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IMPACT OF CULTIVAR CHARACTERISTICS ON THE ECONOMIC EFFICIENCY OF BIRD'S-FOOT-TREFOIL FODDER

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Abstract

The selection of suitable grass fodder crops and their cultivars are key factors determining efficiency in agrarian production. In order to produce the most economically efficient bird's-foot-trefoil cultivar for cultivation under mountain conditions, research was conducted in the experimental field of the Research Institute of Mountain Stockbreeding and Agriculture-Troyan. The experiment was based on the block method with the following bird's-foot-trefoil cultivars: Targovishte 1 (Bulgaria), Bursztym (Poland), Kalo (USA), Lot (Poland), Madison (France), MO – 20 (USA), Nico (Romania) were studied for their impact on economic efficiency. It has been established that the genotypic characteristics of the cultivars and the applied production technology determine the productivity and profitability of the obtained fodder production. Soil and climate conditions has a major impact on the level of average yield, gross revenue and profitability of the obtained fodder. From an economic point of view, the Madison and Bursztym cultivars are the most suitable for inclusion in the structure cultivars in the production of bird's-foot-trefoil fodder. They realize fodder production at the lowest production costs, high gross profit and lowest production costs. Their highest efficiency ratio makes them extremely cost-effective and an alternative for agricultural practice.

Key words**:** *bird's-foot-trefoil, cultivars, economic efficiency*

INTRODUCTION

Bird's-foot-trefoil is a perennial legume that adapts well to cultivation in poorly drained soils with an acidic reaction (Churkova, 2012; Bozhanska, 2020) [2, 3]. It is self-sowing, resistant to disease and pests, responds well to fertilization and does not cause animal bloat in animals (Owens et al., 2012)[12]. As a result, it is grown in places where production of other fodder legumes is limited. In the past, bird's-foot-trefoil was commonly used in grazing systems, and nowadays there are available cultivars suitable for hay production. Legume fodder crops provide ecological benefits to agricultural landscapes in Europe, increase resource efficiency and contribute to balancing the European deficit in plant protein production (Ewert et al., 2005; Goulding et al., 2008; Jensen et al., 2010) [7, 8, 11]. Recently, there has been a decline in the production of legumes in the member states of the European Union (based on FAO). Market demand determines the specialization of cropping systems. The agricultural policy for the cultivation of fodder grasses must be consistent with the agronomic benefits and economic efficiency in the production of legume crops. To a large extent, the economic value of legumes is determined by their cultivation technology (Petkova et al., 2022)[13]. The inclusion of bioproducts with soil and foliar application in modern ecological technologies for growing bird's-foot-trefoil positively affect the productivity and quality of the fodder mass (Bozhanska, 2020a)[1]. The significance of legume fodder crops (Westhoff et al., 2009)[17] in cropping systems depends on their ability to fix nitrogen from the air (Schilizzi and Pannell, 2001)[14], their role as suitable precursors for a number of crops and their environmental impacts (Van Grinsven et al., 2014)[15]. The bird's-foot-trefoil as a nitrogen-fixing component is also significant in organic agriculture (Hirel, 2011; Vasileva et al., 2017)[9, 16], which determines the economic benefits of its cultivation. The appropriate

technological decisions of the respective legume crops contribute to extracting benefits for the environment and increasing the sustainability of agricultural production.

One such technological solution is the introduction of new high yield bird's-foot-trefoil cultivars, combining high productivity and fodder quality (Hunt et al., 2016)[10]. Correctly selected cultivars for specific soil and climatic conditions (Dragomir et al., 2011)[6], with good adaptability, lead to a reduction in the amount of production costs and the cost price of fodder production and increase its profitability (Churkova and Churkova, 2022)[5]. Appropriately defined units of technology for the production of bird's-foot-trefoil fodder is essential for increasing economic efficiency.

The purpose of the present research experiment is to determine bird's-foot-trefoil cultivars on the basis of an economic analysis, as an alternative for including the most suitable ones in the structure of agricultural production.

MATERIALS AND METHODS

The analysis is based on data from a research experiment carried out in the experimental field of RIMSA-Troyan on a light gray pseudopodzolic soil, with an acidic reaction, low phosphorus content, good supply of potassium and low humus content. The economic analysis is made of the bird's-foot-trefoil yields obtained over the years and on average for the period 2013-2015. Database is provided by reports on the G 100 project to the Agricultural Academy and a published paper (Churkova, 2019)[4]. The experimental years differ significantly in terms of the amount of precipitation. 2015 is characterized as the driest, when the precipitation amount during the vegetation was 549.5 mm. In 2014, it was 222.6 mm more than those in 2015.

The spring was relatively cool and well provided with rainfall in the year of sowing, which favors the normal development of crops. The air temperature was above 5°C, which was suitable for the germination and development of meadow grasses. The average air temperature for the vegetation within the three years 2013, 2014 and 2015 varied within small limits (16.0, 15.3 and 16.5 °C).

The experiment was set up according to the block method in four replications with a harvest plot size of 5 m^2 and included the following cultivars and populations of bird's-foot-trefoil: Bursztym (Poland), Kalo (USA), Lot (Poland), Madison (France), MO – 20 (USA), Nico (Romania). The main fertilizers were phosphorus and potassium at a stocking rate of 40 kg/da active substance and pre-sowing with N_6 kg/da once. The sowing was spread by hand in a dose of 1.200 kg/day. The grass stand was harvested in the bud-formation period - the beginning of blossoming.

The following indicators were used to determine the economic efficiency: average dry matter yield for the study period (kg/da); production costs (BGN/da), gross output, (BGN/da), net income (BGN/da), cost price (BGN/kg), profitability rate. The economic efficiency of the costs was based on data on the economic indicators. The economic indicators were determined on the basis of the activities carried out, indicated in technological maps and the obtained dry matter yield. The calculations were made according to prices for the relevant year of production.

Statistical processing of the data was carried out by ANOVA, determining: variation coefficient (CV,%), standard deviation (SD), minimum (min) and maximum (max) limit values.

RESULTS AND DISCUSSIONS

The dry matter yield shown in Table 1 fluctuates widely, both by year and averaged over the period. The productivity of the cultivars in the first year shows significant differences. This is evidenced by the highest degree of variability relative to the value of the variation coefficient (CV=25.39) and standard deviation (SD=102.46). Madison variety stands out with a significantly higher dry matter yield compared to the standard, which forms a yield of 608.58 kg/da. The Kalo cultivar showed a yield below that of the standard, whereas the Lot cultivar was close

to the value of the standard. All other cultivars significantly exceed the productivity of the standard. The obtained significant differences in yield and its lower values compared to the other two years are due to its slower growth and development in the year of sowing.

In the second experimental year, all tested cultivars exceeded the productivity of the standard. Again, the Madison cultivar showed the highest productivity, and a yield close to that of the standard was reported for the Lot and Nico cultivars. The degree of variability was very low, according to the value of the variation coefficient (CV=5.64) and standard deviation (SD =88.88). The low variation coefficient is due to the insignificant difference between the minimum and maximum yield values. In the third year, the tested cultivars retain a relatively high value for this indicator. Bursztym cultivar gave a yield of 1,163.15 kg/da. The degree of variability was average (CV=17.29) with SD=163.12 and mean x=943.23.

On average for the study period, the Madison cultivar realized the highest productivity (1,073.32 kg/da). The coefficient of variation (CV=9.83) was low with mean value (x) of dry matter yield for the experimental period 928.86 kg/da and standard deviation SD = 91.29. Since the coefficient of variation is lower than 30%, the yield results are acceptable, which proves the effect of growing the cultivars under the conditions of the light gray pseudopodzolic soils and the climatic conditions under which the research experiment was carried out. These results show that when applying the same cultivation technology for bird's-foot-trefoil cultivars, the proposed approaches can be applied to estimate expected yields of these cultivars in subsequent years and variation from the average dry matter yield and standard deviation. This will determine which cultivar's productivity will have a larger standard deviation and which cultivar's yields will be more variable than their mean. This will contribute to the correct determination of the cultivar structure in the production of bird's-foot-trefoil as fodder.

Table 1. Dry matter yield of bird's-foot-trefoil cultivars (kg/da) by year and average for the period and statistical analysis of the yield (variation coefficient, standard deviation, mean value, minimum and maximum values)

Cultivars	2013	2014	2015	Average for the period
	kg/da	kg/da	kg/da	kg/da
Targovishte 1	347.31	1,467.03	812.43	826.20
Bursztym	396.09	1,624.83	1,163.15	1,017.12
Kalo	280.94	1,587.23	1,146.92	961.89
Lot	360.82	1,519.06	827.49	851.12
Madison	608.58	1,741.14	1,002.20	1,073.32
MO	432.79	1,563.10	762.14	882.39
Nico	398.68	1,527.70	888.31	890.00
x	403.60	1,575.73	943.23	928.86
SD	102.46	88.88	163.12	91.29
CV	25.39	5.64	17.29	9.83
min	280.94	1,467.03	762.14	826.20
max	608.58	1,741.14	1,163.15	1,073.32

Source: Churkova, 2019 [4].

The Table 2 and Figure 1 of economic indicators shows production costs, gross revenues, gross profit and profitability. The production costs have almost similar values for the studied cultivars because of the applied identical production technology. They vary from 64.29 to 64.89 BGN/da.The highest gross profit was recorded for the Madison cultivar (136.22 BGN/da). Targovishte 1, as the lowest productive cultivar, realized the lowest gross profit (BGN 93.32/da). A high gross profit is also achieved by the Bursztym cultivar (126.28 BGN/da). The high gross profit in these two cultivars is an indicator of

high economic efficiency in fodder production. This makes Madison and Bursztym cultivars economically efficient for cultivation on light gray pseudopodzolic soils in mountain areas. Gross revenue indicators are similar to these indicators. The highest productivity and the highest gross profit of the Madison and Bursztym cultivars also determine the highest values of their gross revenue.

Table 2. Production costs and cost price in the fodder production from bird's-foot-trefoil cultivars on average for the period 2013-2015

Cultivars	Production costs	Cost price
	BGN/da	BGN/kg
1. Targovishte	64.29	0.0778
2. Bursztym	64.76	0.0637
3.Kalo	64.63	0.0672
4.Lot	64.35	0.0756
5.Madison	64.89	0.0605
6.MO	64.4	0.0730
7.Nico	64.44	0.0724

Source: Own calculations.

Through the gross profit, the necessary information is obtained about the achieved economic effect of the fodder production from the studied cultivars, but the measurement of the economic efficiency requires a comparison of the effect with the production costs incurred to achieve it. That is why the profitability rate is a basic economic indicator, summarizing the economic evaluation of the cultivation of the cultivars under specific soil and climate conditions. The high gross profit in the production of fodder from the Madison and Bursztym cultivars and their productivity determine their high profitability rate, which is 209.92 and 195.00%, respectively. The lowest yield was recorded for the Targovishte 1 (826.2 kg/da), the lowest values of gross revenue (157.61 BGN/da), gross profit (93.32 BGN/da) and profitability (145.15%).

From the economic indicators presented, determining the economic efficiency of fodder production from bird's-foot-trefoil cultivars, it can be seen that the Madison and Bursztym cultivars realize the highest dry matter yield, the highest gross revenue, gross profit and profitability (209.92 and 195.00%).

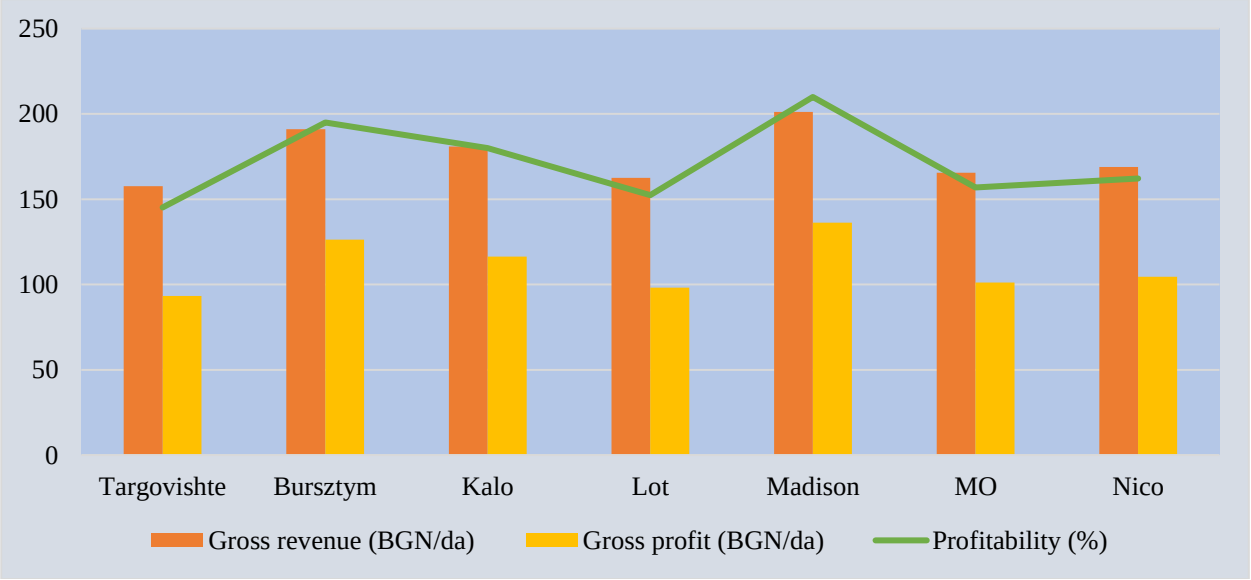

Fig. 1. Economic indicators in the fodder production from bird's-foot-trefoil cultivars on average for the period 2013-2015

Source: Own calculations.

This defines them as economically efficient for inclusion in the cultivar structure of the fodder production under mountain conditions. The cost price of the fodder production (Table 2) depends on the level of dry matter yields for the different cultivars and the amount of production costs. The lower the cost price, the greater the savings inraw materials and

materials, and it reduces the financial means of the production process. The low cost price determines the low price of the fodder production. Of the seven bird's-foot-trefoil cultivars tested, the highest cost price of the obtained fodder production was registered for the standard cultivar (0.0778 BGN/kg), and the lowest for the Madison and Bursztym cultivars (0.0605 and 0.0637 BGN/kg). Cost price depends on the amount of dry matter yield and the production costs incurred, as the highest production costs explain the lowest cost of dry matter yield for Madison cultivar. The difference in the values of the cost price follows the same trend as in the production costs, because of the similar data obtained for the individual cultivars. The lower values of the cost price of the realized fodder production predetermine the receipt of a higher gross profit. This explains the highest gross profit obtained from the fodder production of Madison cultivar.

Table 3. Economic efficiency in the production of fodder of different bird's-foot-trefoil cultivars on average for the period 2013-2015

Cultivars	**Coef. of efficiency (%)**	
1. Targovishte	3.80	100.00
2. Bursztym	4.63	121.84
3.Kalo	4.50	118.42
4.Lot	3.90	102.63
5.Madison	4.61	121.32
6.MO	3.87	101.84
7.Nico	4.04	106.32

Source: Own calculations.

Efficiency coefficient is an expression of the economic efficiency of fodder production, expressed through the ratio of revenue and expenses. The difference between the values of the efficiency coefficients in the production of fodder for the individual cultivars is insignificant (Table 3). It varies from 3.80 to 4.63%, with minimum and maximum values for Targovishte 1 and Madison cultivars. The efficiency ratio of the research experiment performed follows the trend of the production cost and cost price. The values of the efficiency coefficient (4.63%) for Bursztym cultivar and 4.61% for Madison cultivar prove the effectiveness of their cultivation under the soil and climate conditions of Bulgaria. The higher efficiency coefficient determines their better adaptability. The fertilizing method increases the opportunity to obtain a high yield and ecologically clean fodder production from the various bird's-foot-trefoil cultivars. The obtained higher efficiency coefficient according to the economic indicators defines these two cultivars as more profitable to grow compared to the other tested bird's-foot-trefoil cultivars.

CONCLUSIONS

In the present scientific research experiment, an economic evaluation of fodder production from seven cultivars of bird's-foot-trefoil grown under mountain conditions is presented. All tested cultivars were found to be suitable for cultivation because of the extremely low variability of dry matter yield between individual cultivars by year.

From an economic point of view, Madison and Bursztym cultivars are the most suitable for inclusion in the structure cultivars in the production of bird's-foot-trefoil fodder. They realize fodder production at the lowest production costs, high gross profit and the lowest cost price. Their highest efficiency ratio makes them extremely profitable for implementation in agricultural production and they are recommended for cultivation in practice.

REFERENCES

[1]Bozhanska, T., 2020, Application of Lumbrical and Lumbrex biofertilizers and their influence on the nutritional value and quality indicators in artificial grassland of bird‘s-foot-trefoil (*Lotus corniculatus* L.). Bulgarian Journal of Agricultural Science, 26, 4, 761-765.https://www.agrojournal.org/26/04-08.html, Accessed on January 5, 2023.

[2]Bozhanska, T., 2020, Study on the influence of Lumbrical and Lumbrex biofertilisers on an artificial grassland of bird’s-foot-trefoil (*Lotus corniculatus* L.). Forest Science, 1, 45-54. https://naukazagorata.files.wordpress.com/2020/05/ng_1_2020-045-054.pdf, Accessed on January 7, 2023.

[3]Churkova, B., 2012, Biometric performance and productivity of varieties and local populations birdsfoot trefoil under the soil and climatic conditions of Troyan. Banat's Journal of Biotechnology, 2012, Vol. 3(5), 42–46.

[4]Churkova, B., 2019, Grazing capacity of bird's-foot-trefoil cultivar under conditions of Central Northern Bulgaria. Journal of Balkan ecology, 22, 2, 127-134.
[5]Churkova, B., Churkova, K., 2022, Productivity and economic efficiency in the production of seeds of bird's foot trefoil cultivars. Scientific Papers, Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 22(2), 191-196. https://managementjournal.usamv.ro/pdf/vol.22_2/Art23.pdf, Accessed on February 1, 2023.
[6]Dragomir, C., Dragomir, N., Toth, S., 2011, Studies on several Romanian agroecotypes of birdsfoot trefoil (*Lotus corniculatus* L.) with special reference to their productivity and forage quality. Journal of Food, Agriculture & Environment, 9 (3-4), 1124-1128.
[7]Ewert, F., Rounsevell, M. D. A., Reginster, I., Metzger, M. J., Leemans, R., 2005, Future scenarios of European agricultural land use I. Estimating changes in crop productivity. Agriculture, Ecosystems & Environment, 107, 101–116.
[8]Goulding, K., Jarvis, S., Whitmore, A., 2008, Optimizing nutrient management for farm systems. Philosophical Transactions of the Royal Society, B: Biological Sciences, 363, 667–680.
[9]Hirel, B., Tétu, T., Lea, P. J., Dubois, F., 2011, Improving nitrogen use efficiency in crops for sustainable agriculture. Sustainability, 3, 1452–1485.
[10]Hunt, S.R., MacAdam, J. W., Griggs, T. I., 2016, Seeding rate, oat companion crop, and planting season effects on irrigated organic birds-foot trefoil stands in the Mountain West United States. Crop Science, 56, 463 - 473.
[11]Jensen, E. S., Peoples, M. B., Hauggaard-Nielsen, H., 2010, Faba bean in cropping systems. Field Crops Res., 115 (3), 203-216.
[12]Owens, J., Provenza, F. D., Wiedmeier, R. D., Villalba, J. J., 2012, Supplementing endophyte infected tall fescue or reed canarygrass with alfalfa or birds-foot trefoil increases forage intake and digestibility by sheep. J. Sci. Food Agr., 92, 987–992. doi: 10.1002/jsfa.4681.
[13]Petkova, M., Bozhanska, T., Bozhanski, B., Iliev, M., 2022, Chemical composition and energy nutritional value of forage crops under mountain conditions. Journal of Mountain Agriculture on the Balkans, 25 (5), 254-271.
https://jmabonline.com/bg/article/xTYwrVoyMxpS7hC2GICG, Accessed on February 10, 2023.
[14]Schilizzi, S., Pannell, D. J., 2001, The economics of nitrogen fixation. Agronomie, 21, 527-537.
[15]Van Grinsven, H. J. M., Spiertz, J. H. J., Westhoek, H. J., Bouwman, A. F., Erisman, J. W., 2014, Nitrogen use and food production in European regions from a global perspective. The Journal of Agricultural Science,152, Supplement S1: Special Issue from the 17th International Nitrogen Workshop, 9 – 19. DOI: https://doi.org/10.1017/S0021859613000853, Accessed on January 20, 2023.
[16]Vasileva, V., Kertikov, T., Ilieva, A., 2017, Dry Mass Yield and Amount of Fixed Nitrogen in Some Forage Legume Crops after Treatment with Organic Fertilizer Humustim. Bulgarian Journal of Agricultural Sciences, 23(5), 816-819.
[17]Westhoff, P., Emerich, D. W., Krishnan, H. B., 2009, The Economics of Biological Nitrogen Fixation in the Global Economy. Agronomy Monographs. https://doi.org/10.2134/agronmonogr52.c11, Accessed on January 23, 2023.