Design features of the working bodies of the harvester for harvesting melons and gourds

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Abstract. The research is aimed at the problems of the technological process of harvesting the fruits of melons, determining the current state of saturation with melons in the Volgograd region and the equipment of technical means intended for their harvesting. The purpose and objectives of the study are determined depending on the requirements for the design of agricultural machines. The design features of the working bodies of the harvester for harvesting melons and gourds are considered and described in detail in accordance with the requirements for harvesting them. As a result of the theoretical studies, the optimal performance indicators of the working bodies of the combine have been identified and their data have been presented, which will make it possible to create a high-quality design of the combine.

1 Introduction

The Volgograd Region is one of the key vegetable and gourd producing regions in Russia. According to the Committee of Agriculture of the Volgograd Region, about 39 thousand hectares were occupied by all types of gourds in 2021 in the region, 70% of the total area is occupied by watermelon fruits of various varieties, 15% is occupied by melon fruits, 10% by pumpkin fruits and 5% zucchini fruits. The technical equipment of farms engaged in the cultivation of melons and gourds is not enough. Automation of this area of agriculture is no more than 60%, all other technological processes are carried out using manual labor. The most labor-intensive technological operation in the cultivation of gourds is considered to be its harvesting, as soon as it accounts for more than 40% of all labor costs [1;3;5]. As a result of previous studies, a design of a harvester for harvesting melons and gourds was developed (figure 1), which includes the following main components: a swather, a roller, a fruit-lifting circuit, a fruit-catching table, a container and a manipulator.

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2 Materials and methods

The purpose of this work is to determine the design features of the working bodies of the harvester for harvesting melons and gourds. As a result of this goal, the following tasks were identified:

- Determine the main components of the combine.
- To determine the main working bodies of the combine units.
- Explore the working process of the working bodies of the combine.
- To determine the design features of the working bodies of the combine.
- Determine the optimal performance indicators.

Theoretical methods are used to solve the set goal and objectives.

Theoretical research methods make it possible to determine the design features of the working bodies of the combine, which are aimed at high-quality harvesting of melons and gourds.

3 Results

The swather and the packer consist of such main working parts as a hydraulic motor and a fruit-gripping bar.

The main task of the hydraulic motor is to transfer rotational motion to the conveyor belt of the swather and the roller. The conveyor belt is mounted on two vertical shafts, one of which is driving and the second is driven. The shaft of the hydraulic motor is attached to the drive shaft of the swather and the packer through a flexible coupling, and the body of the hydraulic motor itself is attached to the frame of the swather and the packer with the help of special fasteners.
The main design feature of the hydraulic motor is its small size, which allows its installation in hard-to-reach places. The main characteristics of the hydraulic motor include the possibility of reverse movement depending on the tasks, as well as the mandatory possibility of adjusting the rotation speed. Adjustment of the speed of rotation of the hydraulic motor will depend on the harvested variety and type of gourds, yield, as well as field conditions, which include the relief and weediness of the field [2;4;6].

The main task of the fruit-gripping bar is to capture the fruit and transfer torque to it, which helps to create the necessary moment for turning the fruit and moving it into the swath. The shape of the bar should provide a high-quality grip on the fetus, which is formed as a result of the action of the bar on its middle. The material of the bar should not damage the fruits, and, therefore, it must be rubberized, since rubber allows you to grip the fruit without slipping, and it injures the fruits less.

The fruit-lifting circuit of the harvester is closed by its type, therefore, it performs a continuous technological process for moving fruits from the rolling zone to the unloading zone. The fruit-lifting contour is a rubber-fabric tape, which has sufficient rigidity to interact with the soil and fruits, and also allows it to copy its contour qualitatively. The fruit-lifting circuit has two zones, a working zone and an idle zone. The working zone is located from the rolling-in zone to the unloading zone in the direction of rotation of the fruit-lifting circuit, the idle zone is from the unloading zone to the rolling-in zone in the direction of rotation of the fruit-lifting circuit. The main load falls on the fruit-lifting circuit and working bodies in the working area.[7;8;11]

Fruit-lifting blades are installed inside the fruit-lifting circuit, which carry out the capture of fruits in the rolling-in zone, transport them and unload them onto the fruit-catching table. Since the fruit-lifting blades carry out 3 technological operations mentioned earlier, their contour must be rigid for high-quality capture of the fetus, and the inner part of the blade must be elastic, since when the fetus is captured and lifted along the fruit-lifting contour, the fetus must be inside. Overturning (exit of the fruit from the blade) on the fruit-catching table is carried out at the critical moment of the transition of the blade from the vertical to the horizontal position when copying the fruit-lifting circuit. All elements of the blade should be rubberized, as it reduces injury to the fruit.[9-10]

In the upper part of the fruit-lifting circuit, a fruit-catching table is installed, the main task of which is to fix the fruit on its surface and further transport it to the container. The fruit-catching table must have a rubber coating on the outside, which will be applied to the metal base. It should be possible to adjust the height of the fruit-catching table, depending
on the type of melons and gourds being harvested, and the table must also be able to absorb the impact energy resulting from the overturning of the fruit from the fruit-lifting blades. It will be possible to absorb the impact energy by using springs on the racks of the harvesting table. The fruit-catching table must have a trough-like shape, which will allow catching the fruit directed from the blade, and the table must also have an angle of inclination directed towards the container and carrying out directional rolling of the fruit.

The container, in turn, has a sufficient volume, which varies from $V = 0.96 \text{ m}^3$ to $V = 1.96 \text{ m}^3$ and has the ability to load from 500 kg to 1000 kg. In order to unload the fruits from the container, it is equipped with nets that fill the entire volume of the container as it is filled with fruits. The container is equipped with a double self-regulating bottom, which, depending on the increase in the weight of the fruit, moves to the bottom point.

The unloading of the filled nets with fruits from the container is carried out using a manipulator installed in the center of the harvester. The manipulator includes a handle, boom and two hydraulic cylinders that adjust the angle of inclination and reach of the boom. The main task of the manipulator is to capture the net with fruits, lift them, move them to the extreme point of the combine and install the net on the field surface.

### 4 Discussion

The studied design features of the working bodies of the harvester for harvesting melons and gourds meet all the requirements for agricultural machines, and in particular equipment for harvesting melons and gourds. The developed and justified working bodies of the combine allow harvesting melons and gourds not only in the optimal agrotechnical terms, but also in the terms of late harvesting with wet soil.

### 5 Conclusion

As a result of the research, optimal performance indicators were identified and the values of the factors influencing the operation of the combine were optimized. Which include the following indicators:

- Width of capture of the unit - 6 m.
- Swath width - 1 m.
- Roll-in zone width - $C = 2490 \text{ mm}$.
- Height of the active roll-in bar - $B = 417 \text{ mm}$.
- Installation angle of the roll-in bar - 500.
- The height of the blades of the fruit-lifting circuit - $M = 684 \text{ mm}$.
- Distance between the blades "blade pitch" - $t = 684 \text{ mm}$.
- Container volume - from $V = 0.96 \text{ m}^3$ to $V = 1.96 \text{ m}^3$ or with the possibility of loading from 500 kg to 1000 kg.

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References


