

# MEADOW BROMEGRASS-LEGUME

## mixtures for diversified and profitable hay production in Wyoming

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Four years of research at the Sheridan Research and Extension Center suggests grass-legume mixtures with alfalfa are the most productive and profitable, overriding changes in weather conditions and management.

Based on the research, the most recommended forages for Wyoming is a 50-50 percent mixture of meadow brome-grass with alfalfa, a 50-25-25 percent mixture of meadow brome-grass, alfalfa, and birdsfoot trefoil, and 70-30 per-cent mixture of meadow brome-grass with alfalfa. Although mixtures purely of meadow brome-grass and sainfoin had relatively lower gross margins, this crop may have more value considering sainfoin enhances forage palatability and prevents bloat.

Numerous studies indicate grass-legume mixtures can improve forage yields, nutritive value, and net economic benefits. Meadow brome-grass is a popular cool-season grass found suitable. This species can grow upright and allows legumes to thrive in mixtures (Figure 1). Different combinations of meadow brome-grass and legumes includ-ing alfalfa, birdsfoot trefoil, and sainfoin can help alleviate challenges of producing monocrops that include costs of nitrogen (N) fertilizers required to optimize yield, compar-atively low nutritive value of grasses, and bloat disorder in livestock caused by alfalfa.

Alfalfa hay has higher market prices compared to other hay crops. High forage nutritive value has been used as a benchmark for setting alfalfa and grass hay prices. Alfalfa hay with crude protein (CP) values of less than 16, 16-18,





**Figure 1.** Meadow bromegrass-legume mixtures improve forage performance at the University of Wyoming Sheridan Research and Extension Center.

18-20, 20-22, and greater than 22 percent is rated as utility, fair, good, premium, and supreme quality, respectively.

On the other hand, grass hay with CP concentrations less than 5, 5-9, 9-13, and greater than 13 percent is ranked as low, fair, good, and premium quality hay, respectively.

There are no clear price standards for sainfoin, birdsfoot trefoil, and grass-legume mixtures per se. According to USDA NASS report for 2018, alfalfa hay prices increased by \$33 and \$35 following change from fair to good and good to premium quality, respectively.

In contrast, grass hay price increased by \$44 and \$80 corresponding to a change from fair to good and good to premium quality.

Nutritive value of hay fed to cattle determines the net income from livestock farming. According to USDA NASS report, livestock feed accounts for about 12 percent of the total farm operating cost. High-quality hay enhances productivity of beef and dairy cattle.

### **Economic evaluation of meadow bromegrass-legume mixtures**

Experiments from 2013-2017 at the Sheridan Research and Extension Center (ShREC) determined forage yield, nutritive value, and gross margin (GM) for meadow bromegrass, alfalfa, sainfoin, and birdsfoot trefoil mixtures and monocultures.

There were 50-50 percent and 70-30 percent mixtures of meadow bromegrass with each legume, 50-25-25 percent mixture of meadow bromegrass with alfalfa and birdsfoot trefoil, and similar mixture with meadow bromegrass, alfalfa and sainfoin.

The last crop combination was 50-16.7-16.7-16.7 percent mixture of meadow bromegrass, alfalfa, sainfoin, and birdsfoot trefoil.

Grass monocultures received 0, 50, and 100 pounds of N per acre as urea. Seed rates and ratios were estimated by dividing recommended seeding rates with pure live seed (PLS). PLS is the amount of live seed in bulk seed and is calculated by multiplying the percentage of seed





**Figure 2.** Hay baling at the Sheridan Research and Extension Center in June 2016 (left); forage nutritive value analysis using near infrared spectrophotometer at the University of Wyoming forage laboratory (right), December 2016.

purity by percentage of seed germination.

The recommended seeding rates based on PLS for meadow bromegrass, alfalfa, sainfoin and birdsfoot trefoil were 20, 20, 35, and 10 pounds per acre, respectively.

Planting was September 4, 2013, and plots were harvested in mid-June, August, and October each year from 2014 to 2017. Harvested samples were used to estimate forage dry matter (DM) yield per acre and nutritive value using the near infrared reflectance spectroscopy (NIRS) (Figure 2).

Economic analysis was based on expenses involved in producing each crop (Table 1) according to different treatment and cumulative forage dry matter yields. Each treatments was treated as an enterprise. Gross margins (GM) were calculated each year according to Equation 1.

$$GM = CI - VOC$$

Where CI is the cash inflow (U.S. dollars) and VOC is the variable operational cost (\$).

### Effect on forage yield and nutritive value

Variations were observed among treatments for the total forage DM yield. Total forage yield from mixtures was consistently higher compared to legume and grass monocultures 2015-2017 (Table 2). This was particularly evident in the 50-50 percent and 70-30 percent mixtures of meadow bromegrass with alfalfa and 70-30 percent mixture of meadow bromegrass with birdsfoot trefoil.

The same applied to a 50-25-25 percent mixture of meadow bromegrass, alfalfa, and sainfoin; 50-25-25 percent mixture of meadow bromegrass, alfalfa, and birdsfoot trefoil; and 50-16.7-16.7-16.7 percent mixture of meadow bromegrass, alfalfa, birdsfoot trefoil, and sainfoin.

Sainfoin monoculture had the lowest forage yield in all the years.

Alfalfa monocrop CP varied from supreme (28 percent), good (17.7 percent), to supreme (23.9 percent) in 2015, 2016, and 2017, respectively, based on USDA guidelines. Although these guidelines apply only to alfalfa, they were used to evaluate birdsfoot trefoil and sainfoin.

The CP concentration for birdsfoot trefoil was rated as supreme in 2015 and 2017 (22 percent) and good in 2016 (18.1 percent). CP concentration for sainfoin was rated as good in 2015 (18.2 percent) and premium in 2017 (21.9 percent).

Some of the grass-legume mixtures containing alfalfa and birdsfoot trefoil improved forage nutritive value (particularly CP concentration) to levels equivalent to good quality alfalfa in 2015 and 2017. These include 50-50 percent mixture of meadow bromegrass with alfalfa (19.7 percent), 70-30 percent mixture of meadow bromegrass with alfalfa (19.3 percent), and 70-25-25 percent mixture of meadow bromegrass, alfalfa and birdsfoot trefoil (19.1 percent).

## Effect on net economic benefits

Variations were observed among years and treatments for GM (Table 3). The 50-50 percent mixture of meadow brome grass with alfalfa (Figure 3) had the highest four-year total GM of \$1,497 per acre. This was similar to GM for 50-25-25 percent mixture of meadow

brome grass, alfalfa, and birdsfoot trefoil (Figure 3) (\$1,440 per acre) and 70-30 percent mixture of meadow brome grass with alfalfa (\$1,368 per acre).

Sainfoin monoculture earned the lowest total GM of \$62.

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**Table 1.** Operation costs and prices for grass and legume hay at the Sheridan Research and Extension Center 2014-2017.

Operation costs/hay prices	Price unit <sup>1</sup>			
	2014	2015	2016	2017
<b>Fixed operation costs</b>	<b>\$</b>			
Personnel cost (\$ per year)	224.00	224.00	224.00	224.00
Fuel costs for crop monitoring (\$ per year)	2.00	2.00	2.00	2.00
Overheads (land rental charge, \$ per acre)	61.52	61.52	61.52	61.52
Soil tests (\$ per sample)	14.00			
<b>Variable operation costs</b>				
Land preparation (\$ per acre)	62.15	0	0	0
Herbicide (glyphosate, \$ per pound a.i.)	3.00	0	0	0
Herbicide application (\$ per acre) <sup>†</sup>	7.00	0	0	0
Alfalfa seeds (\$ per pound)	4.51	0	0	0
Birdsfoot trefoil seeds (\$ per pound)	5.26	0	0	0
Sainfoin seeds (\$ per pound)	2.70	0	0	0
Meadow brome grass seeds (\$ per pound)	3.00	0	0	0
Planting grass (\$ per acre)	16.36	0	0	0
Planting legumes (\$ per acre)	15.36	0	0	0
Planting mixtures (\$ per acre)	17.44	0	0	0
Urea fertilizer (\$ per pound N)	0.66	0.66	0.85	0.85
Fertilizer application (\$ per pound)	6.24	6.24	6.24	6.24
Irrigation (\$ per acre)	72.87	72.87	72.87	72.87
Hay swathing, raking, and rolling (\$ per acre)	20.10	20.10	20.10	20.10
Hay hauling (\$ per ton)	5.30	5.30	5.30	5.30
Interest on operating capital (4.8%)				
Taxes and insurance (1% of total investment)				
<b>Hay prices per ton<sup>§</sup></b>				
Alfalfa	118.00	118.00	122.00	136.00
BFT	101.00	101.00	106.00	128.00
Sainfoin	101.00	101.00	106.00	128.00
Meadow brome grass	101.00	101.00	106.00	128.00
Meadow brome grass - legume mixture	101.00	101.00	106.00	128.00

<sup>†</sup>Herbicide application before seeding; <sup>§</sup>USDA NASS, 2018.



**Figure 3.** The 50-50 percent mixture of meadow brome grass with alfalfa (left); the 50-25-25 percent mixture of meadow brome grass, alfalfa, and birdsfoot trefoil (right) at the Sheridan Research and Extension Center, June 2016.

**Table 2.** Total forage dry matter (DM) yield and average nutritive value for grass-legume mixtures and nitrogen (N) treatments from different harvests at the Sheridan Research and Extension Center 2015-2017.

Treatment <sup>†</sup>	DM yield				Forage nutritive value <sup>‡</sup>					
	2015	2016	2017	Total	CP	ADF	NDF	IVDMD	TDN	RFV
	tons per acre				%					
Alf (100)	3	5	4	12	24	28	47	69	70	168
SF (100)	2	1	1	4	19	29	47	62	70	172
BFT (100)	3	4	3	10	22	29	47	65	69	174
MB-Alf (50-50)	4	7	7	18	18	33	53	67	65	129
MB-Alf (70-30)	4	5	7	16	18	32	55	66	66	133
MB-SF (50-50)	3	3	3	9	14	34	56	64	65	122
MB-SF (70-30)	3	3	3	9	13	35	55	64	65	118
MB-BFT (50-50)	3	5	5	13	17	34	55	65	64	128
MB-BFT (70-30)	3	5	6	14	17	33	55	66	66	129
MB-Alf-SF (50-25-25)	4	4	6	14	16	34	53	68	65	125
MB-Alf-BFT (50-25-25)	5	7	6	18	18	33	54	68	67	131
MB-Alf-BFT-SF (50-16.7-16.7-16.7)	4	5	6	15	17	32	52	67	66	133
MB-No	3	3	2	8	12	37	60	65	62	104
MB-N50	4	4	2	10	13	37	60	67	63	101
MB-N100	4	5	4	13	14	35	60	66	63	113

<sup>†</sup> MB = meadow brome grass; Alf = alfalfa; SF = sainfoin; BFT = birdsfoot trefoil, No = 0 pound N per acre; N50 = 50 pounds N per acre; N100 = 100 pounds N per acre.

<sup>‡</sup> CP = crude protein; ADF = acid detergent fiber; NDF = neutral detergent fiber; IVDMD = in vitro dry matter digestibility; TDN = total digestible nutrients; RFV = relative feed value.





**Figure 4.** Benefits of grass-legume mixtures. Left, a 50-50 percent mixture of meadow bromegrass and sainfoin without weed problems. Right, sainfoin monoculture infested by weeds at the Sheridan Research and Extension Center, June 2017.

**Table 3.** Operation costs, revenue, and gross margin for different grass-legume mixtures and nitrogen (N) fertilizer rates determined during the years 2014-2017 at the Sheridan Research and Extension Center.

Treatments <sup>†</sup>	Operation costs				Revenue				Gross margin <sup>‡</sup>				
	2014 <sup>§</sup>	2015	2016	2017	2014 <sup>§</sup>	2015	2016	2017	2014 <sup>§</sup>	2015	2016	2017	Total
	\$ per acre												
Alf (100)	397	110	117	117	347	373	562	611	-51	264	445	495	1153
SF (100)	399	104	100	97	306	211	141	105	-93	107	41	7	62
BFT (100)	368	110	112	108	317	327	387	363	-51	217	275	255	696
MB-Alf (50-50)	375	111	127	132	273	352	683	934	-102	241	556	802	1497
MB-Alf (70-30)	371	115	119	130	280	428	511	883	-91	313	393	753	1368
MB-SF (50-50)	368	107	111	109	214	274	357	376	-153	167	246	268	528
MB-SF (70-30)	370	109	109	108	265	314	330	366	-106	204	221	258	577
MB-BFT (50-50)	346	110	118	121	226	327	501	683	-120	217	383	562	1042
MB-BFT (70-30)	362	110	120	124	292	323	550	757	-70	213	430	633	1206
MB-Alf-SF (50-25-25)	367	112	115	123	212	357	439	718	-155	245	325	596	1011
MB-Alf-BFT (50-25-25)	356	116	128	126	224	440	700	802	-132	324	572	676	1440
MB-Alf-BFT-SF (50-16.7-16.7-16.7)	361	114	120	124	211	404	546	760	-150	290	426	636	1202
MB-No	355	111	110	103	249	341	346	232	-106	230	236	130	490
MB-N50	394	152	154	145	318	379	445	316	-76	227	291	171	613
MB-N100	416	186	190	184	350	411	503	468	-66	224	313	283	754

<sup>†</sup> MB = meadow bromegrass; Alf = alfalfa; SF = sainfoin; BFT = birdsfoot trefoil, No = 0 pound N per acre; N50 = 50 pounds N per acre; N100 = 100 pounds N per acre.

<sup>‡</sup> Annual total gross margin from three harvests.

<sup>§</sup> Adjasiwor et al., 2017.

All treatments had a significant increase in GM in the year 2015 compared to 2014 when no enterprise had profits. In subsequent years, some mixtures maintained a consistent increase in profits. These were the 50-50 percent mixture of meadow brome grass with alfalfa (\$241 to 802 per acre) and 70-30 percent mixture of meadow brome grass with alfalfa (\$313 to 753 per acre).

The other crops that maintained an increase in GM during the similar period were the 70-30 percent mixture of meadow brome grass with birdsfoot trefoil (\$324 to 676 per acre) and 50-16.7-16.7-16.7 percent mixture of meadow brome grass, alfalfa, sainfoin, and birdsfoot trefoil (\$290 to 636 per acre).

There were no significant gains in profits for meadow brome grass monoculture with or without fertilizer between 2015 and 2017. It is evident alfalfa and birdsfoot trefoil tended to add value to hay when included in mixtures with grass. Mixtures helped compensate for low sainfoin monocrop yields associated with high temperatures and weed infestation (Figure 4).

In particular, the 50-16.7-16.7-16.7 percent mixture of meadow brome grass, alfalfa, sainfoin, and birdsfoot trefoil showed potential to sustain yields and increase profit margin compared to the consistently low economic benefits from sainfoin monocrop.

## Summary

Overall, grass-legume mixtures, which include alfalfa and birdsfoot trefoil, have potential market value comparable to good quality, pure alfalfa hay. Investments in grass-legume mixtures can be recouped resulting in profits.



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