The use of smart systems in cotton irrigation as a way of water saving in the climatic conditions of the Dashoguz province

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Abstract. Today, Turkmenistan, as a developing country, has great opportunities to meet the needs in all sectors of the economy. The development of agriculture and increase in productivity using modern "Smart" systems is one of the priorities of the State policy of the country. Scientific work on the study of the effectiveness of the use of the sprinkling method in the process of cotton growth was carried out in the scientific and practical site of the Turkmen Agricultural Institute, where cotton was planted in two sites of 1 hectare. The results showed that when using the sprinkling method, cotton germination averaged 92.2% over three years, while in conventional irrigation this figure was 90.2%, the average yield was 43.5 c/ha, and in conventional irrigation this the same indicator was equal to 30.5 c/ha, also the average water consumption was 3472.5 m$^3$, the same indicator in ordinary irrigation became equal to 7000 m$^3$, water savings amounted to 3527.5 m$^3$, which in turn proves the effectiveness of using the sprinkling method to obtain a high yield in climatic conditions of the Dashoguz province.

1 Introduction

One of the main tasks is the introduction of new innovative technologies in the country's agriculture, their management through a digital system, the creation of new scientific discoveries and achievements, the effective use of advanced technologies in cotton and grain farming.

The history of irrigation begins with the history of human existence. Even before the advent of civilizations, some methods of irrigation were used to grow plants. Most civilizations developed in places where there was water and irrigation systems were used.

It is believed that Egypt was the first place where they began to use irrigation in general. The use of irrigation in these countries dates back to many years before our era. In 5000 B.C. crops were irrigated with water from the Nile River. The first dam known to the world was built by King Menes on the Nile. Also in 2000 B.C. The first irrigation canals were built by the queen of Egypt Semirama. Some of these channels are still in use today [1].

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The Mahon Jo Daro culture, which ruled the Indian Indus Valley around 5000 BC, built the most advanced irrigation system to irrigate crops at the time. In the Arabian Peninsula, in Turkey, Iran and in many parts of Central Asia, irrigation has been used since 3000 BC. King Hammurabi of Babylon built public irrigation systems in the 1700s BC and introduced several irrigation laws. He introduced several fines for excessive water pollution [2-4].

Literature review.

In [5], the authors proposed a system built on expert firmware (on Expert Firmware), as well as the Internet of Things (IoT), which made it possible to use the collected information in real time. Installed sensors in and out of the soil to minimize losses due to pathogens and insects and pests would help to take constructive and protective measures. In [6], the authors proposed a low-cost monitoring system for the timely assessment of water quality in Nepal, which can monitor water quality, parameters such as pH (potential hydrogen) and conductivity on a timely basis using the Internet of things.

In order for plants to grow properly, they constantly draw water from the soil through their roots. Water absorbed by the plant:

- Stored as water in plant tissues.
- In plants, it breaks down into parts and promotes the formation of various compounds.
- It leaves the leaves of plants through evaporation [7-8].

When watering plants, the amount of water that plants need depends on the amount of water that evaporates from the plant leaves (transpiration). It is very important that the root system is properly maintained during the growing seasons of plants. Too little or too much moisture leads to low yields [9-10].

As can be seen from the diagram, if agrotechnical measures are carried out correctly, the yield increases as the plants grow during the growing season, and the yield reaches its highest level during normal cultivation. It is also clear that excessive watering reduces the yield of the plant. Waterlogging has a significant impact on groundwater pollution and soil salinization [11–12].

During the growing season of plants, the main reason for the decrease in yields with low moistening of the root system is that due to the fact that water molecules are tightly held by soil cells, plants spend a lot of energy obtaining water through the root system. Therefore, the plant loses the energy it needs to grow, mature and harvest, resulting in low yields.

During the growing season of plants, the main reasons for the decrease in productivity when the root system is moistened more than the norm is the lack of oxygen necessary for the plant when air cells in the soil are filled with water. As a result, there is a decrease in the division and reproduction of root cells, normal root growth slows down, the activity of soil microorganisms that serve to absorb organic nutrients, as well as the formation of compounds that reduce the absorption of nutrients into the soil, stops.

Irrigation is one of the agrotechnical measures for plants, and if other agrotechnical measures are not carried out properly, it is impossible to increase the yield by irrigation alone. It is possible to get a high yield from plants with the correct supply of the water required by the plants and the correct implementation of other agrotechnical measures.

The amount of water required by plants (evapotranspiration) is equal to the sum of water vapor (evaporation) from the soil and evaporation (transpiration) from the leaves of plants and is expressed in millimeters (mm). The water requirement of plants can be estimated by precise calculations or meteorological data. Although accurate measurement methods give positive results, they are costly and time consuming. Therefore, it is determined using calibrated coefficients from climate data indices and native vegetation estimation equations. It also depends on the type and density of the soil when growing plants.
According to scientific sources [13-14], the dynamics of water consumption per day in a place with deep groundwater, gray soil, 30-35 centners of cotton per hectare of cotton crop is as follows: the period of budding of cotton per hectare averages 18-20 m³ per day, mass flowering period is 30-35 m³, mass budding period, each hectare of cotton area consumes more water, that is, an average of 55-60 m³ of water, the bud opening period is 45-50 m³, and the mass bud opening period of 25-30 m³ of water consumption was scientifically calculated. These figures also include water that evaporates from the soil.

In Turkmenistan, cotton is grown on sandy, light, medium loamy and loamy soils in terms of mechanical composition. The water absorption capacity of soil depends on its mechanical properties. Cotton grown in sandy loamy areas should be watered frequently with small amounts of water. Since the water absorption capacity of this area is high, in summer the evaporation of the soil from the soil is strong, and the cotton is waterlogged. In areas with similar light and sandy soils, where the groundwater level is 2-3 meters or lower, 600-700 m³/ha is used during the budding period, 800-900 m³/ha and 650-900 m³/ha during the period of mass flowering and budding 700 cubic meters per hectare during bud break. If possible, it is considered expedient to water cotton plants 5-6 times in areas with sandy, light soil [15-17].

2 Materials and methods

Increasing the yield of cotton under normal conditions depends on many conditions. Among them, the introduction of scientifically based high-quality seeds that meet the requirements of sowing, the use of precision seeders, the use of seeds in a fixed amount, regular sowing and obtaining a high level of greenery, and cotton harvesting with frequent rainfed watering are of great importance. Today, cotton is usually irrigated from side slopes, using 7,000 cubic meters of water per hectare. However, depending on the type of soil in the area where cotton is grown and the level of groundwater, the water demand of cotton is different. According to scientific studies, the main disadvantage of cotton irrigation is the impossibility of accurately determining the amount of water used; to water it, it is necessary to draw threads into cotton wool; In order to bring water to the edge of the cotton field, the soil must be carefully leveled before planting; after watering, it is necessary to wait until places for repair work are found; in this case, the cotton dries up and loses most of its seeds under the influence of strong sunlight; Also, the predominance of consumed water in areas close to groundwater is one of the main causes of land salinization [18–22].

At present, there is a need for a thorough improvement of the cotton irrigation method with the introduction of scientific and new technologies, world experience into production. In the soil and weather conditions of the Dashoguz region, from year to year there are problems in achieving healthy, suitable greenery, dryness and the use of water in the prescribed amount by irrigating cotton in traditional ways.

From this point of view, in 2019-2022, in order to improve the agricultural technology of growing cotton and wheat in the Dashoguz region and obtain reliable, sustainable high yields, as well as the manufacture of a water-saving device from locally produced products and irrigated crops in 2019-2022 in the Turkmen Agricultural Institute carried out research work in this area.

In this scientific work, we will explore a new innovative method of watering cotton by separating water droplets into microparticles in the method of sprinkling cotton through a sprinkler and fully affecting the testicles of cotton, eliminating routine maintenance work, applying fertilizer in dissolved form and controlling the sprinkler through a digital system.
In the scientific study "Innovative method of irrigation of cotton in the method of raining with sprinklers", two methods of irrigation of cotton, i.e. conventional and raining methods, were examined on the basis of comparison.

In the scientific study "Innovative Method of Irrigation of Cotton by the Sprinkler Method", two methods of cotton irrigation were considered on the basis of comparison, i.e. normal and rainy way. Use of sprinklers in the field is shown in Figure 1 below.

As shown in Figure 2, central water pipes with a diameter of 40 mm are drawn from the edge of the cotton field, then 8 rows are placed on both sides of the field, and 16 rows are placed in between, and in order to place the sprinklers along the row, each sprinkler can sprinkle from 7.5 meters to 15 meters. 40 mm diameter transmission pipes are drawn. The sprinklers at the beginning and end of the row are connected at a distance of 7.2 meters, and the distance between the rest is 14.4 meters. Each sprinkler is attached to a 50cm long, 20 mm diameter delivery pipe and connected to a 40mm diameter delivery pipe within the rows. In this case, 49 sprinklers are placed on 1 hectare of land with a width of 100 meters and a height of 100 meters, and 730 meters of a transmission pipe with a diameter of 40 mm. Then there is no water shortage in any part of the cotton field and it is irrigated regularly.

Fig. 1. Installed sprinklers on the field.

Fig. 2. Irrigation of cotton by sprinkler method.

The sprinklers of the sprinkler system are capable of turning the water droplets into micro-particles with a pressure of 1.8-2 bar and spreading them up to a distance of 7.5-15 meters. In the upper part of the sprinkler, there is a device for adjusting the angle of the spraying water. Both the distance of the water spray and the angle of the spray can be adjusted by the same amount. Also, the amount of water passing through the water pipes is
passed through a measuring device, each sprinkler can spray 0.17-2.19 cubic meters of water per hour, the amount of water consumed is accurately determined, the sprinkler can be connected to mobile phones, and digitally controlled. The angle of rotation of the sprinkler is adjustable from 10° to 360°.

Proper feeding is one of the main problems in growing cotton. Traditionally, when feeding cotton, the method of applying mineral fertilizers from under the soil to the roots with the help of fat fertilizers is widely used. In such cases, you have to rely on the power of technology. During the season, tractors carry out 4-5 row treatments and fertilizing before each watering. As a result, it causes soil compaction and damage to plant branches and crop stems.

In the case of a sprinkler system, mineral fertilizers are sprayed onto the plant in dissolved form and fed through the branches. In this case, nutrition is supplied to all tissues of the plant and has a rapid effect. In our scientific work, we conducted a 3-fold liquid top dressing with urea, 200 g. edagum, 5 kg potash, 200 g. oxyhumate fertilizer at the rate of 5 kg, 10 kg and 15 kg during each season from 2019 to 2022.

![Fig. 3. A device that supplies liquid fertilizer to cotton.](image)

<table>
<thead>
<tr>
<th>No.</th>
<th>Irrigation types</th>
<th>Germination, %</th>
<th>Yield, c/ha</th>
<th>Additional yield obtained, c/ha</th>
<th>Amount of water used, m³</th>
<th>amount of water saved, m³</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
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<td>28.2</td>
<td></td>
<td>7000</td>
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<td></td>
<td></td>
<td>2020y 93</td>
<td>31.8</td>
<td></td>
<td>7000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2021y 91</td>
<td>30.6</td>
<td></td>
<td>7000</td>
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<td></td>
<td></td>
<td>2022y 89</td>
<td>31.2</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>average value</td>
<td>90.8</td>
<td>30.5</td>
<td></td>
<td>7000</td>
<td></td>
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<tr>
<td>2.</td>
<td>Sprinkling</td>
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<td>15.7</td>
<td>3540</td>
<td>3460</td>
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<td></td>
<td></td>
<td>2020y 92</td>
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<tr>
<td></td>
<td></td>
<td>2021y 91</td>
<td>44.6</td>
<td>14</td>
<td>3470</td>
<td>3530</td>
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<td></td>
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<td>2022y 94</td>
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<td>12.3</td>
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<td>43.5</td>
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<td>3472.5</td>
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</table>

We started watering the hole every three days from the first decade of May to the first decade of September. Each time, an average of 80-90 cubic meters of water was supplied and 40-43 irrigations were carried out until the end of the season. Save 50% water compared to conventional irrigation method.
3 Results and Discussion

**Fig. 4.** Comparative graph of cotton germination from the method watering.

**Fig. 5.** Comparative graph of the dependence of cotton yield on the method watering.

**Fig. 6.** Comparative graph of the dependence of water consumption on the method of irrigation.
As shown in Table 1 above, under normal irrigation conditions, the average greenness was 90.8%, the yield was 30.5 s/ha and the water consumption was 7000 cubic meters.

When irrigated by sprinkling, the yield was 92.2%, the yield was 43.5 q/ha, the water consumption was 3472.5 m³. The following indicators were obtained: 2 percent yield, 13 centners per hectare, 3527.5 m³ of water saved on water consumption.

4 Conclusion

According to the results of scientific research conducted in 2019-2022, it is possible to reduce the amount of water consumed by cotton in the cotton farm by 50%, significantly reduce the cost and time for equipment for processing and fertilizing cotton. Rows of cotton and, finally, the yield of cotton per hectare is 1. It has been proved that it can be increased by 5-2 times.

Also I would like to note that, It is possible to produce all the water pipes, connecting devices and water taps of the sprinkler irrigation system in the state of Turkmenistan, this lowers the cost of installing a sprinkler system, allowing every farmer to install it at an affordable price and purchase spare parts seamlessly. Sprinkler irrigation system can be installed from 0.5 hectare to any required hectare in few hours.

References

3. M. Ferner, These 11 cities may completely run out of water sooner than you think, The Huffington Post (2013)


