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EFFECT OF FREQUENCY AT WHICH HERBAGE LEFT UNGRAZED BY COWS IS CUT ON THE FEED VALUE OF THE LEGUME-GRASS SWARD UNDER ORGANIC MANAGEMENT

Summary

The aim of the study carried out on an organically farmed field was to estimate the impact of pasture management that included cutting of ungrazed plants on the feeding value of a mixed legume-grass sward. The feeding value of the mixture was assessed in a single-factor experiment which comprised 4 dates on which ungrazed plants were cut (left uncut, cut after the 1st grazing event, cut after the last grazing event, cut after each grazing event). Failure to mow ungrazed plants was found to have a negative impact on forage quality, to lower its energy content and protein value, decrease digestibility, increase filling value and fiber content of fodder. It also promoted weed infestation of the sward and increased the percentage of aged vegetation which is of little use in cattle feeding. In order to obtain a good quality sward of a legume-grass mixture it is necessary to cut the uneaten plants at least once during the grazing season.
***Key words**: organic farming, legume-grass mixture, grazing, feed value*

WPŁYW CZĘSTOŚCI KOSZENIA NIEDOJADÓW NA WARTOŚĆ POKARMOWĄ RUNI PASTWISKOWEJ BOBOWATYCH DROBNONASIENNYCH Z TRAWAMI W WARUNKACH EKOLOGICZNYCH

Streszczenie

Celem badań zrealizowanych na polu ekologicznym była ocena wpływu pielęgnacji pastwiska polegająca na koszeniu niedojadów na wartość pokarmową runi bobowatych drobnonasiennych z trawami. Wartość pokarmową mieszanki oceniono w doświadczeniu dwuczynnikowym, gdzie pierwszym czynnikiem były 4 terminy koszenia niedojadów (bez koszenia niedojadów; *koszenie niedojadów po 1 wypasie; koszenie niedojadów po ostatnim wypasie; koszenie niedojadów po każdym wypasie a drugim wypasy runi). Stwierdzono, że zaniechanie koszenia niedojadów niekorzystnie wpływa na jakości paszy, obniża wartość energetyczną, białkową i strawność paszy, zwiększa wartość wypełnieniową i zawartość włókna w paszy. Ponadto prowadzi do nadmiernego zachwaszczenia runi oraz nagromadzenia w niej pozostałości starej roślinności mało przydatnej w żywieniu krów. Uzyskanie dobrej jakości runi pastwiskowej z bobowatych drobnonasiennych z trawami zapewnia co najmniej jednorazowe w sezonie wegetacyjnym koszenie niedojadów.*
***Słowa kluczowe**: warunki ekologiczne, mieszanki bobowatych drobnonasiennych z trawami, wypas, wartość pokarmowa*

1. Introduction

Animals graze on pasture herbage selectively guided by their preferential feeding habits. They roam from place to place on the pasture in search of good, dense and uniformly tall and quality herbage [1]. For that reason some areas of the sward are trampled down and destroyed during grazing. Such sites are avoided by the animals and left uneaten or leniently eaten. In swards which contain perennial, low-fiber legumes such as white clover the weight of uneaten plant residues usually accounts for up to 20 and sometimes 30% of the sward [2] and is lower compared to that on short-term leys with lucerne and red clover [3, 4, 5]. The failure to cut clumps of uneaten plants in the lucerne-grass and red-clover grass swards or their single removal toward the end of the growing season resulted in an inferior utilization of the next season's crop by the cattle because of the accumulation of aged plants and weeds in the sward [5]. In another study yield losses, reduction in sward persistence and an increase in direct costs for biomass production were reported as related to cutting of uneaten plants [6, 7]. The investigators' recommendation to the farmers was either to refrain from the practice altogether or to limit it to permanent grassland. In this connection, the question arises whether the cutting of uneaten tufts of the sward will have an impact on the feeding value of perennial legume-grass mixtures. Mowing of uneaten plants causes the direct costs to increase since additional inputs are involved: fuel, use of farm machinery and labour?

To address that issue an experiment was set up aimed at assessing the effect of the frequency at which clumps of uneaten herbage were mowed on the feeding value of small-seed legumes with grasses grown under organic management.

2. Material and methods

The study was conducted on an organically-managed temporary grassland of the IUNG-PIB Agricultural Experiment Farm at the village of Grabów (province of

Mazowieckie, 51°21'N; 21°40'E) on a silt loam in the years 2009-2012. A single-factor experiment was set up on a temporary pasture ley of 0.3 ha that involved plots laid out as a mirror reflection design, each 60 m^2 in size and replicated 4 times. Experiment treatments comprised 4 dates on which ungrazed plants were cut (left uncut, cut after the 1st grazing event, cut after the last grazing event, cut after each grazing event). The sward of *Trifolium pratense* (25%)+*Medicago x varia* (25%)+*Lolium perenne* (20%)+*Dactylis glomerata* (10%)+*Festuca pratensis* (10%)+*Phleum pratense* (10%) as well as major weed species – *Taraxacum officinale* F. H. Wigg, *Chenopodium album* (L.), *Capsella bursa pastoris* (L.) Medik., *Plantago major* L., *Stellaria media* (L.) Vill., *Achilleas spec*. L was grazed by a herd of commercially raised cows (56 head livestock unit).

The mixture was sown at a seeding rate of 32 kg ha^{-1} in the spring of 2009 and the turf was was mowed at e height of ca 7 cm on June 23 and July 21, 2009 to suppress weeds and the cut herbage was raked up and removed from the field. In the sowing year, in the first half of October 56 cows were grazed on the experiment sward. In the sowing year and in the production years there was a three-day long grazing event in each grazing session. In the first and second production years there were 4 grazing sessions, each lasting 3 days, which translates to 12 days of grazing in the growing season.

The animals had an access to the entire pasture area on which the experiment plots were established. Once the 3-day grazing was finished the sward was fertilized with rock phosphate meal at 93 kg $P \cdot ha^{-1}$ and with potassium sulphate at 70 kg $K \cdot ha^{-1}$. In October of 2011, at the end of the grazing season composted farmyard manure at 18 t ha^{-1} together with mineral fertilizers was added to the sward. P K fertilizers were applied jointly at a single passage of the tractor.

Over the three-year period the sward was grazed in 11 foraging sessions by a herd of approximately 70 cows, 4 sessions in the first and second years and three sessions in the third year. A detailed description of weather conditions and of their impact on the sward was given in another study by the author (5). Fresh matter yield was determined on herbage samples taken by a forage harvester from an area of 72 m^2 before each grazing event. Yield of uneaten herbage was measured on each plot after grazing was finished. Uneaten plants were mowed at 5 – 6 cm as soon as the grazing was finished, each time in a different part of the plot. Forage fresh matter ingested by cows is calculated based on the difference between the yield of herbage measured before grazing and the weight of uneaten plants. The coefficient of pasture utilization is calculated on 1 ha basis as fresh forage weight ingested by cows /herbage yield x 100. Before each grazing event two samples of forage of 0.5 kg each were collected from each plot and analyzed for the botanical composition of the sward and for chemical constituents in order to calculate feed value of fodder. Winwar ver. 1.3 [8] software package was used to calculate energy content as milk feeding units (UFL), protein value digestible in the intestine (PDI) and filling value units for lactation (LFU) according to the INRA system. The calculations were made on a dry matter basis.

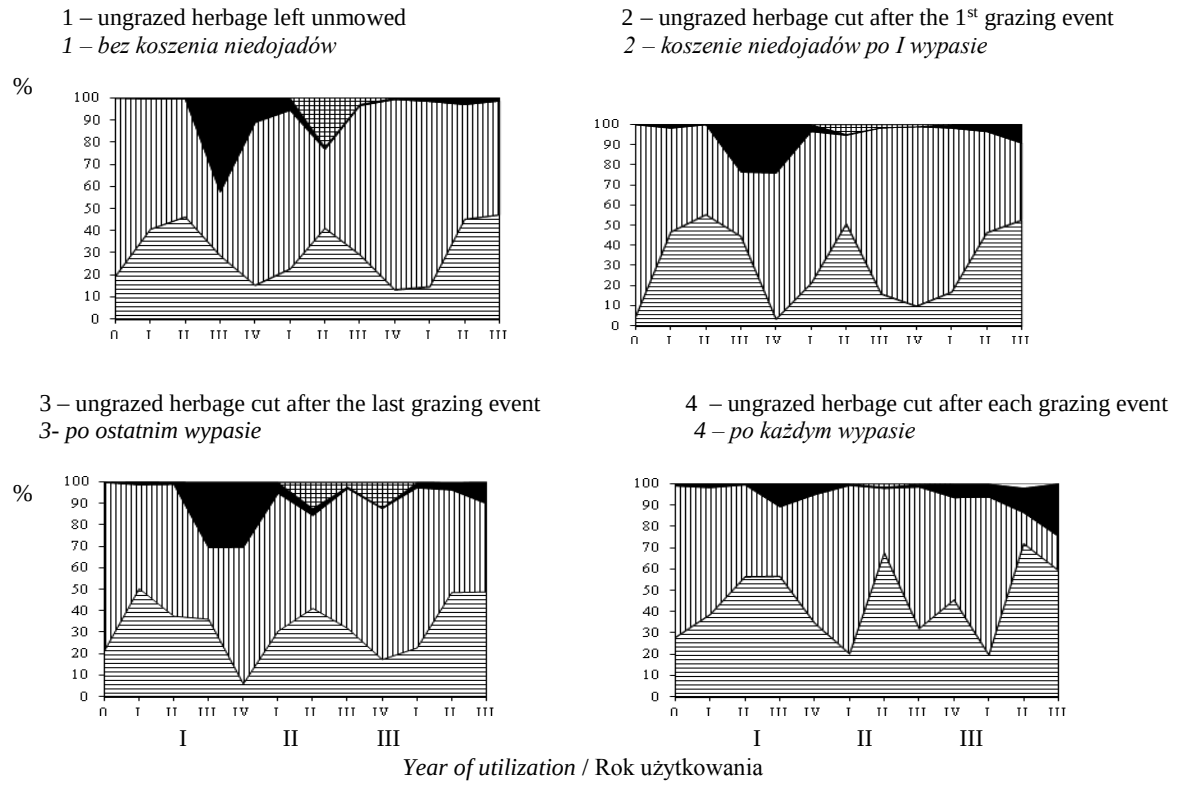
The results were subjected to two-way ANOVA with cutting dates of uneaten forage as factor 1 and grazing events as factor 2. The means of feed value of the sward from different treatments were examined for significant differences using Tukey's HSD at $\alpha = 0.05$.

3. Results and discussion

The botanical composition of the sward was dependent on the date at which patches of ungrazed herbage were cut. After the last grazing event, the weed infestation of the sward increased substantially in non-mowed vs. mowed treatments already in the first production year (fig. 1). In the subsequent year, cows left substantial amounts of uneaten and aged plant residues, mostly legume shoots. In that period, the proportion of weeds in the sward was observed to drop and that of uneaten plants to rise considerably. Particularly large amounts of uneaten herbage were recorded in the year 2011 in the non-mowed treatment and in which the uneaten herbage was mowed only once after the last grazing (fig. 1).

The treatments mowed after each grazing event yielded a sward that was more balanced as it contained nearly equal percentages (close to 50%) of small-seed legumes (red clover and lucerne) and grasses. During the first two production years the of weed infestation in those treatments was slight. In the third year, though, lucerne became the dominant species as in the winter of 2011/2012 red clover was totally lost to frost. There was a 20% increase of weed infestation in that period. In the non-mowed treatment and in that involving mowing after the last grazing the animals utilized the sward poorly because of substantial accumulation of ungrazed plant residues [5]. These data are in good agreement with those obtained by Ostrowski [9] who likewise recorded poor utilization of the sward and lenient grazing in a treatment where uneaten herbage was left unmowed. In the sowing year and in the production years there was a three-day long grazing event in each grazing session. In the first and second production years there were 4 grazing sessions, each lasting 3 days, which translates to 12 days of grazing in the growing season.

Treatment-to-treatment variation in energy content of the sward expressed as feed units for lactation (UFL) occurred only in the third production year and was dependent exclusively on date on which uneaten herbage was mowed (tab. 1). Energy content of the sward was similar for individual grazing events and varied but little from year to year. In the treatments which involved mowing of uneaten herbage after each grazing event the sward of small-seed legumes grown in association with grasses was richer in energy than the sward which was mowed after the last grazing only. Apart from that, energy content of the sward mowed after the first grazing event vs. the unmowed one was also higher in the former. These data differ substantially from those reported in the relevant literature. Wasilewski [10] found comparable energy contents of energy for swards which were mowed on different dates. In another study, energy content of uneaten herbage was lower than that of herbage ingested by animals which was related to higher crude fibre content of the latter [11]. Similar energy content of permanent pastures and short-term leys was described by Ostrowski [9] regardless of whether the uneaten herbage was mowed or left undisturbed.



*legume plants / motylkowate; – grasses / trawy; – weeds / chwasty; - stubble / ścierń; 0** - year of sowing rok siewu, I-IV grazing / wypas*

Source: Own work / Źródło: opracowanie własne

Fig. 1. Per cent of contribution of major floristic groups to pasture herbage as dependent on the cutting frequency of ungrazed plants and on the age of the sward over two years of utilization
Rys. 1. Procentowy udział komponentów w mieszance w zależności od częstości koszenia niedojadów w latach użytkowania

Table 1. Dry matter energy content of small-seed legume-grass herbage depending on the cutting date of uneaten plants and on grazing event (UFL - feed unit for lactation)
Tab. 1. Wartość energetyczna suchej masy mieszanki bobowatych drobnonasiennych z trawami w zależności od terminu koszenia niedojadów i wypasów (JPM – jednostka paszowa produkcji mleka)

Specification	Year of utilization		
	1	2	3
Frequency of cutting of uneaten herbage			
1*	1.09a**	0.87a	0.86a
2	1.017a	0.87a	1.07bc
3	1.16a	0.87a	0.95ab
4	1.07a	0.88a	1.12c
HSD α = 0,05	n.s.	n.s.	0.167
Grazing event			
1	1.08a	0.90a	0.94a
2	1.13a	0.87a	1.03a
3	1.01a	0.86a	1.04a
4	1.11a	0.86a	-
HSD α=0,05	n.s.	n.s.	r.s.

1* – *ungrazed herbage left unmowed / bez wykaszania niedojadów*; 2 – *ungrazed herbage cut after the 1st grazing event / koszenie niedojadów po 1. wypasie*; 3 – *ungrazed herbage cut after the last grazing event / koszenie niedojadów po ostatnim wypasie*; 4 – *ungrazed herbage cut after each grazing event / koszenie niedojadów po każdym wypasie*
*a**values within a column followed by the same letter do not differ significantly*

Source: Own work / Źródło: opracowanie własne

Protein value of fodder expressed as protein digestible in the intestine (PDI) was significantly affected by the date on which uneaten herbage was cut and it also changed over successive grazing events (tab. 2). In the first and the third grazing year the mowing of ungrazed herbage following each cutting event increased the feeding value of the sward. A similar impact of management practices in the treatment in which ungrazed herbage was mowed down after each grazing event was described by Wasilewski [10]. However, other reports give dissenting opinions on the subject. In the studies by Ostrowski [9] and Wasilewski [11] the protein content of the sward was similar regardless of mowing date. Supposedly, low protein value of the herbage in the non-mowed (treatment 1) was the result of the low proportion of small-seed legumes in the sward (fig. 1), the issue having been also raised by the author of this study in her other papers [4, 12]. In the second production year a significant difference occurred between the highest protein value obtained from mowing uneaten herbage after each grazing and the lowest – when uneaten plants were cut after the last grazing session only (treatment 3).

As shown in Fig. 1, aged uneaten plant residues and weeds appeared in the sward that was mowed after the last grazing event and it is the presence of those undesirable components that decreased the protein value of the fodder. Reduction of feed protein value on this object probably occurred because of them. As demonstrated by Duru [13] and Capout [7] the lower portion of the sward and aged uneaten herbage are conspicuous for their low protein content compared to the topmost portion of the sward.

Protein value of the sward varied from grazing to grazing only in the first and in the third production year. (tab. 2). In the first year, the sward grazed during the first grazing session was significantly richer in protein than those grazed in the second and in the fourth session. Those results are not borne out by literature as usually protein value of the sward increased with the advancing season [4, 14]. The early date of the first grazing event (12th to 14th May 2010) was likely to have caused protein value to rise in that period. In the third production year the first regrowth of the herbage was grazed to cows three weeks later (5th to 7th June 2012). it caused the protein value in that regrowth to be lower as compared to that in the 3rd and the 4th grazing sessions (tab. 2).

Table 2. Protein value of dry matter (PDI) as affected by the frequency of cutting uneaten herbage and by grazing event
Tab. 2. Wartość białkowa suchej masy mieszanki bobowatych drobnonasiennych z trawami w zależności od terminu koszenia niedojadów i wypasów wyrażona w jednostkach białka trawionego w jelicie cienkim (BTJ)

Specification	Year of utilization		
	1	2	3
Frequency of cutting of uneaten herbage			
1*	34.19a	35.75ab	27.63a
2	37.44ab	32.83ab	36.80a
3	40.14ab	31.55a	31.55a
4	43.59b	43.76b	40.44b
HSD α = 0,05	8.57	12.21	10.57
Grazing			
1	45.65a	28.38a	26.11a
2	36.09b	39.98a	39.08b
3	40.70ab	37.73a	37.11b
4	32.93b	37.85a	-
HSD α=0,05	8.57	n.s.	8.14

1 - see – table 1. / patrz tab. 1.*
*a** - see – table 1. / patrz tab. 1.*
Source: Own work / Źródło: opracowanie własne

Table 3. Crude fibre content depending on the frequency of cutting uneaten forage and by foraging sessions (g·kg^{-1} DM)
Tab. 3. Zawartość włókna surowego w zależności od terminu koszenia niedojadów i wypasów (g·kg^{-1} s.m.)

Specification	Year of utilization		
	1	2	3
Frequency of removing uneaten herbage			
1*	284.73a**	296.82a	324.00a
2	273.60a	287.65a	258.07bc
3	262.85ab	282.87a	297.88ab
4	225.73b	236.70a	230.30c
HSD α = 0,05	45.91	n.s.	50.19
Grazing event			
1	238.75a	290.82a	300.70a
2	263.27ab	286.72a	264.77a
3	296.37b	268.63a	267.20a
4	248.50a	257.87a	-
HSD α=0,05	45.91	n.s.	n.s.

1 - see – table 1. / patrz tab. 1.*
*a** - see – table 1. / patrz tab. 1.*
Source: Own work / Źródło: opracowanie własne

Crude fiber content of dry forage varied significantly in the first and in the third production year (tab. 3). In that period, the failure to mow uneaten herbage resulted in a significant increase in crude fiber compared to the sward mowed after each grazing event. Similar differences concerning fiber content on the extreme opposites of the management of uneaten herbage (mowed after each grazing event vs. non-mowed) were recorded also by Wasilewski [10]. Apart from that, in the third foraging year the sward that was mowed after the first grazing event was likewise poor in crude fiber. From the survey of literature it is known that the lowest contents of that component are found under controlled grazing management (portions of pasture assigned to one-day grazing sessions) and that the forage from freely grazed swards is highest in fiber [11].

The sward produced by the legume-grass mixture was of sound quality due to is appropriate crude fibre content that showed little variation from grazing to grazing (tab. 3). Most frequently, it is the spring crop of forage that contains the highest amount of fibre which declines in successive grazing sessions [4]. In this study, significantly lower fibre contents were found in the first and fourth vs. the first grazing session of the first foraging year. As fibre content is inversely related to plant age low fibre concentration in the spring forage could be related to younger plants being grazed on (at the vegetative and early earring stage) which was mentioned earlier on. In the remaining years the sward differed but little for that organic component.

Like its protein value, digestibility of the forage varied significantly with the factors under study in the first and the fourth foraging year (tab. 4). In those years, the lowest digestibility figures of the forage were obtained from the non-mowed treatments (tab. 1), and they were associated with a lower proportion of legumes in the sward and with a substantially lower fibre concentration on the dry-matter basis (tab. 3). In the first foraging year, the highest digestibility was obtained from the treatment which involved mowing of uneaten herbage after the last grazing session. In other studies, high digestibility was solely found in swards mowed after each or after the second grazing which was related to those swards being low in crude fiber and in ADF and NDF fractions [10]. As demonstrated by Duru [13], a decline in digestibility of grass forage occurs from the topmost to the basal portion of the sward. It is precisely for that reason that in this study the digestibility of forage from the non-mowed treatment that contained uncut and uneaten plant residues from previous grazing sessions was the lowest. (tab. 4). In the second foraging year comparable digestibility figures were found for comparable managements of uneaten herbage and for comparable grazing sessions. In the third foraging year, though, the forage from the sward mowed after the first grazing was more digestible than that from the non-mowed sward (tab. 4).

The digestibility of roughage is crucial in determining the amount of digestible energy which ruminants can utilize for their subsistence and for production needs [15] and, therefore, it is recognized as a very important element to be used for feed quality assessment. There is a correlation between the growing stage of a plant and its digestibility. Usually, during the first grazing event the herbage fed to animals is more advanced in growth, less digestible and less degradable in the rumen [16, 17]. Presumably, it is because of these factors that in this study (tab. 4) the first spring regrowth was characterized by poorer digestibility compared to the forage from the second and the fourth

grazing events. In subsequent years, the grazing use of organic matter digestibility of the mixture in each grazing was similar (tab. 4).

Table 4. Digestibility of organic mass of the legume-grass herbage depending on the frequency of cutting leavings and grazing (%)
Tab. 4. Strawność masy organicznej mieszanki bobowatych drobnonasiennych z trawami w zależności od terminu koszenia niedojadów i wypasów (%)

Specification	Year of utilization		
	1	2	3
Frequency of cutting of leaving			
1*	73.12a**	66.62a	66.34a
2	74.45ab	66.67a	73.77b
3	82.82b	66.70a	71.16ab
4	77.90ab	66.82a	70.34ab
NIR α = 0,05	9.66	n.s.	7.42
Grazing			
1	71.95a	68.60a	69.39a
2	81.08b	66.57a	71.73a
3	74.88ab	65.82a	70.09a
4	80.40b	65.82a	-
NIR α=0,05	7.00	n.s.	n.s.

1 - see – table 1. / patrz tab. 1.*
*a** - see – table 1. / patrz tab. 1.*

Source: Own work / Źródło: opracowanie własne

Significant differences in the filling value of the forage were found only for grazing events, mowing date was not affected by that parameter (tab. 5).

Table 5. Value of the filling units for lactation depending on the frequency of cutting leavings and grazing (LFU)
Tab. 5. Wartość jednostek wypełnieniowych JWK w zależności od terminu koszenia niedojadów i wypasów

Specification	Year of utilization		
	1	2	3
Frequency of cutting of leaving			
1*	0.62a**	0.77a	0.56a
2	0.67a	0.74a	0.62a
3	0.64a	0.74a	0.56a
4	0.68a	0.79a	0.65a
NIR α = 0,05	n.s.	n.s.	n.s.
Grazing			
1	0.94a	0.73a	0.58ab
2	0.68b	0.72a	0.71b
3	0.50c	0.92b	0.50a
4	0.48c	0.67a	-
NIR α=0,05	0.167	0.085	0.14

1 - see – table 1. / patrz tab. 1.*
*a** - see – table 1. / patrz tab. 1.*

Source: Own work / Źródło: opracowanie własne

The lowest filling values were found in the forage from the third and the fourth grazing session in the first foraging year, the second and third lowest values were determined for the forage from the fourth grazing session in the second year and from the third grazing session in the third year, respectively (tab. 5). As maintained by Ganskopp and Bohnert [18] low filling value of feed is associated with increased requirement for green pasture forage by animals so that they can satisfy their subsistence and production needs. Hence, allowance should be made for inferior filling value of forage by restructuring the grazed area into larger-than-usual paddocks should such a need occur.

4. Conclusions

1. Pasture management that included systematic mowing of uneaten herbage after each grazing event promoted a balanced proportion of legumes and grasses in the turf, increased energy content and protein value of the forage but lowered its filling value and fiber content.
2. Mowing of uneaten herbage over the three-year period, regardless of the date on which the practice was performed, improved the digestibility of the forage as compared to that obtained from non-mowed treatments.
3. Feed quality varied from one grazing event to the next and the highest protein value and digestibility was obtained from grazing sessions later in the season. At the same time, filling value of the forage declined mainly due to the herbage being grazed at early development stages.
4. When left unmowed, clumps of uneaten pasture herbage promote weed development and excessive accumulation of aged plant residues which negatively affects feed quality of the forage.
5. On an organically managed pasture of perennial legumes grown in association with grasses it is essential to remove uneaten herbage from the sward at least once in a year to secure forage of good quality.

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