Abstract. Today, 87 percent of the number of cattle, as well as 90 percent of the number of sheep and goats in Uzbekistan are cared for by farmers. 85-90 percent of the number of livestock in our Republic belongs to peasant farms, and the preparation of feed for the livestock kept in these peasant farms should be implemented using best practices and modern technologies in developed countries, increasing the competitiveness and economic efficiency of the livestock sector is important. Based on the aforementioned information, a small-sized granulation line and a feed mixing device were created that are comparable to large-sized devices in terms of work quality and meet small livestock and poultry farms in terms of size, productivity, and energy consumption. The homogeneity of the feed mixing ratio in relation to the device's paddle shaft rotation count and mixing duration was investigated through experimentation. The results of the trials showed that when the feed mixer paddle rotor was turning at a speed of 50 revolutions per minute and the mixing period was set for five minutes, the optimal mixing quality of ground wheat grain, ground maize grain, ground rice, and wheat bran for the manufacturing of granular feed was reached.

1 Introduction

Small family livestock farms are the primary means of raising livestock in Uzbekistan, and the quantity of small livestock farms involved in this sector is about 5.3 million. Feeding livestock with nutritious feed leads to increase in productivity of livestock, increase in live weight and stability of health [1, 2].

Livestock feeding process includes feed preparation, feed mixing and distribution. Today, there are a number of disadvantages for the maintenance of livestock with pelleted feed on
tiny farms that raise cattle and poultry. That is, the mixing process of these nutrients before releasing the nutrients in the form of granules does not meet the requirement [3-5].

Feed is mixed by hand on small livestock and poultry farms due to the shortage of tiny, compact feed mixers. Consequently, there is poor mixing of feed components, significant labor expenses associated with feed mixing, and low productivity.

There are many factors that affect the quality of the feed mixture. The most important of them are: the size and shape of the particles of the components to be mixed, the sequence of their addition, the density of the components to be mixed, the time of mixing, and the accuracy of the proportions of the components [6-10].

Today, in world practice, granulation lines combining feed mixing and granulation operations are extensively used, which lowers the expenses associated with feed granulation and mixing operations. However, because these feed mixers are made for large livestock farms, they are not suitable for small farms that house 50–60 sheep or 5–10 cattle.

In light of this, studies were done on the creation of a tool for small livestock farms that mixes feed in a granulation line. The primary indicators of the feed mixing device's technical qualities were developed, and an experimental replica was made, taking into account the requirements of farms and the results of the research that was undertaken. The number of revolutions of the feed mixing device's rotor blades and the mixing duration were found to have an impact on the feed mixing quality, according to preliminary research.

2 Materials and methods

For the trials, an experimental clone of the feed mixer was made (Figure 1). GOST 34748-2021 "Machine tools for agriculture." distributors of feed. It was carried out using the "Test methods" standard manual as a guide [5].

Roughages of the same composition were prepared in order to guarantee the same composition of mixed roughage in all trials on the working components' parameters and the feed mixing device's technical process. It was made sure that the mixing mechanism in the experiments received the same quantity of coarse feed.

Fig. 1. Experimental copy of the feed mixing device.
During the comparison of speed and mixing time of mixing shovels, separate samples were taken from rough feed and the homogeneity of the mixing composition of mixed feed was determined according to their ratio.

Deviation of the amount of feed to be mixed from the set and indestructibility of the distributed feed were accepted as criteria for evaluating the device's performance.

The amount of blade rotor revolutions significantly affects the quality of granulated feed mixing. Taking this into account, research was conducted by changing the number of revolutions of the rotor from 40 r/min to 50 r/min based on the performance and size of the feed mixer device specified in the initial requirements and specifications.

The studies were conducted using a one-factor design [11, 12], with the rotor having eight blades, the blowing window measuring 25 cm in width and 30 cm in height, the distance between the blades and the bunker wall being 5 mm, and the width of the blades' working surface being 15 cm. The time of mixing the feed was set to 4–6 minutes, and the mass of the mixed feed in the middle part was taken for 5 minutes, and its mixing composition was determined to be uniform.

Samples of ground wheat, ground maize, ground rice, and wheat bran were placed in the device to identify these markers. Special laboratory filters were then used to separate the various fractions included in the combined feed. An electronic laboratory scale was used to measure each sample's fractional mass to within 0.01 grams, and the mass ratio was used to assess the mixing quality.

The results of the mass and composition of the samples taken in each experiment on food mixing were statistically processed on the basis of existing methodical manuals, and their average value was determined as Fragile, mean square deviation $s$ and coefficient of variation $V$ [11, 12].

In the experimental studies, the number of rotor revolutions was changed from 40 to 50 r/min, the number of blades was changed from 6 to 10 pieces, and the mixing time was observed at intervals of 4–6 minutes in order to ascertain the impact of the mixing device on the quality of feed mixing.

### 3 Results and discussion

In experiments on mixing ground wheat grain, ground maize grain, ground rice and wheat bran in a feed mixer device, it was found that when the number of revolutions of the blade rotor of the feed mixer device is 40 r/min, the mixing percentage of the mixed feeds varies from 85% to 92% in 3–6-minute intervals and averaged 89%. Mixing of the feed was 85 percent when the feed mixer was mixed for 3 minutes at 40 r/min and then sampled from the hopper.

![Fig. 2. Variation of feed mixing quality depending on the number of blade rotor revolutions 40 r/min and time.](image-url)
Mixing of the feed was 88 percent when the device was mixed for 4 minutes and then checked by sampling from the hopper. After mixing for 5 minutes and then taking a sample from the hopper, it was found that the mixing of nutrients was 91 percent, and after mixing for 6 minutes and then taking a sample from the hopper, the mixing of nutrients was 92 percent (Figure 2).

Mixing of the feed was 89 percent when the feed mixer was mixed for 3 minutes at 50 r/min and then sampled from the hopper. When the feed was mixed in the device for 4 minutes and then tested by taking a sample from the hopper, the mixing of the feed was 92 percent. After mixing for 5 minutes, the mixture of nutrients was 95 percent when tested by taking a sample from the hopper. After mixing for 6 minutes, after taking a sample from the hopper, it was found that the mixing of nutrients was 95 percent (Figure 3).

![Fig. 3. Variation of feed mixing quality depending on the number of blade rotor revolutions at 50 r/min and time.](image)

Mixing of the feed was 91 percent when the feed mixer was mixed for 3 minutes at 60 r/min and then sampled from the hopper. When the device was used for 4 minutes and then checked by taking a sample from the hopper, the mixing of nutrients was 93 percent. After mixing for 5 minutes, the mixture of nutrients was 95 percent when tested by taking a sample from the hopper. After mixing for 6 minutes, after taking a sample from the hopper, it was found that the mixing of nutrients was 95 percent (Figure 4).

![Fig. 4. Variation of feed mixing quality depending on the number of blade rotor revolutions at 60 r/min and time.](image)

Experiments have shown that when mixed feed before granulation is mixed with a shovel working part, the specified level of mixing quality, that is, 95 percent and higher, is achieved when the number of shovel shaft revolutions is 50 r/min and the mixing time is 5 minutes.
4 Conclusion

Feeding livestock, poultry and other animals with granulated feed leads to a rapid increase in their productivity. Therefore, a granulation line for small farms and a feed mixing device used in it were developed. From the feeds used in the preparation of granulated feeds, ground wheat grain, ground maize grain, ground rice and wheat bran were selected and mixed in this device, the feed mixer blade rotor's recommended number of rotations was found to be 50 r/min and the mixing time should be 5 minutes in order to achieve a mixing quality of 95%.

Even when the number of revolutions of the blade rotor of the feed mixer device is 60 r/min, the quality of feed mixing is achieved at 95%, but the amount of energy spent on the process increases.

References

6. L. Agbetoye, A. Balogun, Proceedings of the 5th CIGR Section VI International Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management, Potsdam, Germany, 31 August - 02 September, 621-640 (2009)
11. A. Tukhtakuziev, Sh. Ishmurodov, E3S Web of Conferences 390 01039 (2023)
12. A. Tukhtakuziev, Sh. Ishmurodov, IOP Conference Series: Earth and Environmental Science 1231(1) 012055 (2023)