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## **PRODUCTION OF COMPOUND FEEDS IN THE CONDITIONS OF FARMS WITH LOADED RESERVATION OF DOSING AND MIXING**

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*Two options for resource-saving technology of mechanized production of compound feeds and PVMS with flexible connections were developed and implemented in farm conditions with loaded backup of weighing batchers and mixers and with loaded backup of mixers.*

*The studies have established that the dosing accuracy of 0.1 kg., the mixer shaft revolutions have an impact on the mixing quality indicator, so at 30 rpm. mixing quality is 95.18%, and at 46 rpm. – 96.1% and 1 min of mixing. Based on a multifactor experiment, polynomial linear and quadratic models were obtained for the mixing quality of compound feed ingredients due to the factors: rotation speed, number of blades and operating time with a mixer volume of 0.54 m<sup>3</sup>. The time spent on performing operations for the production of compound feed was determined and two versions of the cycle diagrams of the process of compound feed production of technological lines were constructed: with loaded redundancy of weighing batchers and mixers and with loaded redundancy of mixers.*

*The time of the initial cycle of the process of compound feed production of technological lines was established:*

*- with the redundancy of weighing batchers and mixers, the time of the initial cycle was 9.7 min. and the established cycle was 6.9 min.*

*- with the redundancy of mixers, the time of the initial cycle of the process of compound feed production of technological lines with a capacity of 2 tons per hour was 9.7 min. and the established cycle was 5.9 min.*

*It was established that the productivity of technological lines for the production of compound feed was:*

*- using technology with flexible connections and loaded redundancy of two weighing batchers and two mixers - 1.974 t.*

*– using technology with flexible connections and a weighing dispenser, which provides unloading of raw material components in two opposite directions and loaded redundancy of two mixers – 2.307 t.*

**Keywords:** *technologies, compound feed, dosing, displacement, destruction, components*



## ВИРОБНИЦТВО КОМБІКОРМІВ В УМОВАХ ГОСПОДАРСТВ З НАВАНТАЖЕНИМ РЕЗЕРВУВАННЯМ ДОЗУВАННЯ ТА ЗМІШУВАННЯ

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*Проведено розробку та реалізацію двох варіантів ресурсозберігаючої технології механізованого виробництва комбікормів та БВМД з гнучкими зв'язками в умовах господарства з навантаженим резервуванням вагових дозаторів і змішувачів та з навантаженим резервуванням змішувачів.*

*Дослідженнями встановлено, що точність дозування 0,1 кг., обороти валу змішувача мають вплив на показник якості змішування, так при 30 об/хв. якість змішування – 95,18 %, а при 46 об/хв. – 96,1 % та 1 хв змішування. На основі багатофакторного експерименту отримані поліномні лінійна та квадратична моделі для якості змішування інгредієнтів комбікормів за рахунок факторів: швидкості обертання, кількості лопаток та часу роботи з об'ємом змішувача 0,54 м<sup>3</sup>. Визначено витрати часу на виконання операцій по виробництву комбікормів та побудовані два варіанта циклограм процесу виробництва комбікормів технологічних ліній: з навантаженим резервуванням вагових дозаторів та змішувачів і з навантаженим резервуванням змішувачів.*

*Установлено час початкового циклу процесу виробництва комбікормів технологічних ліній:*

*- з резервуванням вагових дозаторів та змішувачів час початкового циклу склав 9,7 хв. а циклу, що установився – 6,9 хв.*

*- з резервуванням змішувачів час початкового циклу процесу виробництва комбікормів технологічних ліній продуктивністю 2 тони на годину склав 9,7 хв. а циклу, що установився – 5,9 хв.*

*Установлено, що продуктивність технологічних ліній виробництва комбікормів склала:*

*– по технології з гнучкими зв'язками та навантаженим резервуванням двох вагових дозаторів та двох змішувачів – 1,974 т.*

*– по технології з гнучкими зв'язками та ваговим дозатором, який забезпечує вивантаження компонентів сировини в двох протилежних напрямках і навантаженим резервуванням двох змішувачів – 2,307 т.*

**Ключові слова:** технології, комбікорми, дозування, змішування, деструкція, компоненти

Creating a comprehensively developed and highly profitable agro-industrial production, including in animal husbandry, is possible only on the basis of accelerated development of achievements of science and technology and is one of the conditions for stable socio-economic development of the country. The main conceptual approaches of the strategy for the development of modern feed production are the introduction of science-intensive, innovative technologies for the use of feed, which will become the



basis for the revival of competitive animal husbandry and guarantee the food security of the state. Innovative feed production, and in particular compound feed, should ensure the sustainable functioning of the agricultural sector. The provision of high-quality compound feed largely determines the level of development and economy of this direction, since in the cost structure of livestock production the cost of feed reaches 65-75%. Therefore, the compound feed industry is an important link in the development of the country's agro-industrial complex. The compound feed industry is characterized by large-scale production and produces significant products that play a leading role in the development of industrial livestock farming in Ukraine.

The most important factors of effective livestock farming and providing it with high-quality feed are taking into account the peculiarities of the territorial distribution of feed raw material production, the availability of resources, and the procurement of feed using domestically produced protein-vitamin-mineral supplement (PVMS) and based on new resource-saving technologies.

Only under such conditions will the implementation of the strategy make it possible to create organizational and economic foundations for the effective, socially directed development of the agricultural sector of the economy. Therefore, the development of compound feed production is very relevant for the stable provision of the industry with agricultural raw materials, and the population with high-quality and safe domestic livestock products (Petrychenko V. et. al, 2022, Voronetska I. et. al, 2021, Fihurska, L., 2024 et. al )

The feed industry in Ukraine requires significant attention, as this industry is one of the main factors in the development of livestock and poultry farming.

In modern conditions, feed is produced at large specialized feed plants, regional and district plants, and directly on farms. The production of compound feed, both at large specialized compound feed plants, regional and district plants and directly on farms, is associated with the use of processes: various types of destruction of raw materials (Hulavskiy V. 2014, Yehorov B. 2019, Postnikova M., et. al., 2019, Soldatenko, L 2020 et. al., Aleksashin, A 2021, Rybalchenko V., et. al. 2023), dosing (Milko D. 2015, Buryma M. A. et. al. 2017, Yehorov B. 2018 , 2019) and mixing (Yeremenko O. et. al.. 2015, Yehorov B. 2019, 2019, Malakov O. et. al. 2019).

Manufacturers of large specialized feed mills declare the completeness of the composition of feed and the maximum productive effect from their use, but it is not always possible to obtain the declared level of quality from them. A study was conducted on the effectiveness of using feed from different manufacturers in feeding hybrid pigs. The effect of using pre-starter and starter feed from the manufacturers of TM "TrauNutryshin Ukraine" and "Yedynstvo" in feeding hybrid piglets was studied. (Chudak R. et al. 2017). Based on these studies, we conducted a multifactorial analysis of the use of feed from these manufacturers. The results of the comparative analysis of the use of pre-starter and starter feeds of different manufacturers in feeding hybrid piglets by the complex efficiency index of each of the alternative options N(Ck) compared to the idealized one allow us to note a significant advantage of using pre-starter and starter feeds of manufacturers of TM "TrauNutryshin Ukraine" in feeding hybrid piglets, for which the objective function according to the considered criteria is the smallest and is 0.02103, while the objective function for "Yedynstvo" feeds is 5.5342 times worse. That is, feeds manufactured by different powerful specialized feed mills differ in quality for the same age groups of pigs. Improved nutrient absorption is necessary to increase productivity, profitability and environmental protection. Incomplete digestion of nutrients reduces the profitability of livestock farming due to limited consumption, reduced animal productivity and increased production of by-products (organic waste), which leads to



increased environmental pollution, in particular greenhouse gases (Novakovska V., 2023; Zolotaryov, et. al., 2021, 2023).

Low-component compound feeds with guaranteed productive effect should be prepared directly on farms from grain of own production and purchased balancing additives. In this case, any one type of grain or grain mixture can be used. Production of low-component compound feeds directly on farms makes it possible to:

- expand the availability of the use of high-quality compound feeds in animal feeding and implement it according to scientifically based standards;
- significantly increase animal productivity and increase the volume of livestock production;
- significantly reduce the cost of compound feeds by reducing transportation costs and energy consumption;
- reduce losses of raw materials and finished products during transportation and storage;
- reduce the cost of production by not including VAT on compound feed (since compound feed is prepared for own consumption).

Research objective. To develop and test the technology of compound feed production with loaded backup of weighing batchers and mixers and with loaded backup of mixers under production conditions to determine the main technical and economic indicators.

**Materials and methods.** The study was conducted on the basis of GSTU 46.007 - 2000 "Machines and equipment for feed preparation"; "DSTU 3218-95 Crushers Test methods"; DSTU OIML R 61 - 1 : 2008 Discrete action weighing batchers.

The following parameters were determined: unit productivity, loading and unloading time, grinding module, dosing accuracy, quality of mixing of compound feed ingredients, operation time.

The mixer productivity ( $W$ ) was determined by the formula (1):

$$W = \frac{m_n}{t}, \quad (1)$$

where  $m_n$  - mass of feed obtained after the mixer, kg;  $t$  - mixing time, h.

The experiment was repeated three times. The mixing duration was determined by a stopwatch SOS-pr-26-2 TU 25.1819.0021.

The quality of mixing of compound feeds was determined by the distribution of the control component in 15-20 samples, which were taken at equal intervals during the unloading of the finished compound feed. The repetition of the experiment was three times.

The weight of the selected samples for compound feed mixtures was 100 g each.

As a control component for compound feed mixtures, table salt was used (for mixtures of crushed concentrated feeds).

The uniformity of mixing of components ( $\rho_m$ ) in percent was determined by the formula (2):

$$\rho_m = 100 - Va, \quad (2)$$

Where  $V_a$  – the coefficient of variation of the actual distribution of the control component in the samples.

$$V_a = \frac{100}{m_{av}} \sqrt{\frac{\sum_{i=1}^n (m_n - m_{av})^2}{n-1}}, \quad (3)$$



Where  $m_n$  is the value of the content of the key component in the samples;  $n$  is the number of selected samples;  $m_{av}$  is the average value of the content of the key component in the grain mixture samples.

In the case of deviation of the actual dose of the control component from 1%, the indicator  $V_a$  was multiplied by  $\sqrt{n_a}$ , where  $n_a$  is the actual and percentage content of the control component in the mixture (obtained in experiments).

The revolutions of the mixer working shaft were determined using the "Time tachometer" brand T410-R, GYU 2.780.001PS, TU 25-07-1051.79.

The problem of obtaining the dependences of the mixing quality by changing three factors:

- rotation speed (rpm);
- number of blades;
- operating time (min).

To solve this problem, experimental studies were conducted - mixing quality at the following values of variable factors:

- rotation speed: 30, 37 and 46 rpm;
- number of blades: 0, 2 or 3;
- operating time: from 1 to 6 minutes with a step of 1 minute.

In total, a full factorial experiment was conducted, containing  $3 \times 3 \times 9 = 54$  studies.

Based on the cycle diagrams of the feed production process on technological lines and a lunch break and two technological breaks of 20 minutes each, the productivity of the mechanized feed production technology was determined, taking into account the dependencies (Chernyaev A.I.):

$$q_1 = \left\{ 1 + \frac{[60 - (T_{IC} + T_{TB})]}{T_{EC}} \right\} \cdot G_{PFI}, \quad (4)$$

where  $q_1$  - productivity of the feed production technological line in the first hour of operation and technological breaks, kg/h;  $T_{IC}$  - initial cycle time, min;  $T_{TB}$  - technological break time, min;  $T_{EC}$  - established cycle time, min;  $G_{PFI}$  - weight of the portion of feed ingredients prepared for mixing, kg.

$$q_2 = \left( \frac{60}{T_{EC}} \right) \cdot G_{PFI}, \quad (5)$$

where  $q_2$  - productivity of the feed production line at the established cycle, kg/h.

Multicriteria analysis was performed using the method of evaluating the integral criterion of the distance to the target using the approach of collapsing all criteria to one  $N$  using. For comparative assessment by a complex indicator based on the multicriteria analysis method, the relative distance  $N(C_k)$  was found for each alternative solution from the expression (Piskun V.I. et. al., 2020).

$$N(C_k) = \frac{\sum_{i=1}^n u_{ij}^N - \sum_{i=1}^n u_{i0}^N}{\sum_{i=1}^n u_{i0}^N}, \quad (6)$$

where  $N(C_k)$  - the efficiency of each of the options under study compared to the idealized one;

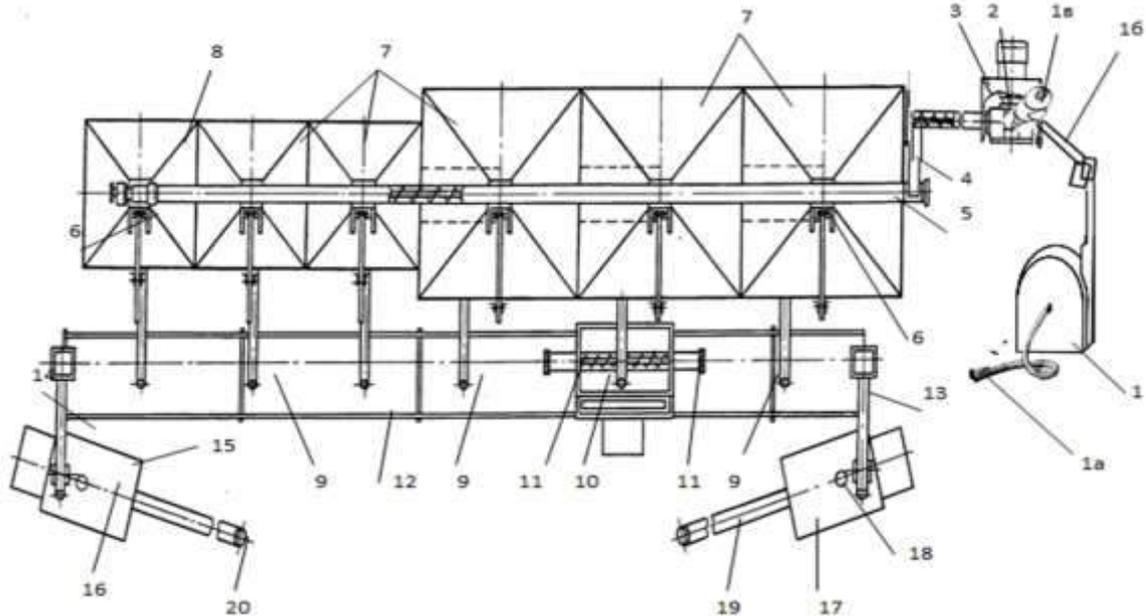
- $u_{ij}^N$  - the normalized  $j$ -th indicator of the option under study;
- $u_{i0}^N$  - the normalized 0-th indicator of the idealized option;
- $n$  - the number of evaluated criteria.



**Research results.** Two original variants of resource-saving technology for mechanized production of compound feed and PVMS with flexible connections in farm conditions have been developed and implemented.

The first variant includes the following main equipment: a grain loader, a crusher hopper, a crusher, a conveyor, a distribution auger, a gate valve and feed ingredient hoppers, each of which has unloading augers that ensure the unloading of raw material components in two opposite directions, two mobile weighing batchers that are installed with the ability to move along the feed hoppers, loading augers and mixers of compound feed ingredients, unloading augers.

The second variant includes the following main equipment: a pneumatic grain loader that has corrugated hoses at the inlet and outlet and a cyclone; a crusher hopper; feed ingredient hoppers, each of which has unloading augers, a mobile weighing batcher, which provides unloading of raw material components in two opposite directions, which is installed with the possibility of moving along the consumable hoppers; loading augers and mixers of feed ingredients for two or more weighing batchers, unloading augers. The scheme of the resource-saving technology of mechanized production of feed and PVMS in the conditions of the farm with loaded backup of mixers is presented in (Fig. 1).



**Fig. 1. Scheme of resource-saving technology of mechanized production of compound feed and BVMD in farm conditions**

Scheme of resource-saving technology of mechanized production of compound feed and PVMS in farm conditions with loaded backup of compound feed and PVMS production line functions as follows: the initial components of the pneumatic grain loader 1 through the input and output corrugated hose 1a, 1b and cyclone 1c are fed to the crusher 3, in which they are crushed, then using the elevator 4 and the distribution screw conveyor 5 the components are distributed to the corresponding bunkers 7, by overlapping the valves 6. Components that do not require crushing, bypassing the crusher, go directly to the storage bunker. Further, through the unloading screws from the component hoppers 9, according to the requirements of the recipe, the components are loaded one by one as they move to the weighing batcher 10. Mineral components are also loaded to the weighing batcher. The mass of finished components is fed to the mixer 17 through the reverse unloading screw 11 of the weighing batcher and the loading screw 13. After mixing, the compound feed is unloaded from the mixer 17 through the screw 19. When



the weighing batcher 10 moves in reverse, again, according to the requirements of the recipe, the components are loaded one by one to the weighing batcher 10 as it moves. Mineral components are also loaded to the weighing batcher. The mass of finished components is loaded into the mixer 15 through the reverse unloading screw 11 of the weighing batcher 10 and the loading screw 14. Subsequently, the ingredients of the compound feed are mixed in the mixer 15. The finished compound feed is unloaded from the mixer 15 by the screw 20. Then the cycle is repeated.

The general view and fragment of the resource-saving technology of mechanized production of compound feed with loaded backup of mixers with a capacity of 2 t/h are presented in Fig. 2 and 3, respectively.

In this variant, one mobile weighing batcher is used, which provides unloading of raw material components in two opposite directions, and is installed with the possibility of moving along the consumable bunkers and mixers of compound feed ingredients, two more than weighing batchers.



**Fig. 2. General view of the resource-saving technology of mechanized production of compound feed**

*1 - auger for loading compound feed ingredients to the weighing batcher; 2 - hopper of compound feed ingredients; 3 - weighing batcher; 4 - auger for loading compound feed ingredients to mixer No. 1; 5 - control panel No. 1; 6 - mixer No. 1; 7 - control panel No. 2; 8 - screw for loading feed ingredients into mixer No. 2; 9 - unloading screw of mixer No. 2; 10 - mixer No. 2*

The results of the study of the technological line show that grinding feed ingredients on a “Kharkiv’yanka” type crusher on a sieve with mesh diameter of 3 mm provides a grinding module: for grain mixture in the range from 2.6 to 2.9 mm., for meal – 1.6-1.8 mm, for corn – 2.3-2.4 mm.

The average value of the grinding module and bulk density of feed ingredients when using a sieve with a diameter of 3 mm and 2.5 mm for grinding and the moisture content of the ingredients are given in Table 1.

By studying the influence of the mixer shaft speed on the mixing quality index, it was found that at 30 rpm. the mixing quality level is 95.18%, and at 46 rpm. – 96.1% and

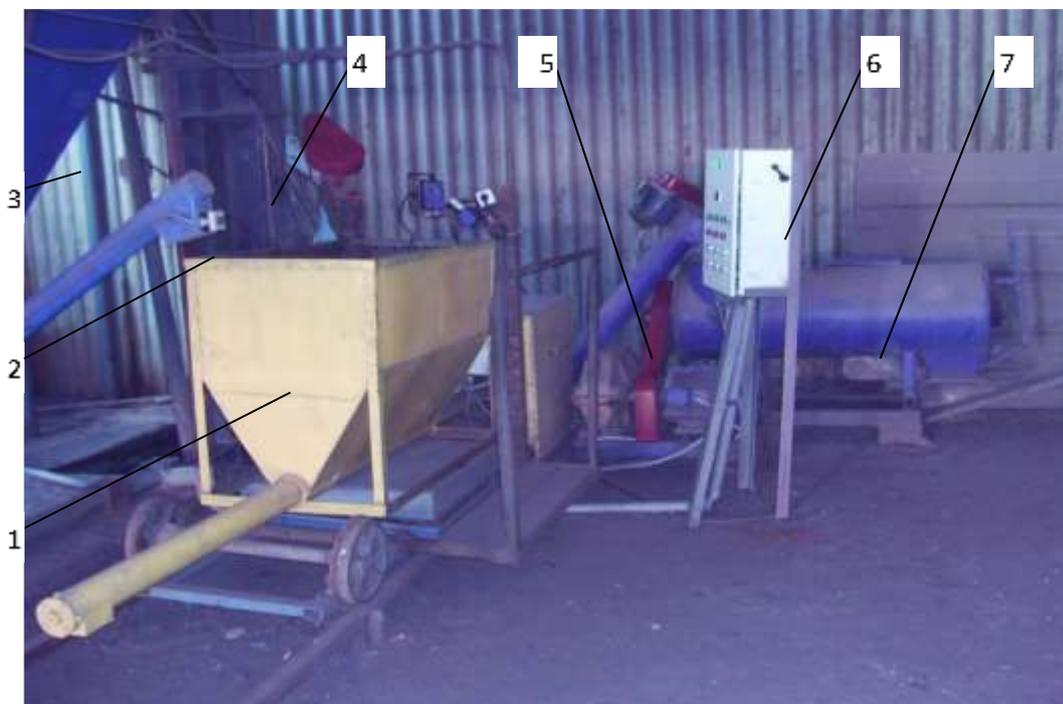


the mixing duration is 1 min. The conducted studies revealed the influence of the presence of blades in the mixer on the mixing quality.

Table 1

**Crusher performance indicators**

Type of ingredient in the feed mill	Sieve with 3 mm mesh diameter						Sieve with 2,5 mm mesh diameter					
	Grinding module, mm		Bulk density, g/l		Humidity, %		Grinding module, mm		Bulk density, g/l		Humidity, %	
	d	d	V	V	W	W	d	d	V	V	W	W
Corn	2,45	0,09	569,67	1,86	16,35	0,25	1,48	0,07	591,0	0,58	16,68	0,55
Grainmix	2,63	0,15	536,33	0,33	11,46	0,49	1,68	0,07	547,67	0,33	14,05	0,45



**Fig. 3. Fragment of resource-saving technology of mechanized production of compound feed**

1 – weighing batcher hopper; 2 – screw for loading compound feed ingredients to the weighing batcher; 3 – compound feed ingredient hopper; 4 – elevator for loading crushed compound feed ingredients; 5 – screw for loading compound feed ingredients to the mixer; 6 – control panel; 7 – mixer

It was established that when mixing feed ingredients for 1 min in the absence of blades in the mixer, the mixing quality was 86.9 %, and with three blades - 96.1 %. The productivity of the resource-saving feed production line is 2 tons per hour, the grinding module of feed ingredients was 1.80-2.60 mm, the dosing accuracy of the weighing batcher with strain gauges is 0.1 kg, the mixing quality is not lower than 95.0%.

Based on a full-factorial experiment containing 54 studies, by changing three factors: rotation speed (rpm); number of blades; operating time (min), two models were obtained – linear



$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 \tag{7}$$

and quadratic

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_1^2 + b_5x_2^2 + b_6x_3^2 + b_7x_1x_2 + b_8x_1x_3 + b_9x_2x_3. \tag{8}$$

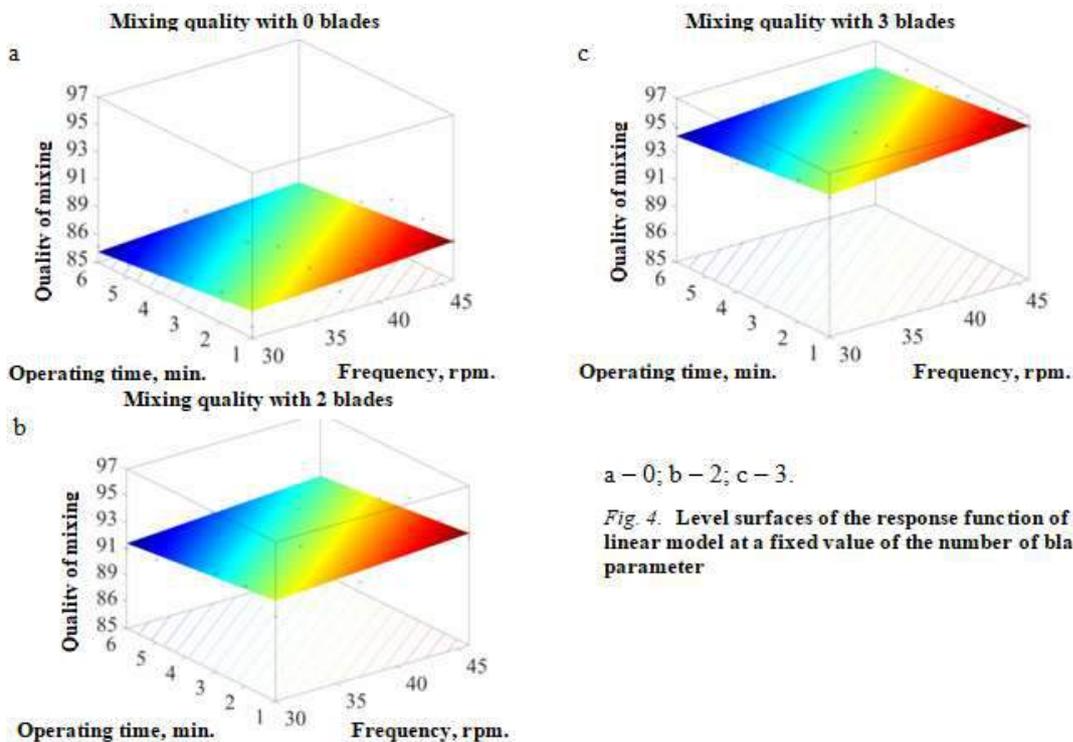
Calculations were performed in the MATLAB mathematical package using the regress function, which allows you to find not only the model parameters themselves, but also confidence intervals for them at a given level of confidence probability (and, if necessary, you can also get other results: the minimum sum of squares of deviations L, various statistics, etc.). We took the confidence probability p=95 %. The results of the calculations were as follows. For the linear model, its coefficients are equal to:

$$\begin{aligned} b_0 &= 85.555191; & b_2 &= 2.819722; \\ b_1 &= 0.054014; & b_3 &= -0.234127. \end{aligned} \tag{9}$$

Confidence intervals for them at the 95% confidence level:

$$\begin{aligned} 84.454801 \leq b_0 \leq 86.655581; & & 2.680337 \leq b_2 \leq 2.959107; \\ 0.027469 \leq b_1 \leq 0.080559; & & -0.335919 \leq b_3 \leq -0.132335. \end{aligned} \tag{10}$$

All factors turned out to be significant: the confidence interval for none of them covers zero. For the linear model, the maximum value of the response function y is always reached at the boundary of the region of permissible values. In our model, y\_max=96.2649, and this value is reached at x1=46 rpm; x2=3 blades; x3=1 min. The response function level surfaces at a fixed value of the parameter x1 or x2 are shown in Fig. 4.



The results for the quadratic model are much more interesting. Its coefficients:



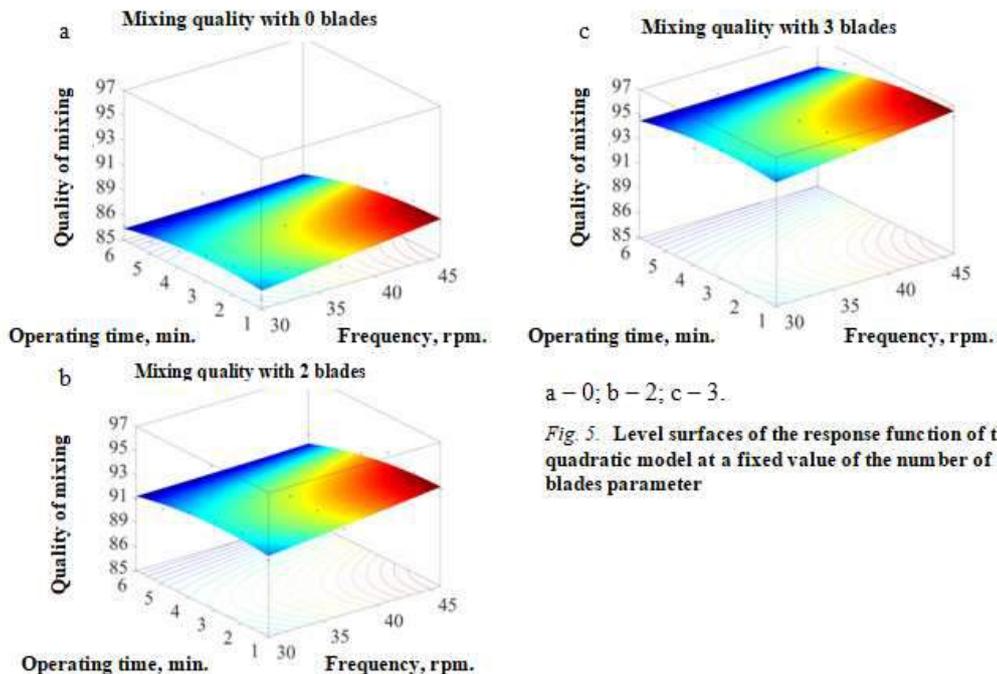
$$\begin{aligned}
 b_0 &= 83.325577; & b_5 &= 0.208056; \\
 b_1 &= 0.076641; & b_6 &= -0.081052; \\
 b_2 &= 2.203267; & b_7 &= 0.000486; \\
 b_3 &= 0.986178; & b_8 &= -0.017381; \\
 b_4 &= 0.000490; & b_9 &= 0.001054;
 \end{aligned}
 \tag{11}$$

and the confidence intervals at the 95% confidence level are as follows:

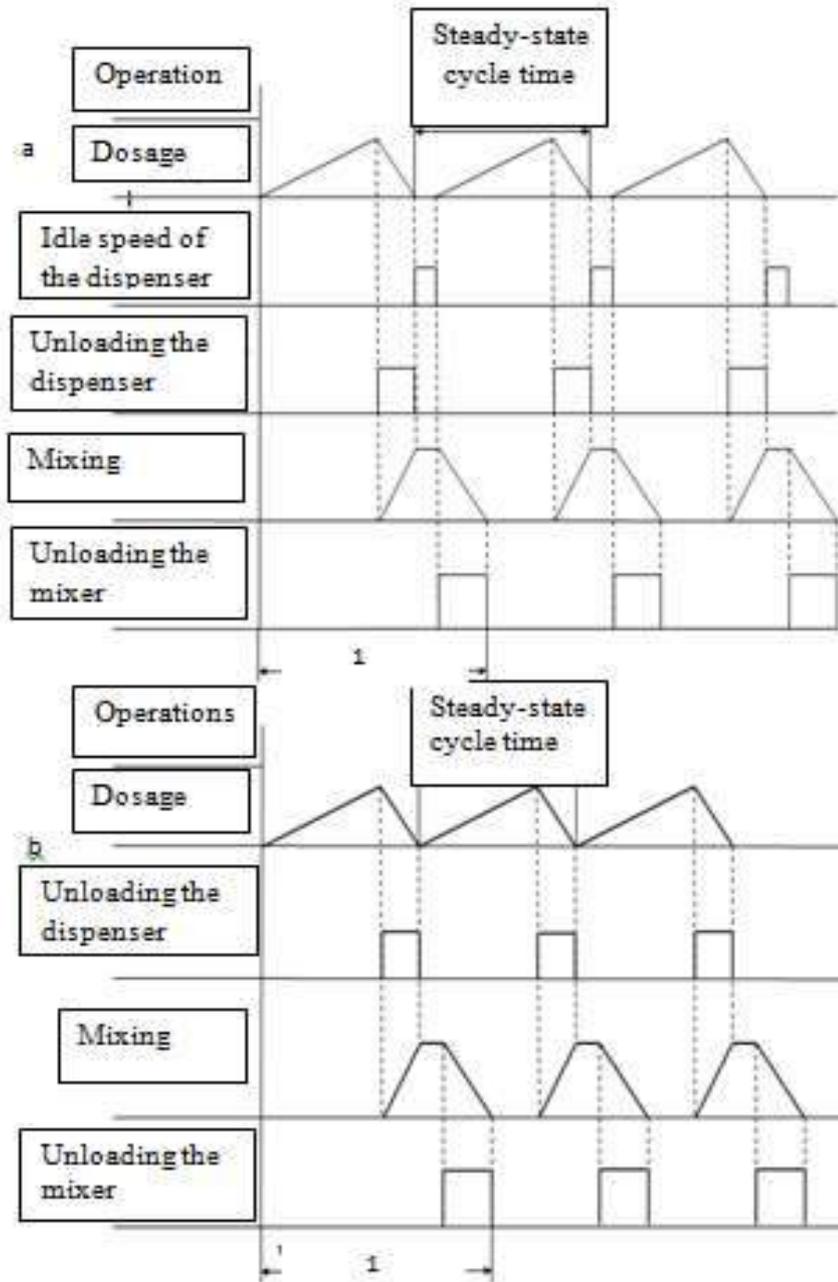
$$\begin{aligned}
 75.545275 \leq b_0 \leq 91.105880; & & 0.041186 \leq b_5 \leq 0.374925; \\
 -0.326294 \leq b_1 \leq 0.479576; & & -0.142986 \leq b_6 \leq -0.019117; \\
 1.300683 \leq b_2 \leq 3.105852; & & -0.018428 \leq b_7 \leq 0.019401; \\
 0.292309 \leq b_3 \leq 1.680046; & & -0.031194 \leq b_8 \leq -0.003568; \\
 -0.004726 \leq b_4 \leq 0.005705; & & -0.071476 \leq b_9 \leq 0.073584.
 \end{aligned}
 \tag{12}$$

According to this model, the factors  $x_1$ ,  $x_1^2$ ,  $x_1x_2$  and  $x_2x_3$  are insignificant: the confidence intervals for them cover zero. At the same time, the factor  $x_1x_3$  is significant. The largest value of the response function  $y_{\max} = 96.5483$  in this model is achieved at  $x_1 = 46$  rpm;  $x_2 = 3$ ; but  $x_3$  it is no longer at the boundary of its range of variation, but at an intermediate point:  $x_3 = 1,2$  min (with an accuracy of 0.1 min).

The level surfaces of the response function of the quadratic model at a fixed value of the parameter  $x_1$  or  $x_2$  are shown in Fig. 5.



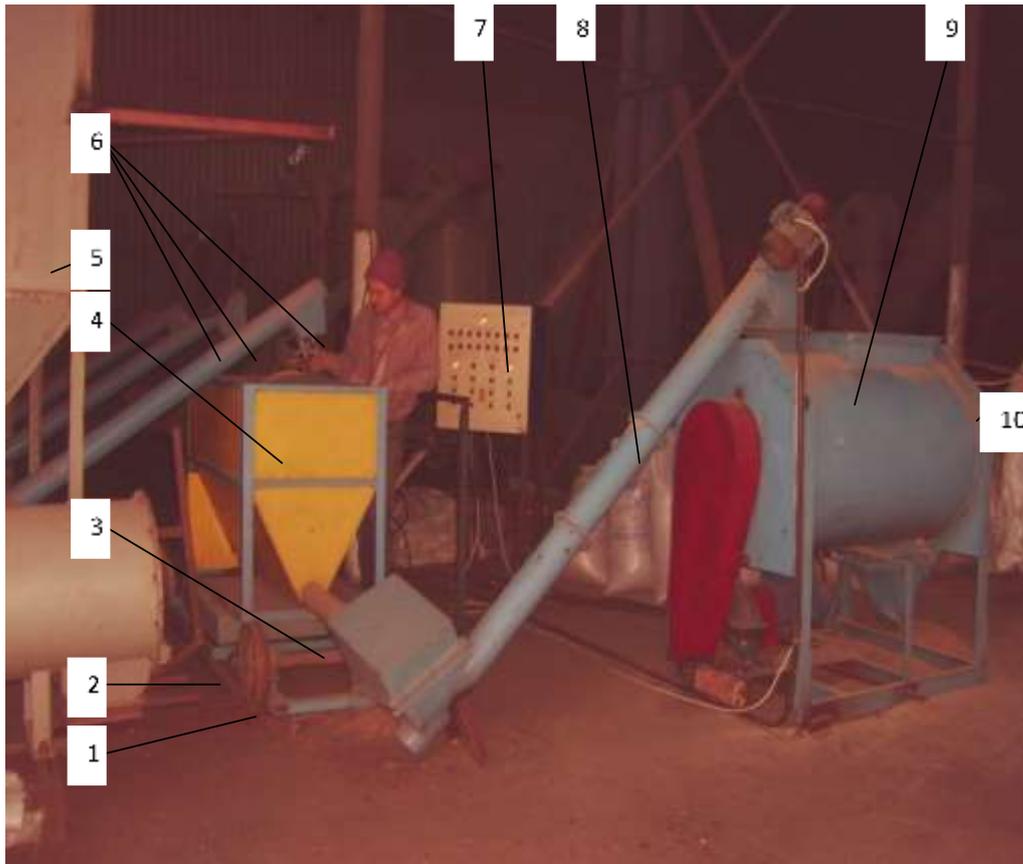
Based on the determination of the time spent on performing operations for the production of compound feed, cycle diagrams were constructed, which are presented in Fig. 6.



**Fig. 6. Cyclediagramsofthefeedproductionprocessoftechnologicallineswith a capacity of 2 tonsperhour for a.s.r. withbackupofweighingdispensersandmixers**

- a - redundancy of weighing batchers and mixers;
- b - redundancy of mixers;
- 1 - time of the initial cycle.

The performance of the unloading augers from the feed ingredient hoppers was determined when loading the feed ingredients into the weigher hopper (Fig. 7). The performance of the unloading augers was  $5.0 \pm 0.06$  tons per hour.



**Fig. 7. Unloading of feed ingredients from the weighing batcher to the mixer**

*1 – mobile platform of the weighing batcher; 2 – platform of strain gauges; 3 – unloading screw of the weighing batcher; 4 – hopper of the weighing batcher; 5 – hopper of feed ingredients; 6 – unloading screws of feed ingredients; 7 – cabinet of start-up and protection equipment; 8 – loading screw; 9 – mixer; 10 – feed unloading screw*

It was established the productivity of the technology of mechanized feed production per hour: according to the technology with flexible connections and loaded redundancy of two weighing batchers and two mixers – 1.974 t/h; using technology with flexible connections and a weighing dispenser, which provides unloading of raw material components in two opposite directions and loaded backup of two mixers – 2.307 t/h.

**Discussion.** Increasing the efficiency of livestock farming at this stage is practically impossible without ensuring reliable production of compound feed for each livestock farm. The use of compound feed produced by powerful specialized compound feed plants and inter-farm compound feed plants has not become widespread mainly due to its high cost and significant transportation costs for transporting grain raw materials and the finished product. The costs of purchasing factory compound feed are often not repaid by the additional increase in livestock production. Therefore, considerable attention is paid to organizing the production of compound feed directly on farms from grain of their own production and purchased protein-vitamin-mineral supplements. This direction allows to significantly reduce transport and overhead costs, to reduce feed consumption in comparison with feeding an unbalanced ration of concentrates. In general, the cost of such compound feeds is 15-30% lower than that produced by specialized enterprises (Sorokin V. 2009).



A well-known line for the production of PVMS and compound feeds almost similar to the equipment we offer, but without loaded backup of mixers, has been tested. According to the developers, its main technical characteristics are: productivity - 1.2 t/h, total power of electric motors - 34.5 kW, dimensions (room): - 6×12×6 m, service personnel - 2 - 4 people (Kosov M. 2020).

At the same time, the solution we proposed for the technology of mechanized production of compound feed using flexible connections and a weighing batcher, which provides unloading of raw material components in two opposite directions and loaded redundancy of two mixers, has a productivity of 2.307 t/h. that is, practically 1.92 times larger and dimensions (room): - 6×12×6 m. The disadvantage of the line without loaded redundancy of mixers is also that it has a high specific material consumption per ton of compound feed produced and at the same time it is possible to produce compound feed of only one recipe, or only a protein-vitamin-mineral supplement.

### **Conclusions:**

1. Two options for resource-saving technology for the production of compound feed and PVMS with flexible connections in farm conditions with loaded redundancy of weighing batchers and mixers and with loaded redundancy of mixers have been developed and implemented.

2. Research into resource-saving technology of mechanized production of compound feeds and PVMS in farm conditions showed that the dosing accuracy is 0.1 kg. It was established that the speed of the mixer shaft has an impact on the mixing quality indicator, so at 30 rpm. mixing quality is 95.18 %, and at 46 rpm. - 96.1 % and 1 min of mixing.

3. Based on a multifactor experiment, polynomial linear and quadratic models were obtained for the quality of mixing of compound feed ingredients due to the factors: rotation speed, number of blades and operating time with a mixer volume of 0.54 m<sup>3</sup>.

4. The time spent on performing operations for compound feed production was determined and two versions of the cycle diagrams of the compound feed production process of technological lines were constructed:

- with loaded backup of weighing dispensers and mixers,
- with loaded backup of mixers.

5. It was established the initial cycle time of the feed production process of technological lines:

- with the backup of weighing dispensers and mixers, the initial cycle time was 9.7 min. and the established cycle time was 6.9 min.

- with the backup of mixers, the initial cycle time of the feed production process of technological lines with a capacity of 2 tons per hour was 9.7 min. and the established cycle time was 5.9 min.

6. It was established that the productivity of technological lines for the production of feed was:

- using technology with flexible connections and loaded backup of two weighing dispensers and two mixers - 1.974 t.

- using technology with flexible connections and a weighing dispenser that provides unloading of raw material components in two opposite directions and loaded backup of two mixers - 2.307 t.

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