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Perennial Cool-Season Grasses under Irrigation for Hay Production and Fall Grazing

Perennial cool-season grasses comprise nearly 25% of hay field acreage in northeast Wyoming. The most popular grasses used for hay production under irrigation in this region has been smooth or meadow brome. Although these two grasses are productive with good stand persistence, they generally reach anthesis, optimum stage for hay harvest, by mid-June most years in northern Wyoming. For operations with significant acreage this could result in some of the hay being lower in quality than what a lactating beef cow or sheep ewe requires due to the maturity of the grasses at harvest. Likewise small hay operations dependent upon custom harvesters can have their fields harvested when these grasses are at a later maturity than desired. The opportunity to select perennial cool-season grasses with varying maturity dates could benefit hay producers in being able to furnish good quality hay for their own livestock as well as to their clients.

Objectives of this study were to assess (1) late spring/early summer hay yields of perennial cool-season grasses; (2) regrowth yields of these grasses for fall grazing; and (3) forage quality of the hay and regrowth.

Materials and Methods

Perennial cool-season introduced grasses seeded in September 2014 underwent harvests over a three year period to assess their hay yields and regrowth forage yields. Hay harvests occurred on 16, 15, and 20 June in 2016, 2017, and 2018, respectively for the smooth bromes -

'Manchar' and 'Carlton', meadow bromes - 'Paddock' and 'MacBeth', orchardgrasses - 'Latar' and 'Profile', and tall fescues - 'Fawn' and 'Texoma MaxQ II'; and on 30 June 2016 and 2017, and on 5 July 2018 for the intermediate wheatgrasses – 'Oahe', 'Rush', 'Luna' and 'Manska', and the timothies - 'Climax' and 'Tuukka'. Note; "Luna' and 'Manska' are pubescent forms of intermediate wheatgrass. Desired stage of maturity for harvest was post-flowering to visible seed development. Regrowth of the grasses underwent a harvest on 10 October 2016, 28 September 2017, and 2 October 2018. The plot area received 150 pounds per acre of nitrogen in November 2015, and in April 2017 and 2018. In addition, 30 and 50 pounds of phosphate was applied in November 2015 and April 2017, respectively.

Results and Discussion

Hay Yields

The intermediate and pubescent wheatgrasses produced the most hay over the three years followed by 'Paddock' meadow brome, the smooth bromes, and 'Tuukka' timothy (Table 1). The two-week harvest delay may have been a contributing factor for why the wheatgrasses produced an average of at least an extra T/ac of hay each year but they were at the same phenological growth stage as the other grasses when harvested.

The bromes and wheatgrasses, except for 'Manchar' and 'MacBeth', generally had lower hay yields in 2017 compared to in 2016 although only 'Carlton's and 'Paddock's' were statistically significant (Table 1). The orchards, tall fescues, and timothies all had significantly greater hay yields in 2017 compared to in 2016. The bromes and wheatgrasses are rhizomatous species (under-ground reproductive stems) and had good stands by the spring of 2016, whereas the other grasses which have a bunch growth form did not but they improved substantially by 2017. It is possible that the rhizomatous grasses were becoming somewhat sod bound by 2017 which may be why their hay yields were slightly less as total April through day before harvest (mid- to late June) precipitation + irrigated water was two inches more in 2017 compared to in 2016 (Table 2). This extra moisture apparently benefitted the bunch type grasses.

All the grasses, except 'Climax' timothy, had lower hay yields in 2018 compared to in 2017 with a few being significant (Table 1). The bunchgrasses had higher hay yields in 2018 compared to in 2016 whereas the rhizomatous grasses did not. This supports the argument that the rhizomatous grasses had become sod-bound to some degree and the bunch type had denser stands in 2018 than they had in 2016. The slightly lower 2018 yields compared to in 2017 for the bunchgrasses may be attributed to the inch and a half less total moisture in 2018 (Table 2).

Another objective for this project was to look at the effect on forage yields under two irrigation regimes. However, hay yields under both irrigation regimes were not significantly different for all grasses all three years, except for 'Tuukka' timothy in 2016 were the yield under the High level was greater than under the Low level, so the reported yields in Table 1 are averages for the two irrigation regimes. Likewise the amounts of irrigated moisture reported in Table 2 are an average for the two levels. An average of an inch more water was not enough to affect hay yields. Based on the lack of significant difference in hay yields among the grasses between irrigation regimes additional water was not necessary to improve yields.

Regrowth Forage Yields

'Latar' orchardgrass produced the most regrowth forage among the grasses followed by 'Texoma MaxQ II' tall fescue and then 'Profile' orchardgrass (Table 3). Regrowth of the grasses averaged 41% of their hay yields in 2016 but fell to 9.5% and 5.6% in 2017 and 2018, respectively. Furthermore, 2017 and 2018 regrowth yields were 25% and 13% of those in 2016, respectively. A plausible reason for the dramatically lower regrowth yields in 2017 and 2018 compared to in 2016 was the amount of moisture (precipitation + irrigation) the plots received in July to a few days prior to harvest (Table 4). The amounts were 17.7, 8.8, and 9.7 inches in 2016, 2017, and 2018, respectively. We probably should have applied an additional 8.0 to 9.0 inches of water in 2017 and 2018. This would have especially been true for 2018 as mean daily temperatures averaged 7.6 degrees warmer compared to in 2016 and 2017 (Table 5). However, except for 'Profile' orchardgrass, 'Fawn' tall fescue, and the two timothies, the other grasses underwent a harvest on 8 October 2015 and their dry matter yields ranged from 1325 to 2710 lb/ac for 'Latar' orchardgrass and 'Paddock' meadow bromegrass, respectively, with a total of 5.25 inches of moisture July – September. The grasses did not undergo a removal of growth prior to this so that may explain in part those reasonably good yields.

Table 1. Cool-season perennial forage grass hay yields (Tons per acre – 88% dry matter).

Harvest Dates: 16 June 2016, 15 June 2017, and 20 June 2018									
Harvest Dates: 30 June 2016, 30 June 2017, and 5 July 2018									
Grass	**Variety**	***2016*** [1,2]		***2017*** [1,2]		***2018*** [1,2]		***Avg.*** [1]	
Smooth brome	**Carlton**	**4.96**	B	**3.73**	DEF	**3.37**	D	**4.02**	B
	Manchar	**3.96**	C	**4.04**	CDEF	**3.23**	DE	**3.74**	B
Meadow brome	**MacBeth**	**3.84**	CD	**3.94**	CDEF	**3.21**	DE	**3.67**	BC
	Paddock	**4.98**	AB	**3.95**	CDEF	**2.84**	E	**3.93**	B
Orchardgrass	**Latar**	**2.74**	E	**4.36**	CD	**3.92**	E	**3.67**	BC
	Profile	**1.72**	F	**3.72**	EF	**2.80**	C	**2.79**	D
Tall fescue	**Fawn**	**1.57**	F	**3.90**	CDEF	**3.27**	DE	**3.11**	CD
	Texoma	**3.17**	DE	**4.32**	CDE	**3.34**	D	**3.61**	BC
Intermediate wheatgrass	**Oahe**	**5.47**	AB	**4.98**	AB	**4.32**	ABC	**4.92**	A
	Rush	**5.52**	AB	**4.99**	AB	**4.57**	AB	**5.03**	A
Pubescent wheatgrass	**Luna**	**5.76**	A	**5.09**	AB	**4.77**	A	**5.21**	A
	Manska	**5.41**	AB	**5.21**	A	**4.24**	BC	**4.95**	A
Timothy	**Climax**			**3.45**	F	**4.14**	BC	**3.78**	*
	Tuukka	**2.62**	E	**4.54**	BC	**4.25**	BC	**3.86**	B
Year averages [3]		***4.12***		***4.32***		***3.74***			

[1]Grass T/ac hay yields within a year and the three-year average not connected by the same letter are significantly different at P < 0.05 (Student's t).

[2]Each grass variety T/ac hay yields colored **blue** are significantly greater than those colored **magenta**; those colored **black** are not different from the **high** and **low** yields; and those colored **brown** are significantly greater than the **low** yield but significantly less than the **high** yield at P < 0.05 (Student's t).

[3]Grass T/ac average yearly hay yields were significantly greater in **2016 and 2017** compared to in 2018 at P < 0.05 (Student's t).

*Not included in analysis of variance due to not being harvested in 2016, average of 2017 and 2018 harvests.

Table 2. Precipitation and irrigated water amounts (inches) April - June 2016, 2017, and 2018.

	Precipitation			Irrigated Water			Total Moisture		
Month	2016	2017	2018	2016	2017	2018	2016	2017	2018
April	4.10	4.22	1.84				4.10	4.22	1.84
May	1.11	1.94	3.13				1.11	1.94	3.13
1 – mid-Jun[1]	0.32	0.69	0.69	1.25	2.03	1.19	1.57	2.71	1.88
Sub-Total[1]	5.53	6.85	5.66				6.78	8.87	6.85
Mid- late Jun[2]	0.03	0.25	0.74	1.50	2.19	0.97	1.53	2.44	1.71
Total[3]	5.56	7.10	6.40	2.75	4.22	2.16	8.31	11.21	8.56

[1]1 to 13 June in 2016, 1 to 12 June in 2017, and 24 May to 14 June in 2018; Sub-totals for 1 April through 13 June 2016, 12 June 2017, and 14 June 2018.

[2]17 to 27 June in 2016, 16 to 28 June in 2017, and 21 June to 1 July in 2018; Totals for 1 April through 27 June 2016, 28 June 2017, and 1 July 2018.

Table 3. Cool-season perennial forage grass regrowth yields (Pounds per acre dry matter).

Harvest Dates: 10 October 2016, 28 September 2017, and 2 October 2018									
Grass	Variety	2016 [1,2]		2017 [1,2]		2018 [1,2]		Avg. [1]	
Smooth brome	Carlton	1445	E	148	E	81	F	558	EF
	Manchar	2612	BC	365	DE	215	DEF	1064	BCDEF
Meadow brome	MacBeth	2557	BCD	767	BC	290	CDEF	1205	BCD
	Paddock	2088	CDE	589	BCD	359	CDE	1012	CDEF
Orchardgrass	Latar	3147	AB	1596	A	791	A	1845	A
	Profile	2807	BC	860	B	660	AB	1442	ABC
Tall fescue	Fawn	2775	BC	598	BCD	446	BCD	1193	BCDE
	Texoma	3748	A	822	BC	501	BC	1690	AB
Intermediate wheatgrass	Oahe	2611	BC	330	DE	157	EF	1033	CDEF
	Rush	1775	DE	414	DE	300	CDEF	830	CDEF
Pubescent wheatgrass	Luna	1598	E	185	E	131	F	638	DEF
	Manska	2163	CDE	281	DE	137	EF	861	CDEF
Timothy	Climax			533	CD	129	F	344	*
	Tuukka	3217	AB	559	BCD	192	EF	1248	ABCD
Year averages[3]		2493		573		311			

[1]Grass lb/ac regrowth forage yields within a year and the three-year average not connected by the same letter are significantly different at P < 0.05 (Student's t).

[2]Each grass variety lb/ac regrowth forage yields colored **blue** are significantly greater than those colored **magenta**; and the one colored **brown** is significantly greater than the **low** yield but significantly less than the **high** yield at P < 0.05 (Student's t).

[3]Grass lb/ac average yearly regrowth forage yield in 2016 was significantly greater compared to those in 2017 and 2018 at P < 0.05 (Student's t).

*Not included in analysis of variance due to not being harvested in 2016, average of 2017 and 2018 harvests.

Table 4. Precipitation and irrigated water amounts (inches) July - Sep 2016, 2017, and 2018.

	Precipitation			Irrigated Water			Total Moisture		
Month	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
July	0.30	0.34	1.71	2.37	0.85	1.02	2.67	1.19	2.73
August	1.50	0.22	1.32	5.81	4.27	2.67	7.31	4.49	3.99
September[1]	6.89	2.15	1.24	0.82	0.94	1.75	7.71	3.09	2.99
Total	8.69	2.71	4.27	9.00	6.06	5.44	17.69	8.77	9.71

[1]September 2016 precipitation included 0.73 inches that occurred 3 – 11 October.

Table 5. Monthly average maximum (Max) and minimum (Min) temperatures and growing degree days (GDD[1]) April - Sep 2016, 2017, and 2018.

	2016			2017			2018		
Month	**Max**	**Min**	**GDD**	**Max**	**Min**	**GDD**	**Max**	**Min**	**GDD**
April	60	33	6.1	59	30	4.6	57	26	4.7
May	70	36	12.2	69	37	11.8	73	42	16.3
June[2]	86	46	23.6	80	49	23.3	79	44	20.3
June[3]	88	46	24.0	79	48	22.0	81	46	21.8
July	91	51	27.1	94	54	28.8	88	52	27.2
August	85	48	23.8	84	46	23.1	84	63	30.5
September[4]	66	38	14.1	71	39	13.7	73	38	14.7

[1]GDD = (Max temp + Min Temp)/2 – 41; If Max temp > 86 than 86 used as Max temp.

[2]1 to 15 June in 2016, 1 to 14 June in 2017, and 1 to 19 June in 2018.

[2]1 to 29 June in 2016 and 2017, and 1 June to 4 July in 2018.

[4]1 September to 9 October 2016, 1 to 27 September in 2017, and 1 September to 1 October in 2018.

Hay Quality Components

The grasses from the 2016 and 2017 harvest were analyzed for their crude protein, net energy maintenance, and macro- and micro-mineral contents.

'Manska' pubescent wheatgrass and 'Carlton' smooth bromegrass contained the highest levels of crude protein among the grasses over the two years and 'Profile' orchardgrass, 'Paddock' meadow bromegrass, and 'Texoma MaxQ II' tall fescue the least (Table 6). However, their protein levels were generally sufficient to meet the needs of a lactating beef cow or sheep ewe.

'Tuukka' timothy, and the smooth bromes 'Carlton' and 'Manchar' contained the highest levels of net energy maintenance (NEm) among the grasses with 'Rush' intermediate wheatgrass the least (Table 6). However, all grasses contained a sufficient amount of NEm to meet the needs of a lactating beef cow or ewe. For those not familiar with using NEm to assess if a feed or forage has an adequate amount to satisfy their livestock's energy needs 0.59 Mcal/lb ≈ 59% TDN and 0.68 Mcal/lb ≈ 65% TDN.

With regard to the macro-minerals the bromes, orchards, and tall fescues, generally contained higher levels compared to the wheatgrasses and timothies (Table 7). In addition, the grasses contained higher levels of calcium, phosphorus, and sulfur in 2017 compared to in 2016 by an average of 0.04, 0.07, and 0.02 percentage units, respectively.

Calcium (Ca) levels of the grasses were generally sufficient for a lactating beef cow as long as she was not a heavy milk producer (> 15 lb/day), especially in 2017 as levels averaged 0.04% higher than in 2016 (Table 7). However, Ca contents tended to be a bit low for a lactating sheep ewe, especially if she is nursing twins. Grass phosphorus (P) levels were more than adequate to meet the needs of a lactating beef cow but not a sheep ewe, except for the bromes, orchards, and tall fescues from the 2017 harvest. Due to the relatively high P levels in the grasses the Ca: P ratio ranged from 0.9: 1.0 for 'Climax' timothy to 1.3: 1.0 for 'Oahe' intermediate wheatgrass which is low. The recommended Ca: P ratio for beef cattle is at least 1.5: to 1.0 and no higher than 7.0: 1.0 (Nutrient Requirements of Beef Cattle, 2000, National Research Council). However, for sheep ewes the amount of Ca in the grasses compared to the levels of P was generally satisfactory (Nutrient Requirements of Small Ruminants, 2007, National Research Council).

The potassium (K) content of all the grasses was sufficient for all beef cattle (0.70% for lactating cows; 0.60% all others) and sheep (0.68% for early lactating ewes; maintenance 0.50%) (Table 7).

Table 6. Cool-season perennial forage grass hay crude protein and net energy for maintenance (NEm) contents for the 2016 and 2017 harvests.

Harvest Dates: 16 June 2016 and 15 June 2017									
Harvest Dates: 30 June 2016 and 2017									
		%Crude Protein[1]				Mcal/lb NEm[1]			
Grass	Variety	2016	2017	Avg.		2016	2017	Avg.	
Smooth brome	Carlton	12.7	12.9	12.8	A	0.65	0.65	0.65	A
	Manchar	12.4	10.2	10.8	ABC	0.64	0.60	0.65	A
Meadow brome	MacBeth	11.3	9.0	9.6	BC	0.64	0.60	0.62	ABC
	Paddock	9.5	8.6	9.4	C	0.62	0.60	0.61	BC
Orchardgrass	Latar	11.7	9.9	11.4	ABC	0.64	0.61	0.63	ABC
	Profile	13.0	9.0	9.3	C	0.67	0.59	0.63	ABC
Tall fescue	Fawn	13.6	10.8	10.9	ABC	0.68	0.64	0.64	AB
	Texoma	10.4	9.1	9.5	C	0.65	0.60	0.64	AB
Intermediate wheatgrass	Oahe	10.2	8.4	9.6	BC	0.61	0.60	0.61	BC
	Rush	9.8	9.8	11.2	ABC	0.60	0.60	0.60	C
Pubescent wheatgrass	Luna	10.2	12.8	12.2	AB	0.62	0.62	0.61	BC
	Manska	10.8	13.8	13.1	A	0.62	0.65	0.61	BC
Timothy	Climax		11.7		*		0.63		*
	Tuukka	11.3	10.1	10.7	ABC	0.68	0.63	0.65	A
Year averages		*11.3*	*10.4*			*0.64*	*0.62*		

[1]Grass hay %crude protein and Mcal/lb NEm values for the two-year averages not connected by the same letter are significantly different at $P < 0.05$ (Tukey HSD).

*Not included in analysis of variance due to not being harvested in 2016.

The bromes, orchards, and tall fescues contained adequate levels of magnesium (Mg) to meet the needs of a lactating beef cow (0.20%) and sheep ewe (0.18%) and all the grasses a sufficient amount to meet the needs of all other classes of beef cattle (0.12%) and sheep (0.15%) (Table 7).

Sulfur (S) levels were adequate in all the grasses to meet the needs of beef cattle (0.15%) but were lower than the requirements for sheep (0.18%) in the wheatgrasses and timothies (Table 7).

The grasses contained similar amounts of iron (Fe) and these amounts were sufficient to meet the needs of beef cattle (50 ppm) and sheep of any size, production stage, and number of lambs (Table 8).

Manganese (Mn) levels in the grasses averaged 13 ppm more in 2017 compared to in 2016 with the amounts in the orchards, bromes, and tall fescues being sufficient for beef cows (40 ppm) in 2017 but not in 2016. The wheatgrasses contained the least amount of Mn among the grasses but still at an adequate level to meet the needs of growing beef cattle (20 ppm) and for sheep at all weights and production scenarios (Table 8).

The timothies contained the highest levels of zinc (Zn) among the grasses but below the 40 ppm required by beef cattle as well as less than the minimum needs for sheep (Table 8). Zinc levels in the wheatgrasses and meadow bromes were the lowest among the grasses.

Table 7. Cool-season perennial forage grass hay percent calcium, phosphorus, potassium, magnesium, and sulfur content averages for the 2016 and 2017 harvests.

Harvest Dates: 16 June 2016 and 15 June 2017												
Harvest Dates: 30 June 2016 and 2017												
Grass	**Variety**	**Calcium[1]**		**Phosphorus[1]**		**Potassium[1]**		**Magnesium[1]**		**Sulfur[1]**		
Smooth brome	Carlton	0.29	AB	0.28	A	2.38	A	0.22	BCD	0.20	CD	
	Manchar	0.29	AB	0.26	AB	2.16	ABCD	0.22	BCD	0.21	C	
Meadow brome	MacBeth	0.28	AB	0.25	ABC	2.26	ABC	0.24	ABC	0.17	DE	
	Paddock	0.28	AB	0.24	ABC	2.29	AB	0.21	CDE	0.16	E	
Orchardgrass	Latar	0.25	AB	0.25	ABC	2.24	ABCD	0.25	ABC	0.25	B	
	Profile	0.27	AB	0.23	ABC	2.07	BCD	0.26	AB	0.21	C	
Tall fescue	Fawn	0.28	AB	0.25	ABC	1.91	DEF	0.25	ABC	0.26	AB	
	Texoma	0.31	A	0.26	AB	1.98	CDEF	0.27	A	0.28	A	
Intermediate wheatgrass	Oahe	0.27	AB	0.21	BC	1.71	F	0.19	DEF	0.16	E	
	Rush	0.22	B	0.21	BC	1.70	F	0.16	F	0.17	DE	
Pubescent wheatgrass	Luna	0.26	AB	0.22	BC	1.76	F	0.17	EF	0.15	E	
	Manska	0.26	AB	0.20	C	1.69	F	0.18	EF	0.15	E	
Timothy	Climax	0.23	*	0.27	*	1.90	*	0.19	*	0.15	*	
	Tuukka	0.25	AB	0.22	BC	1.82	EF	0.17	EF	0.15	E	

[1]Grass hay %calcium, phosphorus, potassium, magnesium, and sulfur values for the two-year averages not connected by the same letter are significantly different at $P < 0.05$ (Tukey HSD).

*Not included in analysis of variance due to not being harvested in 2016, values from 2017 harvest.

The required amount of copper (Cu) for beef cows is 10 ppm and the amount for sheep ranges from 5.7 ppm for mid- to late lactating ewes to 8.0 ppm for gestating and early lactating ewes. None of the grasses contained an adequate amount of Cu to meet either beef cattle or sheep needs, except the smooth bromes for ewes in mid- to late lactation (Table 8).

Table 8. Cool-season perennial forage grass hay parts per million (ppm or mg/kg) of iron, manganese, zinc, and copper content averages for the 2016 and 2017 harvests.

Harvest Dates: 16 June 2016 and 15 June 2017									
Harvest Dates: 30 June 2016 and 2017									
Grass	Variety	Iron[1]		Manganese[1]		Zinc[1]		Copper[1]	
Smooth brome	Carlton	46	AB	39	CD	19	BC	6.7	A
	Manchar	48	AB	38	CDE	19	BC	6.8	A
Meadow brome	MacBeth	46	AB	35	CDE	15	C	4.5	DEF
	Paddock	45	AB	42	BC	14	C	4.1	DEFG
Orchardgrass	Latar	57	A	60	A	20	BC	5.7	BC
	Profile	53	AB	59	AB	17	BC	5.2	CD
Tall fescue	Fawn	49	AB	40	BCD	18	BC	4.5	DEF
	Texoma	45	B	35	CDE	17	BC	3.9	EFG
Intermediate wheatgrass	Oahe	48	AB	29	CDE	16	C	3.5	FG
	Rush	44	B	22	E	15	C	3.3	G
Pubescent wheatgrass	Luna	44	B	31	CDE	15	C	3.4	G
	Manska	43	B	25	DE	15	C	3.4	G
Timothy	Climax	48	*	35	*	26	*	4.8	*
	Tuukka	51	AB	31	CDE	22	AB	4.7	CDE

[1]Grass hay iron, manganese, zinc, and copper ppm values for the two-year averages not connected by the same letter are significantly different at $P < 0.05$ (Tukey HSD).
*Not included in analysis of variance due to not being harvested in 2016, values from 2017 harvest.

Forage Regrowth Quality Components

Regrowth forage crude protein content was similar among the grasses in 2016 and 2017 and was sufficient to meet the needs of a beef cow or sheep ewe (Table 9).

'Tuukka' timothy, and the smooth bromes 'Carlton' and 'Manchar' contained the highest levels of NEm among the grasses with the wheatgrasses the least (Table 9). However, as with crude protein, all the grasses contained an adequate amount of NEm to meet the needs of a beef cow or sheep ewe.

As with the hay from these grasses, the bromes, orchards, and tall fescues generally contained higher levels of the macro-minerals, especially for K, Mg, and S (Table 10). This indicates that the differences in mineral contents between these sets of grasses in the hay was not due to a two-week difference in harvest dates.

Regrowth forage of the grasses from the 2017 harvest contained higher levels of Ca, Mg, and S compared to that from the 2016 harvest by an average of 0.09, 0.03, and 0.04 percentage units, respectively, whereas P and K levels were higher in the 2016 forage by an average of 0.03 and 0.08 percentage units, respectively.

When compared to the macro-mineral content levels in the hay from these grasses, regrowth forage generally contained higher levels of Ca, Mg, and S by an average of 0.22, 0.11, and 0.07 percentage units, respectively, but with respect to K, regrowth forage averaged 0.36 units lower compared to that in the hay (Tables 7 and 10).

All the grasses contained sufficient levels of Ca, P, K, Mg, and S to meet the needs of a beef cow and sheep ewe. Unlike the hay from these grasses the Ca: P ratios ranged from 1.4 to 1.0 for 'Latar' orchardgrass to 2.7 to 1.0 for 'Carlton' smooth bromegrass which means the ratios were within the recommended range, except for 'Latar' which was a bit low.

Except for Cu, regrowth forage of the grasses contained higher amounts of Fe (38 ppm), Mn (25 ppm), and Zn (0.9 ppm) in 2016 compared to in 2017. In addition, grass regrowth forage contained higher levels of Fe and Mn compared to the hay from these grasses (Tables 8 and 11).

Iron content of the regrowth forage from all grasses was sufficient to meet the needs of a beef cow and sheep ewe, whereas Mn levels were adequate in 2016 in all grasses but in 2017 only in 'Carlton' smooth brome, 'Paddock' meadow brome, and the two orchardgrasses (Table 11).

As with the hay from these grasses, Zn levels in their regrowth forage was lower than what a beef cow or sheep ewe requires (Table 11).

Copper levels in the regrowth forage of the grasses was not sufficient to meet the needs of a beef cow or sheep ewe (Table 11).

Harvests will occur again in 2019 with the goals of obtaining hay and regrowth yield differences between the irrigation regimes and regrowth yields comparable to those obtained in 2016.

Table 9. Cool-season perennial forage grass regrowth crude protein and net energy for maintenance (NEm) contents for the 10 October 2016 and 28 September 2017 harvests.

Grass	Variety	%Crude Protein[1]				Mcal/lb NEm[1]			
		2016	2017	Avg.		2016	2017	Avg.	
Smooth brome	Carlton	10.2	10.5	10.3	A	0.66	0.71	0.69	AB
	Manchar	9.1	9.6	9.3	A	0.65	0.69	0.67	ABC
Meadow brome	MacBeth	9.9	10.0	10.0	A	0.65	0.68	0.66	ABC
	Paddock	8.1	9.6	8.9	A	0.64	0.67	0.66	ABC
Orchardgrass	Latar	10.7	10.5	10.6	A	0.68	0.70	0.69	A
	Profile	10.7	10.6	10.6	A	0.67	0.71	0.69	A
Tall fescue	Fawn	10.5	9.6	10.1	A	0.70	0.71	0.70	A
	Texoma	10.7	9.4	10.0	A	0.69	0.70	0.69	A
Intermediate wheatgrass	Oahe	8.4	10.3	9.3	A	0.62	0.67	0.64	BC
	Rush	9.2	10.1	9.7	A	0.61	0.65	0.63	C
Pubescent wheatgrass	Luna	8.9	9.8	9.3	A	0.62	0.64	0.63	C
	Manska	8.9	9.4	9.2	A	0.62	0.64	0.63	C
Timothy	Climax		10.7		*		0.67		*
	Tuukka	10.7	10.9	10.8	A	0.67	0.72	0.70	A
Year averages		*9.7*	*10.0*			*0.65*	*0.68*		

[1]Grass regrowth forage %crude protein and Mcal/lb NEm values for the two-year averages not connected by the same letter are significantly different at $P < 0.05$ (Tukey HSD).

*Not included in analysis of variance due to not being harvested in 2016.

Table 10. Cool-season perennial forage grass regrowth percent calcium, phosphorus, potassium, magnesium, and sulfur content averages for the 10 October 2016 and 28 September 2017 harvests.

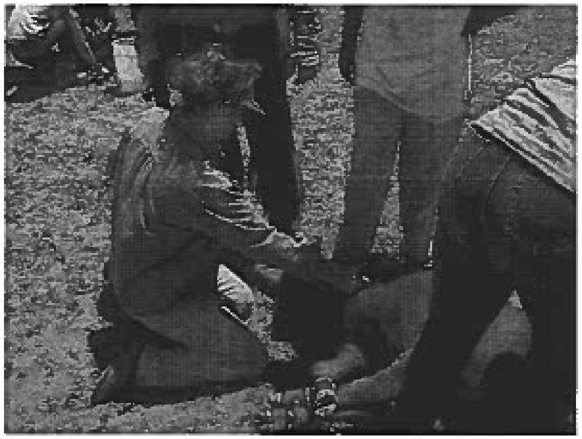
Grass	Variety	Calcium[1]		Phosphorus[1]		Potassium[1]		Magnesium[1]		Sulfur[1]	
Smooth brome	Carlton	0.66	A	0.24	ABC	1.43	DEF	0.42	A	0.29	ABCD
	Manchar	0.52	BCD	0.23	BC	1.38	DEF	0.35	BCD	0.25	CDE
Meadow brome	MacBeth	0.52	BCDE	0.26	ABC	1.85	ABC	0.34	BCD	0.19	E
	Paddock	0.56	AB	0.23	BC	1.60	CDE	0.34	BCD	0.20	E
Orchardgrass	Latar	0.41	DE	0.29	A	2.12	A	0.34	BCDE	0.34	AB
	Profile	0.43	DE	0.27	AB	2.13	A	0.36	ABC	0.30	ABCD
Tall fescue	Fawn	0.39	E	0.26	ABC	1.99	AB	0.36	ABCD	0.32	ABC
	Texoma	0.45	CDE	0.28	AB	2.00	AB	0.38	AB	0.36	A
Intermediate wheatgrass	Oahe	0.52	BCD	0.21	C	1.21	F	0.30	CDE	0.22	DE
	Rush	0.45	BCDE	0.22	BC	1.31	EF	0.27	E	0.26	BCDE
Pubescent wheatgrass	Luna	0.55	ABC	0.24	ABC	1.23	F	0.31	CDE	0.23	DE
	Manska	0.52	BCD	0.24	BC	1.35	DEF	0.30	CDE	0.22	DE
Timothy	Climax	0.42	*	0.23	*	1.74	*	0.31	*	0.26	*
	Tuukka	0.43	DE	0.23	BC	1.72	BCD	0.29	DE	0.22	DE

Table 11. Cool-season perennial forage grass regrowth parts per million (ppm or mg/kg) of iron, manganese, zinc, and copper content averages for the 10 October 2016 and 28 September 2017 harvests.

Grass	Variety	Iron[1]		Manganese[1]		Zinc[1]		Copper[1]	
Smooth brome	Carlton	106	ABCD	71	AB	15.3	AB	4.77	AB
	Manchar	81	ABCDE	64	ABC	16.7	A	4.02	BCD
Meadow brome	MacBeth	92	ABCD	46	CD	12.6	BC	3.75	CDE
	Paddock	97	ABCD	49	BCD	10.8	C	3.22	DEF
Orchardgrass	Latar	76	BCDE	76	A	14.7	AB	5.07	A
	Profile	77	ABCDE	79	A	14.9	AB	4.85	AB
Tall fescue	Fawn	63	DE	41	CD	14.4	ABC	3.99	BCD
	Texoma	38	E	35	D	12.4	BC	3.46	CDEF
Intermediate wheatgrass	Oahe	112	ABC	43	CD	14.2	ABC	2.79	F
	Rush	118	AB	33	D	12.1	BC	3.02	EF
Pubescent wheatgrass	Luna	120	A	48	BCD	14.0	ABC	2.85	F
	Manska	96	ABCD	41	CD	13.8	ABC	2.72	F
Timothy	Climax	58	*	38	*	14.3	*	3.89	*
	Tuukka	79	ABCDE	40	CD	17.5	A	4.27	ABC

[1]Grass regrowth forage macro-mineral percent and micro-mineral ppm values for the two-year averages not connected by the same letter are significantly different at $P < 0.05$ (Tukey HSD).

*Not included in analysis of variance due to not being harvested in 2016, values from 2017 harvest.



The "Heart Of Wyoming Awards" recognize current and historic farm and ranch contributions of women to Wyoming and its fabric called agriculture. As primary partners in each operation, they are often the "magic" which holds it all together; they empower new generations and collaborate on decisions.

This award effort will take annual nominations from agriculture organizations in each county, and begin to highlight the great impacts made across the state. A committee of women producers will lead the review of nominees.

Additional Funding is provided by:

USDA

National Institute of Food and Agriculture

Project: 2016-41210-25621 Western Area Livestock and

WESTERN SARE Sustainable Agriculture Research & Education

USDA U.S. Department of Agriculture Risk Management Agency

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EXCELLENCE IN AGRICULTURE SYMPOSIUM

$25

Wednesday, May 1, 2019

CAMPLEX ENERGY BUILDING

1635 Reata Dr. Gillette, WY 82718

Join us for industry updates, a celebration of Wyoming Women Producers and,

Our Keynote Speaker:

Wyoming First Lady

Jennie Gordon

Pre-registration Required

Co-Sponsored by:

Wyoming Stock Growers Association

Wyoming Farm Bureau Federation

Wyoming Wool Growers Association

University of Wyoming Extension

THE SPEAKERS:

Jennie Gordon, First Lady of Wyoming with her husband Governor Mark Gordon, are the owners/operators of the Merlin Ranch, a cow-calf and heifer development operation located near Buffalo, Wyoming. The Wyoming Beef Council wrote about Jennie, *"She, like the majority of women in ranching, wears many hats. While technically she is the owner-manager, she heads up marketing, record keeping, and the vaccination program on the ranch. Jennie also cooks for everyone working, helps care for the animals and the land, and has been known to mend a fence or two."* Jennie has now added another hat to wear as the First Lady of Wyoming and has kindly agreed to talk about her outlook on agriculture in Wyoming.

Dr. Steve Paisley, UW Beef Specialist and Director of the SAREC, provides leadership to the state on scientific beef data and production guidelines as well as being an active rancher and 1st Vice President of the Wyoming Stockgrowers.

Dr. John Hewlett, UW Ag Econ Specialist and Caleb Carter, SE Area Extension Educator lead the Ag Legacy, Management Skill Transition as well as training on Difficult Conversations: which are ANYTHING you find hard to talk about and could include: the raise you clearly deserve, how we will split up the farm when it comes time, or who should be the one to get a job in town.

Cat Urbigkit is a full-time producer, non-fiction book author, photographer, blogger, and co-owner and editor of The Shepherd magazine. Urbigkit lives on a working sheep ranch in western Wyoming with her family and her livestock guardian animals, including guardian dogs and burros.

Jim Logan, DVM and Wyoming's State Veterinarian is the lead on protecting our state's livestock from disease, agrosecurity risks and interruption of our industries.

Jim Magagna, Executive Director of the Wyoming Stockgrowers Association, plays a lead role in our state monitoring and responding to agriculture issues that need to be addressed in a timely manner.

SCHEDULE

8:30 AM	**Registration and Trade Show**	
9:00AM Concurrent Session 1	Room 1 **Dr. Steve Paisley, UW Beef Specialist - National Beef Quality Emphasis and Production Implications**	Room 2 **Dr. John Hewlett, UW Ag Econ Specialist and Caleb Carter, SE Area Extension Educator—Difficult Conversations**
10:00 AM Break	**Main Room—Sponsored by Wyoming Farm Bureau Federation**	
10:30 AM Concurrent Session 2	Room 1 **Dr. Jim Logan, WY State Veterinarian—Livestock Health & Disease Update**	Room 2 **Cat Urbikit, Rancher & Author—Avoiding Livestock Interaction Disasters with Predators.**
11:30AM Break	**Main Room—Sponsored by Wyoming Woolgrowers Association**	
12:00 Noon	**Updates on Wyoming Agriculture Issues—Jim Magagna, Wyoming Stockgrowers Association**	
12:30 Lunch & Keynote	***Wyoming First Lady, Jennie Gordon—"The Significance of Women In Wyoming Agriculture Production"*** **(Sponsored by the Wyoming Stockgrowers Association and the USDA Western Region Sustainable Agriculture Research and Education program)**	
2:00pm	**Recognition of Wyoming " Heart of Agriculture" Award Winners**	
2:30pm	Program Conclusion	

REGISTER AT:

https://uwextension2019excellenceinag.eventbrite.com

No Later than 4pm Friday April 26, 2019

NOMINEES for the "Heart of Agriculture Award" can be submitted to Scott Cotton, Scotton1@uwyo.edu anytime before April 22, 2019 with inclusion of:

Name, County of Operation, Description of the efforts of the producer, Contact Information for Producer, and a photo if possible. Nominees will be contacted for acceptance. All material will be held confidential by the UW Extension program.

UNIVERSITY OF WYOMING EXTENSION
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UNIVERSITY OF WYOMING
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LAND & LIVESTOCK

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