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JUSTIFICATION OF THE PARAMETERS OF COMBINED-SECTIONAL DIGGING BLADES FOR A GARLIC DIGGER

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Annotation: The article presents an overview of garlic cultivation in the republic, the existing challenges in this sector, and a proposed solution in the form of an energy- and resource-efficient garlic digging machine. The study describes the machine's design, structural features, operating principles, and provides theoretical justification of the parameters of its combined-sectional digging blades.

Keywords: soil-climatic conditions, resource-efficient, friction angle, damage rate, planting pattern, working width, structural dimension, mechanization.

At present, particular attention is being paid in our republic to ensuring a stable supply of food products to the population using domestic resources, as well as to increasing export volumes. In this context, vegetable cultivation has been identified as one of the key development directions. Consequently, the area under vegetable crops in the republic has increased to 300.0 thousand hectares. Among these, garlic cultivation has been rapidly developing, and Uzbekistan has become one of the world's six leading countries in garlic exports [1].

Primarily, garlic in the republic is grown in household plots, small contour fields, and small-scale farms, which requires a high labor input, while the level of mechanization remains very low. About 75% of all expenditures in garlic cultivation are accounted for by the harvesting process [2, 3]. Therefore, the development of a garlic harvesting machine suitable for the soil and climatic conditions of our republic is of current importance.

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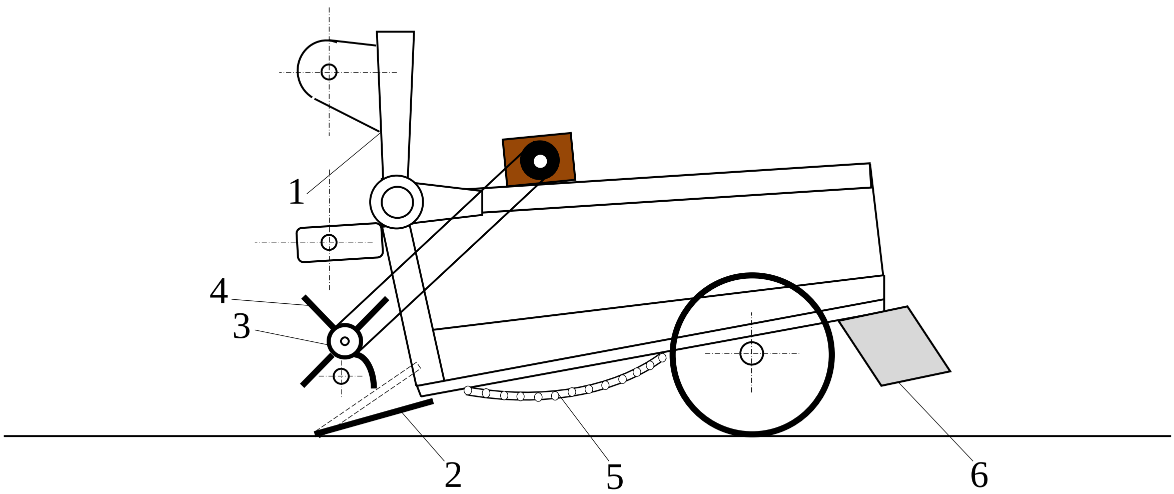
The limited use of foreign machines for garlic cultivation and harvesting in our country is primarily due to the fact that garlic is grown on small-scale plots, which results in varying planting patterns and row irrigation practices. During harvesting, the soil clods, which are often harder and larger than the garlic bulbs, increase the risk of damaging the garlic. This also affects the sorting of bulbs for seed purposes, since their geometric dimensions vary. Moreover, the separation of garlic bulbs for seed purposes and their size-based grading remain largely non-mechanized. In particular, the removal of weeds during the garlic vegetation period is still performed manually, relying entirely on human labor.

The working element that ensures the operational efficiency and energy- and resource-saving performance of the garlic digger is its digging blade. One of the ways to enhance the resource efficiency of the blades is to manufacture them in a sectional design. Accordingly, we propose the design of a garlic digger equipped with sectional blades for garlic harvesting (Figure 1).

The scientific and technical solution involves the justification of the parameters of the proposed garlic digger's sectional digging blades, such as working width, length, the length and opening angle of the nose part, and the installation angles of the blades relative to the horizontal plane, as well as the development of its design. The proposed garlic digger consists of a frame (1), sectional blades (2), a biter with its elastic paddles (3 and 4), an elevator (5), and a garlic collector (6) (Figure 1).



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1 – Frame; 2 – Sectional blade; 3, 4 – Biter and its elastic paddles;

5 – Elevator; 6 – Collector

Figure 1. Design scheme of the garlic digger

The two nose parts of the sectional blades of the garlic digger are flat, i.e., two-edged, while the two side edges of the blade base are slightly inclined relative to the horizontal plane, which effectively makes them a three-edged structure. This design ensures the fragmentation of soil clods during the harvesting of garlic bulbs.

The main parameters of the garlic digger's sectional blade include the installation angle relative to the horizontal plane (α), the opening angle of the blade's nose part (γ), the angle between the two side edges of the blade base (ε), as well as the total length of the blade (L_{um}), the length of the nose part (L_t), and the length (L_{as}) and width (B_l) of the base (Figure 2).

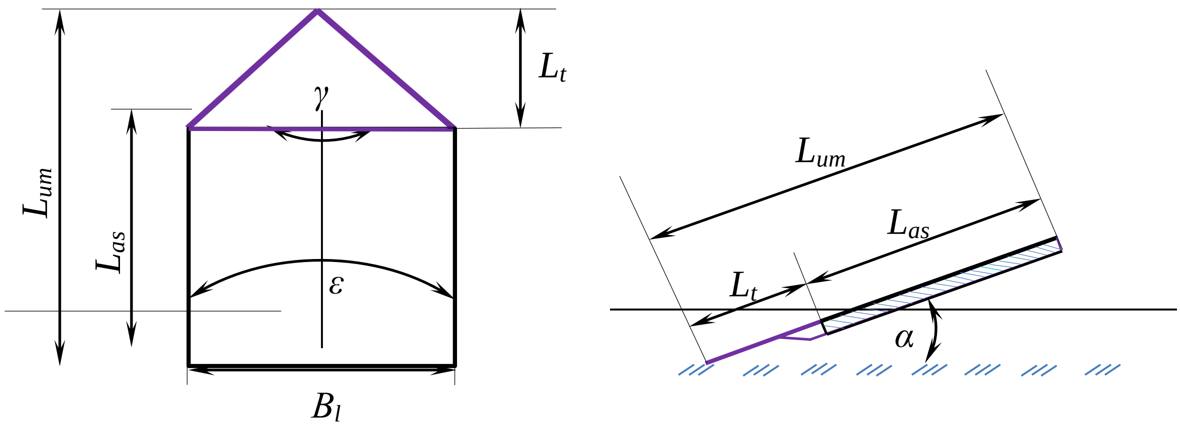

Figure 2. Scheme of the energy- and resource-efficient sectional blade of the garlic digger

During the garlic harvesting process, to ensure the free sliding of soil clods along the blade surface, the installation angle of the blade relative to the horizontal plane should not exceed 24–26° and can be determined using the following expression [2].

Based on the above and taking into account the physical and mechanical properties of garlic bulbs, the width and length of the proposed blade can be justified.

The total width of the garlic digger's blade is selected to fully cover the garlic bulbs in the row, and based on this, the number of blades and the structural dimensions of each sectional blade are determined.

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First, to fully harvest the garlic bulbs in a single row, it is necessary to determine the number of sectional blades. For this purpose, the most commonly used planting pattern of garlic in our republic is considered. According to the analysis of the studied literature, garlic is planted in three rows with a spacing of 15 cm between plants [4].

Thus, the total number of sectional blades should be three to cover a single row of bulbs and six to cover two rows.

Based on the above, the total width of the garlic digger's blades must satisfy the following condition [2, 5]:

$$B_{um} \geq b_{cp} + 3\sigma + c, \tag{1}$$

where

B_{um} – average width of the garlic row;

σ_{row} – root mean square deviation of garlic bulbs in the row;

c – lateral displacement of the machine during operation.

By substituting the values obtained in previous studies into expression (1), we get the following condition: $B_{um} \geq 53$ cm

The width of each sectional blade is determined using the following expression [2]

$$B_l \geq \left(b_{cp} + 3\sigma + c - 2b_n\right)/3, \tag{2}$$

where B_n – the minimum diameter of a garlic bulb.

By substituting the previously determined value Bn=3.0 cm from earlier studies into expression (2), we obtain the following condition: Bl≥15.6 cm.

According to the analysis of the literature, the opening angle of the blade's nose part can be determined using the following condition [2, 5]:

$$\gamma \langle 2(90 - \varphi), \tag{3}$$

where φ – the friction angle of plant roots relative to the blade edge, with a value of φ = 40–50° [2, 5].

According to expression (3), the average opening angle of the blade's nose part can be taken as 90°.

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Based on the condition of expression (3) and assuming the opening angle of the blade's nose is 90° (Figure 2), and considering the nose part as an isosceles right triangle, the length of the blade can be determined using the following expression:

$$L_{um} = \frac{h_{o'rt}}{\sin\alpha}, \tag{4}$$

where h_{ort} – the average height of a garlic bulb

By substituting the values of the blade installation angle relative to the horizontal plane, α=25° [2, 5], and the average height of a garlic bulb, h_{ort}=10 cm [2, 3, 4], into expression (4), we obtain L_{um}=23.6 cm.

Since the nose part of the blade is an isosceles triangle, its length L_t can be considered equal to half of its width B_l, and can be determined using the following expression:

$$L_t = \frac{B_l}{2}. \tag{5}$$

By substituting B_l=16 cm into expression (5), the length of the blade's nose part is determined as L_t=8 cm.

Knowing the value from expression (5), the length of the blade base can be determined as follows:

$$L_{as} = L_{um} - L_t. \tag{6}$$

or

$$L_{as} = \frac{h_{o'rt}}{\sin\alpha} - \frac{B_l}{2}. \tag{7}$$

According to expression (7), the length of the blade base is L_{as}=15.6 cm.

The conducted theoretical studies showed that the optimal parameters of the garlic digger's sectional digging blade can be achieved when its total length is L_{um}=23.6 cm, the width of the sectional blade is B_l=16 cm, and the installation angle relative to the horizontal plane is α=25°.

References

1. Official website: Lex.uz.

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2. Norchaev R., Norchaev D., Norchaev J., Rustamova N. **Construction and Theory of Root Crop Harvesting Machines.** – Tashkent: "Fan va Texnologiya". LLC, 2019. – 104 p.

3. D.R. Norchayev, M.A. Xaliqulov, X.I. Turkmenov, X.P. Shermuxamedov, G.N. Ibragimova. Acceptable solutions for harvesting root crops in the soil climate of the Republic of Uzbekistan // IOP Conference Series: Earth and Environmental Science 1076 (2022) 012029.

4. Norchaev D.R., Norchaev J.R., and Qo'ziev Sh.X. Justification of the Parameters and Energy Indicators of Sectional Blades of a Carrot Digger // Innovative Solutions for Increasing the Efficiency of Agricultural Machinery and the Use of Technical Means: Proceedings of the International Scientific and Technical Conference.– Gulbahor, 2022. 347-353 p.

5. Standards for Labor and Material Resource Consumption in Agricultural Production. Toshkent: QXIITI, 2016. – 80 p.