Universal Tillage Unit

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Abstract. The article presents the problem of the variety of machines used in the implementation of basic tillage, a brief analysis of technologies and mechanized means and the development of a modernized design of a universal tillage unit. In the developed unit, the combination of chiseling methods, including deep one with drainage, with methods of smooth plowing and diskig was carried out. The novelty of the unit is that the frame of the fixed section of the plow is made in the form of a square, in which a channel-shaped guide ring is inserted with a mounted frame of the movable section, made removable and interchangeable with a longer one and with an increase in the number of working bodies depending on the width of the grip. Racks, which are equipped with bearing units, and additional levers, rods and lanyards placed diametrically opposed. The frames of the movable and fixed sections are equipped with holes for fixing with locking fingers in the longitudinal position and in the transverse position.

1. Introduction
Research conducted at the “Kuban State Agrarian University named after I.T. Trubilina ”established that: the key performance indicators of tillage mobile machines are two characteristics - the rate of production (productivity) and fuel consumption. The existing tillage processes are imperfect due to the use of multioperation and the large nomenclature of machines [1]. No less important is another environmental problem related to the quality of tillage and soil compaction [2,3,4], since the low quality of loosening of soil structures of the upper horizon and compaction does not provide conditions for the effective accumulation and use of soil moisture and do not contribute to guaranteed yields cereals in the conditions of risky dry farming. Thus, reducing the variety of machines used and multi-operation is very important, especially for the steppe zone of the North Caucasus (Krasnodar Territory, Rostov Region and Stavropol Territory), which is the main grain-growing zone of Russia. Moreover, the purpose of soil cultivation is the formation of the treated moisture-saving and moisture-accumulating layers of the soil, especially in conditions of insufficient moisture, as well as reducing plant damage from fusarium, due to which crop losses can be from 30 to 40%.

The purpose of the research –is to improve the technology and design of plows to increase the efficiency of tillage and reduce the range; reduction of anthropogenic load on the soil.

Research Objectives:
- to analyze the structural and technological solutions for soil cultivation;
- to develop an improved design of a universal tillage unit for mechanized processes of loosening of soil structures;
- develop design documentation (working drawings of the unit)
2. Materials and methods

Research materials were patents, articles, characteristics of well-known tillage machines and units.

The following research methods were applied in the work:
- exploratory research for solving inventive problems, including: the method of common sense, trial and error, analogy, associations, brain attack (brainstorming), synteics, creative discussion, etc.;
- patent research;
- modeling of structural elements in the form of a list of 3D models with the development of design documentation in accordance with standards.

3. Results and discussion

A brief analysis of well-known structural and technological solutions such as “Plow for smooth plowing” (see RF patent No. 2154925), Utility model “Plow with a rotary beam” (RF patent for utility model No. 184196), to which the working bodies for turning the formation are made in the form of two spherical disks with uprights and bearing assemblies, the utility model “Plow with a swivel beam” (RF patent for utility model No. 193872), which is equipped with a hitch system, with a front beam with chisel working bodies aggregated with each other, a plowing block with swivel beam and packer roller, showed a number of disadvantages.

These include the fact that the “Plow for smooth plowing” and the “Plow with a rotary beam” have a beam with symmetrically fixed rotary working bodies on the frame in two supports (by means of a hinge and a guide), therefore an additional support is needed at the end of the beam - wheel.

It also has low functionality, due to the fact that the plow can only have one operation. The disadvantages of the "Plow with a swinging beam" can also include low functionality - chisel loosening, smooth plowing, rolling.

Low resource of the bearing assembly, due to the need to rotate the disks in one direction or the other. The disadvantages of all these tools include the fact that there is no possibility of increasing productivity, since it is impossible to extend the beam; it is also not possible to move the unit with the swing beam on public roads without coordination with the relevant supervisory authorities, because the transverse dimension is not indicated. Based on search research, we have developed and proposed a universal soil cultivating aggregate (Fig. 1) that contains a coupling system 1 with an energy tool, a front wheel block with height adjusters, a chisel loosening unit 2, a universal plowing or disking unit 3, a transport wheel block 4.

The plowing or disking unit, position 3 in Figure 1, a top view of which is shown in Figure 2, contains a frame 1 of a fixed section which is made in the form of a square square profile welded from a steel pipe with dimensions of 2400 × 2400 mm. A guide ring 2 of a channel-shaped section is inscribed in the square. In the ring there is a frame of the movable section 3 with working disk elements 4 of the "daisy" type at an angle of 140-150 ° to each other, mounted on hinged racks and with angle adjusters 5. The intersection points of their projections are placed along the track of the chisel chisel bits located in front. Using the hydraulic cylinder 6, the movable section 3 can be rotated through an angle α ranging from +45 ° to -45 ° to the direction of travel.

Frames 1 and 3 are equipped with holes for fixing the movable section with snap fingers, in the longitudinal position for plowing, in the transverse position for disking. In preparation for disking, the disks of one row of the movable section are rotated 180 °.

The proposed new elements are known in the engineering fields of science and technology, but this unit is used for the first time.

Using the proposed design of the unit will reduce energy consumption, expand the functionality, improve the quality of tillage.

Development of working drawings of the unit was carried out on the basis of modeling of structural elements in the form of a list of 3D models with subsequent transfer to the «BDT-AGRO» group of companies for manufacturing, field testing and subsequent distribution.

For the working bodies of cheating and disking, past tests and components and parts tested during operation have been used. Fig. 3 presents the types of production sample "Block plowing or disking".
Figure 1. Universal tillage unit.

Figure 2. Block plowing or disking.

Figure 3. Types manufactured at the factory production model "Block plowing or disking".
   a- side view, b-view straight.
4. Conclusion
To solve the problem of reducing the variety of used machines and multioperational main tillage, the goal and objectives of the research were set that were successfully completed:

- based on the analysis of existing tools and technologies revealed their significant shortcomings;
- using search solutions and inventive tasks, taking into account the identified shortcomings, a technological scheme and a constructive solution have been developed;
- based on the modeling of structural elements in the form of a list of 3D models, working drawings of the unit for the «BDT-AGRO» plant were developed, where an industrial design of the “plowing or disking unit” was made for subsequent field trials.

5. References
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Acknowledgments
The universal soil cultivating unit is designed to perform a set of works on soil preparation by plowing with disk plows while chizing and (or) treating it with the disking method.

The possibility of simultaneous rolling.

With its further improvement, the equipment provides for the coverage of the entire spectrum of soil cultivation work both in the pre-sowing and post-harvest periods.

It should be borne in mind that processing can be carried out with implements having a working width within 2.2 ... 4.6 m.

For reference: The design of the unit provides for the possibility of its transportation on public roads without coordination with the relevant supervisory authorities.

In November 2019, the plowing or disking block was demonstrated at the 26th International Agricultural Machinery Exhibition “YUGAGRO”, for which a certificate was issued to the author (Fig.4).