



## 2023 Perennial Grass Variety Trials



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**2023 PERENNIAL GRASS VARIETY TRIALS**  
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In 2019 and 2022, the University of Vermont Extension Northwest Crops and Soils Program initiated two trials evaluating forage yield and quality of an array of cool season perennial grass species and varieties planted in monocultures. The grass species selected were Kentucky bluegrass, festulolium, meadow brome, meadow fescue, orchardgrass, perennial ryegrass, tall fescue, and timothy. Monitoring these stands over multiple years can help evaluate yield, quality, survivability, pest resistance, persistence, and other characteristics of these species and varieties to identify the most suitable forage species and varieties in our region over diverse weather conditions.

**MATERIALS AND METHODS**

Forage species and variety information for the trials are summarized in Tables 1 and 2. The plot design was a randomized complete block with five replications. Treatments were grass varieties seeded in monoculture and evaluated for forage yield and quality.

**Table 1. Perennial grass species and variety information- Trial 1 initiated 2019.**

Species	Variety	Species	Variety	Species	Variety	
Kentucky bluegrass	Balin	Orchardgrass	Echelon	Perennial ryegrass	Calibra	
	Ginger		Harvestar		Kentaur	
Meadow brome	Fleet		Husar		Remington	
	Macbeth		Inavale		Tivoli	
	Montana		Luxor		Tomaso	
Meadow fescue	Laura		Niva	Toronto	Timothy	Barfleo
	Liherold		Olathe	Barpenta		
	Preval	Otello	Climax			
	SW Minto		Lischka			
Tetrax		Promesse				
			Tuuka			

**Table 2. Perennial grass species and variety information- Trial 2 initiated 2022**

Species	Variety	Species	Variety	Species	Variety
Tall Fescue	Dominate	Orchardgrass	Crown Royale	Festulolium	Duo
	Goliath		Echelon		Federo
	Greendale		Extend		Perun
	Kora		HLR	Greenfast	
	Swaj		Potomac	Mixtures	Milkway
	Teton		Trailburst		Organic Partner

<b>Mixtures</b>		
<b>Greenfast</b>	<b>Milkway</b>	<b>Organic Partner</b>
38% 'Perseus' Festulolium	60% Meadow fescue	60% 'Kora' Tall fescue
27% grazing tolerant Orchardgrass	40% soft-leaf Tall fescue	25% late maturing Orchardgrass
22% premium Perennial ryegrass		15% European/premium Timothy
9% 'Freedom' Red clover		
4% 'Alice' White clover		

The soil type at the trial locations was a Benson rocky silt loam (Table 3). The seedbeds were prepared using typical tillage operations for the area prior to planting. The previous crops were soybean and corn silage. Plots were 5' x 20' and replicated 5 times. In 2023 plots were hand harvested for 1<sup>st</sup> cut according to maturity (Table 3). When plots were approximately in the boot stage, the material within a 0.25m<sup>2</sup> quadrat was cut to approximately 4" from the soil surface. The material was weighed and dried to determine dry matter content and yield. In subsequent harvests, plots were harvested with a Carter flail forage harvester in a 3' x 20' area. Trial 1, the older trial, was harvested three times whereas Trial 2, the new trial, was harvested four times. An approximate 1 lb subsample of the harvested material was collected and dried to calculate dry matter yield and forage quality. Heading dates of each variety were noted at the first harvest by leaving a plot of each variety uncut until the variety had fully headed out. Yield and quality were not collected from this replicate at any point throughout the season.

**Table 3. Perennial forage trial management, Alburgh, VT.**

<b>Location</b>	<b>Borderview Research Farm – Alburgh, VT</b>	
	<b>Trial 1</b>	<b>Trial 2</b>
<b>Soil type</b>	Benson rocky silt loam	Benson rocky silt loam
<b>Previous crop</b>	Soybean	Corn silage
<b>Tillage operations</b>	Moldboard plow, disk and spike tooth harrow	Pottinger TerraDisc and spike tooth harrow
<b>Planting equipment</b>	Great Plains small plot drill	Great Plains small plot drill
<b>Treatments</b>	30	16
<b>Replications</b>	5	5
<b>Plot size (ft.)</b>	5 x 20	5 x 20
<b>Planting date</b>	18-Aug 2019	6-May 2022
<b>Harvest dates (2023)</b>	15-May (Balin, Ginger, Otello, Fleet, Macbeth, and Montana); 22-May 27-Jun 1-Aug	15-May (Potomac and Trailburst); 22-May 27-Jun 1-Aug 15-Sep

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) content of forages. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of the plant are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF) which includes cellulose, hemicellulose, and lignin. This measure indicates the bulky

characteristic of the forage and therefore is negatively correlated with animal dry matter intake. The portion of the NDF fraction that is estimated to be digestible after 30 hours of fermentation in rumen fluid is represented by the 30- hour NDF digestibility. Ethanol soluble carbohydrates (ESC) are simple sugars found in grasses. Water soluble carbohydrates (WSC) include simple sugars as well as fructose polymers called fructans. Several quality metrics are combined to predict net energy needed for lactation (NEL), milk yield per ton of forage, and relative forage quality (RFQ).

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and mixtures were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ( $p < 0.10$ ). Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two varieties. Varieties that were statistically similar in performance to one another share a letter.

In this example, variety C is significantly different from variety A but not from variety B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that these varieties yielded significantly different from one another.

Hybrid	Yield
A	6.0b
B	7.5ab
C	<b>9.0a</b>
LSD	2.0

## RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4). In general, the fall of 2022 was warmer and drier than normal. Fall and winter temperatures were above normal, especially in January which averaged six degrees above the 30-year normal. While warm wet conditions in April allowed for early planting of forages and small grains as well as early perennial forage growth, conditions in May and June became cooler and drier with many parts of the region experiencing early season mild drought conditions. However, significant precipitation fell in July and August with 17 inches accumulating during those months. Conditions finally improved in September with warmer temperatures and little rainfall allowing for harvests and other field operations later into the fall. Overall, the grass trials accumulated 4105 Growing Degree Days (GDDs) in 2023, 10 fewer than the 30-year normal.

**Table 4. 2022-2023 weather data for Alburgh, VT.**

	2022			2023								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average temperature (°F)	51.3	41.5	30.7	26.9	23.6	32.2	48.3	57.1	65.7	72.2	67.0	63.7
Departure from normal	0.96	2.24	2.50	6.01	0.65	-0.07	2.70	-1.28	-1.76	-0.24	-3.73	1.03
Precipitation (inches)	2.56	3.01	2.43	2.04	1.36	2.00	4.94	1.98	4.40	10.8	6.27	2.40
Departure from normal	-1.27	0.31	-0.07	-0.09	-0.41	-0.24	1.87	-1.78	0.14	6.69	2.73	-1.27
Growing Degree Days (base 41°F)	366	188	30	3	19	13	306	499	749	991	819	706
Departure from normal	63	106	30	3	19	-9	91	-40	-44	17	-101	54

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.

Historical averages are for 30 years of NOAA data (1990-2021) from Burlington, VT.

***Trial 1- Established 2019, 4<sup>th</sup> full season of production***

***Impact of Species***

After several seasons of droughty conditions, this season presented challenges from excessive moisture and minimal sunlight, however, there were still significant differences between species (Table 5). This year, the orchardgrass, meadow brome, and timothy plots consistently produced the highest yields across the season and overall. The perennial ryegrass, which had performed very well in the spring of 2020, but then likely suffered from drought stress and potentially winter survival issues in the past several years, struggled in 2023 and produced the lowest yields at each cutting and overall. As in other years, the second cut harvest was dominated by timothy with orchardgrass and meadow brome close behind. The third cutting was higher than 2<sup>nd</sup> cut for most species except little harvestable regrowth having accumulated for the perennial ryegrasses. The distribution of yield over the harvest can be a helpful tool in species and varietal selection (Figure 1). Most of the grasses produce more biomass in 1<sup>st</sup> and 3<sup>rd</sup> cuttings while timothy and perennial ryegrass produce more in the 2<sup>nd</sup>.

**Table 5. Yield and quality over three harvests by species, 2023.**

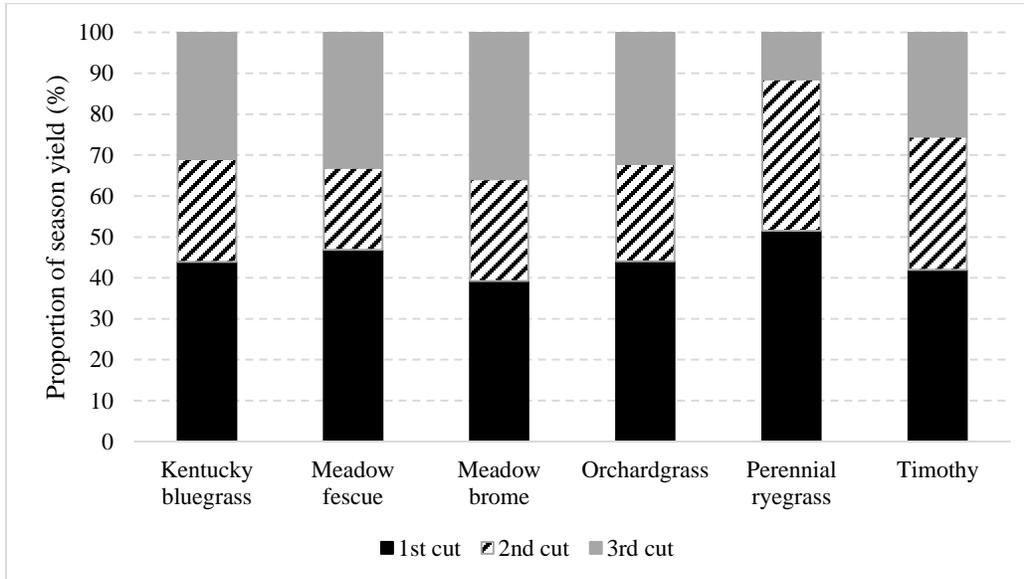
Species	Dry matter tons ac <sup>-1</sup>			Season yield
	1st cut	2nd cut	3rd cut	
Kentucky bluegrass	1.32bc†	0.754abc	0.931ab	3.00b
Meadow fescue	1.48b	0.633c	1.04ab	3.15b
Meadow brome	1.31bc	0.834abc	1.20ab	3.35ab
Orchardgrass	<b>1.78a</b>	0.960ab	<b>1.30a</b>	<b>4.04a</b>
Perennial ryegrass	1.09c	0.783bc	0.243c	2.12c
Timothy	1.43b	<b>1.11a</b>	0.867b	3.40b
Level of significance‡	***	**	***	***
Trial mean	1.44	0.873	0.924	3.24

†Treatments that share a letter performed statistically similarly to one another.

Top performing treatment indicated in **bold**.

‡Level of significance; \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

These differences in distribution are important to consider when selecting a species to ensure that the productivity and timing of that productivity will meet your needs. Comparing over several years can also provide insight into the consistency of performance across variable weather conditions.



**Figure 1. Seasonal distribution of yield by species, 2023.**

Average quality parameters also varied by species across the season (Table 6). Crude protein levels were highest in meadow brome at 16.8%, however this was statistically similar to meadow fescue and Kentucky bluegrass. All other species were at least 2% lower on average. The ESC was highest in the perennial ryegrass, which was higher than all other species. Higher sugar content provides more potential energy to the cow when grazed fresh, but also increases the sugar available to support proper fermentation in fermented stored forages. Net energy for lactation ranged from 0.561 to 0.626 Mcal/lb of forage with timothy and perennial ryegrass averaging the highest levels while orchardgrass and meadow brome were the lowest.

**Table 6. Average forage quality characteristics by species, 2023.**

Species	CP % DM	ESC	NEL Mcal/lb	30-hr NDFD % NDF	Milk yield lbs ton <sup>-1</sup>	RFQ
Kentucky bluegrass	16.4ab†	6.53bcd	0.590b	66.2c	3884bc	160cd
Meadow fescue	16.8a	7.12b	0.597b	<b>72.7a</b>	4046a	172c
Meadow brome	<b>16.8a</b>	5.82de	0.563c	72.4a	3789c	154d
Orchardgrass	14.5cd	5.33e	0.561c	66.6c	3849bc	158d
Perennial ryegrass	13.6d	<b>7.93a</b>	0.622a	71.5ab	3905b	<b>192a</b>
Timothy	14.9bc	6.50c	<b>0.626a</b>	70.3b	<b>4082a</b>	182b
Level of significance‡	***	***	***	***	***	***
Trial mean	15.1	6.51	0.594	69.9	3936	171

†Treatments that share a letter performed statistically similarly to one another.

Top performing treatment indicated in **bold**.

‡Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

Fiber digestibility ranged widely from 66.2% to 72.7% with meadow fescue, meadow brome, and perennial ryegrass performing statistically similarly at the top. Overall, >60% NDF digestibility at 30hrs (NDFD) reflects very digestible forage and therefore all species in the trial produced satisfactory digestible forage. Fiber digestibility tends to decrease when conditions become very hot and moist. Although we had excessive moisture this season, below normal temperatures likely contributed to increased digestibility this season. Overall, milk yields from feeding 1 ton of each species ranged from 3789 to 4082 lbs ton<sup>-1</sup>. Similarly, relative forage quality (RFQ) ranged from 154 to 192 with perennial ryegrass having the highest rating. For comparison, a rating of 150 is typically considered suitable for a lactating dairy cow. Therefore, while all species produced forage that on average would be considered suitable for lactating dairy cows, perennial ryegrass and timothy produced premium qualities over meadow brome and orchardgrass.

Considering both dry matter yield and quality of that dry matter can help us better understand the value of the forage produced by these species (Table 7). Protein yield per acre was statistically similar for all species except for perennial ryegrass, which was significantly lower due to its low dry matter yield. Despite perennial ryegrass' significantly higher ESC content, its yield per acre limited its ESC yield to just 381 lbs ac<sup>-1</sup> which was similar only to Kentucky bluegrass and meadow brome. Orchardgrass produced the highest digestible NDF yields of 1.49 tons ac<sup>-1</sup> which was similar to meadow brome but significantly higher than all other species. Overall milk yield per acre was highest for orchardgrass, which was statistically similar to timothy but higher than all other species. The highest predicted milk yield was almost twice as high as the predicted milk yield from perennial ryegrass, the lowest yielding species. While perennial ryegrass is often regarded as a premium forage, these data suggest that other cool season grass species can produce more substantial yields and ultimately yield more of the desired quality components like sugars and digestible fiber per acre than perennial ryegrass.

**Table 7. Yield of forage quality components by species, 2023.**

Species	CP	ESC	30-hr NDFD	Milk yield
	lbs ac <sup>-1</sup>		tons ac <sup>-1</sup>	cwt ac <sup>-1</sup>
Kentucky bluegrass	987a†	409ab	1.01b	117b
Meadow fescue	1037a	<b>487a</b>	1.10b	129b
Meadow brome	1109a	400ab	1.31ab	127b
Orchardgrass	<b>1149a</b>	463a	<b>1.49a</b>	<b>156a</b>
Perennial ryegrass	532b	381b	0.678c	84c
Timothy	1000a	455a	1.17b	140ab
Level of significance‡	***	**	***	***
Trial mean	962	439	1.15	128

†Treatments that share a letter performed statistically similarly to one another.

Top performing treatment indicated in **bold**.

‡Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

### ***Impact of Variety- Kentucky bluegrass***

Two varieties of Kentucky bluegrass were included in this evaluation (Table 8). In 2023, the two varieties performed similarly to one another in yield and all quality parameters as has been observed in previous years. Through the season they averaged 3.00 tons ac<sup>-1</sup> at 16.4% protein and 66.2% NDF digestibility. The

two varieties differed numerically in total yield, protein yield, and predicted milk yield with Ginger being higher but not statistically. The two varieties also exhibited similar maturation timing beginning heading early in the season around 12-May and being in full head around 18-May.

**Table 8. Yield and quality of two varieties of Kentucky bluegrass, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>							
Balin	<b>1.36</b>	0.632	0.765	2.76	879	407	0.935	109
Ginger	1.27	<b>0.876</b>	<b>1.10</b>	<b>3.25</b>	<b>1095</b>	<b>411</b>	<b>1.08</b>	<b>125</b>
Level of significance†	NS‡	NS	NS	NS	NS	NS	NS	NS
Species mean	1.32	0.754	0.931	3.00	987	409	1.01	117

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

### *Meadow Brome*

Three varieties of meadow brome were included in this evaluation (Table 9). Similar to previous years, the three varieties performed similarly to one another in both yield and quality parameters except at the third harvest. The meadow bromes yielded an average of 3.35 tons ac<sup>-1</sup> over the three harvests with the third harvest being substantially larger for Montana than the other two varieties, especially Macbeth that yielded just under 1 ton ac<sup>-1</sup>. Crude protein averaged 16.8% and NDF digestibility averaged 72.4%. The varieties also exhibited similar maturation timing all fulling heading around the 22-May.

**Table 9. Yield and quality of three varieties of meadow brome, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>							
Fleet	1.31	0.778	1.09	3.17	1023	396	1.25	119
Macbeth	<b>1.32</b>	<b>0.986</b>	0.991	3.30	1091	394	1.31	124
Montana	1.31	0.737	<b>1.52</b>	<b>3.57</b>	<b>1214</b>	<b>410</b>	<b>1.37</b>	<b>137</b>
Level of significance†	NS‡	NS	*	NS	NS	NS	NS	NS
Species mean	1.31	0.833	1.199	3.35	1109	400	1.31	127

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

### *Meadow Fescue*

Five varieties of meadow fescue were included in this evaluation (Table 10). The varieties differed in dry matter yield and quality. Yields at the first cutting were highest for Preval, which produced about 0.5 tons ac<sup>-1</sup> more than the other varieties at that harvest. Yields in subsequent harvests differed numerically, but due to variability across the trial these differences were not statistically significant. Total season yields however were statistically different with Preval producing just over 4 tons ac<sup>-1</sup>, almost 1 ton ac<sup>-1</sup> higher than the next highest yielding variety Liherold. Tetrax, which has been a very high yielding and high-quality variety in previous years was the lowest yielding variety this year yielding just over 2.5 tons ac<sup>-1</sup>. While

Tetrax did have higher average quality, its low yield presents a tradeoff where ultimate yields of these components and predicted milk yields are lower on a per acre basis. These data may also suggest differences in variety persistence especially considering several years of challenging drought conditions were experienced throughout this trial's lifetime. The varieties did differ slightly in maturation timing with SW Minto heading slightly earlier 29-May while the others headed a few days later.

**Table 10. Yield and quality of five varieties of meadow fescue, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>							
Laura	1.40	0.448	0.961	2.80	899	447	0.992	113
Liherold	1.51	0.528	1.07	3.11	1024	491	1.10	129
Preval	<b>1.91</b>	<b>1.03</b>	1.08	<b>4.02</b>	<b>1303</b>	<b>572</b>	<b>1.44</b>	<b>162</b>
SW Minto	1.33	0.663	<b>1.20</b>	3.20	1073	493	1.09	131
Tetrax	1.23	0.499	0.90	2.62	886	434	0.89	108
Level of significance†	**	NS‡	NS	**	NS	*	*	*
Species mean	1.48	0.633	1.043	3.15	1037	487	1.10	129

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

### **Orchardgrass**

The eight varieties of orchardgrass only differed statistically in terms of total yield and some quality contents and yields (Table 11). While yields in each cutting differed numerically, variability across the trial contributed to the lack of statistical differences. However, varieties did differ statistically in total season yield with Harvestar producing the highest yield of 4.64 tons ac<sup>-1</sup>. Of the eight varieties, five yielded over 4 tons, two between 3-4 tons, and only one variety, Husar, produced less than 3 tons ac<sup>-1</sup>. Protein averaged 14.5% with no difference between varieties. The ESC differed slightly with Husar and Harvestar having about 0.5% higher content than other varieties. Varieties did not differ in other average quality parameters.

**Table 11. Yield and quality of eight varieties of orchardgrass, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>							
Echelon	1.81	0.964	1.40	4.17	1110	470	1.55	162
Harvestar	<b>2.06</b>	0.957	<b>1.62</b>	<b>4.64</b>	1285	<b>577</b>	1.68	<b>178</b>
Husar	1.78	0.502	0.677	2.95	729	401	1.09	117
Inavlae	1.71	<b>1.18</b>	1.34	4.23	1209	479	1.57	161
Luxor	1.51	0.973	1.03	3.51	1022	432	1.29	139
Niva	1.87	1.035	1.47	4.37	<b>1353</b>	428	1.62	169
Olathe	2.00	1.022	1.56	4.59	1339	527	<b>1.73</b>	176
Otello	1.50	1.043	1.29	3.84	1142	387	1.40	147
Level of significance†	NS‡	NS	NS	**	*	**	**	**
Species mean	1.78	0.960	1.299	4.04	1149	463	1.49	156

The top performing treatment is indicated in **bold**.

†Level of significance\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

Due to these differences and the differences in dry matter yield, yields of protein, ESC, digestible fiber, and predicted milk, all differed across the varieties. Protein yields were highest for Niva and Olathe, which produced over 1300 lbs ac<sup>-1</sup>. The ESC yields were highest for Harvestar and Olathe, which produced over 500 lbs ac<sup>-1</sup>. Digestible fiber yields were highest for Olathe which produced over 1.7 tons ac<sup>-1</sup>. Predicted milk yields were highest for Harvestar and Olathe which produced over 170 cwt ac<sup>-1</sup>. The varieties also differed dramatically in maturation timing. Otello and Olathe were the earliest maturing heading on the 23-May and 25-May respectively. Luxor, and Inavale headed on 26-May, Harvestar, Husar, and Niva headed on 28-May, and Echelon was the latest heading variety heading on 31-May.

### ***Perennial Ryegrass***

Six varieties of perennial ryegrass were included in this evaluation (Table 12). Perennial ryegrass is the least cold hardy species included in this trial and therefore may not be recommended for your specific location. Sites with prolonged periods of cold temperatures with little to no insulation from snow cover during the winter can lead to reduced survival and productivity.

**Table 12. Yield and quality of six varieties of perennial ryegrass, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>				lbs ac <sup>-1</sup>		tons ac <sup>-1</sup>	cwt ac <sup>-1</sup>
Calibra	1.29	0.551	0.306	2.15	568	390	0.685	86
Kentaur	1.14	0.814	0.390	2.35	573	417	0.744	91
Remington	1.03	0.777	0.284	2.09	525	349	0.674	84
Tivoli	0.845	1.063	0.330	2.24	587	368	0.739	87
Tomaso	1.17	0.777	0.114	2.06	532	387	0.662	84
Toronto	1.06	0.715	0.03	1.81	408	376	0.56	72
Level of significance†	NS‡	*	NS	NS	NS	NS	NS	NS
Species mean	1.09	0.783	0.243	2.12	532	381	0.68	84

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

The plots overwintered but continued to be progressively less vigorous and productive, likely due to several years of compounding drought stress and less snow cover. Dry matter yields varied numerically, but were variable across the trial in most harvests. Varieties were statistically different at the second harvest with Tivoli producing just over 1 ton of dry matter while all others produced approximately 0.5 – 0.75 tons ac<sup>-1</sup>. However, despite ample rainfall through the summer, these varieties had regrown very little by the third harvest with most plots yielding about 0.3 tons ac<sup>-1</sup> and Toronto virtually being unharvestable. Overall season yields were very low averaging about 2 tons ac<sup>-1</sup>. The varieties did not differ in quality or yield of any quality components. The varieties did differ in maturation timing with Toronto, Calibra, and Kentaur heading around the 7-Jun, Remington and Tivoli heading slightly later around 9-Jun, and Tomaso heading the latest on 12-Jun.

### ***Timothy***

Six varieties of timothy were included in this evaluation (Table 13). The varieties differed in yield but not average quality. First cut yields were relatively high with two varieties, Tuukka and Promesse, producing

over 1.5 tons ac<sup>-1</sup>. At the second harvest these two varieties produced 1.3 tons ac<sup>-1</sup> which was outyielded only by Barpenta with 1.57 tons ac<sup>-1</sup>. Yields differed numerically at third harvest, but were not statistically different. Total season yields ranged from about 2.5 tons to just over 4 tons ac<sup>-1</sup>. Protein and fiber digestibility were similar to the orchardgrasses averaging 14.9% and 70.3% respectively. Quality did not differ significantly by variety. The differences in yield, however, are reflected in the yield of quality components and predicted milk with the varieties Tuukka and Promesse yielding the highest protein, ESC, digestible fiber, and milk on a per acre basis. The timothy varieties headed at a similar time as the perennial ryegrasses. The earliest timothy varieties were Barfleo and Lischka which headed on 10-Jun. These were followed closely by Promesse on 11-Jun and all others on 12-Jun.

**Table 13. Yield and quality of six varieties of Timothy, 2023.**

Variety	1st cut	2nd cut	3rd cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>							
Barfleo	1.48	0.649	0.993	3.12	864	438	1.03	129
Barpenta	1.20	<b>1.57</b>	<b>1.06</b>	3.84	1191	465	1.33	156
Climax	1.26	0.914	0.620	2.79	770	388	0.938	113
Lischka	1.15	0.836	0.496	2.48	669	360	0.819	102
Promesse	1.64	1.34	1.05	4.03	1229	520	1.43	166
Tuukka	<b>1.83</b>	1.32	0.980	<b>4.13</b>	<b>1278</b>	<b>561</b>	<b>1.48</b>	<b>171</b>
Level of significance†	**	**	NS‡	*	**	*	*	*
Species mean	1.43	1.107	0.867	3.40	1000	455	1.17	140

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

### ***Trial 2- Established 2022, 1<sup>st</sup> full season of production***

#### ***Impact of Species***

In the first full year of production, the three species and mixture treatments differed in yield across the season (Table 14). Yields at the first harvest did not differ statistically and ranged from 1.32 to 1.58 tons ac<sup>-1</sup>. At the second harvest, the festulolium produced the highest yields of 1.15 tons ac<sup>-1</sup>, however this was statistically similar to all other species except for tall fescue which produced only 0.823 tons ac<sup>-1</sup>. The opposite trend was observed in the third harvest where the tall fescues produced 1.50 tons ac<sup>-1</sup> on average, which was similar to all other species except the festuloliums which produced 0.846 tons ac<sup>-1</sup>. This trend held through the fourth cutting with all species producing about 1 ton ac<sup>-1</sup> except for the festuloliums which produced only 0.689 tons ac<sup>-1</sup>. When looking at total yields gained across the entire season, all species produced at least 4 tons ac<sup>-1</sup> and did not differ statistically. In addition to total yield, the distribution of yield over the harvest can be a helpful tool in species and varietal selection (Figure 2). Most of the grasses produce more biomass in 1<sup>st</sup> and 3<sup>rd</sup> cuttings while the festuloliums produced more equally in 1<sup>st</sup> and 2<sup>nd</sup> harvests and then less in 3<sup>rd</sup> and 4<sup>th</sup> cuttings. These differences in distribution are important to consider when selecting a species to ensure that the productivity and timing of that productivity will meet your needs. Comparing over several years can also provide insight into the consistency of performance across variable weather conditions and an aging stand.

**Table 14. Yield and quality over three harvests by species, 2023.**

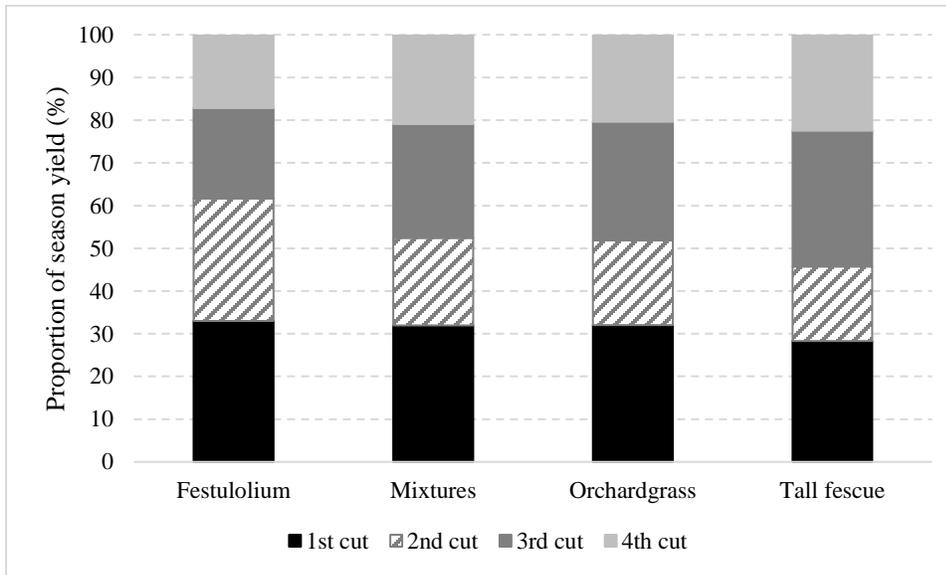
Species	1st cut	2nd cut	3rd cut	4th cut	Season yield
	Dry matter tons ac <sup>-1</sup>				
Festulolium	1.32	<b>1.15a</b> †	0.846b	0.689b	4.01
Mixtures	1.58	1.01ab	1.31a	1.03a	<b>4.94</b>
Orchardgrass	1.53	0.947ab	1.33a	0.973a	4.78
Tall fescue	1.33	0.823b	<b>1.50a</b>	<b>1.06a</b>	4.71
Level of significance‡	NS§	**	**	**	NS
Trial mean	1.44	0.950	1.30	0.964	4.65

†Treatments that share a letter performed statistically similarly to one another.

The top performing treatment is indicated in **bold**.

‡Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

§NS; not statistically significant.



**Figure 2. Seasonal distribution of yield by species, 2023.**

Average quality parameters also varied by species across the season (Table 15). Crude protein levels were highest in the mixtures at 16.5%, however this was statistically similar to all other species except orchardgrass which was approximately 1% lower. The ESC was highest in the tall fescue at 8.06% which was higher than all other species. Higher sugar content provides more potential energy to the cow when grazed fresh but also increases the sugar available to support proper fermentation in fermented stored forages. Net energy for lactation ranged from 0.559 to 0.616 Mcal/lb of forage with festulolium averaging the highest levels and orchardgrass the lowest. Fiber digestibility ranged widely from 67.4% to 71.4% with festulolium and the mixtures performing statistically similarly at the top. Overall, >60% NDF digestibility at 30hrs (NDFD) reflects very digestible forage and therefore all species in the trial produced satisfactory digestible forage. Fiber digestibility tends to decrease when conditions become very hot and moist. Although we had excessive moisture this season, below normal temperatures likely contributed to increased digestibility this season.

**Table 15. Average forage quality characteristics by species, 2023.**

Species	CP % DM	ESC	NEL Mcal/lb	30-hr NDFD % NDF	Milk yield lbs ton <sup>-1</sup>	RFQ
Festulolium	16.3ab†	7.05b	<b>0.616a</b>	<b>71.4a</b>	<b>3940a</b>	163ab
Mixtures	<b>16.5a</b>	6.85b	0.582b	70.1ab	3879ab	160a
Orchardgrass	15.4b	5.56c	0.559c	67.4c	3846b	154b
Tall fescue	16.0ab	<b>8.06a</b>	0.592b	69.1b	3831b	<b>165a</b>
Level of significance‡	*	***	***	***	**	**
Trial mean	15.9	6.85	0.583	69.1	3862	160

†Treatments that share a letter performed statistically similarly to one another.

The top performing treatment is indicated in **bold**.

‡Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

Overall, milk yields from feeding 1 ton of each species ranged from 3831 to 3940 lbs ton<sup>-1</sup> with festulolium and the mixtures performing the highest. Relative forage quality (RFQ) ranged from 154 to 165 with tall fescue being the highest but statistically similar to all other species except orchardgrass. For comparison, a rating of 150 is typically considered suitable for a lactating dairy cow. Therefore, all species produced forage that on average would be considered suitable for lactating dairy cows.

**Table 16. Yield of forage quality components by species, 2023.**

Species	CP lbs ac <sup>-1</sup>	ESC	30-hr NDFD tons ac <sup>-1</sup>	Milk yield cwt ac <sup>-1</sup>
Festulolium	1246	596bc†	1.31b	160
Mixtures	<b>1592</b>	700ab	1.74a	<b>192</b>
Orchardgrass	1438	549c	<b>1.78a</b>	184
Tall fescue	1496	<b>759a</b>	1.57ab	181
Level of significance‡	NS§	**	**	NS
Trial mean	1451	652	1.62	180

†Treatments that share a letter performed statistically similarly to one another.

The top performing treatment is indicated in **bold**.

‡Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

§NS; not statistically significant.

Considering both dry matter yield and quality of that dry matter can help us better understand the value of the forage produced by these species (Table 16). Protein yield per acre was statistically similar for all species. The numerical differences seen in the table were not statistically significant due to variability within the species across the trial. Especially with the mixtures which contained numerous species, differences in establishment may have contributed to variability within treatments and therefore the lack of statistical significance. The ESC yield, however, did differ statistically with tall fescue yielding the highest with 759 lbs ac<sup>-1</sup>, 210 lbs higher than the orchardgrasses. Despite the highest digestibility being observed in the festuloliums, their lower dry matter yield contributed to lower overall digestible fiber yields. The highest digestible fiber yields were produced by orchardgrass which was statistically similar to the mixtures and tall fescue. Overall milk yield per acre ranged from 160 to 192 with Festulolium producing the lowest yields but not statistically differing from any other species. Festuloliums, being a cross between a fescue

(either tall or meadow) and perennial ryegrass, are generally regarded as premium forages similar to perennial ryegrass with higher yields from the fescue. However, these data suggest other cool season grass species can produce more substantial yields and ultimately yield more of the desired quality components like sugars and digestible fiber per acre than festulolium. Festuloliums also typically do not persist in their vigor as long as other species so monitoring this species' performance throughout the lifespan of this stand will be important to understand its value in our region.

### ***Impact of Variety- Festulolium***

Three varieties of festulolium were included in the trial (Table 17). Varieties differed statistically in yield only at the third harvest where the variety Duo produced over 1 ton whereas the other two varieties produced less than 0.75 tons ac<sup>-1</sup>. At the end of the season, however, all three varieties had produced about 4 tons ac<sup>-1</sup>. Average protein content was similar across varieties at 16.3% so, combined with similar dry matter yields led to similar protein yields of about 1250 lbs ac<sup>-1</sup>. However, ESC and NDF digestibility did differ statistically with both being highest in the variety Federo. This contributed to higher yields of ESC and digestible fiber on a per acre basis, especially compared to the variety Duo. Predicted milk yields per acre did not differ between varieties and averaged about 160 cwt ac<sup>-1</sup>. Federo and Duo matured at similar times heading fully around 31-May followed closely by Perun on 2-Jun.

**Table 17. Yield and quality of three varieties of festulolium, 2023.**

Variety	1st cut	2nd cut	3rd cut	4th cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>								
Duo	1.11	0.911	<b>1.14</b>	<b>0.753</b>	3.92	1232	484	1.07	153
Federo	<b>1.54</b>	1.25	0.665	0.662	<b>4.11</b>	<b>1255</b>	<b>684</b>	<b>1.45</b>	<b>166</b>
Perun	1.32	<b>1.29</b>	0.738	0.651	4.00	1253	619	1.41	161
Level of significance†	NS‡	NS	**	NS	NS	NS	**	**	NS
Species mean	1.32	1.15	0.846	0.689	4.01	1246	596	1.31	160

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

The top performing treatment is indicated in **bold**.

### ***Mixtures***

The three pre-mixed mixtures included in this trial performed very similarly to one another (Table 18). All three were very productive at the first harvest producing over 1.5 tons ac<sup>-1</sup>. At 2<sup>nd</sup> cut the three averaged about 1 ton ac<sup>-1</sup> with the Milkway mix being slightly below the others at 0.917 tons ac<sup>-1</sup>. By the third harvest, there were some numerical differences with the Greenfast mix yielding the lowest and Organic Partner mix yielding the highest but these were not statistically different. Similar trends were observed at the 4<sup>th</sup> harvest and with total season yields. Overall, all three mixtures produced over 4.5 tons ac<sup>-1</sup>. The mixtures also differed in quality with the Milkway mix having statistically higher ESC content and fiber digestibility. However, when combined with dry matter yield, no statistical differences were found in the yield of these components or predicted milk yield on a per acre basis. The Greenfast and Organic Partner mixtures both include orchardgrass which was the first species in those mixtures to head out. However, they included late maturing varieties and thus headed in late May. The Milkway mixture contained meadow and tall fescues which generally head slightly later than late maturing orchardgrass. This mixture was noted as heading out around 1-Jun.

**Table 18. Yield and quality of three pre-mixed mixtures, 2023.**

Mixture	1st cut	2nd cut	3rd cut	4th cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>								
Greenfast	<b>1.62</b>	1.06	1.06	0.897	4.63	1468	679	1.61	180
Milkway	1.58	0.917	1.37	1.03	4.89	1618	<b>777</b>	1.71	192
Organic Partner	1.53	<b>1.07</b>	<b>1.52</b>	<b>1.18</b>	<b>5.30</b>	<b>1689</b>	643	<b>1.89</b>	<b>205</b>
Level of significance†	NS‡	*	NS	NS	NS	NS	NS	NS	NS
Species mean	1.58	1.01	1.31	1.03	4.94	1592	700	1.74	192

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

The top performing treatment is indicated in **bold**.

### *Orchardgrass*

Six varieties of orchardgrass were included in this trial (Table 19). While some numerical differences can be seen across the yield and quality data, no statistical differences were found between these varieties. Yields in this first full year were quite substantial from all orchardgrass varieties with all producing around 4.75 tons ac<sup>-1</sup>.

**Table 19. Yield and quality of six varieties of orchardgrass, 2023.**

Variety	1st cut	2nd cut	3rd cut	4th cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons ac <sup>-1</sup>								
Crown Royale	1.61	0.847	1.44	1.00	<b>4.89</b>	<b>1517</b>	565	<b>1.83</b>	188
Echelon	1.69	0.972	1.22	1.00	4.88	1446	577	1.80	<b>189</b>
Extend	1.33	1.01	1.45	0.933	4.71	1455	512	1.75	181
HLR	1.43	<b>1.15</b>	1.21	0.851	4.64	1467	505	1.72	178
Potomac	1.29	0.935	<b>1.51</b>	<b>1.08</b>	4.81	1457	550	1.80	184
Trailburst	<b>1.85</b>	0.764	1.16	0.972	4.74	1287	<b>586</b>	1.77	183
Level of significance†	NS‡	NS	NS	NS	NS	NS	NS	NS	NS
Species mean	1.53	0.947	1.33	0.973	4.78	1438	549	1.78	184

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

The top performing treatment is indicated in **bold**.

With similar yields and quality, yield of protein, ESC, digestible fiber, and milk on per acre bases were similar. As in our other trial, a wide range of maturities were included noted by variable heading dates. The earliest variety was Extend which was fully headed by 20-May. Crown Royale, Potomac, and Trailburst were close behind on 22-May. HLR was a bit later heading on 26-May, and the latest maturing variety in this trial was Echelon which didn't head out fully until 31-May.

### *Tall fescue*

Similar to the mixtures, few statistical differences were seen between the six tall fescue varieties (Table 20). Despite numerical differences that are quite large at times, variability within treatments may have

contributed to the lack of statistical significance. First cut yields ranged widely from 0.521 tons to 1.83 tons  $\text{ac}^{-1}$  but were not statistically different. The second harvest was lower for all varieties averaging around 0.8 tons  $\text{ac}^{-1}$ . Yields increased at the third harvest and presented statistical differences between varieties. Greendale produced almost 2 tons  $\text{ac}^{-1}$  which was at least 0.3 tons  $\text{ac}^{-1}$  higher than all other varieties. All varieties continued to produce substantial biomass late into the fall and were harvested a fourth time yielding about 1 ton  $\text{ac}^{-1}$ . Overall, season yields ranged from 3.65 to 5.94 tons  $\text{ac}^{-1}$  with Greendale and Goliath yielding over 5 tons  $\text{ac}^{-1}$ , however, these were not statistically different from any other variety. No statistical differences were seen in average quality between the varieties. However, with some differences in dry matter yields, predicted milk yield on a per acre basis differed statistically. Greendale had the highest predicted milk yield of 230 cwt  $\text{ac}^{-1}$  followed closely by Goliath with 198 cwt  $\text{ac}^{-1}$ . The lowest yielding variety, Teton, was predicted to yield only 138 cwt  $\text{ac}^{-1}$ .

**Table 20. Yield and quality of six varieties of tall fescue, 2023.**

Variety	1st cut	2nd cut	3rd cut	4th cut	Season yield	CP	ESC	30-hr NDFD	Milk yield
	Dry matter tons $\text{ac}^{-1}$								
Dominate	1.33	0.691	1.60	1.04	4.66	1474	742	1.58	174
Goliath	1.83	0.824	1.42	1.05	5.12	1604	839	1.73	198
Greendale	1.68	1.07	1.93	1.26	5.94	1879	920	2.01	230
Kora	1.42	0.806	1.52	0.987	4.74	1501	804	1.57	183
Swaj	1.22	0.668	1.47	0.789	4.14	1335	691	1.33	160
Teton	0.521	0.877	1.02	1.23	3.65	1182	555	1.21	138
Level of significance†	NS‡	NS	**	NS	NS	NS	NS	NS	*
Species mean	1.33	0.823	1.50	1.06	4.71	1496	759	1.57	181

The top performing treatment is indicated in **bold**.

†Level of significance; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.0001$

‡NS; not statistically significant.

## DISCUSSION

In the final year of production, the perennial grasses in Trial 1 produced yields averaging 3.24 tons  $\text{ac}^{-1}$  which was higher than previous years where drought conditions were experienced. Similar to other years, the orchardgrasses produced the highest yields. In the first year of production in Trial 2, yields were higher averaging 4.65 tons  $\text{ac}^{-1}$  but did not differ statistically between species/mixtures. While the meadow bromes did not perform as well this year as in previous years in Trial 1, they still produced average yields. While perennial ryegrass quality was quite high compared to some species like orchardgrass, these other species maintained satisfactory quality while producing higher yields. It is also critical to recognize that forage quality is significantly impacted by harvest timing. Within species, varieties differed in maturation timing which can impact the suitability to your operation. Fields that tend to be wetter and more difficult to harvest early in the spring should be planted to later maturing varieties, allowing a longer harvest window prior to declines in quality. Finally, the distribution of dry matter production throughout the season can be important to consider, especially for use in grazing systems. In addition, palatability of some of these species, namely meadow brome and tall fescue, may present challenges for grazing and were not explored in these trials.

Yield and quality data by variety across each cutting can be found in Tables 21-24 and Figures 3-6. It is important to recognize that these data only represent one year and should not alone be used to make management decisions.

## ACKNOWLEDGEMENTS

Funding for this project was through the USDA OREI Grant (2018-02802) UVM Extension would like to thank Roger Rainville and his staff at Borderview Research Farm in Alburgh for their generous help with the trials. We would like to acknowledge Anna Brown, John Bruce, Catherine Davidson, Hillary Emick, Lindsey Ruhl, Laura Sullivan, and Sophia Wilcox Warren for their assistance with data collection and entry. The information is presented with the understanding that no product discrimination is intended, and no endorsement of any product mentioned, or criticism of unnamed products is implied.

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**Table 21. Dry matter yields for 30 varieties of six perennial grass species (Trial 1), 2023.**

Species	Variety	Heading date	DM Yield			Total
			1st cut 15 and 22-May	2nd cut 27-Jun	3rd cut 1-Aug	
Kentucky Bluegrass	Balin	20-May	<b>1.36</b>	0.632	0.765	2.76
	Ginger	18-May	1.27	<b>0.876</b>	<b>1.10</b>	<b>3.25</b>
Species mean			1.32	0.754	0.931	3.00
Meadow Brome	Fleet	22-May	1.31	0.778	1.08	3.17
	Macbeth	22-May	<b>1.32</b>	<b>0.986</b>	0.991	3.30
	Montana	22-May	1.31	0.737	<b>1.52</b>	<b>3.57</b>
Species mean			1.31	0.833	1.20	3.35
Meadow Fescue	Laura	1-Jun	1.40	0.448	0.961	2.80
	Liherold	30-May	1.51	0.528	1.07	3.11
	Preval	31-May	<b>1.91</b>	<b>1.03</b>	1.08	<b>4.02</b>
	SW Minto	29-May	1.33	0.663	<b>1.20</b>	3.20
	Tetrax	31-May	1.23	0.499	0.895	2.62
Species mean			1.48	0.633	1.04	3.15
Orchardgrass	Echelon	31-May	1.81	0.964	1.40	4.17
	Harvestar	28-May	<b>2.06</b>	0.957	<b>1.62</b>	<b>4.64</b>
	Husar	28-May	1.78	0.502	0.677	2.95
	Inavale	26-May	1.71	<b>1.18</b>	1.34	4.23
	Luxor	26-May	1.51	0.973	1.03	3.51
	Niva	28-May	1.87	1.03	1.47	4.37
	Olathe	25-May	2.00	1.02	1.56	4.59
	Otello	23-May	1.50	1.04	1.29	3.84
Species mean			1.78	0.960	1.30	4.04
Perennial Ryegrass	Calibra	7-Jun	<b>1.29</b>	0.551	0.306	2.15
	Kentaur	8-Jun	1.14	0.814	<b>0.390</b>	<b>2.35</b>
	Remington	9-Jun	1.03	0.777	0.284	2.09
	Tivoli	9-Jun	0.845	<b>1.06</b>	0.330	2.24
	Tomaso	12-Jun	1.17	0.777	0.114	2.06
	Toronto	6-Jun	1.06	0.715	0.034	1.81
Species mean			1.09	0.783	0.243	2.12
Timothy	Barfleo	10-Jun	1.48	0.649	0.993	3.12
	Barpenta	12-Jun	1.20	<b>1.59</b>	<b>1.06</b>	3.84
	Climax	12-Jun	1.26	0.914	0.620	2.79
	Lischka	10-Jun	1.15	0.84	0.496	2.48
	Promesse	11-Jun	1.64	1.34	1.05	4.03
	Tuukka	12-Jun	<b>1.83</b>	1.32	0.981	<b>4.13</b>
Species mean			1.43	1.11	0.867	3.40

**Table 22. Average quality of 30 varieties of six perennial grass species (Trial 1), 2023.**

Species	Variety	CP	ESC	30-hr NDFD	NEL	RFQ	Milk yield	CP	ESC	30-hr NDFD	Milk yield
		% of DM		% of NDF	Mcal lb <sup>-1</sup>		lbs ton <sup>-1</sup>	lbs ac <sup>-1</sup>		tons ac <sup>-1</sup>	cwt ac <sup>-1</sup>
Kentucky Bluegrass	Balin	15.9	<b>6.92</b>	66.1	<b>0.591</b>	<b>164</b>	<b>3931</b>	879	407	0.935	109
	Ginger	<b>16.8</b>	6.15	<b>66.3</b>	0.588	156	3837	<b>1095</b>	<b>411</b>	<b>1.08</b>	<b>125</b>
Species mean		16.4	6.53	66.2	0.590	160	3884	987	409	1.01	117
Meadow Brome	Fleet	16.4	6.01	72.6	0.562	152	3767	1023	396	1.24	119
	Macbeth	16.5	<b>5.73</b>	<b>72.6</b>	0.550	152	3730	1091	394	1.31	124
	Montana	<b>17.4</b>	5.72	72.0	<b>0.576</b>	<b>157</b>	<b>3870</b>	<b>1214</b>	<b>410</b>	<b>1.37</b>	<b>137</b>
Species mean		16.8	5.82	72.4	0.563	154	3789	1109	400	1.31	127
Meadow Fescue	Laura	16.6	7.01	71.2	0.578	164	4006	899	447	0.992	113
	Liherold	16.7	7.20	72.9	0.599	174	4125	1024	491	1.10	129
	Preval	16.4	6.28	69.6	0.582	161	3964	<b>1303</b>	<b>572</b>	<b>1.44</b>	<b>162</b>
	SW Minto	16.8	7.44	73.5	0.605	171	4050	1073	493	1.09	131
	Tetrax	<b>17.2</b>	<b>7.65</b>	<b>76.2</b>	<b>0.621</b>	<b>191</b>	<b>4086</b>	886	434	0.889	108
Species mean		16.8	7.12	72.7	0.597	172	4046	1037	487	1.10	129
Orchardgrass	Echelon	13.2	5.37	65.7	0.554	160	3849	1110	470	1.55	162
	Harvestar	14.3	5.76	65.2	0.567	158	3829	1285	<b>577</b>	1.68	178
	Husar	13.5	<b>5.78</b>	<b>67.3</b>	<b>0.577</b>	<b>162</b>	<b>3876</b>	729	401	1.09	117
	Inavale	14.7	5.34	66.6	0.552	153	3807	1209	479	1.57	161
	Luxor	15.0	5.68	67.3	0.575	161	3936	1022	432	1.29	139
	Niva	<b>15.6</b>	4.51	66.2	0.555	155	3845	<b>1353</b>	428	1.62	169
	Olathe	14.7	5.31	67.2	0.555	156	3819	1339	527	<b>1.73</b>	<b>176</b>
	Otello	14.9	4.92	66.8	0.553	157	3835	1142	387	1.40	147
Species mean		14.5	5.33	66.6	0.561	158	3849	1149	463	1.49	156

**Table 22 Continued. Average quality of 30 varieties of six perennial grass species (Trial 1), 2023.**

Species	Variety	CP	ESC	30-hr NDFD	NEL	RFQ	Milk yield	CP	ESC	30-hr NDFD	Milk yield
		% of DM	% of NDF	Mcal lb <sup>-1</sup>	lbs ton <sup>-1</sup>	lbs ac <sup>-1</sup>	tons ac <sup>-1</sup>	cwt ac <sup>-1</sup>			
Perennial Ryegrass	Calibra	14.5	7.17	71.1	0.611	184	3820	568	390	0.685	86
	Kentaur	12.3	8.02	70.5	0.613	194	3814	573	417	<b>0.744</b>	<b>91</b>
	Remington	13.0	7.61	71.7	0.621	185	<b>3982</b>	525	349	0.674	84
	Tivoli	14.5	7.84	72.2	0.627	189	3892	<b>587</b>	368	0.739	87
	Tomaso	<b>14.6</b>	7.99	<b>72.9</b>	<b>0.631</b>	195	3954	532	<b>387</b>	0.662	84
	Toronto	12.9	<b>8.97</b>	70.7	0.630	<b>203</b>	3966	408	376	0.564	72
Species mean		13.6	7.93	71.5	0.622	192	3905	532	381	0.678	84
Timothy	Barfleo	14.6	6.47	69.1	0.622	183	4088	864	438	1.03	129
	Barpenta	15.3	6.24	70.5	0.625	178	4093	1191	465	1.33	156
	Climax	13.9	6.63	69.5	0.624	<b>186</b>	4012	770	388	0.938	113
	Lischka	14.2	<b>6.92</b>	69.6	0.624	184	4075	669	360	0.819	102
	Promesse	15.4	6.26	71.2	0.628	181	4093	1229	520	1.43	166
	Tuukka	<b>15.9</b>	6.48	<b>71.7</b>	<b>0.631</b>	181	<b>4133</b>	<b>1278</b>	<b>561</b>	<b>1.48</b>	<b>171</b>
Species mean		14.9	6.50	70.3	0.626	182	4082	1000	455	1.17	140

**Table 23. Dry matter yields 18 varieties of four perennial grass species (Trial 2), 2023.**

Species	Variety	Heading date	DM Yield (tons ac <sup>-1</sup> )				Total
			1st cut 15 and 22-May	2nd cut 27-Jun	3rd cut 1-Aug	4th cut 15-Sep	
Festulolium	Duo	31-May	1.11	0.911	1.136	0.753	3.92
	Federo	31-May	1.54	1.249	0.665	0.662	4.11
	Perun	2-Jun	1.32	1.291	0.738	0.651	4.00
Species mean			1.32	1.15	0.846	0.689	4.01
Mixtures	Greenfast	31-May	1.62	1.06	1.06	0.897	4.63
	Milkway	1-Jun	1.58	0.917	1.37	1.03	4.89
	Organic partner	31-May	1.53	1.07	1.52	1.18	5.30
Species mean			1.58	1.01	1.31	1.03	4.94
Orchardgrass	Crown Royale	22-May	1.61	0.847	1.44	1.00	4.89
	Echelon	31-May	1.69	0.972	1.22	1.00	4.88
	Extend	20-May	1.33	1.01	1.45	0.933	4.71
	HLR	26-May	1.43	1.15	1.21	0.851	4.64
	Potomac	22-May	1.29	0.935	1.51	1.08	4.81
	Trailburst	22-May	1.85	0.764	1.16	0.972	4.74
Species mean			1.53	0.947	1.33	0.973	4.78
Tall fescue	Dominate	27-May	1.33	0.691	1.60	1.04	4.66
	Goliath	27-May	1.83	0.824	1.42	1.05	5.12
	Greendale	29-May	1.68	1.07	1.93	1.26	5.94
	Kora	29-May	1.42	0.806	1.52	0.987	4.74
	Swaj	30-May	1.22	0.668	1.47	0.789	4.14
	Teton	25-May	0.521	0.877	1.02	1.23	3.65
Species mean			1.33	0.823	1.50	1.06	4.71

**Table 24. Average quality of 18 varieties of four perennial grass species (Trial 2), 2023.**

Species	Variety	CP	ESC	30-hr NDFD	NEL	RFQ	Milk yield	CP	ESC	30-hr NDFD	Milk yield
		% of DM	% of DM	% of NDF	Mcal lb <sup>-1</sup>		lbs ton <sup>-1</sup>	lbs ac <sup>-1</sup>	lbs ac <sup>-1</sup>	tons ac <sup>-1</sup>	cwt ac <sup>-1</sup>
Festulolium	Duo	16.1	6.23	68.2	0.637	172	3873	1232	484	1.07	153
	Federo	16.5	7.56	73.3	0.603	160	3950	1255	684	1.45	166
	Perun	16.4	7.35	72.8	0.607	157	3997	1253	619	1.41	161
Species mean		16.3	7.05	71.4	0.616	163	3940	1246	596	1.31	160
Mixtures	Greenfast	16.3	6.80	69.5	0.584	162	3842	1468	679	1.61	180
	Milkway	16.8	7.72	72.0	0.591	166	3911	1618	777	1.71	192
	Organic partner	16.4	6.04	69.0	0.571	152	3883	1689	643	1.89	205
Species mean		16.5	6.85	70.1	0.582	160	3879	1592	700	1.74	192
Orchardgrass	Crown Royale	15.9	5.54	68.2	0.562	154	3857	1517	565	1.83	188
	Echelon	15.4	5.71	67.6	0.560	154	3852	1446	577	1.80	189
	Extend	15.6	5.36	66.9	0.557	155	3847	1455	512	1.75	181
	HLR	15.8	5.32	66.6	0.562	150	3810	1467	505	1.72	178
	Potomac	15.4	5.74	68.3	0.559	153	3867	1457	550	1.80	184
	Trailburst	14.2	5.66	66.6	0.553	157	3840	1287	586	1.77	183
Species mean		15.4	5.56	67.4	0.559	154	3846	1438	549	1.78	184
Tall fescue	Dominate	15.9	8.11	68.0	0.584	161	3766	1474	742	1.58	174
	Goliath	15.7	7.81	69.5	0.586	162	3840	1604	839	1.73	198
	Greendale	16.0	7.68	68.6	0.600	161	3885	1879	920	2.01	230
	Kora	16.0	8.37	69.4	0.602	165	3840	1501	804	1.57	183
	Swaj	16.2	8.29	71.2	0.596	181	3836	1335	691	1.33	160
	Teton	16.2	8.10	68.0	0.586	161	3821	1182	555	1.21	138
Species mean		16.0	8.06	69.1	0.592	165	3831	1496	759	1.57	181

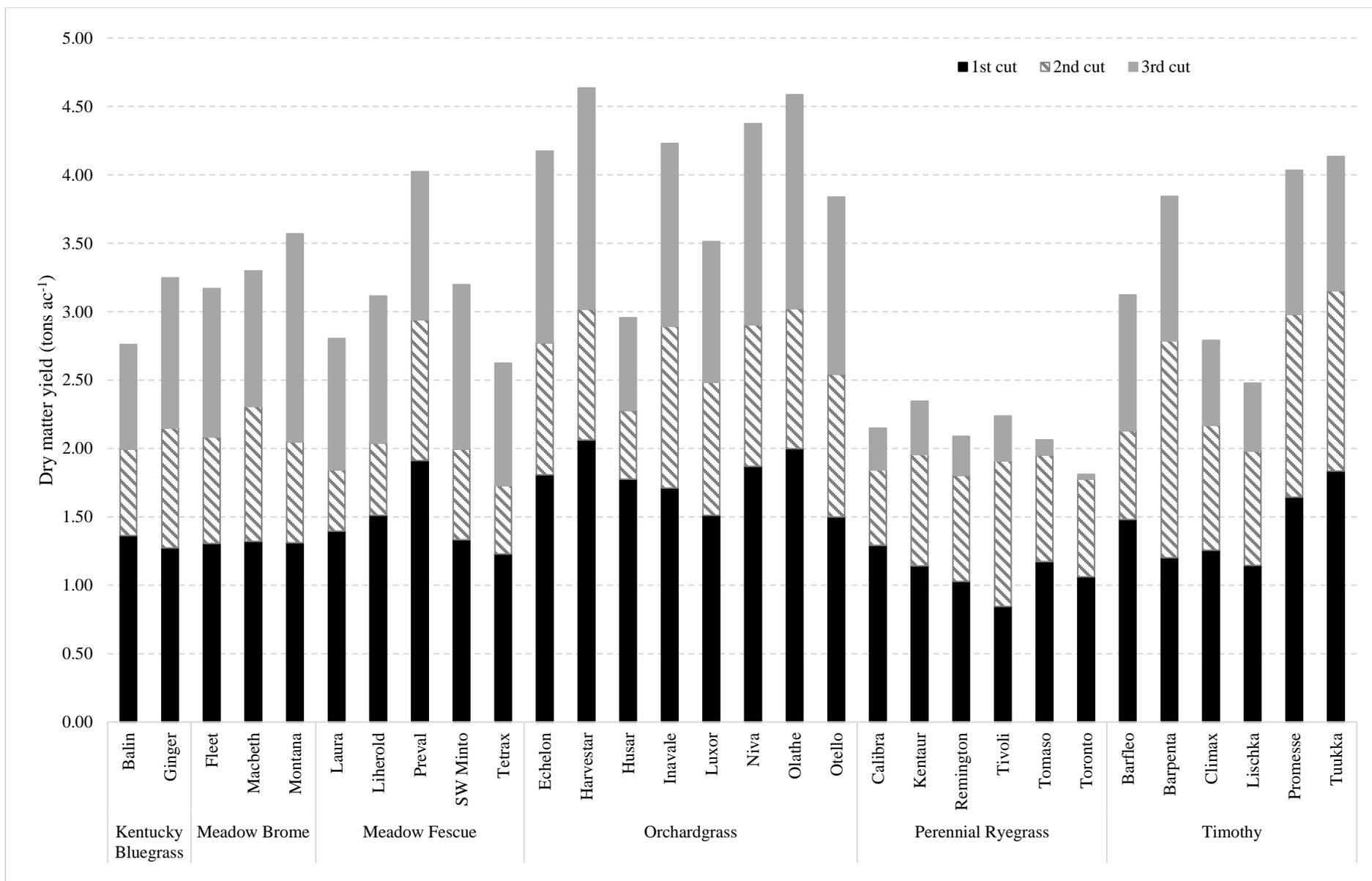


Figure 3. Dry matter yields over three harvests (Trial 1), 2023.

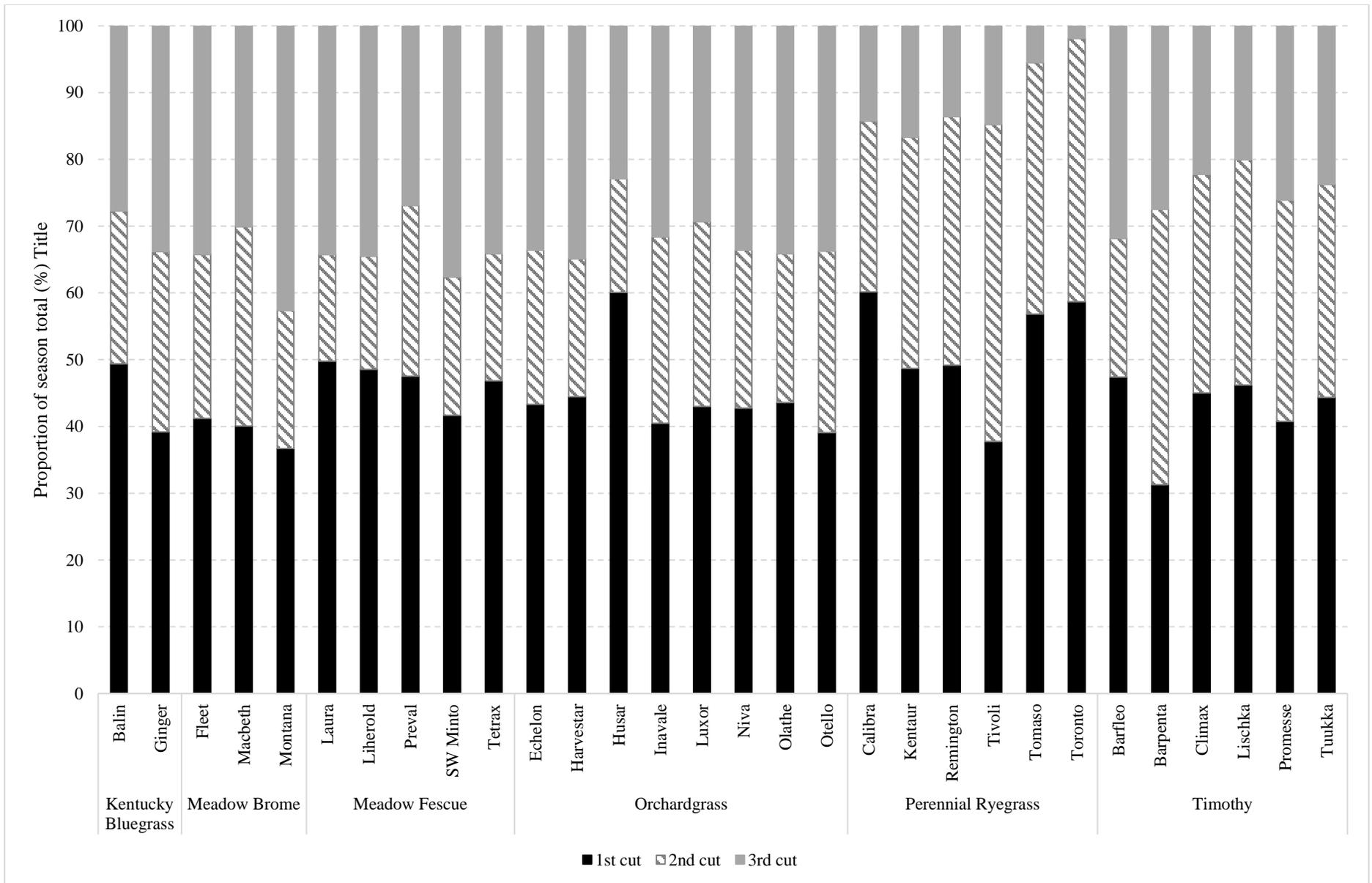


Figure 4. Dry matter yield distribution over three harvests (Trial 1), 2023.

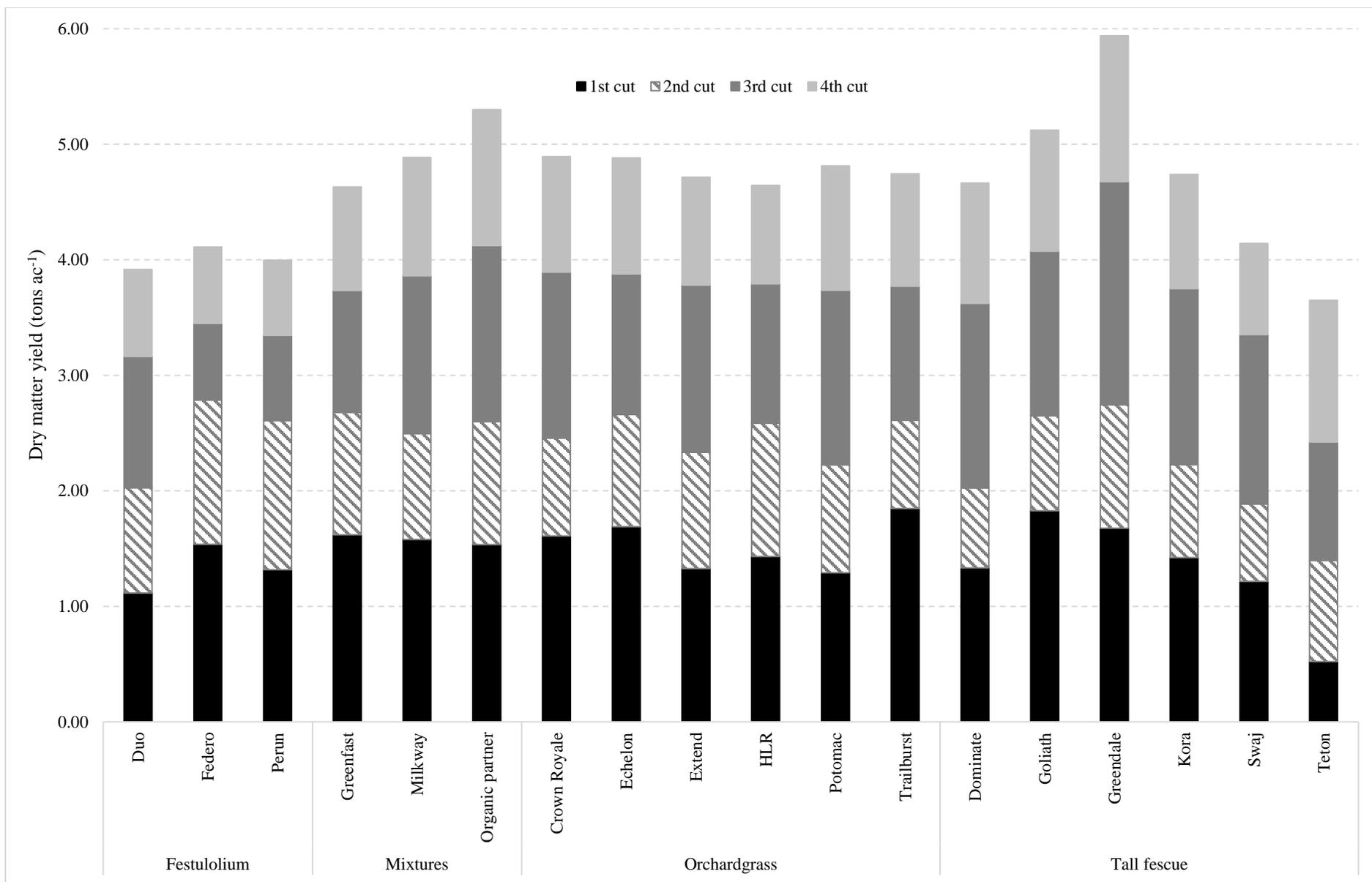


Figure 5. Dry matter yields over four harvests (Trial 2), 2023.

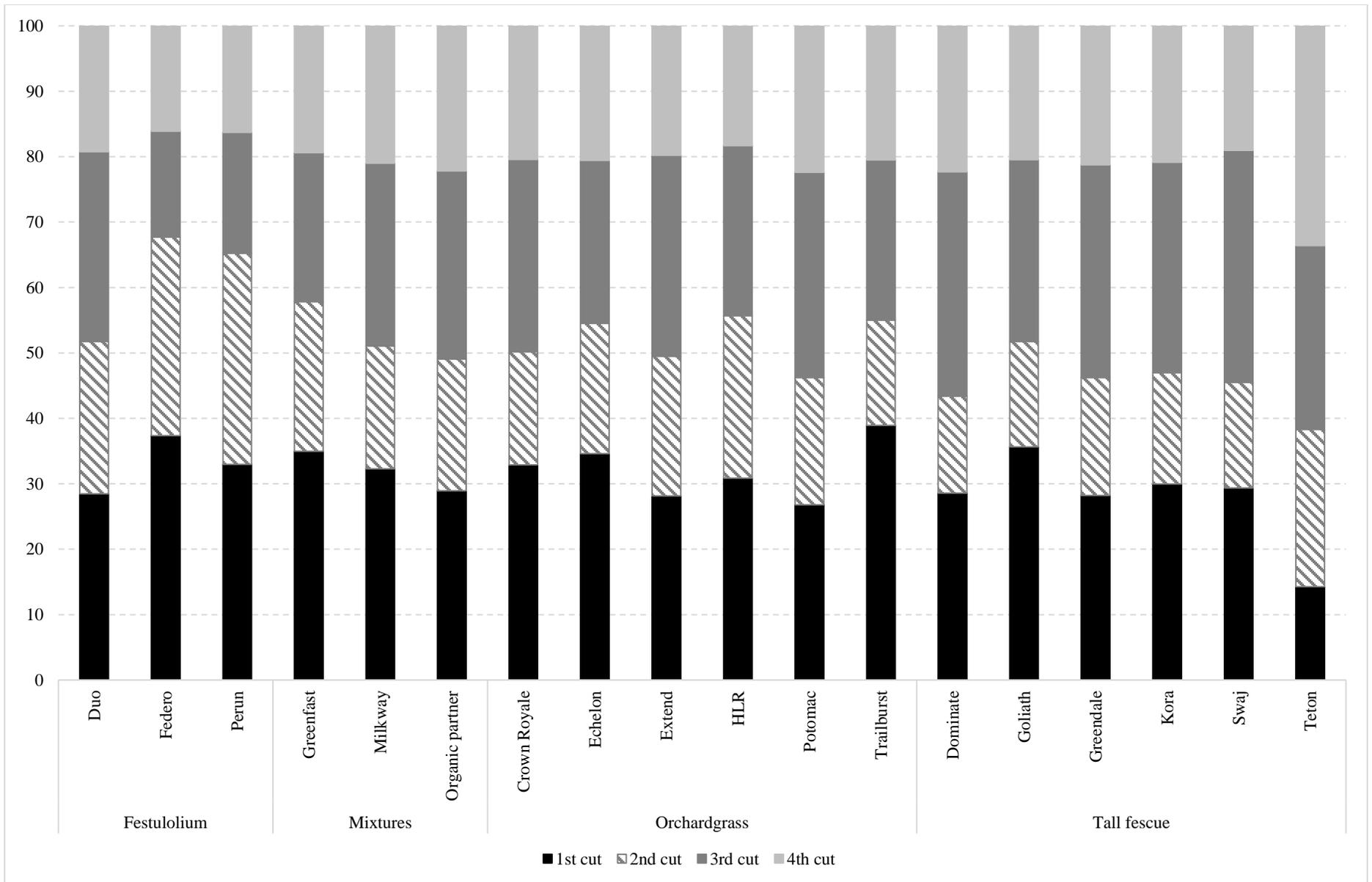


Figure 6. Dry matter yield distribution over four harvests (Trial 2), 2023.