Evaluation of perennial grass mixtures of different species and varieties in the central part of Latvia introduced from other European countries

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Abstract. Forage grasses growing in the wild and cultivated in fields represent many species with various properties. Scientists at the LUA Research Institute of Agriculture have for many years performed purposeful breeding work with the aim of originating new, highly productive cultivars of different grassland species with good forage quality suitable for growing under Latvia's climatic conditions, as well as being competitive in the EU countries. A field trial was sown in 2007 to evaluate our new cultivars in the poly-component mixtures with diploid and tetraploid varieties of forage grasses and mixtures offered by other companies and countries. Twenty-two multiform grassland mixtures for cutting and pastures were compared. The test results proved that it is possible to obtain two full cuttings from these mixtures in the sowing year under good climatic conditions; the most productive mixtures yielded 8 t ha^{-1} DM and more. In the first year, with three cuts, DM yields ranged within 8.89–16.11 t ha^{-1} the highest DM yields were obtained from mixtures with the newest perennial grass cultivars of the Research Institute. The average DM yields for better swards (SK-1, SK-2, SK-3, P/2) were above 10 t ha^{-1} in three years. The mixtures with white clover and rhizomatous low grasses proved to be most winter-hardy. The highest protein content and digestibility in the first year of use were the characteristic features of cutting mixtures SK-5 and P/1, but in the second year, it was found in mixtures for grazing Dot-21, Dot-24, SK-6 and G-2.

Key words: forage grasses, varieties, mixtures, DM yield, forage quality

INTRODUCTION

Latvia's humid climate on the Baltic Sea is especially suited for the development, growth and harvesting of high yield perennial grasses. It is no wonder that these grasses take up almost half the meadows and pastures of the land suitable for agriculture. Precisely these perennial grasses that occur in the natural or cultivated biocenosis make the most complete and effective use of our comparatively short growing period; in addition, they are the most economical consumers of applied fertilizer. Therefore this is the most important plant group in our country and the main source of energy and nutrients for dairy cattle, meat animals, horses, goats and sheep for use in summer and winter. The perennial grasses of Latvia, both natural and cultivated, represent many species and noticeably more varieties with various agricultural and biological properties (Jansone et al., 2008). Legumes and perennial grasses usually occur together, forming symbiotic plant communities, which have best adapted to the specific ecological properties and conditions of use (Adamovics, 2001.). It is profitable to make use of these characteristics in developing high yield perennial cultivated grasslands with good forage quality. The rational choice of species and varieties appropriate to each soil type and requirements guarantees an adequate supply of fodder the whole year through. It is necessary to note also that a correctly composed mixture of grasses will best utilize solar energy and the photosynthesis processes will occur more intensively because the foliage of perennial and legume grasses occur at different architectonic levels, but their root systems develop at differing depths.

The main criteria for structuring perennial grasslands are their biological harmony, the economic effectiveness of growth and productive sustainability (Vasjko, 2007). In order for cattlemen to have a grass mixture suitable for each farm's needs and specialization to develop various fodder mixtures, the Research Institute of Agriculture (RIA) has for many years pursued selection work aiming to develop new, high yield and long-term grass and legume cultivars. The goal of the research was to compare the newest grass varieties and mixtures that have been selected in Latvia with those of other countries, to evaluate their winter-hardiness and productivity as well as the quality of the fodder under our climatic conditions. Grazing legume/grass mixtures can increase the polyunsaturated fatty acid content of milk and can thus have a positive impact on consumers' health (Peeters et al., 2006). The use of legume grasses also promotes long-term agricultural development and protects the ecosystem because of their capacity to fix atmospheric nitrogen (N) (Kadziuliene & Sarunaite, 2005; Peeters et al., 2006). Farmers are also under the pressure of environmental regulations, notably the European Nitrate directive and its national transpositions. Common Agricultural Policy (CAP) could now shift the balance of economic advantage towards legumes and away from high usage of inorganic N fertilizers on grass swards (Rochon et al, 2004). This is also one of the goals of the experiment – to obtain maximal fodder yield with a high energy potential but with minimal nitrogen fertilizer.

MATERIALS AND METHODS

The experiment was established on May 23, 2007 on the experimental fields of the Research Institute of Agriculture (RIA) on podzolic, for clay-sandy to sandy clay loam with pH_{KCl} of 6.1, humus 2.0–2.5%, phosphorus (P) content 200–220 mg, potassium (K) 230 mg per kilogram of top-soil. Before sowing the field received a fertilizer complex of NPK 5-20-20 with microelements of 300 kg ha^{-1}. This complex fertilizer of 300 kg ha^{-1} was used in the following two years immediately after the start of vegetation. Sowing was done without cover crop; plots of 10 m^2 were randomized in a complete block and replicated three times. At development of the 2–3 leaf stage, the plants were sprayed against dicotyledon weeds.

Included in the experiment were 22 different legume and perennial grass mixtures, which were intended for cutting and grazing, including seven mixtures created by the (RIA) (SK-1, SK-2, SK-3, SK-4, SK-5, SK-6, SK-7); 7 mixtures offered by Ltd.'Seeds of Latvia' (P/1, P/2, P/3, P/4, G-1, G-2, G-4); five 'Dotnuvos Projektai' (Dot-L1, Dot-L2, Dot-21, Dot-24, Durpe-2) and 3 Danish mixtures (SweDane I, SweDane II, SweDane III). The composition of the grass mixtures is shown in Table 1. In the RIA mixtures various diploid and tetraploid legumes and perennial grasses species of various earliness were used. The poly-component mixtures were compared with the traditional mixture of red clover and timothy, which is still relatively widely used in production.

Table 1. The composition of the grass mixtures included in the experiment.

Mixtures	Composition		
	Species	Cultivar	% of seeds weight
SK-1	Red clover (*Trifolium pratense L.*)	Skriveru agrais	30
	Timothy (*Phleum pratense* L.)	Teicis	20
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)	Saikava	25
	Meadow fescue (*Festuca pratensis* Huds)	Silva	25
SK-2	Red clover (*Trifolium pratense L.*)	Skriveru tetra	29
	Timothy (*Phleum pratense* L.)	Teicis	11
	Perennial ryegrass (*Lolium perenne* L.)	Spidola	14
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)	Saikava	25
	Meadow fescue (*Festuca pratensis* Huds)	Patra	21
SK-3	Red clover (*Trifolium pratense)*	Jancis	29
	Meadow fescue (*Festuca pratensis* Huds)	Vaira	11
	Meadow fescue (*Festuca pratensis* Huds)	Silva	18
	Perennial ryegrass (*Lolium perenne* L.)	Spidola	11
	Timothy (*Phleum pratense* L.)	Teicis	11
	Timothy (*Phleum pratense* L.)*L.*)	Varis	10
	Red fescue (*Festuca rubra* L.)	Vaive	10
SK-4	Red clover (*Trifolium pratense L.*)	Divaja	24
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)	Saikava	24
	Meadow fescue (*Festuca pratensis* Huds)	Patra	24
	Timothy (*Phleum pratense* L.)	Varis	28
SK-5	Red clover (*Trifolium pratense L.*)	Stendes velais	41
	Timothy (*Phleum pratense* L.)	Varis	59
SK-6*	White clover (*Trifolium pratense* L.)	Daile	4
	Perennial ryegrass (*Lolium perenne* L.)	Spidola	26
	Meadow fescue (*Festuca pratensis* Huds)	Silva	22
	Timothy (*Phleum pratense* L.)	Teicis	26
	Red fescue (*Festuca rubra* L.)	Vaive	9
	Meadow grass (*Poa pratensis* L.)	Gatve	13
SK-7	Alfalfa (*Medicago varia* M.)	Skriveru	40
	Meadow fescue (*Festuca pratensis* Huds)	Patra	20
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)	Saikava	20
	Timothy (*Phleum pratense* L.)	Teicis	20
P/1	Red clover (*Trifolium pratense L.*)		45
	Timothy (*Phleum pratense* L.)		55
P/2	Red clover (*Trifolium pratense L.*)		27
	Meadow fescue (*Festuca pratensis* Huds)		23
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)		23
	Timothy (*Phleum pratense* L.)		27
P/3	Red clover (*Trifolium pratense L.*)		18
	Alfalfa (*Medicago sativa* L.)		27
	Timothy (*Phleum pratense* L.)		55
P/4	Red clover (*Trifolium pratense L.*)		36

	Annual ryegrass (*Lolium multiflorum* Lam.)		40
	Timothy (*Phleum pratense* L.)		24
G-1*	Red clover (*Trifolium pratense L.*)		13
	White clover (*Trifolium pratense* L.)		10
	Meadow fescue (*Festuca pratensis* Huds)		17
	Timothy (*Phleum pratense* L.)		20
	Perennial ryegrass (*Lolium perenne* L.)		20
	Red fescue (*Festuca rubra* L.)		13
	Meadow grass (*Poa pratensis* L.)		7
G-2*	Red clover (*Trifolium pratense L.*)		10
	White clover (*Trifolium pratense* L.)		10
	Meadow fescue (*Festuca pratensis* Huds)		20
	Timothy (*Phleum pratense* L.)		17
	Red fescue (*Festuca rubra* L.)		26
	Meadow grass (*Poa pratensis* L.)		17
G-4*	White clover (*Trifolium pratense* L.)		20
	Meadow fescue (*Festuca pratensis* Huds)		13
	Timothy (*Phleum pratense* L.)		13
	Perennial ryegrass (*Lolium perenne* L.)		30
	Hybrid ryegrass (*Lolium x boucheanum* Kunth.)		24
SweDane-I	Cocksfoot grass (*Dactylis glomerata* L.)	Amba	72
	Timothy (*Phleum pratense* L.)	Comtal	21
	Meadow fescue (*Festuca pratensis* Huds)	Sobra	7
SweDane-II	Red clover (*Trifolium pratense L.*)	Attaswede	10
	White clover (*Trifolium pratense* L.)	Klondike	5
	Timothy (*Phleum pratense* L.)	Tiller	24
	Timothy (*Phleum pratense* L.)	Goliath	24
	Perennial ryegrass (*Lolium perenne* L.)	Napaleon	10
	Perennial ryegrass (*Lolium perenne* L.)	Tove	10
	Meadow fescue (*Festuca pratensis* Huds)	Senu Pajb	17
	White clover (*Trifolium pratense* L.)	Klondike	10
	Timothy (*Phleum pratense* L.)	Tiller	10
	Timothy (*Phleum pratense* L.)	Goliath	10
SweDane-III*	Perennial ryegrass (*Lolium perenne* L.)	Napaleon	18
	Perennial ryegrass (*Lolium perenne* L.)	Tove	17
	Meadow fescue (*Festuca pratensis* Huds)	Senu Pajb	15
	Meadow grass (*Poa pratensis* L.)	Balin	10
	Red fescue (*Festuca rubra* L.)	Gondolin	10
Dot-21	Alfalfa (*Medicago sativa* L.)	Birute	50
	Meadow fescue (*Festuca pratensis* Huds)		20
	Timothy (*Phleum pratense* L.)		20
	White clover (*Trifolium pratense* L.)		10
Dot-24	Perennial ryegrass (*Lolium perenne* L.)		50
	White clover (*Trifolium pratense* L.)		17
	Meadow fescue (*Festuca pratensis* Huds)		13
	Timothy (*Phleum pratense* L.)		13
	Meadow grass (*Poa pratensis* L.)		7
Durpe-2	Festulolium (x *Festulolium*)		30
	Alsike clover (*Trifolium hybridum* L.)		25
	Meadow fescue (*Festuca pratensis* Huds)		25
	Timothy (*Phleum pratense* L.)		20

Dot-L1	Timothy (*Phleum pratense* L.)	30
	Perennial ryegrass (*Lolium perenne* L.)	20
	Meadow fescue (*Festuca pratensis* Huds)	15
	Red clover (*Trifolium pratense L.*)	15
	Meadow grass (*Poa pratensis* L.)	10
	White clover (*Trifolium pratense* L.)	10
Dot-L2	Alfalfa (*Medicago sativa* L.)	50
	Meadow fescue (*Festuca pratensis* Huds)	14
	Timothy (*Phleum pratense* L.)	14
	White clover (*Trifolium pratense* L.)	14
	Meadow grass (*Poa pratensis* L.)	8

*- mixtures for cutting and grazing

In the spring, after the start of vegetation, each mixture was evaluated for winter-hardiness according to the scale of 10 points. Later in the growth period, various tests were performed: visual inspection before each cut of legume, ground cover within the test area; botanical analyses; observation of green and dry mass production. An evaluation was also made of the quality of forage by performing chemical analyses utilizing standard methods. Dry mass (DM) was determined by drying a sample at the temperature of 105°C to the unchanging mass. Common nitrogen by Kjeldahl and then multiplied by 6.25 for crude protein. Digestibility by *in vitro* method, and the dry matter was dissolved with enzyme pepsin and cellocandin. The mathematical processing was done by computer program Microsoft Excel analysis of data subprogram (Berzins, 2002).

RESULTS AND DISCUSSION

Favorable climatic conditions in the sowing year promoted rapid sprouting and growth. The first cut was done in the first decade of July or 44 days after sowing. The DM yield of the first cut varied from 2.23 t ha^{-1} (SweDane-I) to 6.25 t ha^{-1} (Durpe 2). In the second cut, 68 days later in the middle of September, the lowest DM content was 1.37 t ha^{-1} of the P-3 mixture, and the highest content of 4.03 t ha^{-1} occurred for mixture P-1.

In the sowing year for two cuts, the standard mix SK-5 (late clover ‘Stendes velais II’ and timothy ‘Varis’) produced 8.31 t ha^{-1} DM, and slightly higher yields were obtained with the local mixtures in which the fast growing legume and perennial grasses dominated: SK-1: 8.79 t ha^{-1}; SK-2: 8.8 t ha^{-1}; and SK-3: 8.78 t ha^{-1} (Table 2). The lowest DM yield was obtained from the Danish mix SweDane-I, which consisted of perennial grasses with a considerable amount of cocksfoot (72%). The grazing mixture with low grasses, which developed more slowly in the initial growth period had also low yield, like the mixtures with alfalfa (Table 2).

Evaluating the condition of the swards before wintering, it was noted that all the mixtures started over-wintering in good condition. The winter conditions were favorable and the spring re-growth began in the first days of April. The monthly average temperature and rainfall were near normal, which favored the development of the grasses.

In the spring of the first year, evaluation of the levels of winter hardiness of the experimental fields showed that no damage had occurred and the winter-hardiness was found to be high (7–9 on a scale of 10). The lowest winter-hardiness (7) was found in mixture P-4, because the annual ryegrass (*Lolium multiflorum*), which made up 40% of the seed mixture by weight, did not survive the winter and was not suited to Latvian climatic conditions.

Table 2. Average DM yields of the forage grasses mixtures in 2007–2009.

Mixture	DM, t ha^{-1}				DM, % compared to standard
	Sowing year	1st year of use (3 cuts)	2nd year of use (3 cuts)	Average of 3 years	
SK-5 (standard)	8.31	12.05	8.10	9.49	100
SK-1	8.79	15.06	9.58	11.14	117
SK-2	8.80	14.75	8.95	10.83	114
SK-3	8.78	14.96	9.51	11.08	117
SK-4	8.52	13.40	7.58	9.83	104
SK-6	7.46	12.49	10.34	10.10	106
SK-7	7.09	13.98	7.05	9.37	99
P/1	8.56	15.58	7.97	10.70	113
P/2	7.65	16.11	8.25	10.67	112
P/3	5.33	10.65	8.14	8.04	85
P/4	7.88	13.95	8.32	10.05	106
G-1	8.20	13.01	8.86	10.02	106
G-2	7.43	11.93	9.93	9.76	103
G-4	8.50	11.14	8.55	9.40	99
SweDane-I	4.44	8.89	8.08	7.14	75
SweDane-II	7.33	10.51	9.64	9.16	97
SweDane-III	7.74	11.96	10.39	10.03	106
Dot-21	8.16	13.09	8.84	10.03	106
Dot-24	7.18	13.24	9.05	9.82	103
Durpe-2	8.01	11.83	7.07	8.95	94
Dot-L1	7.48	11.98	10.78	10.08	106
Dot-L2	7.20	10.08	11.37	9.55	101
$LSD_{0.05}$	0.82	1.73	1.13	1.39	

Weather conditions in April, which supported growth, a long dry period started in May, which adversely affected growth and development of the grasslands. On May 26 it was noted that the average height of the legume grasses had reached 32–59 cm, but the perennial grasses reached 54–75 cm (depending on the species). The first cut was done on June 2, when the grasses had formed panicles, but the early legumes were in full budding and beginning of flower phase. Before the cutting, a visual inspection was made of the land cover of the legumes in the sward. The best development and ground cover was found in the plots of the red clover varieties 'Skriveru agrais', 'Skriveru tetra', and 'Stendes velais II'. The highest yield of green mass 43.13 t ha^{-1} of the first cut was reached by the mixture SK-2 with early tetraploid (4n) variety of the red clover 'Skriveru tetra', meadow fescue 'Patra' (4n), perennial ryegrass 'Spidola' (4n), hybrid ryegrass 'Saikava' (4n) and timothy 'Teicis' (2n). The DM of the first cut of this mixture was 7.28 t ha^{-1}. A high DM yield of approximately 8 t ha^{-1} was also achieved by SK-1, SK-3, P/2, Dot-24. The lowest green and DM yield was obtained from the mixture SweDane-I: 17.33 t ha^{-1} and 5.01 t ha^{-1} respectively.

On evaluating re-growth intensity after cut, it was noted that more intensive herbage re-growth occurred with the early red clover varieties ‘Skriveru agrais, ‘Skriveru tetra’, and top grasses cocksfoot grass ‘Amba’, meadow fescue ‘Patra’ and meadow fescue ‘Silva’, as well as mixtures with white clover. Forage mixtures that included white clover, formed a thick, rich sward, which provided good ground coverage. Such were SK-6, Dot -24, G-2, G-4, and SweDane III.

Before the second cutting, another evaluation was made of ground cover of the legume swards; they had increased in almost all variants in comparison with the first growth. After the first cut the red clover species formed dense sward and the white clover spread vegetatively. The lowest (45%) legume cover had the mixture Durpe-2, which included alsike clover, but the highest cover (84%) had the mixture P/3, which included both red clover and alfalfa.

The second cut formed approximately half (50–60%) of the first harvest. The highest yield of green mass, which exceeded 26 t ha^{-1} was produced by SK-5, SK-1, SK-2, SK-3, P/1 and P/2; the lowest (7.3 t ha^{-1}) by mixtures SweDane-I, Durpe-2 (13.2 t ha^{-1}) and G-4 (15.07 t ha^{-1}). Similar rank of the mixtures remained in the dry matter yield of the second cut.

Before each cut samples were taken for botanical analyses. In the first year of the experiment weeds were rare in the mixtures. In the total yield the highest proportion of perennial grasses (67–76%) was in the mixtures SweDane I, G-4, Durpe-2, SK-7, Dot-L1. The greatest percent of legumes (59–85%) was in the mixtures SK-5, P/1, Dot-24 and SweDane II. Comparison of the botanical composition of the first and second cut showed noticeable differences. The abundant rainfall of July promoted legume growth and vegetative propagation, and its quantity by weight increased up to 62–88%, except in the two mixtures in which the legume portion was minimal: Durpe- 2 (15%) and SweDane I (4%). In the second and third cut the amount of alfalfa by weight increased noticeably in mixtures SK-7 and P/3, and reached 40% and 23% respectively in comparison with the first cut, when it was 9% and 8% respectively.

Thanks to warm and humid weather in July and August all the grasses re-grew rapidly; at the end of August the third cut was possible. On average, the yield was 50% of that of the second cut, but the yield of the most productive mixtures, SK-2, P/1, P/2, SK-3, Dot 21, exceeded 12 t ha^{-1} of green mass and more than 2 t ha^{-1} DM.

In summary, in the first year of use with three cuts, the highest green mass yield was obtained with the newest variety mixtures of the Research Institute: SK-2 (96.20 t ha^{-1}), SK-3 (85.23 t ha^{-1}), SK-1 (84.67 t ha^{-1}) and Ltd. ‘Seeds of Latvia’ mixture P/2 (85.67 t ha^{-1}). The DM yield of these mixtures exceeded 15 t ha^{-1}. The lowest green mass and DM yield in the first year were obtained from fodder mixtures SweDane-I: 32.4 t ha^{-1} of green mass and 8.89 t ha^{-1} of DM; and P/3: 48.42 t ha^{-1} and 10.65 t ha^{-1} respectively. For the establishment of grazing grasslands the best grass mixtures were Dot-24 with a DM yield of 13.24 t ha^{-1}, Dot-21 13.09 t ha^{-1}, G-1 13.01 t ha^{-1}, SK-6 12.49 t ha^{-1}, SweDane-III 11.96 t ha^{-1} (Table 2).

The 2008/09 winter conditions were not very favorable for perennial grasses: repeated freezing and thawing and there was very thin layer of snow cover in the fields. At the end of March water puddles formed with a covering of ice, under which a large amount of red clover died off. Snow mould was noted on the more sensitive perennial grasses – perennial ryegrass and hybrid ryegrass. Upon inspection of the swards in early spring, 2–3 weeks after the start of vegetation, it was noted that the swards with white clover and rhizomatous low grasses had wintered best. Also, upon inspection a month later and before the first cut, the scene was similar. Mixtures Dot-L1, Dot-L2, Dot-24 swards were dense and healthy with a composition of 35–50% legumes, which consisted specifically of white clover. Also uniformly dense were SK-6 with a legume content of 30%, as well as SweDane III (40%) and Durpe-2 (50%) (Table 3). The lowest evaluation was given to P/1, P/2, P/3, SK-7 and G-4, which were unevenly distributed with empty areas where weeds had infiltrated.

Table 3. Sward evaluations and legumes' specific weight in the second year of use.

Mixtures	Evaluation of grasses, 1st cut points (1–5*)	Specific weight of legumes green mass in sward, %		
		1st cut	2nd cut	3d cut
SK-5 (standard)	3.3	25	30	60
SK-1	4.1	30	45	60
SK-2	3.5	28	45	73
SK-3	3.8	25	29	50
SK-4	3.4	22	25	30
SK-6	3.9	30	65	40
SK-7	2.9	8	13	30
P/1	2.8	6	8	10
P/2	2.7	10	18	23
P/3	2.9	16	21	38
P/4	3.5	24	36	75
G-1	3.0	3	1	4
G-2	4.0	20	28	37
G-4	2.7	1	10	10
SweDane-I	2.0	0	0	0
SweDane-II	4.5	15	55	68
SweDane-III	3.9	40	67	70
Dot-21	3.9	13	55	57
Dot-24	3.8	32	50	54
Durpe-2	4.5	50	20	17
Dot-L1	4.5	18	60	80
Dot-L2	4.5	10	50	40
$LSD_{0.05}$	0.6	11	16	19

* 5 points – dense, healthful, uniform sward

The first yield of green mass in the second year of use ranged from 13–28 t ha^{-1}. The second cut was done after 44 days and it was obvious that the proportions by weight of white clover had increased, especially in the grazing mixtures. After the first cut it had propagated thanks to an adequate supply of moisture. The highest content of white clover was found in the mixtures SweDane-III (75%), SK-6 (65%), Dot-L1 (60%), Dot-21 and SweDane-II, which formed very dense swards free of weeds and which completely cover the ground. The opposite was noted with SweDane-I, G-1 and P/1 swards, which resembled more natural unfertilized meadow swards with sparse and without legumes. That was reflected also in the sward's yield. Even though the yield of the second cut was only about 50% of the yield of the first cut, the green mass of the swards reached 15.5–16.8 t ha^{-1}, while the lowest were within the range of 5.6–6.4 t ha^{-1}, which is almost three times less. In the third cut, in mid-September, the portion of legumes determined by weight increased even more due to the ability of white clover to spread vegetatively and because of the growth capacity of early red clover. Therefore the yield of the third cut was on average equivalent to the yield of the second cut, obtaining 15–16.6 t ha^{-1} from the better swards. In the second year of use, the

highest DM yield in three cuts had the mixtures Dot-L2 (11.37 t ha^{-1}), Dot-L1 (10.78 t ha^{-1}), SweDane-III (10.39 t ha^{-1}) and SK-6 (10.34 t ha^{-1}) (Table 2).
In three years, the average DM yield (10.83–11.14 t ha^{-1}) was obtained with the mixtures SK-1, SK-3 and SK-2. Those are mixtures intended for cutting, which contain both diploid and tetraploid red clover varieties and the newest perennial grass varieties created in the Research Institute. The lowest yields of DM were obtained from the swards of SweDane-I (7.14 t ha^{-1}), which consisted of three perennial grass varieties Durpe-2 with alsike clover (8.95 t ha^{-1}) and mixtures with alfalfa P/3 – 8.04 t ha^{-1} and SK-7 – 9.37 t ha^{-1} (Table 2). The soil of the experimental field was not suitable for growing alfalfa.

Table 4. The quality of the grass mixture swards in 1st and 2nd year of use.

Mixture	Crude protein, (%) 1st year of use, 1st cut	Crude protein, (%) 2nd year of use, 1st cut	Digestibility, (%) 1st year of use, 1st cut	Digestibility, (%) 2nd year of use, 1st cut
SK-5 (standard)	17.2	15.7	70	61
SK-1	12.0	14.1	68	64
SK-2	13.9	14.7	66	63
SK-3	12.4	11.6	63	57
SK-4	14.0	13.9	61	63
SK-6	10.8	14.0	59	56
SK-7	11.2	10.6	62	58
P/1	15.2	13.1	63	59
P/2	8.8	12.3	42	60
P/3	8.2	11.4	54	54
P/4	11.0	13.8	52	58
G-1	10.8	10.1	51	53
G-2	10.7	13.0	50	58
G-4	7.2	11.7	49	48
SweDane-I	7.4	8.7	46	58
SweDane-II	12.8	13.8	59	59
SweDane-III	10.5	14.3	62	60
Dot-21	13.5	14.8	66	62
Dot-24	12.8	14.7	64	62
Durpe-2	9.1	12.8	59	56
Dot-L1	11.0	14.6	55	50
Dot-L2	11.5	11.9	60	50
$LSD_{0.05}$	4.2	3.7	10.7	8.3

Due to the extreme climatic conditions in the first year of use – the long dry period in April and May, the majority of the swards had very low protein content. For the mixtures P/1 and SK-5, with predominating red clover, the protein content in the first cut was 15.2 and 17.2% respectively. The protein content of other swards varied from 7.2 to 14%, depending on the botanical content of the swards (Table 4). That also affected the digestibility, which was for the best mixtures SK-5, SK-1, SK-2, Dot-21, 70–66% respectively.

In the second year of use, the best mixtures that had higher protein content were the grazing mixtures, in which white clover made up more than half of the sward. They are Dot-21, Dot-24, SK-6, G-2, as well as mixtures with the newest tetraploid varieties. These also ranked higher for digestibility.

CONCLUSIONS

In the sowing year, without cover, and two cuts, the highest DM yield was obtained by the mixtures SK-1 (8.79 t ha^{-1}), SK-2 (8.8 t ha^{-1}), SK-3 (8.78 t ha^{-1}), but the lowest DM yield – 4.44 t ha^{-1} had the mixture SweDane-I.

In the first year of use, the mixtures, which produced the highest green mass and DM yield contained both the legumes and the newest tetraploid varieties of perennial grasses. Dense uniform swards were formed with pasture mixtures, which contained white clover. These were SK-6, Dot-24, G-4, SweDane-III. In the first year of use, in three cuts, high yields were obtained. The greatest green mass yields were produced by the mixtures SK-2 (96.2 t ha^{-1}), SK-3 (85.2 t ha^{-1}), SK-1 (84.7 t ha^{-1}), P/2 (85.7 t ha^{-1}). The DM yield of these mixtures exceeded 15 t ha^{-1}. For establishing grazing lands the best grass mixtures were Dot-24, Dot-21, G-1, which dry mass yield was higher than 13 t ha^{-1}.

In the second year of use, the mixtures with white clover and rhizomatous low grasses proved to be the most winter-hardy. These were Dot-L1, Dot-L2, Dot-24, SK-6, SweDane-II, with an evaluation of 4.5 (5 point scale). The lowest rating of 2.0–2.7 was received by swards with the mixtures P/1, P/2, P/3, SK-7 and G-4, which were uneven spread, had empty areas and weeds included. In the second year of use, in three cuts, the mixtures, which excelled in total DM yield were Dot-L2, Dot-L1, SweDane-III, SK-6, which yield exceeded 10 t ha^{-1} dry mass.

In the first year of use, the highest protein content and digestibility were the characteristic features of the cutting mixtures SK-5 and P/1, but in the second year of use, the grazing mixtures Dot-21, Dot-24, SK-6 and G-2 achieved the best results.

The share of legumes by weight increased noticeably with each subsequent cut in the swards, which contained white clover and early red clover varieties.

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