Scientific Papers. Series A. Agronomy, Vol. LXVI, No. 1, 2023
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

GRASSLANDS AS FODDER FOR ANIMALS AND RENEWABLE SOURCE OF ENERGY BIOMASS

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Abstract

Grasslands have a wide range of economic and ecological functions. We studied the productivity and quality of the biomass obtained from an area of grassland with Elymus repens, Poa pratensis and Festuca valesiaca, which is found within the boundaries of Orhei National Park, Republic of Moldova. The biomass was harvested at the beginning of the flowering stage and was dried under natural conditions. It was established that the productivity of grassland with Elymus repens were 4.72-9.31 t/ha dry matter, the grassland with Poa pratensis 1.38-3.63 t/ha dry matter and the grassland with Festuca valesiaca 1.59-3.77 t/ha dry matter. The biochemical composition of hay dry matter was: 6.62-13.90% crude protein, 1.31-3.43% crude fat, 26.65-40.78% crude cellulose, 43.27-53.02% nitrogen free extract, 2.41-6.82% sugars, 1.40-2.83% starch, 6.79-11.29% ash, 0.27-0.73% Ca, 0.15-0.30% P, 4.40-41.12 mg/kg carotene with energy concentration 17.78-18.44 MJ/kg GE, 7.93-9.73 MJ/kg ME and 4.28-5.50 MJ/kg NEl. The gas forming potential of the fermentable organic matter of the hay collected from the studied grassland varied from 400 to 598 l/kg VS, and specific methane yield varied from 210 to 314 l/kg VS.

Key words*: biochemical composition, fermentable organic matter, grasslands, hay, productivity, specific methane yields.*

INTRODUCTION

Grasslands play an important role in global agriculture; they are a basic source of nutrients for herbivores and ruminants and play an important role in the prevention of erosion, the immobilisation of leaching minerals and in carbon storage, help regulating water regimes and the purification of soils from pesticides and fertilizers (Marușca et al., 2014; Marușca, 2016; Sărățeanu et al., 2023).

The natural grasslands in the Republic of Moldova are in a poor condition, being heavily affected by excessive, unregulated grazing throughout the year and totally lacking a pastoral management system, a fact that affects their productive potential. In recent years, our region has been facing severe droughts. This phenomenon manifests itself more strongly when the soil drought is accompanied by atmospheric drought, and also by soil salinization. This leads to a decrease in the production of plant biomass, the appearance of imbalances in food supply for animals and, implicitly, to a decrease in zootechnical production (Lazu, 2014; Leah, 2016).

Considering this aspect, it is necessary to undertake activities to evaluate the grass cover of meadows, to determine the content of nutrients in aerial biomass, to establish the technological elements of re-cultivation that will contribute to the manifestation of the productive potential, to reduce the negative effects of drought and salinization on providing farm animals with high-quality feed, but also obtaining biomass for energy production.

The rapid increase in prices and the insecurity of the supply of the necessary amount of oil, gas and coal, as well as the global warming caused by greenhouse gas emissions have made humanity turn to new stable, non-polluting and renewable energy sources. The complex issues of renewable energy production are now addressed, in terms of policies, at global and regional scale. The European Commission has approved the Energy Policy which foresees the following objectives for the year 2030: a 33.5% increase in energy efficiency, a 40% reduction in greenhouse gas emissions and achieving a 32% share of renewable energy sources (EU Directive 2018 /2001*). From a historical point of view, biomass was the first form of energy source that was used by people since the discovery of fire. Biomass is considered a "carbon neutral" energy source because the carbon emitted during combustion was previously absorbed through photosynthesis during plant growth. Nowadays, bioenergy represents 60-70% of renewable energy production and is seen as a key solution for encouraging the sustainable development of rural areas. The problem of using renewable energy sources is still relevant for the Republic of Moldova, which is totally dependent on the import of fossil energy resources. The Law on Renewable Energy (2016) *** and the Energy Strategy until 2030 (2013) were approved; the "Energy and Biomass in Moldova"** Project was promoted in 2011-2017, being financed by the European Union.

The Republic of Moldova has no nuclear power plants, oil and natural gas deposits, the forest areas are limited, and most of the traditional energy resources are imported at high prices.

Being aware of the quantity and quality of forage provided by grasslands is very important in the context of establishing and applying sustainable grassland management measures. The evaluation of the current productivity and quality of grasslands is necessary for establishing and observing the grazing capacity, as well as for the sustainable development of the animal husbandry sector and the increase of the living standards in the rural areas.

The botanical composition, soil fertility and climatic conditions, as well as the time and frequency of harvesting of grasslands are the major factors that determine the productivity and nutritive value of pastures and the quality of prepared hay.

At national level, there are few studies on the amount of fodder on permanent grasslands and their biochemical composition, a fact that prompted the realization of this study.

The main objective of this research was to evaluate the productivity and quality of the biomass (hay) obtained from an area of grassland with *Elymus repens, Poa pratensis* and *Festuca valesiaca,* and prospect it use as forage for livestock and also as substrate for biogas production.

MATERIALS AND METHODS

The research was carried out during the years 2020-2022, in 3 types of grasslands, in the territory of Orhei National Park - grasslands with *Elymus repens, Poa pratensis* and *Festuca valesiaca* - as part of a comprehensive study which included the entire area of pastures in this park. Also, in the study it was included a sector of meadow with sedge (*Poa pratensis*) on the territory of the "Alexandru Ciubotaru" National Botanical Garden (Institute) (NBGI) with a balanced phytosociological composition, rich in plant species from the Fabaceae family considered as a standard.

Hay production was calculated by the gravimetric method based on the grass harvested at the first cut. Grass samples were taken from the studied grassland sectors at the beginning of the full flowering stage from sample areas of 1 m^2, in 3 repetitions, weighing the harvested green mass. The grass was mowed by hand at a height of 5-7 cm. The samples were dried under natural conditions in open air and then weighed again to calculate the amount of dry matter (hay).

The evaluation of hay quality: crude protein (CP), crude cellulose (CF), crude fat (EE), nitrogen-free extract (NFE), soluble sugars (SS), starch, ash, calcium (Ca), phosphorus (P), carotene, were carried out in the Laboratory of Nutrition and Forage Technology of the Scientific-Practical Institute of Biotechnology in Animal Husbandry and Veterinary Medicine, in accordance with the methodological indications. The gross energy (GE), metabolizable energy (ME), net energy for lactation (NEl) were calculated according to standard procedures:

GE=23.9xCP+39.8xEE+20.1xCF+17.5xNFE;

ME=14.07+0.0206xEE-0.0147xCF-0.0114xCP+4.5%;

NEl=9.10+0.0098xEE-0.0109xCF-0.0073xCP.

The carbon content of the substrates was determined from data on volatile solids (organic dry matter), using an empirical equation according to Badger et al. (1979). The biogas production potential and specific methane yields were evaluated by the parameter "content of fermentable organic matter", according to Weissbach (2008). The data were statistically processed using the MS Excel program.

RESULTS AND DISCUSSIONS

The economic importance of grasslands is determined by the diversity of plant species that make up the grass cover, which, correlated with the seasonal conditions and the management of the meadows, ensures both a high productivity and quality of fodder for animal husbandry.

The studied grasslands differ according to the phytosociological composition, the conditions of the site on which they are located and the way of exploitation, as well as the lack or presence of maintenance and care works. The main characteristics of the studied grasslands are presented in Table 1. By analysing the data, it is found that the *Festuca valesiaca* grasslands are located on slopes with predominantly northern exposure, with 4-15° inclination. They are used in mixed mode. *Poa pratensis* and *Elymus repens* grasslands are floodplain meadows, used as hayfield or pasture.

Table 1. The general characteristic of the studied grasslands

Year	Name of the local public authority	Name of the grassland area	Plot, subplot	Plot area ha	Relief type	Slope exposure	Inclination angle	Grassland type	Way of usage
2020	Ivancea	"Lângă Ivancea"	3B	3.62	slope	N	9 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)
	Ivancea	"La Iaz"	6A	10.87	slope	N	6 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)
	Puțintei	"Opt Martie"	8A	7.49	plain	-	-	grassland with *Elymus repens*	mixed (hayfield - pasture)
	Puțintei	"Hîrtoape Lagăr"	20A	29.71	slope	NW	10 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)
2021	Ghetlova	"Fîntîna Popii"	1A	13.83	plain	-	-	grassland with *Elymus repens*	mixed (hayfield - pasture)
	Ghetlova	"Șes la Ghetlova"	13A	5.61	plain	-	-	grassland with *Elymus repens*	mixed (hayfield - pasture)
	Ghetlova	"Budăi Hulboaca"	17B	12.62	slope	NE	15 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)
	Morozeni	"Breanova"	1E	18.20	slope	NE	8 °	grassland with *valesiaca*	mixed (hayfield - pasture)
	Morozeni	"Breanova"	1F	12.17	slope	N	4 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)
2022	Ivancea	"Dereneuca"	2 A,B	17.24	plain	-	-	grassland with *Poa pratensis*	mixed (hayfield - pasture)
	Trebujeni	"La Potîrcă-1"	4A	11.22	plain	-	-	grassland with *Poa pratensis*	pasture
	Trebujeni	"La Peșteri"	13B	22.16	plain	-	-	grassland with *Poa pratensis*	hayfield
	NGBI	"Luncă cu firuță"	NGBI	1.00	plain	-	-	grassland with *Poa pratensis*	hayfield
	Codreanca	"Valea Rohului"	3C	18.30	slope	SE	8 °	grassland with *Festuca valesiaca*	mixed (hayfield - pasture)

Based on the harvests from the sample areas, after the drying of the cut grass and the subsequent weighing of obtained dry mass, the production of hay per hectare was calculated. The average production per hectare for each type of grassland was also calculated and the productivity category was established. The obtained results are presented in Table 2.

The highest production of hay was obtained on *Elymus repens* grasslands, on average about 6 t/ha, which places them in the category of grasslands with very high productivity.

Poa pratensis grasslands have productivity of 1.38-3.63 t/ha dry matter. The average production obtained from these grasslands is about 2.5 t/ha, which corresponds to the high productivity category. According to the obtained data, the highest productions are obtained from the grasslands used as hayfields (the grassland 13B - "La Peșteri" belonging to the town hall of Trebujeni; the grassland "Luncă cu firuță" of NBGI).

The *Festuca pratensis* grasslands, although located on slopes, but used rationally in a mixed regime, provide good hay production, between 1.59 and 3.77 t/ha hay. The average production for this type of grasslands, obtained during the study period, is 2.7 t/ha, which corresponds to the medium productivity category.

Table 2. Hay production under the conditions of the years 2020-2022, by type of grasslands (t/ha)

Year	Name of the local public authority	Name of the grassland area	Plot, subplot	*Elymus repens*	*Poa pratensis*	*Festuca valesiaca*
2020	Ivancea	"Lângă Ivancea"	3B			2.03
	Ivancea	"La Iaz"	6A			2.69
	Puțintei	"Opt Martie	8A	4.72		
	Puțintei	"Hîrtoape Lagăr"	20A			1.68
2021	Ghetlova	"Fîntîna Popii"	1A	9.31		
	Ghetlova	"es la Ghetlova"	13A	5.03		
	Ghetlova	"Budăi Hulboaca"	17B			3.75
	Morozeni	"Breanova"	1E			3.77
	Morozeni	"Breanova"	1F			3.64
2022	Ivancea	"Dereneuca"	2 A,B		2.24	
	Trebujeni	"La Potîrcă-1"	4A		1.38	
	Trebujeni	"La Peșteri"	13B		3.63	
	NBGI	"Luncă cu firuță"	NBGI		2.88	
	Codreanca	"Valea Rohului"	3C			1.59
Average production, t/ha hay				6.35	2.53	2.74
Productivity category				Very high	medium	medium

Several literature sources have described the productivity of permanent grasslands. According to Medvedev & Smetannikova (1981), the hay yield of grassland with *Elymus repens* varied from 3.2-12.5 t/ha, but grassland with *Poa pratensis* 2.5-3.0 t/ha. Samuil & Vintu (2012) mentioned that the dry matter production of permanent grassland with *Festuca valesiaca* was 3.3 t/ha, but in the variants with fertilization treatments with different rates and combinations of organic and mineral fertilizers – it was 4.2-5.1 t/ha. Vintu et al. (2017) revealed that the productivity of non-fertilized *Festuca valesiaca* grasslands was 2.30 t/ha, but manure applied at 10-40 t/ha contributed to an increase in productivity between 54 and 67% or 3.55-3.83 t/ha DM.

Forages are a major source of nutrients for herbivores. Sometimes the balance of nutrients or the presence of some constituents in the forage will have positive or negative effects on animal health and productivity. The biochemical composition and energy concentration of prepared hays from the studied grasslands are presented in Table 3. The hay collected from grasslands with *Elymus repens* contained 6.62-11.79% CP, 1.31-2.47% EE, 30.78-37.17% CF, 40.64-53.01% NFE, 4.31-6.82% sugars, 1.40-1.79% starch, 7.12-7.69% ash, 0.27-0.49% Ca, 0.16-0.21% P, 4.40-9.0 mg/kg carotene with energy concentration 17.94-18.22 MJ/kg GE, 8.05-9.73 MJ/kg ME and 4.39-5.50 MJ/kg NEl. The forage quality of hay from grasslands with *Festuca valesiaca* was 7.85-12.20% CP, 1.99-3.15% EE, 29.92-40.78% CF, 40.42-49.03% NFE, 2.41-5.37% sugars, 1.78-2.93% starch, 6.79-8.44% ash, 0.31-0.48% Ca, 0.13-0.20% P, 3.45-29.00 mg/kg carotene, 18.17-18.41 MJ/kg GE, 7.93-9.48 MJ/kg ME and 4.28-9.48 MJ/kg NEl. The hay from grasslands with *Poa pratensis* contained 10.19-13.43% CP, 2.53-3.43% EE, 26.25-32.02% CF, 43.27-47.77% NFE, 5.24-8.23% sugars, 1.79-2.83% starch, 7.74-11.29% ash, 0.34-0.73% Ca, 0.27-0.30% P, 29.50-41.12 mg/kg carotene, 17.78-18.44 MJ/kg GE, 9.11-9.55 MJ/kg ME and 5.16-5.4 MJ/kg NEl.

Some authors mentioned various findings about the forage quality. According to Nissinen & Hakkola (1995), the quality of the hay from *Poa pratensis* was characterized by 10.0-11.8% CP, 32.7-33.9% CF and 70.8% OMD, but from *Festuca pratensis* - 8.7-11.4% CP, 34.2-36.2% CF and 63.9% OMD. Yagi et al. (2001) revealed that the hay prepared from *Elytrigia repens* contained 241 g/kg CP, 528 g/kg NDF, 295 g/kg ADF, 2.4 g/kg Ca, 3.9 g/kg P, and *Poa pratensis* hay - 210 g/kg CP, 579 g/kg NDF 330 g/kg ADF, 3.1 g/kg Ca, 3.5g/kg P; *Dactylis glomerata* hay - 194 g/kg CP, 525 g/kg NDF, 293 g/kg ADF, 2.9 g/kg Ca, 3.2g/kg P; *Lolium perenne* hay -224 g/kg CP, 511 g/kg

NDF, 283 g/kg ADF, 5.3 g/kg Ca, 3.4 g/kg P and *Phalaris arundinacea* hay contained 212 g/kg CP, 549 g/kg NDF, 309 g/kg ADF, 2.9 g/kg Ca, 3.2g/kg P, respectively. Dürr et al. (2005) found that the chemical composition of fodder from Kentucky bluegrass cultivars was 24.8-40.6 g/kg N, 524-565 g/kg NDF, 268-290 g/kg ADF, 3.8-5.1 g/kg Ca, 3.1-3.7 g/kg P. Maheri-Sis et al. (2008) mentioned that the chemical composition and nutritive value of hay from quackgrass, *Agropyron repens* harvested at late maturity was 950 g/kg DM, 887 g/kg OM, 8.9% CP, 1.44% EE, 34.30% CF, 66.0% NFE, 8.96% NFC, 69.60% NDF, 38.30% ADF, 5.70% ADL, 11.2% ash, 43.54% ODM and 6.58 MJ/kg ME. Tambe & Rawat (2009) reported the *Festuca valesiaca* fodder is characterised by 11 % CP, 81 % NDF, 41% ADF, 57% DDM, RFV=65. Samuil & Vintu (2012) mentioned that the dry matter collected from unfertilized permanent grassland with *Festuca valesiaca* contained 90.1 g/kg CP and 242.2 g/kg CF, but in the variants with fertilization treatments, 90.6-103.4 g/kg CP and 237.8-241.2 g/kg CF were obtained, respectively. Jankowska-Huflejt (2014) remarked that the hay from organic grasslands contained 10.75% CP, 2.98% EE, 30.59% CF, 7.31% ash, 0.64% Ca, 0.25% P. Vintu et al. (2017) found that the chemical composition and the nutritive value of forage from non-fertilized *Festuca valesiaca* grasslands was 7.8% CP, 75.2% NDF, 46.8% ADF, RFV=65, but in manure applied variants respectively 9.2-10.4% CP, 56.8-60.8% NDF, 41.9-42.4% ADF, RFV=87-93. Boob et al. (2019) remarked that the nutritive value of lowland hay meadows were 6.80-13.50% CP, 4.46-5.81 MJ/kg NEl. Nazare et al. (2019) reported the quality of the forage obtained from a *Festuca valesiaca* grassland, harvested at the ear formation stage, was 8.17% CP, 56.77% NDF, 34.84% ADF, RFQ=109.20, but in the variants with the application of fertilizers the respective values were obtained 8.86-12.36 % CP, 48.92-57.77% NDF, 32.29-35.29% ADF, RFQ=107.67-126.38. Çaçan (2022) revealed that quality characteristics of *Poa pratensis* were 11.07-13.50% CP, 5.77% ash, 1.40% EE, 51.5-59.66% NDF 26.7-32.3% ADF, 0.60-4.47% ADL, 63.5-65.65% DDM, RFV=102.2-123

Table 3. Nutrients and energy concentration in prepared hays from studied grasslands

Plot, subplot	Nutrients										Energy concentration		
	CP, %	EE, %	CF, %	NFE, %	sugars %	starch %	ash, %	Ca, %	P, %	carotene, mg/kg	GE, MJ/kg	ME, MJ/kg	NEl, MJ/kg
Elymus repens grasslands													
8A	6.62	2.47	30.78	53.01	-	-	7.12	-	-	4.40	18.01	9.73	5.50
1A	8.36	1.31	36.87	45.77	6.82	1.79	7.69	0.27	0.16	9.00	17.94	8.33	4.61
13A	11.79	2.07	37.17	40.64	4.31	1.40	7.60	0.49	0.21	6.50	18.22	8.05	4.39
Festuca valesiaca grasslands													
3B	10.35	3.15	30.42	47.64	-	-	8.44	-	-	13.00	18.17	9.48	5.33
6A	9.58	2.60	31.27	49.03	-	-	7.52	-	-	10.83	18.19	9.32	5.24
20A	12.20	2.98	29.92	47.38	-	-	7.52	-	-	24.64	18.41	9.29	5.24
17B	9.31	2.29	36.35	45.05	3.80	1.92	7.00	0.45	0.20	3.45	18.38	8.09	4.67
1E	9.16	2.17	40.03	40.42	2.41	1.78	8.22	0.48	0.13	28.8	18.18	7.94	4.28
1F	7.85	1.99	40.78	41.76	2.54	2.83	7.62	0.47	0.15	19.3	18.18	7.93	4.28
3C	7.94	2.34	35.70	47.23	5.37	2.17	6.79	0.31	0.17	29.00	18.27	8.77	4.86
Poa pratensis grasslands													
2AB	11.00	3.43	31.52	46.31	8.23	2.83	7.74	0.34	0.27	-	18.44	9.30	5.20
4A	13.90	2.79	26.65	47.77	6.32	1.94	8.89	0.46	0.30	41.12	18.15	9.55	5.46
13B	10.19	2.53	32.02	46.30	6.65	1.97	8.96	0.48	0.27	29.50	17.99	9.11	5.16
NBGI	13.43	2.86	29.15	43.27	5.24	1.79	11.29	0.73	0.30	34.12	17.78	9.24	5.21

Increasing biomass usage leads to the reduction of greenhouse gases emissions compared to the use of fossil fuels. After harvesting often such biomass is stored for long periods for composting due to the lack of alternative use strategy, excess biomass must be used for energy renewable production. In recent years considerations on grassland use for bioenergy have increased considerably, can be used as biomass feedstock for production solid fuel, lignocellulosic bioethanol, synthetic natural gas or synthetic biofuels, and in particular for biogas production. Grass is being considered as a potential feedstock for biogas production, due to its low water consumption compared to other crops, and the fact that it can be cultivated in non-arable lands, avoiding the direct competition with food crops. The grasses need to be collected and processed to the required condition, e.g. grass silage, hay, hay pellets, for use for energy production purposes (Prochnow et al. 2009; Rösch et al. 2009; Meyer et al. 2014; Dubrovskis et al. 2018).

Organic dry matter or volatile solid yield is an important factor influencing biogas and methane yield. Differences in gas formation potentials of crops are mainly due to specific chemical compositions of the plant material. Crude protein is the main nitrogen-containing nutrition component for microbes converting biomass. It is a commonly known fact that methanogenic bacteria need a suitable ratio of carbon to nitrogen for their metabolic processes, ratios higher than 30:1 were found to be unsuitable for optimal digestion, and ratios lower than 10:1 were found to be inhibitory, because of low pH, poor buffering capacity and high concentrations of ammonia in the substrate. The nitrogen content in the studied hay substrates ranged from 10.59 to 22.24 g/kg, the estimated content of carbon - from 492.9 to 517.8 g/kg, the C/N ratio varied from 23 to 29.

It is well known that fat is a good source of energy. Carbohydrates supply most of the energy for maintaining vitality. The two carbohydrate fractions commonly used in evaluating the carbohydrate content of substrates are crude cellulose and nitrogen-free extract. The capability of biomass methanization is tightly associated with nutrient digestibility and plant species. When crude cellulose content increases, digestibility usually decreases. Nitrogen-free extract contains the most digestible portion of the carbohydrates. Fermentable organic matter represents the proportion of organic matter which can be biologically degraded under anaerobic conditions and, thus, can be potentially utilized in biogas facilities. The fermentable organic matter concentration in the tested hay substrates ranged from 500 to 747 g/kg, the gas forming potential of the fermentable organic matter varied from 400 to 598 l/kg VS, and specific methane yield - from 210 to 314 l/kg VS (Table 4). The best results were achieved in hay substrates collected from grassland with *Poa pratensis* with specific methane yield of 282-314 l/kg VS, likely low content of crude fiber. The methane yield per ha for grassland with *Elymus repens* ranged from 1217 to 2273 m^3/ha, and from grassland with *Poa pratensis* - 433 to 998 m^3/ha, while from grassland with *Festuca valesiaca* - 409 to 941 m^3/ha, respectively.

According to Mähnert et al. (2002) methane yields from grasses with intensive growth were 310-360 l/kg VS. Kaparaju (2003) found that the specific methane yield of grass hay substrates varied from 270 to 350 l/kg VS. Mähnert et al. (2005) compared the quality of biomass from seven types of grass, the results for biogas yield were: perennial ryegrass 904-929 l/kg VS, cocksfoot 718-800 l/kg VS, tall fescue 818-836 l/kg VS, red fescue 767-845 l/kg VS, meadow fescue 846-909l/kg VS, meadow foxtail 804 l/kg VS and timothy grass 591- 828 l/kg VS. Amon et al. (2007) mentioned that the specific methane yields of grassland from the mountain and from the valley region showed significant differences. Irrespectively of the number of cuts, only a low specific methane yield (128-221 l/kg VS) was measured from the biomass coming from the hill site, but the grass grown at the valley site produced 190-392 l/kg VS methane; the highest methane yield with one cut was reached with the late first cut in the three-cuts system namely 1872 m^3/ha; the average methane yield of the hill site was 910 m^3/ha. Seppälä et al. (2009) remarked that specific methane yields of grass substrates varied from 253 to 394 l/kg VS, and the methane and energy yields from different harvest years ranged from 1200 to 3600 m^3/ha/year.

Meyer et al. (2014) revealed that methane yield of roadside grass was 220-390 l/kg VS. Țîței (2016) reported that the methane yield of native perennial grasses (*Dactylis glomerata*, *Festuca arundinacea)* ranged from 2077 to 2243 m^3/ha, and from introduced *Agropyron* species - 1386-1605 m^3/ha, *Miscanthus* species 3348-4128 m^3/ha. Mattioli et al. (2017) reported that the biogas production from grass collected from public parks was 600-650 m^3/t. Dubrovskis et al. (2018) found that the grass hay pellet substrate achieved 666 l/kg VS biogas or 355 l/kg VS methane. Boob et al. (2019) mentioned that the methane yield of the substrate from lowland hay meadows was 259-320 l/kg VS.

Table 4. The methane production potential of hay substrates from studied grasslands

Plot, subplot	Nitrogen, g/kg	Carbon, g/kg	C/N	Fermentable organic matter, g/kg	Biogas potential, l/kg	Specific methane yield, l/kg	Methane production potential, m^3/ha
Elymus repens grasslands							
8A	10.59	516.0	49	672	538	282	1331
1A	13.38	512.8	38	580	464	244	2272
13A	18.86	513.3	27	575	460	242	1217
Festuca valesiaca grasslands							
3B	16.56	508.7	31	687	549	288	585
6A	15.33	513.8	34	682	546	286	769
20A	19.52	513.8	26	703	562	295	496
17B	14.90	516.7	35	598	478	251	941
1E	14.66	509.9	35	511	409	215	811
1F	12.56	513.2	41	500	400	210	765
3C	12.70	517.8	41	612	490	257	409
Poa pratensis grasslands							
2AB	17.60	512.6	29	676	540	284	636
4A	22.24	506.2	23	747	598	314	433
13B	16.30	505.8	31	654	524	275	998
GBNI	21.49	492.8	23	678	543	282	812

CONCLUSIONS

The productivity of grassland with *Elymus repens* were 4.72-9.31 t/ha dry matter, the grassland with *Poa pratensis* 1.38-3.63 t/ha dry matter and the grassland with *Festuca valesiaca* 1.59-3.77 t/ha dry matter.

The biochemical composition of hay dry matter was: 6.62-13.90% crude protein, 1.31-3.43% crude fat, 26.65-40.78% crude cellulose, 43.27-53.02% nitrogen free extract, 2.41-6.82% sugars, 1.40-2.83% starch, 6.79-11.29% ash, 0.27-0.73% Ca, 0.15-0.30% P, 4.40-41.12 mg/kg carotene with energy concentration 17.78-18.44 MJ/kg GE, 7.93-9.73 MJ/kg ME and 4.28-5.50 MJ/kg NEl. The gas forming potential of the fermentable organic matter of the hay collected from the studied grassland varied from 400 to 598 l/kg VS, and specific methane yield varied from 210 to 314 l/kg VS.

The hay collected from the studied grasslands can be used as fodder for livestock, also as energy biomass for biomethane production.

ACKNOWLEDGEMENTS

The study has been carried out in the framework of the projects: 20.80009.7007.01 and 20.80009.5107.02

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