The key condition for animals' productivity improvement is to establish sound forage source the prime of which is silage.

At conventional ensilage, due to sugar fermentation, lactic and acetic acids are produced in the fodder resulting in acidic medium (pH=3.9-4.0), the increased activity of putrefaction and lactic acid bacteria is observed. [1].

To obtain high-quality silage the organic acids helping to reduce dry matter loss are used [2]. Formic, acetic and benzoic acids as well as sodium salts, ammonia, etc are used as preservatives.

The preservatives in a powder or liquid form are added into the mown and shredded mass either in field condition or during transportation, as well as at green mass compacting in trenches.

The results of studying rather hard and labor intensive process of applying powdery preservatives into the green mass showed that in case the moisture of the green mass is over 70% the preservatives should be applied into the green mass directly in the trenches while compacting certain layers. For uniform spread of organic acids on the green mass compacted in the trenches we propose the device design introduced beneath (Fig. 1).

The device is fixed on the compacting tractor (1) and consists of the hopper (2) with the mixing box and feed auger, the ventilator (4), the reduction gear (3), chain drives and operating parts (5). The operating part (Fig. 2.) is presented by pipes (1) with rectangular cross-sections, at the end of which spreading nozzles (2) are fixed. 1 operating tool is attached to the ventilator neck dispenser (3) from every side.

The device operates as follows. The torsion torque from the tractor power shaft is transmitted to the ventilator (4) through the driveline and reduction gear 3 (Fig. 1). At the same time with the help of chain gear the mixing box and feed auger in the hopper are set in rotation. By the feed auger the powdery preservative with the air flow is steadily delivered to the pipes (1) through the dispenser (3) and then through the spreading nozzle (2) it is spread onto the compacted layer of the ensiled mass (Fig. 2).

We determined the optimal capacity of the powder preservative hopper, the preservative required to be input subject to the traverse speed of the compacting tractor and the thickness of the compacted green mass layer.

In fact, the preservative is spread on the compacted mass, then a new layer of green mass is added and evened, compacted and then again the preservative is spread. Thus, to determine the optimal capacity of hopper ($V$, kg), the amount of green mass subject to compacting in the very cycle ($G_2$) and the preservative application rate ($q$, kg/t) are considered in accordance with the following condition:

$$V \geq G_2, \quad (1)$$

where $G_2$ - the required output of preservative from the pipes in the certain cycle:

$$G_2 = qG_1, \quad (2)$$
The application rate of powdery preservatives into the ensiled mass makes \( q = 2.8 \) kg/t. Thus, after compacting the green mass in the certain spreading cycle the required amount of preservative in the hopper is determined considering the maximal application rate (8 kg/t). Our observations on the RA farm “Balahovit” showed that when transporting the green mass by KamAz trucks the amount of ensiled mass was 5-7t. And after unloading each truck the compacting was done and then the preservative was spread onto that compacted mass. To chose the hopper optimal capacity the dependency graph (Fig. 3) is drawn. It illustrates the hopper capacity dependence \((V)\) on the preservative application rate \( (q)\) for the vehicles with 5 and 7t carrying capacity.

The graph shows that the hopper with 40 kg capacity completely meets the requirements for 8 kg/t preservative application rate when the amount of the ensiled mass is 5t; and for 7t green mass the preservative application rate is 5.7 kg/t. The results are satisfactory considering that the acceptable error of preservative spreading goes up to 20%, i.e. 20% of 8 kg/t makes up 1.6 kg/t. On the other hand, choosing the right type of preservative and reducing the green mass moisture it is possible to decrease the application rate to 5.7 kg/t. On the other hand, choosing the right type of preservative and reducing the green mass moisture it is possible to decrease the application rate to 5.7 kg/t. Thereby, 40 kg capacity hopper completely meets the requirements.

The preservative amount required for spreading in the certain cycle is:

\[
M = G\cdot q = V\cdot \gamma \cdot q \text{, kg,}
\]

where \( V \) – the compacted layer volume, m³; \( \gamma \) – bulk weight of compacted layer, t/m³.

The dependence graph of the required amount of the preservative spread \((M, \text{ kg})\) and compacted green mass \((G, \text{ t})\) at different application rates \((q, \text{ kg/t})\) of the preservative is introduced on the Fig. 4.

During the device operation it is very important to provide the uniform spreading of the required amount of the preservative all over the compacted mass area in the certain cycle. For this purpose the process-dependent parameters and operating conditions of the proposed device should be optimized considering the preservative application rate, cross-section area of pipes of the operating part, coefficient of acceptable non-uniformity of the preservative spreading, compacted green mass area, traverse speed and grasp width of tractor aggregate. The cycle time of spreading the required amount of the preservative onto the compacted mass is determined as follows:

\[
t = \frac{G\cdot q}{60n \cdot q_j} \text{ min}
\]

where \( n \) – number of pipes, \( q_j \) – amount of preservative discharged from one pipe, kg/sec.

Changing \( G\) and \( q_j\) values allows regulating \( t\) value in accordance with the cycle time of tractor aggregate operation. It is essential since the cycle time of spreading the required amount of preservative all over the compacted mass area should be equal to the operation cycle time of the tractor aggregate.

The operation cycle time of the tractor aggregate is determined as follows:

\[
t = \frac{m(l_1 + l_2)k}{V_T} \text{ min}
\]

where \( m \) – travel number of tractor aggregate, \( l_1 \) – travel (stroke length), \( l_2 \) – idle stroke length (at series change), \( m; V_T \) – tractor traverse speed, km/h; \( k \) – coefficient considering the dimensionality change (km/h was converted in m/min), \( K = 0.06 \).

In case \( t = t_T\), the uniform spread of preservative is provided all over the compacted mass area. In order to provide the preservative uniform spread along the device grasp width, it is necessary that the distances \( b\) between the pipes of the operating part were equal (Fig. 2):

\[
b = 2h \cdot \tan \alpha + d \text{ m}
\]

where \( h \) - distance from the spreading nozzle to the compacted layer, \( m; d \) - nozzle width, m; \( \alpha \) - angle of nozzle inclination to the vertical.

Required number of pipes:

\[
n = \frac{B}{b},
\]

where \( B \) - grasp width of the aggregate, m.

Inserting value \( B \) from formula (7) into formula (6), we get:

\[
b = 2h \cdot \tan \alpha + d \text{ m}
\]
d=0.1 m, thus h= 0.2m, 2) if d=0.2 m, thus h=0.15 m and 3) if d=0.3 m, thus h=0.1 m. Thus, for the uniform spreading of the preservative from 8 pipes all over 4m grasp width the following limits of nozzle width values $d$ and spread height $h$ are recommended: $d=0.10…0.30$ m and $h=0.20…0.10$ m. These limits of values $d$ and $h$ are recommended to be used at different values of $B$ ($B=1; 2; 3; 4$) and $n$, observing the essential requirement $\frac{B}{n} = 0.5$ m.

References:

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