

# Development of human capital through education and training for sustainable use of the region's natural resources

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**Abstract.** The modern livestock faces the task to optimize feed rations, on which productivity growth directly depends. Russia continues to maintain a stable trend associated with a reduction in the livestock population, so the growth of production should be ensured mainly by intensive factors, namely productivity, the increase of which is achieved through proper and balanced feeding. An extensive livestock reproduction by expanding its population is quite acceptable and effective in Russia with its large territory and various agricultural lands (arable lands, hayfields, pastures). Small-scale farming should also be actively involved in livestock production by providing with targeted state support and preferences. In the region under study, productivity growth is achieved primarily through feed improvement and optimization. Research shows that the growth rate of livestock productivity outpaces the growth rate of feed consumption, which means that the current feed is acceptable, but requires some adjustment. The region is focused on the concentrate animal feeding. The desire to increase the proportion of concentrates in the feed is dictated by the need to ensure accelerated rates of productivity growth, but its increase does not always give the desired effect, so it is necessary to replace them with succulent feed, silage, hay, herbage.

## 1 Introduction

Feed plays a key role in ensuring the growth of livestock productivity. Given this feature, its production is traditionally distinguished as an independent sub-sector of the livestock industry. The problems of modern livestock farming and improvement of the feed base have been raised in a number of scientific publications. For example, a number of authors believe that economic sanctions have a negative impact on its development [1, 2], others explain the need for comprehensive state support for households that are engaged in livestock breeding and contribute their share to the production of the industry's products, pointing to the problem of the high price of concentrated feed [3-5], the justification for the need to expand the area under perennial and annual grasses, as irreplaceable types of animal feed, is evidenced by the studies of a number of authors [6-10], other works are devoted to the issues of degradation of agricultural lands, and therefore forage lands [11-15], technical and technological aspects of organizing effective feed production and livestock breeding are presented in a number of scientific studies [16-18]. Thus, research in the feed production sub-sector of the livestock industry indicate the multifaceted nature of the problems that exist. The livestock industry

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faces an important task to optimize feed rations, on which productivity growth depends. It is possible to spend significant volumes of feed, spending large financial resources on this, but not receive the proper return, only because this ration does not have a balanced content of feed units, digestible protein, micro- and macroelements. The average feed consumption in animal husbandry per conventional head of cattle in the country in 2000 was 28.5 dt to unit and in 2021 it was 29.2 dt to unit, i. e. the increase over the study period was only 0.7 dt to unit or 2.5%, and milk yields almost doubled, from 2 502 kg in 2000 to 4 988 kg in 2021, thus, the growth rate of animal productivity significantly outpaced the growth rate of feed consumption, which indicates the efficiency of their use at the current stage of industry development. However, in order to achieve animal productivity indicators up to the level of foreign countries, Russia still has many untapped reserves that should be identified and used in practice.

2 Materials and methods

The experience of many agriculturally advanced foreign countries shows that a balanced feed ration is given priority, not by chance, due to this high productivity indicators are achieved, in particular, milk yield per cow, the quality of the obtained products. For example, in the USA, feeding dairy cows is characterized by a large amount of alfalfa hay in winter and by green fodder in summer. In Holland the productivity of the dairy herd reaches 250-300 dt of milk per year, in addition, there are prospects for productivity growth taking into account further improvement of the feeding ration. At present, a stable trend, associated with a reduction in the number of animals, including dairy ones, continues to persist in the country and the overwhelming majority of regions, as evidenced by the analytical data of Table 1.

**Table 1.** Dynamics of changes in the livestock population in Russia and Ryazan region.

Year	Russia				Ryazan region			
	cattle population		including cows		cattle population		including cows	
	million heads	change index	million heads	change index	million heads	change index	million heads	change index
2000	27.5	1.00	12.7	1.00	361.7	1.00	171.8	1.00
2005	21.6	0.79	9.5	0.75	214.3	0.59	92.9	0.54
2010	19.8	0.72	8.7	0.69	152.2	0.42	62.6	0.37
2015	18.6	0.68	8.1	0.64	143.4	0.39	57.8	0.34
2020	18.0	0.65	7.9	0.62	145.3	0.40	59.5	0.35
2021	17.6	0.64	7.8	0.61	145.2	0.40	59.3	0.34

The presented dynamics of the animal population indicates a significant reduction both in the country as a whole and in the region under study, including the dairy cattle. For example, if in 2000 the cattle population in Russia as a whole was 27.5 million heads, in 2021 its number was only 17.6 million heads, i. e. it decreased by 9.9 million heads or 36%, and in the region under study these figures were 216.5 thousand heads and 60%, respectively. The reduction in the number of dairy cattle was even greater, by 39% in the country as a whole, by 66% in the region. Thus, the number of dairy cattle is decreasing at the fastest rate. Taking into account the current trends, intensive production factors should be considered the priority direction for growth in production volumes in the livestock industry. For a country with its vast territories and very significant feed resources in the form of hayfields, pastures, meadows, the extensive type of reproduction is also quite acceptable, especially since these natural forage lands are distinguished by the high quality of the feed obtained from them, such as hay, grass. Therefore, for the successful management, development and improvement of the livestock farming system in Russia, in our opinion, both types of reproduction,

intensive and extensive, are quite acceptable. When organizing the production process in the industry, it is only necessary to determine the priority of one or another type of reproduction. The growing needs of the population of the country for high-quality products of the industry (milk, meat) should currently be covered primarily by increased productivity. this factor is of priority importance for the growth of production volumes. In order to achieve the set goals, one of the key areas of modern development of the livestock industry is increased productivity, which should be ensured by effective and balanced feeding of animals. According to research, productivity closely correlates with the level and quality of feeding; animal productivity depends on this parameter by 63-75%, so it should be considered that this is the determining factor in the growth of cattle productivity, and consequently, the volume of milk and meat production.

Ryazan region is actively developing the agricultural sector, both livestock and crop production. In recent years, structural shifts have been taking place in the volumes of agricultural production towards an increase in the share of the crop production sector, which is associated with an increase in demand for grain, both on the domestic and foreign markets. In the current situation, there is a threat of a reduction in the production of livestock products, especially in medium and small agricultural organizations, peasant (farming) households, since the production of milk and meat is less profitable than grain production. Large dairy complexes built in the region will certainly retain their narrow specialization and areas of activity, and many other regional agricultural producers can reorient their specialization to a more efficient and profitable area of activity - crop production. Under these conditions, a shortage of livestock products may arise, which will inevitably entail an increase in prices and a decrease in consumer demand. All this justifies the need for the region to prioritize intensive reproduction factors, i. e. growth in production volumes due to intensive factors, primarily due to growth in animal productivity, which largely depends on the level and quality of feeding. In recent years, Ryazan region has achieved higher productivity indicators among the regions of the country and the Central Federal District, especially in the dairy cattle industry, however, today there are many unused reserves for productivity growth (Table 2).

**Table 2.** Average milk productivity per cow, kg.

Year	Russia		Ryazan region	
	milk productivity of one cow, kg	change index	milk productivity of one cow, kg	change index
2000	2 502	1.00	2 570	1.00
2005	3 210	1.28	2 851	1.11
2010	3 776	1.51	4 453	1.73
2015	4 308	1.72	5 596	2.18
2020	4 839	1.93	7 960	3.09

According to the presented data, the growth of productivity of dairy herd in the studied region is occurring at a higher rate in comparison with the average statistical indicators in the country as a whole, if on average in Russia the growth of productivity from 2000 to 2021 has increased twofold, then in the studied region the productivity of dairy herd has increased more than threefold (by 3.13 times), which indicates serious and effective organization of work aimed at increasing the productivity of the dairy cattle industry. The growth of regional productivity is achieved primarily due to the improvement and optimization of the structure of the feed ration. Table 3 presents the indicators of specific feed consumption per head of cattle.

**Table 3.** Specific feed consumption per head of animals, dt to unit/head.

Year	feed consumption per head of cattle					
	per head		cattle		dairy cows and bulls	
	dt to unit	change index	dt to unit	change index	dt to unit	change index
2000	27.02	1.00	16.30	1.00	32.15	1.00
2005	32.10	1.19	19.48	1.19	42.48	1.32
2010	32.90	1.22	22.44	1.38	51.34	1.59
2015	33.73	1.25	22.17	1.36	56.16	1.75
2020	34.61	1.28	22.25	1.37	64.18	2.00
	including concentrated feeds					
2000	7.49	1.00	2.77	1.00	4.52	1.00
2005	10.79	1.44	4.44	1.60	9.35	2.06
2010	16.04	2.11	6.20	2.23	15.50	3.43
2015	18.10	2.40	7.11	2.57	19.81	4.38
2020	20.07	2.66	6.81	2.46	25.01	5.53

According to the table, there is a stable increase in feed consumption per head of animal, an important task is its efficient use and the most complete return on the spent feed resources. It should be noted that over a fairly long ten-year period of study, feed consumption in the region per conventional head has increased insignificantly - by 28%, at the same time, the dairy cattle industry has seen the largest increase in specific feed consumption per head, namely, from 32.15 dt to unit in 2000 to 64.18 dt to unit in 2020, or twice as much. This is understandable, since the dairy cattle industry in the region occupies a significant place in the volume of agricultural production, therefore, special attention should be paid to the structure of the feed ration in order to increase animal productivity. The main task is to ensure that the current dynamics of growth in specific feed consumption per head of animal is efficient, i. e. pays off in the output. Increased feed consumption and low or decreasing animal productivity indicate its inefficient use in the industry, given another factor, which is that the cost of feed, especially purchased feed, is steadily increasing, which means that the cost of products (milk, meat) obtained in the industry is also growing. Therefore, the main goal in the direction of feed production development is to improve the structure of the feed ration.

There is an increase in the proportion of concentrated feed in the structure of the feed ration for all animal groups in the region, and for the dairy direction, the growth of the proportion of concentrates in the structure of the ration has increased almost 6 times compared to the base period. Thus, it can be said that the region is focused on the concentrate type of feeding of animals, especially dairy ones. The region's focus on the concentrate type of feeding has its positive aspects and advantages, but within certain limits. When a high proportion of concentrated feed in the animal's ration is achieved, productivity growth slows down, resulting in the problem of finding a new, more efficient ration. Many years of practical experience of leading agricultural enterprises engaged in cattle breeding indicate that the structure of the animal's feed ration must necessarily include succulent and green fodder, such as herbage of annual and perennial grasses, fodder beet, turnip and other lactogenic types of feed, which stimulate productivity growth and, no less importantly, the quality of the resulting products.

3 Results and discussion

Analysing the current trend, in order to find efficient methods of running a livestock farming system and to find future reserves for increasing animal productivity, it is advisable, from our point of view, to calculate the indicator for assessing the efficiency of feed payback by

the output of the livestock industry, in particular the dairy cattle industry, which can be determined by the ratio of annual productivity to the consumption of feed resources used to obtain it. In this case, the indicator will be determined that characterizes the output of products (milk, meat) per unit of feed, and the higher it is, the more efficient the feeding system is. Feeding efficiency can be assessed by specific types of products obtained, for example, number increase, weight gain, milk. In this case, the calculation algorithm may look like this (formula 1):

FP = AP/FC,

(1)

where,  
FP – feed payback by production output  
AP – annual productivity, kg  
FC – annual feed consumption per head of animal, dt to unit.

Considering that dairy farming in the region is a system-forming sub-sector of the agriculture, it is quite reasonable to evaluate the payback efficiency of this type of product. Moreover, if we consider that the region is focused on the concentrate type of feeding and the proportion of concentrated feeds is growing in the structure of the feed ration, it is quite fair to evaluate the effect of using this type of feed. We will apply the calculation algorithm according to the formula proposed above, calculate the feed payback by the output of dairy products in the region under study, and also evaluate the efficiency of using concentrated feeds in the animal's diet (Table 4).

**Table 4.** Analytical assessment of feed payback by output of dairy cattle industry.

Indicator	Year					Deviat ion
	2000	2005	2010	2015	2020	
Productivity of one head of dairy cattle, kg	2 570	2 851	4 453	5 596	7 960	+5 390
Change index	1.00	1.11	1.73	2.18	3.09	+2.09
Feed consumption per head of dairy cattle, dt to unit	32.15	42.48	51.34	56.16	64.18	+32.03
Change index	1.00	1.32	1.59	1.75	2.00	+1.0
Feed payback by output, kg/dt to unit	79.9	67.12	86.74	99.64	124.0	+44.1
Change index	1.00	0.84	1.09	1.25	1.55	+0.55
including concentrated feed per head, dt to unit	4.52	9.35	15.50	19.81	25.01	+20.49
Change index	1.00	2.07	3.43	4.38	5.53	+4.53
Concentrated feed payback by output, kg/dt to unit	568.6	304.9	287.3	282.5	318.3	-268.3
Change index	1.00	0.53	0.51	0.48	0.56	-0.44

According to calculations, the current dynamics of feed consumption growth in the dairy cattle industry for the period under study is quite justified for the region under study. Thus, a two-fold increase in the specific feed consumption per head of animal ensured a more than three-fold increase in milk productivity. However, the decrease in the efficiency of the growth of the specific weight of concentrated feed in the structure of the dairy herd diet is alarming; the payback of concentrated feed by the output of products throughout the entire study period decreased by 56%. The ongoing changes in the organization of the modern livestock farming system and the production cycle of the industry leave their mark on the change in the structure of the feed ration, which, as a rule, should ensure an increase in production volumes, since the needs of the market and, first of all, the population, in dairy products are growing, which, as a rule, is achieved by increasing the specific weight of concentrated feed in the diet. The desire to increase the proportion of concentrated feed in the structure of the feed ration is dictated by the need to ensure accelerated rates of growth

in the productivity of dairy cattle; however, as studies show, an increase in the proportion of concentrates does not always achieve the desired effect for the dairy sector of the cattle breeding industry. In the 2000s, the structure of the feed ration was distinguished by a greater variety of components, there were hay, succulent feed, silage, haylage, herbage of annual and perennial grasses in significant quantities, and therefore specific weights, as a result of which the quality of milk was at a high level, although the payback was slightly lower (79.9 kg/dt to unit) than the current level (124.0 kg/dt to unit). Taking into account the current indicators, it is advisable to increase the efficiency of concentrated feed, since at present the effect of their use in the dairy cattle breeding industry of the region is somewhat reduced. The natural and climatic features of the region allow keeping animals in two periods, namely, winter-stall and summer-pasture. In recent years, there has been a need to transition to an industrial type of production, which dictates the need to organize large dairy and fattening complexes, which mainly have a stall period of keeping. Taking into account these features, an important direction for productivity growth should be considered the organization of an effective system of animal feeding. The level of animal productivity is affected by a set of factors, for example, the system of keeping, caring for animals, milking and watering technology, however, the structure of the feed ration is the determining factor for productivity. It can be said with confidence that at present, productivity growth should be achieved through intensive production factors, including, first of all, rationalization and optimization of feeding. For a more detailed study of the "payback" indicator, we will consider a multifactorial analytical model that allows to determine the degree of influence of a particular factor on the result. The conducted study will be presented by the data of analytical table 5.

**Table 5.** Analytical assessment of the influence of key factors on indicator "feed payback by output".

Indicator	Base period (2000)	Reporting period (2020)	Deviation
Annual productivity of one head of dairy cattle, kg	2 570	7 960	+5 390
Feed consumption per head of dairy cattle, dt to unit	32.15	64.18	+32.03
including concentrated feed, dt to unit	4.5	25.01	+20.51
Feed payback by output, kg/dt to unit	79.9	124.0	+44.1
Total deviation of feed payback by output, efficiency, kg/dt to unit	+44.1		
including:			
1) due to feed consumption (except concentrated)	-21.0		
2) due to concentrated feed consumption	-18.8		
3) due to annual productivity of one head of dairy cattle	+83.9		
Identification of deviation parameters	-21.0 + (-18.8) + 83.9 = +44.1; +44.1 = +44.1 (corresponds)		

The increase in feed consumption is justified, since the positive result of the influence of the "annual productivity" factor (+83 p.p.) significantly covers the negative values of two other factors, namely, the "feed consumption (except concentrated)" factor - (-21.0 p.p.) and the "concentrated feed consumption" factor - (-18.8 p.p.), the combined influence of which is (-39.8 p.p.). Nevertheless, the efficiency of the "feed payback on production" indicator tends to decrease, the main reason for this, in our opinion, is the constant increase in the share of concentrated feed in the structure of the feed ration of the dairy herd.

## 4 Conclusion

The increase in the proportion of concentrated feed in dairy cattle breeding in the region at the current level of feeding organization does not provide for adequate productivity gains and should be within regulatory limits. The current structure of the dairy herd feed ration should be varied, provided with an optimal amount of feed units, digestible protein, macro- and microelements, focused on stable productivity growth. Research shows that in the organization of livestock production, the rate of productivity growth outpaces the rate of feed consumption growth, which means that the current structure of the feed ration is quite acceptable, but requires certain adjustments. For example, it is necessary to abandon the increase in the share of concentrated feed in the feed ration, replace it with succulent feed, silage, hay, herbage. To calculate the optimal feed ration for animals, it is necessary to take into account age and sex groups, apply optimization methods of economic and mathematical modeling, linear programming.

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