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Linear-step plow for smooth plowing of field slopes

Farmon Mamatov, Nurbek Rashidov, Isroil Temirov, Sunatullo Badalov

Professor, Karshi Engineering-Economics Institute (KIEI), Karshi, Uzbekistan,
Doctoral studies, Karshi Engineering-Economics Institute (KIEI), Karshi, Uzbekistan,
Assistant professor, Karshi Engineering-Economics Institute (KIEI), Karshi, Uzbekistan,
Researcher, Karshi Engineering-Economics Institute (KIEI), Karshi, Uzbekistan

ABSTRACT: The aim of the research is to develop a linear-step plow for the smooth plowing of the slopes of fields. The authors proposed a plow with additional disk workers for plowing slope fields. The design of the developed plow and the results of its field tests are given. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Tests of the plow showed that during the operation of a linear-step plow, ridges with a height of 11.5-13.4 cm are formed on the surface of the arable land, and loosened steps are formed at the bottom of the furrow. The combination of the stepped bottom of the furrow with the ridge surface of the arable land contributes to the retention of water and the exclusion of soil flushing after heavy rainfall.

KEY WORDS: technology, plow, smooth plowing, inclination of fields, spherical disk, water erosion.

I. INTRODUCTION

Studies of scientists [1-6] have established that agricultural techniques are important for preventing water erosion and combating it. In the conditions of the bagarny zone of Uzbekistan, which is subject to water erosion, in order to protect the bogarny dark gray-earth soils from water erosion, to preserve the deficit-free balance of humus and the main elements of plant nutrition, S. S. Rustamov recommends using non-fallow tillage with flat cutters and heavy harrows (BDT-3.0) with alternating traditional dump plowing to a depth of 20-22 cm [7]. To reduce moisture losses in the plowed layer, a method of plowing the soil on the slopes is proposed, including two-layer treatment with a turnover of the upper and lower layers [4-6]. The upper layer is plowed to different depths, i.e. stepwise, and so that the upper adjacent layers increase in depth in the direction of the slope rise. The lower treatment is also carried out by plowing, and the layers of the upper and lower layers are swapped. The thickness of the adjacent layers of the lower layer increases in the direction of lowering the slope so that the total processing depth remains constant and the upper layers are laid on the lower ones with an offset, overlapping the joints between the lower layers. This makes it possible to obtain intra-soil step plowing, which contributes to the retention and accumulation of soil water on sloping fields, as well as the elimination of intra-soil erosion.

II. SIGNIFICANCE OF THE SYSTEM

The article presents the results of research on the development of a linear-step plow for the smooth plowing of the slopes of fields. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. LITERATURE SURVEY

Ukrainian scientists [8] have recognized the promising periodic use of the following long-tier soil treatments in the crop rotation system: two-tier plowing, dump-flat-cutting, dump-chisel and flat-chisel treatments. K.V.Alexandryan and others [5] claim that plowing with a soil depression on slopes with a steepness of more than 2° reduces runoff by 40% compared to conventional plowing, and soil deepening by 30-35 cm reduces runoff from 0.8 to 4.5 mm for each centimeter of the recess.

Deep and continuous plowing to a depth of 35-40 cm has not found wide application in Russia and abroad due to the increased energy intensity of the unit, its low productivity, significant labor and money costs, high fuel consumption [4, 5]. Step plowing is one of the effective ways to regulate intra-soil runoff [5]. At the same time, loosened strips (steps)

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are laid along the direction of movement of the unit in the subsurface layer. Well-known methods of loosening the sub-arable soil layer are strip and ribbon soil-deep loosening. A kind of step plowing is a ridge-step tillage, in which furrows are formed on the surface of the arable land, and at the bottom of the arable layer, loosening-steps. Ridge-step plowing prevents the runoff of meltwater on slopes with a steepness of up to 6° [4-8]. For comb plowing, a conventional plow is used, in which one of the bodies has an elongated blade up to 40-50 cm. This dump forms a ridge at each passage of the arable unit, blocking the way for water runoff [5].

F.M.Mamatov and B.M.Mirzaev proposed a plow consisting of plow bodies displaced relative to each other, ploughs, soil dredgers installed behind even-numbered buildings [9-12]. The disadvantage of this plow is the low quality of work. Since the odd plow bodies carry out an incomplete rotation of the formation. As a result, plant residues are not fully sealed. At the same time, the layer wrapped with an odd body rests on the front part of the layer wrapped with an even body at 180°, as a result, a large void is formed under the incompletely turned layers, which can lead to the accumulation of water, respectively, washing away the soil. In addition, ridges with a small height are formed on the surface of the arable land, which does not contribute to the complete retention and accumulation of rainwater. As a result, the occurrence of water erosion is not completely prevented.

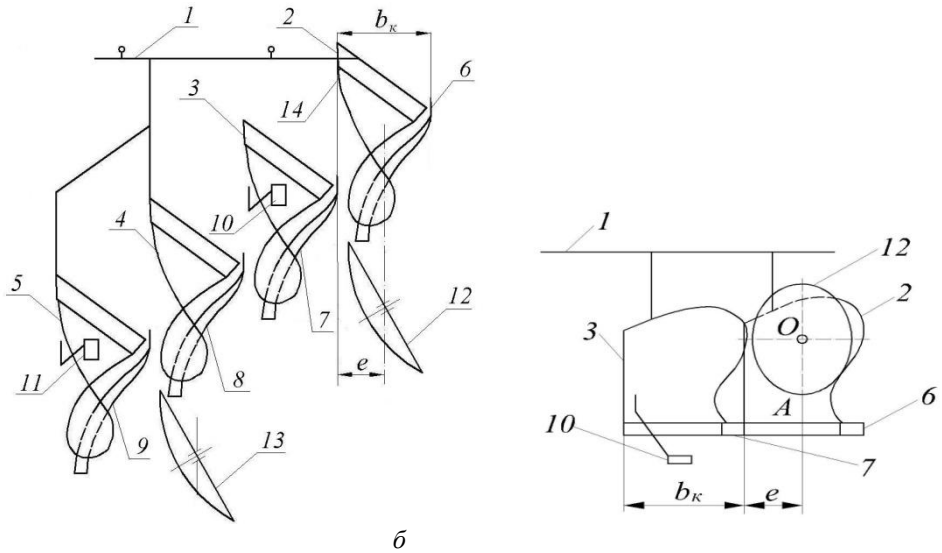
The purpose of the study is to develop a linear-step plow for the smooth plowing of the slopes of fields.

IV. METHODOLOGY

The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study.

V. EXPERIMENTAL RESULTS

The authors [9] proposed for processing slope fields (Fig. 1). The plow contains a frame 1, on which the housings 2, 3, 4 and 5 are installed sequentially in turn. The housings are located with an offset relative to each other, on which guide plates 6, 7, 8 and 9 are installed with working surfaces facing the ploughshare surfaces of the housings. Soil dredgers 10 and 11 are installed behind the black buildings 3 and 5. Spherical disk working bodies 12 and 13 are installed behind the odd housings 2 and 4, while the lower cutting point A of the working body is located in the plane of the middle of the body's grip width, i.e. in the transverse direction, the center of rotation of the disk *O* is located at a distance e=0.5 b_k from the field cut line 14 of the odd housing.



а *б*

Fig. 1. Diagrams of the plow for plowing slope fields (*a*) and the relative position of the housings and the disk working body (*b*)

The plow works as follows. Plowing with a plow is carried out across the slope. In the process of tillage across the slope, an odd body 2 with a gripping width b_k=45-52. 5 cm, penetrating into the soil, separates the layer with a

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thickness a from the bottom of the furrow and interaction with the guide plate 6 wraps it 180° into its own furrow. Then the spherical disk worker 12 removes the top layer of soil from the middle of this layer and turns it to the right on the previous layer. After that, an even body 3 also with a gripping width bk, penetrating into the soil, separates the layer with a thickness a from the bottom of the furrow and, interacting with the guide plate 7, wraps it 180° into its own furrow. Simultaneously with the rotation of the formation with an even body 3, the soil dredger 10 performs sub-tillage loosening of the soil to a depth of ap. The other buildings work in the same way. At the same time, a depression is formed on the surface of the arable land in the middle of the formation turned by odd hulls, and at the junction of this layer with the previous layer – a water-retaining ridge. Thus, after the passage of the plow, a stepped bottom of the furrow and a ridged surface of the arable land are obtained. The combination of the stepped bottom of the furrow with the ridge surface of the arable land contributes to the retention of water and the exclusion of soil flushing after heavy rainfall. All this contributes to improving the quality of processing and preventing water erosion on slope fields.

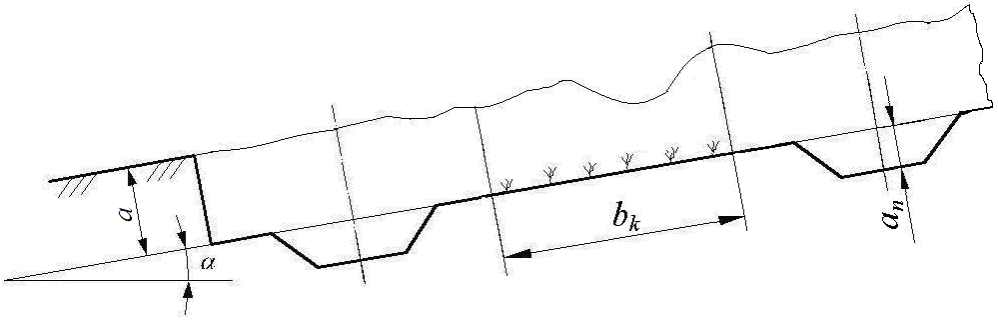

Fig. 2. Cross-section of the field after ploughing

The authors developed and manufactured a linear-step plow with additional disk working bodies for plowing the soils of slope fields (Fig. 3).

Fig. 3. General view of a linear-step plow for plowing the slopes of fields

The results of preliminary tests show that when the proposed plow is used for comb-step plowing, ridges with a height of 11.5-13.4 cm are formed on the surface of the arable land, and loosened steps are formed at the bottom of the furrow. The distance between the loosened steps and the ridges is 90 cm. The combination of the stepped bottom of the furrow with the ribbed surface of the arable land contributes to water retention and the exclusion of soil flushing after heavy rainfall, i.e. water erosion. In addition, the plow for comb-step plowing when working carries out a shuttle method of movement without pile ridges and camber furrows, which contributes to a significant increase in the quality of plowing and labor productivity.

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VI. CONCLUSION AND FUTURE WORK

1. A linear-step plow for smooth plowing of field slopes improves the quality of processing and prevents water erosion on slope fields.
2. It is established that during the operation of the proposed plow for comb-step plowing, ridges with a height of 11.5-13.4 cm are formed on the surface of the arable land, and loosened steps are formed at the bottom of the furrow, which help to prevent water erosion on slope fields.

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