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Principle of Using Furrow Bottom Compaction Device in Reducing Soil Erosion Processes

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ABSTRACT: The article presents analytical results in the use of a device for compacting the bottom of the furrow along the length to prevent soil erosion and obtain a high and stable cotton yield through the rational use of water resources. Field experiments are presented on the use of a device for compacting the bottom of the furrow along the length to reduce soil erosion in non-eroded, eroded and eroded lowered parts of the field.

KEYWORDS: Furrows, furrow bottom compactor, technology, soil, erosion, cotton, productivity.

I. INTRODUCTION

There are types of soil erosion in the republic, such as wind, irrigation, mountainous, water and cliff erosion, and many studies have found that serious damage to agricultural crops is caused by wind and irrigation erosion. Mountain and flood erosion can also cause severe damage at times [9].

It is no coincidence that the fourth direction of the Address sent by the President of the Republic of Uzbekistan Shavkat Miromonovich Mirziyoyev to our nation in 2023 is related to the fact that ecology, especially water issues are becoming a global problem. According to the petition, rainfall has decreased by 25% in the last 15 years, and water scarcity has increased. In this regard, the reform of the water management system is emphasized [1]. It is planned to introduce a system of open accounting of water and to digitize about 13 thousand water management facilities in the next three years. At the same time, 16 large pumping stations will be modernized and transferred to alternative energy based on public-private partnerships. It was determined that the composition of the soil in the cultivated areas is deteriorating, the fertile land is shrinking, and desertification, lack of water, drought, and the need to provide the population with clean drinking water. At the same time, effective and rational use of available water resources, as well as the use of a device for compaction of the bottom of the soil is of great importance in achieving uniform wetting of the root zone where the plant is located along the length of the soil.

In the strategy of agricultural development of the Republic of Uzbekistan for 2020-2030, "Improving the amelioration of irrigated lands, rational and economical use of water resources and achieving the stability of production of agricultural products on this basis" is defined as one of the important tasks. saving irrigation water by providing water at an acceptable rate during irrigation, preventing mineral fertilizers from being washed away by soil particles, reducing erosion processes, keeping the environment clean, and preserving the fertile soil layer, as well as PF-5742 of the President of the Republic of Uzbekistan dated July 17, 2019 "On measures of effective use of land and water resources in agriculture" is of great importance due to the adoption and implementation of Decree No. 2 [2, 3].

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II. THE DEGREE OF STUDY OF THE PROBLEM

Conservation and sustainable management of natural resources are one of the most important areas of science. Soil erosion has become a serious environmental problem for many agricultural countries of the world. Soil erosion is the separation of soil from the bedrock and its displacement by the carrier [4, 5].

Soil erosion is the most common type of degradation. It causes enormous economic and environmental damage, as it can lead to the loss of soil as the main means of agriculture and as an irreplaceable component of the biosphere. The soil layer is being eroded under the influence of various improperly organized human activities. Erosion is a very common and devastating consequence of such soil impacts [6].
Over the past 40 years, one-third of the world's cropland has been seriously affected by erosion, a process that is increasing by nearly 10 million hectares per year. The amount of soil erosion is mainly influenced by vegetation cover, topographic features, climate change, and soil properties. Human activities and regional events that change the productive cover of cropland are intended to prevent the rate of soil erosion from being affected. Consideration of the advantages of using the device of at-bottom compaction in preventing or reducing soil erosion is determined.

Soil erosion is one of the most urgent problems in Uzbekistan's agriculture, and several popular scientists have conducted their scientific research on its spread, causes, types, and methods of elimination. In particular, V.B. Hussak, M.A. Pankov, Z.N. Antoshina, F.K. Kocherga, M.B. Doshanov, R.G. Murodova, K. Mirzajonov, H.M. Maksudov, L.A. Gafurova, A.A. Khannazarov, Sh. Nurmatov, S.P. Suchkov, N.F. Matyunin, H. Khamdamov, S.M. Elyubaev, A. Nigmatov, B. Joraev, K. Usmonov, M. Khamidov, S.Meylibaev, O.Haqberdiev, V.N.Li, B.Ahmedov, and many other scientists have thoroughly studied the process of erosion in all regions of our republic and developed scientific bases for eliminating this process [7, 8, 9].

III. RESEARCH METHODS

The subject of the research is the typical gray soils of the Tashkent region, which have been irrigated since ancient times, the device for densifying the bottom of the furrow, the medium-fiber variety of cotton “Sultan” [10].

Conducting field experiments, conducting field and laboratory experiments, “Methods of agrochemical analyzes of soil plants in Central Asia”(1977), “Methods of conducting field experiments” (Tashkent, 1981, UzPITI, 2007) manuals were used [11, 12, 13].

According to the results of the scientific research carried out by scientists, soil erosion as a result of irrigation erosion can reach 100 - 150 tons per hectare every year, and even more, on slopes with a slope of more than 50, it reaches 500 tons per hectare, together with this soil, the annual loss of humus is 500 tons per hectare. - 800 kg, nitrogen 100-120 kg per hectare, phosphorus 75-100 kg, and more [14].

As for the description of the eroded lands of the Republic of Uzbekistan, unwashed and washed-out soils - 52.8 %, weakly washed-out soils - 3.4 %, moderately washed-out soils - 6.8 %, strongly washed-out soils - 5.5 % and other lands - is 31.5 percent [15].

In the analysis of the theoretical basis of the improvement of its technical elements in irrigation erosion-prone soils, the great bottom compaction device was used. It is appropriate to provide a brief overview of the device used in field conditions. The device allows compacting the entire cross-section of the bottom of the gate from the maximum value at the beginning of the gate to the zero value at the end of the gate (Fig. 1) [16].

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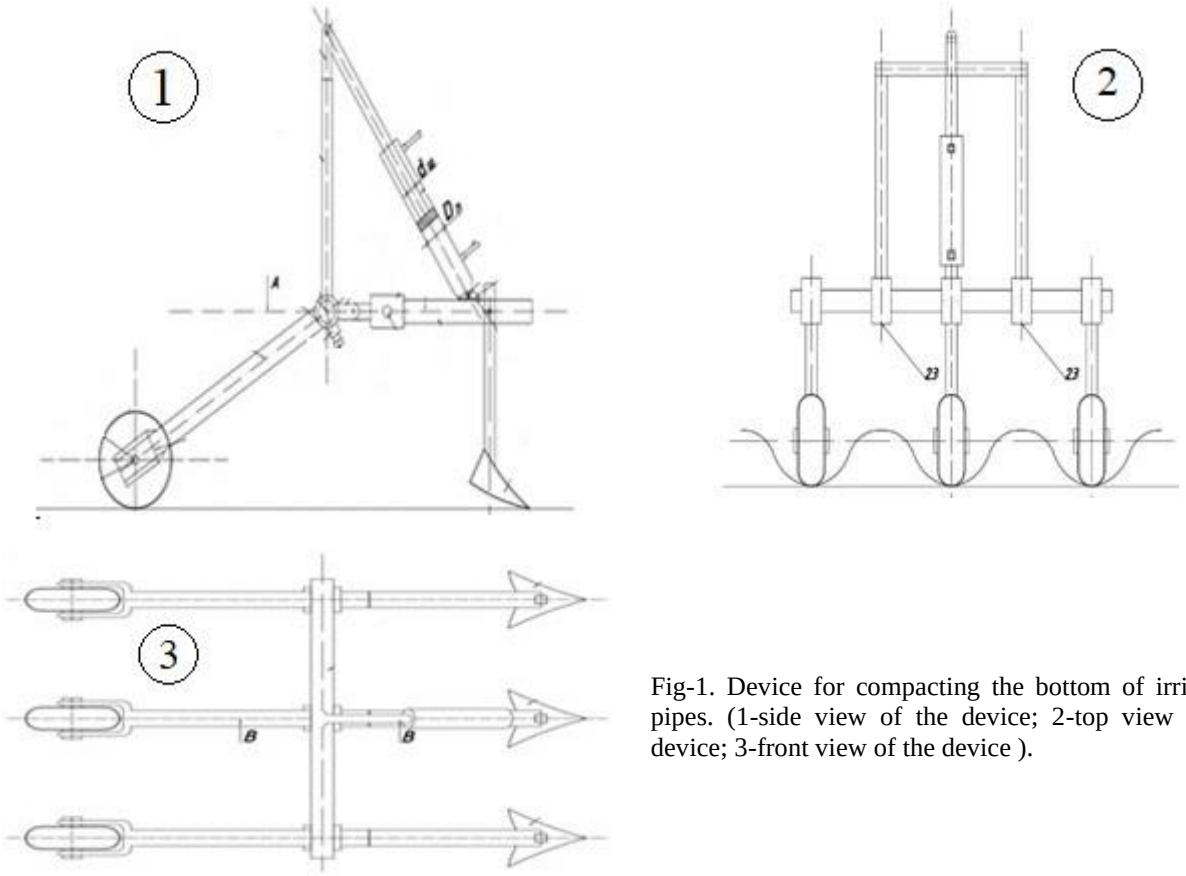

Fig-1. Device for compacting the bottom of irrigation pipes. (1-side view of the device; 2-top view of the device; 3-front view of the device).

Even when the surface of the field is roughly leveled, the technology that provides a variable density of the side and bottom of the screed along the length and the machine with automated working equipment that performs it (Fig. 1) ensures the accurate creation of the cross-sectional image of the longitudinal length of the screed. Uneven silting of the soil under the bottom of the soil, i.e., maximum silting at the beginning and minimum silting at the end, eliminates uneven wetting of the root spreading layer of the soil [17].

In terms of technology, working equipment was prepared with the help of technical means of the automated control system, and it was possible to save the norms of the amount of water supplied during the growing season of the crops in the irrigated fields, to achieve a smooth development of the crops and a higher yield.
When conducting field experiments, the following research tasks were determined:

1. Determining the slope level of the research area.
2. Experiment in the field, to test the device used to open the soil before irrigation in cotton care (densification of the soil).
3. In production conditions, using a new device (consolidation of the bottom of the soil) in cotton irrigation, conducting observations on determining water consumption and soil leaching, etc. were determined.

Based on the above-mentioned objectives and tasks, in the soils prone to irrigation erosion, typical gray soils of the Tashkent region, in the conditions of irrigation erosion, using the egat bottom compaction device for irrigation of cotton, the growth, and development of cotton, as well as the cotton a high yield was obtained.
Figure 2 shows photographs of the operation of the furrow bottom compactor, and the results obtained are presented below.

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Figure 2. The process of using the device for compacting the bottom of the gates in the experimental field (you need to put yourself from the pictures)

IV. RESEARCH RESULTS

In the conditions of the republic's typical soils subjected to irrigation erosion, the soil was compacted and irrigated using the traditional method and the device of soil thickening before irrigation. The slope of the experimental field is 1.50, and according to the results of the conducted research, when cotton is irrigated in the traditional way, 3911.9 m3/ha of water was consumed and 2.84 t/ha of cotton was grown. When the soil was compacted and irrigated, 3890.9 m3/ha of water was consumed, and 3.1 tons/ha of cotton was grown. 4916.4 m3/ha of water was consumed and 2.62 t/ha of cotton was grown when cotton was irrigated in the washed part of the soil. Before irrigating the cotton, when the soil was compacted and then irrigated in the washed part of the soil, 4344.3 m3/ha of water was consumed, and the cotton yield was 2.8 t/ha. 3794.7 m3/ha of water was consumed and 3.75 t/ha of cotton was grown when cotton was irrigated in the washed-out part of the soil. Before irrigating the cotton, in the washed-out part of the soil, the bottom of the cotton was compacted and irrigated using a device that thickens the bottom of the cotton, 3705.3 m3/ha of water was used, and the cotton yield was 4.12 t/ha.

The results of the experimental field research are presented graphically in Figures 3 and 4.

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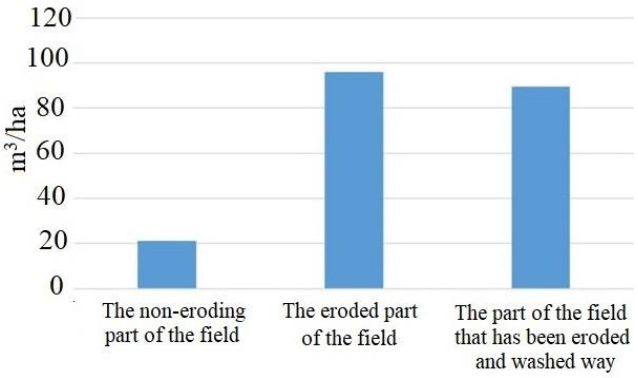

Figure 3. Experimental field water conservation on soil erosion

Based on the analytical results, it was found that in the non-eroding part of the field, 21 m^3 of the planted area of cotton was saved, 95.9 m^3 in the eroded part of the field, and 89.4 m^3 in the eroded part of the field, compared to the traditional option. It can be seen that 74.9 m^3 was saved in the eroded part of the field compared to the non-eroding part, and 5.4 m^3 compared to the eroded part. However, to determine the economic sustainability of the option, it is necessary to calculate the productivity of water used for harvesting (Figure 3).

The productivity of irrigation water use in the experimental fields was calculated using the yield obtained according to the variants and the seasonal irrigation rate used (Fig. 4).

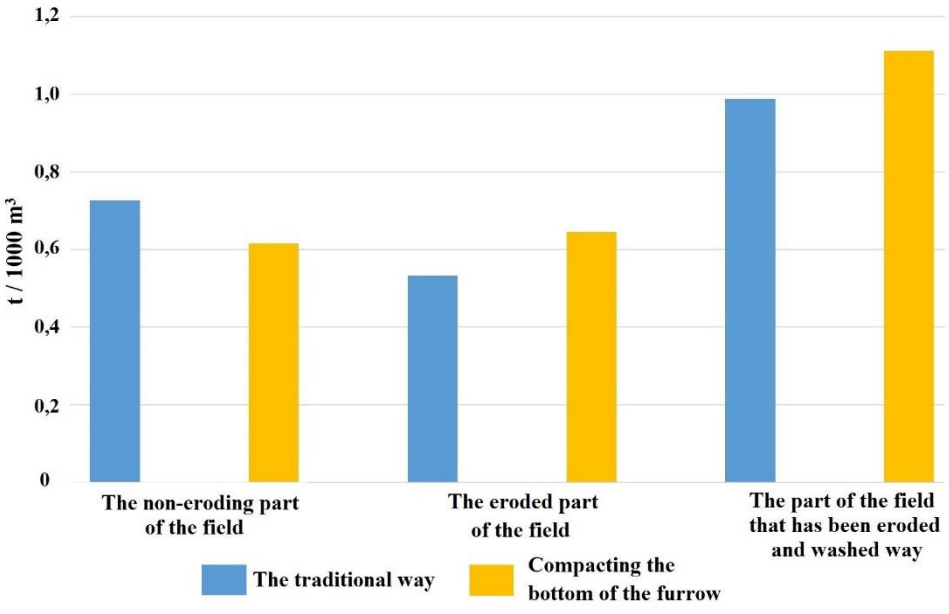

Figure 4. Experiment with field irrigation water use productivity

As a result of the scientific research conducted in the experimental fields, the yield of cotton obtained by using 1000 m^3 of water was determined. In the non-eroding part of the field, the harvest was 0.72 tons as a result of the conventional method, while in the non-eroding part of the field, the yield was 0.61 tons. In the remaining experiments, the results were as follows: 0.53 tons; 0.64 tons, i.e. increased to 0.11 tons (the eroded part of the field). By using 1000 m^3 of water in the eroded part of the field, 0.98 tons of cotton were harvested in the traditional method, and 1.11 tons of cotton was obtained in the version with compacted soil.

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V. CONCLUSION

In the conditions of irrigation erosion of the Tashkent region, typical gray soils, by testing the compaction device of the bottom of the cotton, ensuring uniform moistening of the layer along the length of the furrow during cotton irrigation, and as a result, it was scientifically justified that the production of high and high-quality cotton crops due to the wastage of irrigation water and the prevention of washing away of the fertile part of the soil.

For example, when the soil is compacted and irrigated through the soil compaction device before watering cotton, the plant grows and develops better due to the reduction of soil washing processes compared to the traditional method of soil extraction. Accordingly, in the unwashed part of the soil, an additional 1.7 t/ha of cotton was grown, the soil in the washed part, an additional 2.0 t/ha, of the cotton crop was achieved, in the washed-out part of the soil, an additional 1.9 t/ha, cotton crop was achieved.

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Professor Matyakubov Bakhtiyar Shamuratovich has been working at the National Research University "Tashkent institute of irrigation and agricultural mechanization engineers" (NRU "TIIAME") in Uzbekistan since 1988. His background is irrigation and drainage. During 1982-1987 Prof. Matyakubov graduated his University degree with honors from the Department of Irrigation and Melioration at TIIAME. He worked in the Department of Irrigation and Melioration during 1988-2019 as the head of a laboratory assistant, a graduate student, an assistant, associate professor, doctoral student and professor, as well as the dean of Hydromelioration faculty and the Department of Advanced Training at TIIAME. Prof. Matyakubov conducted field experiments in the Khorezm region in the field of cotton irrigation regime and introduction of water-saving irrigation technologies. On the basis of his research work he defended his doctoral dissertation (DSc) on the topic "Scientific and practical foundations of the effective use of water resources in irrigated agriculture: In the case of Khorezm oasis" and received a doctorate in agricultural sciences. He has published over 140 scientific and methodological works, including 1 monograph, 2 patent in water management, 5 textbooks and 1 study guide. He led the defense of 2 PhD student, 20 Masters and 86 Undergraduate students.

Khayitova Makhbuba, Doctoral students (PhD) of the National Research University "Tashkent institute of irrigation and agricultural mechanization engineers". She is conducting scientific research on the topic "Substantiation of elements of cotton irrigation technique on lands subject to irrigation erosion (in the example of Tashkent region Republic Uzbekistan)". To date, she has published more than 6 articles on his doctoral thesis. At the same time, she published 2 articles in SCOPUS international database.