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Analysis of Ground Feed in a Drum Grinder

Borotov Atkham [1], Baimakhanov Kenzhemirza [2]

[1] National research university "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" (Uzbekistan)

[2] Associate Professor of the Department of Water Resources, Land using and Agrotechnology, M.Auezov South Kazakhstan State University (Kazakhstan)

Abstract: In Uzbekistan, special attention is paid to the development of livestock, poultry and fish farming. In the ration of animals, green fodder obtained by cutting green stalks corn, alfalfa and other feed crops has a special place. For high-quality chopping of stalks with the required cutting length for each type of animal, a chopper has been developed with a simple design for chopping green feed.Testing of the chopper work, carried out at an engine speed of 2800 rpm, a cutting drum rotation speed of 950 rpm and in two rotations of the feed rollers 10 rpm and 20 rpm with an average length of alfalfa stalks 71.6 cm and an average length of corn stalks 216.4 cm, showed that at a feed roller rotation speed of 10 rpm the average cutting length of the stalks was 10.6 mm, and at a feed roller rotation speed of 20 rpm - 17.6 mm. It can be seen from the data that with a twice increase in the feed roll speed, the cutting length increases 1.66 times, which confirms the theoretical assumptions obtained.

Keywords: stalks, chopper, cutting drum, knife, drum speed, cutting length.

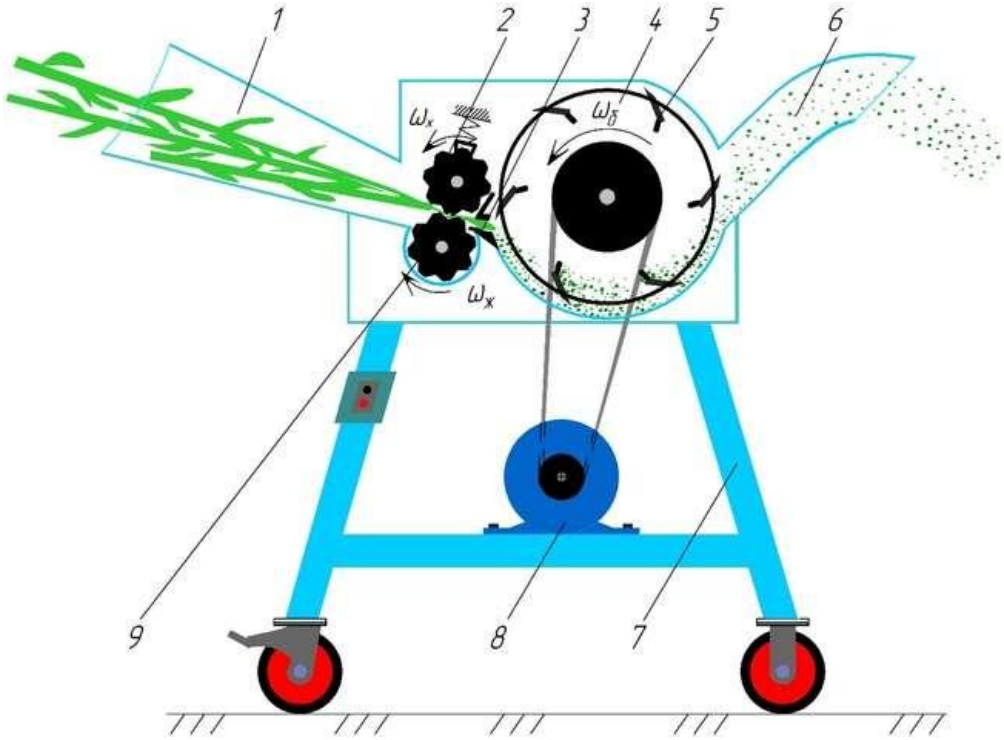
Introduction. Uzbekistan pays special attention to the development of livestock, poultry and fish farming. The emphasis is on the introduction of modern technology and innovative developments in industries. In the face of energy and resource shortages, it is important to create universal design of feed chopping machines that are resource-intensive, low-power, and reliably carry out technological processes and allow for the proper chopping of staple feeds. Therefore, research has been carried out on the development of choppers used in chopping of green stalk feeds in livestock, poultry and fisheries farms and cutting the feeds for each category of animal. As you know, feeding efficiency of livestock, poultry and fish farming depends on sorts of fodder and chopping them as well depending on the type and size of the creatures, it is necessary to trim the stalks from 5 to 100 mm [1, 2]. This is achieved by selecting the optimal type of chopping equipment, which is the main working part of the chopper. The results of the study of existing devices have shown that choppers with more blade drums meet this requirement [3-5].

Methods. For defining the work-quality indexes of the cutting used methods in State Standard 11448-2002 «Powered shredders and chippers. Safety requirements and test procedures» and testing the fodder choppers and their work efficiencies were determined according to State Standard 20915-2011 «Testing of agricultural tractors and machines. Procedure for determination of test conditions».

The technological scheme of the green stalk chopper was developed based on the analysis of existing equipment used for chopping and preparing feeds and the structure of their cutting apparatus.

The experiments were performed on the device's experimental sample.The experiments were carried out on chopping alfalfa and corn at a drum rotation frequency of 950 rpm and at a feed roller speed of 10 rpm and 20 rpm.

Result and Discussion. Devices for chopping and preparation of beetroot and other types of feeds, types of cutting machines used for chopping stalks and their cutting knives were studied [6-7]. Based on the research, a technological scheme of a compact lightweight device for chopping green staples for livestock, poultry and fish was developed (Fig. 1).



1-hopper; 2-spring pressing mechanism; 3-top roller; 4-cutting drum; 5-cutting knife; 6-deflector; 7-frame; 8- electric motor; 9-bottom roller.

Fig. 1. Green stalk chopper machine.

Chopping and feed cutting device consists of hopper 1, spring pressing mechanism 2, top and bottom roller 3 and 9, cutting drum 4, cutting knife 5, deflector 6, frame 7 and motor 8. The operation of the equipment for coarse chopping unit is as follows (Fig.1). The coarse chopping unit is capable of chopping green stalk feeds, and the stalk feeder passes hopper 1 to the roller 3 and 9. Then, rollers deliver to the cutting drum 4 using a counter-cutting plate and after completion of the chopping process, put in a special container. The movement is transmitted by the transmission of the motor 8. It is possible to trim the stalks to the required length by varying the number of rotating shafts and cutting drum rotations. The operation of this device has no negative impact on the environment and nature.

The theoretical studies were conducted to determine the cutting length of the stalk on the developed device. One of the most important indicators of stalks chopping is the cutting length [8]. When designing the chopper, a number of expressions are used to determine the cutting length depending on the type of chopping machine. The following expression is proposed by S.V.Melynikov to determine the computational cost of cutting length of stalk feeds

$$l_c = \frac{Q}{0.16azp\omega}, \qquad (1)$$

where Q - working capacity of the chopper, m;

a - height of the transmission line, m;

b - width of transmission line, m;

ρ - density of chopped feed, kg/m^3;

z - number of blades in the drum, m;

ω - angular velocity of the drum, s^{-1}.

This expression determines the length of the feed depending on the milling performance, the feed density, the height and the width of the feed, and when the stalk density changes, there is some uncertainty in determining the length of the trimming.

The cutting length of the trunks transmitted to the chopper is usually the following:

$$l_c = V_{tr} t_c, \quad (2)$$

where V_{tr} – the speed of the stalks transfer, m/s;

t_c – the time the knives are placed in the cutting drum to cut the stalks, s.

The time it takes to cut the stalk from the side blades can be calculated as follows

$$t_c = \frac{\pi D_d}{Z_k V_d} = \frac{2\pi}{Z_k \omega_d}, \quad (3)$$

where D_d - cutter drum diameter, m;

V_d - drum rotation speed, m/s;

Z_k - number of knives in the drum, m;

ω_d - angular velocity of the drum, s^{-1}.

Taking into account the time it takes to cut the stalk knives in parallel, the expression (1) appears as follows

$$l_c = V_{tr} \frac{2\pi}{Z_k \omega_d}. \quad (4)$$

The unknown value in this expression is the rate at which the stalks are transmitted to the truncation, as determined by the transmitter parameters. In the projected chopper, we choose the most commonly used corrugated surface pair of transporter-coupling transmission mechanisms. In such a transmission mechanism, the movement of the stalks between the transmitting joints is variable and the time taken to pass them

$$t = \frac{2\alpha_0}{\omega_r}, \quad (5)$$

where α_o - the angle of inclination of the stalk, degrees;

ω_r - angular velocity of rollers, s^{-1}.

The passing distance of stalks through rollersis as follows

$$S_d = 2(R_r + r_s)\sin\alpha_0, \quad (6)$$

where R_r – radius of roller, m;

r_s – radius of stalk, m.

According to (5) and (6), the speed of passing or transmitting the stalk between the rollers is as follows.

$$V_{tr} = \frac{2(R_r + r_s)\sin\alpha_0}{\frac{2\alpha_0}{\omega_r}} = (R_r + r_s)\omega_r \frac{\sin\alpha_0}{\alpha_0}. \quad (7)$$

In terms of the value of (7) and (4), the length of the stalk cutting in the cutter drum is:

$$l_c = \frac{2\pi}{Z_k \omega_d}(R_r + r_s)\omega_r \frac{\sin\alpha_0}{\alpha_0}. \quad (8)$$

In this expression, the value of all of the constituents in determining the length of the rods in the chopping process is unchanged, and only by adjusting the number of rotation cores and the transporter rotation can ensure the required cutting of the straps in the chopper. According to S.V.Melynikov's research, the speed of the feeder mounts should be higher than the transporter's velocity $V_r \succ V_{tr}$ and in this range, in order to better transfer the stalk to the cutting drum $V_r = (1{,}25 \div 1{,}35)V_{tr}$. According to N.E.Reznik there is a slip in the transmission of the stalk, and the rate of transmission of the stalks is always lower than the speed of the stalk $V_{tr} = (0{,}88 - 0{,}93)V_r$ and this is the ratio.

Taking this into account, the expression for determining the length of the straps on the drum chopper appears as follows.

$$l_c = \frac{2\pi}{Z_k \omega_d}(R_r + r_s)0{,}9\omega_r \frac{\sin\alpha_0}{\alpha_0}. \quad (9)$$

In this regard, the aim of the study was to develop an innovative small chopping machine that breaks down the green feed at the minimum requirements and justifies its parameters and operating modes.

From equation (9) it can be seen that the length of cutting of the stalks decreases with increasing frequency of rotation of the drum and the number of knives on the drum, and with increasing frequency of rotation and the diameter of the feed rolls, the length of cutting of stalks increases.

Conclusions. Testing of the chopper work, carried out at an motor speed of 2800 rpm, a cutting drum rotation speed of 950 rpm and in two frequency of the feed rollers 10 rpm and 20 rpm with an average length of alfalfa stalks 71.6 cm and an average length of corn stalks 216.4 cm, showed that at a feed roller rotation speed of 10 rpm the average cutting length of the stalks was 10.6 mm, and at a feed roller rotation speed of 20 rpm - 17.6 mm. It can be seen from the data that with a twice increase in the feed roll speed, the cutting length increases 1.66 times, which confirms the theoretical assumptions obtained.

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