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IMPROVEMENT OF THE PREPARATION PROCESS OF MULTICOMPONENT FODDER FOR SMALL CATTLE

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Summary. Existing constructions of fodder chopper-mixers for small cattle are considered. Appropriateness of the design of a modular feed-preparing machine is proved.

Key words: Working body, module, technological effectiveness of the structure.

PROBLEM

At present, one can state with certainty that the basic direction of animal husbandry in Jordan is sheep breeding. Dynamics of sheep population is the evidence of this.

Table 1. **Dynamics of sheep population in Jordan according to the data of Food and Agriculture Organization of the United Nations (FAO)**

Year	1985	1990	1995	2000	2005	2010
Number of animals, head	582000	1121000	1556000	2181939	1833986	2331850

As it can be seen from the data of FAO as of 2010, 2331850 head of sheep were numbered in Jordan which on average made 0.4 sheep per one person. In addition, farmers of Jordan raise goats; in 2010 their total livestock population made 881970 head. Due to this reason fodder preparation for feeding is a very burning task which requires scientific researches.

Currently, fodder preparation process for feeding small cattle is not studied thoroughly. Absence of diversity of alternatives of fodder chopper-mixers adapted to a definite manufacturing environment indicates this. Therefore, it is necessary to work out a science-based theory of design of such machines.

Analysis of recent researches and published works. The basic results of theoretical and experimental researches of the efficiency of fodder chopper-mixers are

given in the works of famous scientists: S.V. Melnikov, S.I. Nazarov, V.I. Perednya, L.P. Kartashov and others [1-4]. The works of these scientists are directed at the improvement of a working body which can chop several types of fodder and, at the same time, effectively mix ground components. However, in practice, chopping of concentrated fodder and roughage at the same time is not reasonable because fibrous materials of roughage decrease the impact force of nonground grains upon chopper's working surfaces.

The aim of the research is to determine the ways for improvement of a manufacturing process of fodder chopper-mixers for small cattle.

Results of the research. Effective sheep breeding is impossible without using multicomponent fodder (fodder mixtures) in ration.

Composition of loose fodder mixtures for small cattle is the following: 20 – 40% - straw, 12 - 26 – hay, 40 - 60 – silage, 7 - 17% – mixed fodder.

Composition of pelleted fodder mixtures for small cattle is the following: 35 - 50% – straw, 18 - 30 – grass meal, 20 - 40 – hay and grain fodder, 14 – 20% – mixed fodder.

Each component of a fodder mixture must correspond to definite zootechnical requirements which regulate: size of particles, number of admixtures, moisture and etc. In most cases, for manufacture of multicomponent fodder mixtures it is necessary to mix components which differ considerably by size features, see table 2.

Table 2. **Degree of grinding of fodder for small cattle**

Type of fodder	Size of particles, mm
Hay, straw	20-30
Silage, haylage	up to 50
Concentrated fodder	1-1.5
Tuberous roots	10-15

Taking into consideration the above-mentioned facts, we can say that increase of the efficiency of a mixing process of fodder for small cattle can be achieved using a mixing working body which can move effectively groups of particles of different size from one position into another. Moreover, an effective mixer must provide a continuous technological process with minimal energy and human resources expenses. It is also very important to take into account the fact that a fodder mixture of high quality can be obtained only from properly ground components.

The process of chopping and mixing of fodder mixture components for small cattle is effective only at a definite rotational frequency of a working body of a machine, see table 3.

Table 3. **Rotational frequency of a working body of a feed-preparing machine, turn/min**

Type of fodder	Chopper	Mixer
Hay, straw	650-800	18-250
Silage, haylage	700-1400	25-300
Concentrated fodder	980-1250	70-400
Tuberous roots	500-1000	275-350

As it can be seen from table 3 the rotational frequency of a working body is different for various fodder mixture components, though, despite such conditions, attempts are made to create fodder chopper-mixers which can provide rational modes of chopping and mixing during manufacture of multicomponent fodder mixtures.

It is necessary to make an analysis of the existing constructions of these machines in order to define the most rational construction of a fodder chopper- mixer for small cattle. The process of chopping and mixing is carried out simultaneously by a single working body of chopper-mixers. At present, the fodder chopper-mixer ISK-3 is very widespread (fig. 1).

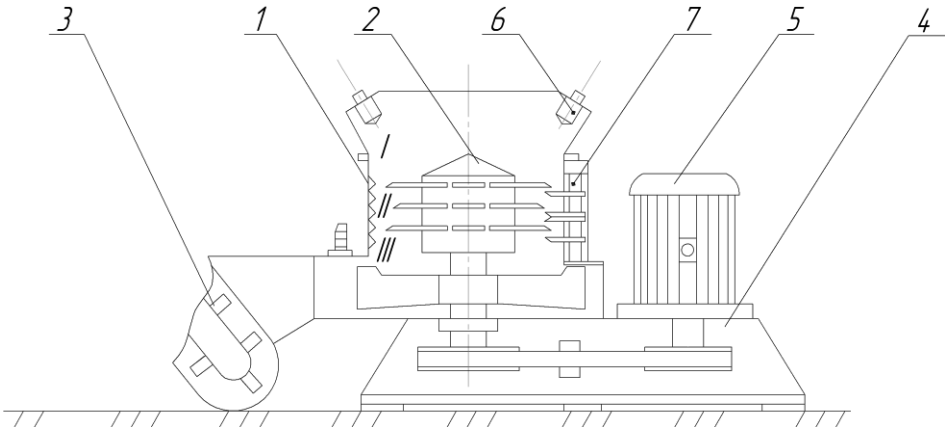

Fig. 1. Fodder chopper-mixer ISK-3:
1 – toothed deck; 2 – blade rotor; 3 – unloading conveyor; 4 – frame; 5 – power-driven station; 6 – nozzle; 7 – countercut; *I* – inlet chamber; *II* – chopping and mixing chamber; *III* – unloading chamber

The machine consists of a blade rotor 2; an inlet chamber *I,* a working chamber *II* and an unloading chamber *III* situated one above another; a bunker; an unloading conveyor 3; a set of countercuts 7; toothed decks 1; an electric motor and a V-belt drive equipped with a belt idler. Two nozzles 6 at an inlet and two of them at an unloading chamber are provided for the injection of liquid additives into the work bulk. The inlet and working chambers are connected by flip-up mounts. There are six openings in the walls of a working chamber where sets of blade-countercuts and toothed decks are installed.

Chopper's blades, which are used as mixers, and hammers are situated on a working body-rotor. A two-blade spinner is situated in the lower part of the rotor situated in the unloading chamber.

A set of blade-countercuts is gathered at the shaft which is installed in a jointed position on the basis mounted to the body of the working chamber by bolts. In case if extraneous objects get into the chamber, a hinged spring mount of countercuts allow them to deflect without a breakdown and let solid objects in.

The productivity of the machine which works at mixing can reach 25 t/h, at mixing with partial regrinding – up to 5 t/h, at chopping, for example, of straw – up to 3-4 t/h at the cutting length of up to 30 mm and 4-8 t/h at the cutting length of 50 mm.

The chopper-mixer provides mixing of silage, straw, edible roots and mixed fodder with a degree of homogeneity – 80-90%; engine's installed capacity is 39.2 kW; rotor's rotational frequency – 17 c^{-1}; machine's dimensions –1600x1090x1150 mm; weight with an unloading conveyor – 2200 kg. The chopper-mixer is operated by one worker.

Advantages of ISK-3:

- continuity of the process;
- simplicity of the construction;
- chopping and mixing is carried out simultaneously;
- protection against consequences in case if extraneous objects get into the working zone;
- high homogeneity of mixture.

Disadvantages of ISK-3:

- high energy intensity of the process of fodder mixture preparation;
- pelleted fodder can't be added to a fodder mixture without being destructed;
- it doesn't mix fodder with grass meal;
- it doesn't chop concentrated fodder;
- the machine is stationary.

Fodder chopper-mixer-distributors are very widespread at present time. One of the disadvantages of ISK-3 has been removed; chopper-mixer-distributors are mobile machines. chopper-mixer-distributors are intended for preparation (loosening, partial chopping and mixing) and distribution (depending upon the used ration) of components (green bulk, silage, haylage, loose and pressed hay, liquid fodder additives) without a device for self-loading of components using an electronic system of weighting of fodder mixture components.

Working bodies of such machines are a twin-screw mixer with blades installed on its augers (fig.2).

The distinctive feature of these machines is a vertical or horizontal position of two augers of a higher pitch. It allows to obtain loose fodder mixture from several components. Availability of adjustable countercuts permits to change a degree of chopping of fodder mixture components. The productivity of such machines makes 12 t/h, bunker capacity – 12 m3, mixing time – 5-7 minutes; weight – up to 5300 kg; it is unitized with a 1.4-2 ton-force class tractor [5, 6].

Advantages of fodder chopper-mixer-distributors:

- high productivity;
- considerable body space;
- the machine is mobile;
- mixing time – 5-7 minutes;
- availability of an electronic system of weighting of fodder mixture components.

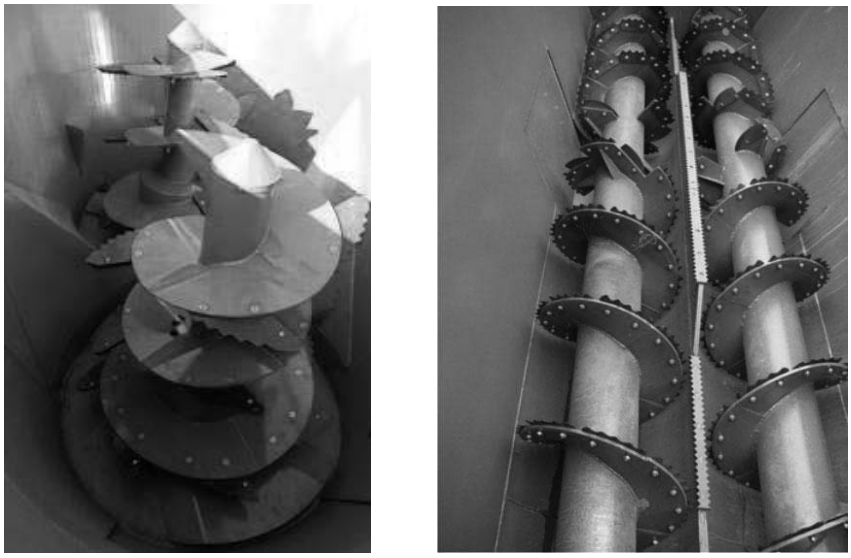

Fig. 2. Working bodies of fodder chopper-mixer-distributors:
a – a vertical twin-screw one (ISRV-12);
b – a horizontal twin-screw one (RSK-12)

Disadvantages of fodder chopper-mixer-distributors:

- the machine is of a sampling action;
- high energy intensity and materials consumption;
- low quality of chopping of roughage, stem and succulent fodder;
- chopping of concentrated fodder is impossible;
- low efficiency during mixing of concentrated fodder with roughage and succulent fodder.

It is possible to estimate technological effectiveness of the above-mentioned constructions of chopper-mixers with the help of a coefficient of block structure.

Block coefficient *Cb* increases technological effectiveness of the construction [1-4]:

$$Cb = \frac{\sum Caut}{\sum Ct},$$

where: $\sum Caut$ - number of the independent systems of the construction, table 4;

$\sum Ct$ - total number of systems of the construction (loading, chopping with mixing, unloading).

Table 4. **Calculation of block coefficient for analyzed machines**

Model of a machine	Total number of systems of the construction, pieces	Number of the independent systems of the construction, pieces	Block coefficient
ISK-3	3	1	0.33
ISRV-12	3	2	0.66
RSK-12	3	2	0.66

On the basis of Table 4 we can make a conclusion that an effective fodder chopper-mixer for small cattle must consist of several independent units (modules). It is evident that the number of independent modules must correspond to the quantity of the operations carried out by a chopper-mixer.

The analysis showed that equipping screw working bodies with blades doesn't provide the necessary degree of chopping of all the components of a fodder mixture for feeding small cattle so one can suppose that a mixing working body of a fodder chopper-mixer for small cattle and its chopping units must be an independent module.

CONCLUSIONS

1. Simultaneous chopping of concentrated fodder and roughage is not reasonable because fibrous materials of roughage decrease grain's impact force upon the working surface of a chopper; that is why equipping screw working bodies with blades doesn't provide the necessary degree of chopping of all the components of a fodder mixture for feeding small cattle.

2. An effective fodder chopper-mixer for small cattle must consist of several independent units (modules); the number of independent modules must correspond to the quantity of the operations carried out by a chopper- mixer.

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СОВЕРШЕНСТВОВАНИЕ ПРОЦЕССА ПРИГОТОВЛЕНИЯ МНОГОКОМПОНЕНТНЫХ КОРМОВ ДЛЯ МРС

Аль Атум Мохаммад

Аннотация. Изучены существующие конструкции измельчителей-смесителей кормов для мелкого рогатого скота. Доказана целесообразность разработки модульной кормоприготовительной машины.

Ключевые слова: Рабочий орган, модуль, технологичность конструкции.

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