Intensification of dairy cattle breeding on the basis of improving the methods of sampling feed

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Abstract. In the current economic and political conditions, the sustainable development of dairy cattle breeding, its intensification are a complex system of interrelated measures for the maintenance, fodder production, feeding and breeding of animals, as well as technical modernization, rational use of resources, etc. We believe that feed production and feeding of farm animals are among the key elements of this system. At the same time, assessment of the quality of the harvested feed, analysis of their nutritional value and chemical composition in the diet are of particular importance. As studies conducted by us on materials of the Vologda region show, different types of feed samplers are used in farms, rations are represented by an abundant set of feed and balancing feed additives with a large variety of chemical composition and nutritional value. However, the wide range and diversity of the chemical composition and nutritional value of the feeds used in animal diets confirm not only violations in the technology of harvesting feeds, but also an imperfect method of their selection. In view of this, we have developed and scientifically substantiated the method of selecting feeds, and also presented the results of approbation of the OBA-1 deep-boring feed sampler in agricultural organizations in the Vologda region with various methods of housing and milking cows. The theoretical and methodological basis of the study consisted of the fundamental works of the Russian scientists and economists; general scientific research methods were used (abstract-logical, systemic approaches, economic and statistical, etc.), statistical (grouping, sampling, comparisons, etc.), as well as graphical and table data visualization techniques. The practical significance of the study lies in the fact that its results can be used in the production of agricultural organizations to improve the feed production system, intensify production, increase the economic efficiency of the enterprise as a whole, and also serve as a basis for further research on this issue.

Currently, a number of systemic problems in dairy cattle breeding in Russia remain unsolved, which not only hinder the development of the industry as a whole, but also hinder its transition to an intensive development path. Thus, studies clearly demonstrate that throughout 1990-2017, one could observe a still low level of profitability, rising costs, a lack of equity. In that period, there was also a reduction in the annual number of cows, the production volume of milk was not balanced, and a number of other negative trends were in place [1-3]. We believe that one of the main reasons for the current situation in the industry is the unsatisfactory condition of the food supply.

As the theory and practice of effective livestock breeding shows, stabilization, increase in animal productivity and intensification of the industry as a whole are determined primarily by achievements in scientifically based feeding of farm animals [4-7]. Experts note [8-10] that the commodity characteristics of cattle (productivity, weight gain, etc.) depend on genetic characteristics approximately by 25-35% (that is, on the breed), determined by 10-20% on the conditions of detention, and more than 50% is directly determined by the quality of feed and diet. It follows that in order to intensify dairy cattle breeding, it is necessary to create a solid, balanced feed base that would ensure an uninterrupted supply of farms with high-quality feed. In this regard, topical issues for agricultural science and practice is the improvement of methods of sampling feed, assessing their quality, nutritional value, and chemical composition in the diet of animals.

It should be noted that the feeding of cows, depending on the physiological state and the level of productivity, differs significantly. The complexity of industrial milk production technologies, from the point of view of the organization of feeding, lies in combining unified and individual feeding methods [11, 12]. When prescribing rations, lactation should be assessed as a whole both in relation to the level of feeding and distribution of feed during the entire lactation cycle.

Thus, the differential distribution of the diet of cows in different phases of lactation, taking into account body weight, milk production, and the physiological state of animals, is one of the most progressive and rational methods of normalized feeding [11, 14, 15]. At the same time, knowledge of the quantitative content of nutrients in the feed is necessary for the preparation of correct, balanced, differentiated diets for feeding animals in order to increase productivity at optimal cost of feed.

First, we make a reservation that, in general, dairy cattle breeding in the conditions of the Vologda oblast, which is a zone of risk farming, is a priority sub-sector. So, in the ranking of the subjects of the North-West Federal District, the region ranked second in 2016 in terms of the number of cattle (including cows) and gross milk yield. In terms of productivity of the dairy herd, the Vologda region ranked fourth in Russia (12th place in 2010, 9th in 2014, 6th in in 2015) [1, 3]. At the same time, agricultural producers provide the population of the region with milk in accordance with the recommended standards [22], and more than 200 thousand tons of milk and dairy products are exported annually.

In 2016,the Vologda region, in all categories of farms, produced 489.3 thousand tons of milk, which was 19.7 thousand tons more than in 2015 and 0.8 thousand tons than in 2000 (Figure 1).

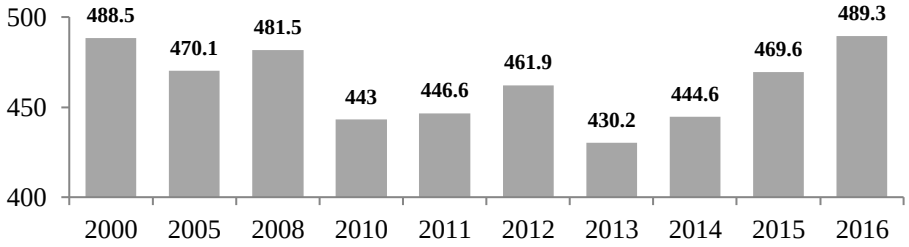


Figure 1. Gross milk production in the Vologda region, thousand tons, households of all categories.
Source: official statistics of the site of the Unified Inter-Agency Information and Statistical System (EMISS). URL: http://fedstat.ru.

As for the dynamics of the number of cattle livestock, in all categories of farms for the years 2000–2016, it decreased by 151 thousand heads (47.6%), including by 74.7 thousand heads (49.7%) in cows. However, since 2013, the decline in their numbers has slowed [3]. It should be noted that the number of breeding livestock in the total cattle population of the region increases every year. The proportion of breeding cows in the overall structure of the herd in 2016 was about 60%.

It should be noted that the increase in milk production in the region in 2016 (by 4.2% since 2015 and 1.1% since 2000) was achieved due to an increase in cow productivity by 4.0%. Thus, the average milk yield from a single cow in the agricultural organizations of the region for 2016 was 6668 kg, which is 4.0% higher than in 2015 and 2.2 times in 2000 (Fig. 2). Among the farms of the region, the

SKHPK "Prisuhonskoe" of the Vologda region has kept the first place in terms of cow productivity over the past years, demonstrating 10838 kg per cow (+682 kg to the level of 2015). On the second place is the SEC Vologodsky of the Vologda region, with 8936 kg, +46 kg; the third place is occupied by the Pokrovskoye LLC of the Gryazovetsky district (8900 kg, +395 kg) [1].

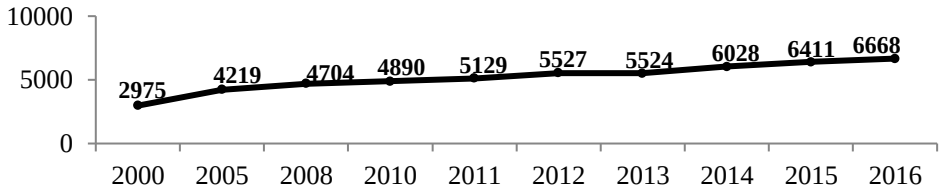


Figure 2. The productivity of cows in the Vologda region, kg of milk per cow per year, farms of all categories.

Source: official statistics of the site of the Unified Inter-Agency Information and Statistical System (EMISS). URL: http://fedstat.ru.

One of the factors of productivity growth in dairy cattle breeding is the improvement of the diet of animals and the food supply in general. In 2016, 833.1 thousand tons of feed was harvested (by 4.3% higher than the level of 2015), including 266.6 thousand feed units or 21.8 centners to the unit by 1 conditional in head bulky feed (without grain forage) (4.0% below the level of 2015); and 157 thousand tons in grain forage [2]. In total, in 2016, 36.0 centners of raw materials were procured per conditional head, including grain forage; it was 38.9 centners in 2015. It should be noted that the average consumption of all feeds increases every year: in 2016, 21.6 centners of coal was consumed to the unit of all feeds, which is 3.4% higher than the level of the previous year and 41.2% higher than the 2000 level [1, 3, 8, 16] (Figure 3).

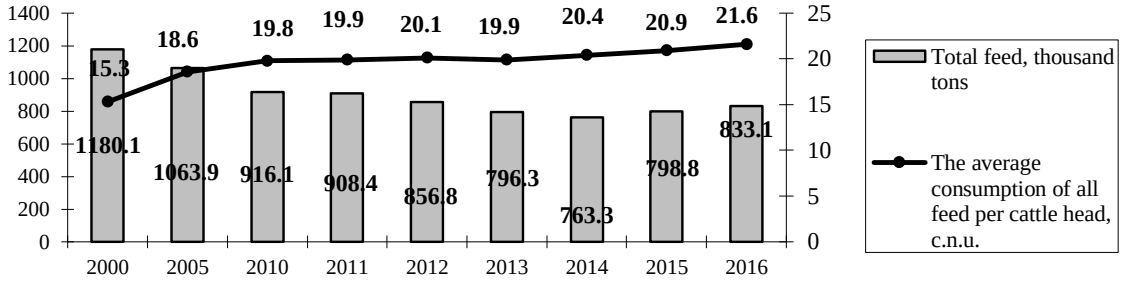


Figure 3. Feed base of the Vologda region.

Source: data of the official site of the territorial body of the Federal State Statistics Service in the Vologda region. URL: www.vologdastat.ru.

It should be noted that with the development of advanced technologies in the field of fodder production, the requirements for the evaluation and analysis of fodder resources are increasing. Recently, a greater bias has been applied to the use of a homogeneous mixture consisting of several types of feed: ground hay, haylage, silage, a mixture of concentrates, mineral and vitamin premixes. According to many years of experience, with such a feeding system, an average of 5000-7000 kg of milk per year can be obtained from a cow [13, 17]. Russian scientists are conducting extensive research on improving the feeding of farm animals, studying the tethered housing of animals, but feeding cows with loose housing, including their robotic milking, has been little studied [13, 16, 18, 19].

Currently, an objective assessment of the quality of feed is a key indicator in agricultural production, while using sampling for testing using the current GOSTs, including the GOST ISO 6497-2014 [23] "Feed. Sample selection". After several point, samples are taken from different places of the silo trench; after mixing, they form a combined sample weighing at least 2 kg, from which the average

sample of silage and haylage weighing 0.5–1.0 kg are separated by dividing a square. For sampling of hay and senazh, one uses the GOST R 55452-2013 “Hay and haylage. Technical conditions” [24]. If necessary, containers with cooling and temperature control can be used to transport the collected samples, which allow determining the temperature conditions during storage and transportation.

It should be noted that the effective use of such feed, in particular silage, haylage and hay, requires constant and careful control over their quality [25-26]. Before including these feeds in existing rations, it is necessary to know what condition they are in, to determine the content of dry matter, crude protein, crude fiber, crude ash, BEV, etc. The same requirements apply to other types of feed, including wood-branch, used by wild species of animals, for example, bison [14, 20]. If the quality of natural fodder mainly depends on climatic factors and agrochemical background of the soil, then the process of harvesting silage, haylage and hay is of great importance for the value of the finished feed and its consumption by farm animals. Subjectively, the quality of feed can be assessed visually as well as by smell.

We believe that a more objective assessment of the quality of the harvested feed can be made by analyzing certain parameters that will indicate how successful the harvesting of the feed was. When analyzing the parameters of natural fodder, we estimate the agrochemical background of the soil and other vegetation growth conditions that provide the fodder capacity of the territory. Using the NIR method, you can determine such parameters as lactic, butyric and acetic acid, ammonia, pH.

In accordance with the recommendations for assessing the quality of the main types of feed for ruminants, the sampling of silage and haylage is determined not earlier than 30 days after they have been stored and no later than 15 days before the beginning of feeding the finished feed to animals. However, at present, due to the laboriousness of the sampling process, many farms assess the quality of the forage after excavating the silage mass from the trench, which is carried out by roller cutters, clamshell loaders, comb silo selectors, block silo cutters, vertical mixers with movable and fixed knives, milling feed mixers. In this case, information about quality comes when the feed is already fed, which contradicts the successful development of rations that ensure the production of animal products and the viability of the animal organism as a whole [23].

Samples of feed are taken from the trenches at the maximum penetration depth, preferably not less than 2 m, while the analysis does not include the upper 20 cm layer. Samples are taken manually or by mechanical sampler. First, three single samples of feed are taken: the first is in the center of one of the end sides at a distance of 5 m from it; the second - in trenches with straight walls at a distance of 0.5 m, and with sloping walls is at a distance of 1 m from one of the walls in the middle part along the length of the trench; the third is in the center of the trench. Samples of succulent fodder (silage, green mass, etc.), as well as woody feed, must be packed in plastic bags due to their high humidity, it is necessary to remove air from the bag as much as possible and close the bag. It is allowed to store the average sample in the refrigerator for 24 hours from the time it arrives at the laboratory. The sample is delivered to the laboratory as soon as possible in compliance with the storage regimes [21].

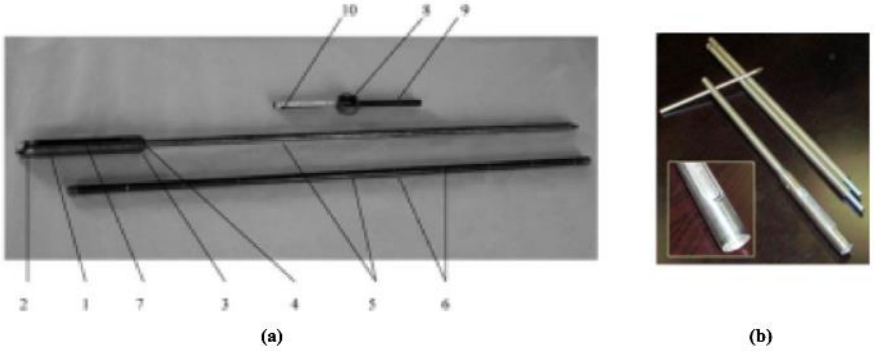
The average sample of hay pledged for storage on farms is taken at the end of its harvesting, but not earlier than 30 days after laying in stacks, ricks, sheds, hangars. Single samples from unpressed hay 200-250g from each place are taken manually or by sampler from a batch weighing up to 25 tons (20 samples) and from each subsequent 5 tons (4 samples). From a batch of pressed hay to 15 tons, 3% of bales are taken (at least 5 bales), 15-50 tons in weight constitute 1% of bales (at least 15 bales). Single samples are taken from each bale in one layer: from the first is the surface, from the second is the next one, etc. The initial sample must be at least 5 kg. From the original sample, laid out in a thin layer on a flat surface measuring 2*2 m, an average sample is taken from 10 different places of 100 g each, which in general should be at least 1 kg. The sample sent to the laboratory must be dry. After that, the average sample is carefully packed in thick paper or plastic bag (the bundle should be long, not shorter than 50 cm) and sent to the laboratory with an accompanying document. A label is placed on the sample indicating the origin of the hay, the number of the plot, the date of hogging and sampling, the weight of the lot [24].

It should be noted that in order to control the quality of the feed placed in the trench at the entire depth of its storage, it is necessary to use special technical means – samplers. Recommendations and sampling techniques, as a rule, do not contain clear and sufficient information about the applied technical means, and are limited by general requirements, such as compliance with particle size, sample volume, physical state, etc. Also, there is no special regulatory framework for sampling mechanisms, where it would be indicated, what to select and with what characteristics. In general, the requirements for samplers are determined by the method of selection itself, i.e. by agro-technical requirements (the depth of sampling, the mass of the sample, its volume, etc.). Depending on the purpose of the research, these requirements may be refined, thereby changing the design of the samplers.

Considering the procedure for sampling feed, we note that it can be made with manual and mechanical samplers. The most common are manual samplers. Mechanical samplers along with the positive aspects of the complexity, the process performance has a number of drawbacks associated with cumbersome drive, decrease reliability and resource exploitation.

Of course, there is a wide variety of designs of devices for the selection of feed, which are principally divided into selectors with cutting a sample with a blow or similar impact and cutting a sample with sliding cutting (rotation or its equivalent). However, in the course of the research, the advantages of the chosen principle of cutting a sample by a screw working body using the effect of sliding cutting and freeing the cutting area from the feed using a special extractor. The constructive solution of the new device for cutting a sample from the monolith of feed in the form of a screw device can significantly reduce the energy intensity of the process.

The process of impact cutting in samplers using the inertia of the mass of the sample selector during its sweeps has been significantly simplified. Such structures were developed at the All-Russian Research Institute of Feed, SZNIIMESH, etc. (Figure 4).



(a) Silo selection probe, constructed in the All-Russian Williams Fodder Research Institute

(b) The drill - BP-1 sampler for silage and rolled grain, designed by IEEP - BRANCH OF FSAC VIM

Figure 4. Samplers.

One of the main criteria for evaluating samplers is energy consumption and manual labor costs. Energy costs for sliding cutting is about 5 times less than when cutting with a tube. Therefore, the use of samplers that use sliding cutting is energetically justified, but they require a rotation drive mechanism. The design of such a sampler was developed by the scientists of SZNIIMLPH, patent No. 21000793 “Sedunov V. A. sampler”. Quite a large number of these samples work in the farms of Vologda and other regions of Russia.

Figure 5. Sedunov's V. A. sampler.

The search for ways to improve the sampling process for feeds has been determined by the previously unused principle of cutting out the sample. This principle is implemented in the design of the OCA-1.5/2/0 sampler, experimental samples of which showed their efficiency. The sampler consists of a rod with a screw, extension, and rotation. Sampling is carried out as follows: when the rod rotates with a rotate, the cutting knives located on the edge of the auger windings cut out a part of the feed that is captured by the cylindrical part of the auger. When the auger is filled with food, the sampler is removed to the surface, where the sample is dumped onto the canvas canopy. The process is repeated until the required depth of sampling (Figure 6).

Figure 6. The OCA-1.5/2/0 sampler.

As a result of studying the experience of 38 advanced farms of the Vologda region and many years of research on this issue[1], 10 thousand tons of haylage, 400 thousand tons of silage, as well as other feed used in diets of farm animals (grass pastures, green top dressing, grain-new feed, cake, molasses, premixes, various additives). In addition, we studied the chemical composition and nutritional value of the natural food used by bison of a free-breeding population adapted in the North of the European part of Russia.

It has been revealed that in recent years, the species composition of forage harvested from green mass (haylage, silage) has significantly expanded, new types of grass mixtures have appeared, and the

[1] Chemical analysis of feed was determined in the SZNIIMLPKH Laboratory of Chemical Analysis, an isolated subdivision of the FGBUN VolSC RAS. Zootechnical analysis was carried out according to GOST 23637-95, 23638-95, 1349.0-95, 4808-97, 13496.4-99, 55986-2014, 55452-2013.

use of 2-3-4-5 component mixtures has resumed. It is important to note that the use of various types of silage takes place in the system of rationed animal feeding, and many farm specialists work in terms of expanding the species composition of grass mixtures.

As for the quality of feed, on average in the Vologda region in 2017, the feed corresponded to the quality class II; the silage quality class I was only 24.7% (Table 1). On average, in farms, the tendency of harvesting silos has decreased and is 7.99%.

Table 1. Quality of feed in the Vologda region in 2017, %.

Feed type	Quality classes				Total
	I	II	III	n/cl	
Haylage	-	14.74	11.31	73.95	100.00
Silage	24.78	39.58	27.65	7.99	100.00

Source: compiled by the authors

Haylage, in fact, ceased to cook as a kind of food. This is mainly fodder from the pre-grown grass of the first mowing at the end of July-August, during the ripening of grass seeds, when the nutritional value is lost, and only in terms of the dry matter content we attribute it to haylage. In 2017, the Class I haylage was completely absent, including 14.4% in the Class II quality and 11.31% in the Class III. The bulk of the haylage belongs to the classroom quality of the feed and is 73.95%.

In evaluating haylage and silage in accordance with GOST, the content of organic acids, which largely determine the correctness or violation of the harvesting technology, is of paramount importance. In Table 2, we present the certification of the quality of silage and haylage in the Vologda region on average.

Table 2. Certification of the quality of silage and haylage in 2017, on average in the Vologda region, % in natural feed.

Feed type	Cl	pH	Acetic acid	Butyric acid	Lactic acid	Total amount	Mass fraction of lactic acid in the total amount (lactic, acetic, butyric) acids, %
Haylage	2	3.99	0.65	0.068	2.31	3.03	76
Haylage	3	4.29	0.34	0.104	2.41	2.85	84
Haylage	4	4.53	0.64	0.08	2.57	3.29	78
Haylage TOTAL		4.35	0.61	**0.078**	2.48	3.17	**78**
Silage	1	4.1	0.8	0.029	2.71	3.54	76
Silage	2	3.96	0.81	0.0	2.72	3.53	77
Silage	3	4.08	0.95	0.0	2.54	3.49	73
Silage	4	4.22	0.86	0.143	2.47	3.47	71
TOTAL		4.06	0.86	**0.014**	2.62	3.49	**75**

Source: author's research.

As we see from Table 2, as a regional average, the content of organic acids in silage is 0.014% in natural feed, and it is 0.078% in the haylage (corresponds to Class I).

The high content of butyric acid in silage and haylage leads to high losses of dry matter and digestible energy. In ruminants, this leads to a decrease in palatability of feed and problems with the exchange of substances. If possible, silage with a high content of butyric acid should be excluded from the rations of ruminants, especially pregnant and lactating cows. In the presence of such feed and the

need to include it in the diet, it is subject to feeding in the first place, preventing the accumulation of unwanted organic acid [27].

Table 3. The nutritional value of harvested succulent feeds in 2017 on average in the Vologda region.

Feed group	Dry matter, g / kg	OE	Feed units	Raw protein	Raw fiber	Carotene
In a natural feed		MJ / kg	kg / kg	g / kg	g / kg	mg / mg
Haylage	418,36	3.48	0.24	36.01	125.47	32.03
Silage	261,91	2.53	0.2	32.09	77.98	25.38
In abs. dry food		MJ / kg	kg / kg	%	%	mg / mg
Haylage	418,36	8.32	0.57	8.72	30.17	78.85
Silage	261,91	9.67	0.76	12.27	29.79	97.63

Source: author's research.

In the study of voluminous feeds for nutrients for the analyzed period, it was revealed that the protein content in absolutely dry feed in the silage is 12.27%, carotene is 97.63 mg / kg, and the fiber content is 29.79% (Table 4). This is due to the fact that farms are trying to improve the storage conditions of bulky feed, due to the complex preparation of trenches for the procurement period.

Table 4. Nutritional value of haylage and silage in 2017, on average in the Vologda region, depending on species composition.

Feed group	Feed type	Absolutely dry matter, g / kg	OE, MJ / kg	Feed units, kg / kg	Raw protein, %	Raw fiber, %	Carotene, mg / mg
Haylage	Perennial legume-cereal herbs	491.11	8.33	0.57	8.99	27.45	36.7
Haylage	Perennial cereal-legume herbs	417.66	7.81	0.5	7.19	33.17	93.4
Haylage	Perennial cereal herbs	517.08	8.68	0.62	8.76	29.63	93.4
Haylage	Perennial herbs + annuals	247.57	8.44	0.57	9.92	30.41	91.9
Silage	Perennial legume-cereal herbs	252.68	9.62	0.75	13.86	28.44	103.5
Silage	Perennial cereal-legume herbs	246.84	9.76	0.77	12.38	29.35	103.2
Silage	Perennial cereal herbs	261.65	9.44	0.73	10.86	30.29	114.0
Silage	Perennial herbs + annuals	286.46	9.84	0.8	11.99	29.08	69.8

Source: Author's research.

Analyzing the data in Table 4, it becomes clear that the highly nourishing silage is prepared from legume-cereal grass stands. The mass fraction of raw protein in it was 13.86%, 28.44% in raw fiber, 9.62 MJ / kg in OE, 0.75 units / kg in feed units. As for the silage from cereal and cereal-legume grass stand, the concentration of raw protein in it was from 10.86-12.38%, from 29.35-30.29% in raw fiber, from 9.44-9, 76 MJ/kg in OE, from 0.73-0.77 units/kg in feed units. However, the content of carotene in the cereal herbs silage is the highest, which is 114.0 mg/kg. Low protein content, metabolic energy

is present in the haylage. This is explained by the fact that most of the haylage is represented by such only by the amount of dry matter per 1 kg of natural feed. Technologically, this is a silage (lack of drying) of late harvesting, obtained from the end of July or August, from dry, overgrown, old herbs.

Analysis of the nutrient content in harvested rough and succulent feeds allows predicting the causes of poor quality and planning the elimination of these causes for the future.

The quantity of high-quality feeds is an aggregate indicator of the degree of compliance with technological requirements during their harvesting, the level of organization of farm management, the ability of specialists and managers to use material and technical resources of an enterprise to obtain high quality feed, the level of performance discipline of the company's employees. The reasons for the errors arising from the practical assessment of the nutritional value of feed are their dependence on natural and technological factors, such as the climatic conditions of a given year, the vegetation stages during harvesting, the technology of cultivation and harvesting of feed, the timing of chemical analysis of feed, evaluation of their digestibility. The primary condition for the reliability of determining the quality and nutritional value of feed is the correct sampling of feed for testing. Methods and methods of selection are included in the system of rationed animal feeding, which involves measuring and managing the quality control of har-vested and used feed.

Thus, devices for mechanical sampling of plant samples reduce the laboriousness of the working process, increase the productivity of sampling for carrying out laboratory qualitative analysis of samples from silage trenches. This solves the problem of objective control of the technological process of harvesting and storage of feed.

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