuric acid and removed by wastewater.

To regulate the alkaline environment of the soil, it is useful to add gypsum (which is stored as a gypsum reclamation agent) with fertilizers and mineral fertilizers to it.

If there are no obstacles to the beneficial effects of mineral fertilizers on the soil (salinity, alkalinity), they will not be able to reliably increase the yield of any crop.

Registration of nutrients of the soil

The retention of nutrients and their suitable form in the soil, the rate at which nutrients that plants cannot assimilate into a suitable form and the reversal of these conversions are considered key determinants of crop nutrition and fertilization requirements.

If the amount of nutrients in the soil of plants is higher, their need for fertilizers less and, if it is less, increases. Different soil types do not have the same nutrient reserves and suitable forms. Therefore, the need for fertilizers in different soils is not the same.

Fertilizers poured into the soil undergo various changes. As a result, their properties, solubility and suitability for agricultural crops change. These changes depend on the nature of the soil and occur at different levels. The fertilizers themselves affect the character of the soil. They enrich the soil with nutrients. They affect the alkalinity and acidity of the soil and increase the activity of small bodies. For a more efficient use of fertilizers, it is even more important to study the physical, chemical and biological phenomena that occur when they are introduced into the soil in various soil and climatic conditions.

Soil is a multi-system, consisting of three types of composition: soil-air, solution and solid [7]. Although they are very close to each other, they do not retain the same degree of degradation and nutrients. The nitrogen retention in the soil depends on the amount of humus. Phosphorus also retains well in organic-rich soils. Potassium reserves depend on the soil and the mineral composition of the soil. The amount of nutrients in the soil is tens, hundreds of times higher than the consumption of agricultural crops. But plants are not able to absorb even a small part of them. This is due to the fact that the main part of nitrogen (99%) consists of organic substances, phosphorus minerals and organic substances, as well as potassium minerals, and for plants they are hardly soluble or insoluble compounds.

They determine effective soil fertility by the level of storage of **active nutrients** that are suitable for plants in the soil and can provide high yields. Plants are able to absorb nutrients that are dissolved and assimilated from the soil in water and weak acids. The start of the transformation of nutrients in the soil into an assailable form is provided as a result of biological, chemical and physicochemical effects.

The reserves of nutrients in the soil depend on its mechanical composition, agro technical measures, the type of crops grown [12]. Nitrogen in soil is mainly stored in the soil (98-99%).It not only serves as a source of nitrogen for root crops, but also its important properties, such as soil absorption capacity, water permeability and moisture capacity, depend on its amount. The root is also important for speeding plant growth. Preservation of humus in the soil consists in its oxidation with a solution of double chromic acid in potassium sulfuric acid and tracing the remaining chromium anhydride using Mohr's salt. The more humus in the soil, the more chromium anhydride is consumed. Therefore, this method involves determining the amount of humus in the soil based on the amount of consumed chromium dioxide.

Transition of titration to (reaction) oxidation:

$$2K_2Cr_2O_7+8H_2SO_4=2K_2SO_4+2Cr_2(SO_4)_3+8H_2O+3O_2$$

$$3C=3O_2=3CO$$

As a result of titration of the residual chromic acid with Mohr's salt, the following (reaction) occurs:

$$6FeSO_4+(NH_4)_2SO_4+K_2Cr_2O_7+7H_2SO_4=Cr(SO_4)_3+Fe_2(SO_4)_3+6(NH_4)SO_4+K_2SO_4+7H_2O$$

In order to calculate the amount of nitrate nitrogen, one of the soil samples is taken and dissolved in water or 0.05% potassium sulfate, a soil solution is obtained. From this solution, it needs to take 50 mm of the solution, is poured it into a phosphoric bowl and it is kept in a water bath. The amount of nitrogen in the solid residue is determined on the basis of mg / kg. Usually its amount is 1-2% of the total nitrogen. When the amount of nitric nitrate is high, the color of the soil turns yellow.

The solution must be prepared to determine the amount of phosphorus in the soil, where various disputes arise. The main source of phosphorus in the soil is the salts of phosphoric acid ($-H_2PO_4$,$-HPO_4$,$-PO_4$).In addition, scientists have established the presence of monophosphates and polyphosphates in the soil. Those compounds that are insoluble in water are not absorbed by plants. The sun's rays in our country convert polyphosphates into a simple water-soluble form. This is because farmers continue to use streams of mud and old clay fences as fertilizers, which not only absorb nitrogen but also contain large amounts of phosphorus available for cultivation. Therefore, it would be advisable to take into account the total amount of phosphorus that can be contained in the soil and can be converted into solution. This indicator increases if the solution is prepared with the addition of a weak acid. Therefore, it is considered more accurate if both methods are used in the phosphorus problem to obtain their average performance. Cotton can also contain a certain amount of phosphorus, which dissolves in the soil due to organic acid that is released through the root canal.

The amount of exchangeable potassium should be determined on a flammable photometer by the method of B.P. Machigin in an aqueous solution obtained from the soil. In our conditions, the amount of potassium in clay soils is often sufficient, while in light sandy soils it is small. But even in clay soils that have been cultivated for many years, the amount of assimilated potassium begins to decrease. As the yield increases, the potassium supply to the soil also increases (if fertilizers are not used).

Cotton plant accepts mineral fertilizers in a certain ratio. Currently, the ratio of nitrogen, phosphorus and potassium is taken equal to 1;0.7;0.3, that is, the amount of mineral phosphorus and potassium should be, respectively. 70 and 30 kg / ha of nitrogen which is given to the soil at 100 kg / ha. As a rule, the required amount of phosphorus and potassium must be determined in accordance with the nitrogen requirements of the crop. If you have a soil agrochemical map, you can rate the nutrient supply for your soil based on the following table *(Table 4).*

Table 4

Providing the soil with assimilated nutrients

Providing soil with nutrients	**The amount of nutrients, mg / kg**		
	N	**P_2O_5**	**K_2O**
Very weak	0-15	0-5	<150
weakly	16-30	16-30	150-250
Average	31-45	31-45	250-400
High	46-60	46-60	400
Above	>60	>60	

The ratio of phosphorus and potassium to nitrogen should be determined using Table 5.

Table 5

The ratio of phosphorus and potash fertilizers to the level of soil supply depends on the amount of nitrogen fertilizers applied.

(on influential nutrients)

The amount of phosphorus in the soil,mg / kg	Nitrogen to phosphorus ratio	The amount of potassium in the soil,mg / kg	nitrogen to potassium ratio
Up to 15	eleven	Up to 150	1:0.8
16-30	1:0.8	150 - 250	1:0.6
31-45	1:0.4	250-400	1:0.4
46 - 60	1:0.3	> 400	1:0.25
> 60	1:0.1		

After determining the specific indicators of this relationship based on the agrochemical cartogram of the soil to be fertilized, it is possible to determine the application rates of these fertilizers for the planned yield using the data from Table 6.

Table 6

The amount of use of mineral fertilizers in cotton, kg / ha

Cottonyield, kg/ha	In fine staple cotton			In medium staple cotton		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
15-20	125-160	90-110	-	100-130	70-90	-
20-25	160-200	110-135	40-50	130-160	90-110	35-40
25-30	200-240	135-160	50-60	160-190	110-135	40-50
30–35	240-275	160-180	60-70	190-220	135-155	50-60
35-40	275-310	180-200	70-80	220-250	155-175	60-70
40–45	310-350	200-230	80-100	250-265	175-185	70-80

The application system of mineral fertilizers in cotton growing

A complex of agronomic and organizational measures aimed at increasing cotton yields, soil fertility, labor productivity and effective use of fertilizers is called a fertilizer use system. The second part consists of such organizational measures as preparation, storage and transportation of fertilizers, as well as an assessment of the effectiveness of their use.

According to scientific data, for the production of 1 centner of a cotton crop, an average of 6 kg of nitrogen is required for medium-fiber, 2 kg of phosphorus and 5 kg of potassium. Fine staple cotton requires 20-25% more fertilizer than medium staple cotton. Some of these fertilizers get into the soil due to the previously applied fertilizers. The rest, which is not enough for the planned harvest, needs to be applied to the soil in the form of mineral fertilizers.

Soil nutrients are not the same everywhere. Therefore, it is clear that the amount of fertilizer applied to the soil may not be the same everywhere.

In order for mineral fertilizers additionally applied to the soil to be effective, they must be calculated on a scientific basis. And too much or too little fertilization is equally harmful for the farmer.

To get a high yield of cotton, it is necessary to use local fertilizers along with mineral fertilizers. This is due to the fact that cotton is a crop that requires mineral fertilizers, so it is impossible to get a high yield without additional nutrition. Therefore, mineral fertilizers are the key to high yields. Fertilizers also have a certain value, that is, their cost requires calculation in their effective required amount. To do this, you need to know the following:

The amount of nitrogen, phosphorus and potassium in the soil. The amount of nutrients in the soil is determined in special agrochemical laboratories. For example, some of the results from a project to familiarize one of the laboratory data are shown in Table 7.

Table 7

Information on the preservation of humus, exchangeable potassium, active phosphorus on agricultural lands of agricultural fields in Lebap region.

(Based on data from the Council of United Nations Development Program in Turkmenistan, 2018)

Sign of Contours	**Area, ha**	**The amount of active phosphorus in the soil (P_2O_5)**		**The amount of potassium in the soil (K_2O)**		**The amount ofhumus in the soil**		**The mechanical composition of the soil**
		mg/kg	***level***	***mg/kg***	***level***	***%***	***level***	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	2.0	7	below	62	below	0.76	below	Average

Continue of table 7

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
2	2.24	10	below	128	below	0.52	below	Average
3	1.75	13	below	380	Average	0.78	below	Average
4	24.0	5	below	107	below	0.52	below	easy
		15	below	100	below	0.45	below	
		nine	below	157	dog	0.52	below	
		7	below	100	below	0.40	below	
		5	below	215	dog	0.65	below	
		5	below	87	below	0.40	below	
		6	below	74	below	0.52	below	
		5	below	87	below	0.76	below	
Average arithmetic		***7***	***below***	***116***	***below***	***0.55***	**below**	

However, in the absence of access to the services of such laboratories or when the land user has a particular interest in the work, farmers themselves can determine these indicators using mobile (portable) equipment. There are many types of such devices. The equipment shown in Figure 11 was used during the project.

*Figure 11.***A handy (mobile) device that determines the amount of nutrients in the soil**

A soil sample, dried and sieved, is mixed with chemical reagents and a soil solution is obtained. It contains the amount of a particular element. These results can be accurately calculated using the device shown in Figure 11, and the result can be obtained in units of mg / kg or kg / ha.

Consumption of nutrients for the cotton crop. Distinguish between biological and economic forms of nutrient intake. Biological consumption is a designation for the formation of a certain amount of nutrients consumed by the root system, branches, stems, leaves and all yielding parts (1c, 1t).

Use of plant nutrients through the soil. The degree of utilization of nutrients in the arable layer of crops, calculated in% or kg, indicates the amount of nutrients that are absorbed from this layer. The amount of nitrogen, active phosphorus and exchangeable potassium cotton absorbed by the soil is 3.5-4.5, respectively, in terms of nitrogen, phosphorus and potassium; 20 and 15%. The amount of absorption by nutrition of cotton from the soil in kg / ha is determined by the following equation (formula):

$$K = (a \times b):100$$

Here:

K - plant capable of absorbing nutrients from the soil, amount, kg/ha;

a - in the arable layer on an area of 1 hectare of unfertilized land the total amount of active (assimilated) nutrient, kg;

b - from which the plant can be accurately assimilated, kg / ha.

It is necessary to find out how many kg / ha of nutrients is present in the arable layer of the field (0-30), and also to increase the amount of mg by 4 times in accordance with its agrochemical cartogram. For example, if 10 mg / kg phosphorus - P_2O_5 is in the arable layer, then it is equal to 10 x 4 = 40 kg / ha P_2O_5 The amount of nitrogen, on the other hand, is calculated based on the storage stock per hectare, depending from humus storage. For example, if the amount of precipitation in the soil is 0.70%, then we multiply this number by 40, and we find the amount of stocks of tons of sediment stored in the silt layer per hectare, which is 0.70 x 40 - 28 tons. nitrogen is counted as 5% (28000 x 5): 100 = 1400 kg. It is in the range of 3.5-4.5% 1 that the plant can use or assimilate. In our example, this is: (1400 x 4): 100 = 56 kg / ha. The amount of kg / ha of this cotton can absorb from the soil from phosphorus and potassium is calculated according to the above equation K = (a x B): 100.

On irrigated soils, the content of active phosphorus and potassium in cotton averages 20% and 15% are respectively.

The utilization of nutrients in soil depends on soil type, texture, weather conditions, and level of agricultural measures and biological characteristics of crops. The more nutrients are stored in the soil, the utilization rate is so higher.

The assimilation of cotton nutrients with local and mineral fertilizers The percentage of nutrients consumed by crops to obtain additional yield from fertilizers applied to the soil is called their fertilization level.

The utilization of nutrients from fertilizers is determined as follows, based on the difference in the amount of fertilized and unfertilized crops:

$$K=((X_d-X_o)x100:Y$$

Here:

K - the level of assimilation of nutrients from fertilizer%;

X_o - the amount of nutrients assimilated by the plant without fertilizers, kg / ha;

X_d is the amount of fertilizers for the crop, kg / ha;

Y is the amount of fertilizers fed with nutrients, kg / ha.

The utilization of nutrients from fertilizers can be more accurately determined using the atomic (or isotope) method. But this requires higher technological equipment. Here, regardless of whether the physical and mechanical properties of the soil are favorable or unfavorable for plant growth, soil moisture has a definite effect. When these places are auspicious, when the plants are fed, their parts of growth and yields are greatly increased. Consequently, they are able to absorb nutrients from the soil more than on the soil without fertilization, thanks to a strong and powerfully developed root system. As an example, let's calculate the amount of mineral fertilizers required to harvest 30 c / l of cotton fiber. For this we use the following table 8.

Table 8

Accounting of mineral fertilizers required for the planned harvest

No.	**Indicators**	**unit of measurement**	**N**	**P_2O_5**	**K_2O**
1	The amount of nutrients required to obtain a centner of a cotton crop	kg	6	1.6	5
2	Necessary nutrients for the planned yield of 30 cent / ha	kg	180	48	150
3	The amount of nutrients present in the soil	mg / kg	0.98 %	eighteen	200
4	The amount of nutrients in the soil layer is 0-30 cm.	kg / ha	1960 g.	72	800
5	Soil Nutrient Utilization Ratio in Cotton	%	4	twenty	15
6	Cotton nutrients from soil	kg / ha	78	14.4	120
7	Cotton Giving Nutrients	kg / ha	102	33.6	thirty
8	Fertilizer nutrient absorption rate	%	50	22	50
9	The amount of fertilizers used in the diet	kg / ha	204	153	60

Note:

1. to calculate the absorption of nitrogen humus directly, its sum must be multiplied by 80 coefficient.
2. To determine the rate of fertilizers used according to Table 8. For calculation in fine-staple cotton, multiply the coefficient by 1.2.

First of all, you need to know the amount of nutrients consumed per 1 quintal of cotton crop. This is according to the element on the first line; 6, 1.6, 5. Then you must know the amount that will be needed to determine 30 s / ha: 30 x 6 = 180, 30 x1.6 = 48, 30 x 5 = 150. The numbers shown in the second row are the number of products for the cultivation of such cotton, the required volumes are calculated. The amount of rot in the soil (for calculating nitrogen) is 0.98%, that of phosphorus is 18 mg / kg, and that of potassium is 220 mg / kg The amount was calculated as 39200 x. (5: 100) = 1960 kg, 18 x 4 = 72 kg of phosphorus and 200 x 4 = 800 kg / kg of potassium. The ability to absorb these elements, respectively,%: 4; in the numbers 20 and 15 in the fifth line and in the sixth line are expressed in kg / ha: 1960 x (4: 100) = 78 kg / ha, 72 x (20: 100) = 14.4 kg, 800 x (15: 100) = 120 kg. Then, the amount of nutrients obtained from the soil, shown in the seventh line, from the amount of cotton required for cultivation of 30 s / ha shown in the second line is subtracted from the required sum : it should be calculated as 180 - 78 = 102 kg, 48 - 14.4 = 39 , 6 kg, 150 - 120 = 30 kg. These numbers mean that 100% of the nutrients must be fed into the soil with cotton fertilizers. When we take cotton from the mineral nutrients from cotton in the amount of 55% nitrogen, 22% phosphorus, 50% potassium: N = 30x (100: 50) = 204 kg, P_2O_5 = 33.6 x (100: 22) = 153 kg, K_2O = 62 x (100: 50) = 60 kg indicates the amount of nutrients should be served with fertilizers. These numbers will be converted to physical weights based on the nutrient content of the fertilizer. For this, the nutrients to be transferred to the physical weight must be placed in front of the affected food in the fertilizer, placing zero lice in it. For example, when 60 kg of nitrogen are transferred to 46% urea, it is equal to the physical weight of this fertilizer at 60:0.46 = 1 kg / ha.

The main fertilizers. Agricultural crops, including cotton, are fertilized with mineral fertilizers before sowing in autumn and early spring, when sowing in spring, in late spring and summer during the growing season as top dressing. The fertilizer given before sowing is called the main fertilizer. Part of the annual fertilizer rate ⅔ - is poured into the bottom of autumn plowing to a depth of 15–16 cm. a chisel cultivator before sowing, providing fertilizer with the remaining nutrients throughout the growing season. Fertilizing deeper soil layers is considered important for cotton. Because its root is a highly developed root and located below.

It is desirable to suggest the use of local fertilizers, including manure, as the main fertilizer. If the manure is not completely rotten, that is, it should be poured in half-life a few months before plowing. According to the experience of the research institutes of Turkmenistan, every 3-4 years at the expense of 1 ha, 30-40 tons of manure are poured, which melts good results.

It is also important to use siderites - green fertilizers as the main fertilizer. Green manures are mainly of the legume family and are often planted as catch crops with lupine, alfalfa, peanuts, and vetch and hardy crops during the fall-winter-spring months and grown until they bloom. Then they are plowed and mixed with the soil. Then they are rubbed with a rotating foot rake, crushed and mixed with the soil. According to field experiments, the weight of green manure reaches 30–40 t / ha and also accumulates 100–150 kg of nitrogen. This is equivalent to feeding 30 tons of manure per hectare. In places planted with green manure, the amount of nitrogen use can be reduced by 15-20%.

The use of basic fertilizers also differs where alfalfa is planted. Alfalfa, grown at a high level of agriculture, leaves 10-15 tons of leaves, twigs, twigs and roots in 3 years at the rate of 3 hectares per hectare. It contains 200-300 kg of valuable biological nitrogen. The water-soil conditions of the lands sown with alfalfa are improving the ameliorative state. The soil is enriched with organic matter. Not only the agrophysical and agrochemical properties of the soil are improved, but the soil is also cleared of small pests and weeds that cause pests. It is considered a high-grade healthy livestock feed.

Considering the above, local fertilizers are introduced into the crop rotation in wheat-alfalfa-cotton in 4–5 years after highly productive alfalfa.

If, for some reason, rinse water does not reach cotton plantations, it is recommended to add half of the rotten manure for autumn plowing at the rate of 30–40 t / ha. If the cotton fields are saline, then in the fall it is washed off with water. Local fertilizers are applied for spring plowing. The application of alkaline cotton fertilizers to alfalfa differs sharply, i.e., the rate of nitrogen fertilizers decreases and the amount of phosphorus fertilizers increases.

In addition to local fertilizers, phosphate fertilizers are used as the main fertilizer. Before the autumn plowing of cotton fields, it is recommended to add 65–70% of the annual amount of phosphorus fertilizers. When growing cotton, it is very effective to apply phosphorus fertilizers to a depth of at least 25–35 cm. This is because they move less in the places where they were given and the main part remains in this layer.

However, phosphate fertilizers from light soils and saline drainage basins can also wash out to a certain extent, transferring to the lower layers, even into groundwater, and can cause losses. For these areas, it is better to apply phosphorus fertilizers with a tool (mechanism) ChKU-4 in the pre-spring or pre-sowing treatment, and not in the fall.

50% of arable land is provided with potassium compounds suitable for plants. However, if large-scale crops, including cotton, are regularly planted in a certain area, potassium reserves in the soil are significantly reduced. Therefore, in these areas it is necessary to water potash fertilizers. If the potassium norm does not exceed 50-60 kg / ha, it should be watered for the autumn herd in areas with clay soils, where sewage does not pass.

Nitrogen fertilizers are also used as the main fertilizer. In our irrigated agriculture, it is not recommended to apply nitrogen fertilizers in the fall, because nitrogen fertilizers are very active and are quickly washed out of the arable layer. Even in the case of nitration, some of the nitrogen is lost from the soil. With improper nutrition, the loss of nitrogen fertilizers from the soil exceeds 50%. Therefore, the use of nitrogen fertilizers in accordance with the recommendations and research requirements give good results.

Before sowing, fertilize with a cultivator 25-30% of the annual rate of nitrogen fertilizers. Basic fertilization is also carried out with full fertilization if necessary. But one of its main requirements is the need to apply fertilizers to the wet soil layer.

The fertilization technique depends on the machines and equipment used to fertilize them. Local fertilizers are pre-plowed with ROU-6 and mineral fertilizers using equipment such as RUM-5-03 and CTT-10. Nitrogen fertilizers are fed with a CHKU-4 soil softener before sowing.

Sowing fertilizers. As we noted above, up to 15-20 days after germination of cotton, its need for nitrogen and phosphorus is high. If these elements are not enough in the soil, the latest nitrogen and phosphorus fertilizers will not be able to significantly improve the condition of cotton. Therefore, when sowing seeds, in order to provide young cotton with a sufficient amount of nitrogen and phosphorus, nitrogen and phosphorus fertilizers are applied to a depth of 10-12 cm from the side of 5-7 cm of the row. These fertilizers are applied in small quantities and provide nutrients during the period when the cotton is just sprouting. According to studies carried out by research centers and research institutes, it is proposed to apply 10–20 kg of nitrogen and 20–40 kg of phosphorus per hectare of sowing. It is recommended to apply these fertilizers to complex fertilizers so as not to interfere with sowing. In the absence of such fertilizers, you can use 100 kg of ammonium superphosphate produced in our country. Potash fertilizers are not required during this period.

An agricultural machine KXU-4 or other replacement mechanism is used for the simultaneous sowing of seeds and fertilizers during the cotton sowing season.

Cotton nutrition. When feeding cotton, the rows between special cultivators are softened and filled with mineral fertilizers. For this work, the cultivator KRN-3,6 or KHU-4 is used. Depending on the annual rate, it is necessary to feed the cotton plant 2-3 times with mineral fertilizers, especially nitrogen fertilizers. For feeding with nitrogen fertilizer, the remainder of its norm should be divided into 2 or 3 equal parts, depending on its amount. Its first part must be fertilized when 2-3 true leaves are formed in cotton, if potash fertilizer remains, it should be added. The rest of the nitrogen should be fed when the cotton is blooming and blooming. The last feeding period should be completed in Dashoguz region and Darganata district of Lebap region on July 15 and in other regions of Turkmenistan on July 10.

Due to the high concentration of nitrogen in urea, it must be obtained by adding it evenly throughout the earth. Before use, it must be well mixed with other fertilizers. Urea undergoes chemical changes in the soil. When the soil is alkaline, the ammonium carbonate immediately dissolves the CO_2 and NH_3 of the ammonia. It damages them when it comes to seedlings. In alkaline soils, this effect is stronger and faster.

There is a feature that must be considered when using urea. When this fertilizer is granulated, the amount of bur yet increases (NH_2-CO-NH-CO-NH_2).When the amount of bur yet exceeds 0.8%, it has a toxic effect on plants. It decomposes in soil within 10-15 days. Therefore, the introduction of carbamate into the soil, which contains such an amount of bur yet, stops the growth of plants. In soil, when the amount of urease enzymes is low, carbamate gives a low result. Therefore, it is advisable to increase the amount of organic fertilizers in the soil.

If, as a result of agrochemical studies in the soil, there is a deficiency of such trace elements as boron, zinc, manganese and copper, then it is recommended to give them micronutrient fertilizers. Good results are obtained by using micro fertilizers before or during the first feeding of autumn plowing. With a deficiency of these microelements, it is recommended to give 0.7 kg per hectare, 2-3 kg of copper, 4-5 kg of zinc and 5-6 kg of manganese.

The first top dressing should be carried out simultaneously with inter-row cultivation, while fertilizer should be given 12-15 cm from the cotton and 12-14 cm in depth from the side (row).

During the cotton planting period, fertilizer is applied at a distance of 20–22 cm from the plant. During the flowering period, the distance between the plant and the fertilizer should be 30–33 cm with row spacing of 90 cm and 3–4 cm below the working depth in the middle of the bed at 60 cm.

Fertilizers should be thoroughly weed out in advance and watered immediately within 1-2 days after fertilization. These measures further increase the effective effect of fertilizers.

The amount of used fertilizers. In all places where cotton is grown, there are no plant-suitable nitrogen and phosphorus compounds.

Local fertilizers should be given primarily to vegetables, melons, orchards and grapes. Of course, it not only increases the accumulation of sugar in vegetables, fruits and grapes, but also reduces the storage of nitrates (compounds harmful to the human body).Therefore, it is recommended to use local fertilizers in combination with mineral fertilizers in order to obtain a stable and rich cotton crop. The rate of mineral fertilizers in the study areas is significantly reduced.

The nitrogen norm of cotton when sowing alfalfa for 1-2 years decreases by 1-1.5 times. After 3-4 years, the full nitrogen rate is reset. The use of local fertilizers gives good results from the 4th year of sowing alfalfa. Using local fertilizers can save all kinds of nutrients, and using green manures can save nitrogen fertilizers.

In the soil and climatic conditions of Turkmenistan, it is recommended to use 260-280 kg of nitrogen per hectare for the production of 35-40 c / ha of cotton. The application rate of nitrogen fertilizers is regulated by the amount of nitrogen ($N - NO_3$) and ammonium ($N - NH_4$) nitrogen in the soil. This is done using the correction level shown in Table 9.

Table 9

Correctional level according to the amount of ammonium nitrogen (N–NH4) and nitrate (N–NO3)

($NO^-_3 + NH^+_4$) sum, based on mg / kg	Correction Rate to Proposed Nitrogen Rate
5-15	1.25
16-30	1.0
31-45	0.75
46 - 60	0.50

Due to the lack of modern equipment, the rates of nitrogen fertilization are determined based on the planned yield by the amount of soil rot.

As noted above, nitrogen fertilizers are applied before sowing, during sowing and as feed during the growing season. If the annual nitrogen norm is about 100 kg per hectare, then it should be fed in sowing and 2-fold fertilizing. At high nitrogen rates, sorghum is pre-sown with 25–30% (30–60 kg / ha), and the rest is evenly divided into 2-3: with the formation of 2–3 true leaves (30–50 kg / ha). at sowing (30–65 kg / ha), kg / ha) and at the beginning of flowering (30–65 kg / ha). Sowing sows 10–20 kg of nitrogen per hectare.

Nitrogen fertilization should be completed by July 10-15, when the feeding period will be set.

Fertilizer using methods. The main fertilizer. In order to get the best results from fertilizers, they are used in agricultural plants at different times. The main fertilizer is used to provide crops with nutrients throughout the growing season. In it, most of the annual norm is given for autumn plowing and pre-sowing cultivation. The use of fertilizers at different times depending on the properties of the fertilizers in the soil: solubility, soil retention, conversion, leaching is related to the texture of the soil. For example, phosphorus and potash fertilizers are less washed out of the soil. They can last for a long time, especially in the soil layer. Thus, 60-70% of the annual rate of phosphorus and 50-100% and potassium are added for autumn plowing. But nitrogen fertilizers containing nitrates dissolve easily in the soil and are more capable of being washed out of it. Therefore, it is beneficial to use them in sowing food during the growing season. which contains the ammonium nitrogen group, NH_4^- the group is attached in the assimilated complex (exchange reaction). Thus, they are less washed out of the soil and therefore are recommended for use in pre-sowing treatment [10]. In our soil and climatic conditions, the biological activity of the soil is high and ammonium nitrogen fertilizers quickly form nitrates as a result of nitration:

$$(NH_4)_2SO_4 + 4O_2 = 2HNO_3 + H_2SO_4 + 2H_2O$$

$$2NH_4NO_3 + 4O_2 = 4HNO_3 + 2H_2O$$

$$CO(NH_2)_2 + 2H_2O = (NH_4)_2 CO_3$$

$$(NH_4)_2CO_3 \rightarrow NH_4HCO_3 + NH_3$$

$$2NH_3 + 3O_2 = 2HNO_2 + 2H_2O$$

$$2HNO_2 + O_2 = 2HNO_3$$

These phenomena increase the loss of nitrogen in the soil as compared to ammoniacal nitrogen. For fertilizers to be more effective, they must be applied to the moist soil layer. In general, when fertilizers are applied less than 15-20 cm from the soil, that is, the wet layer, they are well preserved and act more efficiently.

When pre-sowing treatment, it is recommended to give 25–30% of the total nitrogen fertilization rate with chisel to a depth of 15–16 cm.

Soil texture also has a big impact on fertilization at different times. Potash fertilizers are effective on clay and loamy soils in autumn and on sandy areas before pre-sowing treatment.

After flushing saline soils, it is recommended to use non-sprinkled fertilizers in the main fertilizer. Pour 25-40 cm deep for plowing and mix with soil. Feeding phosphate fertilizers into the deep layer is very effective. Because where it was fertilized it moves less and was given 10 cm deep into the soil, given surface fertilizers, especially phosphorus fertilizers for crops, they cannot use better.

Manure, first of all, should be fertilized in a semi-rotten form for plowing. It is mineralized until spring and the nutrients become more suitable. Most of the mineral fertilizers are also given at that time.

Mineral and local fertilizers are sprayed with appropriate machines and completely sprinkled on the ground. The composition does not lose nutrients immediately during plowing.

Phosphorus and potash fertilization before planting (inline) can help give the best results when fertilizer is used efficiently. But in order to use this method, the places of the rows must be determined.

The main reserve of fertilizer is used in some places for 3-4 years of storage of phosphorus and potash fertilizers. So, for example, from two to three annual alfalfa yields 120-180 ha per hectare, 50-70 kg of potassium at a time before plowing. This method is also widely used in other cultures. Potassium chloride can be effectively used as an autumn fertilizer. It is recommended to use manure at a rate of 30-40 t / ha per hectare for three to four years.

In the fall, it is important to apply potassium chloride fertilizers. This is due to the fact that the potassium cation in the fertilizer accumulates in the absorbing complex of the soil (TST), and the chlorine ion creates conditions for crops.

Rules for the transportation and storage of fertilizers

Storage of mineral fertilizers. Mineral fertilizers are stored in specially formulated fertilizers. Fertilizers should not be stored outdoors or in substandard homes. Fertilizer losses in it can be 10-15% and more. Outdoor fertilization worsens moisture, worsens the hardening quality and reduces the beneficial effect.

Mineral fertilizers other than ammonium nitrate can be stored on a pallet in a bag covered areas (basal), where there is no water. They should be placed at the top of the terrace, covered with a tarpaulin, where it is not possible to store them indoors. Ammonium nitrate should be stored in separate rooms for safety reasons. These houses must be equipped with fire extinguishers.

Fertilizer bases should be located at a distance of at least 200 m from residential and industrial, livestock buildings and poultry farms. It is advisable to build according to the project special fertilizer bases providing farms for 1-2 thousand tons. In many farms, fertilizer bases for 400-500 tons are being built. The capacity of the fertilizer bases under construction is considered to be 50% of the annual fertilizers used on the farm

Fertilizer bases must meet the following requirements: rainwater, drainage water, and humid air should not be allowed into the fertilizer bases, if possible. In the fertilizer bases until the end of the premises, there must be at least 12 meters of space for the entry and exit of trucks. The gates should be inserted from the long side of the room directly to each other, but not in the middle, the width of which should be no more than 3 meters. Fertilizers without bags should be stored separately on a concrete or asphalt place. Bagged fertilizers are stored separately from bag less fertilizers. The gaps between the types of fertilizers should be limited by wooden or concrete walls, there should be shields. They should be labeled with the names of fertilizers and their percentage of nutrients. The height of the pile of fertilizers without bags should not exceed 2-3 meters. The storage heights of fertilizers with bags are shown in table 10.

Table 10

Height of mineral fertilizers when stored in bags

Fertilizers	**Number of bags when pressing fertilizers**	**Fertilizers**	**Number of bags when pressing fertilizers**
Ammonium nitrate ammonium nitrate	10	Double superphosphate	20
Urea carbamide	12-15	Ammophos	20
Sulfur ammonium	15	Sulfur nitrophoska	15
granulated superphosphate	20	Potassium chloride	20

As noted above, due to the risk of fire of ammonium nitrate, it should be kept in a separate room. The gap between fertilizer and walls should be 0.5 m.

The fertilizer specialist should record the time of their arrival and use in a special notebook. He should be fully responsible for organizing the work with fertilizers and for safety measures. The inside of the fertilizer base should be painted with bitumen. The responsible fertilizer specialist should note in a special notebook its time of use and its arrival. He should be responsible for technical safety measures and the organization of work in the fertilizer bases.

Fertilizer transportation. Fertilizers are delivered by trucks from the plant to railway transport, from the railway fertilizer base to economic bases it is transported by buses.

In order to reduce the loss of fertilizers on the railways, only in whole wagons, fertilizers with bags should be transported in special closed wagons (pallets).

Fertilizers without bags should be transported in self-unloading wagons. Fertilizers from the wagon must not be unloaded into an open space. When transporting fertilizers, they must not be mixed with other types.

Places of the bus where fertilizer is loaded must be intact and superficially closed. It should be covered with a waterproof material. After unloading fertilizers, wagons and other transports there must be completely cleaned.

Methods of transporting and using fertilizers with direct pouring and unloading them in the fields are being implemented. In some cases, fertilizers are taken out on the same machine and poured out directly onto the field (RUM-3, PMG-4, etc.). In the second method, fertilizers are delivered to the field by truck and dropped onto a specially prepared low-lying area, which is then loaded and used by other machines.

Suggestions for the efficiency using of mineral fertilizers

1. In cotton growing, for the effective use of mineral fertilizers, the requirements must be met together with irrigated agriculture, the economy and the environment. These requirements are interrelated. Economic development improves the living conditions of the population, and if the living conditions improve, more attention is paid to environmental problems in the village.
2. For the effective use of mineral fertilizers in cotton growing, it is necessary to calculate the exact rate of mineral fertilizers for the yield. When deciding on the amount of the planned harvest, analyzes should be made for all conditions of influence of the formation of the crop and determine the yield limitation. The restrictive conditions must be taken into account and specifically fixed for the planned yield.
3. When adopting a resolution on the norms for the use of mineral fertilizers in cotton growing, the degree of salinity, the amount of nitrogen, phosphorus and potassium, soil alkalinity, and local soil and climatic conditions must be taken into account.
4. To determine the amount of nitrogen, phosphorus, potassium present in the soil, its alkalinity, it is recommended to use portable (portable) equipment or an agrochemical cartogram of agricultural land.

5. It is recommended to use conductometers to measure its level under the limiting conditions of yield and soil salinity.

6. The types of fertilizers should be selected depending on the composition of the soil, the time of their application and the method of fertilization.

7. It is necessary to achieve the use of mineral fertilizers in accordance with certain periods during the growing season of cotton. The farmer and land users at the right time need to be provided with mineral fertilizers in a sufficient amount of the required types.

8. The bases of fertilizers should take into account the provision of the necessary mechanisms for acceptance, grinding, mixing, for accounting for the export and delivery to the sown fields with the collection of vehicle weights. This scale can also be used to measure other household goods (products).

9. Mineral fertilizers should, if possible, be used in combination with organic fertilizers.

10. Scientifically based crop rotations should be established on agricultural fields.

We hope that the practical use of farms from the recommendations and proposals outlined in the manual will contribute to the successful implementation of the tasks set by our esteemed President for the agro-industrial sector of our country.

Information on improving the efficiency of fertilizer use in cotton growing is also provided in the appendix of the manual.

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APPLICATION

Annex 1

The amount of mineral fertilizers used in cotton growing, kg/ha

Cotton yield, kg/ha	In fine staple cotton			In medium staple cotton		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
15-20	125-160	90-110	-	100-130	70-90	-
20-25	160-200	110-135	40-50	130-160	90-110	35-40
25-30	200-240	135-160	50-60	160-190	110-135	40-50
30–35	240-275	160-180	60-70	190-220	135-155	50-60
35-40	275-310	180-200	70-80	220-250	155-175	60-70
40–45	310-350	200-230	80-100	250-265	175-185	70-80

Notes:

1. 1.The amount of nitrogen used is calculated for areas with a normal supply of soil humus (more than 0.8%). On poor soils (up to 0.8%), nitrogen use increases by 20-25%
2. The amount of phosphorus and potassium changes according to table 5 of the manual, depending on the amount of active phosphorus and exchangeable potassium in the soil. Their use in the table is for soils that are low in phosphorus and potassium.

Appendix 2

Impact of nitrogen fertilization on cotton harvest

(Data from the Agricultural Research Institute)

The soil in which the experiment wascarried out and its agricultural characteristics	experien ce	Cotton yield, kg/ha fertilizers are applied per hectare during sowing		Additional nitrogencollecti on,s/e
		20 kg P_2O_5	20 kg P_2O_5 + 10 kg N	
Real gray soil with old watering	10	33.4	35.9	2.5
Real gray soil, first year after alfalfa	4	40.3	43.4	3.1
Light gray soil, first year after alfalfa	2	43.4	45.2	1.8
Old irrigated pastures	3	35.4	38.2	2.8

Appendix 3

Influence of phosphorus fertilizers on sowing, s/ha

Land where the experiment was conducted	Cotton harvest		Additional yield from sowing phosphorus
	when all the phosphorus is introduced before plowing	when applying phosphorus before and during plowing	
Real and pure gray	38.0	41.2	3.2
Pastures and meadows	36.1	39.2	3.1
Salty herbaceous	24.7	27.0	2.3
Pasture	40.5	43.0	2.4

Appendix 4

Influence of fertilizers on the yield of fine-fiber cotton depending on soil moisture

Experience options	Moisture of soil layers before irrigation, maximum (useful) area in% of moisture capacity				
	0-5 cm=19.1%; 5-20cm=43.5; 20-30 cm=52.0; 20-100 cm =62.7		0-5 cm=33.6%; 5-20 cm=52.3; 20-30 cm=62.2; 20-100 cm=70.9		
	Total yield, c/ha	then the proportion of fertilizers	Total yield, c/ha	additional yields from moisture and fertilizers, c/ha	then only aproportion of fertilizers
No fertilization	21.7	-	23.9	2.2	-
N_{120}	32.8	11.1	38.0	5.2	3.0
$N_{120}P_{60}$	33.8	12.1	39.1	5.3	3.1
$N_{120}P_{90}$	34.8	13.1	40.4	5.6	3.4
$N_{120}P_{120}$	37.0	15.3	43.6	6.6	4.4
$N_{180}P_{90}$	36.6	14.9	44.7	8.1	5.9
$N_{180}P_{120}$	40.6	18.9	50.5	9.9	7,7
Irrigation schedule	1-4-1			2-5-1	

Appendix 5

Influence of mineral fertilizers on soil moisture during flowering, s/ha

Experiments (options), kg/ha		Normal depth (4-6cm)	Wet layer (15-18cm)	Additional yield due to feeding into the wet layer
annual amount	From this during the flowering period			
P_{90}	-	29.7	33.8	4.1
$N_{120}P_{90}$	P_{30}	36.6	43.3	6,7
$N_{150}P_{90}$	$N_{30}P_{30}$	39.6	48.1	8.5
$N_{180}P_{90}$	$N_{60}P_{30}$	41.0	44.4	3.4
$N_{180}P_{120}$	$N_{60}P_{60}$	40.7	46.6	5.9

Appendix 6

Influence of late nitrogen fertilization on cotton yield, kg/ha

The amount of nitrogen used, kg/ha	Nitrogen supply timing				cotton harvest
	3-4 sheets (04.06)	inbudding (27.06)	in bloom (15.07)	in the phase of boxes (13.08)	
80	-	40	40	-	44.1
150	50	50	50	-	47.0
150	30	40	40	40	43.2

Appendix 7

Influence of the penetration of mineral fertilizers into different depths of soil tillage with different implements%

Tools, the depth of their processing, cm	Soil layer, cm		
	0-5	**5-10**	**10-20**
Heavy rake with a rotating knife BDT-2.2 (disc)	27	45	28 year
Spring cultivator (20 cm deep)	32	31 year	37
Universal cultivator with boom (20 cm deep)	38	34	28 year
The cultivator is similar, but cultivator (depth 10cm)	84	16	-
toothed rake	100	-	-
Heavy toothed rake	97	3	-

Appendix 8

Transfer rate (ratios) of fertilization to nutrients and nutrients to fertilizers

1. Transfer of nutrients to fertilizers			2. Transfer of fertilizers to nutrients		
Food names	**Fertilizer names**	**Fertilization factors of feeds**	**Fertilizer names**	**Food names**	**Fertilizer nutrition ratio**
Nitrogen	Ammonium nitrate (N 34%)	2.94	Ammonium nitrate (N 34%)	Nitrogen	0.34
	Urea (Urea), (N 46%)	2.17	Urea (Urea), (N 46%)		0.46
	Sulfuric acid ammonium (N 20%)	5.00	Sulfuric acid ammonium (N 20%)		0.20
Nitrogen and phosphorus	Ammonium superphosphate (N 9% + P_2O_5 10%)	10.00	Ammonium superphosphate (N 9% + P_2O_5 10%)	Nitrogen and phosphorus	0.09 and 0.10
Phosphorus	Simple superphosphate (14%)	7.14	Simple superphosphate (14%)	Phosphorus	0.14
Potassium	Potassium chloride (56%)	1,786	Potassium chloride (56%)	Potassium	0.56
	Potassium sulfur (46%)	2.17	Potassium sulfur (46%)		0.46

Note: *You need to multiply the amount of nutrients by the corresponding fertilizers and the specified factors in order to convert the fertilizers to the corresponding nutrients.*

CONTENT