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RELATIVE FEED VALUE OF SWARD FROM PERMANENT DRY MEADOW BEFORE AND AFTER RENOVATION AT DIFFERENT FERTILISATION

Summary

It is possible to obtain much wholesome bulk fodder that meets the requirements of highly productive animals from permanent grasslands of appropriate species composition. Important components of such fodder are: neutral detergent fibres (NDF) and acid detergent fibres (ADF). Based on their content one may calculate digestibility of dry mass (DDM), dry mass intake (DMI) and relative feed value (RFV). Presented studies were performed in the years 2009-2014 on five plots in a long-term experiment situated on a permanent dry ground meadow, that belonged to the Experimental Farm of the ITP in Falenty. In spring 2012 the meadow was renovated through undersowing. Mean values of analysed parameters were similar and more distinct differences were found between cuts and subsequent study years. Mean NDF content ranged between 501 and 567 g kg^{-1} while ADF content – between 265 and 325 g kg^{-1}. Digestibility of analysed sward was lower than optimum and amounted from 60.1 do 63.6 % dry mass. Intake was assessed at 2.12 to 2.48%. Mean values of RFV were in the range of 100 to 120 which placed the fodder in the third and fourth quality class according to Linn and Martin [8].
***Key words**: permanent meadow, undersowing, NDF & ADF content, digestibility*

WZGLĘDNA WARTOŚĆ POKARMOWA RUNI ŁĄKI TRWAŁEJ GRADOWEJ PRZED ORAZ PO RENOWACJI W WARUNKACH ZRÓŻNICOWANEGO NAWOŻENIA

Streszczenie

Na trwałych użytków zielonych o odpowiednim składzie gatunkowym uzyskuje można uzyskać dużą ilość pełnowartościowych pasz objętościowych, spełniających wymogi wysoko produkcyjnych zwierząt. Ważnymi składnikami paszy są włókna neutralno detergentowego (NDF) oraz kwaśno-detergentowego (ADF). Na ich podstawie można wyliczyć strawność (DDM), pobieranie suchej masy (DMI) oraz względna wartość pokarmową (RFV). Omawiane badania prowadzono na pięciu obiektach w latach 2009-2014 na długoletnim doświadczeni zlokalizowanym na łące trwałej gradowej należącej do ZD ITP w Falentach. Wiosną 2012 r. przeprowadzono renowację łąki metodą podsiewu. Średnie wartości badanych parametrów na poszczególnych obiektach były na zbliżonym poziomie, a wyraźniejsze różnice stwierdzono miedzy pokosami oraz kolejnymi latami badań. Średnia zawartość NDF wynosiła od 501-567 g kg^{-1}, natomiast ADF od 265 do 325 g kg^{-1}. Strawność badanej runi była niższa od optymalnej i wynosiła 60,1 do 63,6 % s.m.. Pobierania wyliczono na 2,12 do 2,48 %. Średnie wartości RFV mieściły się w zakresie od 100 do 120, co plasowało ją w III i IV klasie jakości według Linna i Martina [8].
***Słowa kluczowe**: łąka trwała, podsiew, zawartość ADF i NDF, strawność*

1. Introduction

Permanent grasslands may be a source of cheap and high quality fodder for ruminants, unfortunately in Poland their potential is often underutilised. Inappropriate meadows' management leads to their inevitable degradation, which directly translates into the quality of obtained fodder. That issue, also present in organic farms, in a significant way affects yield and quality of crops. Botanical composition, fertilisation and the term of harvesting exert the greatest effect on sward quality [5, 7, 11]. The factors limiting intake, digestibility and energetic value of fodder are cell walls of plants determined as fractions of neutral detergent fibre (NDF) and acid detergent fibre (ADF) [1; 3]. Based on their content one may calculate theoretical digestibility (DDM) (should be at least 65%), dry mass intake (DMI) and relative feed value (RFV). Feed doses of dairy cows should contain up to 25 % NDF and 19% ADF [4]. Literature data suggest that fodder from meadow sward may have much higher content of both of these fractions [2; 10, 12]. There is no available data in present literature that describes the effects of liming and renovation on the content of fibre fractions and relative feed value.

The aim of this study was to estimate the effect of renovation (preceded by liming) at different fertilisation on the content of neutral and acid detergent fibre fractions and relative feed value of meadow sward.

2. Methods

Studies were carried out in the years 2009–2014 on a permanent dry ground meadow that belonged to the Experimental Farm of the Institute of Technology and Life Sciences (ITP) in Falenty (52°08′05.6″N 20°55′14.0″E) in Masovian Voivodeship, Pruszków County, Raszyn Commune.

The experiment was set up in a random block design in four repetitions. Plots had an area of 27 m^2 (4 m x 6.75 m). Meadows were mown three times a year. Five fertilisation variants were applied (tab. 1) using nitrogen in a form of ammonium saltpetre (34,5% N), phosphorus in a form of triple superphosphate (46% P_2O_5), potassium in a form of potassium salt (57% K_2O) and cattle manure, which covered the needs for potassium while those for nitrogen and phosphorus were supplemented with mineral forms.

Table 1. Scheme of fertilisation in experimental variants (in kg·ha^{-1})
Tab. 1. Schemat nawożenia na obiektach doświadczalnych (w kg·ha^{-1})

Element	Objects				
	A	B	C	D	E*
N	60	120	180	240	240
P	10,9	21,8	31,7	43,6	43,6
K	33,2	66,4	99,6	132,8	132,8

* - liquid manure covered needs for potassium, nitrogen and phosphorus were supplemented with mineral form

Source: own work / Źródło: opracowanie własne

Renovation started in autumn 2011 when meadows were sprayed with selective herbicide Starane (1.5 l·ha^{-1}) to eliminate dicotyledon weeds and then limed with carbonate-magnesium lime at a dose of 4 t·ha^{-1}, i.e. 1.44 t CaO·ha^{-1} and 0.4 t MgO·ha^{-1}. In spring 2012, before vegetation period, meadows were undersown the use of grass harrow aggregate (fig. 1) that destroyed about 30% of old turf. Mixtures of grass and legume seeds in amount of 25 kg·ha^{-1} were used for undersowing (tab. 2).

Source: own work / Źródło: opracowanie własne

Fig. 1. Grass harrow aggregate
Rys. 1. Agregat pasmowo gryzujący

Table 2. Composition of the mixture used for undersowing
Tab. 2. Skład mieszanki użytej do podsiewu

Species	Share (%)
Festuca pratensis Huds. (Anturka)	25
Phleum pratense L. (Granolia)	20
Dactylis glomerata L. (Amila)	5
Lolium perenne L. (Flinston)	20
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl & C. Presl (Median)	10
Poa pratensis L. (Skiza)	10
Trifolium pratense L. (Kranta)	10

Source: own work / Źródło: opracowanie własne

Mean air temperature (tab. 3) in the study period was higher then the long-term average. The same as regards mean precipitation in the vegetation season. Annual sums of precipitation (with the exception of the year 2012) also exceeded the long-term values.

The content of NDF and ADF was determined in near infrared (NIRS) with the NIRFlex n-500 apparatus by BUCHI. Obtained results were statistically processed. Polynomial trend lines and R^2 coefficients were calculated. Analysis of variance was performed with the Statistica software. Comparisons of the means and division into homogenous groups were made using HSD Tukey T test at $p \leq 0.05$.

3. Results

The share of grasses in meadow sward (tab. 4) in the years 2009-2010 was estimated at about 95%. In 2011 their share decreased to 80-86% in variants B, C, D and E. The cock's-foot and couch grass were dominating species among grasses. In variants C, D and E they constituted an important component of meadow sward. The common meadow-grass present in all variants was the dominating (31 to 60%) species among low grasses. The next was the perennial rye-grass with percentage share between 4 and 11%. Remarkable share of the red fescue was found in variant A (42-50%) and B (24-32%). Legumes were present in variants A and B only. The common sorrel represented plants from the group of herbs and weeds in the years 2009 and 2010 in all variants**.** Dandelions and the bitter dock were present in variants C, D and E and their share increased in variants B, C, D and E to 14-20% in 2011.

After renovation the share of grasses in meadow sward was 88-97%. In the years following undersowing the share of tall grasses systematically increased mainly due to dynamic growth of the oat-grass. The cock's-foot and couch grass dominated in variants C, D and E. The group was supplemented by the timothy grass and tall fescue. The common meadow grass (19-51%) and perennial ryegrass (6-12%) dominated among low grasses in all variants. Significant share of the red fescue was found in variants A and B. The share of legumes did not exceed 5%. The share of herbs and weeds did not exceed 5%.

Yielding of meadow sward (tab. 5) increased with fertilisation. Variants B, C, D and E gave yields significantly higher than variant A in 2009. In the years 2010-2011 yields from variants C, D and E were significantly higher than that from variant A. After renovation in 2012 variants B, C, D and E yielded significantly more than A and yields from variants D and E were significantly higher than the yield from variant B. In 2013 yields from variants C, D and E were higher than that from A and the yield from D was higher compared with the yield from B. In 2014 variants C, D and E yielded significantly more than variant A and the yields from D and E were also higher than the yield from B.

Table 3. Mean air temperature and precipitation in the years 2011-2012
Tab. 3. Średnia temperatura powietrza i opady w latach 2011-2012

	Period	Multiplicity	Stage I			Stage II		
			2009	2010	2011	2012	2013	2014
Temperature (average)	vegetation season	14,8	15,5	15,8	15,9	16,0	15,6	15,8
	annual	8,7	11,8	12,0	12,0	12,4	11,8	12,8
Precipitation (sum)	vegetation season	334,7	645,3	1026,1	794,8	537,8	713,1	654,3
	annual	541,8	656,0	1050,9	538,1	382,1	474,3	654,3

Source: Weather Station in Falenty / Źródło: Stacja Meteorologiczna w Falenatch

Table 4. Dominating species of meadow plants in particular groups and their share in meadow sward
Tab. 4. Dominujące gatunki roślin łąkowych w poszczególnych grupach i ich udział w runi

Species	Objects														
	N-60			N-120			N-180			N-240			G-240		
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
Dactylis glomerata L.		1	2	1	3	2	7	8	7	15	15	14	35	31	28
Agropyron repens (L.) P. Beauv.				+			9	10	8	15	16	13	17	16	12
∑ high	1	3	4	2	5	5	17	19	17	30	31	28	52	47	41
∑ medium high	+						1						1		
Festuca rubra L. s. s.	50	46	42	32	30	24	6	4	3				+		
Poa pratensis L.	42	45	44	56	52	50	64	61	55	61	58	53	33	37	32
Lolium perenne L.	4	4	4	7	9	7	8	11	8	4	5	4	9	9	7
∑ low	96	95	90	95	91	81	78	76	66	65	63	57	42	46	39
Total grasses	97	98	94	97	96	86	96	95	83	95	94	85	95	93	80
Total legumes	1	+	+	+											
Taraxacum officinale F. H. Wigg.		+				1		1	6		1	3	1	2	10
Rumex obtusifolius L.									+		2	4	3	4	6
Rumex acetosa L.	1	1	3	1	3	11	1	3	11	1	3	7	+	+	3
Total herbs and weeds	2	2	6	1	4	14	1	4	17	2	6	15	5	7	20
Empty spaces				2			3	1		3					
Sum	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
After renovation															
Species	N-60			N-120			N-180			N-240			G-240		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Festuca arundinacea Schreb.	3	2	3	3	2	3	1	+	1	+	1	+	+	+	+
Dactylis glomerata L.	2	3	2	4	5	4	9	10	9	15	8	15	26	26	26
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl & C. Presl	+	4	10	+	5	14	+	6	15	+	6	14	+	7	16
Phleum pratense L.	+	1	2	1	3	4	4	5	6	2	4	5	2	3	3
Agropyron repens (L.) P. Beauv.		+				1	15	13	12	24	10	19	23	19	18
∑ high	7	14	25	10	19	35	31	37	52	43	32	57	51	56	65
∑ medium high	1	0	0	0	0	1	0	0	0	0	1	0	7	0	0
Festuca rubra L. s. s.	37	32	25	24	20	12	3	2	1	+	3	+	+		
Poa pratensis L.	40	39	36	44	46	37	51	46	31	44	47	30	29	31	19
Lolium perenne L.	8	8	7	11	11	9	12	11	9	7	12	6	11	10	7
∑ low	85	79	68	83	77	58	66	59	41	52	62	36	40	41	26
Total grasses	93	93	93	93	96	94	97	96	93	95	95	93	88	97	91
Trifolium pratense L.	2	5	3	2	3	2	1	2	1	+	2	1	+	1	1
Total legumes	2	5	4	2	3	2	1	2	1	+	2	1	+	1	1
Total herbs and weeds	1	2	2	5	1	3	2	2	4	5	3	2	4	2	4
Empty spaces	4		1			1			2			4	8		4
Sum	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: own work / Źródło: opracowanie własne

Table 5. Annual yields of meadow sward
Tab. 5. Roczne plony runi łąkowej

Year	Objects				
	A	B	C	D	E
2009	5,70a	8,01b	9,38b	9,55b	9,98b
2010	7,84a	10,03ab	11,52b	11,45b	11,38b
2011	5,33a	7,80ab	8,35b	8,41b	8,73b
2012	2,96a	4,93b	6,42bc	7,60c	7,33c
2013	6,15a	8,46ab	10,31bc	11,05c	10,64bc
2014	6,99a	9,95ab	11,53bc	13,50c	13,39c

Source: own work / Źródło: opracowanie własne

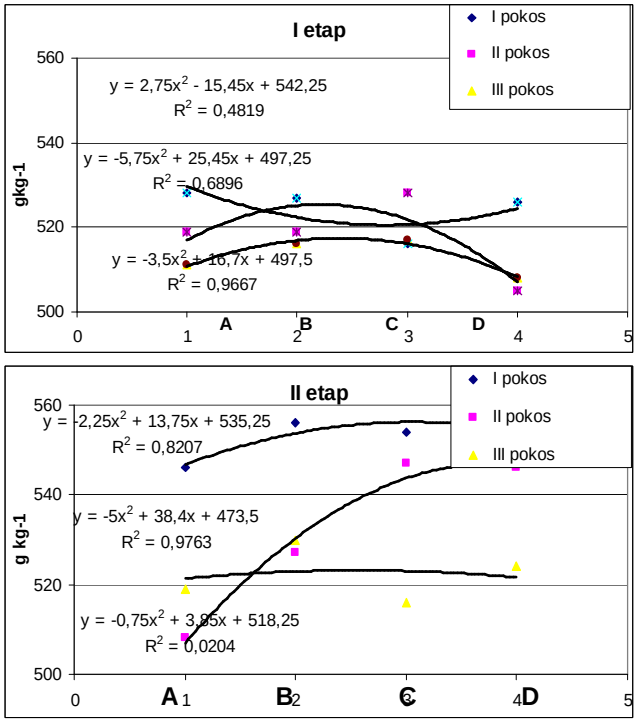
Mean content of NDF (fig. 2) in the first stage of the study was similar in all variants and ranged from 505 to 527 g kg^{-1}. Sward from variants A and D had the lowest content of this fibre fraction. In the second stage of the study the highest content of NDF (546 to 556 g kg^{-1}) was noted in the first cut, in the second cut its content was more variable and ranged from 508 to 547 g kg^{-1}. In the third cut the content of neutral fibre fraction was from 516 to 530 g kg^{-1}.

In the first stage of this study the content of ADF (fig. 3) ranged from 342 to 369 g kg^{-1}. The lowest content was found in sward from variant D irrespective of the cut. In the second stage ADF content was from 332 to362 g kg^{-1}. An increasing trend of ADF content with fertilisation was noted in the first and second cut while in the third cut this relationship was reverse.

The intake of dry mass of meadow sward (tab. 6) calculated from NDF fibre fraction (Tab. 6) ranged from 2.21 to 2.48% (with a mean of 2.31 to 2.34%) in the first stage and from 2.12 to 2.34% (with a mean of 2.22 to 2.29%) in the second stage.

Digestibility calculated from ADF (tab. 6) content was from 60.1 to 62.6% (mean 60.9 to 61.8%) in the first stage and from 60.5 to 63.6% (mean 61.7 to 62.3%) in the second stage.

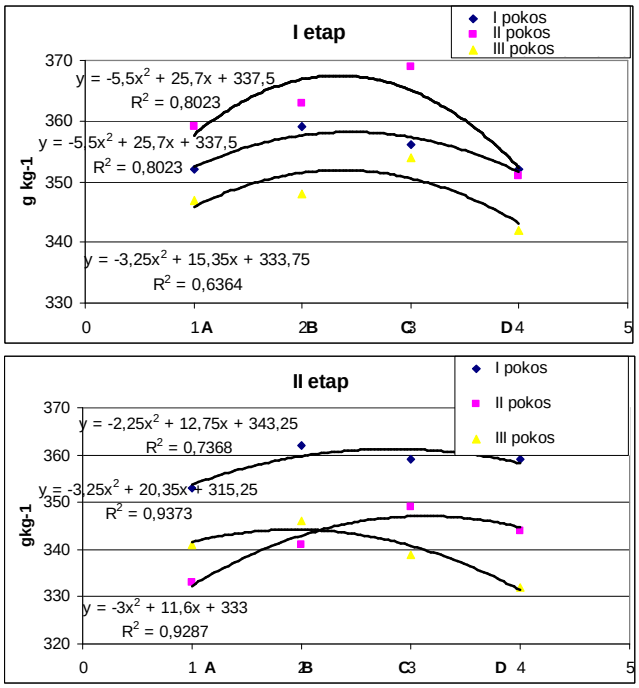
Mean relative feed value (tab. 7) of the analysed sward was 104 to 115 in the first stage of the study and from 100 to 115 in the second stage. The highest RFV values were obtained in 2011 (about 115) and in 2012 (112 – 115). The lowest value of 100 was noted in 2014.



Source: own work / Źródło: opracowanie własne

Fig. 2. The effect of fertilisation on the mean content of NDF in cuts of meadow sward (g kg^{-1} dry mass) in subsequent study periods coefficient of determination

Rys. 2. Wpływ poziomu nawożenia na średnią zawartość NDF w runi łąkowej w pokosach (g kg^{-1} w s.m.) w etapach badań współczynnik determinacji



Source: own work/ Źródło: opracowanie własne

Fig. 3. The effect of fertilisation on the mean content of ADF in cuts of meadow sward (g kg^{-1} dry mass) in subsequent study periods

Rys. 3. Wpływ poziomu nawożenia na średnią zawartość ADF w runi łąkowej w pokosach (g kg^{-1} w s.m.) w etapach badań

Table 6. Calculated intake of dry mass (in %) and digestibility (in %)

Tab. 6. Teoretyczne wyliczone pobieranie suchej masy w % oraz strawność w %

Parameter	Objects	I stage				II stage			
		Year			_ x	Year			_ x
		2009	2010	2011		2012	2013	2014	
DMI	A	2,25	2,33	2,36	2,31	2,34	2,33	2,21	2,29
	B	2,21	2,32	2,39	2,31	2,31	2,26	2,13	2,23
	C	2,23	2,29	2,41	2,31	2,28	2,27	2,13	2,23
	D	2,29	2,34	2,39	2,34	2,28	2,25	2,12	2,22
	F	2,21	2,31	2,48	2,33	2,30	2,23	2,12	2,22
DDM in %	A	61,0	60,9	62,3	61,4	63,4	62,0	61,4	62,3
	B	61,0	60,6	61,8	61,1	63,1	61,4	60,5	61,7
	C	61,0	60,1	61,5	60,9	63,1	61,6	60,5	61,7
	D	61,6	61,3	62,4	61,8	63,4	62,0	60,8	62,1
	F	61,2	60,5	62,6	61,4	63,6	61,6	60,7	62,0

Source: own work / Źródło: opracowanie własne

Table 7. Relative feed value

Tab. 7. Względna wartość pokarmowa

	I stage				II stage			
	year			_ x	year			_ x
	2009	2010	2011		2012	2013	2014	
A	106	110	114	110	115	112	105	111
B	104	109	115	109	113	108	100	107
C	105	107	115	109	112	108	100	107
D	109	111	115	112	112	108	100	107
F	105	108	120	111	114	106	100	106

Source: own work / Źródło: opracowanie własne

4. Discussion

In the first stage of study no significant differences were found in the yielding of sward of degraded meadow in variants fertilised with nitrogen at a dose of 120, 180 and 240 kg ha^{-1}. No response to increased fertilisation was a result of inappropriate species composition of the sward from mown meadow, namely too high share of low grasses and weeds. In the second stage, after undersowing, remarkable impact of fertilisation on yielding was noted.

The content of NDF in particular cuts ranged between 505 and 527 g kg^{-1} in the first stage and from 508 to 556 g kg^{-1} in the second stage. These results are more favourable than those obtained by Jankowska-Huflejt and Wróbel [6] in organic farms (514-616 g·kg^{-1} dry mass) but less favourable than those obtained by Grzelak and Bocian [5] in fodder from permanent meadow (412-501 g·kg^{-1} dry mass). Increasing the share of tall grasses at the expense of low grasses in the second stage increased the content of NDF, which corresponds to result reported by Tomic et al. [13] on a high content of this fibre fraction (636g·kg^{-1} dry mass) in *Dactylis glomerata*.

Mean ADF contents in cuts varied from 342 to 369 g kg^{-1} dry mass in the first stage and from 332 to 362 g kg^{-1} in the second stage of experiment. These values are much higher than those obtained by Grzelak and Bocian [5] (277 to 343 g·kg^{-1} dry mass) but close to results found by Jankowska-Huflejt and Wróbel [6] in organic farms (247 to 484 g·kg^{-1} dry mass).

Mean values of feed intake were 2.2-2.5% of body mass in the first stage and 2.1-2.3% of body mass in the second stage, so close to the values reported by Jankowska (2014) and higher than those obtained in organic farms by Jankowska-Huflejt and Wróbel [6].

Mean digestibility of dry mass of meadow sward from analysed variants was 60.1 to 62.8% in the first stage and from 60.5 to 63.6% in the second stage being much lower than the minimum 65% adopted by Preś [9].

The test of RFV showed that raw fodder material from particular variants, irrespective of the stage of study, fell mainly within the III class (intended for good beef cattle, older heifers and marginally for dairy cows) with the exception of the year 2014, when it fell within the IV class (intended for beef cattle and non-milking dairy cows) in the V-degree scale of Linn-Martin [8]. Our results are similar to those obtained in organic farms by Jankowska-Huflejt and Wróbel [6].

5. Conclusions

1. Renovation of the meadow preceded by liming increased the share of tall grasses and yielding, particularly in variants of the highest rate of fertilisation.
2. Increased share of tall grasses after undersowing increased the content of NDF in the sward from all cuts and most variants irrespective of fertilisation.
3. High fibre content in fodder is mainly an evidence of a too late term of mowing.
4. Performed undersowing did not markedly change the relative feed value of the meadow sward from analysed variants.
5. The effect of fertilisation on relative feed value was negligible, irrespective of the stage of study, which could be a result of a high share of *Poa pratensis* L in analysed variants.
6. An effective way to improve permanent grasslands, also in ecological farms, is over drilling with the use of streaked harrowing aggregate.

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