Theoretical and experimental determination of the dimensions of the slope and length of the feed distribution device for family livestock farms

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Abstract. The livestock sector in family livestock farms is characterized by high productivity despite the small number of livestock and low consumption costs. But one of the main problems in these farms is the primitiveness of production and the high level of manual labor due to the lack of equipment suitable for their needs and requirements, including feed distribution devices. Taking into account the above, a small-sized, low-metal and energy-intensive resource-saving feed dispenser for family livestock farms was developed and its parameters determined.

1 Introduction

Today, cattle breeding in Uzbekistan is mainly developed in family cattle farms, where there are a total of 13 million animals in our republic. 12 million out of 154.3 thousand head of cattle. 169.2 thousand heads or 92.5 percent, 18 million sheep and goats in total. 91.3 thousand heads or about 80.5 percent are raised in family livestock farms [1-2].

Until now, the RMM-F-6, SRK-11V, KTU-10A, ISRK-12 and other dispensers were designed for large livestock farms, and due to their extremely large metal and energy capacity and high cost, the number of livestock today is small. family animal husbandry is ineffective when used on farms [3]. This situation, in turn, requires the development of a distribution device that will fully satisfy family livestock farms in terms of productivity and energy consumption, and in terms of work quality, it will not be inferior to the existing large-sized machines, which will distribute crushed coarse feed in high quality [4].

Considering the above, a small-sized, low-metal and energy-demanding resource-saving feed distributor device for family livestock farms was developed, and its theoretical and experimental dimensions of the slope and length of the discharge chute were determined [5].

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2 Materials and methods

Based on this, according to the theoretical research conducted, the crushed coarse feed coming out of the discharge window of the feed distribution hopper moves on the discharge chute under the influence of its own gravity and the discharge chute should have a certain slope.

We determine the slope of the discharge chute δ from the equation of motion of the crushed coarse feed

$$m\ddot{x} = G\sin\delta - F_{ishq}, \tag{1}$$

where F_{ishq} – friction force.

If we consider that $F_{ishq} = fN$, $N = G\cos\delta$, we can write the expression (1) as follows

$$m\ddot{x} = G\sin\delta - fG\cos\delta, \tag{2}$$

The analysis of the expression (2) shows that the following condition must be met for the crushed coarse feed to move freely on the discharge chute and spill onto the ground, i.e., the component of the gravity force along the surface of the chute should be greater than the friction force [6]:

$$G\sin\delta > fG\cos\delta. \tag{3}$$

(3) if we shorten the expression to G, this expression will have the following form:

$$\sin\delta > f\cos\delta. \tag{4}$$

Expression (4) can be written as:

$$\frac{\sin\delta}{\cos\delta} > f. \tag{5}$$

Since $\frac{\sin\delta}{\cos\delta} = tg\delta$ and $f = tg\varphi_{ishq}$ in expression (5) this expression is as follows:

$$tg\delta > tg\phi_{ishq}$$

or

$$\delta > \phi_{ishq}. \tag{6}$$

According to this condition, the slope of the discharge chute δ should be greater than the friction angle φ_{ishq} of the feed to the chute so that the crushed coarse feed moves freely on the chute and spills onto the ground.

If we take into account that the angle of friction of coarse feed is 29^0 according to the results of the experiment, then we can find out that the slope of the feed distributor discharge chute should be $\delta > 29^0$.

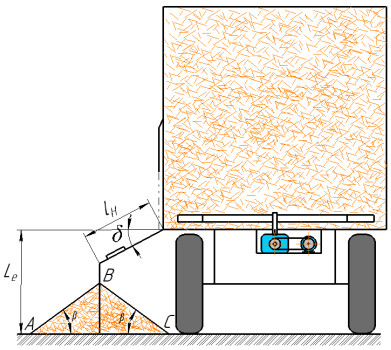

Fig. 1. Schematic diagram of a spillway and a pile of feed spilled on the ground.

A pile of coarse feed spilled on the ground is vertical and has a triangular cross-section in the plane perpendicular to the direction of the device. This triangle is labeled ABC in Figure 1.

The dimensions of the pile, namely height BD and width AC, the amount of distributed mass q and the volumetric weight of the unpressed (empty) coarse feed ρ_b and the natural slope angle β depend on it.

To find this relation, we use the following expression:

$$q = \frac{1}{2} BD \cdot AC \cdot \rho_b \cdot \tag{7}$$

(7) from $BD = DC \cdot tg\beta$ and $AC = 2DC$ in the composition

$$q = DC^2 tg\beta \cdot \rho_b \cdot \tag{8}$$

As a result, the height of the organization and it is found:

$$DC = \sqrt{\frac{q}{tg\beta \cdot \rho_b}}, \tag{9}$$

$$BD = \sqrt{\frac{q \cdot tg\beta}{\rho_b}}, \tag{10}$$

$$AC = 2\sqrt{\frac{q}{tg\beta \cdot \rho_b}} \cdot \tag{11}$$

The pile must be completely outside the hopper channel, so the following condition must be met:

$$DC < l_н \cos\delta, \tag{12}$$

where $l_н$ is the length of the drain.

From expressions (9) and (12), we determine the length of the drain pipe:

$$l_н > \frac{1}{\cos\delta}\sqrt{\frac{q}{tg\beta \cdot \rho_b}} \cdot \tag{13}$$

In addition, the bottom of the trough should be higher than the top of the pile, that is:

$$BD < L_e - l_н \sin\delta \cdot \tag{14}$$

From expressions (10) and (14), we define an additional condition for the length of the drain line:

$$l_н < \frac{1}{\sin\delta}\left(L_e - \sqrt{\frac{q \cdot tg\beta}{\rho_b}}\right) \cdot \tag{15}$$

If $q = 5kg/m$; $\delta = 35^0$; $L_e = 0{,}5m$; $\beta = 55^0$; $\rho_b = 70kg/m^3$, the following conditions must be met for the length of the drain pipe: $l_н > 0{,}273m$ and $l_н < 0{,}315m \cdot$

3 Results and discussion

According to the results of the experiment, the slope of the discharge chute The quality of uniform distribution of nutrients in the coarse feed distribution device depends to a large extent on the slope of the discharge chute. Therefore, in order to experimentally study the effect of the pouring chute on the quality of feed distribution, experiments were conducted by changing the slope of the chute from 30° to 45°.

In this case, when the slope of the pouring channel was increased from 30^0 to 45^0, when conducting experiments on distributing corn stalks, when the slope of the pouring channel was 30^0, the average amount of spilled feed was 4.3 kg/m, when it was 35^0, the average

amount was 4.72 kg/m, and when it was 40^0, the average amount was 5.29 kg/m. m, at 45^0 it was found to change to 6.42 kg/m on average (Figure 2).

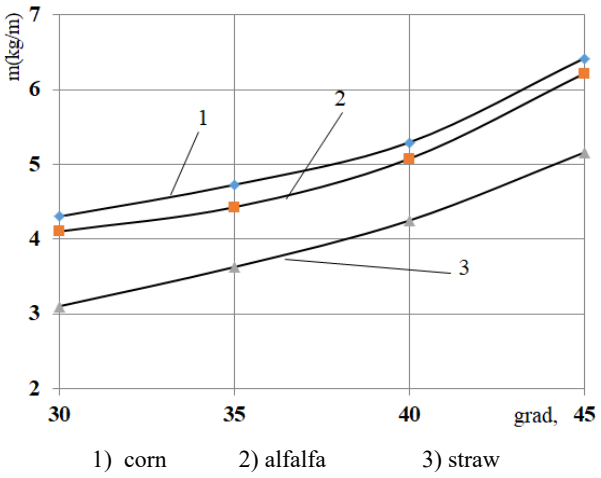

Fig. 2. Coarse feeds depending on the slope of the chute change in the amount of distribution.

When experiments were carried out in the above order and the alfalfa was studied by studying the slope of the pouring chute at 30^0, the average amount of spilled feed was 4.1 kg/m, at 35^0 the average was 4.42 kg/m, at 40^0 the average was 5.07 kg/m, at 45^0 the average was 6.21 It was determined to change up to kg/m (Figure 2).

When chopped straw was also studied, the average amount of feed spilled at 30^0 was 3.1 kg/m, at 35^0 was 3.62 kg/m, at 40^0 was 4.25 kg/m, and at 45^0 was 5.16 kg/m. change was found (Figure 2).

According to the results of the above experiments, it was determined that the quality of distribution of corn, alfalfa and straw is at the required level when the slope of the pouring channel is 35°. The mass of distributed feed was 4.72 kg/m in corn, 4.42 kg/m in alfalfa and 3.62 kg/m in straw, meeting the requirements [7-10].

From the above tables, it can be seen that when the slope of the discharge chute is 30^0, 40^0 and 45^0, the average amount of feed spillage corresponds to the specified level of demand, but it was determined that the feed is distributed unevenly.

Therefore, it was accepted that the slope of the drain channel should be 35°.

4 Conclusion

According to the above theoretical and experimental results, the distribution quality of corn, alfalfa and straw stalks of coarse feed is selected according to the amount of one-time feed in the daily ration of livestock in the range of 4-5 kg for corn and alfalfa, 2-3 kg for straw. taking into account the coefficient, it was determined that the slope of the spillway should be greater than 290, and the length of the spillway should be between 0.273 m and 0.315 m to prevent spillage of nutrients.

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