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# Grassland – a European Resource?

*Edited by*  
**Piotr Goliński**  
**Marianna Warda**  
**Piotr Stypiński**



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## The effect of nitrogen fertilization on quality and yield of grass-legume mixtures

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### Abstract

Studies were carried out in pure stands of three grasses: cocksfoot, meadow fescue and perennial ryegrass, and lucerne, as well as their mixtures with different ratios of individual components. The trial was carried out on an experimental field of the Institute for Animal Husbandry (Belgrade, Serbia). Fertilization with N caused a significant increase of yield. The highest yields were determined in treatments with 100 kg N ha<sup>-1</sup>, and the lowest in treatments without fertilization. Fertilization increased significantly the CP content, but without impact on other quality parameters. CP, NDF and ADF differed significantly in various crops.

Keywords: grass-legume mixture, quality, dry matter yield

### Introduction

Grass-legume mixtures, as well as pure stands, are important for production of high quality forage, especially in conditions of lowland livestock production, in conditions of farm housing and systems of free grazing of animals. Growing of lucerne and other legumes in mixtures with grasses has numerous advantages, such as a possibility of utilization through grazing, better conservation of water and mineral salts in soil (Lazaridou *et al.*, 2006), higher yields than pure stands during vegetation, better quality of forage, better utilization of soil nutrients, as well as more economically efficient production due to reduced use of nitrogen fertilizers (Tekeli and Ates, 2005). Applied nitrogen fertilizers in a grass-legume mixture increase the DM yield, as well as the content and yield of CP. Komarek *et al.* (2007), in their study of the effect of complex mineral fertilizers, with and without N, on yield of grasslands, concluded that by adding 90 kg N ha<sup>-1</sup> the yield of DM increased by 1.89 t ha<sup>-1</sup>, and by adding 180 kg N ha<sup>-1</sup> an increase of 3.03 t ha<sup>-1</sup> was recorded. In the study by Tomić *et al.* (2011), fertilization increased significantly the yield of CP by 194.1 kg ha<sup>-1</sup> in monoculture and by 323.2 kg ha<sup>-1</sup> in mixtures. The objective of this research was to study the effect of different N rates from mineral fertilizers on production and qualitative properties of grasses and legume plants in monoculture and in mixtures.

### Material and methods

The trial was carried out on the experimental field of the Institute for Animal Husbandry, according to a CRB design in 4 replicates. The effect of 3 N rates (0, 50 and 100 kg ha<sup>-1</sup>) on DM yield, content of CP, CF, NDF and ADF in pure crops (lucerne, cocksfoot, meadow fescue and perennial ryegrass) and grass-legume mixtures: lucerne and cocksfoot (50:50); lucerne, cocksfoot and meadow fescue (50:25:25 and 25:50:25); lucerne, cocksfoot, meadow fescue and perennial ryegrass (40:20:20:20), was investigated. Sowing was carried out in the autumn of 2010, on basic parcel/plot of 10 m<sup>2</sup>. Phosphorus was deficient and it was added at the amount of 165 kg ha<sup>-1</sup>. N fertilization of crops was carried out by the end of March 2011, using 27% N. Soil type was moderate humus and slightly or moderately acid. Results of total yield of DM in pure crops and grass-legume mixtures, as well as of the quality in the first cut, were processed using standard laboratory methods and analysed

by parametric tests (ANOVA and LSD test) at the 0.05 probability levels, using statistical package Statistica 8.

## Results and discussion

Based on the results obtained (Table 1), fertilization with 0–100 kg N ha<sup>-1</sup> caused a significant increase in yield of pure crops and grass-legume mixtures by an average of 1.42 t ha<sup>-1</sup>. In pure crops, the highest yield of 7.66 t ha<sup>-1</sup> was recorded in perennial ryegrass fertilized with the highest N rate, whereas the lowest yield was obtained in the control treatment of cocksfoot (4.94 t ha<sup>-1</sup>). The highest yield (8.78 t ha<sup>-1</sup>) was realized by the four-component mixture in the treatment with 100 kg N ha<sup>-1</sup>, and the lowest (4.35 t ha<sup>-1</sup>) was for the mixture of lucerne, cocksfoot and meadow fescue (25:50:25) without fertilization. The results are consistent with findings of Bijelić *et al.* (2011) who concluded that DM yield increases in proportion to the amount of added N, 13.7–14.2 t ha<sup>-1</sup>.

Table 1. Total yield of DM of pure lucerne, cocksfoot, meadow fescue and perennial ryegrass crops and their mixtures, depending on the N fertilization (t ha<sup>-1</sup>)

Crop	N fertilization (kg ha <sup>-1</sup> )			Means mixture
	0	50	100	
lucerne	6.13	6.62	7.01	6.59 <sup>b</sup>
cocksfoot	4.94	5.84	5.80	5.53 <sup>cd</sup>
meadow fescue	6.47	6.15	7.28	6.63 <sup>b</sup>
perennial ryegrass	7.10	6.90	7.66	7.22 <sup>a</sup>
lucerne+ cocksfoot 50:50	5.42	5.33	6.70	5.81 <sup>c</sup>
lucerne + cocksfoot + meadow fescue 50:25:25	5.91	7.51	7.00	6.80 <sup>b</sup>
lucerne + cocksfoot + meadow fescue 25:50:25	4.35	6.60	7.22	6.05 <sup>c</sup>
lucerne + cocksfoot + meadow fescue + perennial ryegrass 40:20:20:20	5.70	7.62	8.78	7.36 <sup>a</sup>
Means for N fertilization	5.75 <sup>c</sup>	6.57 <sup>b</sup>	7.18 <sup>a</sup>	–
LSD <sub>0.05</sub> mixture = 0.3830; LSD <sub>0.05</sub> fertilization = 0.3316				

LSD<sub>0.05</sub> – least significant difference at  $P \leq 0.05$ .

In Table 2, the contents of CP, CF, NDF and ADF in pure crops and mixtures, depending on the N fertilization, are presented. CP was one of the most important parameters of forage quality, and it determines the biological value of food. Legumes are characterized by significantly higher CP content than in grasses. Conservation of forage in the form of hay can cause a decrease of CP content, because of improper handling, excessive drying or loss of leaves. Content of CP varied significantly in relation to crop and fertilization. The highest CP in pure crops was recorded in lucerne (14.9%), and in mixtures of lucerne and cocksfoot (12.68%). Fertilization influenced the increase CP of (9.90–13.10%). Komarek *et al.* (2007), reported that a treatment with the highest N rate (180 kg ha<sup>-1</sup>) influenced the increase of CP in grass-legume mixtures of 120.6–134.6 g kg<sup>-1</sup> DM. Content of CF in forage dry matter is an important energy parameter and significant component of every forage mixture. Studied factors had no significant influence ( $P = 0.08$ ) of this quality parameter whose value ranged from 26.58–29.00%. Good balance of diet enables better intake of available food by animals. The ratio between ADF, NDF and fibre is especially important. In a diet for high yielding cows in lactation, it is necessary to ensure at least 19–21% ADF and 28–30% NDF. Roughage should ensure at least 21% NDF in DM. ADF and NDF do not change under the influence of fertilization of any mixtures or pure crops ( $P \leq 0.05$ ), two indicators between different crops. Of all the factors studied, only sward type had an impact

on NDF and ADF. The highest NDF was recorded in cocksfoot (63.59%) and in the mixture (25:50:25) of lucerne, cocksfoot and meadow fescue (63.56%), and the lowest in lucerne (44.48%) and the mixture of lucerne and cocksfoot (59.22%).

Table 2. CP, CF, NDF and ADF in pure crops and mixtures depending on fertilization (%)

Main effect	CP	CF	NDF	ADF
Crop				
lucerne	14.29	27.81	44.48	36.34
cocksfoot	11.10	28.78	63.59	37.44
meadow fescue	9.23	27.41	61.68	37.55
perennial ryegrass	8.94	26.58	52.69	32.57
lucerne+ cocksfoot 50:50	12.68	28.76	59.22	37.34
lucerne + cocksfoot + meadow fescue 50:25:25	13.08	29.00	61.30	36.31
lucerne + cocksfoot + meadow fescue 25:50:25	11.33	27.65	63.56	38.04
lucerne + cocksfoot + meadow fescue + perennial ryegrass 40:20:20:20	12.29	29.28	60.95	39.19
LSD 0.05	1.24	ns	2.47	2.50
N fertilization (kg ha <sup>-1</sup> )				
0	9.90	28.11	57.61	36.84
50	11.86	28.45	58.57	37.08
100	13.10	27.91	59.11	36.62
LSD 0.05	1.07	ns	ns	ns

Numerous research studies have reported that fertilization of grass-legume mixtures with N significantly increases the NDF, as a consequence of it increasing the proportion of grass, whereas ADF content remains unchanged under the influence of N (Bijelić *et al.*, 2011).

## Conclusions

In Serbia, grass-legume mixtures as well as pure stands of grassland species realized satisfactory yields of DM in the first production year, as well as quality: CP, CF, NDF and ADF. With an optimum rate of 100 kg N ha<sup>-1</sup>, the yield of pure stands of perennial ryegrass at 7.66 t DM ha<sup>-1</sup> was lower than the 8.78 t DM ha<sup>-1</sup> of 4-component mixtures with the same fertilization. This high quality mixture can be recommended for growing since it has significantly higher yield and better quality (CP, NDF, and especially ADF) in comparison with other studied mixtures.

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