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Technologies and Technical Means for Basic Tillage of the Cotton-Growing Zone

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Abstract: The article analyzes the existing technologies and technical means for basic tillage of the cotton-growing zone. Based on the analysis of technologies and technical means for the main tillage of the cotton-growing zone, it was found that improving the quality and stability of the technological process, reducing energy and labor costs when processing soils with low humidity can be achieved by developing a combined tillage tool, the working bodies of which would loosen the topsoil and plow in one pass. In such a combined unit, the working organs of passive and active action should be optimally combined.

Keywords: soil, technology, plowing, plow, implement, depth of tillage.

Introduction. Winter plowing with formation turnover in the cotton growing area is the key to high efficiency of all subsequent agrotechnical measures. The yield of agricultural crops largely depends on the quality of its implementation. To carry out plowing in optimal time, a conveyor method of preparing fields is used. First of all, winter plowing is carried out in fields that have been freed from grain, corn, vegetable, fodder and other crops, and then, as the cotton harvest is completed, they move to the areas occupied by this crop. Numerous studies [1-5] have established that the depth of winter plowing should be differentiated taking into account soil differences, soil thickness, characteristics of the cultivated crop and other factors. In most soils of the irrigated zone of Central Asia, winter crops are plowed, as a rule, to a depth of 25-27 cm. The depth of the main tillage for cotton, the main crop of this zone, varies significantly by soil and climatic zones. In the northern and middle cotton growing zones, plowing is carried out to a depth of 30 cm on powerful typical and light gray soils, as well as meadow soils in Tashkent, Samarkand, Syrdarya, Namangan, Ferghana and foothill lands of Andijan region, Bukhara region, and the Karakalpak Republic. In areas with earlier spring and warm and long autumn, as well as in the southern cotton-growing zone, plowing is carried out at 40 cm on the strong soils of Surkhandarya, Kashkadarya, Chordzhou, Vakhsh regions.

Results. Based on the requirements of modern agro technical science for plowing in the cotton-growing area, we have analyzed the known technological processes of plowing. The main indicators characterizing the agro technical quality of the technological process, based on the above requirements, are the uniformity of the depth of processing, the depth of embedding of plant residues, soil crumbling and the ridges of the soil surface.

Plowing with general-purpose plows without plows does not provide a complete turnover of the formation. The plant residues are located in inclined cross sections throughout the processing depth [5]. Incomplete turnover is also characteristic of the technological process of plowing with enclosures equipped with angle lifts.

A better degree of sealing and a larger angle of rotation are characteristic of cultural plowing with ploughs. However, the depth of embedding of plant residues (7-12 cm) is not sufficient for effective control of perennial weeds. Therefore, this technological process in the cotton growing area is used only for processing soils for grain crops. The technological process is more advanced. Two-tier plowing can provide complete (100%) and deep sealing of plant residues.

The idea of layered (tiered) plowing has long been of interest to scientists, engineers and farmers. Attempts to create a deep-plough longline plough have been known since 1908 [6]. Since 1935, the VISKHOM 13 collective has been working in this direction [6]. The agronomic prerequisites are formulated in the basic principles of cultural plowing in Tulaganov [7]. Avazov I's research became the main engineering development [8].

The issue of the mutual arrangement of the working bodies of a two-tier plow was first theoretically considered by F. Mamatov [9, 10, 11]. And now these developments are the basis for new research.

R Karimov [12], I Ergashev [13] and others have been engaged in research on plows in the cotton-growing zone at various times.

As a result of the analysis of the conducted research, long-term observations and opinions of agricultural leaders, the following main features of the main processing of cotton soils can be distinguished: a large unevenness of the depth of processing associated with the relief of the cotton field; the timing and quality of plowing associated with the presence of cotton stems; block formation due to low soil moisture and over-compaction of its upper soil layer.

U Kodirov [14] and S Gapparov [15] studied the influence of the relief of the cotton field on the operation of plows in order to improve the quality of processing and the stability of the course of the arable unit. Studies [16-20] have established that before plowing, cotton fields have a pronounced uneven relief characterized by the presence of ridges and irrigation furrows. In fields with a row spacing of 90 cm, the height of the ridges varies from 7 to 24 cm, and in fields with a row spacing of 60 cm from 6 to 18 cm.

The presence of ridges and irrigation furrows in the fields significantly worsens the quality of work and dynamic performance of the plow [20]: the coefficient of depth variation goes beyond the agrotechnical tolerance υ_a=24,9%,, reached the υ_a=24,9%, the degree of unevenness of traction resistance to δ=0,4, and the bottom of the furrow turns out to be stepped. To improve the uniformity of the plowing depth, Mamatov [9, 10-15] developed a pair of swing-type support wheels, when installed on a mounted plow, the coefficient of variation of the processing depth decreased by 2-2.3 times, and the productivity of the plowing unit increased by 23.8%.

Based on the research conducted by B.Mirzaev [8, 11], it was found that general-purpose plows in conditions of pronounced relief can meet the requirements of GOST, but only if the width of the plow is a multiple of the row spacing.

When installing a swing-type support wheel and making the plow's gripping width a multiple of the row spacing, the uneven loading of the plow housings is not eliminated, which negatively affects the stability of the plow stroke in the horizontal plane, the rotation of the formation, the sealing of plant residues and the alignment of the field surface.

The issues of the influence of terrain on the performance of two-tier plows have not been studied. Therefore, the establishment of patterns of changes in the quality of plowing and the energy intensity of two-tier plowing depending on the relief of the cotton field, the improvement of technologies and, accordingly, two-tier plows are urgent tasks of practical importance.

One of the main features of the cotton field of the field is the presence of cotton stems. Therefore, the timing and quality of plowing cotton soils mainly depend on the timely harvesting of cotton stems after harvesting raw cotton.

Both Temirov and others [18] note that soil preparation for cotton sowing, which is widespread in all areas of the United States, begins with crushing and plowing cotton stalks into the soil. When filling the soil with cotton stalks, cotton yield increases on average over three years when plowing 5 t/ha of stems by 39.9%, 10 t/ha – by 48% and 15 t/ha – by 68%. Therefore, it is advisable to plow the stems as fertilizer.

In this regard, the latest technology of harvesting cotton stems is currently widely used, since fields infected with wilt make up an insignificant part of the acreage allocated for cotton in the Republic of Uzbekistan [18].

For crushing cotton stems with and without extraction of the root system, the industry produces uprooting grinders KIR-1.5, KI-1.2, KIV-4, etc. However, firstly, state farms and collective farms are not provided with a sufficient number of such machines, and secondly, they are energy-intensive and metal-intensive. In addition, when using them, the number of tractor passes through the field increases, which leads to excessive soil compaction and additional costs.

In connection with the above, currently many farms produce plowing of cotton stalks with two-tier plows without grinding them. At the same time, the stems are poorly embedded in the soil and lead to frequent clogging of the plow, which significantly reduces the productivity of arable units. In the spring, uncultivated cotton stalks are harvested by various means – harrows and other homemade tools. Some of the cotton stems, embedded shallowly, do not have time to decompose during the winter period, which sharply worsens the quality of all subsequent work.

Employees of the Scientific Research Institute of Agricultural Mechanization of Uzbekistan believe [18] that the reason for the unsatisfactory operation of plows in fields with uncollected husks is the discrepancy between the width of the body and the width of the aisle. The width of the bodies with a two-tier plow is 35 cm, as a result of which, when plowing fields with a row spacing of 60 and 90 cm, the ridges and edges fall either on the toe, or on the middle, or on the end (heel) of the plowshare.

And Temirov et al. [18] note that the deep sealing of the husk and the weeds located on the ridge of the rows are sealed when they fall on the heel of the ploughshare of the upper body. At the same time, the number of clogs decreases. When the plowshare hits the toe, the sealing depth is minimal, and the plow is often clogged, recommends that in the future the body width should be 30 cm, as the largest divider in relation to the width of the aisle.

The Scientific Research Institute of Agricultural Mechanization of Uzbekistan [19] has developed a PDN-6-30 semi-mounted plow for the promising T-250 class 5 tractor. The disadvantage of plows with a working width of 30 cm is that when plowing fields with a row spacing of 90 cm, their bodies will be loaded unevenly due to the uneven terrain of the field. At the same time, the quality indicators of the plow deteriorate. In addition, with a high density and height of the stems, they will become clogged.

A screw cutting machine was developed at the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers [19] to grind cotton stalks during plowing. It was hung in front of the tractor of the arable unit. When the tractor was moving, screw cutting knives cut the stems in three tiers. At the same time, the average length of the crushed stems is 23.4-31.3 cm, and the maximum length is 29.0-40.0 cm [19]. It was found that at a speed of 1.2-2.0 m/s, the rotational speed of the screw cutting knives should be 300-700 min-1. At the same time, the required power on the chopper drive is 1.5 kW with a two-tier version of 2.0 kW with a three-tier version of the chopper. The results of field tests showed that the screw cutting machine does not meet the agrotechnical requirements for shredders of cotton stems. The main disadvantages of a screw cutting machine for grinding cotton stalks are: poor grinding quality, heterogeneity of the fractional composition of the crushed mass, the inability to adjust the degree of grinding.

The research results [19] prove the effectiveness of combining two operations – basic tillage and crushing of cotton stems. At the same time, the timing of plowing is accelerated, higher quality

of tillage is ensured, the productivity of the arable unit increases, the number of tractor passes through the field decreases and fuel consumption and other means are reduced. Therefore, the development and research of combined arable units that simultaneously perform plowing and crushing of stems on the basis of advanced plows is an urgent task.

One characteristic feature of soil cultivation in the southern zone of Uzbekistan is the formation of large blocks. In the cotton growing zone, soil cultivation is carried out in July-August from under grain crops, and in November-December from under cotton. During this period, the topsoil compacted by tractors and harvesters is severely desiccated. The moisture content of the upper layer is reduced to 5%, and the hardness is up to 11.8 MPa [20]. Therefore, when processing soils prone to clumping, plowing turns out to be coarse-clumped. Precipitation in winter and early spring periods on such soil evaporates quickly.

To prepare such soils for sowing, it is necessary to carry out 10-12 additional operations or watering before plowing. To improve the quality of soil crumbling, M Halilov [20] recommends preliminary loosening of the upper layer with a milling cutter to a depth of no more than 15-17 cm before plowing. At the same time, the degree of soil crumbling increases by 2-3 times, and the energy intensity of tillage increases by 5.6 Wh/m3. Due to the high energy intensity, low productivity and complexity of the milling cutter design, this technology has not been used in production.

Conclusion. Based on the analysis of technologies and technical means for the main tillage of the cotton-growing zone. It was found that improving the quality and stability of the technological process, reducing energy and labor costs when processing soils with low humidity can be achieved by developing a combined tillage tool, the working bodies of which would loosen the topsoil and plow in one pass. In such a combined unit, the working organs of passive and active action, should be optimally combined.

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