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ECONOMIC EVALUATION OF FERTILIZING WITH ORGANIC FERTILIZERS IN THE PRODUCTION OF BIRD'S FOOT TREFOIL FODDER

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Abstract

The impact of organic fertilizers, such as Blago 5 at doses of 300 and 600 ml/da and Fertileader Axis at doses of 500 and 1,000 ml/da were tested on a bird's foot trefoil grassland (Lotus corniculatus L.) in the experimental field of the Research Institute of Mountain Stockbreeding and Agriculture of Troyan (RIMSA) from 2020 to 2023. To analyze the main economic indicators based on dry matter yield, graphical and tabular methods, comparative methods were used; method of analysis and synthesis; descriptive statistical analysis and correlation analysis. The high productivity of the grassland treated with the Blago 5 at doses of 600 ml/da determined the lowest cost price and the highest profitability rate of this organic fertilizer. A strong correlation dependence of yield with gross revenue and gross profit (r=1.000) was established, and the high correlation coefficient between gross profit and profitability (0.994) proves the good interdependence between these two indicators. The established results show that Blago 5 applied at a dose of 600 ml/da is a suitable for practical use for the production of bird's foot trefoil forage.

Key words**:** *bird's foot trefoil, fertilizing, economic indicators, correlation dependences*

INTRODUCTION

The changes that have occurred in forage production, especially in the cost prices determine its rethinking from an economic point of view. This necessitates the application of new technological solutions, determining increased productive efficiencies of plants, reduced cost price, increased profitability, and efficiency of the obtained forage [7].

A large part of scientific research is related to the search for opportunities to increase the yield of green and dry matter in several forage legumes important for Bulgaria [10]. Bird's foot trefoil is a forage species [3], characterized by good adaptability for cultivation under different soil-climate conditions, especially on acidic soils [5]. It is rich in protein, with high dry matter yield and high nutritional value [2].

There are several experiments regarding obtaining profitable production. For this purpose, various agrotechnical events related to balanced fertilizing and treatment with foliar fertilizers are applied [4; 18].

The application of organic fertilizers in the agricultural sector is a good prospect for improving the quality of the harvested biomass, with smaller amounts of harmful emissions for the environment and the soil [8]. In recent years, agrarian science has been directed towards the application of organic agricultural products [16], which are used as substitutes for synthetic fertilizers.

One of the strategies for the development of the agricultural sector is the use of foliar fertilizers and biostimulants [1; 14; 19], which affect the biological potential of plants [11], replace mineral fertilizing and are an alternative for ecological and sustainable agriculture [7; 12; 20]. A large part of them contain living microorganisms and, through symbiotic nitrogen fixation, procure the necessary amount of nitrogen for the growth and development of plants [15; 17].

[13] demonstrated that the economic efficiency of grasslands depends on the costs and returns associated with the production of dry matter yield and the nutritional value of the forage [6].

The increase in yields leads to an increase in farmers' incomes [9], and this is related to the application of new innovative technologies.

Agricultural practices can contribute to the reduction of agrobiodiversity, which determines the demand for incentives to implement sustainable ones. Improving the condition and diversity of agricultural ecosystems will increase the sector's resilience to climate change and environmental risks. Fertilizing is such an economically effective ameliorating measure, preserving and improving agrobiodiversity.

The objective of the research work is to determine the economic efficiency and analyze the economic indicators in the production of bird's foot trefoil forage, after applying organic fertilizers Blago 5 and Fertileader Axis.

MATERIALS AND METHODS

The research experiment was conducted in the period 2020-2023 in the experimental field of the Research Institute of Mountain Stockbreeding and Agriculture of Troyan on light grey pseudopodzolic soil. It was set up according to the block method in four replications with a harvest plot size of 5 m^2 with Targovishte 1 variety, treated with the biological products Blago 5 at doses of 300 and 600 ml/da and Fertileader Axis at doses of 500 and 1,000 ml/da.

Blago 5 is a highly concentrated foliar fertilizer from lake sapropel. It lowers the lodging of the crops, as it increases the immunity of the plants; reduces the risk of diseases; stimulates growth; helps to overcome short-term droughts or in conditions of acute lack of moisture; and promotes the development of a powerful, secondary root system. The recommended dose is 300 ml/da.

Fertileader Axis is a systemic product. It has several effects, such as intensifying photosynthesis, a pronounced anti-stress effect, and slowing down the aging of chloroplasts. It improves the absorption and mobility of nutrients in the plant and its resistance to stress factors, improves metabolism supplies plants with zinc and manganese, and improves energy exchange in cells and energy transfer. The composition of the product is as follows: Nitrogen (3%); phosphorus (18%); zinc (5.7%); and manganese (2.5%). The recommended dose is 500 – 1,000 ml/da.

Foliar feeding with the experimental fertilizers was applied twice, before harvesting the regrowths each year. The working solution was applied with a backpack sprayer during the period of active vegetation of the bird'sfoottrefoil.

Yield data are averaged over the four years in kg/da. They were processed by the method of analysis of variance. The economic evaluation includes indicators, such as production costs (BGN/ha), gross revenue (BGN/ha), gross profit (BGN/ha), cost price (BGN/t) and profitability rate (%). Based on the received data of the economic indicators, the economic efficiency of the costs (C_{ef}) was calculated. The economic indicators are divided based on performed activities, indicated in technological maps, and obtained dry matter yield. The analysis of the economic evaluation was conducted based on dry extraction by applying a graphical and tabular method, a comparative method; a method of analysis and synthesis; and descriptive statistical analysis. The statistical processing of the data was conducted according to ANOVA and included correlation analysis between the main economic indicators and yield.

RESULTS AND DISCUSSIONS

Economic evaluation of the production of bird'sfoottrefoil forage after organic fertilizing

The economic indicators (Table 1) for the fertilizing variants largely depend on the productivity of the grassland. On average for the four years, the yield of dry matter with imported biofertilizer Blago 5 was 8,308.03 t/ha at a dose of 300 ml/da and 9,017.02 t/ha at a dose of 600 ml/da. The effect was reversed in fertilizing with Fertileader Axis, which was applied at a lower dose (500 ml/da) and realized higher productivity compared to the higher dose 1,000 ml/da, respectively 8,888.08 and 8,467.04 t/ha.

Table 1. Economic evaluation of the production of bird'sfoottrefoil forage after organic fertilizing for the period 2020-2023

Fertilizing variants	Average yield	Production costs	Cost price	Gross revenue	Gross profit	Profitability
	t/ha	*BGN/ ha*	*BGN/t*	*BGN/ha*	*BGN/ ha*	%
Blago 5 300 ml/da	8,308.03	691.40	0.83	1,961.12	1,952.39	282.38
Blago 5 600 ml/da	9,017.02	740.45	0.82	2,132.54	2,118.99	286.17
Fertileader Axis 500 ml/da	8,888.08	812.63	0.91	2,098.13	2,088.69	257.02
Fertileader Axis 1,000 ml/da	8,467.04	999.45	1.18	1,986.24	1,989.75	199.08

Source: Own calculations.

The production costs determine the amount of investments made for the produced dry matter yield, as their values are from 691.40 to 999.45BGN/ha. Differences in the minimum and maximum value of the production costs are evident, which is due to the different types of fertilizers, their price, doses, and their effect on forage yield. The fertilizing costs of Blago 5 are significantly lower than Fertileader Axis. The lower dose of both fertilizers determines a lower level of production costs in forage production. Therefore, the type of fertilizer and its amount are decisive for the production costs. The difference in the cost price of the obtained production is insignificant. The variants fertilized with Blago 5 in both doses realized similar cost price values (0.83 and 0.82 BGN/t). This is due to the extremely small difference in the values of the production costs of the fertilizer rates. The lower dose of Fertileader Axis gave a higher yield, lower production costs, and a lower cost price of the obtained forage (0.91 BGN/t) compared to the higher dose (1.18 BGN/t).

An opposite trend was observed at a dose of 1,000 ml/da, where the lower dry matter yield and higher production costs determined the higher cost price of forage production compared to the lower dose.

The amount of gross revenue is determined by the amount of mining. The highest incomes obtained, respectively 2,132.54 BGN/t after fertilizing with Blago 5 at a dose of 600 ml/da, corresponding to the highest productivity (9,017.02 t/ha). The grassland fertilized with Fertileader Axis at a dose of 500 ml/da, which also had a high dry matter yield, realized gross revenues of 2,088.69 BGN/ha.

The lower values of the cost price of the realized predetermine a higher gross profit. This explains the highest gross profit obtained from the forage production after fertilizing with Blago 5 at a dose of 600 ml/da (2,118.99 BGN/ha).

The grassland fertilized with Blago 5 at a dose of 300 ml/da, achieved the lowest productivity and the lowest gross profit (1,952.39 BGN/da). The high gross profit is an indicator determining the economic efficiency of forage production after applying organic fertilizing. The gross profit determines the effect of the applied fertilizing on the grassland under certain soil-climate conditions [7]. In this case, the fertilizing with Blago 5 at a dose of 600ml/da appears as an economically effective technological measure for forage production in growing bird's foot trefoil on light gray pseudopodzolic soils in the mountain regions.

The gross profit gives the necessary information about the achieved economic effect of the forage production as a result of fertilizing [6]. However, the measurement of economic efficiency requires a comparison of the effect with the production costs incurred to achieve it. Thus, the profitability rate is determined as a basic economic indicator, summarizing the economic evaluation of the organic fertilizers applied on a given grassland that is grown under specific soil-climatic conditions. The profitability depends on the gross profit, as its maximum values are registered after a higher dose of *Blago 5*, which showed a profitability rate, respectively 286.17%. The high profitability of this fertilizing is the result of the high dry matter yield. According to the presented economic indicators and productivity, fertilizing with Blago 5 at a dose of 600 ml/da can be

recommended from an economic point of view. This fertilizer applied in this dose realized the highest dry matter yield (9,017.02 t/ha), the highest gross revenue (2,132.54 BGN/ha), gross profit (2,118.99 BGN/ha) and profitability (286.17%).

Economic efficiency in the forage grass production from artificial grassland as a result of organic fertilizing

The efficiency coefficient (Fig. 1) did not show significant differences in fertilization rates. The lowest economic efficiency was recorded in the first experimental year. An exception is fertilizing with Fertileader Axis at a dose of 1,000 ml/da. The values of the efficiency coefficient are from 0.612 to 0.625%. As a perennial legume, bird's foot trefoil realizes the most expenses for the creation of the grassland in the year of sowing. This also proves the significantly higher efficiency factor in the first experimental year [6] for all fertilizing variants. In the remaining three years, a decreasing trend of the efficiency ratio was observed from the first to the fourth years. Both by year and on average for the study period, the economic efficiency was higher after fertilizing with Blago 5. In the first, second, and fourth years, the lower dose determined a higher economic efficiency, which according to the efficiency coefficient is 0.625; 5.463 and 2.933%. The higher dose of Fertileader Axis (500 ml/da) in all experimental years had a lower economic efficiency (0.481; 3.458; 4.229; 2.349). The analysis of the obtained results proves that the values of the efficiency coefficient depend on the size of the costs, the type of fertilizers and their doses, and last but not least, the productivity of the grasslands.

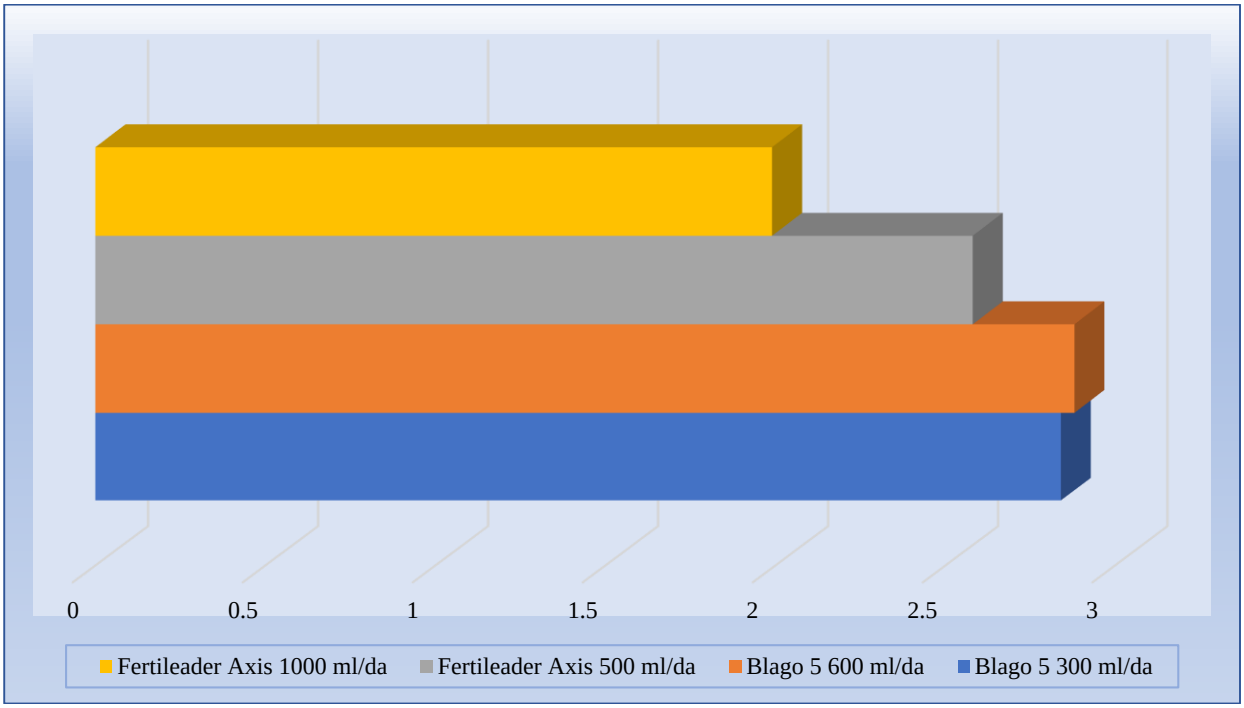

Fig. 1. Economic efficiency in the forage grass production from artificial grassland as a result of organic fertilizing average for the period 2020-2023
Source: Own results.

On average for the study period, the higher dose of Blago 5 the higher the efficiency coefficient (C ef = 2.880%), and when fertilizing with Fertileader Axis, the trend is the opposite, i.e. the lower dose realizes a higher efficiency coefficient (C_{ef} = 2.582%).

Correlation dependences

The correlation dependences in Table 2 show that the dry matter yield has the highest positive correlation with the gross revenues and gross profit (r=1.000), as well as with profitability (r=0.994). The cost price has a very high positive correlation with the values of production costs (r=1.000).

Table 2. Correlation dependences (r) between yield and main economic indicators of forage production from artificial grassland with bird's foot trefoil after organic fertilizing with Blago 5 and Fertileader Axis over the years

Indicators	Average yield	Production costs	Cost price	Gross revenue	Gross profit	Profitability
Average yield	1					
Production costs	-0.999	1				
Cost price	-1.000	1.000	1			
Gross revenue	1.000	-0.999	-1.000	1		
Gross profit	1.000	-0.999	-1.000	1.000	1	
Profitability	0.994	-0.998	-0.996	0.994	0.994	1

Source: Own calculations.

Analysis of the statistical correlation coefficients of production costs shows that they are in a very strong negative correlation with gross revenue (r=-0.999), gross profit (r=-0.999), and profitability (r=-0.998). Gross profit and profitability are highly correlated with gross revenue, with correlation coefficient values of r=1.000 and 0.994, respectively. The high correlation coefficient between gross profit and profitability (0.994) proves the good dependence between these two indicators. The correlation dependences mentioned above prove that fertilizing significantly influenced the change in yield values, and hence, the economic indicators of the dependence between them. High correlation coefficients make it possible to tentatively determine yield through economic indicators, and those with the highest correlation determine productivity prediction through regression equations.

CONCLUSIONS

Increased dry matter yields have an impact on the economic efficiency of forage production. This is proven by the application of the fertilizers Blago 5 (300 and 600 ml/da) and Fertileader Axis (500 and 1,000 ml/da) on the production of bird's foot trefoil forage.

The forage from a monoculture crop with bird's foottrefoil, fertilized with Blago 5 at a dose of 600 ml/da was the most cost-effective and economically efficient agro-ecological measure, according to the economic efficiency of costs.

Both biofertilizers determined the high positive correlation dependence of yield with gross revenue, gross profit (r=1.000), and profitability (r=0.994).

Foliar feeding with Blago 5 and Fertileader Axis on forage production from legumes is absolutely suitable in mountainous areas.

The application of Blago 5 at a dose of 600 ml/da on bird's foot trefoil forage production realizes high yields and high economic efficiency. This makes it practically applicable, and the resulting fodder production is ecologically clean, due to the use of organic fertilizers.

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