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Selection of perennial grasses for an extended pasture in the autumn period

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Abstract. The relevance of the study lies in the fact that until recently the reaction of various types of perennial grasses to the terms of alienation of herbage in the last cycle of use has not been clarified, which hinders the development and implementation of technology for creating perennial agrophytocoenoses in the continuous pasture

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system with an extended grazing period for meat livestock in the late autumn period. The purpose of the study was to select the best perennial grasses for late autumn alienation of herbage in the system of an extended continuous pasture for meat breeds of cattle in the Right-Bank Forest-Steppe. The results of long-term research on the features of the development of the yield of aboveground biomass, the chemical composition of feed, the stability of certain types of grasses depending on the time of alienation of aboveground biomass in total for all cycles of use and in the last cycle in the autumn period are presented. The highest productivity (at the level of 0.60-0.95 t/ha of dry weight) of all types of grasses in the last (autumn) cycle of use is provided when the green mass is alienated on October 1. When alienated at a later date, the collection of dry mass from 1 ha decreases, while the quality of feed worsens due to a decrease in the content of crude protein and an increase in the concentration of crude fibre to the limits that do not meet the zootechnical norm of feeding cattle and the requirements of DSTU for green feed. Studies have identified the best single-species agrophytocoenoses of grasses, which include smooth brome, cocksfoot grass, and intermediate wheatgrass. On average, for 2008-2015, in the sum of all three cycles of use, they provide a productivity of 6.52-7.19 t/ha of dry weight when applying N_{120}. The results of these studies can be used in the development of recommendations for the creation of continuous pasture with an extended period of grazing grass with meat livestock in the autumn period, which reduces the cost and increases the competitiveness of livestock products

Keywords: fertilisers; green feed; productivity; pasture; mode of use; reserve paddock; chemical composition of feed; cycle of use

INTRODUCTION

Increasing the production of competitive livestock products, in particular cattle breeding products, is impossible without developing a high-quality feed base. In the structure of feeding beef cattle, green fodder should account for at least 60-70% in the summer and autumn period. The cheapest are grass feeds, in particular pasture ones, developed based on perennial grasses, which, along with feed-producing ones, are of great environmental importance (Crews *et al.,* 2018; Reynolds *et al.,* 2021; Kurhak, 2023).

Such agrophytocoenoses are the basis for profitable production of meat cattle products. In this regard, it is extremely important for beef cattle, which are the least demanding in terms of feed and maintenance, to extend the grazing period. Previous studies by V. Kurhak and U. Karbivska (2019), U. Karbivska (2020a), S. Panasiuk (2023) suggest that the grazing period in late autumn can be extended by 60 days, and under favourable weather conditions up to 90 days, until snow falls.

The presence of several optimal dates for the beginning of regrowth of autumn aftergrass in combination with grass stands of different types in ripeness ensure the continuous supply of pasture feed in reserve pens. Especially promising is the use of reserve pens in pasture, where a supply of grass is formed for grazing beef cattle or sheep in the late autumn period. For this purpose, meadow lands can be used, which are reproduced on former arable land in the erosion-hazardous zone of agricultural landscapes, including by their spontaneous overgrowth with grassy vegetation. As evidenced by V. Picasso *et al.* (2019), S. Culman *et al.* (2023), for this purpose, hayfields and seed beds of perennial grasses can also be used, or the cultivation of perennial grasses for grain, the aftergrass of which can be used for grazing livestock in the late autumn period. The maintenance of meat livestock extended to 200 or more days is possible not only on cultivated pastures, but also on uncultivated pastures and even on unequipped sites or summer camps. This allows feeding live weight of animals on cheap grass feeds in the late autumn period. All this, combined with the subsequent intensive fattening of animals in stable conditions, will significantly reduce the cost of beef and accelerate the achievement of high weight conditions of meat cattle (Favre *et al.*, 2019; Hunter *et al.*, 2020)

Such an alternative possibility of extending the pasture period in the late autumn period due to perennial grasses, which causes the late alienation of the grass stand during this period, which is not recommended until now, becomes a reality due to new theoretical prerequisites for preserving the species composition and productive longevity of meadow coenoses under certain conditions. Such prerequisites, according to the authors' experience and previous research, may include the use of reserve paddocks in the system of haylage or pasture rotation, selection of appropriate components that can withstand late autumn alienation (Panasiuk, 2023).

However, until recently, there are still many unexplored issues in the use of pastures, which negatively affects the development of scientific foundations and technologies for creating reserve pens for grazing cattle in the late autumn period. That is why the purpose of the study was to select the best perennial grasses for late autumn grass alienation in the system of extended continuous pasture for beef cattle breeds with green fodder supply for 200-220 days in the Right-Bank Forest-Steppe.

MATERIALS AND METHODS

Research on the selection of perennial grasses for late autumn alienation of grass stand in the system of extended continuous pasture was conducted during 2008-2015 at the National Research Centre Institute of

Agriculture of the National Academy of Agrarian Sciences in Fastiv district, of Kyiv Oblast. The experiment was established in the spring of 2007 and conducted on dry meadows of normal moisture with grey forest light loamy soil. In a 0-20 cm layer, this dry soil contained 1.7% humus, 83 mg/kg – alkaline hydrolysed nitrogen, 175 mg – P_2O_5, and 98 mg – K_2O. The salt pH – 5.5. The terrain of the research site was flat. The size of the sown area is 21 m^2, accounting – 15 m^2. The experiment was repeated four times. The number of variants – 32, and the number of land plots – 128.

The alkalisation of experimental areas was carried out in early spring without cover. For this purpose, zoned varieties of cereals were used, in particular: cocksfoot grass *Muravka*, smooth brome *Vyshhorodskyi,* meadow fescue *Siverianka,* tall fescue *Dominika,* meadow timothy *Vyshhorodska,* intermediate wheatgrass *Vitas,* red fescue *Manchul,* smooth meadow-grass *Alex*. A two-factor field experiment to investigate the reaction of perennial grasses to late autumn use of herbage was carried out according to the scheme shown in Table 1.

***Table 1**. Experiment scheme*

Factor A Cereals (types and norms of sowing seeds, kg/ha at 100% economic capacity)	Factor B Mode of use with different dates of the last grazing cycle
1. Smooth meadow-grass (*Poa pratensis L.*) – *20*	1. September 1
2. Smooth brome (*Bromopsis inermis* (Leyss.) Holub) – 28	2. October 1
3. Meadow fescue (*Festuka pratensis Huds)* – 25	3. November 1
4. Tall fescue (*Festuca orientalis* (Hack.) – 25	4. December 1
5. Meadow timothy (*Phieum pratense* L.) – 15	
6. Intermediate wheatgrass (*Elytrigia intermedia* (Host) Nevski – 22	
7. Red fescue (*Festuca rubra L.*.) – 22	
8. Smooth meadow-grass (*Poa pratensis L.*) – 15	

***Source:** developed by the authors*

The experiment was conducted against the background of the introduction of $N_{120(40+40+40)}P_{45}K_{90.}$ Nitrogen fertilisers (ammonium nitrate) were applied separately in equal parts in three terms: N_{40} in early spring for the 1st cycle, N_{40} for the 2nd cycle, and N_{40} for the 3rd (last) cycle of use. Phosphorous (simple granular superphosphate) and potash (potassium chloride) were applied early in spring in the same period. The weather conditions for the vegetation of grass plants were generally satisfactory in the spring-summer period and often not favourable, mainly in August and September, when there were long rainless periods, which negatively affected the regrowth of grasses.

Phenological observations of the growth and development phases of perennial grasses were carried out in accordance with DSTU 4674:2006 (2008). The dry weight content was determined by the thermostatic-weight method at a temperature of 105°C according to DSTU 4674:2006 (2008). Accounting of the green mass yield was carried out by weighing and then calculating the yield per 1 ha of dry weight according to DSTU 8044:2015 (2018). In dry vegetable mass, the content of crude protein and protein was determined according to DSTU ISO 5983-2003 (2003); crude fat – according to DSTU ISO 6492-2003 (2005); crude fibre, crude ash – according to DSTU ISO 5984:2004 (2005); nitrogen, phosphorus, potassium – by infrared spectroscopy according to DSTU 4117:2007 (2007); the content of nitrogen-free extractives (NFE) – according to DSTU 4674:2006 (2008).

Agrochemical parameters of the soil were determined in a 0-20 cm layer of soil according to generally accepted methods, namely: humus – by Tyurin according to DSTU 4289:2004 (2006), nitrogen, which is easily hydrolysed by alkali – by Cornfield according to DSTU 7863:2015 (2018), mobile phosphorus and potassium – by Chirikov according to DSTU 4115:2002 (2003), pH (salt) – using the potentiometric method by V.F. Moiseichenko, V.O. Eshchenko according to DSTU ISO 10390:2001 (2008).

Experimental studies of plants (both cultivated and wild), including the collection of plant material, were in accordance with institutional, national or international guidelines. The authors adhered to the standards of the Convention for the Protection of Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS AND DISCUSSION

The dynamics of the content of sown cereals in single-species cereal agrocoenoses by year during 2008-2015, depending on the duration of the last cycle of use, is shown in Table 2. According to average indicators, the duration of the last cycle of use in terms of the share of sown crop did not significantly affect the smooth brome, tall fescue, meadow timothy, red fescue, and smooth meadow-grass. At the latest period of the last alienation, namely 1.12 compared to the earliest (1.09), the share of sown crops in single-species agrophytocoenoses of cocksfoot grass, meadow fescue, and medium wheatgrass decreased by 5-7%. Analysis of the findings showed that the species characteristics of grasses had a greater impact on their stability over the years of use. According to average indicators, the

highest proportion of sown crops (76-89%) was best kept in agrophytocoenoses with the highest proportion of sown crops (76-89%), cocksfoot grass and smooth brome, and the worst – meadow fescue with the proportion of sown crops of 41-48%. Other species occupied an intermediate position.

***Table 2**. Content of sown cereals depending on the period of the last cycle of use of herbage by year, %, 2008-2015*

Duration of the last cycle	Years of use								Average for these years
	2008, 1st	2009, 2nd	2010, 3rd	2011, 4th	2012, 5th	2013, 6th	2014, 7th	2015, 8th	
Cat grass – *Dactylis glomerata* L., Muravka variety									
1.09	91	96	94	89	88	82	84	81	88
1.10	92	95	95	88	90	83	82	84	89
1.11	90	93	92	84	85	84	81	80	86
1.12	89	90	92	83	83	80	76	72	83
Smooth brome *Bromopsis inermis* (Leyss. Holub – Vyshhorodskyi									
1.09	88	89	92	86	82	74	69	59	79
1.10	87	90	93	87	81	76	70	54	80
1.11	85	87	88	84	80	76	73	54	77
1.12	86	87	81	82	79	73	71	52	76
Meadow fescue – *Festuka pratensis Huds* – Siverianka									
1.09	96	81	66	49	35	19	18	14	47
1.10	95	83	67	48	34	22	20	13	48
1.11	91	78	58	41	28	25	21	12	44
1.12	88	76	55	38	27	20	16	10	41
Tall fescue – *Festuca orientalis* (Hack.) – Dominika									
1.09	82	83	87	75	71	66	70	62	74
1.10	81	84	86	74	73	67	74	63	75
1.11	80	82	83	71	70	69	77	63	74
1.12	81	80	84	70	66	65	76	61	72
Meadow timothy – *Phieum pratense* L. – Vyshhorodska									
1.09	92	87	71	59	52	49	41	26	60
1.10	93	88	72	58	57	54	42	25	61
1.11	90	85	70	58	55	56	44	23	60
1.12	90	80	70	57	54	55	38	21	58
Intermediate wheatgrass – *Elytrigia intermedia* (Host) Nevski – Vitas									
1.09	97	85	81	77	72	58	52	41	70
1.10	94	86	80	78	73	66	56	40	72
1.11	93	80	78	64	66	65	58	35	67
1.12	91	77	74	63	61	59	51	32	63
Red fescue – *Festuca rubra L.*. – Manchulska									
1.09	83	79	72	68	66	57	52	48	67
1.10	84	80	71	69	67	81	61	50	70
1.11	82	80	72	71	65	80	74	56	72
1.12	81	76	70	65	63	72	72	57	69
Smooth meadow-grass – *Poa pratensis L.* – Alex									
1.09	96	90	78	64	61	49	49	41	66
1.10	94	91	77	65	59	53	53	43	67
1.11	92	89	74	66	62	58	58	38	67
1.12	92	88	72	63	58	60	48	38	65

***Note:** the experiment was conducted against the background of $N_{120\ (40+40+40)}\ P_{45}\ K_{90}$*
***Source:** compiled by the authors*

This pattern was more clearly manifested in the years of life and use of herbage. Notably, in the first three years, all types of grasses were well preserved in agrophytocoenoses with a seeding rate of 55-97%. In the following years, up to the 8th year of use, the cocksfoot grass with a high proportion of sown crops was best preserved. The fastest rate of decline in sown crops occurred in the agrophytocoenosis from meadow fescue, which almost completely fell out of the grass stand, starting from 2013 to 2015 with a share of 10-25%, which negatively affected the productivity of this species.

Meadow timothy was also characterised by a strong liquefaction of the herbage over the years of use, which almost fell out of the herbage in the 8th year of life and use, when the content of the main crop in the variants did not exceed 21-26%. Other species (smooth brome,

tall fescue, intermediate wheatgrass, red fescue, smooth meadow-grass), except for cocksfoot grass, which was well preserved in all years, are better preserved in herbage. Their number gradually decreased over the years, but still was at a sufficient level and in the 8th year ranged from 32-62%. Among these species, at the last year of use in 2015, the best preserved are smooth brome, tall fescue, and red fescue.

Studies have established that the productivity of single-species crops of cereals was determined not only by the share of the sown species, but also by weather conditions during the years of study (Table 3). With the application of a total dose of nitrogen N_{120}, the productivity of different types of these grasses in total for all mowing ranged from 5.08-7.19 t/ha of dry weight on average in 2008-2015. Regardless of the timing of the last cycle of use, the most productive were herbage, which was formed based on single-species crops of cocksfoot grass, smooth brome, and medium wheatgrass, and the least productive – agrophytocoenosis from meadow fescue, where the share of sown crop was the smallest in the yield. Other species, namely tall fescue, meadow timothy, red fescue, smooth meadow-grass, occupied an intermediate position.

Table 3. *Dynamics of productivity of cereals depending on the period of the last cycle of use by year, t/ha of dry weight, 2008-2015*

Duration of last cycle	Years of use								Average for 2008-2015
	2008, 1st	2009, 2nd	2010, 3rd	2011, 4th	2012, 5th	2013, 6th	2014, 7th	2015, 8th	
Cocksfoot grass									
1.09	8.90	7.18	5.74	5.24	5.12	5.65	9.64	5.11	6.52
1.10	9.32	7.23	5.82	5.32	5.20	5.96	9.72	5.29	6.73
1.11	9.24	6.93	5.68	5.18	5.06	5.72	9.80	5.17	6.60
1.12	8.53	6.60	5.39	4.89	4.77	5.43	9.69	5.05	6.25
Smooth brome									
1.09	11.90	7.70	5.62	5.12	5.00	5.17	8.81	5.36	6.81
1.10	12.34	7.71	5.67	5.17	5.05	5.49	8.96	5.55	6.96
1.11	12.23	7.39	5.55	5.05	4.93	5.23	9.03	5.39	6.87
1.12	11.64	7.08	5.32	4.82	4.70	4.92	8.93	5.30	6.62
Meadow fescue									
1.09	11.95	7.80	3.40	2.90	2.78	3.84	6.12	3.25	5.22
1.10	12.03	7.81	3.49	2.99	2.87	4.19	6.19	3.29	5.33
1.11	11.72	7.55	3.40	2.90	2.78	4.10	6.16	3.27	5.25
1.12	10.98	7.23	3.32	2.82	2.70	3.77	6.14	3.23	5.08
Tall fescue									
1.09	11.91	8.11	4.04	3.54	3.42	5.05	7.48	3.99	5.92
1.10	12.00	8.13	4.05	3.55	3.43	5.29	7.61	4.15	6.04
1.11	11.55	7.84	3.88	3.38	3.26	5.07	7.69	4.17	5.81
1.12	11.06	7.51	3.73	3.23	3.11	4.61	7.62	3.96	5.66
Meadow timothy									
1.09	10.85	8.06	4.82	4.32	4.20	4.11	7.01	3.44	5.85
1.10	11.01	8.09	4.84	4.34	4.22	4.40	7.06	3.49	5.93
1.11	10.61	7.82	4.74	4.24	4.12	4.35	7.09	3.47	5.81
1.12	10.17	7.54	4.63	4.13	4.01	3.88	7.04	3.45	5.60
Intermediate wheatgrass									
1.09	11.71	8.33	7.48	6.98	6.86	4.72	7.22	3.77	7.13
1.10	11.81	8.35	7.49	6.99	6.87	4.86	7.27	3.88	7.19
1.11	11.34	8.14	7.28	6.78	6.66	4.51	7.30	3.79	6.97
1.12	11.06	7.78	7.00	6.50	6.38	4.29	7.26	3.71	6.70
Red fescue									
1.09	11.05	6.80	4.85	4.35	4.23	4.60	7.61	3.82	5.76
1.10	11.18	6.88	4.86	4.35	4.23	5.03	7.70	3.86	5.83
1.11	10.68	6.77	4.64	4.14	4.02	4.75	7.77	3.99	5.64
1.12	10.20	6.48	4.32	3.82	3.70	4.21	7.73	3.94	5.52
Smooth meadow-grass									
1.09	11.44	7.36	5.62	5.12	5.00	4.36	6.56	3.70	6.22
1.10	11.57	7.39	5.71	5.21	5.09	4.58	6.62	3.83	6.25
1.11	11.16	7.10	5.62	5.12	5.00	4.32	6.64	3.75	6.05
1.12	10.73	6.82	5.54	5.04	4.92	4.06	6.53	3.67	5.92
LSD_{05}, t/ha	0.41	0.22	0.19	0.27	0.17	0.19	0.37	0.07	0.13

Note: *productivity in total for three cycles of use against the background of* $N_{120\ (40+40+40)}\ P_{45}\ K_{90}$
Source: *compiled by the authors*

According to the average indicators, the duration of the last cycle of use had a different effect on the total productivity of the species under study. The highest productivity of all species was obtained for the alienation of aboveground biomass 01.10, which ranged from 5.33 (meadow fescue) to 7.19 (intermediate wheatgrass) t/ha. This mowing period slightly reduced the total productivity for all mowing periods at alienation 1.09 and 1.11. And only with the last alienation of 1.12, the total productivity compared to the last alienation of 1.10 significantly decreased by 0.31-0.48 t/ha. This decrease was slightly greater in the cocksfoot grass and less in the red fescue and smooth meadow-grass.

Productivity significantly changed in the sum for all mowing and for the years of use of the stands of grass types under study. The highest productivity was obtained in the 1st year of use, which was in the range of 10.20-12.34 t/ha of dry weight. The exception was the cocksfoot grass, whose productivity, due to favourable conditions, was greatest in the 7th year of use. The productivity of the cocksfoot grass that year from other species was less by 2.20-3.05 t/ha, which naturally differed little in productivity.

Over the years, the productivity of all species gradually decreased, with the exception of 2014, when due to the favourable conditions of moistening and overwintering of perennial grasses, the spread of unseeded (wild) species and groups of mixed grasses and cereals, and the good development of sown species, their productivity level was in second place after the first year of use. The exceptions were meadow fescue and tall fescue, whose productivity level in the last year ranked third after the first year. These species took the second place in terms of productivity in the 2nd year of use. In general, the smallest decrease in productivity over the years was observed in the cocksfoot grass and smooth brome, whose performance was more or less stable during all 8 years of use. The productivity of intermediate wheatgrass and smooth meadow-grass was maintained at a relatively stable level for the first 5 years. In the 6th and 8th years, they sharply reduced their productivity. Other species, namely meadow fescue, tall fescue, meadow timothy, red fescue, sharply reduced their productivity, starting from the 3rd, with the exception of the 7th year of use of agrophytocoenoses.

The analysis of literature sources shows that reserve pens on pastures for grazing meat cattle in the autumn period are created based on the development of a reserve of grass feed from the last mowing or cycle of use of perennial grasses or natural meadow phytocoenoses (Kurhak & Karbivska, 2019; Karbivska, 2020b; Panasiuk, 2023). Results of evaluation of the feed productivity of various types of perennial grasses in the last cycle of use at different times of its implementation against the background of the introduction of $N_{40}$is shown in Table 4. The productivity of the last cycle of use of the studied types of herbs with different terms of its implementation in terms of yield from 1 ha of dry weight ranged from 0.29-0.86 tonnes, fodder units – 0.15-0.53 tonnes, and crude protein – 0.04-0.16 tonnes. It was the largest in intermediate wheatgrass and red fescue, and the smallest in meadow fescue and smooth meadow-grass. Analysis of the results of productivity studies for different periods of alienation of the aboveground mass in the last cycle of use shows that its increase occurred only up to 1.10, after which it gradually decreased and it was the smallest at the alienation of 1.12. The highest productivity of the last cycle of all species obtained on 01.10 ranged from 0.60 (smooth meadow-grass) to 0.95 (red fescue) t/ha, and the lowest productivity on 01.12 – in the range of 0.29-0.51 t/ha.

***Table 4**. Productivity and quality of the last cycle of use of perennial grasses, depending on the duration of its implementation, average for 2008-2015*

Date of the last mowing	Dry weight, t/ha	Fodder units, t/ha	Crude protein, t/ha	Provision of the fodder unit with digestible protein, g	Dry weight content, %
Cocksfoot grass					
1.09	0.73	0.44	0.12	122	31.9
1.10	0.85	0.54	0.11	120	31.3
1.11	0.69	0.43	0.10	118	30.8
1.12	0.40	0.39	0.08	115	34.8
Smooth brome					
1.09	0.69	0.40	0.11	121	33.4
1.10	0.83	0.51	0.14	117	33.2
1.11	0.63	0.38	0.10	114	32.7
1.12	0.39	0.25	0.06	108	35.2
Meadow fescue					
1.09	0.56	0.39	0.09	119	32.0
1.10	0.66	0.42	0.11	115	33.6
1.11	0.52	0.32	0.08	113	31.9
1.12	0.31	0.17	0.05	110	35.1
Tall fescue					
1.09	0.72	0.42	0.10	112	32.4

Table 4. Continued

Date of the last mowing	Dry weight, t/ha	Fodder units, t/ha	Crude protein, t/ha	Provision of the fodder unit with digestible protein, g	Dry weight content, %
Tall fescue					
1.10	0.81	0.50	0.14	109	31.8
1.11	0.68	0.41	0.12	106	33.1
1.12	0.35	0.23	0.05	103	34.2
Meadow timothy					
1.09	0.57	0.31	0.08	118	33.0
1.10	0.65	0.40	0.11	113	33.4
1.11	0.50	0.31	0.08	109	32.9
1.12	0.30	0.17	0.04	102	35.3
Intermediate wheatgrass					
1.09	0.82	0.51	0.13	110	33.7
1.10	0.88	0.56	0.15	114	34.2
1.11	0.67	0.42	0.11	105	34.1
1.12	0.39	0.24	0.05	103	36.2
Red fescue					
1.09	0.86	0.53	0.14	121	34.3
1.10	0.95	0.60	0.16	118	34.5
1.11	0.85	0.52	0.14	116	33.6
1.12	0.51	0.33	0.06	115	34.1
Smooth meadow-grass					
1.09	0.51	0.28	0.06	113	33.5
1.10	0.60	0.37	0.09	112	32.8
1.11	0.45	0.27	0.06	110	34.1
1.12	0.29	0.15	0.05	109	36.7
LSD_{05}, t/ha	0.04				

Note: *the dose of nitrogen fertiliser for this mowing is* N_{40}
Source: *compiled by the authors*

Analysis of the quality indicators of grass feed obtained in the last cycle of use at different times of its implementation showed that the provision of the feed unit with digestible protein ranged from 102 to 122 g, and the content of dry weight in the green mass of feed – from 31.9 to 36.7%. With the shift of the last usage cycle from 1.09 to 1.12, the parameters of these indicators worsened. In particular, the supply of digestible protein to the fodder unit during this period decreased by 4-16 g, and the dry weight content in the green mass of feed increased by 1.8-3.2%. Slightly better availability of one fodder unit in the last cycle of use was characterised by single-species agrophytocoenoses of the cocksfoot grass, smooth brome, and red fescue. Analysis of feed chemical composition indicators on average for 2008-2015 (Table 5) showed a deterioration in the quality of feed in the last cycle of use due to alienation at a later date. In particular, with the monthly shift of the last cycle of use of grass stands from 1.09 to 1.12, the content of crude protein in the dry matter of grass stands decreased by 2.9-3.9%, and crude fibre, as the least valuable (ballast) indicator of feed quality, increased by only 5.2-7.5%. However, the content of protein, crude fat, and mineral elements, in particular, phosphorus, potassium, and calcium, decreased. The worst indicators of the chemical composition of the feed were for the alienation of the last cycle of use at the latest, namely 1.12. According to the content of crude protein, the chemical composition of the feed in the last cycle of use was slightly better: cocksfoot grass, smooth brome, red fescue.

Table 5*. Chemical composition of the fodder of the last cycle of use of cereals, depending on the period of its implementation, % in dry weight (average for 2008-2015)*

Duration of the last cycle	Crude protein	Crude protein	Crude fat	Crude fibre	NFE	P	K	Ca
Cocksfoot grass								
1.09	14.5	13.4	3.16	28.2	44.6	0.37	2.36	0.77
1.10	15.3	13.8	3.29	29.6	42.1	0.35	2.10	0.41

Table 5. Continued

Duration of the last cycle	Crude protein	Crude protein	Crude fat	Crude fibre	NFE	P	K	Ca
Cocksfoot grass								
1.11	12.4	11.0	3.02	32.5	43.0	0.29	2.08	0.47
1.12	11.9	11.0	2.58	35.7	38.6	0.28	2.01	0.50
Smooth brome								
1.09	14.7	13.6	2.92	29.8	42.5	0.37	1.34	0.69
1.10	15.1	13.7	3.15	29.7	43.1	0.39	2.08	0.56
1.11	12.8	11.6	3.11	33.2	41.6	0.40	2.14	0.51
1.12	11.2	10.2	2.29	36.5	38.7	0.32	2.04	0.49
Meadow fescue								
1.09	13.1	12.2	2.89	30.5	43.6	0.37	1.52	0.74
1.10	13.4	12.4	3.01	31.4	42.3	0.37	2.09	0.48
1.11	12.1	11.4	2.96	33.1	41.4	0.37	2.13	0.43
1.12	9.8	9.1	2.36	38.3	38.1	0.31	1.88	0.36
Tall fescue								
1.09	14.5	13.3	3.12	29.6	42.7	0.36	1.75	0.67
1.10	14.2	12.7	3.31	30.3	42.1	0.38	2.07	0.45
1.11	13.1	11.5	2.93	32.9	40.6	0.36	2.18	0.54
1.12	10.7	9.8	2.35	36.3	39.2	0.31	2.07	0.46
Meadow timothy								
1.09	13.6	12.5	3.17	29.1	43.2	0.36	1.70	0.59
1.10	12.9	11.8	2.74	31.8	43.0	0.38	2.10	0.41
1.11	12.4	11.3	2.49	33.9	42.2	0.37	2.12	0.48
1.12	10.2	9.6	2.38	38.3	37.5	0.29	1.66	0.38
Intermediate wheatgrass								
1.09	14.1	13.0	3.13	29.5	43.6	0.37	1.96	0.70
1.10	13.3	12.1	3.02	31.1	42.6	0.37	2.05	0.48
1.11	12.6	11.7	2.92	33.4	40.8	0.36	2.19	0.40
1.12	10.6	9.8	2.19	37.2	38.5	0.26	1.61	0.29
Red fescue								
1.09	14.8	13.5	2.73	30.6	42.7	0.35	1.80	0.51
1.10	14.7	13.5	3.35	27.7	44.6	0.36	2.11	0.50
1.11	13.3	12.3	3.22	32.5	41.0	0.36	2.13	0.49
1.12	11.9	10.9	2.18	35.4	39.2	0.33	1.80	0.38
Smooth meadow-grass								
1.09	14.1	12.8	3.46	29.5	43.3	0.35	1.83	0.74
1.10	13.9	12.6	3.19	31.4	42.0	0.38	2.11	0.47
1.11	12.2	11.4	2.83	33.7	40.6	0.40	2.17	0.48
1.12	10.2	9.6	2.45	36.8	38.9	0.29	1.66	0.35
LSD_{05}, t/ha	0.5	0.4	0.1	1.0	1.9	0.02	0.13	0.03
Zootechnical norm	14	–	3-5	25-30	–	0.2-0.4	1.0-3.0	0.3-0.6

Source: *compiled by the authors*

However, the forage of agrocoenoses of grasses, even after the last cycle of use 1.12, was quite suitable for grazing less demanding beef cattle. The obtained data on the chemical composition of the feed showed that the biomass of grass stands was more or less balanced in terms of the content of organic and mineral elements and, in general, met the zootechnical standards for feeding cattle.

The study by V. Kurhak *et al* (2023) shows that the creation of intensive-type sown grasslands with multi-mowing has an important role in increasing the production of cheap grass fodder. They are a reliable measure to increase the productivity of meadow land and significantly improve the quality of fodder compared to traditional single- or double- mowing. Multi-mown grass stands are created using economically feasible and environmentally sound doses of nitrogen mineral fertilisers at the level of N_{90-150} in combination with the application of phosphorous and potash fertilisers. These fertilisers increase the productivity of floodplain, lowland, normal dry and irrigated grasslands by 2-3 times, the productive longevity of sown cereal components, and the share of valuable forage grass species in natural grass stands.

In single-species coenoses, they react well to nitrogen and are among the more productive perennial grasses: smooth brome, cocksfoot grass, red fescue, smooth meadow-grass, perennial ryegrass (Kurhak & Karbivska, 2019). One of the most important areas of grassland farming is the creation of multi-seasonal sown high-yield grasslands. On high agricultural backgrounds, subject to the recommended regimes of use, multi-season grass stands provide not only high productive longevity of meadow coenosis and proper fodder quality, but also, due to the wide range of species and varieties, allow organising continuous fodder production based on them. Such intensive grass stands should be created during the application of full mineral fertiliser in meadows with sufficient moisture (low-lying, floodplain small rivers, dry land with normal moisture.

Along with increasing the yield of sown meadow lands by selecting the most productive species and varieties, creating optimal growing conditions for them, obtaining high-quality feed is important for feeding livestock. It is known that under certain conditions, good quality of grass feed is also provided by grass stands. First of all, this is ensured by applying sufficient doses of nitrogen fertilisers. With increasing doses of nitrogen fertilisers, the content of crude protein and protein in grasses increases and the content of nitrogen-free extractives and, in particular, their component part – hydrocarbons, including water-soluble or sugars – decreases (Karbivska, 2020a; 2020b).

The mode of use also significantly affects the productivity and quality of feed. As the frequency of grass alienation increases, the possibilities of using solar energy decrease, since most of the growing season is used to grow them when they do not yet have the optimal leaf surface for maximum photosynthesis. With frequent mowing, the roots are more depleted and less "spare substances" are deposited in the reserve organs. In many herbs, these substances begin to accumulate intensively only in the phases of stemming, earing, budding, and even flowering. Therefore, frequent alienation is particularly dangerous for them, they grow weaker, overwinter worse, and provide lower yields (Kurak, 2023).

The timing of harvesting perennial herbs has a decisive influence on the content of protein, fibre, mineral elements, vitamins, and other substances in plants. The best quality fodder is obtained when mowing grasses in the early phases of vegetation, when plants use the main nutrients, including spare and re-synthesised ones, to increase the vegetative mass. As plants age, especially during the flowering period and seed formation, when growth processes slow down and nutrients are deposited in the storage organs, the quality of grass biomass deteriorates greatly. All this is accompanied by a decrease in valuable nutrients (protein, carotene, minerals) and an increase in the content of the least nutritious part of the feed in grass biomass — fibre (Favre *et al.,* 2019).

Thus, the analysis of literature sources has shown that one of the conditions for obtaining sufficient productivity of cereal herbage and good feed quality is the introduction of environmentally and economically justified doses of mineral fertilisers, and mowing grasses in optimal terms. This is of particular importance when alienating grass stands in the late autumn period, which is confirmed by current research.

CONCLUSIONS

Against the background of $N_{120}P_{45}K_{90}$ application on grey forest soils, perennial grasses are suitable for late autumn use in the continuous pasture system for grazing beef cattle in reserve pens, which, with long-term use (on average, 8 years), provide 5.33-7.19 t/ha of dry weight. Perennial grasses are characterised by various productive longevity. In single-species agrophytocoenoses, it is best to preserve the cocksfoot grass, smooth brome, tall fescue, and red fescue with a 50-97% share of sown culture for 8 years, and the highest productivity is the cocksfoot grass, smooth brome, and intermediate wheatgrass. It is well kept in single-species agrophytocoenoses at the level of 55-96% and provides high productivity only during the first three years of meadow fescue and meadow timothy. Tall fescue, red fescue, and smooth meadow-grass occupy an intermediate position in these indicators.

All types of perennial grasses provide the highest productivity in the total for three cycles of use due to the alienation of aboveground biomass in the last cycle of use 01.10. With the last alienation of 1.12 compared to alienation of 1.10, the total productivity decreases by 0.31-0.48 t/ha. The productivity of the last cycle of use of the grass species under study with different periods of its implementation in terms of dry weight per 1 ha ranges from 0.29-0.86 t, fodder units – 0.15-0.53 t, and crude protein – 0.04-0.16 t. The most productive are intermediate wheatgrass and red fescue, and the least – meadow fescue and smooth meadow-grass. In the last cycle of use, at different times of its implementation, the supply of the fodder unit with digestible protein ranges from 102 to 122 g, and the dry weight content in the green mass of feed ranges from 31.9 to 36.7%. With the shift of the last cycle of use from 1.09 to 1.12, the quality of feed worsens: the supply of digestible protein to the fodder unit decreases, and the content of dry weight in the green mass of feed increases. At the same time, the crude protein content in dry weight decreases by 2.9-3.9%, and protein, crude fat, and the mineral macronutrients phosphorus, potassium and calcium, while the crude fibre content increases by 5.2-7.5%.

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CONFLICT OF INTEREST

None.

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Добір багаторічних злакових трав для подовженого пасовищного конвеєра в осінній період

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Анотація. Актуальність наведених результатів досліджень полягає в тому, що до останнього часу не з'ясовано реакцію різних видів багаторічних злакових трав на строки відчуження травостоїв в останньому циклі використання, що стримує розроблення і впровадження технології створення багаторічних агрофітоценозів у системі зеленого пасовищного конвеєра з подовженим терміном випасання м'ясного поголів'я худоби в пізньоосінній період. Мета досліджень полягала в доборі кращих багаторічні злакові трави для пізньоосіннього відчуження травостою у системі подовженого пасовищного конвеєра для м'ясних порід великої рогатої худоби в Правобережному Лісостепу. Наведено результати багаторічних досліджень з вивчення особливостей формування урожаю надземної біомаси, хімічного складу корму, стійкості окремих видів злакових трав залежно від строків відчуження надземної біомаси в сумі за всі цикли використання та в останньому циклі в осінній період. Найбільшу продуктивність (на рівні 0,60-0,95 т/га сухої маси) всі види злакових трав в останньому (осінньому) циклі використання забезпечують при відчуженні зеленої маси 1-го жовтня. При відчуженні у пізніші строки збір сухої маси з 1 га зменшується, одночасно погіршується якість корму через зменшення вмісту сирого протеїну та збільшення концентрації сирої клітковини до меж, що не відповідають зоотехнічній нормі годівлі великої рогатої худоби та вимогам ДСТУ на зелені корми. Дослідженнями виявлено кращі одновидові агрофітоценози злакових трав, якими є стоколос безостий, грястиця збірна, пирій середній. Вони в середньому за 2008-2015 роки у сумі за всі три цикли використання при внесенні N_{120} забезпечують продуктивність на рівні 6,52-7,19 т/га сухої маси. Результати цих досліджень можуть бути використані при розробленні рекомендацій щодо формування пасовищних конвеєрів з подовженим в осінній період терміном випасання травостою м'ясним поголів'ям худоби, що дозволяє знизити собівартість і підвищити конкурентноздатність тваринницької продукції

Ключові слова: добрива; зелені корми; продуктивність; пасовище; режим використання; резервний загін; хімічний склад корму; цикл використання