

Economic efficiency of creation and use of long-term hayfields on dry lands of the Non-Chernozem zone

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Abstract. In order to accelerate the implementation of improved technologies, taking into account the requirements of a market economy, the economic assessment of the creation and use of long-term haymaking was carried out according to five technological systems of management, using the methodology approved by the Russian Academy of Agricultural Sciences (1995). On long-term haymaking (75 years of life) over the past 28 years, productivity in extensive low-cost management systems amounted to 1.9-3.9 thousand fodder. units / ha, conditionally net income 11.7-13.2 thousand rubles / ha, with a production profitability of 52-174%. In intensive technological systems, the productivity of long-term haymaking increased to 3.4-4.5 thousand fodder. units / ha, conditionally net income from 11.9 to 16.2 thousand rubles / ha, with a production profitability of 56-60%. Extensive management systems can be used on farms with limited material and technical resources. Capital costs for the creation of long-term haymaking during the development period (2 years) amounted to 32.5 thousand rubles / ha, which paid off in 1.4-3.0 years, the annual production costs for five technological systems - 6.6-28, 3 thousand rubles per year, 40-75% of them were hay bales, with a feed unit cost of 3.5-6.4 rubles. The creation of long-term hayfields on the basis of self-renewing cereal species of phytocenosis allows saving material resources for re-planting herbage by 8-10 times, providing animals with high-quality hay, and reducing the volume of concentrates in the winter stall period.

Keywords: economic efficiency, long-term haymaking, phytocenosis, technological systems, conditionally net income, profitability.

Natural fodder lands on the territory of the Russian Federation occupy 92 million hectares, from 30 to 50% of the area in the forest zone of the European part falls on meadow hayfields with a productivity of up to 1.2 thousand fodder. units / ha and low quality of voluminous forage [1,2]. An increase in the productivity, nutritional value and energy saturation of animal feed is possible when creating sown long-term hayfields. With a constant increase in prices for material and technical means, a decrease in the supply of mineral fertilizers in meadow farming, it is necessary to conduct an economic assessment of energy and resource-saving technological systems of haymaking, which can significantly reduce production costs for the production of high-quality and cheap feed [3,4,5,6] ... One of the most important methods of increasing the productivity of sown hayfields is the use of mineral fertilizers [7,8,9]. To further reduce costs while maintaining high productivity of hayfields and the quality of the obtained voluminous fodder, a comprehensive assessment of systems for managing long-term hayfields is required when developing multivariate technological systems [10, 11].



The purpose of the research is to conduct an economic assessment of five technological systems for the creation and use of long-term haymaking for the production of high-quality hay.

Determination of the economic efficiency of the creation and use of seeded long-term hayfields was carried out in the Federal Research Center "VIK im. VR Williams ". In 1946 Romashov P.I. and M.S. Afanasyev laid a field experiment on the effect of mineral fertilizers on the productivity of phytocenosis. The soil of the experimental plot is sod-podzolic (dry land of temporarily excessive moisture) with a content of 2.03% humus, 70 mg / kg of exchangeable potassium, 50 mg / kg of mobile phosphorus, $pH_{\text{con.}} - 4.3$. Before plowing, 5 t / ha of lime was applied. Sowing was carried out with a complex seven-component grass mixture (without cover), traditional for that period: meadow clover (*Trifolium pratense* L., 3 kg / ha), creeping clover (*Tr. Repens* L., 2), meadow timothy (*Phleum pratense* L., 4), meadow fescue (*Festuca pratensis* Huds., 10), meadow foxtail (*Alopecurus pratensis* L., 3), awnless rump (*Bromus inermis* L., 3), meadow bluegrass (*Poa pratensis* L., 2). Fertilizer doses varied over the years of use from 1947 to 1958. contributed $N_{60,90}P_{30}K_{30}$; from 1958 to 1976 г. – $N_{60-120}P_{30}K_{90}$; from 1977 to 2020 г. – $N_{60-180}P_{45}K_{90}$. Since 1950, manure has been applied in doses of 10 and 20 t / ha superficially - once every four years (in the autumn). Half-ripe manure (after storage for 5-6 months) with an average: N – 0,40 %, $P_2O_5 - 0,25\%$, $K_2O - 0,45\%$. The use of herbage is two-cut: the first in the phase of mass flowering of the dominant species (meadow foxtail) in mid-June, the second - in the first ten days of September. The experience is included in the register of the Geographic Network, and is the property of the Russian agricultural science.

Determination of economic efficiency was carried out taking into account the productivity of haymaking according to five technological systems: technogenic (control) - seeded grass stand without the use of mineral fertilizers; integrated - the introduction of phosphorus-potassium fertilizers contributes to an increase in legumes that use the biological nitrogen of the soil; organic - the use of 20 t / ha of manure once every 4 years; technogenic-mineral - annual application $N_{60,90,120,180}P_{45}K_{90}$; combined (mineral-organic) - the use of 20 t / ha of manure in combination with $N_{90}P_{45}K_{90}$. The costs of agrotechnical methods were determined in 2 periods. The first period is the determination of the costs of tinning (capital costs) and the use of grass stand in two years, payback; the second period is the determination of the annual production costs for the use of herbage over the past 28 years. The structure of capital investments included the cost of cutting sod, pre-sowing introduction of 5 tons of lime, plowing and disking, pre-sowing and post-sowing soil rolling, sowing seeds. Operating costs included: application of fertilizers supporting liming (4.5 t / ha in 2008), hay harvesting in rolls, transportation and laying in sheds. Counting of yield and analyzes of plant samples was carried out according to generally accepted methods, statistical processing of yield - dispersed method, economic efficiency based on a methodological manual for agro-energy and economic assessment of technologies, productivity (collection of feed units from 1 hectare), taking into account technological losses when harvesting hay - 25% , the cost of agrotechnical methods was determined at prices for the 1st quarter of 2020, the cost of 1 feed unit at the price of feed oats - 9.8 rubles / ha.

In the first period of development (1946-1947), the assessment of the economic efficiency of long-term haymaking was carried out according to three systems: technogenic; integrated and technogenic-mineral (against the background $N_{60,90}P_{30}K_{30}$). Technogenic-mineral and organic (against the background $N_{60-180}P_{30}K_{90}$) were included in the experiment scheme since 1950. The amount of capital expenditures in the first development period amounted to 32.5 thousand rubles / ha. In the structure of capital investments, 25% of the costs were for tillage (plowing, disking, pre-sowing and post-sowing packing), 48% for the introduction of five tons of lime, 25% for the purchase of 27 kg / ha of seeds and 2% for sowing seeds. In the structure of total costs, capital costs in the man-made system (control) amounted to 89%, in the integrated system they decreased by 8%, in the man-made-mineral system they were 70% and 74%. In the structure of current production costs, the cost of using fertilizers ($N_{60-90}P_{30}K_{30}$) in the technogenic-mineral system accounted for 53%, in the integrated system ($P_{30}K_{30}$) were 1.9-2.8 times lower. Productivity in the first period of mastering technological systems against the background of $N_{60,90}P_{30}K_{30}$ changed from 2.5 to 3.8 thousand feed. units Taking into account current prices, the cost of products in the technogenic system amounted to 24 thousand rubles / ha, in the integrated one - when

applying P₃₀K₃₀ it increased by 117%, in the technogenic-mineral by 142% and by 154% in comparison with the control. The payback period for capital investments in the technogenic-mineral system was 1.4 years, in the technogenic system it increased 2.1 times. Thanks to self-renewing species of cereal grasses (meadow foxtail, meadow bluegrass, awnless rump, introduced species - red fescue) and an increase in the doses of phosphorus and potassium fertilizers to (P₄₅K₉₀), nitrogen up to N₁₈₀ and the introduction of manure, a highly productive herbage is preserved to the present day. Economic efficiency over the past 28 years was determined by five technological systems. In the technogenic system - (control without fertilization), the yield of cereal-legume-forb herbage was 3.3 t / ha of dry matter (table). In an integrated system when making P₄₅K₉₀ due to the participation of legumes - meadow clover, perennial clover, meadow rank, mouse peas and an increase in the content of cereal species, the yield increased by 1.5 times, as in the organic system when 20 t / ha of manure is applied once every 4 years.

Table 1. Economic efficiency of technological systems for the use of long-term haymaking (1993-2020).

Herbage composition	Fertilizers	Productivity, t / ha DM	Annual production costs, rubles / ha	Productivity of herbage, fodder. units / ha	Production cost, rubles / ha	Cost of 1 feed. units, rub.	Conditional net income RUB / ha	Profitability, %
Technogenic system								
Cereal-legume-forb	No fertilizers	3,28	6632	1867	18326	3,5	11694	176
Integrated system								
Cereal-legume-forb	P ₄₅ K ₉₀	4,93	15691	2699	26450	5,8	10759	68
Organic system								
Cereal-legume-forb	20 t / ha of manure once every 4 years	4,95	10805	2720	26656	4,0	15851	147
Man-made mineral system								
Cereal-herb	N ₆₀ P ₄₅ K ₉₀	5,89	19751	3225	31605	6,1	11854	60
Cereal-herb	N ₉₀ P ₄₅ K ₉₀	6,27	21311	3386	33183	6,3	11872	56
Cereal-herb	N ₁₂₀ P ₄₅ K ₉₀	7,17	24035	3926	38475	6,1	14440	60
Cereal-herb	N ₁₈₀ P ₄₅ K ₉₀	8,18	28327	4540	44492	6,2	16165	58
Combined (organo-mineral) system								
Cereal-herb	20 t / ha of manure	7,40	25358	3940	38612	6,4	13254	53

once every 4 years + N ₉₀ P ₄₅ K ₉₀	
LSD ₀₅	0,85

Productivity in the technogenic-mineral system against the background N₆₀₋₁₈₀PK with a cereal content of 89-98%, 1.8-2.5 times higher than the control, in the combined system it was identical to the yield when applied N₁₂₀PK. The annual production costs include: the cost of fertilizers, a single application of lime, hay bales (mowing, tedding, raking, raking, rolling into rolls, transportation, storage). Collection of feed units (taking into account technological losses) in the technogenic system - control amounted to 1.9 thousand feed units. per 1 ha, while the annual production costs are 6.7 thousand rubles. per 1 hectare, with the cost of 1 feed unit 3.5 rubles, which is 2.8 times lower than the cost of 1 kg of feed oats, the profitability of hay production was 176%. In an organic system when applying manure, production costs are 1.5 times lower than those in an integrated system when applying P₄₅K₉₀. The collection of fodder units in both systems was 1.4 times higher than the control, with the cost of a fodder unit being 4.0 rubles. and 5.8 rubles. The profitability of hay production in an organic system is close to control and 2 times higher than application P₄₅K₉₀. In the technogenic-mineral system, production costs increased from 19.8 thousand rubles / ha when applying N₆₀PK up to 28.3 thousand rubles / ha when applying N₁₈₀PK, which is 3.0-4.3 times higher than the control, 1.2-1.8 times higher than the application P₄₅K₉₀. Productivity of herbage in the technogenic-mineral system against the background N₁₂₀PK60% is represented by meadow foxtail, against the background N₁₈₀PK awnless rump (62%), and amounted to 3.2-4.5 thousand feed. units per hectare, which is 1.7-2.4 times higher than the control. The prime cost of 1 feed unit was 6.1-6.3 rubles, with a conditionally net income of 11.8-16.2 thousand rubles / ha, the profitability was 56-60%. In the combined (organo-mineral) system, the production annual costs were close to the costs of applying N₁₂₀PK, 3.8 times higher than the control and 2.3 times higher than the application of 20 t / ha of manure 1 time in 4 years. The collection of fodder units amounted to 3.9 thousand / ha, conditionally net income - 13.2 thousand rubles / 1 ha, profitability - 52%.

The assessment of the economic efficiency of the five technological systems for the creation and use of long-term haymaking indicates their high efficiency, allows them to be widely used by farms, depending on the availability of material and technical means. The use of the grass stand for 75 years allows you to preserve a high-quality grass stand and exclude nine to ten over-planting.

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