Washakie County Forage Trial – Summer 2021

Dr. Caitlin Youngquist, University of Wyoming Extension, Washakie County

In May, 2021, a hailstorm damaged several sugarbeet fields south of Worland, WY. To minimize revenue loss, the farmer replanted the damaged fields to annual forages in early July. This provided an opportunity to compare a variety of forages including two "ancient grains". A concurrent trial was planted near Ten Sleep (Big Trails) in late July.

Table 1. Planting Dates and Growing Conditions

	Worland	Ten Sleep
Planting	7/12/21	7/28/21
Cut for forage analysis[1]	8/27/21	9/13/21
Average first frost[2]	Oct 1-10	Sept 21- 30
Growing Degree Days[3] (base T = 50)	931	739
Irrigation	Yes	Irrigated only once
Fertilizer	No	70 units of N
Previous crop	Sugar beets	Oats

1. Both trials were cut at 46-47 days of growth
2. Median first 28°F freeze – National Weather Service
3. GDDs are used to estimate plant and insect growth during a growing season. The base temperature depends on the crop being grown (ie. base 50°F for warm season crops and base 40°F for cool season crops). GGD values are calculated by subtracting the base from the mean daily temperature. For example, an average daily temperature of 62°F at a base of 50°F gives a GDD value of 12. GDD values cannot be negative.

Table 2. Forage Varieties, Seeding Rates, and Estimated Costs

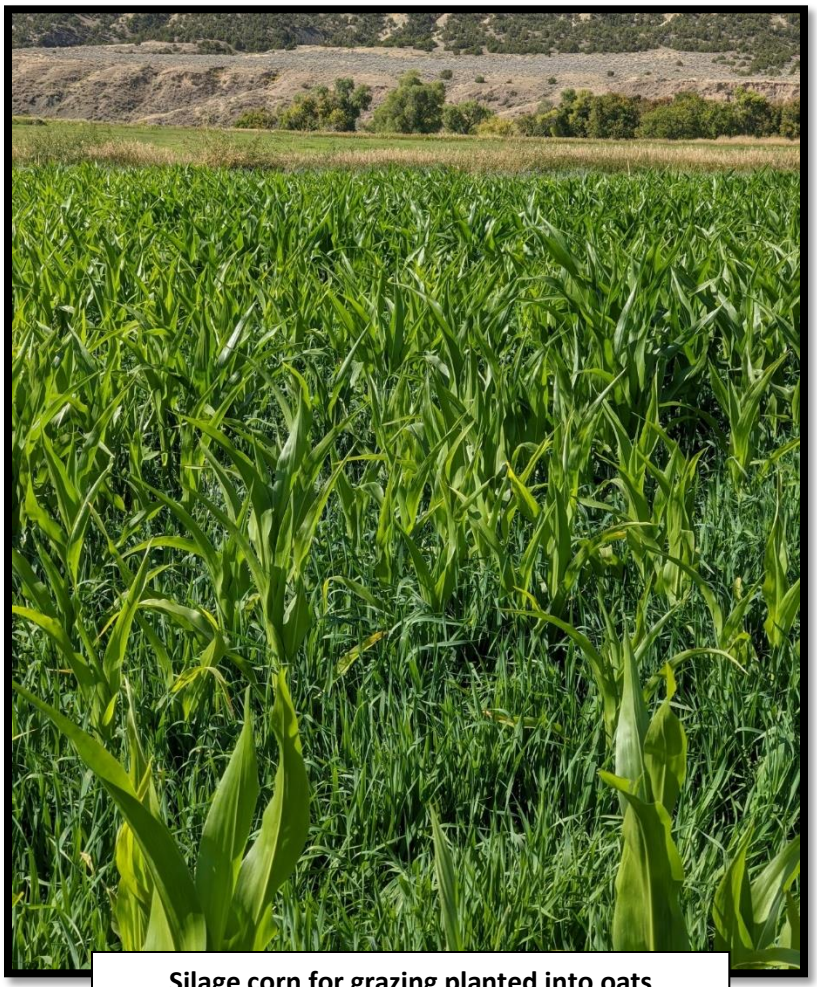
	Worland	Ten Sleep	Target seeding rate	Cost	
	acres		lbs / acre	$ / lb	$ / acre
Warm Season					
Silage Corn[1]	0	1	25-30	3.00	75
German (Foxtail) Millet[1]	2	2	25	0.95	24
Siberian (Foxtail) Millet[1]	2	2	25	0.90	23
Japanese Millet[1]	2	0	25	0.90	23
Cool Season					
'Stockford' Hay Barley	1	1	95	0.36	34
'EverLeaf®' Forage Oats	1	1	80	0.51	41
'Lucile' Emmer	1	1	125	nd[3]	-
'Origine' Spelt[2]	1	1	125	nd[3]	-
'Alturas' HWS Wheat	1	0	100	0.29	29
Spring Triticale[1]	0	1	80-100	0.34	31

1. Variety not specified
2. This is a grain spelt but there are several forage spelt varieties available.
3. Seed was left over from another research project and provided by UW Extension. In 2018, spring spelt (var. 'Origine') was purchased for $1.54/lb and winter spelt (var. 'Frank') was purchased for $0.50/lb.

Excess nitrate accumulation in cereal grains, corn and millet can be dangerous to stock. Horses are less susceptible to nitrate toxicity than ruminants. Forage nutrition and yield are affected by stage of maturity. As the plant matures from the boot stage to the dough stage, forage quality decreases and dry matter yield increases. Small grain development stages are as follows:

1. Boot - grain head is enclosed by the sheath of the uppermost leaf
2. Milk - grain head releases a white liquid substance when opened
3. Dough - grain head begins to turn to a doughy consistency

Corn is a warm season crop that needs a minimum soil temperature of 50^{o}F at planting. Silage corn can be included in cover crops for grazing and annual forage mixtures. It can also be grown to maturity and used for winter grazing. Brown Mid Rib (BMR) corn has been developed to be more digestible (lower lignin) than other varieties. In Ten Sleep, silage corn grew very well and created lush mixed forage stand with volunteer oats from the previous crop.



Silage corn for grazing planted into oats following harvest for hay.

Millet is a warm season annual grass that can be grazed and cut for hay. A soil temperature of 60°F is ideal for germination. Millet does not accumulate prussic acid. Millets require approximately 10 lbs of N, 5 lbs of P_2O_5, and 12 lbs of K_2O per ton of forage produced.

Japanese Millet

- Very rapid growth, ready to cut in 50 days, grows up to 5 ft tall
- Good regrowth for multiple cuttings or grazings
- Higher tolerance to flooding, wet, and saline soils than other millets
- For hay, cut in the boot stage or earlier and leave 4" of stubble for the best regrowth
- For a single cutting (no regrowth), cut in in late boot through early seedhead emergence
- Start grazing before any seedheads have emerged and graze to a minimum stubble height of 4" before removing livestock and allowing regrowth

German and Siberian Millett (foxtail type millets)

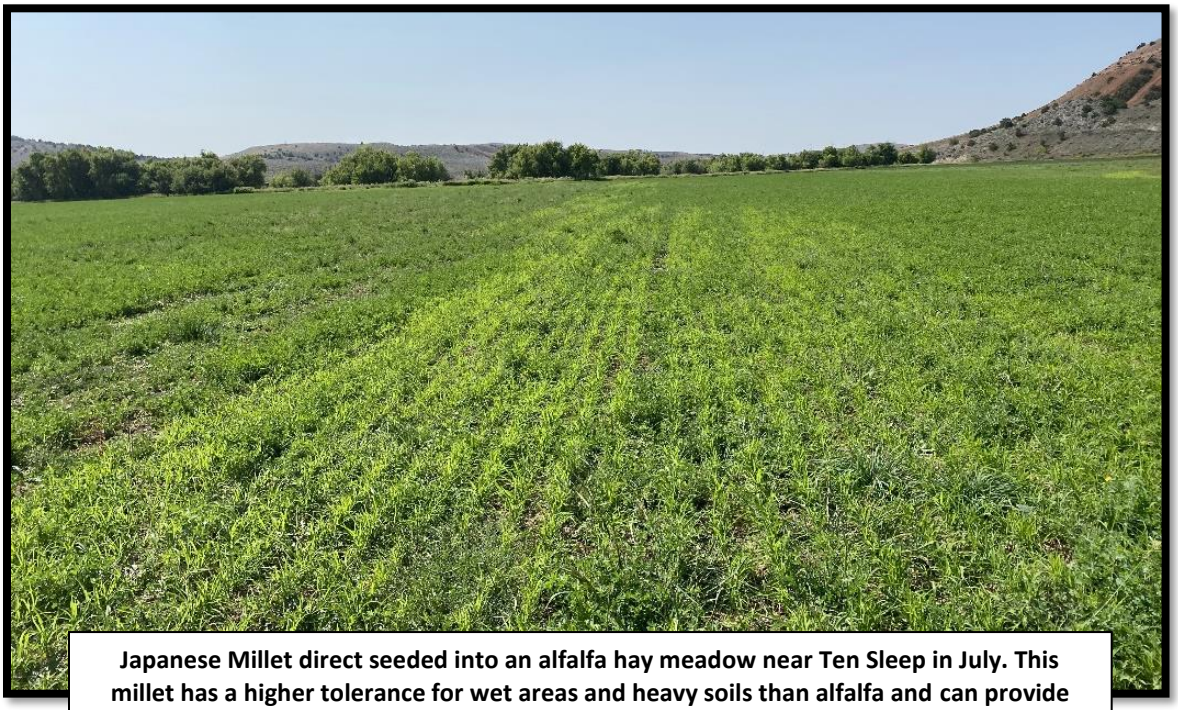
- Commonly planted as a single-cut hay millet
- Can be ready to cut for hay 60 days from planting (Siberian will mature a week before German)
- Produces hay that will cure easily and be highly palatable for livestock.
- Drought tolerant, grows rapidly during hot summer conditions
- German Millet does well in light soils due to its high level of water efficiency
- Of all three millet varieties, Siberian has the smallest stem and will dry down faster for hay
- Cut for hay between late boot stage and early seedhead emergence, palatability declines with mature seedheads
- Foxtail millets can be dangerous to horses due to high levels of oxalates and glucosides

The three millet varieties had the best early growth in the Worland trial and were 10-12 inches taller than the other grains when cut at 46 days. As expected, they had poor regrowth and low cold tolerance. The millet also did well in Ten Sleep but looked comparable to the oats and hay barley in biomass, likely due to cooler temperatures (fewer Growing Degree Days).

Millet near Worland showing strong early growth compared to emmer and hay barley. Planted July 12. Photo taken August 26

Five small grains grown near Worland. Planted July 12 and harvested August 27.
Left to right: hay barley, hard white spring wheat, EverLeaf® oats, spelt, and emmer.

Three millet varieties grown near Worland. Left to right:
Siberian, Japanese, and German.
Planted July 12 and harvested August 27.



Japanese Millet direct seeded into an alfalfa hay meadow near Ten Sleep in July. This millet has a higher tolerance for wet areas and heavy soils than alfalfa and can provide additional forage in areas that alfalfa does not thrive.

Cereal grains (wheat, oats, barley, rye) are cool season annual grasses. Minimum soil temperature for germination is 35 to 40ºF. Of these grains, oat is the least cold tolerant. Cereal forages are generally low in minerals, so forage testing is recommended. Magnesium supplementation may be necessary when grazing cattle on cereal pastures to prevent grass tetany (a magnesium deficiency). Potassium and nitrogen fertilization of the crop can increase the risk of grass tetany in cattle grazing annual cereal pastures. Small grains require approximately 9 lbs of N, 11 lbs of P_2O_5, and 45 lbs of K_2O per ton of forage produced.

EverLeaf® Forage Oats

- Spring oat developed as a true forage variety
- Slow maturing variety with long vegetative phase – shows a very different growth habit than grain oats in the Ten Sleep trial
- Not drought tolerant or prone to lodging
- For highest quality hay, cut in the late boot through milk stage
- For silage, cut in soft dough stage
- For grazing, they have some regrowth potential if grazed during vegetative stage

Spring Triticale

- Rye and wheat hybrid known for high yields and cold tolerance
- Later maturing than oats or barley with a long harvest window
- Drought tolerant, performs well in a range of conditions, moderate salinity tolerance
- Graze or cut for hay/silage from late boot stage through the soft dough stage
- In Ten Sleep, triticale had the slowest initial growth of all grains

Stockford Hay Barley

- Beardless spring barley, taller and leafier than grain barley
- Produces a fine-stemmed, palatable hay
- Tolerant of drought and saline conditions
- Beardless, maintains forage quality longer than many other small grain crops

- Cut for hay or silage at any point from the late boot stage through the early milk stage
- In Worland, this barley showed slow early growth and very rapid regrowth and high biomass production after the weather cooled down

Alturas Spring Wheat

- Soft white spring wheat (this is not a forage variety, and does have awns)
- Wheat tends to be more tolerant of wet soils than oats or barley, and less tolerant of wet soils than rye or triticale
- In the Worland trial, this was the first cereal grain to mature
- Very little biomass was produced and forage value was low due to long awns and early maturity
- In Ten Sleep it stayed in the vegetative stage longer and showed more potential as forage
- Winter wheat can be used as a dual-purpose crop (e.g., plant in the late summer, graze in the fall, and harvest for grain or graze again the following summer)

Ancient Wheats

- Emmer and Spelt are ancient wheat varieties used for food that also have some forage value
- Spelt is awnless and emmer has very long awns
- In Ten Sleep, emmer showed the most aggressive early growth of all cereal grains and appeared to produce more biomass than the millets
- Spelt produces a very high-quality forage and will get taller than emmer at maturity but has slower early growth with a more prostrate habit
- Grain protein for spelt and emmer is typically higher than barley and oats
- In this trial, emmer and spelt tended to be higher in iron and zinc and lower in sodium than the other cereals
- Forage yield potential for spelt is reported to be similar to triticale and it produces a very high-quality straw

L – grain oats grown for hay; R – EverLeaf ® forage oats.

Forage quality data is represented in Table 3. This was not a replicated trial and the forage quality data represents a snapshot in time (46-47 days). It does not account for forage quantity or palatability. Nevertheless, some trends are worth noting.

Across both locations the corn and millets trended higher in magnesium compared to the cereal grains; the foxtail millets and ancient wheats trended higher in zinc; corn, japanese millet and hay barley trended higher in calcium; and the oats and barley were much higher in sodium. In Worland, the ancient wheats were higher in iron than the other cereal grains.

In Worland, oats, barley, and spelt had the highest overall feed quality. In Ten Sleep, Japanese millet, triticale, and spelt had the highest overall feed quality.

Acid detergent fiber (ADF) is a measure of the least digestible parts of the plant (cellulose and lignin) and is inversely related to digestibility. Lower ADF values indicate higher energy. Total digestible nutrients (TDN) is the sum of the fiber, protein, carbohydrates, and lipids.

Table 3. Nutritional Value of Annual Forage Crops Grown in Worland and Ten Sleep

	Crude Protein (%)	ADF	TDN	Net Energy (gain)	Calcium (%)	Magnesium (%)	Iron (ppm)	Zinc (ppm)	Sodium (%)
Worland									
German Millet	21.0	35.7	61.8	0.33	0.57	0.52	86	37	0.06
Siberian Millet	18.5	35.1	62.5	0.34	0.49	0.47	93	36	0.02
Japanese Millet	23.2	30.8	67.4	0.41	0.88	0.54	114	29	0.10
'EverLeaf®' Oats	31.5	28.2	70.4	0.45	0.58	0.27	88	29	0.75
'Stockford' Barley	31.6	29.6	68.8	0.43	0.70	0.25	85	29	0.77
'Alturas' Wheat	28.2	31.4	66.8	0.40	0.41	0.22	86	30	0.11
'Origine' Spelt	32.0	28.1	70.5	0.45	0.49	0.24	112	33	0.15
'Lucile' Emmer	26.8	32.5	65.5	0.38	0.54	0.19	122	37	0.32
Ten Sleep									
Corn	16.8	28.0	70.6	0.46	0.69	0.50	79	73	0.01
German Millet[1]	19.3	27.6	71.1	0.46	0.55	0.29	147	60	0.03
Siberian Millet	18.6	30.0	68.3	0.42	0.54	0.36	123	58	0.03
Japanese Millet	23.0	25.0	74.0	0.50	0.87	0.47	103	44	0.05
Grain Oats	22.1	30.4	67.9	0.42	0.72	0.27	100	48	0.10
'EverLeaf®' Oats	21.7	28.8	69.7	0.44	0.51	0.33	nd[1]	48	0.60
'Stockford' Barley	16.7	30.9	67.3	0.41	0.84	0.25	80	41	0.31
Triticale	28.6	26.1	72.8	0.48	0.49	0.20	122	63	0.06
'Origine' Spelt	28.2	28.0	70.6	0.46	0.52	0.26	103	62	0.11
'Lucile' Emmer	20.0	33.8	64.0	0.36	0.53	0.17	85	64	0.08

1. No data – sampling error

Einkorn, emmer, and spelt were also compared to barley for suitability as a fodder grain. Barley trended lower in iron and manganese than the ancient wheats, and higher in Net Energy of Gain (Table 4). The higher ADF in the fodder made with ancient wheats is likely due to the larger hulls. For pigs, the higher iron (especially in einkorn) could be a significant benefit.

To grow fodder, the grains were soaked in water for one day and then grown in trays. They were fed to sheep, pigs, and chickens on Day 8. Emmer had the thickest root mat of all four grains. Barley was the fastest to germinate and develop green shoot growth, however by Day 8 the three other grains appeared to have more biomass.

The einkorn, emmer, and spelt were able to germinate and grown at colder temperatures than the barley. This was an advantage for growing fodder in the fall as the fodder growing system was not in a heated building. Given a choice the animals preferred the barley and spelt fodder to the emmer and einkorn, but still willingly ate everything.

Table 4. Nutritional Value of Fodder Grown from Barley and Three Varieties of Ancient Wheat

	Crude Protein (%)	ADF	TDN	Net Energy (gain)	Iron (ppm)	Manganese (ppm)
Barley	14.4	12.9	87.3	0.61	51	24
Einkorn	12.1	26.9	71.9	0.47	99	57
Emmer	21.2	23.3	76.0	0.53	73	44
Spelt	14.0	21.8	77.7	0.54	52	43

Barley fodder grown as feed for sheep, pigs, and poultry.

Further reading:

1. Millets: Forage Management – Iowa State University
   https://www.extension.iastate.edu/sites/www.extension.iastate.edu/files/iowa/MilletFS55.pdf
2. Using Small Grains for Forage – Michigan State University
   https://www.canr.msu.edu/news/using_small_grains_for_forage
3. Grass Tetany – North Dakota State University
   https://www.ag.ndsu.edu/publications/livestock/grass-tetany
4. Cereal Forage: Nitrate– Montana State University
   https://www.montana.edu/news/910/cereal-forage-yield-and-harvest-qualities
5. Potential Alternative Crops for Eastern Oregon – Oregon State University
   https://agsci.oregonstate.edu/sites/agscid7/files/cbarc/attachments/AlternateCrops.pdf
6. Grazing Cattle on Corn – Manitoba Agriculture https://www.gov.mb.ca/agriculture/crops/crop-management/forages/pubs/grazing_cattle_on_corn.pdf
7. Using Corn for Livestock Grazing – Ohio State University Extension
   https://ohioline.osu.edu/factsheet/anr-11

Funding was provided by the Western Sustainable Agriculture Research and Education program. Please visit wwww.western.sare.org to learn about farmer-driven research and education projects.