ECONOMY OF SILAGE PRODUCTION FROM GRASSLAND*

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Production and nutritious data were obtained during the period of several year's research (1992–1996) in the perennial grassland and grassland with additional sowing in the area of Strážov Upland. The obtained results formed the basis for economy of silage production. The results of the economic evaluation of two systems of grassland cultivation supported the claim that, with regard to inputs of fossil energy, fertilizer together with agricultural machinery has a crucial position. Costs for 1 ha of grassland have maximum values at the highest intensity of fertilization (used: fertilizer) and lowest in the non-fertilized grassland. We recommend to use the lower doses of N-fertilizer (variant 3: the perennial grassland – 90 kg $N.ha^{-1}$ + PK) because lower costs, high production of NEL and N-substances were obtained in the perennial grassland – variant 3. The results of experiments pointed out the need to use existing resources – grassland keeping high biodiversity. It is necessary to pay attention to low input agricultural systems and agro-environmental steps in the original perennial grassland without destruction of sod mat.

grassland; production; silage; quality; economy

INTRODUCTION

The grassland is an important component of forage crops and fodder in submarginal and marginal regions of Slovakia. Production functions, the higher ecological stability and biodiversity are typical for the grassland of forest and agricultural regions (Krajčovič, 1997). The use of additionally sown association, where efficient and quality varieties of clover crop and grass are used, is a good way of improving the production of fodder from the grassland. If we want to integrate the grassland with additional sowing into the system of farming in PHO and HO, we have to take into account the total economic system of farming in relation to the applied agricultural systems acceptable for environment (Krajčovič, Holúbek, 2000). In Slovakia, the conditions for cultivation and production of forage crops and fodder have changed since 1989. The attention is paid to the quantity and quality of forage crops (Murgaš, 1998). Costs are important indicators of economic performance of agribusinesses. All aspects of production are represented by them, namely the technological equipment of agribusinesses, the productivity of labour, the intensity and organization of production, the influence of nature and economic conditions and costs of energy inputs that influenced the economy (Bielik et al. 1998).

Two technologies of grassland cultivation are compared in the article. The main aim of the comparison is to evaluate the costs for 1 ha and a production unit, the economic gain and efficiency of utilization of invested costs.

MATERIAL AND METHODS

Our experiment was based on the block method (two blocks were used in the experiment). The first block consisted of the perennial grassland and the second one comprised the grassland with additional sowing. In the second block, the additional sowing of clover-grass mixture into the original grassland was carried out.

The original perennial grassland was identified as the association of *Lolio-Cynosuretum typicum*. The same variants of mineral nutrition and the same term of utilization were used for both blocks (3 cuts) (Table 1).

The aim of the research was to observe floristic, production and nutritious changes of individual types of grassland with emphasis on the production of dry matter,

Table 1. Doses of nutrients and their distribution

Variant	Number of utilization	Dose of nutrients ($kg.ha^{-1}$)			Date of nitrogen application		
		P	K	N	in spring	after the first cut	after the second cut
1	3	–	–	–	–	–	–
2	3	30	60	–	–	–	–
3	3	30	60	90	30	30	30
4	3	30	60	180	60	60	60

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content of N-substances, production of N-substances, concentration of energy in dry matter and production of energy for 1 ha.

The observed technologies of grassland cultivation (5 years) in production and nutritious indicators formed the basis for the observation of costs used for production of silage (the content of dry matter – 40%). The calculation formula was used to calculate costs spent in the course of experiment (K u b á n k o v á et al., 2000).

The computer program "Tekons" helped us to determine the costs needed for machinery equipment (N o z d r o v i c k ý et al., 1998). The survey of costs and direct costs for 1 ha and a production unit was obtained from the economic evaluation of achieved results of grassland cultivation.

We used the so-called fuzzy clustering analysis to evaluate the results of our experiments (S t e h l í k o v á, 2000). The fuzzy clustering allows us to find a fuzzy partition and the associated cluster centers. The result is a value of the membership function to cluster for every grassland type. Elements x belong to the cluster if $Ax \geq \vee \{Ax; x \in U\} - \varepsilon$. It is reasonable to choose $\varepsilon = 0.2$. Then we tolerate the elements x for which $Ax \geq 0.8$. The element x is not made definite if its membership function to every cluster is less than 0.80. The typical representatives of individual clusters are also the result of fuzzy clustering. The number of clusters was chosen on the basis of the maximum value of the coefficient of separation.

RESULTS AND DISCUSSION

The analysis of costs used for working operations of machinery pointed out the fact that the highest labour costs (4,927 SK.ha^{-1}) were obtained in the grassland with additional sowing (Table 2). Labour costs for the perennial grass, where the lowest inputs were used, were 4,726 SK.ha^{-1}.

Material costs were represented by mineral fertilizer (variant 2: 2,010 SK.ha^{-1}; variant 3: 3,630 SK.ha^{-1}; variant 4: 5,210 SK.ha^{-1}) and seed stock of clover-grass mixture (800 SK.ha^{-1}). The above-mentioned factors influenced costs for a tract unit and a production unit (Tables 2 and 3).

The lowest costs for 1 ha of grassland were obtained in non-fertilized controls: 4,381 SK.ha^{-1} in the perennial grassland and 5,582 SK.ha^{-1} in the grassland with additional sowing. The highest costs were obtained in the variants fertilized by the highest doses of mineral fertilizer: 11,923 SK.ha^{-1} in the perennial grassland and 13,124 SK.ha^{-1} in the grassland with additional sowing. Costs for 1 ha of grassland had increasing tendency (perennial grassland – grassland with additional sowing). Analogous results from ecosystemic research were obtained by K r a j č o v i č et al. (2001).

The aim of the research was also to obtain a survey of costs for a production unit. The highest costs per ton of silage were obtained in the grassland fertilized with phosphorus and potassium (perennial grassland: 1,242 SK.ha^{-1} and grassland with additional sowing: 1,225 SK.ha^{-1}). The lowest costs were obtained in non-fertilized controls: 781–836 SK.ha^{-1}. The fertilization with nitrogenous fertilizer influenced the amount of costs for 1 ton of silage. The grassland with additional sowing was the most effective (costs for 1 ton were 1,167–1,222 SK.ha^{-1}). The lowest efficiency was obtained in the perennial grassland fertilized with 180 kg N + PK fertilizer (1,242 SK.ha^{-1}). The production of grassland was also evaluated according to the yield of energy

Table 2. Costs and yields in SK for 1 ha and a production unit (perennial grassland) (x = 1992–1996)

Indicator	Production region of highlands			
Type of grassland	perennial grassland			
Variant	1	2	3	4
Costs for operation of machines	3,651	4,726	4,726	4,726
Bought seeds	–	–	–	–
Produced seeds	–	–	–	–
Bought fertilizer	–	2,010	3,630	5,210
Produced fertilizer	–	–	–	
Direct costs	3,651	6,736	8,536	9,936
Production overheads and administrative expenses	730	1,347	1,707	1,987
Costs for 1 ha	4,381	8,083	10,243	11,923
Yield of silage t.ha^{-1}	5.24	6.51	8.63	9.76
Costs for 1 ton of silage	836	1,242	1,187	1,222
Production of NEL MJ.ha^{-1}	22,843	28,403	37,103	43,079
Costs for MJ NEL	0.19	0,28	0,28	0,28
Yield of N-substances t.ha^{-1}	0,649	0.832	1.079	1.353
Costs for 1 ton of N-substances	6,750.4	9,715.1	9,493.0	8,812.3
Costs for 1 kg of silage	0.84	1.24	1.19	1.22

Table 3. Costs and yields in SK for 1 ha and a production unit (grassland with additional sowing) (x = 1992–1996)

Indicator	Production region of highlands			
Type of grassland	grassland with additional sowing			
Variant	1	2	3	4
Costs for operation of machines	4,652	4,927	4,927	4,927
Bought seeds	800	800	800	800
Produced seeds	–	–	–	–
Bought fertilizer	-	2,010	3,630	5,210
Produced fertilizer	–	–	–	
Direct costs	4,652	7,737	9,357	10,937
Production overheads and administrative expenses	930	1,547	1,871	2,187
Costs for 1 ha	5,582	9,284	11,228	13,124
Yield of silage t.ha^{-1}	7.15	7.58	9.20	11.25
Costs for 1 ton of silage	781	1,225	1,220	1,167
Production of NEL MJ.ha^{-1}	30,735	32,090	39,1436	49,143
Costs for MJ NEL	0.18	0.29	0.28	0.27
Yield of N-substances t.ha^{-1}	0.974	1.070	1.259	1.563
Costs for 1 ton of N-substances	5,731.0	8,676.6	8,918.2	8,396.7
Costs for 1 kg of silage	0.78	1.22	1.22	1.17

Table 4. Values of the separation coefficient

Number of clusters	2	3	4	5
Separation coefficient	6.83959	6.28571	6.52797	6.69423

(NEL) from a tract unit on the basis of concentration of NEL in MJ in 1 kg of dry matter (Tables 2 and 3).

The grassland with additional sowing fertilized by nitrogen has a higher level of production and economic indicators in comparison with non-fertilized variants.

The production of NEL in MJ.ha^{-1} has increasing tendency in both technologies of grassland cultivation (from the non-fertilized control to the highest intensity of fertilization by NPK fertilizer). The values of production range from 22,843 MJ.ha^{-1} (non-fertilized perennial grassland) to 49,143 MJ.ha^{-1} (variant 4 – grassland with additional sowing).

The index of costs/MJ (pastures = 1.0) reached, in comparison with chosen forage crops, very good values in non-fertilized controls (1.29–1.43). The index of costs/MJ of grassland fertilized by mineral fertilizer is comparable with lucerne (*Medicago sativa*) and maize (*Zea mays*), which is an energy fodder plant. The grassland utilized by cutting fall behind the pasture. It is a result of lower inputs (mainly lower direct costs). Direct costs are lower because animals are pastured on the grassland (Holúbek, 2002; Murgaš, 1998).

In evaluated fodder plant, the nitrogenous substances have an important position in the nutrition of ruminants. In our experiments, the grassland produces 0.64–1.56 t.ha^{-1} of N-substances. Their production is stepped up together with the intensity of fertilization. The lowest values of costs for 1 ton of N-substances are in non-fertilized controls: 5,731–6,750 SK and the highest values are in controls fertilized by PK fertilizer: 9,715 SK (perennial grassland) and 8,676 SK (grass stand with additional sowing). The lowest costs for 1 ton of N-substances are produced by grassland fertilized by the highest dose of nitrogen (Tables 2 and 3).

The values of the separation coefficient are in Table 4. We chose two clusters because the maximum value of the separation coefficient was 6.83959.

Typical representatives of individual clusters are in Table 5.

The typical features of the first cluster are low costs for 1 ha (6.908) and the lower production of NEL per 1 ha (28,780). The yield of N-substances per 1 ha is lower (0.8853) than the yield of the second cluster (1.3390). Costs (for 1 of silage) of a typical representative of the first cluster are lower (1.023) than the costs of a typical representative of the second cluster (1.201). High costs for 1 ha (11,770) and the high production of NEL (42,700 MJ) are characteristic for the typical representative of the second cluster. The yield of silage in the first cluster is lower (6.577) than the yield in the second cluster (9.811).

The typical features of the individual clusters are as follows:

– the first cluster is a cluster with the low costs for 1 kg of silage, low yield of silage, low production of NEL and low yield of N-substances.

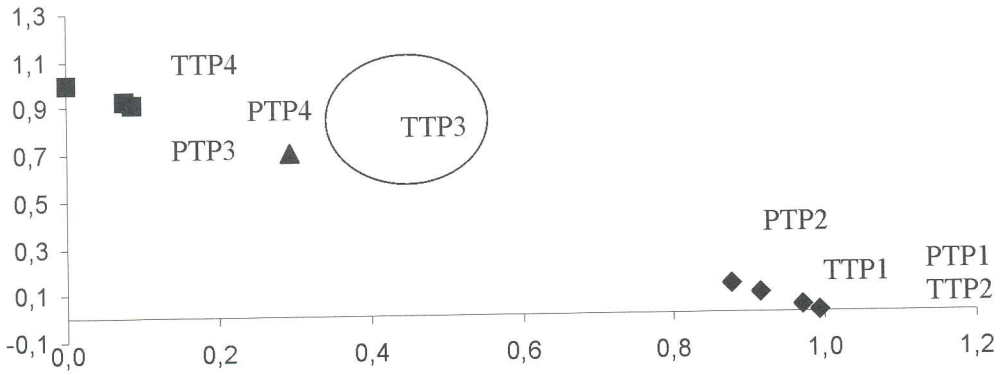

Fig. 1. The membership of individual types of grassland to clusters

◆ the first cluster, ■ the second cluster, ▲ not made definite
TTP – perennial grassland, PTP – grassland with additional sowing

Table 5. Typical representatives of clusters

Indicator	The first cluster	The second cluster
Costs for 1 ha	690.8	11,770.0
Yield of silage t.ha^{-1}	6.577	9.811
Production of NEL MJ.ha^{-1}	28,780	42,700
Yield of N-substances t.ha^{-1}	0.8853	1.3390
Costs for 1 kg of silage	1.023	1.201

Table 6. Values of the membership function for individual types of grassland

Type of grassland and variant	Value of the membership function	
	the first cluster	the second cluster
Perennial grassland 4	0.0007	0.9993
Grassland with additional sowing 3	0.0766	0.9234
Grassland with additional sowing 4	0.0873	0.9127
Perennial grassland 3	0.2955	0.7045
Grassland with additional sowing 2	0.8776	0.1224
Perennial grassland 1	0.9150	0.0850
Grassland with additional sowing 1	0.9703	0.0297
Perennial grassland 2	0.9931	0.0069

– the second cluster is a cluster with the high costs for silage, high production of NEL and N-substances as well as the high production of silage from 1 ha.

Variants of evaluated types of grassland with lower costs and high production of NEL, N-substances and silage are not made definite. It is important to emphasize that variants of grassland, which are not made definite, are important in practice.

The perennial grassland 2, the grassland with additional sowing 1, the perennial grassland 1 and the grassland with additional sowing 2 belong to the first cluster. The perennial grassland 4, the grassland with additional sowing 3 and the grassland with additional sowing 4 belong to the second cluster. The perennial grassland 4 is not made definite. The membership to clusters is in Table 6.

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Ekonomika produkcie siláže z trávneho porastu.

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Experimentálnymi prácami v rokoch 1992–1996 na pratotechnicky ovplyvňovaných trvalých a prisiatych trávnych porastoch v Strážovskej vrchovine sme získali výsledky v produkčných a nutričných ukazovateľoch, ktoré v priemerných hodnotách vytvorili dobrý základ pre ekonomiku výroby siláže.

Z ekonomického hodnotenia dvoch systémov obhospodarovania trávnych porastov rezultuje, že z hľadiska vstupov fosílnej energie majú rozhodujúce postavenie priemyselné hnojivá a poľnohospodárska technika. Vlastné náklady na 1 ha trávnych porastov dosahujú maximálne hodnoty pri najvyššej intenzite hnojenia priemyselnými hnojivami. Z hľadiska praktického využitia experimentov odporúčame aplikovať nižšie dávky N-hnojív (var. 3 TTP – 90 kg $N.ha^{-1}$ + PK), pri ktorých sa dosiahli nižšie náklady spojené s vysokou produkciou NEL a N-látok.

Výsledky experimentálnych prác poukázali na potrebu využitia existujúcich zdrojov, ktoré poskytujú trávne porasty pri zachovaní vysokej biodiverzity, jej zvyšovania v spojení so zvýraznením problémov ochrany životného prostredia zo všetkých hľadísk. Je to najmä orientácia na poľnohospodárske systémy nízkych vstupov organického hospodárenia a agroenvironmentálnych opatrení na pôvodných trvalých trávnych porastoch bez narušenia mačiny.

trávny porast; produkcia; siláž; kvalita; ekonomika

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