DOI 10.32900/2312-8402-2023-130-50-64
UDC: 636.2.082

EFFICIENCY OF THE USE OF TYPICAL AND INNOVATIVE RATIONS FOR FEEDING COWS IN THE SOUTH OF UKRAINE

Elfeel Ayman Anwar Alsaliheen, Postgraduate,
https://orcid.org/0000-0003-0821-1964
Susol Ruslan, Doctor of Agricultural Sciences, Professor,
https://orcid.org/0000-0003-2395-1282
Kirovych Nataliia, Candidate of Agricultural Sciences, Associate of Professor
https://orcid.org/0000-0002-9177-8832
Odesa State Agrarian University, Odesa, Ukraine

The paper presents an innovative view of the recommended feeding rations for effective milk production on an industrial basis in the conditions of southern Ukraine, taking into account the fact that this territory belongs to the zone of risky land use and the negative effect of global warming, which has been manifested in recent years. Scientific and economic experiments were carried out at the State Enterprise "SF Andriyivske" of the Bilhorod-Dnistrovsky district of the Odesa oblast according to generally accepted methods. The advantages of using winter rye as a crop whose growing season falls on wetter periods of the year have been established, which makes it possible to harvest high-quality silage with an energy content of 12.0 MJ, crude protein 12.7%, neutral detergent fiber 51.9% in the calculation per 1 kg of dry matter. A tendency to advantage in terms of milk yield was established from the cows of the experimental groups that received rye silage in combination with wet beer groats as the main fodder. Taking into account the ratio of fat and protein in the milk of the cows of the experimental groups in our studies, the optimal ratio of fat: protein was established in the cows of IV experimental group (1.2: 1), whose rations as the main forage contained only 45.0 kg of rye silage with the addition to this 6.0 kg of wet beer grain. The use of rye silage in combination with wet beer groats in the feeding rations of the cows of the experimental groups revealed a positive effect on indicators of rumen fullness, manure consistency, feed digestion, cow fattening, health status, reproductive capacity and animal survival. A tendency was established for the superiority of the milk yield of the cows of the experimental groups for 305 days of lactation by 95-258 l, respectively, compared to the animals of the control group, where the milk yield was 7,898 l, which, due to the use of cheaper ingredients in the rations, made it possible to reduce the cost of production of 1 liter of milk by 11.3-23.7%.

Key words: feed ration, rye silage, beer grain, yield, fat content, protein content, economic efficiency.

ЕФЕКТИВНІСТЬ ВИКОРИСТАННЯ ТИПОВОГО ТА ІННОВАЦІЙНИХ РАЦІОНІВ ГОДІВЛІ КОРІВ В УМОВАХ ПІВДНЯ УКРАЇНИ

Елфеел А. А. А., асп., https://orcid.org/0000-0003-0821-1964
Сусол Р. Л., д. с.-г. н., професор, https://orcid.org/0000-0003-2395-1282
Кірович Н. О., к. с.-г. н., доцент, https://orcid.org/0000-0002-9177-8832
Одеський державний аграрний університет

У представленій статті наведено інноваційний погляд щодо рекомендованих раціонів годівлі задля ефективного виробництва молока на промисловій основі в умовах півдня України з урахуванням належності даної території до зони ризикованого землекористування та негативної дії глобального потепління, що виявляється останнім роками. Науково-господарські досліди проведено в умовах ДП«ДГ«Андріївське» Білгород-Дністровського району Одеської області за загальноприйнятими методиками. Встановлені переваги використання озимого жита як культури, вегетаційний період якої припадає на більш вологі періоди року, що дає можливість заготовити достатньо якісний силос із вмістом енергії 12,0 МДж, сирого протеїну 12,7 %, нейтрально-детергентної клітковини 51,9 % в розрахунку на 1 кг сухої речовини. Установлено тенденцію до переваги за рівнем надою у корів піддослідних груп, що отримували в якості основного фуражного корму житній силос у поєднанні з вологою пивною дробиною. З урахуванням співвідношення жиру і білка в молоці корів піддослідних груп у наших дослідженнях оптимальне співвідношення жир : білок встановлено у корів IV дослідної групи (1,2 : 1), раціони яких в якості основного фуражного корму містили лише 45,0 кг житнього силосу з доповненням до цього 6,0 кг вологої пивної дробини. Використання житнього силосу у комбінації з вологою пивною дробиною у раціонах годівлі корів дослідних груп виявили позитивний вплив на показники наповненості рубця, консистенцію гною, перетравлення корму, вгодованості корів, статусу здоров'я, відтворювальної здатності і збереженості тварин. Установлено тенденцію до переваги за рівнем надою корів дослідних груп за 305 днів лактації відповідно на 95-258 л порівняно з тваринами контрольної групи, де надій склав 7898 л, що за рахунок ще й використання більш дешевих інгредієнтів раціонів дозволило зменшити собівартість виробництва 1 л молока на 11,3-23,7 %.

Ключові слова: раціон годівлі, житній силос, пивна дробина, надій, вміст жиру, вміст білку, економічна ефективність.

In the conditions of industrial-type domestic dairy cattle breeding, fodder such as corn silage and alfalfa hay play an important role in ensuring a stable and high level of productivity of the dairy herd, since currently most farms practice year-round monofarming (Drackley J. K. et al., 2014; Ruban S. Yu. et al., 2015; Kozyr V. S., 2019).

In fact, the analysis of corn silage shows that the main indicators of its quality such as dry matter content, exchangeable energy concentration, pH, level of digestibility of organic matter as a percentage of total dry matter, and starch content are lower than the existing norms, because silage is often harvested in suboptimal conditions due to the heat the phase of its maturity. We should outline that such a situation is not uncommon in the south in conditions of ongoing global warming. In connection with the existing difficulties of growing corn for silage and alfalfa for hay due to the lack of moisture in the south of Ukraine, which have recently been exacerbated by global warming, the

search for alternative fodder crops for dairy cattle breeding is an urgent task today (Elfeel A. A. A. et al., 2023).

The effective "healthy" ration for feeding dairy cows contains coarse and juicy forages of at least 60.0% of the dry matter in the ration (Pidpala T. V. et al., 2019; Riznychuk I. et al., 2023).

In addition to corn for silage, which is a feed rich in exchangeable energy, various cereal crops can be conserved, with winter crops being a priority, as their active vegetation occurs during wetter periods of the year. Quite often ensiled crops are rye or triticale. The question arises, which culture is better for silage and subsequent feeding to dairy cattle? Thus, studies in one of the US pilot projects did not reveal a significant difference between rye and triticale, not even significant changes in quality were noted between fresh and ensiled feed from these ingredients. The main thing is to harvest these crops for ensiling at the stage of flag leaf formation, this ensures low fiber content and high digestibility (*Crops and Forages. Hoard's Dairyman*).

Cereal crops can be alternative feed for small dairy farms in limited climatic conditions, given their short growing season (Burgess P. L., et al., 1973).

Research conducted in Mexico, where the climate is quite arid, found that both rye and triticale are good alternative forage crops for ensiling (Vega-García Jesús I. et al., 2023).

Cultivation of such forage crop as winter rye (Secale cereale L.) helps not only to meet the growing demand for feed ingredients, but also to improve crop rotation (Herbstritt S. et al., 2022).

The purpose of the work is to determine the efficiency of using typical and innovative feed rations for cows in the production of milk on an industrial basis in the conditions of the south of Ukraine, which belongs to the zone of risky land use and under the negative effects of global warming.

In order to achieve the goal, using the feeding technology based on feed rations with different proportions of rye silage and the use of wet beer groats as a corrective component of the ration in the conditions of the southern region of Ukraine, the following tasks were solved:

- to evaluate the milk productivity of cows (yield by stages of lactation, yield for 305 days of lactation, fat and protein content in milk, amount of milk fat and protein);
- to study the influence of the use of rye silage and wet beer groats in feed rations on indicators of rumen fullness, manure consistency, feed digestion, cow fattening, health status, reproductive capacity and survival of cows in the experimental groups;
- to determine the economic efficiency of the conducted research.

Research materials and methods. The object of research was indicators of milk productivity and reproductive capacity of cows using a feeding technology based on feeding rations with different proportions of rye silage and the use of wet beer groats as a corrective ingredient of the ration in the conditions of the southern region of Ukraine.

Scientific and economic experiments were carried out in the conditions of the State Enterprise "SF Andriyivske" of the Institute of Climate-Oriented Agriculture of the National Academy of Agrarian Sciences of Ukraine, Bilhorod-Dnistrovsky district, Odesa oblast, according to methods generally accepted in dairy cattle breeding, and laboratory research of silage samples in the conditions of a specialized laboratory for the research of fodder *Frank Wright LTD (Ashbourne, United Kingdom)* using the method of infrared spectroscopy.

To conduct the experiment, a control group and 4 experimental groups of cows of the Ukrainian red dairy breed of the Holstein type, 10 heads each, were formed using

the pair-analogue method. A total of 50 cows at the age of 2-3 lactations were involved in the experiment. The early lactation feeding rations of animals of the control group included a set of feeds traditional for dairy cows in industrial production conditions (corn silage – 25 kg, alfalfa haylage – 8.0 kg, alfalfa hay – 1.5 kg, compound feed – 11.3 kg). The compound feed included corn, wheat, barley, sunflower meal, soybean cake, salt, chalk, premix. The rations of experimental groups I-III, in addition to the specified traditional set of feeds, contained a reduced amount of corn silage (22.0; 16.0; 12.0 kg, respectively, for experimental groups I, II, III) and alfalfa hay (6.0; 3.0 kg, respectively, for I and II experimental groups). 13.0 and 25.0 kg of rye silage were included in the rations of cows of II and III research groups, respectively. The amount of compound feed for animals of I, II, III, IV experimental groups was 10.2 each; 10.1; 9.6; 10.9 kg respectively. The feeding rations of the cows of IV experimental group contained only rye silage in the amount of 45.0 kg, alfalfa hay – 1.0 kg and beer grain – 6.0 kg from basic fodder. Their feed also included corn, wheat, barley, sunflower meal, soybean cake, salt, chalk, and premix. The composition of the feed rations of the cows of I-III experimental groups included fresh wet beer grain in the amount of 10.0 kg.

The milk productivity of cows was evaluated for 305 days of lactation by the method of conducting control milking every decade. The content of fat and protein in milk was determined using an ultrasonic milk analyzer Ecomilk Standard-4600-00002. Average milk samples were taken from each cow during control milking (Soboliev O. I. et al., 2022; Ladyka V. I. et al., 2023).

The number of animals chewing the cud was determined by their relative number (%) in relation to the total number of animals in the experimental group.

The fullness of the rumen of cows in farm conditions was assessed on a 5-point scale, where the smallest amount corresponds to 1 point, and the maximum – 5 points. The optimal indicator is desirable for dairy cows with normal health status and appetite corresponds to 3 points. The individual feed intake of each cow was studied 1 time per 3 days in the period of early, middle and late lactation during herd inspection (Götze K. et al., 2019).

Methodology for assessing the consistency of manure and the level of digestibility of ration components in points from 1.0 to 5.0 (Cow Talk).

Fatness of dairy cows was assessed on a 5-point scale. At the same time, 1 point corresponds to a very thin animal, 5 to excessively fat and 3 to factory fattening (Cow Talk).

Statistical processing of the results was carried out using modern packages of Microsoft Excel 2010 application programs using generally accepted methods (Kramarenko S. S. et al., 2019).

Research results. Our analyses of corn silage in the conditions of southern Ukraine prove that its basic quality indicators, such as the content of dry matter (DM) was 36.1%, the concentration of exchangeable energy (12.8 MJ/kg of DM), the content of crude protein (7.7 %/kg of DM), the *pH* level (4.0), the level of digestibility of organic matter from the total composition of dry matter (75.3%), the content of starch (35.6%) are beyond the existing normative indicators, because due to hot weather conditions silage often has to be collected during a sub-optimal maturity phase. Considering this, any winter crop can be a more optimal crop for ensiling in the conditions of southern Ukraine. We got positive results on winter rye. Thus, rye silage is to a certain extent inferior to corn silage in terms of dry matter content by 12.8%, but in terms of crude protein it exceeds it by 5.0%. Regarding the level of digestion of organic substances, the advantage is on the side of corn silage (by 6.3%). Corn silage is characterized by in-

creased exchangeable energy by 0.8 MJ/kg of dry matter due to the content of 35.6% starch, which is absent in rye silage.

According to such a critically important indicator as neutral detergent fiber (NDF) for ruminants, rye silage (51.9%/kg of DM) has a significant advantage of 17.9% compared to corn silage. In addition, the digestible NDF (77.4%/kg of DM) in rye silage is 7.4% higher than in corn silage.

The use of wet beer groats and rye silage in the feeding of dairy cows makes it possible to optimize the indicators of crude protein content and significantly reformulate the daily dose of protein ingredients of compound feed from 130 g/l to 90 g/l of milk, to ensure the dry matter content of feed rations at the level of 35.0%, increase the level of consumption of the ration with a better appetite.

The strength of feeding rations based on the use of wet beer groats and rye silage is the absence of starch in their composition, which, when formulating a fully mixed ration, allows to ensure the content of total starch at the level of 20.0% of the dry matter of the ration and even along with the increased sugar content in rye silage compared to corn, such rations have an appropriate total content of starch + sugar, which prevents the phenomenon of acidosis.

The use of special modern computer programs for drawing up rations for feeding dairy cows provides the correct approach to the formation of rations based on the concentration of exchangeable energy and crude protein, even when using different components, but due to the different content of fiber (both NDF and physically effective NDF), which effects on the fat content in the milk and on the health status of the cow. With an increase in the content of NDF in the feed rations of the cows of the experimental groups, the fat content in their milk increases in direct proportion. Taking into account the ratio of fat and protein in the milk of the cows of the experimental groups in our research, the optimal ratio of fat to protein was established in the cows of IV experimental group (1.2 : 1).

The analysis of the obtained results according to the indicators that allow to evaluate the relative number of animals chewing the cud in a calm state, the state of rumen filling, the consistency of manure, the degree of digestion of nutrients and the fatness of cows in the dynamics of the early, middle and late phases of lactation (Table 1) indicates the fact that no significant difference was found in the vast majority of the considered cases, only tendencies towards one or another advantage were noted, which to a certain extent indicates that the feed rations of the cows of all experimental groups were relatively correctly balanced. Thus, with regard to the indicator of the relative number of animals chewing the cud in a calm state during early lactation, a reliable advantage was established in cows of III and IV research groups, respectively, by 20.0% ($p < 0.01$) and 30.0% ($p < 0.001$) compared to animals of the control group. In general, a regularity can be observed that with an increase in the level of NDF in the dry matter of the ration, this indicator increases in direct proportion. According to this indicator, a similar pattern continues to be observed in the mid-lactation phase, but the difference between the groups is statistically improbable. It remains in the phase of late lactation, but a significant difference of 20.0% ($p < 0.01$) compared to animals of the control group is noted only in cows of the IV experimental group. In general, we note that under the existing standard, according to this indicator, 50.0-70.0% of the total number of cows in a calm state should chew the cud. This is exactly what happened in the vast majority of animals in the experimental groups. The exceptions were only the cows of the control and I experimental groups in the early lactation phase, when the corresponding indicator was 10.0% less than the lower limit of the norm, and the cows of the IV exper-

imental group in the late lactation phase, which exceeded the upper limit of the norm by 10.0%.

Table 1

Assessment of rumen fullness, manure consistency, feed digestion and fatness of cows of experimental groups (n=10), $\overline{X} \pm S_{\overline{X}}$

Indicator	Group of cows				
	C	E-I	E-II	E-III	E-IV
Early lactation					
Animals chewing the cud, %	40.0 ± 3.09	40.0 ± 6.90	50.0 ± 4.36	60.0 ± 4.88 **	70.0 ± 3.09 ***
Rumen fullness, points	2.8 ± 0.20	3.0 ± 0.15	3.1 ± 0.28	3.2± 0.29	3.4 ± 0.27
Manure consistency, points	2.9± 0.18	3.0 ± 0.15	3.0 ± 0.15	3.2 ± 0.13	3.2 ± 0.20
Manure assessment (digestion), points	1.5 ± 0.27	1.3 ± 0.21	1.2 ± 0.13	1.3 ± 0.21	1.2 ± 0.13
Fatness, points	2.6 ± 0.27	2.7 ± 0.26	2.8 ± 0.20	2.7 ± 0.15	2.9 ± 0.18
Mid-lactation					
Animals chewing the cud, %	60.0 ± 2.18	50.0 ± 9.0	60.0 ± 6.55	60.0 ± 8.16	70.0 ± 4.36
Rumen fullness, points	3.0 ± 0.15	3.0 ± 0.15	3.2 ± 0.25	3.3 ± 0.30	3.3 ± 0.26
Manure consistency, points	3.0 ± 0.15	3.0 ± 0.26	3.0 ± 0.15	3.1 ± 0.10	3.2 ± 0.15
Manure assessment (digestion), points	1.2 ± 0.13	1.2 ± 0.13	1.1 ± 0.10	1.2 ± 0.13	1.3 ± 0.15
Fatness, points	3.0 ± 0.15	2.9 ± 0.18	3.0 ±0.15	3.0 ± 0.15	3.0 ± 0.15
Late lactation					
Animals chewing the cud, %	60.0 ± 3.78	60.0 ± 5.77	60.0 ± 7.24	60.0 ± 5.35	80.0 ± 3.78**
Rumen fullness, points	3.4 ± 0.27	3.4 ± 0.31	3.7 ± 0.30	3.6 ± 0.34	3.8 ± 0.25
Manure consistency, points	3.2 ± 0.25	3.2 ± 0.29	3.2 ± 0.20	3.2 ± 0.13	3.5 ± 0.17
Manure assessment (digestion), points	1.1 ± 0.10	1.2 ± 0.13	1.1 ± 0.10	1.1 ± 0.10	1.1 ± 0.10
Fatness, points	3.6 ± 0.16	3.3 ± 0.15	3.5 ±0.17	3.3 ± 0.15	3.2 ± 0.13

*Note. **- probability p<0.01; ***–p<0.001*

The assessment of the degree of indicators of rumen fullness and manure consistency in the different phases of lactation proves that the corresponding indicators were within the existing norms of 3.0 points each, respectively. The average values of these indicators below the existing norm were established only in animals of the control group in the period of early and middle lactation. In addition, with an increase in the level of NDF in the dry matter of the feeding rations of the cows of the experimental groups, these indicators were characterized by a tendency to increase.

The assessment of manure by the level of digestion in the different phases of lactation proves that this indicator was completely within or approaching the existing norm

of 1.0 points. The average values for this indicator deviated more strongly from the existing norm, again in animals of the control group in the period of early and mid-lactation, but again, with an increase in the level of NDF in the dry matter of the rations of the cows of the experimental groups, this indicator was marked by a tendency to improve as it approached the optimal normative value.

The analysis of the assessment of the fatness index in the section of different phases of lactation proves that the indicated average indicator was completely within the recommended limits or approached the existing norm 3.0 points. The average indicators of fatness in points deviated more significantly from the existing standard in animals of the control group in the period of early lactation (below by 0.4 points from the standard) and in the period of late lactation (higher by 0.6 points from the standard), but also with an increase in the level NDF in the dry matter of the feed rations of the cows of the experimental groups, this indicator was characterized by a tendency to improve as it approached the optimal regulatory value. Animals of I, III, and IV experimental groups in all periods of lactation had the most close-to-normative indicators of total fatness. Regarding the animals of II experimental group, a similar situation was noted in the phase of early and mid-lactation, however, for the cows of this group in the period of late lactation, the fat content had a tendency to prevail over the animals of the other experimental groups and approached the level of the maximum indicator of the control group.

In general, it should be outlined that the average scores of the animals of the control and experimental groups were within the norm, only individual representatives in each of the groups provided a tendency towards one or another deviation from the desired norm 3.0 points.

Analysis of the influence of the use of rye silage and wet beer groats in the rations of dairy cows on the health status, reproductive capacity and their preservation (Table 2) proves that the rations of the cows of the experimental groups are balanced according to basic indicators, but metabolic diseases in the different form occurred in the animals of the control, I, II, IV experimental groups.

We can note that with an increase in the NDF level to 35.6% and more along with the decrease in the content of starch in the dry matter of the ration, no signs of subclinical acidosis were detected in the animals of II-IV research groups, however, the problems with energy deficit are relevant, that is, to solve this issue it is worth thinking about using special ingredients. The mentioned metabolic disorders were not detected only in the animals of III research group.

The reproductive capacity of cows was evaluated based on the absence of heat on the 28th, 49th, and 70th day after calving. Representatives of the control, I and II research groups in the period on the 28th and 49th day after calving had slightly worse indicators compared to the counterparts of III and IV research groups. Thus, 100.0% of representatives of II-IV experimental groups had signs of sexual desire during the 70th day after calving.

Increased indicators of the duration of the service period were found in the animals of the control, I, II experimental groups. The smallest and, accordingly, the most desired indicator was found in the cows of III experimental group, which had fertile insemination 26.9 days or 26.1% earlier than the animals of the control group ($p < 0.05$), and in the cows of IV experimental group this advantage was 23.9 days or 23.2% ($p < 0.05$). In addition, the animals of the control group had a loss of embryos in the first 90 days after fertilization at the level of 10.0%.

Table 2

The influence of the use of rye silage and wet beer groat in the rations of dairy cows on the health status, reproductive capacity and survival of dairy cows (n=10), $\overline{X} \pm S_{\overline{X}}$

Indicator	Group of cows				
	C	E-I	E-II	E-III	E-IV
Hidden rumen acidosis, %	20.0	10.0	-	-	-
Subclinical ketosis, %	10.0	10.0	10.0	-	10.0
Lack of desire on the 28th day after calving, %	40.0	30.0	10.0	20.0	10.0
Lack of desire on the 49th day after calving, %	10.0	10.0	10.0	-	-
Lack of desire on the 70th day after calving, %	10.0	10.0	-	-	-
Service period, days	103.1 ± 9.77	101.0 ± 6.40	99.0 ± 8.62	76.2± 6.24*	79.2 ± 5.63*
Yield of calves per 100 cows, %	94.0	95.0	96.0	102.0	100.0
Loss of embryos in the first 90 days after fertilization, %	10.0	-	-	-	-
Duration of lactation, days	337.0± 12.19	326.0 ± 6.82	324.0± 9.45	301.0± 5.7*	304.0 ± 6.27*
Dry period, days	67.0 ± 4.48	64.5 ± 3.02	63.5 ± 3.66	63.0± 2.13	64.0 ± 3.06
Intercalving interval, days	404.0 ± 6.41	390.5 ± 9.26	387.5± 12.25	364.0± 8.63 *	368.0 ± 8.86
Barrenness, %	10.0	-	-	-	-
Infertility, days/ head.	23.1	21.0	19		
Infertility, days/group	231	210	190	-	-
Rate of elimination of cows, %	20.0	20.0	10.0	-	-

*Note. * – probability p<0.05*

The differentiated duration of the service period also affects the yield rate of calves per 100 cows. Thus, in our studies, the yield of calves in cows of all experimental groups was at a fairly high level of 94.0-102.0%, but the most optimal data for this indicator were in cows of III and IV experimental groups, which exceeded the control group by 8.0, respectively and 6.0%.

The average indicator of the optimal duration of the intercalving period of 365 days is not always reached even in the leading herds of European countries with developed dairy farming. It is worth noting that this indicator as a whole for all experimental groups was in the range from 364.0 to 404.0 days, which, accordingly, roughly reflects the general picture regarding the duration of the intercalving period in average domestic industrial-type milk production farms. It should be noted that in all the cows in the experimental groups there is a tendency to advantage in terms of this indicator over the analogues of the control group. Thus, the duration of the intercalving period of cows of I, II, III, IV research groups was shorter by 13.5 days or by 3.3%, respectively; by 16.5

or 4.1%; by 40.0 or 9.9% ($p < 0.05$); by 36.0 or by 8.9% for the duration of the intercalving period of representatives of the control group.

Thus, for the duration of the service period of less than 80 days, economically undesirable days of infertility are completely absent only in animals of III and IV experimental groups, while the analogues of the control group had 231 days of infertility per group, and in the animals of II experimental group, their number decreased by 9.0%, in animals of III experimental group – by 18.0% compared to the control.

During the year, in conditions of intensive milk production technology, the culling rate is on average 30.0-35.0%. In our studies, the rate of culling of cows was significantly lower and amounted to only 20.0% in animals of the control and I experimental groups, and 10.0% in II experimental group. It is interesting that in III and IV experimental groups, a 100.0% level of cow survival was observed. This confirms our assumption that the use of rye as the basis of the ration, and hence the decrease in the level of starch, contributes to a better level of preservation of dairy cows and increases the necessary productive longevity of the dairy herd.

The analysis of the economic feasibility of using typical and innovative feeding rations for cows in different phases of lactation (Table 3) proves the economic advantage of feeding all experimental groups, where due to the reduction of the daily cost of the feed ration, the cost of feeding decreased from UAH 3340.0 to UAH 9110, or from 10.1% to 21.2% compared to the control group. This, in turn, contributed to the reduction of the total cost of production, which consisted of feed costs and 40.0% of overhead costs, and due to the increased milk yield of the cows of the experimental groups, it led to a decrease in the cost of production of 1 liter of milk by 0.86–1,81 UAH or by 11.3–23.7% compared to animals of the control group.

Table 3

Economic efficiency of using typical and innovative feeding rations of cows in different phases of lactation

Ingridients, kg	Group of cows				
	C	E-I	E-II	E-III	E-IV
Early lactation					
Cost of ration, UAH	168.8	147.5	141.1	137.5	137.7
Savings, UAH	-	21.3	21.7	31.3	31.1
Mid-lactation					
Cost of ration, UAH	151.9	138.4	132.9	128.7	121.0
Savings, UAH	-	13.5	19.0	23.2	30.9
Late lactation					
Cost of ration, UAH	109.6	101.0	90.6	86.9	80.5
Savings, UAH	-	8.6	19.0	22.7	29.1
305 days before lactation					
Feed costs, UAH	43030.0	38690.0	36460.0	35310.0	33920
Savings, UAH	-	4340.0	6570.0	7720.0	9110.0
Savings, %	-	10.1	15.3	18.0	21.2
Full cost of production, UAH	60242.0	54166.0	51044.0	49434.0	47488.0
Yield per lactation, l	7898.0	7993.0	8124.0	8119.0	8156.0
Cost of 1 liter of milk, UAH	7.63	6.77	6.28	6.08	5.82
Savings, UAH	-	0.86	1.35	1.55	1.81
Savings, %	-	11.3	17.7	20.3	23.7

The economic calculation of the efficiency of using rye silage and wet beer groat in the recommended feed rations of dairy cows (Table 4) has a positive effect on the formation of the price of milk (40.0% for fat content, 60.0% for protein content), because with the price policy UAH 10.0 for 1 liter of milk with a fat content of 3.7% and a protein content of 3.3% with a slight but present difference in milk yield between the control and I-IV research groups due to the different content of fat and protein, only the milk of cows of III and IV experimental groups, respectively, corresponded to the declared price of UAH 10.0 or exceeded it by 3.6%. In general, we note that the difference between milk yield, milk quality, which affects the price policy for 1 liter of milk, received a significant difference in the monetary equivalent for commercial milk from cows of the experimental groups, from UAH 2914.52/head (I experimental group – minimal increase) up to UAH 9,556.10/head (IV experimental group – maximum increase) for 305 days of lactation.

Table 4

Economic efficiency of using recommended feeding rations for dairy cows to determine the price of milk

Ingredients, kg	Group of cows				
	C	E-I	E-II	E-III	E-IV
Yield per lactation, l/ head	7898.0	7993.0	8124.0	8119.0	8156.0
Milk fat percentage	3.53	3.66	3.74	3.82	3.99
Milk protein percentage	3.10	3.17	3.18	3.23	3.33
Payment for fat, UAH	3.82	3.96	4.04	4.13	4.31
Payment for protein, UAH	5.64	5.76	5.78	5.87	6.05
Payment for 1 liter of milk. UAH	9.46	9.72	9.82	10.00	10.36
Commercial milk, l/ head	7658.0	7753.0	7884.0	7879.0	7916.0
Commodity milk, UAH/ head	72444.70	75359.20	77420.90	78790.00	82000.8
Additional funds, UAH/ head	-	2914.52	4976.20	6345.30	9556.10

The analysis of dairy cattle conservation indicators per 100 heads in farm conditions was within the technological standard (70.0% or more) in all experimental groups, however, conservation in the conditions of the control and I, II experimental groups exceeded the so-called minimum limit of the technological standard by 10.0%, 10.0% and 20.0%, respectively, and during the period when the experiment continued, not a single head from the III and IV research groups was lost (the level of preservation is 100.0%), which, in our opinion, is due to optimization of the level of starch in the dry matter of the ration due to the use of ingredients that do not contain it such as rye silage and wet beer groats, which in turn is good for preventing metabolic disorders in dairy cattle.

Discussion. Our studies carried out in dairy farming using rye silage are consistent with other researchers (Miedaner T. et al., 2019). Thus. there is a study where rye together with triticale is preferred by domestic researchers in the conditions of southern Ukraine as a zone of risky land use (Podobed L. Y., 2012). There are studies

recommending the use of rye-alfalfa silage (Syrovatko K. M., 2019) or triticale hay (Kotets H. I., 2016) as protein-rich ration ingredients.

Cereal crops can be alternative feed for small dairy farms in limited climatic conditions. given their short growing season (Burgess P. L. et al., 1973). The studies conducted in the conditions of Mexico where the climate is rather arid. evaluated the inclusion of silage from rye (Secale cereale L.) or triticale (Triticosecale spp.) when feeding 10 kg of silage of these species in dry matter per cow per day. In addition, the cows had access to grazing for 8 hours a day with the grass Cenchrus clandestine (Hochst. ex Chiov) and received a concentrate of 3.6 kg in terms of dry matter. Both rye and triticale have been found to be good alternative forage crops (Vega-García Jesús I. et al., 2023). In our studies, the maximum amount of rye silage for animals of IV research group was 10.4 kg. which is in principle consistent with the above-mentioned studies.

According to some research data (Burgess P. L. et al., 1973; Herbstritt S., 2022). dairy cows are fed about 10.0-12.0 kg of rye silage in physical weight in the daily ration, which does not agree with our results, where cows of IV experimental groups were fed with an increased amount of rye silage 45.0 kg/head, which is equivalent to 10.4 kg of dry matter. Provided that there were practically no other types of silage and haylage in the ration, and a cow should receive 12.0 kg of dry matter per day from coarse and juicy fodder, that is why the animals ate such an increased amount of rye silage. In addition, rye silage was fed in combination with wet beer groats, which further improved the palatability of the ration and increased appetite, hence the consumption, which is consistent with the recommendations of Garcia A., 2021. Regarding the feeding of increased amounts of rye silage to dairy cows, we see a difference from the results of other authors, which ensures the scientific novelty of our research on the one hand, but on the other hand, it should be considered as a forced measure, since it becomes increasingly difficult to grow corn for silage in the conditions of southern Ukraine due to frequent droughts.

There is information on improving the attractiveness of ruminant rations after adding wet beer groats to it (Perera A.N.F. et al., 2006). because wet beer groats, like other distillates, provide the ration of dairy cows not only with useful nutrients, but also reduce feed costs (Chase L. E., 2006), which is generally consistent with our research and recommendations.

Replacing corn silage with silage from winter crops is quite possible, which, accordingly, makes it possible to use the moisture of autumn and winter precipitation, and it also optimizes crop rotation, peak loads during autumn work, but the use of silage from winter crops is not a reason to abandon corn silage, it is only an opportunity to prevent risks and to form a suitable fodder base in the farm due to high temperatures and moisture deficit in summer, which has been observed recently, as a rule (*Agroexpert*, 2013).

It is recommended that it is better to prepare rye hay or silage with the use of specialized preservatives based on hybrid varieties and to observe the optimal collection phase – the flag leaf phase. Winter rye has recently become very popular among dairy farmers of the world due to its high yield, quite variable sowing dates, unpretentiousness to soils and early silage harvesting dates (O. Tytarenko, 2020), which is consistent with our results and recommendations.

Rye hay, in case it is collected early (timely and optimally), provides a high level of digestibility of rationary fiber, the content of exchangeable energy and crude protein, which makes it a rather promising ingredient of a fully mixed ration of high-yielding dairy cows, since rye hay complements basic bulk fodder (corn silage, alfalfa

hay), which are suitable for feeding the entire herd, and in the case of low quality, will also compensate for these shortcomings. What's more, if specialized hybrid rye varieties are used, the crude protein content in it even reaches 18.0-19.0% in dry matter, which corresponds to quite nutritious fodder grasses, while the NDF reaches 70.0%. In addition, the level of digestibility of NDF exceeds the similar indicator of the highest quality samples of corn silage (Vysotskyi I., 2016).

In the north-central part of the United States (the state of Wisconsin), it is practiced to sow corn for silage after harvesting rye for silage. Thus, the rye harvested for silage decreased preplant and in-season soil nitrate, and total yield equalled or exceeded corn silage yield despite a 13.0% decrease in corn silage yield (West J. R. et al., 2020).

As feed costs increase, cattle farmers are constantly looking for alternative options to use effective feed ingredients, so many farmers today prefer cereal crops, the most popular of which is rye, which has gained popularity in cattle feed rations in the United States because rye is a versatile and high-yielding crop (DeYoung J., 2022).

The results obtained by us regarding the formation of rations with such a principle that the dry matter from forage accounts for at least 60.0% of the dry matter of the ration, and the content of rationary fiber was more than 34.0% of the dry matter of the ration, which ensures a "healthy ration", and hence the prevention of the problem of rumen acidosis, which is consistent with other researchers (Drackley J.K. et al., 2014; Galbat S.A. et al., 2020).

The results we obtained regarding the difficulty of growing corn both for silage and for grain in the conditions of southern and other regions of Ukraine (Syrovatko K. M., 2019; Borshch O. O. et al., 2021) are consistent with the results of global calculations, which state that under the conditions of global warming, in the near future there will be more and more areas unsuitable for growing corn and other spring cereals (Ramirez-Cabral N. Y. Z. et al., 2017).

The obtained results regarding the influence of the use of rye silage in the feeding rations of dairy cows on the health status, reproductive capacity and their preservation are consistent with the work of other authors (Maltz E. et al., 2020; Galbat S.A. et al., 2020; Jaramillo-López E. et al., 2017).

Conclusions:

1. Positive effect of feeding rations of cows of the III, IV experimental groups using rye silage in combination with wet beer groats on the specific gravity of animals chewing the cud during rest by 20.0% ($p<0.01$) and 30.0% ($p<0.001$), respectively, during early lactation. In addition, a tendency to advantage in terms of rumen fullness, manure consistency, feed digestibility, cow fattening, health status, reproductive capacity, and animal survival was established compared to the use of corn silage and alfalfa hay as basic fodder for animals of the control group in the periods of medium and late lactation.

2. The tendency to advantage in terms of milk yield for 305 days of lactation was established in cows of I, II, III, IV research groups by 95, 226, 221, 258 l. Respectively, compared to animals of the control group, whose milk yield was 7.898 l, and the use of cheaper feeding rations for the animals of the research groups made it possible to reduce the production cost of 1 liter of milk by 11.3-23.7%.

3. The use of the correct approach to the formation of rations based on energy concentration, even with the use of different components in all experimental groups. ensured a generally good level of milk yield in 305 days of lactation (7898-8156 l), however, due to the different content of fiber in the dry matter of the ration, the content of fat and protein in milk turned out to be different (from 3.53% in the control group to 3.66-3.99% in the experimental groups), which along with the differentiated content of

protein in milk and under the condition of forming a price policy for milk of 40.0% fat, 60.0% protein, allowed to receive additional funds in the amount of 2914.52; 4976.20; 6345.30; and UAH 9.556.10, respectively, for cows of I, II, III, IV experimental groups relative to the animals of I control group.

Recommendations for production

In connection with the difficulties of agrotechnical cultivation of corn for silage in the modern conditions of the south of Ukraine as a zone of risky land use, as well as due to the negative effects of global warming recently, we recommend partially switching to the cultivation of fodder crops for silage that use autumn-winter moisture, such as winter rye or triticale, which will successfully complement corn silage and alfalfa hay.

For better eating of rye silage, supplement the daily feeding ration of dairy cows with wet beer groats in the amount of 6.0-8.0 kg per head.

References

Borshch O. O., Ruban S., Borshch O. V. (2021). Review: The influence of genotypic and phenotypic factors on the comfort and welfare rates of cows during the period of global climate changes. *Journal of Agricultural Science*, 32 (1) https://dspace.emu.ee//handle/10492/6894

Burgess P. L., Nicholson J. W. G., and Grant E. A. (1973).Yield and nutritive value of corn, barley, wheat, and forage oats as silage for lactating dairy cows. *Canadian Journal of Animal Science, 53 (2), 177-178.* https://doi.org/10.4141/cjas73-039

Chase L. E. (2021). Food Waste as Animal Feed: Wet Brewers and Wet Distillers Grains. *Pro-Dairy*: website. URL: https://ecommons.cornell.edu/server/api/core/bitstreams/7070906e-cf53-431d-91d6-a23785ca9222/content (date of application: 14.09.20 23).

DeYoung J. (2022). Rye, Other Cover Crops Make High-Quality Cattle Feed. *Cove rcrop strategies* https://www.covercropstrategies.com/articles/2422-rye-other-cover-crops-make-high-quality-cattle-feed

Drackley J.K., Cardoso F.C. (2014). Prepartum and postpartum nutritional management to optimize fertility in high-yielding dairy cows in confined TMR systems. *Animal.* 2014, 8(1), 5-14. doi: 10.1017/S1751731114000731

Elfeel A. A. A., Susol R., Kirovych N. (2023). Issues of Forage Quality under Industrial Milk Production in the South of Ukraine. *Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies*. Series: *Agricultural sciences*, 25 (99), 145-150. https://doi.org/10.32718/nvlvet-a9924

Galbat S.A., Keshta H.G. (2020) Evaluation of rumen transfaunation after treatment of rumen acidosis in cows. *Current Science International*, 09 (04), 625-632. DOI: 10.36632/csi/2020.9.4.55.

Garcia A. (2021). Evaluating wet feedstuffs for dairy cows. *Progressive Dairy*: website. URL: https://www.agproud.com/articles/55047-evaluating-wet-feedstuffs-for-dairy-cows (date of application: 14.09.20 23).

Götze K., Crivellaro P., Pieper L., Engelhard T., Staufenbiel R. (2019). Assessment of rumen fill in dairy cows for evaluation of the individual feed intake in herd management. *Tierarztl Prax Ausg G Grosstiere Nutztiere*, 47(1), 5-13. doi: 10.1055/a-0827-5656.

Herbstritt S., Richard T. L., Lence S. H., Wu H., O'Brien P. L., Emmett B. D., Kaspar T. C., Karlen D. L., Kohler K. and Malone R. W. (2022). Rye as an Energy Cover Crop: Management, Forage Quality, and Revenue Opportunities for Feed and Bioenergy. *Agriculture*, 12, 1691. https://doi.org/10.3390/agriculture12101691

Jaramillo-López E., Itza-Ortiz M. F., Peraza-Mercado G., Carrera-Chávez José M. (2017). Ruminal acidosis: strategies for its control. *Austral journal of veterinary sciences,* 49 (3). http://dx.doi.org/10.4067/S0719-81322017000300139

Kotets H. I. (2016). Khimichnyi sklad ta pozhyvnist sinazhu iz sumishi trytykale z vykoiu [Chemical composition and nutritional value of triticale-vetch haylage]. *Tekhnolohiia vyrobnytstva i pererobky produktsii tvarynnytstva,* 1, 58-62. http://nbuv.gov.ua/UJRN/tvppt_2016_1_13 (in Ukrainian).

Kozyr V. S. (2019). *Innovatsiini pryiomy pidvyshchennia efektyvnosti skotarstva u stepovii zoni Ukrainy : monohrafiia* [Innovative methods of increasing the efficiency of cattle breeding in the steppe zone of Ukraine : monograph]. Dnipro : PP «Nova ideolohiia» (in Ukrainian).

Kramarenko S. S. (Ed.), Luhovyi S. I., Lykhach A. V., Kramarenko O. S.. (2019). Analiz biometrychnykh danykh u rozvedenni ta selektsii tvaryn : navchalnyi posibnyk [Analysis of biometrychnykh danykh u rozvedenni ta selektsii tvaryn : navchalnyi posibnyk]. Mykolaiv: MNAU. (in Ukrainian).

Ladyka V. I., Khmelnychyi L. M. (Ed.), Povod V. V. (2023) Tekhnolohiia vyrobnytstva ta pererobky produktsii tvarynnytstva: pidruchnyk dlia aspirantiv [Technology of production and processing of livestock products: a textbook for graduate students]. Odesa: Oldi+ (in Ukrainian).

Maltz E, Barbosa LF, Bueno P, Scagion L, Kaniyamattam K, Greco LF, De Vries A, Santos JE (2013). Effect of feeding according to energy balance on performance, nutrient excretion, and feeding behavior of early lactation dairy cows. *J Dairy Sci*., 96(8), 5249-66. doi: 10.3168/jds.2013-6549.

Miedaner T., Laidig F. (2019). Hybrid Breeding in Rye (Secale cereale L.) *Advances in Plant Breeding Strategies: Cereals,* 5, 343-372 DOI:10.1007/978-3-030-23108-8_9

Perera A.N.F., Perera E.R.K. (2006). Evaluation of lesser-known feeds for ruminants to improve and sustain animal productivity during dry periods. *Improving Animal Productivity by Supplementary Feeding of Multinutrient Blocks. Controlling Internal Parasites and Enhancing Utilization of Alternate Feed Resources*. International Atomic Energy Agency, 249-255. URL:https://www-pub.iaea.org/MTCD/Publications/PDF/te_1495_web.pdf (date of application: 14.09.20 23).

Pidpala T. V., Strikha L. O., Vetushniak T. Yu. (2019). Otsinka osoblyvostei intensyvnoi tekhnolohii vyrobnytstva moloka [Evaluation of the features of intensive milk production technology]. *Tavriiskyi naukovyi visnyk*. 106, 26-30. http://www.tnv-agro.ksauniv.ks.ua/archives/106_2019/30.pdf (in Ukrainian).

Podobed L. Y. (2012). Korma y kormlenye vusokoproduktyvnoho molochnoho skota: monohrafyia [Feed and feeding of highly productive dairy cattle: a monograph.]. Dnepropetrovsk: OOO PKF «Art-Press», 416 (in Russian).

Quantifying cow signals. *Cow Talk.* Available at https://www.publish.csiro.au/ebook/chapter/9781486301614_Chapter6

Ramirez-Cabral N. Y. Z., Kumar L., Shabani F. (2017). Global alterations in areas of suitability for maize production from climate change and using a mechanistic species distribution model (CLIMEX). *Scientific Reports*, 7, 5910.

Riznychuk I., Nikolenko I., Kyshlaly O., Mazhylovska K., Harbar A. (2023). Prohrama hodivli koriv za periodamy vyrobnychoho tsyklu [Cow feeding programme by period of the production cycle] / *Ahrarnyi visnyk Prychornomoria*, 107, 99-103 https://doi.org/10.37000/abbsl.2023.107.15 (in Ukrainian).

Ruban S. Yu. & Vasylevskyi M. V. (2015). *Orhanizatsiia normovanoi hodivli v skotarstvi* [Organisation of normalised feeding in cattle breeding]. Kyiv. (in Ukrainian).

Rye and triticale can deliver quality forage. *Crops and Forages. Hoard's Dairyman.* Available at https://hoards.com/articles.sec-5-1-crops-and-forages.html

Soboliev O. I. (Ed.), Nedashkivskyi V.M., Petryshak R.A. Metodolohiia ta orhanizatsiia naukovykh doslidzhen u tvarynnytstvi: navchalnyi posibnyk [Methodology and organisation of scientific research in animal husbandry]. Bila Tserkva, 2022, 74-81 (in Ukrainian).

Sylos iz ozymykh zlakiv. Tse variant [Silage from winter cereals. This is an option.]. *Agroexpert*. 2013. № 1 (54). S. 84-85. (in Ukrainian).

Syrovatko K.M. (2019). Zhytno-liutsernovyi sylos u povnozmishanomu ratsioni diinykh koriv. *Ahrarna nauka ta kharchovi tekhnolohii tekhnolohiia kormiv*, 5(108), 2, 38-44. http://techfood.vsau.org/en/particles/rye-alfalfa-silage-in-a-fully-mixed-diet-of-milking-cows (in Ukrainian).

Tytarenko O. Zhytnii sinazh v dueti z konservantom: te, shcho potribno hospodarstvu [Rye haylage in duo with a preservative: what the farm needs]. Tvarynnytstvo Veterynariia. 2020. № 4. S. 36-38. (in Ukrainian).

Vega-García Jesús I., López-González Felipe, Morales-Almaraz Ernesto, and Arriaga-Jordán Carlos M. (2023). Secondary growth rye or triticale silage: Small-grain cereals as a dual-purpose forage option for small-scale dairy systems in the highlands of Mexico. *CHILEAN JOURNAL of AGRICULTURAL RESEARCH* 83(1). https://www.scielo.cl/pdf/chiljar/v83n1/0718-5839-chiljar-83-01-31.pdf

Vysotskyi I. Zhytnii sinazh – optymalnyi inhrediient ratsionu dlia koriv [Rye haylage is an optimal ingredient in the diet for cows]. *Agroexpert*. 2016. № 1 (54). S. 104-105.

West J. R., Ruark M. D., Shelley K. (2020).Sustainable intensification of corn silage cropping systems with winter rye. *Agronomy for Sustainable Development.* 40: 11. https://doi.org/10.1007/s13593-020-00615-6