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Methodology of estimating the economic efficiency of milk production technologies in the summer period

The methodology of estimating the milk production technologies efficiency during the summer period is described in the article. Three types of cow housing: stall and pasturable, camping and pasturable, stall and outdoor were analyzed and the results are produced here. It is proved, that for the farms of all types and sizes the camping and pasturable cow housing leads to the lowest values of reduced expenditures and milk cost price during the summer period. These performance indicators can be obtained only if the intensive technologies of milk production are used during the summer period, i.e. the combined green forage chain with the rotational rationed system of livestock grazing and two-shift work scheme.

Milk production technology, cow productivity, production cost, reduced expenditures, economic effect.

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In dairy cattle breeding, summer period is an important organizational and technological stage, which allows without any additional material costs to increase milk yields and reduce production costs, to improve the health of cows and their reproductive functions. With the proper organization of feeding, milking and housing of cows during this period, farm enterprises receive the cheapest milk, the production cost of which is 1,5 – 2 times lower, than during the stall housing [4]. Further improvement of the dairy cattle breeding technical equipment is becoming a trend, and a factor of economic changes; however, the choice of cow housing system in the summer period at the designing stage should be economically grounded, and in case of possessing appropriate means, farms should have a notion about the economic effect, which can be obtained when introducing innovative technologies.

Given the importance of the tasks facing the dairy cattle breeding concerning the production output increase and its cost price reduction, the aim of the work is to improve the methodology of estimating the milk production technologies efficiency during the summer period. To achieve this goal it is necessary to solve the following tasks: substantiate the distinctive features of the proposed methodology; select the criteria for evaluating the economic efficiency of the compared types of cow housing in the summer period; to specify the economic indicators calculation algorithm and approbate the methodology on a real object.

When selecting the most cost-effective technologies of milk production during the summer period it is necessary to correct existing methodical provisions and recommendations concerning the economic justification of standard project solutions of cattle-breeding farms and complexes according to the country's zones [1, 6], in order to estimate objectively the compared types of cow housing in the summer period with regard to the influence of various factors and production conditions.

The most important of these factors are the systems of cow housing and feeding in the summer period depending on the spatial, planning and constructive peculiarities of farms and summer cow camps, means of technological processes mechanization, systems of production and labour organization. The economic performance of technological options depends also on the different sizes and types of farms and summer camps, the productivity levels of cows, forage production options.

The differentiated approach used in the calculation of milk production costs by the periods of the year is the distinctive feature of the proposed methodology. In order to identify the main factors influencing costs in the summer period, it is necessary to vary the production technologies of that period only. It is necessary to consider the widespread cow housing types given the different variants of the green forage chain organisation: stall and pasturable, camping and pasturable with the use of various grazing types; stall and outdoor, camping and outdoor with the use of the green fodder and changing its transportation distance.

Another distinctive feature of the proposed methodology is the clarification of milk production costs calculation by taking into account the capital investments into the main livestock breeding assets along with the capital investments into the main fodder production assets. The latter change depending on the green forage chain options and influence the amounts of current as well as reduced expenditures.

Another distinctive feature of the methodological recommendations is the consideration of the time factor when calculating the reduced expenditures by the reduction of the main production assets to the single moment of time. Capital investments in buildings, constructions, equipment, summer camps, in the animals of the basic herd as well as the machinery for fodder production constitute the main production assets having different lifetime. While using the farm buildings with the longest service life, other fixed assets with shorter life duration will be repeatedly renewed. The total one-time accounting of all capital investments in the reduced expenditures calculation does not assess the compared options objectively enough.

Therefore, in order to take into account the time factor in calculating the reduced expenditures and the annual economic effect according to the technological options, it is necessary to multiply all capital investments in the basic production assets, renewable several times during the operation of the basic objects with the longest service life, by the variable reduction coefficient.

Economic efficiency estimation, when using different technologies and technical solutions, involves applying the system of indicators, reflecting the cost and natural characteristics of the studied cow housing types.

The objects under consideration, i.e. milk production technologies during the summer period, are a complex system; therefore, the technological processes efficiency estimation requires a multi-criterion approach. The efficiency criterion should be considered, taking into account the following aspects: the trends in the development of the summer cattle breeding technologies and forecast of optimal economic indicators of the studied technologies for the specific regional conditions of their application.

The maximum of the expected annual economic effect which is determined as the difference between the reduced costs of compared technological options is used as the global criterion to ensure the adequate, on the social production scale, approach to the planned perspective technologies.

$$E = (R_1 - R_2)A \rightarrow \max, \qquad (1)$$

E – annual economic effect, rubles;

R_1 and R_2 – reduced costs for the unit of production (work), produced (performed) with the use of basic and new equipment, rubles;

A – annual production (work) output with the use of new equipment in the estimated year, in physical units.

The expected annual economic effect describes the peculiarities and efficiency of the object as a whole. It connects the private, integral and local criteria. In the technological processes forecasting and optimization, with regard for the zonal conditions, it is suggested to use the reduced costs minimumas the integral (generalized) criterion, it establishes a linkage between private and local criteria, provides a compromise solution to the problem of technological variants optimization. It is suggested to use the reduced costs minimum index at the stage of making a decision concerning the farm or summer camp reconstruction or the new construction [3, 4].

Essentially, the reduced costs include both intensive and extensive components, i.e. the current production expenses and one-time expenses – capital investments in fixed assets.

Then the reduced costs of milk production during the summer period can be determined as follows:

$$R_{iab} = C_{iab} + E_N K_{iab}, \qquad (2)$$

E_N – normative coefficient of capital investments efficiency equal to the refinancing interest rate established by the RF Central Bank with regard to inflation;

C_{iab} – production unit cost, rubles;

K_{iab} – capital investments in the main production assets according to the technological options, reduced to the initial level by multi-plying by the reduction coefficient, (α_i), rubles.

The amount of capital investments in fixed assets is determined in accordance with the estimates and projects on standard sizes and types of farms or summer camps for cattle. Thereby, the standard general layout projects of the farms and camps' types and sizes are reduced to a comparable view according to the structure of buildings, constructions and the level of equipment, and the estimated costs are adjusted accordingly.

At pasturable cow housing the additional capital investments in permanent fences along drove paddocks, stock driving roads and at stall housing – around barn yards are taken into account.

In order to determine the amount of capital investments in tractors and machinery for forage production given the different variants of the green forage chain organization, the calculation of the required areas for forage procurement is produced here. The areas of herbage procurement for the summer period are calculated by dividing the gross requirement for each crop by its yielding capacity. The areas suitable for cultivation, maintenance and harvesting are multiplied by the specific capital investments in tractors and machinery for fodder production.

The production cost of milk in the summer period will be determined as follows [2, 5]:

$$C_{i\alpha\beta} = C^{F}_{i\alpha\beta} + C^{P}_{i\alpha\beta} + C^{AR}_{i\alpha\beta} + C^{E}_{i\alpha\beta} + C^{W}_{i\alpha\beta} + + C^{MD}_{i\alpha\beta} + C^{L}_{i\alpha\beta} + C^{OM}_{i\alpha\beta} - C^{M}_{i\alpha\beta}\ , \quad (3)$$

i – sizes and types of farms and summer camps;

α – cow housing and feeding options in the summer period, ways of production and labour organization;

β – average productivity of cows in the summer period depending on the duration of the period, kg;

$C^{F}_{i\alpha\beta}$ – fodder price and the costs of its transportation and distribution according to the green forage chain options, rubles;

$C^{P}_{i\alpha\beta}$ – total payroll fund in the summer period, rubles.;

$C^{AR}_{i\alpha\beta}$ – amortization and current repair charges in the summer period, rubles.;

$C^{E}_{i\alpha\beta}$ – electricity costs in the summer period, rubles;

$C^{W}_{i\alpha\beta}$ – water costs in the summer period, rubles;

$C^{MD}_{i\alpha\beta}$ – expenses on medicines and disinfectants in the summer period, rubles;

$C^{L}_{i\alpha\beta}$ – cost of litter in the summer period, rubles;

$C^{OM}_{i\alpha\beta}$ – price for by-products (manure) in the summer period, rubles;

$C^{M}_{i\alpha\beta}$ – production organization and management costs, tax and insurance payments for the summer period, rubles.

The production cost of product unit (1 centner of milk) in the summer period is calculated according to the formula:

$$C^{I}_{i\alpha\beta} = \frac{C_{i\alpha\beta}}{n_i M^{100}_{\alpha\beta} m_\alpha}, \quad (4)$$

n_i – coefficient of cows and heifers population depending on the sizes and types of farms and summer camps;

$$M^{100}_{\alpha\beta} = M^{100}_{\beta} + T^{100}_{\beta}\, v_\alpha\, w\ ,$$

$M^{100}_{\alpha\beta}$ – milk production per 100 cows with regard to calf crop, centners;

m_α – coefficient of cows productivity increase depending on the type of summer housing and feeding;

M^{100}_{β} – milk production per 100 cows during the summer period, centners;

T^{100}_{β} – calf crop per 100 cows during the summer period, head;

v_α – coefficient of increase of calf crop per 100 cows depending on the type of summer housing and feeding;

w – coefficient indicating the relation between the number of calves and milk yield accepted at the rate of 1.5 centners for 1 calf.

Fodder price and the costs of its transportation and distribution according to the green forage chain options are calculated by the formula:

$$C^{F}_{i\alpha\beta} = n_i (C^{1003H}_{\alpha} + N^{1003F}_{\alpha} P^{HT} + C^{100RFC}_{\alpha}) + + (P^{CF} + P^{CFT}) + (n_{iC} N^{100CFC}_{\beta} + n_{iH} N^{100CFH}_{\beta}) + + C^{FL}_{i\alpha}, \quad (5)$$

n_{iC} – cow population coefficient;

n_{iH} – heifers population coefficient;

C^{1003H}_{α} – herbage cost per 100 cows depending the green forage chain options, rubles;

C^{100RFS}_{α} – costs and expenses on the transportation of roughage feed and microaddings from a farm to a camp per 100 cows, rubles;

P^{HT} – cost of herbage transportation depending on the distance, rubles/t;

P^{CF} – price for the concentrated feedstuffs, rubles/t;

P^{CFT} – cost of the concentrated feed stuffs transportation, rubles/t;

N^{1003F}_{α} – requirement for the green fodder procured outside a pasture per 100 cows, t;

N^{100CFC}_{β} – requirement for concentrated feedstuffs in summer per 100 cows, t;

N^{100CFH}_{β} – requirement for concentrated feedstuffs in summer per 100 heifers, t;

$C^{E}_{i\alpha}$ – expenses for fuels and lubricants (fodder loading and distribution) in the summer period per a farm, camp, rubles.

The costs of the feedstuffs are firstly determined per 100 cows by multiplying their gross requirement by the production cost calculated in operation cards; secondly, they are multiplied by the livestock population coefficients, corresponding to the types and sizes of farms and summer camps.

The costs for transportation of mineral additives and concentrates from a farm to a camp are additionally taken into account, as well as roughage transportation in transition periods.

The requirement for feedstuff for several livestock productivity levels is calculated per 100 cows given the feeding rates, which take into account the energy and protein concentration in dry matter of the diet. In order to simplify the calculations, the gross demand for herbage in summer can be considered common for all levels of cows' productivity, but not less than 60 kg per head.

The need for concentrates per 100 cows at different productivity levels is calculated on the basis of 3 physiological groups into which a herd is divided: newly calved cows under 100 days of lactation (26 head),dairy cows 100 up to 300 days of lactation (56 head), dry cows (16 head). This distribution of the cows livestock in a herd is given with regard to regular annual calving.

The green forage chain options, most acceptable in the Non-Black Earth Zone, per 100 cows for different types of pastures and without them are developed for calculating green fodder input in the summer period. Grazing performance, the distribution of green matter yield by the cycles, average yielding capacity of annual and perennial crops are determined by the generalization of the region's data.

The expenses for fuels and lubricants during the loading and distribution of fodder in the summer period are calculated according to the formula:

$$C_{i\alpha}^{FL} = K_i(\sum_{i}^{K} \frac{N^{1003H} + N^{100RF}}{W})P^{FL}, \quad (6)$$

i – types and sizes of farms and camps;

K_i – amount of technical means;

N^{1003H} – need for herbage per 100 cows, t,

N^{100RF} – need for roughage feed per 100 cows in summer, t;

W – technical equipment (loader and fodder distributor) performance per hour of the main time, t/hour;

P^{FL} – cost of fuels and lubricants per 1 hour of operational work of technical equipment, rubles/hour.

In order to calculate the payroll fund for the summer period it is necessary to determine the labour intensity of the works, the number of maintenance and management personnel depending on the size of the farm or summer camp, the system of cow housing in the summer and stabling periods, the average annual and summer productivity of the animals, the work management, the duration of the grazing period.

The number of livestock maintenance personnel (milking machine operators – milkers; livestock maintenance personnel – cattlemen, shepherds; cattle-feeding operators, etc.)is calculated according to the standard norms of livestock maintenance, depending on the level of production organization and mechanization.

The number of administrative personnel can be defined by the norms of technological projecting.

Labor costs per 1 centner of production, depending on the technology options, are determined by dividing the total working time fund by gross milk production.

Depreciation and current repair allocations in the summer period are calculated as follows:

$$C_{i\alpha\beta}^{DR} = (C_{i\alpha}^{DRF} + C_{i\alpha}^{DRC} + C_{i\alpha}^{DRP}) \frac{D^S}{365}, \quad (7)$$

D^S – duration of the summer period, days;

$C_{i\alpha}^{DRF}$ – depreciation and current repair allocations for a farm, rubles;

$C_{i\alpha}^{DRC}$ – depreciation and current repair allocations for a summer camp or summer barnyards, rubles;

$C_{i\alpha}^{DRP}$ – depreciation and current repair allocations for the fencing of pastures and livestock pasture watering equipment, rubles.

The amounts of depreciation and current repair allocations are defined according to the current normative and reference material.

The electricity costs in the summer period are determined as follows:

$$C_{i\alpha\beta}^{E} = n_i E_\alpha 100 P^E \frac{D^S}{365}, \quad (8)$$

E_α – summarized norms of energy consumption in production processes for 1 head of livestock per year depending on the summer housing option, kWh/head a year;

$100P^E$ – price for 1 kW•h of electricity for agriculture, rubles.

The costs of water supply:

$$C_{i\alpha\beta}^{W} = n_i W 100 P^W D^S, \quad (9)$$

W – summarized rate of water consumption for one cow per day, m^3;

P^W – the cost of water, rubles/m^3.

Costs of medicines and disinfectants:

$$C_{i\alpha}^{MD} = n_i 100 P^{MD} \frac{D^S}{365}, \quad (10)$$

P^{MD} – price for medicines and disinfectants for one cow per year in average, rubles.

The cost of litter and by-products (manure) in the summer period are determined according to the formulae:

$$C_{i\alpha}^{L} = n_i 100 N^L D^S P^L, \quad (11)$$

N^L – amount of litter for one cow per day, t;

P^L – price for litter, rubles/t.

$$C_{i\alpha}^{M} = n_i 100 (N^M + N^L) 0.7 D^S P^M, \quad (12)$$

N^M – manure output for one cow per day, t;

0.7 – organic fertilizer output rate;

P^M – price for by-products, rubles/t.

The average data on the regional farms' expenses can be used in order to simplify the calculations of production and management costs, insurance payments in the summer period for all the options.

$$C_{i\beta}^{PM} = n_i 100 C_\beta \frac{D^S}{365}, \quad (13)$$

C_β – farms' average expenses for organizing management and production, rubles.

The three types of cow housing: stall and pasturable, camping and pasturable, stall and outdoor were compared, and the results prove that the lowest values of milk production costs during the summer period are obtained for all farm types and sizes (200, 400, 600, 800 head) when using the camping and pasturable cow housing type [4]. Accordingly, in the summer period, the milk production cost is 19 – 26% lower, reduced costs are 6 – 7% lower, and the profit is 12 – 16% higher than the indicators for the stall and outdoor cow housing.

The stall and pasturable cow housing ranks second according to the performance indicators: the milk production cost in the summer period is 20 – 27% lower, reduced costs are 5 – 6% lower, and the profit is 10 – 15% higher than the indicators for the stall and outdoor housing.

If a summer camp is located at a 12 km distance from a farm, the economic performance indicators decline insignificantly – in the limit of 1%. For the stall and outdoor housing, if herbage transportation distance increases from 3 to 12 km, the milk production cost in the summer period increases by 6 – 8% and reduced costs – by 2 – 3%.

The construction of summer camps requires from 1000 to 3000 rubles of additional capital investments per one cow.

However, this eliminates the need for hard surface barn- and feed yards, which allows reducing capital investments for the farm improvement up to 1000 rubles per one cow. In addition, capital investments in agricultural equipment for fodder production increase 1.2-fold and fuel and lubricants consumption increases by 10 – 14% per year when using the green forage chain of grazing crops as compared to the pasturable cow housing type.

These efficiency indicators can be obtained only when using the intensive technologies of milk production during the summer period [3], i.e. the combined green forage chain with the rotational rationed system of livestock grazing and two-shift work scheme. When using camping and pasturable housing type, it is essential to implement advanced planning and building solutions for summer camps and new technological equipment.

References

1. GOST R 53056-2008. Agricultural machinery. Methods of economic evaluation. Moscow: Publishing house of the standards, 2008.
2. Tuvayev V.N., Tuvayev A.V. Methodology of determining economic efficiency of the scientific and technical progress achievements implementation in agroindustrial complex. Vologda, 2012.
3. Soon E.F., Artyushin A.A., Kleimenov I.I., Tsoi Yu.A. Tuvayev V.N. The perspective organizational-technological and technical solutions of milk production in the summer period for the farms of the Non-Chernozem Zone of the RSFSR EF. Ed by Soon E.F. Moscow: Scientific and Technical Information, Propaganda and Advertising Center, 1988.
4. Tuvayev V.N. Increasing the milk production efficiency through substantiation and development of advanced technological processes for the livestock breeding in the summer period: Dr. of technical Sciences Thesis synopsis. Saint Petersburg, 2003.
5. Tuvayev V.N., Kuznetsova N.I. Methodology of calculating the economic efficiency of milking centers. In: Scientific management of the education quality. Vol. 2. Engineering science: collection of works of the Vologda State Dairy Farming Academy named after N.V. Vereshchagin on the results of the work of the International scientific-practical conference dedicated to the 96-th anniversary of the Academy. Vologda, 2007. P. 111-117.
6. Shpilko A.V., Dragaitsev V.I., Morozov N.M. Economic efficiency of the mechanization of agricultural production. Moscow: Russian Academy of Agricultural Sciences, 2001.