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Effectiveness of the Combined Plough Fitted with Rotary Operative Parts

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ABSTRACT: This article discusses units and operating principles of the combined plough with rotary share, its field test results and performance analysis in comparison with the ordinary share-mouldboard plough.
KEYWORDS: share plough, tillage, combined plough, rotor, skim cutter, tractor hydraulic system, crumbling, traction resistance, rotation speed, energy assessment of the plough.

I. INTRODUCTION

Soil-climatic conditions in irrigating regions of Uzbekistan can allow to get rich crop of vegetable, feed and other crops as re-harvesting in the fields freed from cereal crop.
Re-harvesting cultivation provides the needs for food products, fodder crop, productive use of sown area in the republic. Well-timed and high quality land preparation for sowing, especially in hot summer period plays primary importance in the land treatment complexes aimed at getting high productivity in re-harvesting.
At present time soil preparation for sowing re-harvesting in the fields freed after gathering cereal crops is performed by tillage machines used for cultivating cotton plant (Panov, 1985). However, physical-mechanical features of the soil in summer period sharply differ from physical-mechanical features of the soil in the period of sowing cotton. Therefore, while preparing the soil for re-harvesting soil cultivating machines and cotton growing devices are repeatedly used that leads to material and labor expenditures increase, and the worst is that it causes sowing time delay and consequently it causes to crop capacity decrease.
Now tillage with general-purpose plough is carried out leveling back ridge and open furrow with 25-27 cm deep after the field is freed from cereal crops. Because of moisture deficiency in soil ploughing naturally becomes lumpy. That is why in order to achieve high-quality soil cultivation such fields are cultivated by machines repeatedly.
Investigations carried out by many scholars show that accurate mixing the topsoil leads to a significant increase of biological activeness and effective fertility in the whole topsoil that increases agricultural crop capacity.
Meanwhile ploughing with moldboard-share plough, even with the help of additional treatment by the cultivator, harrow and other implements do not provide mixing topsoil properly (Ruziyev I.S., 2010). For the purpose of elimination of above mentioned defects of moldboard-share ploughs much work is being performed in different directions one of which is combining ploughing with additional soil cultivation by means of plough body combination with different types of operative parts (Katkov P.I., 2006), among which is believed to be perspective is operating parts with hydraulic actuator letting more effectively use the tractor power to rather effective work, and consequently, to gain higher efficiency of the aggregate.

II. RELATED WORK

The substantiation of the parameters and operating mode of the combined plough with rotary share in the Russian Federation was carried out by I.M. Panov (1970), M.D. Podskrepkov(1979), A.S. Shmonin(1970), P.I. Katkov(2008),and In India R.G.Jakasania (2017), In Sudan Ahmed MH (1993).However, the soil and climatic conditions of the Russian Federation and others are very different from the soil conditions of the Republic of Uzbekistan. Therefore, the results of these studies are not acceptable for our conditions and it is necessary to conduct studies on the reasonable parameters and operating modes of the mentioned plow.

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III. MATERIALS AND METHODS OF INVESTIGATION

In several foreign countries combined ploughs assembling plough body with spinning rotor are used to improve the main soil cultivation quality and decrease tractive resistance. In order to check effectiveness of such plough in soil-climatic conditions of irrigating agriculture in Uzbekistan a three-unit mounted plough with rotary mouldboard has been produced (Baymetov et all, 2006) in the Agriculture mechanization research institute (figure 1). The plough consists of a frame 1, a mounting system, hydraulic and chain gear, hydraulic motor 2, a supporting wheel 3 and a rotary mouldboards 4.

Figure 1:Overview of the plough with rotary mouldboards:
1-plough frame; 2-hydraulic motor; 3-supporting wheel; 4-rotor.

The rotors are rotated from the tractor's hydraulic system through a hydraulic motor, sprocket and chain gear. The frame of the plough serves to protect the chain gear, as for the safety and ergonomics all gears (chains, sprockets) are located inside the frame of the plough. Ploughing depth is steeplessly regulated by means of rotation of propeller fixed on the support wheel.

The specific feature of the plough is an operative part consisting of shortened ploughshare, mouldboard and spinning rotor from hydraulic system of the tractor.

Differing from the moldboard-share plough operation technological process of operation is realized as follows: the soil layer is cut from side and bottom with the help of a field cutter and shortened share plough body and is fed to the spinning rotor. With the stabbings of knives (shoulder blades) of the rotor, the soil layer is further destroyed, turned around and thrown into the furrow of the previous passage.

Experimental investigations have been carried out to prove theoretical background and getting main parameters and operating regime of the combined plough.

Economic tests of the plough were performed in the fields of the farm "Nurafshan" in Jizzakh region in the summer period while preparing the soil for re-harvesting after harvesting cereal crops.

Test conditions of the area satisfied all agro-technical requirements. Average humidity and soil hardness in layer 0... 30cm was 8.9... 12.5% and 1.8... 4.4MPa.

The combined experimental plough was aggregated with the 3rd class CASE MAXXUM MXM-140 tractor.

Assessment of the quality of the experimental plough was carried out in comparison with the mounted plough PN-3-35. Ploughing was carried out in the depth of 27... 30cm and at three speeds of 6, 7 and 8km/h in comparative tests. The crest of the ploughed field was determined by a rack-and-gear type profiler.

IV. RESULTS AND THEIR DISCUSSION

Economic tests of the experimental sample of the plough showed its high efficiency. While plowing the field after harvesting crops in the summer period on soils with insufficient humidity gave a small lumpy crumbling of the soil with the output of agronomical valuable fraction sizes less than 50mm was 83-88%, when the output of this fraction was 61% in comparison with the production plough. Moreover, the output of the soil fraction of more than 100mm in the production plough was 18%, whereas on the plough with rotary moldboard was 2-3% (Figure 2).

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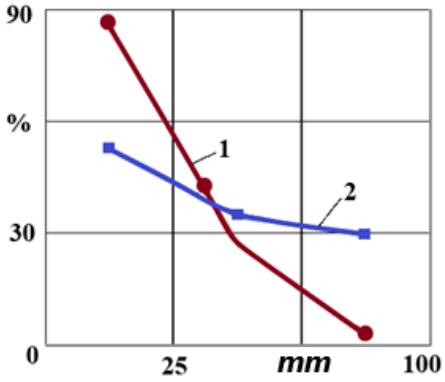

Figure 2: Comparative graph of the degree of soil crumbling combined plough (1) and plough PN-3-35 (2)

Profiles of the ploughed field surface before (a) and after processing (b) by means of conventional and experimental ploughs are shown in Figure 3 and 4.

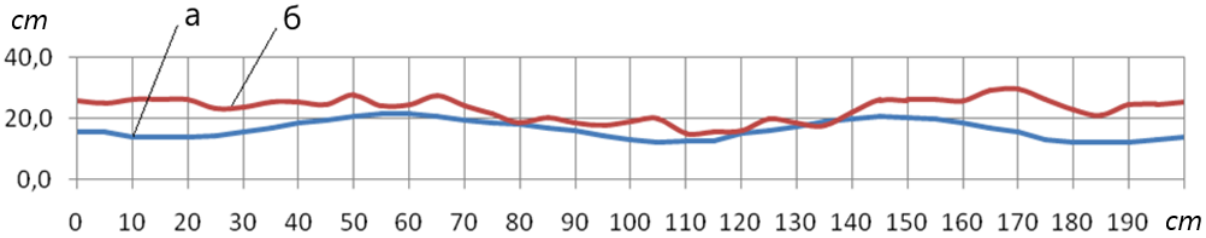

Figure 3: Profiles of the field surface before (a) and after ploughing (b) by the plough PN – 3-35

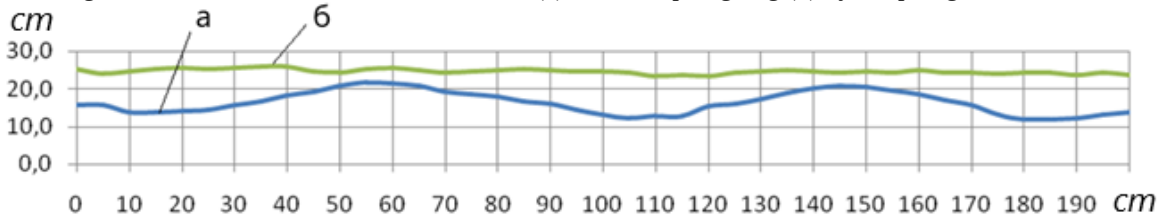

Figure 4: Profiles of the field surface before (a) and after ploughing (b) by experimental plough with a rotor

From Figure 3 and 4 it is clear that the ploughing surface after processing by an experimental plough is levelled, the average height of the crests does not exceed 5cm, while the ploughing surface after processing with a conventional plough requires additional operation by other tools for destroying large boulders and leveling the irregularities of the field surface. The depth of the plant residue was 8...10cm at the depth of 27-30cm. The degree of soil spraying is almost the same as the degree of spraying by conventional ploughs.
The dependence of ploughs traction resistance on the progressive speed of the unit is given below in figure 5.

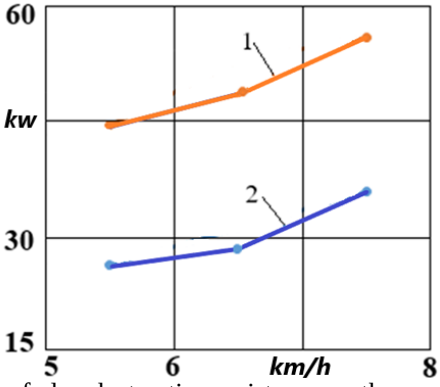

Figure 5: The dependence of ploughs traction resistance on the progressive speed of the unit

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The line graph shows that traction resistance of experimental plough with combined moldboard is 22… 26% less than share plough. The traction resistance of the combined plough is reduced due to the formation of the pushing reactive force. Thus, transferring some of the power through the tractor's hydraulic system, the combined plough more rationally uses the power of the tractor.

V. CONCLUSION

Comparative economic tests have shown that the plough with rotors according to the main agro-technical readings such as the degree of soil crumbling, lumpiness and leveling the surface of the ploughing land exceeds mouldboard-share plough.

Good crumbling of the soil and mixing with it organic and mineral fertilizers throughout the arable layer, reducing the number of passage units and a number of other positive elements is obtained with the use of combined ploughs, which improves conditions of agricultural crop yields. The plough with rotary mouldboard gives a smooth, merged prepared for sowing arable land for one pass, replacing the treatment of the soil with a share-moldboard plough following chisel plowing and harrowing.

The application of a plough with rotary mouldboards increases the use of the tractor's useful power, which is particularly important for energy-saturated tractors, by transferring part of the power through the hydraulic system or PTO.

Technologically-economic calculation shows that the given cost of preparing the soil for sowing a combined plough is much less than when plowing with a share-mouldboard plough following chisel plowing and harrowing.

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