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The impact of grassland renovation on sward composition and quality under organic farming conditions

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Abstract. The aim of the research carried out in the organic field was the valuation of influence of renovation of sward with legume-grass mixtures on the quality of fodder obtained. The two-factor field experiment was conducted in 2013–2016 in the Agricultural Experimental Station IUNG-PIB Grabów (Mazowieckie voivodeship, Poland). It compares two ways of renovating grassland: A – after ploughing and B – after superficial disturbance of the soil to the depth of 5 cm with a compact harrow, as well as three legume-grass mixtures (Krasula mixture + 3.5 kg of white clover, Cent 4, and original mixture). The field experiment evaluated: dry matter yield, share of legumes and grass species in the sward of mixtures, content of: protein, P, K, Ca, Mg and fiber fraction, relative nutritional value and feed unit for lactation, protein value of dry matter, and the filling units for lactation. The method of renovation of grassland and the species composition of the sward did not affect the quality of the fodder obtained or its energy and filling value. A decrease of sward abundance in total protein under the influence of increasing percentage of grasses in sward of mixtures, was found. Medium-quality fodder was obtained, which in the first year of use was rated as class III and in the following years as class IV of relative feed value.

Keywords: organic system, legume-grass mixtures, grassland renovation

INTRODUCTION

Under the conditions of an organic dairy farm, the cost of fodder production accounted for 84% of direct costs. It was showed that the high share of permanent grassland in the fodder area reduces the production costs of fodder and animal products made on the basis of these feeds (Borecka, Szumiec, 2013). The high level of yield and good quality of fodder from grassland is achieved among other things by proper use and maintenance of legume plants in sward, proper care of sward and reduction of weed infestation which are the main cause of grassland degradation (Isselstein and Kayser, 2015). Harasim and Harasim (2003) believes that a small percentage of legumes and high weed infestation lowers the nutritional quality of permanent grassland sward. Yields and nutritional and feed quality of fodder can be improved by renovation of grassland sward using different methods, among others by applying full cultivation method after ploughing or undersowing of degraded sward (direct sowing) (Barszczewski et al., 2013; Domański, 1999; Isselstein and Kayser, 2015; Mendra, 2017). In our own research, carried out under organic field conditions that compared two methods of sward renovation and three legume grass mixtures, better production effects were obtained after renovation carried out with the simplified method, after surface soil penetration to a depth of 5 cm than after ploughing and full soil cultivation (Gaweł, 2017). It was decided to extend these studies by including a qualitative evaluation of fodder carried out in the first growth of grassland sward renewed with two methods (full and simplified tillage). It was assumed that better quality fodder could be obtained in the case of renovation of grassland using the simplified method (after applying the compact harrow to the surface soil disturbance) than under the full tillage method after ploughing.

The aim of the study was to evaluate the quality of fodder after renovation of grassland sward with the traditional method, after ploughing (treatment A) and with the simplified method, after surface soil disturbance to the depth of 5 cm with a compact disc harrow (treatment B). The study also verified the usefulness of some commercially available legume-grass mixtures for renovation.

MATERIAL AND METHODS

Under organic conditions, at the Agricultural Experimental Station IUNG-PIB Grabów (Mazowieckie voivodeship), a study was carried out on the impact of the renovation of grassland using the full and simplified cultivation

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method on the quality of fodder. For this purpose, in the years 2013–2016, a strict field experiment was set up in a two-factor split-block design. The 1st research factor was two methods of grassland renovation: A – after ploughing + seeding mixtures with a grain sowing machine; B – after surface soil disturbance to the depth of 5 cm with a compact disc harrow + seeding of mixtures with a grain sowing machine. The 2nd research factor was three legume-grass mixtures: K – modified Krasula mixture, C – Cent 4 mixture, and O – original mixture. The exact species composition and proportion of components of mixtures used in the tests: K – perennial ryegrass (25.7%), Italian ryegrass (9.19%), meadow timothy (13.79%), orchard grass (9.19%), red fescue (9.19%), tall fescue (9.19%), blue fescue (4.59%), red clover (4.59%), lucerne (4.59%), bent grass (1.83%), 3.5 kg ha^{-1} white clover (cv. Romena, 8.11%); C – perennial ryegrass (40.0%), Italian ryegrass (10.0%), tall fescue (15.0%), meadow fescue (5.0%), meadow timothy (5.0%), meadow bluegrass (5.0%), festulolium (5.0%), lucerne (10.0%) and white clover (5.0%); O – white clover cv. Barda (10%), hybrid lucerne cv. Radius (20%), red clover cv. Milena (20%), perennial ryegrass cv. Artemis (15%), orchard grass cv. Amila (15%), meadow fescue cv. Anturka (10%), festulolium cv. Agula (10% in pure sowing). Mixtures were sown on June 20th 2013.

Pre-sowing fertilization applied amounted to 1 ha: 90 kg P_2O_5 (phosphate meal) and 70 kg K_2O (potassium sulphate). In the year of sowing, the mixtures were mown twice (mid-August, mid-September). The third sward regrowth, without estimation of yields, was used for one-day grazing to 60 cow herd.

In the spring (last decade of March) of each full production year the mixture was fertilized with bovine manure at a rate of 10 t ha^{-1}, phosphorus (90 kg P_2O_5 ha^{-1}), and potassium (70 kg K_2O ha^{-1}). In the full production years after harvesting of the first swath, potassium fertilization at 30 kg K_2O/ha was applied to the sward.

Botanical-weight analysis was performed in 0.5 kg samples of green fodder taken from each plot during harvest. Green forage of legume-grass mixtures was separated into grasses (all species together), lucerne, clovers (white and meadow) and weeds. The plants were then dried at 60° C and weighed and the percentage of legume-grass mixture components in the sward was calculated.

Chemical analysis of the plant matter

During the harvest of the first sward regrowth, a 0.5 kg sample of green fodder was collected on each plot in order to analyse the chemical composition. Plant material from each of the 3 full utilization years was analysed. After drying the plant material from 4 replications in each treatment was brought together and ground. The dry matter content of mixtures was determined by weight method according to test procedure PB 35.1 - first edition - 10.05. 2013, total nitrogen – flow analysis (CFA) (PB 33.1 - second edition - 05.03.2014), P – flow analysis (CFA) (PB 33.1 - second edition - 05.03.2014), K – atomic emission spectrometry AES (PB 32.1 - second edition - 08.03.2014), Ca and Mg – flame atomic absorption spectrometry (FAAS) (PB 32.1 - second edition - 08.03.2014); while the contents of crude fibre and fibre fraction (Neutral Detergent Fibre – NDF; Acid Detergent Fibre – ADF; Acid Detergent Lignins – ADL) – according to test procedure PB 51.1 - second edition - 01.08.2013. The results of these analyses were used to calculate the energy, protein value and filling units for lactation (according to Jarrige, 1989) and relative nutritional value on the basis of the fibre fraction content in feed (Linn, Martin, 1989).

In the study periodical grazing was used, i.e. some sward regrowths were mowed for haylage, while others were grazed by cows. In the first year of use (2014), the mixture was harvested four times. First and second regrowth were mown for silage, cows were grazed on the other two sward regrowths. In the second and third year of use (2015 and 2016), due to drought, only three sward regrowths were harvested, and before winter grazing of cows was carried out without estimation of yields. In these years the first regrowth was cut, the next ones were grazed to cows.

Statistical analysis

For comparison of the content of total protein, crude fibre in mixtures, digestibility of organic mass, content of neutral and acid detergent fibre (NDF, ADF and ADL), as well as relative nutritional value, the analysis of variance was applied. Calculations were performed in the program Statistica (Stat Soft Inc., USA). The Tukey's test ($P \leq 0.05$) compared the mean values for the factors tested in the field experiment; the 1st factor – two methods of grassland renovation; the 2nd factor – three legume-grass mixtures.

Weather conditions in vegetation seasons of the study years

Weather conditions changed during the experiment. In 2013, 2015 and 2016, total rainfall in growing period was 395.6 mm; 387.1 mm and 352.7 mm respectively and were lower than the mean monthly multiannual average for the Agricultural Experimental Station of the Institute of Soil Science and Plant Cultivation in Grabów (408 mm). In the year of sowing (2013), the legume-grass mixtures were sown in June, after previous heavy rainfall, so emergence and initial development of plants proceeded in good humidity conditions. In the following year (2014), the rainfall was 574.2 mm and far exceeded the average rainfall of long-term average. In 2015 and 2016 there was a significant shortage of rainfall compared to the average rainfall of long-term average, after harvest the plants regrew more slowly, so in these years only three harvests were carried out each season, and the last sward regrowth was grazed to cows (without estimating the yield and botanical and weight analyzing). According to Grabarczyk (1989) in Poland, the optimal annual rainfall should be between 420 mm and 450 mm for pastures. Considering the results obtained by this author, it is concluded that good humidity conditions for the renewed sward occurred only in 2014. In the remaining years of the study, soil moisture deficiency was observed, and the driest was 2016.

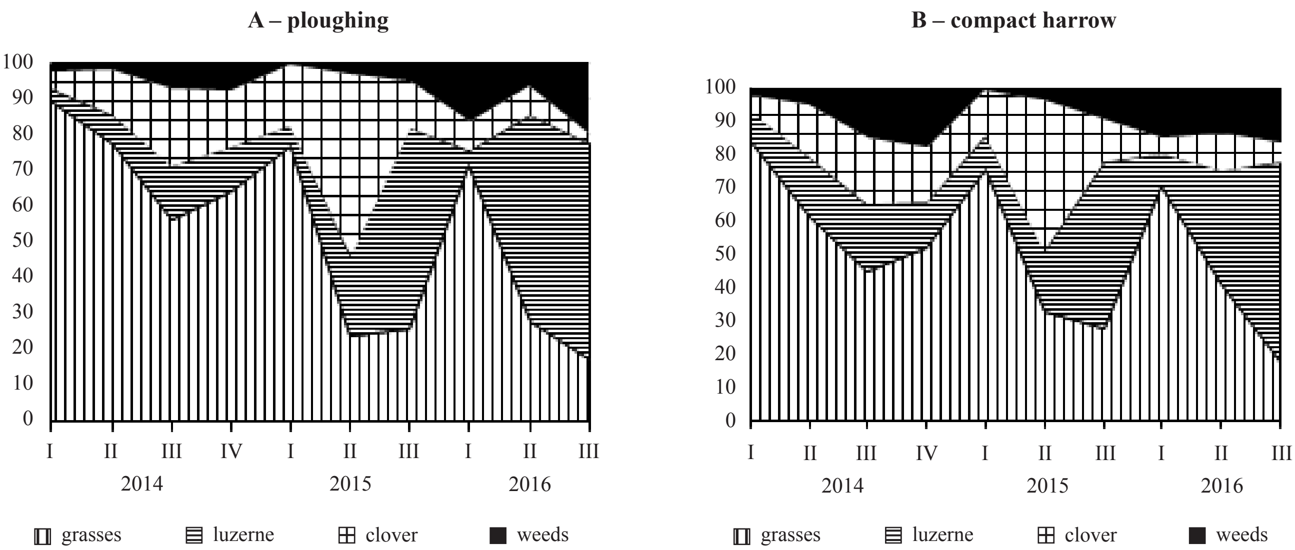
RESULTS AND DISCUSSION

Percentage of mixtures components in the sward

In the first production year of the mixture (2014), grasses dominated in the ploughing treatment (A) and compact harrow treatment (B), approaching 84 and 89% of plants. In this period in treatment A clover was slightly more numerous than lucerne (Fig. 1). However, in the first year after renovation with compact harrow (treatment B), there were more lucerne than clovers in the first, second and third regrowth (Fig. 1). In combination with the renovation of grassland using the full tillage method (treatment A), weed infestation in the two first production years was smaller than in the case of the compact harrow treatment (B). It is likely that soil disturbance with the compact harrow (treatment B) did not destroy all the dicotyledonous herbs and weeds. This could have contributed to a higher weed infestation of the sward on this research treatment. After the renovation of the sward with ploughing (treatment A) and using the compact harrow (treatment B), weed infestation increased in summer and autumn. However, at the end of the growing season in the third year of use, lucerne was the dominant species in the sward (Fig. 1).

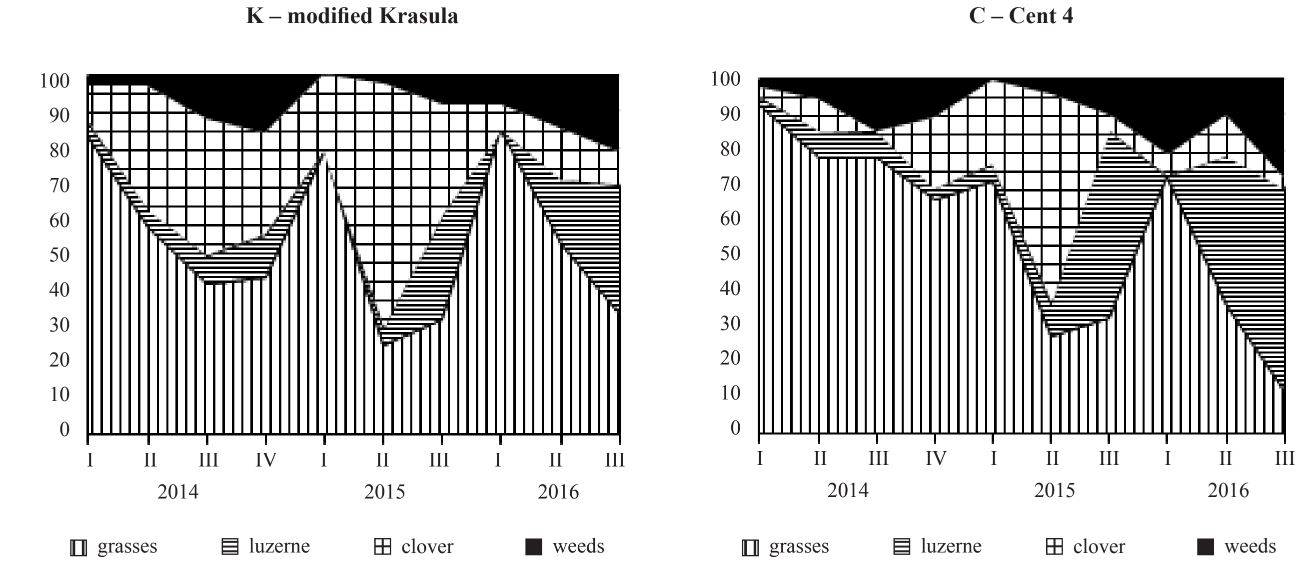
Species composition and weather conditions influenced the proportions of components in the sward of legume-grass mixtures (Fig. 2). In the spring of each year of use, grasses dominated in the sward of the compared mixtures. In summer and autumn, under unfavourable humidity conditions (July and August in 2013, September 2014. June, July, August and September 2015, August and September 2016), they receded from the sward, and their place was taken by legumes and weeds. In the first and second year of use (2014 and 2015), in modified Krasula mixture and Cent 4, there were more clovers than lucerne plants in the sward (Fig. 2). In the following year, the proportions of components changed and the dominant species in the sward was lucerne. In the case of the Original mixture, from the first year of use, lucerne dominated in the legume fraction. In the third production year, there were more legume plants than grasses in the sward of the compared mixtures (Fig. 2).

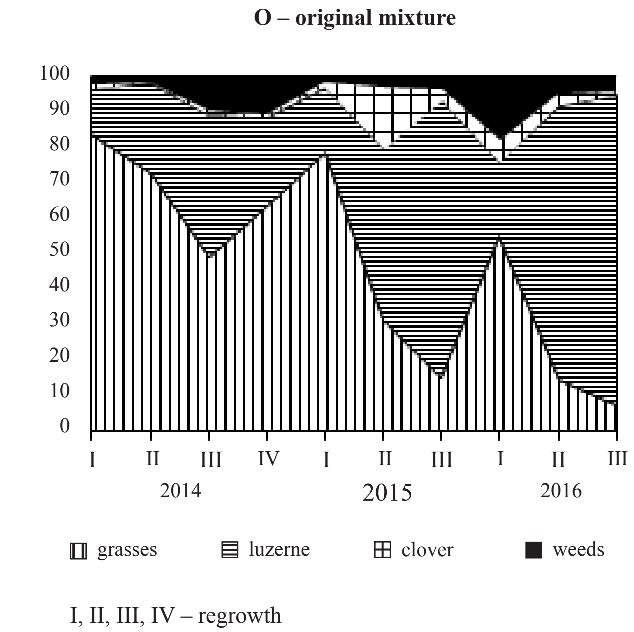
Other authors also reported dynamic changes in the botanical composition of sward and the dominance of grasses in the first period after renovation. Barszczewski et al. (2013) observed the largest share of grasses in the sward in the first year after renovation, in the following years the share of meadow clover increased, and its largest share in the sward was recorded in the third year after renovation. In contrast, Mendra (2017) observed a decrease in the share of high grasses in sward in subsequent years after renovation in favor of low grasses.



I, II, III, IV – regrowth

Figure 1. The percentage of components in the dry matter yield depending on the method of mixture sowing in the years 2014–2016.





Mixture composition

K – modified Krasula: perennial ryegrass (25.7%), Italian ryegrass (9.19%), meadow timothy (13.79%), orchard grass (9.19%), red fescue (9.19%), tall fescue (9.19%), blue fescue (4.59%), red clover (4.59%), lucerne (4.59%), bent grass (1.83%) + 3,5 kg ha^{-1} white clover (cv. Romena, 8.11%)

C – Cent 4: perennial ryegrass (40.0%), Italian ryegrass (10.0%), tall fescue (15.0%), meadow fescue (5.0%), meadow timothy (5.0%), meadow bluegrass (5.0%), festulolium (5.0%), lucerne (10.0%) and white clover (5.0%);

O – original mixture: white clover cv. Barda (10%), hybrid lucerne cv. Radius (20%), red clover cv. Milena (20%) (legumes accounting for 50% in total), perennial ryegrass cv. Artemis (15%), orchard grass cv. Amila (15%), meadow fescue cv. Anturka (10%), festulolium cv. Agula 10% in pure sowing.

Figure 2. The percentage of components in the dry mater yield depending on species composition of mixtures in the years 2014–2016.

Content of organic components and relative nutritional value

Feed obtained during the three-year period of use of the sward of mixtures was characterized by a low content of total protein (Table 1). It was 2.0 and 2.5 times smaller than that obtained in the first regrowth of multi-species mixtures in other studies by the first author (Gaweł, 2009a; Gaweł, 2009b) and in the sward of ecological continuous pasture under difficult conditions of the Austrian Alps (Starz et al., 2011). It was found that 12% of total protein content in sward is the lower limit necessary in the production of milk and beef livestock, while the content higher than 18% was considered harmful and causing diseases in animals, such as fertility reduction (Domański, 1999). The compared methods of grassland renovation after ploughing (treatment A) and after compact harrow (treatment B), as well as the species composition of mixtures, had no significant effect on the total protein content in the renovated sward. In the conditions of sward renovation by sur-

Table 1. Content of organic components and digestibility of feed [g kg^{-1} d.m.].

Treatment	Total protein			Crude fibre			Digestibility of organic mass		
	Production year								
	I	II	III	I	II	III	I	II	III
Applied renovation method									
A – ploughing	76.2	101.1	108.3	305.8	303.4	295.0	716.4	689.8	600.4
B – compact harrow	85.5	87.4	129.2	313.0	322.9	305.0	716.1	712.2	506.9
Legume-grass mixtures									
K – modified Krasula	82.3	101.0	134.4	312.1	309.6	297.0	716.9	713.0	505.1
C – Cent 4	80.2	104.5	103.1	308.3	312.4	311.0	715.7	678.0	657.9
O – original mixture	80.0	77.2	118.8	308.5	317.4	292.0	716.1	711.5	497.9

K, C, O – see Fig. 2.
I – 2014, II – 2015, III – 2016

face soil disturbance to the depth of 5 cm (treatment B), a tendency to a greater abundance of sward in protein was observed than in the case of renovation after ploughing (treatment A). The close relationship between high protein content and high percentage of legumes in sward was described in other studies by Gaweł (2008) and Ścibior and Magnuszewska (1999). The research of Elgersma et al. (2000), Elgersma and Søegaaed (2018) and Lemaire et al. (2008) shows that in the chemical composition of legume plants there is more nitrogen and total protein than in grasses, which is why in the first research swath characterized by a high proportion of grasses (Figs. 1 and 2) a low protein content was found.

Many factors influence the nutritional quality of the mixtures, including the development stage and mowing date, the date of the first cut, the intensity of mowing (Mastalerczuk, 2007) and a share of legume plants in the grassland sward (Elgersma, Søegaaed, 2016; Elgersma, Søegaaed, 2018). The research results showed a lower nutritional value of the sward of mixtures collected in the first cut compared to the subsequent ones (Gaweł, 2008; Sosnowski, Jankowski, 2013; Wróbel, 2012).

According to Brzóska (2003), the optimal crude fiber content in forage green fodder should be 160–200 g kg^{-1} of dry matter, while the permissible concentration of this ingredient in ruminant feed should not exceed 280 g kg^{-1}. In our experiment a higher-than-optimal concentration of crude fiber was found in dry matter, and it was similar for the compared restoration methods (treatments A and B) and mixtures (Table 1).

During the three-year period of the study, the factors compared in the experiment did not significantly affect the digestibility of organic matter (Table 1). The highest digestibility was recorded in the first year and the lowest in the third full production year, when the lignin (ADL) content was highest (Table 2). In the case of fodder plants, dry matter digestibility ranged between 50 and 80% (Falkowski et al., 2000). The level of lignin content in plant cell walls increased in subsequent years, and its highest concentration was recorded in the third production year, which significantly reduced the digestibility of organic matter in this period. The digestibility is affected, among others, by the development stage, whereas further regrowths of the sward of mixtures are characterized by a higher value of this parameter (Gaweł, 2012). In the case of grasses, the first sward regrowth is characterized by the lowest dry matter digestibility, as at this time, they produce the highest number of generative shoots, therefore the fodder obtained in this period shows a high lignin content. Qualitative analyses in our research were carried out in the first regrowth

Table 2. Content [g kg^{-1} d.m.] of neutral and acid detergent fiber (NDF, ADF, ADL).

Treatment	NDF			ADF			ADL		
	Production year								
	I	II	III	I	II	III	I	II	III
Applied renovation method									
A – ploughing	595.3	662.8	612.7	329.8	412.1	385.0	35.17	62.40	68.67
B – compact harrow	578.7	674.5	588.7	326.2	422.2	354.3	32.53	59.70	58.67
Legume-grass mixtures									
K – modified Krasula	595.2	684.9	589.5	328.0	431.9	374.5	32.05	64.30	65.00
C – Cent 4	598.4	670.6	608.0	326.0	409.5	367.5	29,15	58.20	63.50
O – original mixture	567.6	650.4	604.5	329.2	409.7	367.0	40.35	60.60	62.50

K, C, O – see Fig. 2
I – 2014, II – 2015, III – 2016
NDF – neutral fiber fractions, ADF – acid fiber fractions, ADL – lignin fraction

of mixture sward dominated by grass, which resulted in obtaining low nutritional value of the feed. A similar negative effect of a high proportion of ADL fiber fraction on the digestibility of organic mass has been stated earlier by Elgersma and Søegaard (2016).

Feed intake, digestibility and energy value depend on the structure of cell walls and cell interior content, while the main factors limiting the consumption of dry matter by cattle are NDF and ADF fibre fractions (Brzóska, Śliwiński, 2011a; Brzóska, Śliwiński, 2011b). In own studies, the method of grassland restoration and the species composition of mixtures did not significantly affect the content of neutral and acid fiber fraction or lignin fraction in the dry matter of mixtures (Table 2). The content of NDF and ADF in the sward increased in the second production year, while the concentration of lignin – almost in each year. The results correspond to those published by Jankowska-Huflejt and Wróbel (2008) but they not confirm the decrease in NDF and NDF content in the dry matter of the sward under soil moisture deficiency and the dominance of legume plants in the grassland sward (Elgersma, Søegaaed, 2016; Elgersma, Søegaaed, 2018). Mendra (2017) found no effect of various renovation methods on NDF content in grassland sward. Before renovation, the sward's content of this organic component ranged from 505 to 527 g kg^{-1}, and was close to that obtained after renovation and was between 508 and 556 g kg^{-1}. In our own research, the NDF content in the dry mass of sward was or greater than that obtained by Mendra (2017). The content of NDF and ADF in the feed exceeded that obtained by Grzelak and Bocian (2009) for the first swath of ecological meadows in the area protected under NATURA 2000.

Under the conditions of full tillage (treatment A) and undersowing of the sward after surface soil disturbance with the compact harrow (treatment B), the relative nutritional value of the fodder was found to be similar (Table 3). There was also no significant impact of the mixture to be undersown on this research parameter. The highest relative value of feed calculated according to the Linn and Martin method (1989) was recorded for feed collected in the first production year (2014) (Table 3). It was included into the 3rd (III) quality class with a recommendation for feeding good beef cattle, older heifers, and marginally dairy cows. Mendra (2017) also obtained a similar relative nutritional value. In the second and third production year (2015 and 2016), the produced feed can be fed to beef cattle or dried dairy cows as the relative nutritional value calculated for the sward of mixtures in this period was classified to the 4th (IV) quality class (Jeranyama, Garcia, 2004; Linn, Martin, 1989). In other studies, Jankowska-Huflejt and Wróbel (2008) obtained the best relative nutritional value for pasture herbage in comparison with meadow green fodder and silage and the lowest for meadow hay (mainly because the pasture was additionally fertilized with excrements left by animals). However, in the experiments carried out by Sosnowski and Jankowski (2013) under mineral nitrogen fertilization, the highest relative nutritional value of sward was obtained in the first cut in comparison with the subsequent cuts.

Table. 3. Relative nutritional value (RFV).

Treatment	Production year		
	I	II	III
Applied renovation method			
A – ploughing	107.2	89.5	90.0
B – compact harrow	111.4	87.8	97.2
Legume-grass mixtures			
K – modified Krasula	107.6	86.2	94.7
C – Cent 4	107.1	88.9	92.5
O – original mixture	113.1	90.9	93.7

K, C, O – see table 1
I – 2014, II – 2015, III – 2016

Mineral composition of the sward

In a good quality sward, the optimal nutrient content should be about 20 g kg^{-1} nitrogen, 3 g kg^{-1} phosphorus, 17 g kg^{-1} potassium, 2 g kg^{-1} magnesium, 7 g kg^{-1} calcium, and 1.5–2.5 g kg^{-1} sodium (Falkowski et al., 2000). The optimum phosphorus content for cattle was obtained only in the third production year of the mixtures (Table 4). The tested factors did not have a significant influence on phosphorus concentration in legume-grass mixtures. It is known from the literature that the high concentration of phosphorus characterize plants harvested at early development stages, e.g. in the growing stage, or is connected with intensive use of sward (Falkowski et al., 2000; Gaweł, 2009b). In our experiment plants were cut at more advanced development stage, which could have contributed to low phosphorus concentration in the sward (Table 4). Another reason for low phosphorus concentration in the sward of these mixtures could be the low soil abundance in this component, due to restrictions imposed on sward fertilization under ecological conditions.

In the first production year, the potassium content significantly exceeded the optimal value of 17 g kg^{-1} of dry matter, while in the following years, it was lower than the optimal value (Table 4). There was no effect of the method of grassland renovation and species composition of grass-legume mixtures on the abundance of this macroelement in the sward. The decrease in potassium content in the second and third production year was probably related to the deficit of soil moisture described in the previous study (Gaweł, 2017).

The studied factors had no significant influence on calcium concentration in the sward (Table 4). In some research treatments, calcium content of the sward was higher than optimal for ruminants (7 g kg^{-1} of dry matter).

Table 4. Content of P, K, Ca and Mg [g kg^{-1} d.m.] in legume-grass mixtures.

Treatment	P			K			Ca			Mg		
	Production year											
	I	II	III	I	II	III	I	II	III	I	II	III
Applied renovation method												
A – ploughing	2.37	2.70	3.07	18.0	12.2	16.7	7.2	10.3	6.43	2.0	2.6	2.1
B – compact harrow	2.63	1.04	3.30	21.9	13.9	20.0	8.0	7.4	8.1	2.2	2.2	2.2
Legume-grass mixtures												
K – modified Krasula	2.45	2.60	3.15	22.0	13.4	23.0	7.8	9.0	7.6	2.2	2.4	2.2
C – Cent 4	2.60	1.67	3.35	19.6	12.9	15.0	6.3	8.8	6.5	1.8	2.2	2.1
O – original mixture	2.45	1.33	3.05	18.3	12.9	17.0	8.7	8.8	7.7	2.4	2.5	2.2

K, C, O – see Fig. 2.
I – 2014, II – 2015, III – 2016

Table 5. Energy content (UFL – feed unit for lactation in 1 kg d.m.), protein value (PDI – protein digested in small intestine – g kg^{-1} d.m.) and the filling units for lactation (LFU in 1 kg d.m.) of legume-grass mixtures.

Treatment	UFL			PDI			LFU		
	Production year								
	I	II	III	I	II	III	I	II	III
Applied renovation method									
A – ploughing	0.94	0.91	0.68	15.68 **a**	21.07	24.37	0.87	0.68	0.99
B – compact harrow	0.94	0.94	0.72	18.08 **b**	18.26	29.05	0.78	0.69	0.84
Legumes grass mixtures									
K – modified Krasula	0.95	0.94	0.73	16.72 a	21.08	30.21	0.78	0.64	0.83
C – Cent 4	0.94	0.89	0.69	16.99 a	21.77	23.18	0.79	0.77	0.94
O – original mixture	0.95	0.94	0.68	16.93 a	16.16	26.72	0.90	0.65	0.98

K, C, O – see Fig. 2.
a, b – the values marked with different letters differ significantly
I – 2014, II – 2015, III – 2016

Magnesium concentration in the sward changed over the production years and was generally close to the optimal content of 2 g kg^{-1} of dry matter (Falkowski et al., 2000) (Table 4). The examined factors did not have a significant impact on the sward's magnesium content. A high concentration of calcium and magnesium in the sward is usually associated with a high proportion of legumes in mixtures that contain more of these components than grasses (Gaweł, 2009a, Gaweł, 2009b).

Nutritional value of legume-grass mixtures

The method of grassland renovation and the selection of mixtures for undersowing did not have a significant impact on the energy value of fodder calculated for the first cut of the sward (Table 5). High quality forage according to Zarudzki et al., (2000) should be characterized by energy value of fodder higher than 1.06 expressed in milk production units (UFL). Feed obtained in our study had a low energy value. It probably resulted from the harvesting of sward at the beginning of grass earing (late harvest). The nutritional value tables show a decrease in the nutritional value of grassland sward as the harvest was delayed to more advanced stages of plant development (Jarrige, 1989). In the following production years, a decrease in the energy value of dry matter of mixtures was noted.

In the first full production year, a significantly higher protein value of fodder (PDI) was obtained for the renovated treatment after soil disturbance to the depth of 5 cm with a compact disc harrow (treatment B) than on the treatment renovated with the full tillage method (treatment A) (Table 5). This resulted from a higher percentage of lucerne and a higher weed infestation in this research treatment than in the treatment after ploughing (treatment A). In the other production years, a similar PDI value was obtained in the compared methods of grassland renovation. The species composition of mixtures did not differentiate PDI. It was increased by the growing percentage of legumes in the sward of mixtures in the subsequent years (Table 5). The calculated PDI for the compared methods of grassland renovation and mixtures turned out to be much lower than that described in the literature (Gaweł, 2008; Gaweł, 2012).

The method of renovation and selection of species for undersowing of the mixture sward had no significant impact on the feed filling value (LFU) (Table 5). Previously, a higher filling value of mixtures with lucerne than with meadow clover (Gaweł, 2012) was found, whereas the greatest value was recorded in the third production year. The tables of feed nutritional value show that the higher feed filling value is related to the advanced developmental stages of plants (Jarrige, 1989). Gaweł and Nędzi (2014) drew attention to the decrease in the filling value of grazing carried out in the early stages of the development of legume and grass sward. According to Granskoop and Bohnert (2006), obtaining a low filling value in the pasture conditions makes it necessary to increase the area of plots in order to provide the animals with an adequate amount of feed covering their living and production needs.

CONCLUSIONS

1. Under organic conditions, the quality of fodder of the first sward regrowth of mixtures with a predominance of grasses, after the renovation of the sward with the ploughing method and after the surface disturbance of the soil to the depth of 5 cm, was similar. Similar fodder quality of tested mixtures indicates their equal suitability for grassland renovation.
2. Feed obtained after the renovation of grassland was generally characterized by a lower than optimal total protein, higher concentration of crude fiber, and worsening organic matter digestibility over production years as a result of an increasing amount of lignin in the feed.
3. Due to higher concentration of total protein and significantly larger protein digested in the small intestine (PDI), it is advisable to renovate grassland using a simplified method, after surface disturbance of the soil to a depth of 5 cm rather than to use the traditional approach that involves renovation after ploughing.
4. The method of sward renovation and the species composition of the mixtures did not affect the concentration of macroelements in the first regrowth. The abundance of dry matter in P and Mg was similar to the optimum one, regardless of the factors studied, while the content of K (in the first and third years of use) and Ca exceeded the recommended standard concentration for cattle.
5. In the compared methods of grassland restoration (after ploughing – treatment A and the simplified method after moving the soil to the depth of 5 cm – treatment B), regardless of the species composition of the mixtures, the energy, protein (in the second and third years) and filling values of the fodder were similar.
6. Testing for quality identified the feed obtained in the first production year to rate as class III in terms of relative nutritional value intended for feeding good beef cattle, older heifers, and sporadically, for feeding dairy cows. Deteriorating relative nutritional value of fodder in subsequent production years (class IV) makes it suitable to be used in the feeding of beef cattle and dry dairy cows.

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