

Strip tillage as an implementation of resource-saving approaches in areas of risky agriculture

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Abstract. Zones of farming with arid climate require scientific justification and competent approach in the field of tillage. The main objectives in developing approaches to mechanical tillage in the field of soil-protective technologies are to reduce erosion processes, accumulate and retain moisture, create favorable conditions for the growth of cultivated plants in the root zone. Reducing the number of soil treatments during the growing season of plants contributes to the ecologization of the soil treatment process and the solution of economic problems. Soil-protective measures also include methods of wind speed reduction in the surface layer. In the article various approaches to the methods of mechanical soil tillage, recommended for use in the zones of risky agriculture on the example of the Volgograd region, are considered. Technical solutions, which allow solving the problems of a modern crop producer by improving the environmental friendliness of agriculture, increasing the crop yield, and increasing the profitability of production, are proposed.

Deep tillage is the most important link in the system of agrotechnical measures aimed at maintaining optimal conditions for plant development. However, this operation is high-cost in terms of energy and as a consequence, its economic efficiency is reduced. In recent years, technologies that reduce these costs have become increasingly attractive. The choice of producers is often aimed at minimizing tillage. In the arid conditions of the Lower Volga region the techniques of moisture accumulation and retention are extremely relevant. Combining the two most important aspects in the approaches to tillage is helped by a number of technical and technological solutions, the aim of which is to till the soil with the help of a harrow in the framework of strip-till technology [1,2,3].

The possibility of minimizing tillage depends on the correspondence of agro-ecological conditions of the land plot to the grown crop, and the intensity of tillage - on the quality of the soil itself [4,5,6]. Factors for choosing the minimum tillage system are significant deviations from the normative indicators of density, fusion, hydromorphism and solonetzicity. The presence of other undesirable characteristics of the soil environment are also taken into account in the choice of methods to regulate the state of the arable horizon. This affects the development of necessary approaches to the formation of energy-saving principles and systems of tillage [7,8,9]. In this connection, we have developed a method of

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minimum tillage [Patent 2612798 RF], a resource-saving tool "ROPA" [Patent 2489826 RF] (Figure 1), and a soil tillage tool for strip-tillage OMPO-5.6 [Patent for useful model No. 154634 RF] (Figure 2), performing shallow tillage with a strip-till.



Fig. 1. Working body "ROPA": 1 - rack; 2- blade; 3- chisel; 4- fastening bolt; 5- paw; 6- attachment point of the trimming foot.

During the movement of the machine-tractor unit the technological process of loosening is carried out under the action of tensile and compressive forces, which cause intensive destruction of intra-soil bonds. With the help of the chisel the undercut layer of soil is lifted, bent and stretched in both planes. The required zone of continuous loosening is formed due to undercutting of inter-soil ridges by one-side undercutting foot, which has the possibility of vertical movement along the prop. The adopted construction of the working body "ROPA" allows to halve the number of working bodies on the tool frame in comparison with the work tools with straight legs. This also affects the operational and economic performance of the machine-tractor unit.

Cultivation of row crops has its own features. Tilled crops are responsive to deep tillage. That is why the depth of tillage and possibility of its regulation is extremely important. In areas of risky agriculture tillage should have the purpose of extensive accumulation of precipitation and its retention in the soil [10,11,12]. Therefore, it is recommended to use tools for strip-till deep tillage for row crops. This machine has a possibility to regulate the parameters of the cultivated strip [patents RF 2533038 and 2544950] (Figure 3). The tillage depth is limited by the critical loosening depth. There is also a possibility of using this machine for tillage of various crops due to adjustable width of cultivated strip (0.25 - 0.3 m).

The central place in the construction is occupied by the cheesecloth. If a seed line is installed on the cheesecloth, it is possible to sow simultaneously with the ripping operation (with a single-phase stripper). If a fertilizer and ameliorants can be applied to the root zone of cultivated plants at the same time. In order to trim weeds or improve the quality of the cultivated strip, the undercutting tines can be installed on the cheesecloth with the possibility of vertical movement. The working width of the cutting tines does not exceed the working width.

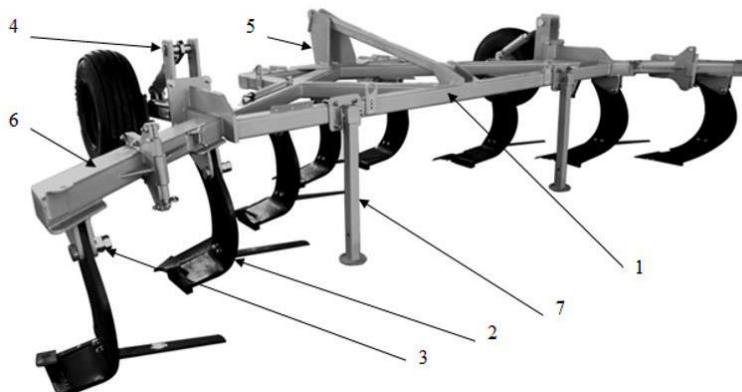


Fig. 2. OMPO-5.6 minimal strip processing tool: 1 - frame; 2 - working body; 3 - bracket; 4 - wheel mechanism; 5 - hitch; 6 - console; 7 – stand.

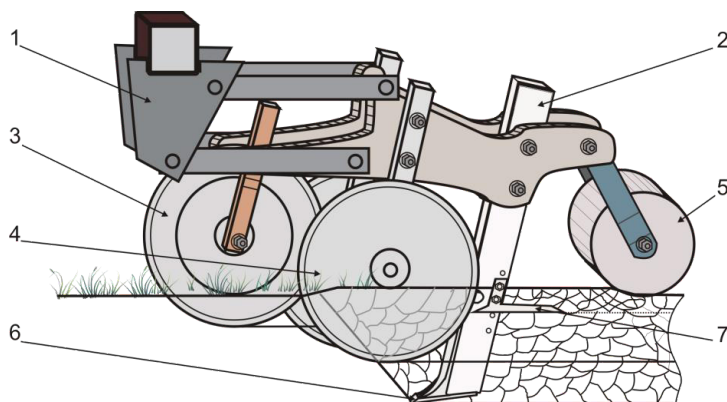


Fig. 3. Tool for deep strip tillage: 1 - parallel linkage system; 2 - moldboardless ripper with a fertilizer guide; 3 - central circular knife; 4 - circular knives; 5 - rolling roller; 6 - chisel; 7 - trimming paw.

In order to improve the operational and technological performance of the tool for strip deep tillage, the design of the working elements has been changed [Patent RF 2714289] (Figure 4) [14].

The implement has the ability to carry out deeper tillage up to 0.45 m. The straight tine with a tine tip up to 0.03 m creates a slot into which autumn and winter precipitation is actively infiltrated. In the upper part of the tine there are undercutting wings, which have the ability to move to the desired depth for additional crumbling of the soil in the cultivated layer. This is achieved by bending the outer ends of the undercutting wings. The profile of the bent end along the bend line in the longitudinal plane forms an angle of additional soil crumbling in the area formed by the undercutting wings. The size of the undercutting wings is made according to the size of the ripping strip taking into account the thickness of the stand. This technical solution is recommended for main deep soil cultivation primarily for row crops, but also for various other agricultural crops grown in the strip-till farming system.

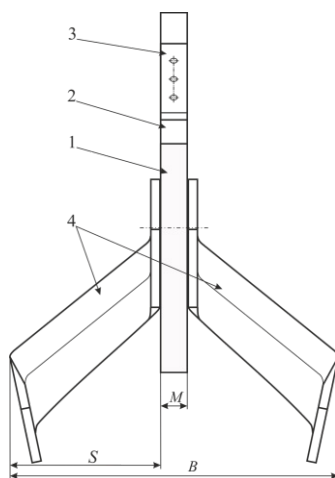


Fig. 4. Working body of the tool for strip deep tillage with the possibility of additional soil crumbling in the regulated layer (assembled view): 1 - rack, 2 - shoe, 3 - superimposed chisel; 4 - undercutting wings.

The technical effect is achieved by vertical undercutting of a cultivated strip and increasing the zone of soil deformation of undercutting wings without increasing the width of a cultivated strip.

The approaches proposed by the authors are highly effective methods of soil protection from all types of erosion and contribute to active accumulation and retention of moisture [14,15,16]. This makes the tillage technology resource-saving, economically and environmentally attractive for all regions of arid and risky agriculture [17].

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