Digestibility and nutritive value of late mowed grassland

Enikő Ilona Magyar[1] – Reinhard Resch[2] – László Szemán[1] – Daniel Warner[2]
[1]Department of Grassland Management,
Faculty of Agricultural and Environmental Sciences,
Szent István University, Gödöllő
[2]Institute of Agricultural Research and Education Centre
Raumberg-Gumpenstein (HBLFA), Austria
magyar.eniko@hungerit.hu

SUMMARY

Nutritive value of a fodder from extensive established pasture was tested. The nutrient content was measured by the Wendee-analysis and by in vitro ruminant digestibility method. Results of former experiments showed that the nutritive value of an extensive established pasture in the case of late outdoor growing is low. In our results the highest crude protein content was in the year 2002, while in 2003 can be observed a steep decline, which showed in 2004 further decrease. The crude protein values were the highest in case of middle seed norm. The nutritive values of these pastures provide just supply for the demand and it was declined due to the negative N-balance in the rumen. Our results showed that the samples from the year of establishment could possibly be used for preserved feed (6.01 MJ NE $_l$ kg^{-1}). The crop from all other years and sowing times did not reach a value of 5.00 MJ NE $_l$ kg^{-1}, but approach a level of 4.4 to 4.5 MJ NE $_l$ kg^{-1}, thus they would not be suitable for preserved feed. It can be recommended that this late season crop should rather be used for grazing of livestock than as preserved feed.

***Keywords**: in vitro digestibility, ruminant, nutritive value, grassland*

INTRODUCTION

Nowadays, the production of farm animals has developed towards highly specialized coordinated production systems. Variability in the growth rates is important to the production costs. Increasing attention has been focused on the improvement of grassland management in the European Union and also in the world. Different types of sward management have also influenced herbage quality and yield. The European Union and also Hungary [FVM 150/2004. (X. 12.)] describes several regulations for extensive grassland farming. One of them is the late mowing of grasses, which means not before June 15th (Szemán, 2005).

The optimal mowing time of grasses is in early flowering stage, generally in May, because that is the best time for the grasses to provide the highest nutritive value feed for animals. This late mowing however decreases the forage quality, whereas several herbs improve the nutritive value of pasture. There are only few exact data available for the nutrient content research of late harvested crop from extensive pasture, so our results give some directions in the international applied research. It could be useful in practice to improve the degraded grasslands with herbs, and owing to the fodder diversity, animal production, and due to the natural antibiotics from medicinal plants in pastures, also animal health. In homeopathy it can be used for the application of a lot of medicaments in human medicine, but also more and more in the veterinary practice as well.

In present study it was investigated the improvement of nutritive parameters in established pasture directly by herbs, but at a late mowing time.

The most important parameter of nutritive value of different feeding stuffs for dairy cow is that of energy concentration because it determines how much milk will be produced from basic forage. Quality of feed stuffs is important in milk production and forage intake (Gruber et al., 2001). To produce 1 kg milk 3.17 MJ NE$_l$ kg^{-1} is needed (Steinwidder, 2003). Gruber et al. (2001) showed a decrease of 1.5 kg week^{-1} in milk production from basic forage if the energy concentration decreased from 6.8 MJ NE$_l$ kg^{-1} to 5.2 MJ NE$_l$ kg^{-1}. This shows the significant influence of the aging process on the quality of basic forage. According to Wiedner (1998) among standard conditions the energy concentration of basic forage is 4.8 and 5.8 MJ NE$_l$ kg^{-1}, while under better circumstances it can reach 6.0 or even more. The Hungarian Feed Codex (2004) carried out 6.65 MJ NE$_l$ kg^{-1} energy in the primary growth at heading stage for the Hungarian conditions if in the pasture the dominant grass species is *Lolium perenne* L. and 5.48 MJ NE $_l$ kg^{-1} at later phenophase, while for an extensive pasture or grassland in the first growth at heading stage 5.42 and at flowering stage 4.31, additionally in the summer as young second cut hay 5.35 MJ NE$_l$ kg^{-1}. According to Buchgraber and Resch (1997) forage is the most favourable with an energy value over 6.0 MJ NE $_l$ kg^{-1}. They categorized the forage as medium quality between 5.0 and 6.0 MJ NE$_l$ kg^{-1}, and under 5.0 MJ NE$_l$ kg^{-1} energy content indicate a late mowing time or higher pollution.

Another important nutrient, the crude protein (CP) content taken alone provides insufficient information about the protein supply. More important is the amount of intestinal available protein (NXP), which characterizes the N-balance of ruminants. According to Gruber et al. (1997), Schubiger et al. (2001) and Buchgraber (2004) the most practical method is the two-staged one according to Tilley and Terry (1963) for estimating *in vivo* digestibility. The *in vitro* methods are used more often, because they are cheaper than the *in vivo* method and a lot of trials can be managed. However this method shows without doubt more sensibility vs. activity of gastric juice, which requires multiple repeats for compensating.

MATERIALS AND METHODS

Experimental trials and design

The experiment in Gödöllő (approximately 30 km to the East of Budapest) in altitudes up to 207 m were at two sowing times (spring and autumn) of the year 2002 with three seed norm (1=5000 seed m^{-2}, 2=10000 seed m^{-2} and 3=15000 seed m^{-2}) as a type of an extensive pasture established. Several grass and herb species (*Lolium perenne* L., *Poa pratensis* L., *Festuca rubra* L., *Festuca heterophylla* Lam., *Achillea collina* (L.) Beck., *Plantago lanceolata* L., *Thymus vulgaris* L., *Origanum vulgare* L., *Hypericum perforatum* L.) and two accompanying species (*Salvia pratensis* L., *Dianthus giganteiformis* Borb.) were sown directly into the grassland to study the achievable degree of nutrition value in this examined pasture. In order to get a well-utilizable plant-culture, the proportion of different plant species in the mixture was regulated. Different plant species were sowed as grass and herbs together in a seed mixture. The years of investigation and mowing time were from 2002 to 2004 continuously. Cover and growing ability of spring-sown and autumn-sown pasture stands in May 2003 and 2004, separately were also examined.

Sampling

The influence of the botanical composition and sowing time on the nutritive value of forage from 72 crops (grass+herbs mixture and grass samples alone) of quite extensively used pasture from Hungary at one cutting time during the primary growth was also investigated. The first mowing had to be carried out June 15th. Two types of crops were harvested on the production site. In the first case the grasses alone were harvested separately, while in the second case the grasses with herbs were harvested together for the analysis of digestibility of organic matter (DOM) in the rumen.

Chemical analyses

From the feed samples collected in the experimental period the contents of crude protein and crude fibre were determined according to the Hungarian Feed Codex (2004) (*Table 1*). The nutritive value was determined using the *in vitro* ruminal digestibility method according to Tilley and Terry (1963). The rumen liquor ensure from two or more different sort of beeves to equalize the difference. Forage was examined in three replicates for nutrient content and in two replicates for *in vitro* analyses. As follows were together six replicates for the estimate of representative means. The coefficient of variation for extreme values were tested, where the average deviation was estimated at the level of 3%.

Table 1

The mean crude protein and crude fibre content of the feedstuff

Observed year/ sowing time	n=12	Composition (g kg^{-1})					
		Crude protein			Crude fibre		
		Seed mixture					
		5000 seed m^{-2}	10000 seed m^{-2}	15000 seed m^{-2}	5000 seed m^{-2}	10000 seed m^{-2}	15000 seed m^{-2}
2002 in spring	mean	179.4	181.6	204.2	208.3	205.1	195.2
	± SEM	16.83	17.54	13.56	12.87	16.94	25.08
2003 in spring	mean	75.1	83.5	83.1	291	278.1	285.3
	± SEM	5.68	10.12	8.89	12.78	18.49	25.9
2003 in autumn	mean	78.7	96.9	95.5	246.2	282.5	291.7
	± SEM	44.73	2.85	6.09	70.86	8.31	26.55
2004 in spring	mean	58.3	51.7	42	331.3	331.4	361.4
	± SEM	20.57	14.04	5.73	17.49	10.17	11.46
2004 in autumn	mean	53.2	44.4	41.6	340.9	324.6	337
	± SEM	8.94	3.82	4	12.88	41.5	20.37
2004 (grass-herb mixed samples) in spring	mean	53.9	47	51.4	361.1	348.7	360.9
	± SEM	12.94	8.08	4.04	29.18	25.6	27.31

Statistical analysis

Data were statistically evaluated with program SPSS/Win 12.0 (ANOVA, Bonferroni-test, Pearson-correlation). According to the regression equation by digestibility of organic matter we can regularly estimate the energy contents (NE_l) too.

The ruminal N-balance (RNB) was estimated by digestibility of crude protein [ABB in %], ruminally undegradable crude protein [UDP in % of Dry Matter (DM)], usable crude protein [nXP in g kg^{-1} DM] and the metabolic energy [ME in MJ kg^{-1} DM].

Digestibility of crude protein (ABB_XP) was estimated based on the database of DLG – Futterwerttabellen-Wiederkäuer (1997).

UDP=(100-BB_XP)/100*XP
nXP=(11.93-(6.82*(UDP/XP)))*ME+1.03*UDP
RNB=(XP–nXP)/6.25 (Lebzien et al., 1997).
Net energy of lactation (NE_l) was estimated the regression factors from the database according to DLG – Futterwerttabellen-Wiederkäuer (1997).
(NE_l) (Grass fodder 1. growth)=dOMD*0.0125344-2.20899
(NE_l) (Grass fodder 2. and following growth)=dOMD*0.0136031-2.84447
dOMD=digestible Organic Matter in Dry Matter [g kg^{-1} DM]

RESULTS

During the observation of changes in botanical components we found a higher dicotyledonous proportion on plots established in spring than in autumn. However the influence of established herbs on the nutritive value was not significant (*Table 2*), because the herbs in the pasture were not given a proportion which would have favourably changed the forage value of late mowed pasture.
The digestibility of feedstuffs showed close correlation with the fibre contents, on the other hand the fibre content influences the feed intake, so it determines significantly the nutritive value. If the crude protein decreased the crude fibre in the grass-herb mixture samples increased. The highest crude protein content was in the year 2002, while in 2003 it can be observed a steep decline, which showed further decrease in 2004. It can be observed in the year 2003 in both of sowing time, that the crude protein values are the highest in the case of middle seed norm (Table 1). In this treatment the crude protein values were about the same also in 2004.
In 2003 and 2004 the sowing time as a treatment significantly influenced the crude protein and crude fibre content, however in the grass-herb mixed feedstuff in 2004 the dicotyledonous did not determine significantly the nutritive value (*Table 3*).

Table 2

The significance among the seed norms of the crude protein and crude fibre content of the feed

Observed year/ sowing time	Among the seed norms	Composition (g kg^{-1}) Crude protein	Crude fibre
		Significance	
2002 in spring	1-2	0.947	0.663
	2-3	0.683	0.536
	1-3	0.732	0.302
2003 in spring	1-2	0.369	0.56
	2-3	0.836	0.594
	1-3	0.482	0.276
2003 in autumn	1-2	0.001[a]	0.005[a]
	2-3	0.245	0.088
	1-3	0.008[a]	0.141
2004 in spring	1-2	0.546	0.397
	2-3	0.175	0.849
	1-3	0.064	0.505
2004 in autumn	1-2	0.196	0.086
	2-3	0.943	0.273
	1-3	0.219	0.472
2004 (grass-herb mixed samples) in spring	1-2	0.459	0.835
	2-3	0.285	0.918
	1-3	0.087	0.916

Significance among the different seed norms: $^{a}P < 0.01$

Table 3

The significance between the sowing times of the crude protein and crude fibre content of the feed

Observed year/sowing time	Composition (g kg^{-1}) Crude protein			Crude fibre		
	Seed mixture					
	5000 seed m^{-2}	10000 seed m^{-2}	15000 seed m^{-2}	5000 seed m^{-2}	10000 seed m^{-2}	15000 seed m^{-2}
2003 in spring–in autumn	0.007[a]	0.066	0.551	0.019[b]	0.222	0.968
2004 in spring–in autumn	0.204	0.06	0.569	0.628	0.045[b]	0.37
2004 (grass-herb mixed samples) in spring*	0.467	0.388	0.58	0.423	0.164	0.188

Significance between the two sowing times: $^{a}P < 0.01$; $^{b}P < 0.05$; *=between the grass samples alone and the grass-herb mixed samples: in that case the sowing time was in spring.

In the crops from Hungary a negative N-balance was found in both establishments 2003 and 2004 on average, however the grass which were established in spring and mowed in 2003 showed a lower tendency. Establishment in autumn resulted in a slight positive trend, which was caused by grass established in autumn and observed in 2003 with a higher positive proportion (*Figure 1-3*). In one case an absolutely positive N-balance was found in the grass of 2002 (*Figure 1*).

Comparing the times of establishment (spring and autumn) on average, we get higher values from samples established in autumn. In spring, there were values found even below 50%. Establishment in autumn decreased the digestibility when the seed norm increased (52.1, 51.75 and 50.65%, respectively), while the plots established in spring with a medium seed norm of 10000 seed m^{-2} showed the highest value (51.09%) (*Figure 4*). The lowest digestibility value was found with a high seed norm of 15000 seed m^{-2} (48.83%). The samples of the examined pasture were given a 49.7% value with the low (5000 seed m^{-2}) seed norm.

When we compared the grass alone and grass-herb mixed samples, values of digestibility with an establishment in autumn were higher than in two samples established in spring. Accordingly there were two samples from spring, one of which consisted of grass and herbs mixed, and had the lowest values of digestibility. In addition the two samples of 2003 from both terms of establishment (establishment in spring 49.68, 51.85 and 50.38%; in autumn 52.5, 52.88 and 50.05% with the seed norm increasing) were similar to 2004, however in 2002, the spring established samples showed the highest values, where in the treatments with low and high seed norm the values were almost similar (74.4 and 74.13%), whilst in the treatment with medium seed norm it reached 71.55%.

Figure 1: **N-balance in the rumen (RNB) of grass established in spring and mowed in 2003 (left) and established in autumn and mowed in 2003 (right) according to treatments**

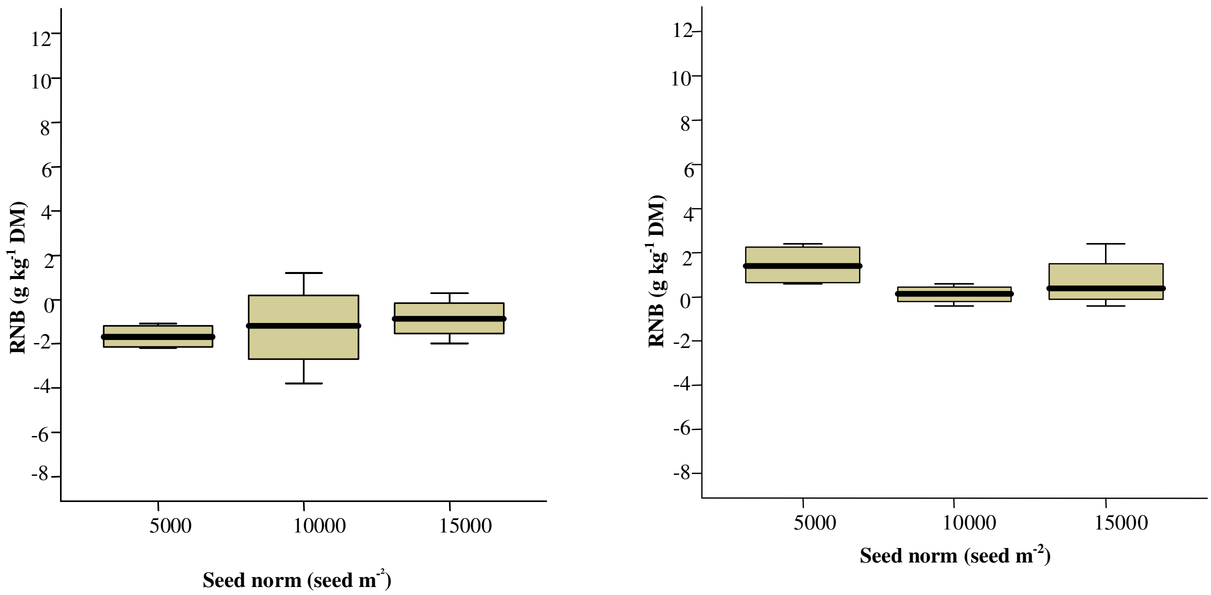


Figure 2: **The N-balance in the rumen (RNB) of grass established in spring and mowed in 2004 (left) and established in autumn and mowed in 2004 (right) according to treatments**

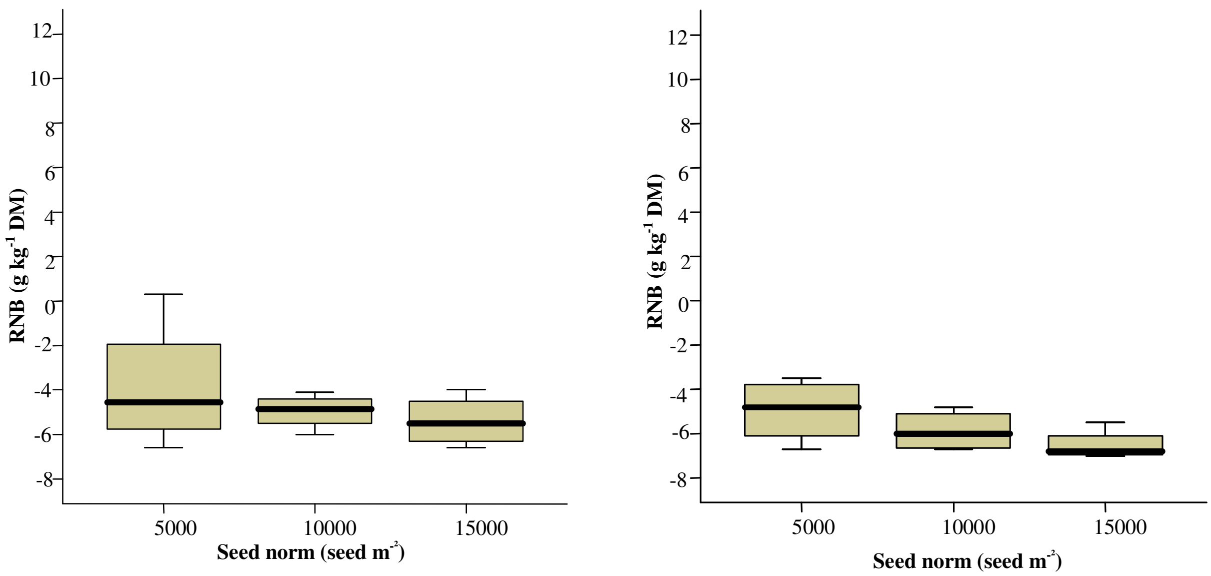


Figure 3: **The N-balance in the rumen (RNB) of grass established in spring and mowed in 2002 (left) and in grass-herb mixtures established in spring and mowed in 2004 (right) according to treatments**

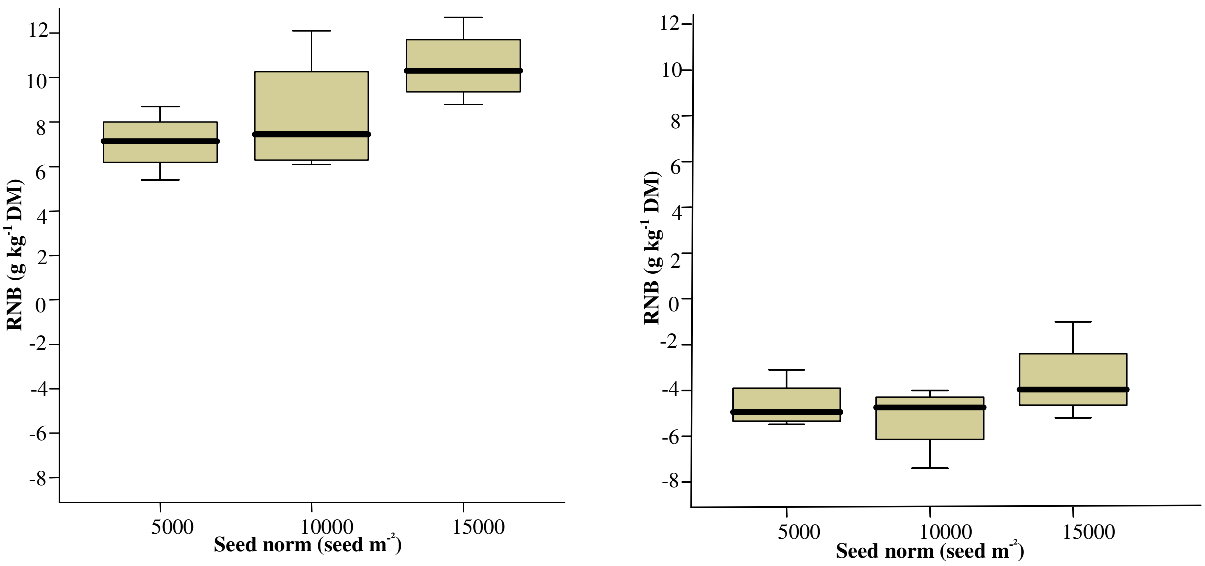
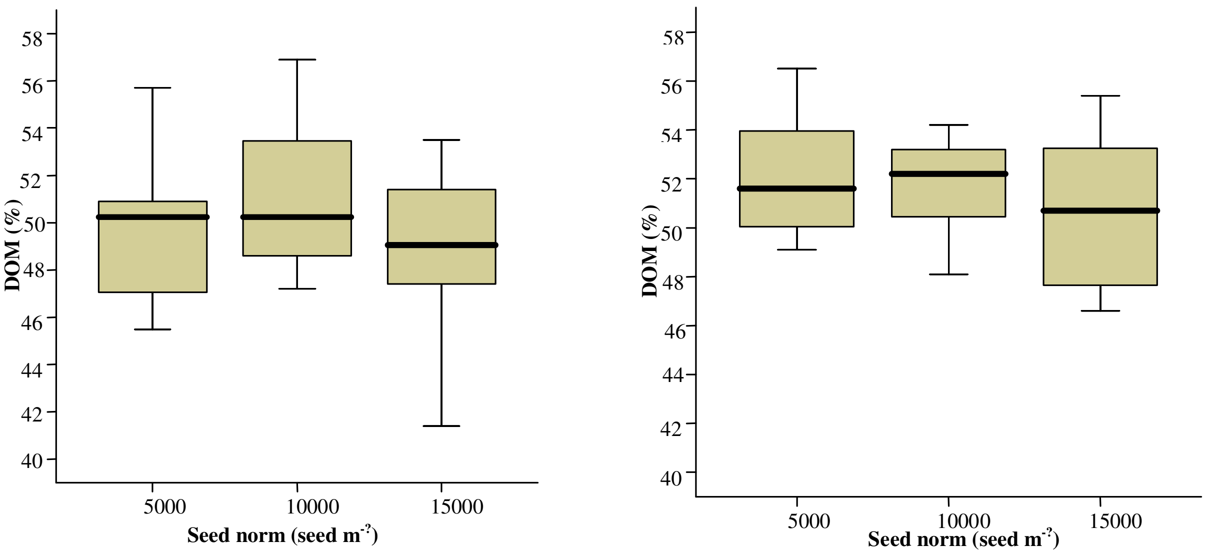


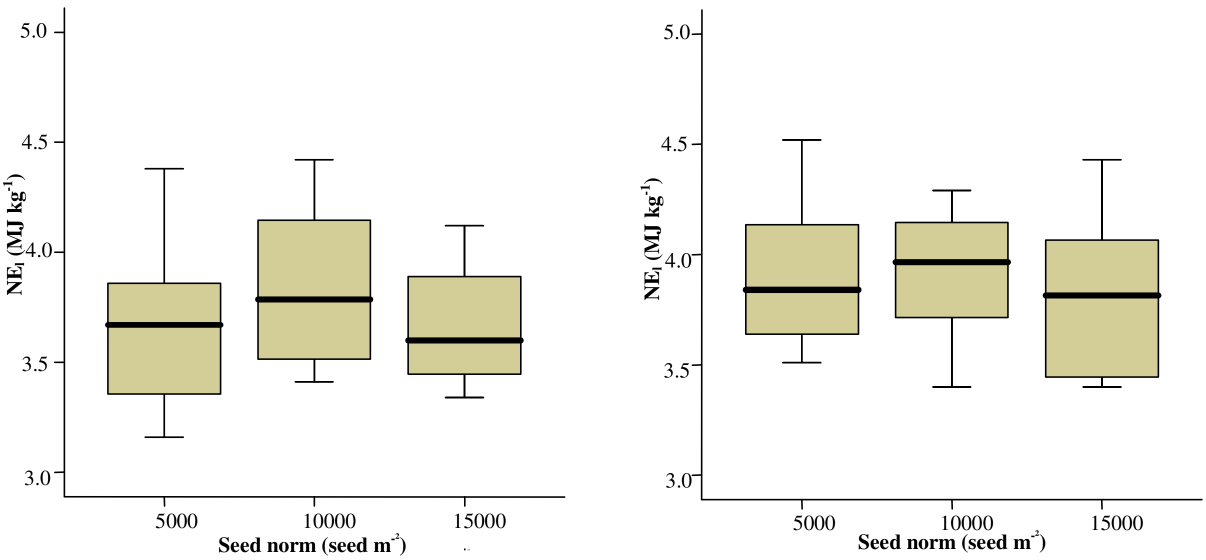
Figure 4: **The DOM of grass established in spring (left) and in autumn (right) according to treatments on a two-year average**



In the present study we examined the net energy of lactation alone. The Tilley and Terry (1963) analysis additionally showed, that the energy values were low (4.10 MJ NE_l kg^{-1}), except in the year 2002 of establishment. The net energy values in our forage varied between 3.46 and 6.01 MJ NE_l kg^{-1}, while in the grass-herb mixture samples, the net energy of lactation value was not significantly higher (3.46 MJ NE_l kg^{-1}) than in the case of grass samples (3.57 MJ NE_l kg^{-1}).

On average, in samples from 2003 and 2004, lower energy values were found in the samples from spring (3.70 MJ NE_l kg^{-1}) compared to the average values from grass established in autumn (3.88 MJ NE_l kg^{-1}). When we look at the treatments in both terms of establishment (in spring 3.84 MJ NE_l kg^{-1}, in autumn 3.92 MJ NE_l kg^{-1}), the highest values were in treatment with medium seed norm (10000 seed m^{-2}) (*Figure 5*). With establishment in spring, in treatment with low seed norm (5000 seed m^{-2}) the value was 3.66 MJ NE_l kg^{-1}, and in treatment with high seed norm (15000 seed m^{-2}) it was 3.58 MJ NE_l kg^{-1}, whilst the same values in autumn were 3.91 and 3.81 MJ NE_l kg^{-1}.

Figure 5: **The net energy of lactation (NE_l) of grass established in spring (left) and in autumn (right) according to treatments on a two-year average**



In the samples of 2004 the highest energy value was found in grass from autumn (3.8 MJ NE_l kg^{-1} in average of treatments), whilst the lowest was in grass-herb mixed crops (3.50 MJ NE_l kg^{-1}). With treatments alone the grass crops were correlated with increased seed norms: 3.63, 3.72 and 3.38 MJ NE_l kg^{-1}, also in spring established but in grass-herb mixture samples: 3.70, 3.57 and 3.10 MJ NE_l kg^{-1}, whilst in autumn established grass: 3.78, 3.70 and 3.83 MJ NE_l kg^{-1}.

The energy content of forage samples showed a similar trend to the digestibility of organic matter. Higher digestibility result an increase in the energy concentration too. A close relationship was found consistently between these two quality parameters in all years and establishment terms.

DISCUSSION AND CONCLUSION

The performance and condition of ruminants is influenced significantly by the nutritive value of feedstuffs, so the data from our research contribute to the opinion of the nutrient supply for the grazing livestock more exactly. The main objective of our research was the analysis of the digestibility of grass which were established with different seed norms and harvested at determined late mowing times. Our results were compared with feed data which were taken from plant communities of an optimal mowing time.

According to Buchgraber and Resch (1997) net energy values of lactation of 6.3-6.5 MJ NE_l kg^{-1} were found in Austria in twice and three time-mowed meadows in an early vegetation stage. This result can reach a value of 7.0 MJ NE_l kg^{-1} in the case of more frequent mowing of more optimal field sites. In the work of Buchgraber and Resch (1997), net energy values were highlighted. Our results showed that the samples from the year of establishment could possibly be used for preserved feed (6.01 MJ NE_l kg^{-1}). The crop from all other years and sowing times did not reach a value of 5.00 MJ NE_l kg^{-1}, but approach a level of 4.4 to 4.5 MJ NE_l kg^{-1}, thus they would not be suitable for preserved feed. In the grass-herb mixtures the net energy of lactation was not significantly higher (3.46 MJ NE_l kg^{-1}) than in the crops of grass alone (3.57 MJ NE_l kg^{-1}). In the spring establishments, there was a lower net energy value of lactation than for establishments in autumn. This could possibly cause by the fact that establishing in spring produces a higher dicotyledonous proportion, resulting in a less significant yield.

From the results of this study it can be concluded the follows: Although regulations for extensively managed grasslands were followed, the feed quality of this grassland containing four different grass species could not be improved by the addition of the given herbs. Therefore, after following the European Union regulations for extensive grassland farming, it was our determination that the examined grassland would be more suitably used at late mowing times for pasture as well as herb gathering, rather than for preserved feed, because the feed value of this late maturity stage grass was not satisfactorily sufficient, either in the grass feed alone or in the grass-herb mixture, for preserved feed.

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