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STATISTICAL ANALYSIS AND ECONOMIC EFFICIENCY OF FODDER PRODUCTION FROM NATURAL GRASSLAND (TYPE *CHRYSOPOGON GRYLLUS* L.) FERTILIZED WITH HUMATE FERTILIZERS

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Abstract

During the period 2013-2015, a field experiment was conducted on a natural grassland of Chrysopogon gryllus L. type, fertilized with phosphorus humate, boron and molybdenum humate and their combination. On the basis of the obtained yield, on average for the study period, economic indicators were determined and correlation dependences, economic efficiency and regression equations were calculated. It was found that fertilizing with humate biofertilizers showed a high positive correlation dependence between dry matter yield and gross income (r = 1.0000); cost price and production costs (r = 0.9708); profitability with gross profit (r = 0.8241). The coefficient of determination R^2 = 0.9675 of the very good regression dependence between production costs and cost price is high enough to represent the regression dependence equation (y = 150.72x + 1.5118). The high coefficient of economic efficiency in fertilizing with boron humate (2.90) gives grounds for the application of fertilizer for practical purposes in mass production of fodder in a natural meadow of Chrysopogon gryllus L type.

Key words**:** *economic efficiency, natural grassland, statistical analysis*

INTRODUCTION

Natural grass associations are a huge natural resource that provides environmentally friendly and low-cost raising of ruminants. They are the subject of research by both economics and ecology. Environmental protection and restoration of natural resources [9] are important for the animal husbandry in a number of regions and an opportunity to increase farmers' incomes and produce traditional Bulgarian food to find markets in Bulgaria and the European Union [7].

The amount of hay obtained determines the unsatisfactory condition of natural meadows, which is below the biological potential of grass species and of low quality. Yields from natural meadow and pasture ecotypes are very low. Their use can be considered as a dependence on maintaining the biological balance in nature [8], as well as on the share of species in the grass composition [2, 4]. Therefore, the establishment of environmentally friendly organic fertilizers for foliar or soil application is particularly relevant. Bioproducts are an important component of the integrated nutritional treatment of organic farming. The trend of changing agricultural practices and prevention of harmful effects of chemical fertilizers has imposed biofertilizers in recent years [15].

In this way, the opportunities for environmental pollution of mountain areas will be reduced to a minimum [5].

An innovative technology in modern agriculture is the application of biohumus. Humin substances [12, 13] restore the organomineral balance and realize the production of ecological products [14]. This increases productivity by stimulating nutrient movement and improving the root system.

This necessitates studying the dependencies on climate and the impact of various natural factors, as well as human intervention on the botanical composition and yield of pastures and meadows, which will support the introduction of new environmentally and economically feasible systems for grassland and fodder management in the mountaine regions of Bulgaria.

The increase in economic efficiency is related to the methods of production, which in market

conditions imply a rational combination and use of limited resources to ensure the greatest possible profit. Rationality in the utilization of resources is achieved by directing them to activities in which maximum effect is obtained [10]. It is affected by a variety of internal and external (economic, social, environmental, natural) factors.

The present study aims to present the statistical analysis and the result of the economic efficiency in the production of fodder from a natural grassland, fertilized with certain doses of humate fertilizers.

MATERIALS AND METHODS

Empirical data for dry matter yield of natural grassland, published by [1], were used to perform statistical analysis. They are for the period 2013-2015, when the research experiment was conducted in the experimental field of the Research Institute of Mountain Stockbreeding and Agriculture - Troyan with 5 different fertilizing variants on a natural grassland of *Chrysopogon gryllus* type.

The biological preparations included in the experiment were administered in the following doses:

1. Control (without fertilizing);
2. Phosphorus humate (300 ml/da);
3. Boron humate (160 ml/da);
4. Molybdenum humate (160 ml/da);
5. Phosphorus humate + Boron humate + Molybdenum humate (200 ml/da + 100 ml/da + 100 ml/da).

The methods of analysis can generally be grouped into: general (used by all sectors of the economy) and specialized (suitable for determining the subject and specific features of agriculture). The main statistical methods that are applied are correlation and regression analysis, tabular and graphical [3].

Correlation analysis is defined as the dependence between yield and key economic indicators (production costs, cost price, gross income, gross profit and profitability of production). In practice, correlation and regression analysis are often used together [6]. Each regression analysis or regression coefficient shows by how many units the (+/-) result (impact) changes when the i-th factor changes (+/-) with the same unit [16].

Of particular significance in the application of regression analysis is the size of the sample.

For the compilation of the statistical analysis technological maps have been developed by [11], who calculated the production costs, cost price, gross income, gross profit and profitability of dry matter yield from a natural grassland, and the prices are presented in BGN/da.

To establish economic efficiency, gross income and production costs were taken to determine how effective this experiment was.

RESULTS AND DISCUSSIONS

Correlation dependences and regression equations between yield and main economic indicators of fodder production from a natural grassland, fertilized with humate fertilizers

Fertilizing of a natural grassland of *Chrysopogon gryllus* type with humate fertilizers had the greatest impact on the change in average yields. Dry matter yield in fodder production registered the highest positive correlation (Table 1) in the gross income indicator (r = 1.0000) and in contrast a negative correlation dependence with production costs (r = - 0.0232), cost price (r = - 0.2602), and profitability (r = -0.0164).

The theoretical regression line and the equation of the regression dependence between dry matter yield and gross income from a grassland with bird's foot trefoil are shown in Figure 1, where y = 0.0899x + 26.23 at high coefficient of determination - R^2 = 0.9006.

Table 1. Correlation dependences between yield and main economic indicators of fodder production from natural grassland (*Chrysopogon gryllus* L.), fertilized with humate fertilizers

	Yield	Production costs	Cost price	Gross income	Gross profit	Profitability
Yield	1					
Production costs	-0.0232	1				
Cost price	-0.2602	0.9708	1			
Income	1.0000	-0.0229	-0.2598	1		
Profit	0.4722	-0.8922	-0.9735	0.4718	1	
Profitability	-0.0164	-0.9430	-0.9070	-0.0168	0.8241	1

Source: own calculations.

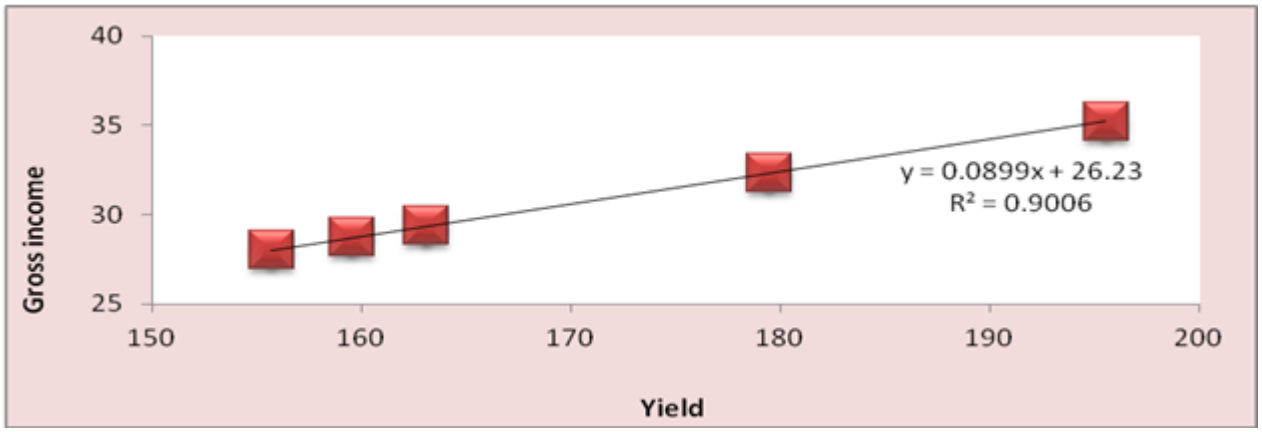

Fig. 1. Theoretical regression line and equation of the regression dependence between gross income and yield in dry matter production
Source: Own calculations and derived equation.

The obtained profit showed a positive but relatively weak correlation with the realized yield (r = 0.4722), which proved the interrelation between these two indicators.
The efficiency of the applied fertilizing is a numerical expression of the obtained high value of the correlation coefficient between the production costs and the cost price, which is respectively r = 0.9708. Figure 2 presents a very high coefficient of determination (R^2 = 0.9425) and the regression equation for predicting the cost price of the obtained fodder production by the average values of production costs (y = 150.72x + 1.5118).

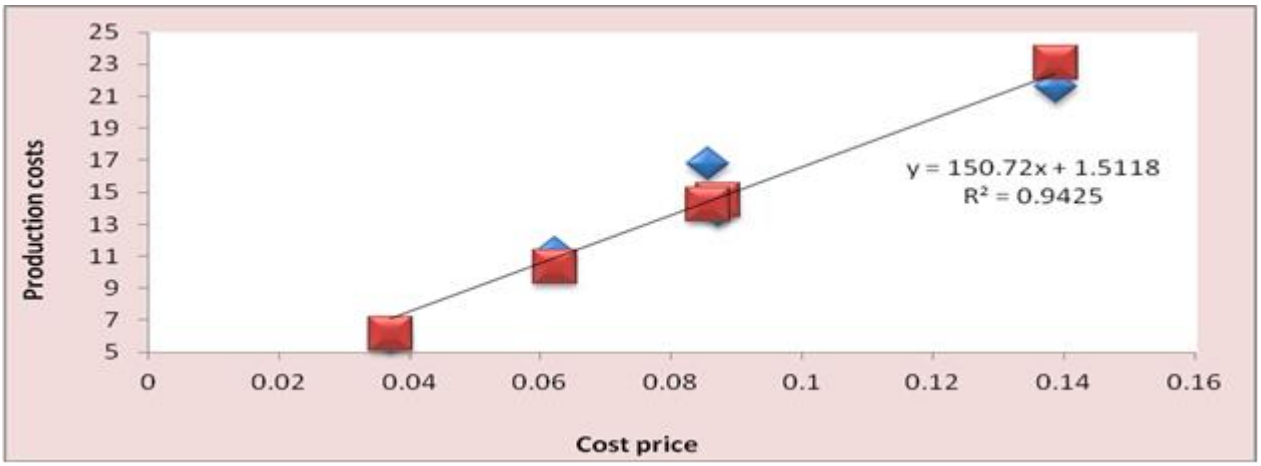

Fig. 2. Theoretical regression line and equation of the regression dependence between production costs and cost price of dry matter production
Source: Own calculations and derived equation.

The results of the analysis show a positive correlation (r = 0.8241) between the indicators gross profit and profitability. The high correlation dependence makes it possible to

derive a regression equation (Figure 3), which is respectively y = 0.0401x + 10.235, with a coefficient of determination R^2 = 0.6791.

A negative correlation dependence is observed between cost price and gross income (r = -0.2598), profit (r = - 0.9735) and profitability (r = - 0.9070).

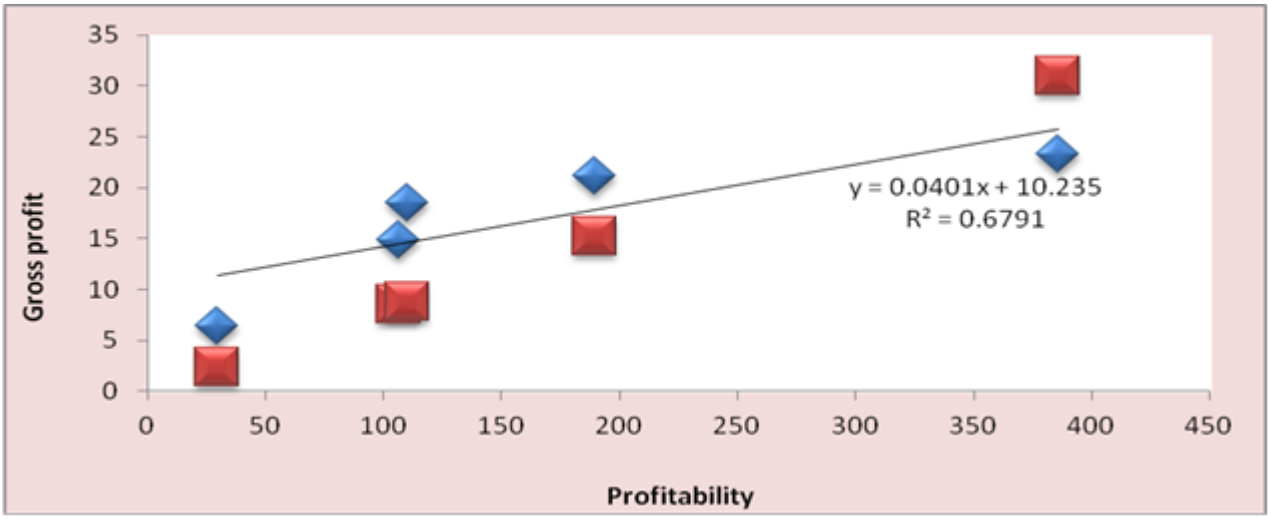

Fig. 3. Theoretical regression line and equation of the regression dependence between gross profit and profitability in dry matter production
Source: Own calculations and derived equation.

Economic efficiency of fodder production from natural grasslands, as a result of fertilizing with humate fertilizers

The indicator of economic efficiency aims to show its usefulness by comparing the income from the sale of production and the costs and even the investments in its implementation. It helps to form a clearer assessment of farmers in the analysis of income and expenditure at a later stage. Economic efficiency answers the question of how efficient a farm is.

The highest efficiency coefficient (Table 2), showing the ratio of income from the sale of fodder production to the production costs, is observed in the variant of fertilizing with Boron humate for all three studied years (252.82%; 230.20% and 396.80%). The trend is maintained at the coefficient with the lowest value, namely in fertilizing with the combination of the three types of fertilizers (125.20%; 121.01% and 143.74%). These numbers clearly show that fertilizing with Boron humate is the most suitable variant, which has the highest economic efficiency, while the variant with combined fertilizers is economically inefficient for producers.

Table 2. Economic efficiency and cost-effectiveness ratio (Cef) of fodder production from natural grasslands, as a result of fertilizing with humate fertilizers

Variants	2013		2014		2015		2013-2015	
	C_{ef}	%	C_{ef}	%	C_{ef}	%	C_{ef}	%
1. Control (without fertilizing)	4.08	408.30	4.33	433.50	6.43	642.72	4.86	485.93
2. Phosphorus humate 300 ml/da	1.95	195.22	2.21	221.48	2.03	202.98	2.06	206.47
3. Boron humate 160 ml/da	2.53	252.82	2.30	230.20	3.97	396.80	2.90	289.52
4. Molybdenum humate 160 ml/da	1.89	189.19	1.64	163.56	2.83	282.84	2.10	210.21
5. Phosphorus humate 250 ml/da + Boron humate 100 ml/da + Molybdenum humate 100 ml/da	1.25	125.20	1.21	121.01	1.44	143.74	1.30	129.72

Source: Own calculations.

The study on the economic efficiency in the variant of fertilizing with Phosphorus humate, has shown the following change: In the first and in the second analyzed years the fertilizing with Phosphorus humate ranked second in efficiency after the variant with the highest efficiency (with Boron humate). In 2015, however, fertilizing with Phosphorus humate was practically ineffective (C_{ef} = 2.03) compared to fertilizing with Molybdenum humate (C_{ef} = 2.83). This change in the last year of the study is reflected in the ranking of fertilizing variants according to their average efficiency coefficient for the period. Overall, the study period (2013-2015) has indicated that the most effective fertilizing variant was with Boron humate (C_{ef} = 2.90), followed by the second most effective one with Molybdenum humate (C_{ef} = 2.10 or 210.21%). Phosphorus humate fertilizing has an efficiency coefficient of 2.06 or 206.47%.

CONCLUSIONS

It was found that fertilizing with humate biofertilizers showed a high positive correlation dependence between dry matter yield and gross income; cost price and production costs; profitability with gross profit.

There is a very good regression dependence between dry matter yield and gross income, which allows the development of a regression equation. The coefficient of determination R^2 = 0.9006 is high enough to represent the equation of the regression dependence between these two indicators (y = 0.0899x + 26.23). The strong relationship between production costs and cost price, expressed by the coefficient of determination R^2 = 0.9425, determines the representation of the regression dependence equation in the form y = 150.72x + 1.5118.

Fertilizing with Boron humate on natural grassland showed the highest economic efficiency and proved to be the most suitable and efficient for the production of fodder.

All analyzed fertilizing variants are suitable for organic production, but the relationship between yield and economic indicators and the applied statistical data processing define bioproducts as economically and environmentally efficient.

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