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Einkorn field, Hot Springs County, Wyoming.

GROWING EINKORN, EMMER, AND SPELT IN WYOMING

Wyoming farmers are well suited to produce small grain crops and already grow 250,000 acres of wheat, oats, and barley. Ancient wheats (einkorn, emmer, and spelt) are alternative crops that can be grown with existing equipment and fit well into current crop rotations. These grains are taller than modern varieties with more robust roots and more leaf area. They produce high quality straw and can also be used for forage.

Einkorn, emmer, and spelt are early predecessors of modern wheat and are some of the many "ancient grains" gaining popularity with consumers and chefs. There was a 269% increase in processed food products labeled as "ancient" between 2010 and 2016. A report from Market Data Forecast predicts that the ancient grains food market will expand at a growth rate of over 35% to $6.3 billion by 2024, and that more than 20% of shoppers are willing to pay a premium for products that contain ancient grains.

Worland, Wyoming was home to an emmer breakfast food factory circa 1915 under the ownership of Professor B.C. Buffum (former

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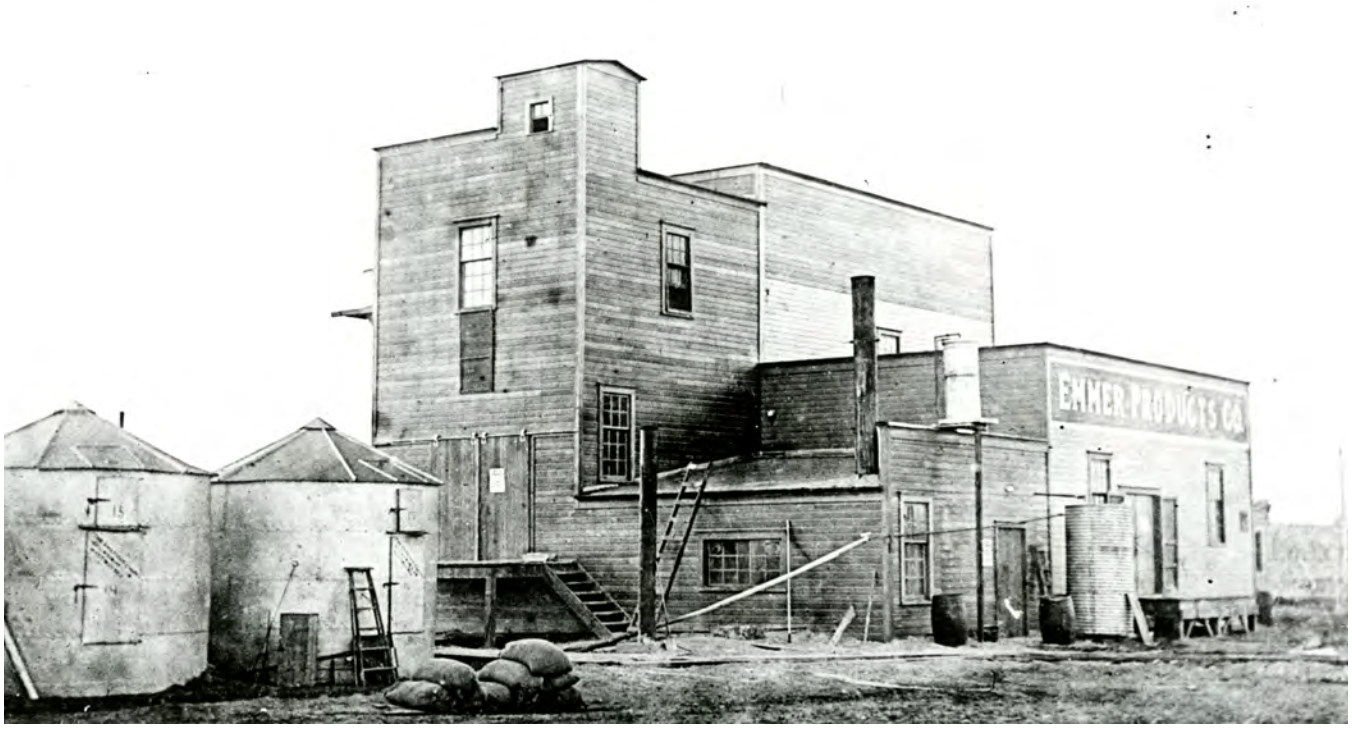

Courtesy Washakie Museum and Cultural Center

Emmer Products Company, Worland, Wyoming, circa 1915.

director of the University of Wyoming Agricultural Experiment Station and a Worland native). An article published in 1911 in *The National Magazine* about Buffum's work claims that "improved winter Emmer…is surpassing even the best wheat as a food for civilized man."

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Emmer (L) and einkorn (R) test plots, Hot Springs County, Wyoming.

Einkorn, emmer, and spelt are used in baking and cooking but have higher protein than most modern wheat varieties. They also can be malted and used for flavor in brewing. These early wheats are higher in some vitamins and minerals than modern wheat (Boukin et al., 2018). Research comparing spelt and soft winter wheat grown in the same field in Belgium found that spelt was 30–60% higher in iron, zinc, copper, magnesium, and phosphorus; 40% lower in phytic acid; and had nearly twice as much oleic acid (an omega-9 fatty acid) (Ruibal-Mendieta, et al., 2005). Phytic acid inhibits the absorption of calcium, iron, and zinc and is found in many grains, nuts, and legumes.

Some people with gluten sensitivity can eat these early varieties with little or no adverse effects. A comprehensive review of current research concludes that "ancient wheat varieties have shown convincing beneficial effects on various parameters linked to cardio-metabolic diseases" and "the consumption of ancient wheat products ameliorate pro-inflammatory/anti-oxidant parameters, as well as glycemic and lipid status" (Dinu et al., 2018).

Einkorn (*Triticum monococcum*) was one of the first cereal grains domesticated and grown for food in the Fertile Crescent (Tigris-Euphrates region). It was widely cultivated throughout the Near East, Mediterranean region, southwestern Europe, and the Balkans during the Neolithic and early Bronze Ages (10,000–4,000 BCE). While einkorn is more nutritious than common wheat (higher in protein, fat, phosphorus, potassium, and beta-carotene), the dough quality (gluten) is considered inferior for baking. Einkorn is a diploid wheat, which means it only has 2 sets of chromosomes. Some people with gluten sensitivity can eat einkorn without adverse effects.

Emmer (*Triticum dicoccoides*) and barley eventually replaced einkorn as the dominant cereal grains near the end of the Bronze Age. The addition of another genome gave it four sets of chromosomes (tetraploid) and allowed it to thrive in a wider range of conditions than einkorn. It was more widely used than einkorn but was eventually replaced by the hulless wheats. Similar to einkorn, emmer tends to outperform modern wheat under marginal

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Test plots of emmer (L) and spelt (R), Washakie County, Wyoming.

conditions. It is less challenging to bake with than einkorn but still considered inferior in dough quality compared to modern wheat.

Spelt (*Triticum spelta*) is even more widely adapted than einkorn and emmer due to the addition of a third genome from a wild grass, giving it 6 sets of chromosomes. Like modern wheat, this makes spelt a hexaploid. More crop breeding and cultivar selection work has been done with spelt than einkorn and emmer. As a result, it has less tendency to lodge and is higher yielding. When grain lodges, it falls over in the field which causes yield loss. There are also several forage spelt cultivars. Spelt and emmer production in the U.S. peaked in the early 1900s at nearly 600,000 acres. Spelt is easier to bake with than einkorn and emmer and is still used in many commercial bread products in the U.S and Europe.

Common wheat (*Triticum aestivum*) is a hexaploid species also known as "bread wheat" or "modern wheat." Durum wheat (*Triticum durum*) is another tetraploid species commonly used for pasta that is very high in protein but does not make a strong bread dough.

It is important to distinguish between the grains referred to as "ancient" wheat in this bulletin and varieties commonly identified as "heritage" wheat. Heritage varieties of *T. aestivum* and *T. durum* were grown prior to the Green Revolution and the development of High Yielding Varieties (HYVs) of wheat, corn, and rice. Popular heritage wheat varieties include Red Fife (a hard red wheat), and White Sonora (a soft white wheat). The modern varieties of wheat were developed for stronger gluten, shorter stalks to reduce lodging, reduced susceptibility to pests and disease and greater uniformity. As a result, they can produce higher yields in high input systems than the ancient or heritage varieties. These HYVs helped increase food production worldwide and uniformity for industrial bakers and food processors. They also led to a decrease in genetic diversity, and reduced the nutritional and nutraceutical value of wheat as heritage and ancient varieties were almost completely replaced by modern varieties in American diets (Dinu et. al., 2018). As a result, consumer interest in ancient and heritage wheat varieties is growing due to their complex and unique flavors and potential nutritional and health benefits.

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Durum (L) and emmer (R)

Since the ancient wheats have not undergone the same plant breeding efforts as modern wheats, there is less uniformity within individual varieties, and greater variation in yield, plant height, and heading time between varieties. They are also taller than modern wheat, and more at risk of lodging (Longin, et al., 2015).

Research across many growing regions shows that einkorn, emmer, and spelt have higher nitrogen and water use efficiency when grown in low input systems (Chapagain and Riseman, 2012; Cazzato et al., 2013; Parmar, 2015). Field trials in Iran showed that under low nutrient conditions, ancient wheats had greater leaf area and better nitrogen uptake efficiency (Pourazari et al., 2015). A trial in Germany found that einkorn and emmer grain were significantly higher in protein than modern wheat, despite having received only a quarter of the nitrogen (Longin et al., 2015). These early wheats seem more tolerant of marginal conditions and may outperform their modern cousins when water and nutrients are limited.

Table 1. Seeds per pound of grain in the hull, seeds per individual hull, seeds per acre, and germination rate of ancient wheats and modern spring wheat grown in Wyoming.

Grain	Seeds per lb	Seeds per hull	Seeds per acre (100 lbs per acre[1])	Seeds per acre (60 lbs per acre[1])	Germination rate
'Stone Age' Einkorn	17,356	1	1,735,595	1,041,357	100%
'Lucile' Emmer	11,408	2	1,140,740	684,444	92%
'Ethiopian Blue' Emmer	14,657[2]	2	1,465,716	879,429	93%
'Frank' Winter Spelt	15,758	2	1,575,838	945,503	90%
'CDC Origin' Spring Spelt	8,201	2	820,092	492,055	90%
'SY605' Spring Wheat	10,604[2]	1	1,060,449	636,270	100%

[1]Target seeding rate of 950,000 seeds / A for dryland and 1,500,000 seeds / A for irrigated.
[2]Free threshing grain (without hull).

Table 2. Kernel yield[1] (kernel weight/weight of grain in the hull) after de-hulling of einkorn, emmer, and spelt grown in 2019 and 2020 at three UW research stations.

Grain	Range of kernel yields (%)	Average kernel yield (%)
'Stone Age' Einkorn	53–77	61
'Lucile' Emmer	58–86	71
'CDC Origin' Spelt	42–74	61

[1]Incudes irrigated and dryland production across three fertility levels.

Table 3. Test weight of hulled and naked grain grown in Wyoming (lbs/bu)

Grain	Hulled Grain	Naked Grain
'Moravian 170' and 'Miller Coors BC100' Barley	51.6	n/a
'SY605' Spring wheat	n/a	59.9
'Stone Age' Einkorn	29.1	60.0
'Lucile' Emmer	35.5	59.2
'Ethiopian Blue' Emmer	n/a	58.7
'CDC Origin' Spelt	28.1	61.0

A comparison of 15 varieties of bread wheat, durum wheat, spelt, emmer, and einkorn found that heading was 10 days later in einkorn compared to all other wheats in the trial. This was attributed to slower germination and tillering (Longin, et al., 2015). Einkorn trials in Wyoming have also shown delayed germination, tillering, and heading. While growers can expect einkorn to catch up, this does make it less competitive with weeds and better suited for a clean field.

Ancient and heritage wheats can also be used for forage. Research in Italy found that emmer harvested at boot stage ranged from 10.6 to 12.8% crude protein (on a dry matter basis), while spelt ranged from 9.0 to 10.6% crude protein (Cazzato et al., 2013). Results from a non-replicated trial using these grains for forage and fodder in Wyoming are shown in Tables 7 and 8, page 11.

Most ancient wheat varieties are not free-threshing. This means the grain does not come out of the hull at harvest and requires an extra processing step

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Emmer (L) and spelt (R)

before use as food. A comprehensive comparison of ancient hulled wheats with modern free threshing wheat found an average kernel yield (by weight) of 70% for spelt and emmer, and 58% for einkorn (Longin, et al., 2015). University of Wyoming trials in 2019 and 2020 found an average kernel yield of 61% for einkorn and spelt, and 71% for emmer (Table 2).

Some of the Wyoming producers and researchers who participated in these trials found that the size of the spelt and emmer seed (in the hull) made it challenging to plant or required adjustments to the planter.

Germination rates and number of seeds per pound were compared for the early wheats and a modern variety of spring wheat (Table 1). The germination rate for spelt and emmer was the lowest, presumably because there are two seeds per hull but they did not always both germinate. There was considerable difference in seed and hull weight between varieties. This would cause large variations in actual seeding rates between varieties if target planting rates were not adjusted accordingly.

For spelt, the Northern Grain Growers Association recommends using the setting for oats on the drill and planting at 80–100 lbs. per acre and at a depth of 1¼ inches. Research in eastern Canada found that seeding rates between 250 and 450 seeds per square meter (1,012,145–1,821,862 seeds per acre) did not have a significant effect on spelt grain yield (Dorval et al., 2015).

North Dakota State University's Carrington Research Extension Center researchers have been conducting research on einkorn, emmer, and spelt since 2003 and have identified 100lbs per acre as the optimum seeding rate for most of their work with all three grains (Table 6, page 11). It is worth noting that at lower seeding rates, there were fewer plants per area, but more spikes per plant. This ability to adapt to variable seeding rates was especially notable with einkorn.

A seeding rate trial for emmer conducted in 2008 at North Dakota State University, Carrington Research Station, compared five seeding rates ranging from 50–150 lbs per acre. The highest yields (91 and 92 bu/A) were reported for seeding rates of 76 and 100 lbs/A. The lowest yields (86–87 bu/A) were reported for seeding rates of 50 and 150 lbs/A (https://www.ag.ndsu.edu/varietytrials). While there were approximately 15% more heads per acre at the 150 than the 75–100 lbs/A seeding rate, the yield was still lower.

Yield Conversion

The hulls on einkorn, emmer, and spelt add additional weight and volume and so comparing yields in bushels may lead to confusion. Table 3, page 5, provides a comparison of grain test weight for the hulled and naked grains. Bushels (bu) are a measurement of volume, not weight. The term "test weight" (TWT) refers to the pounds of grain per bushel. For example, modern wheat (a naked grain) has a test weight of around 60 lbs/bu. In Wyoming trials, spelt in the hull has a test weight of 29 lbs/bu. Therefore, "100 bushel wheat" would mean a grain yield of about 6000 lbs/A, but "100 bushel spelt" would mean a grain yield of only about 2900 lbs/A. An additional consideration when harvesting hulled ancient wheats is that the yield monitor in the combine needs to be calibrated for each crop. Using a wheat calibration will not provide an accurate measure of yield.

Table 4. Yield (bu/a based on TWT for the crop Table 3) and Production Practices for On-Farm Trials in Wyoming

County	Crop	Grain in the hull (bu/a)	Grain in the hull (lbs/a)[1]	Estimated yield of dehulled grain (lbs/a)[1]	Irrigation	Planting Date	Harvest Date	Production Notes	Crop Observations
Hot Springs	'Lucile' Emmer	70	2485	1765	Furrow	4/9/19	8/27/19	No fertilizer; 2 irrigations vs 3 for barley; long-term no-till field with 2.4% organic matter; entire field treated with a growth regulator; swathed then threshed in windrow.	Matured 3 weeks later than malting barley; weaker straw than einkorn with some lodging; started losing heads a week after maturity.
Hot Springs	'Stone Age' Einkorn	70	2039	1244	Furrow	4/9/19	8/31/19		Very slow emergence; matured 5 days later than emmer; held heads more than a month after maturity; tall, stiff straw that cows preferred over barley straw.
Washakie	'Ethiopian Blue' Emmer	17[2]	1020	1020	Furrow	4/1/21	8/6/21	Same fertility management as malting barley; growth regulator applied to half of field; gravelly soil and very low organic matter.	Very short plants; emmer matured more quickly than spelt in the same field; shorter stems (less straw) where plants were treated with GR but no lodging anywhere.
Washakie	'CDC Origin' Spelt	112	3147	1919	Furrow	4/1/21	8/6/21		
Sheridan	'Ethiopian Blue' Emmer	20[2]	n/a	1200	Dryland	4/22/19	8/24/19	No fertilizer; Certified Organic; direct seeded into wheat stubble; heavy weed pressure.	Ergot in emmer but not spelt.
Sheridan	'CDC Origin' Spelt	33	927	566	Dryland	3/31/20	8/4/20		
Sheridan	'Stone Age' Einkorn	69	2010	1226	Dryland	4/22/19	8/30/19	No fertilizer; conventional tillage	Half of crop leaned over but not enough to prevent harvest; used direct cut header with straight reel bats and crop lifters on cutter bar.
Sheridan	'Lucile' Emmer	65	2308	1639	Dryland	4/22/19	8/14/19	No fertilizer; conventional tillage	Fragile grain; too many cracked grains at harvest indicated combine cylinder speed was set too high.

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Sheridan	'CDC Origin' Spelt	70	1967	1200	Dryland	4/22/19	8/28/19	No fertilizer; conventional tillage	No harvest issues.
Platte	'Lucile' Emmer	37	1314	933	Dryland	4/8/19	8/28/19	Fertilizer: 30N-30P-15S at planting 20N post emergence; conventional tillage	Heavy shatter losses; harvesting a week earlier may have decreased loss.
Platte	'Stone Age' Einkorn	58	1690	1031	Dryland	3/29/20	8/25/20	Fertilizer: 30N-30P-15S at planting	Poor stand.
Goshen	'Stone Age' Einkorn	24	699	426	Pivot	9/24/19	7/22/20	No fertilizer; very poor stand establishment due to planter clogging with hulls; target planting rate 90 lbs/a	Grown as winter grain.
Goshen	'Lucile' Emmer	6	213	130	Dryland	4/17/19	8/18/19	18T/ac manure pre-plant; planted at 73 lbs/a; very sandy, low organic matter soil; poor stand, high weed pressure	Used research plot combine to harvest; awns plugged stalk walkers and made harvest challenging.

[1]Based on average test weights and kernel loss values reported in Table 2.
[2]Naked grain. A comparable yield to the 'Lucile' Emmer would be around 28 bu/A.

Table 5. Yield and Production Practices for trials at UW Research Stations in Wyoming

Location	Crop	Grain in the hull (bu/a)	Grain in the hull (lbs/a)[1]	Est. yield of dehulled grain (lbs/a)[1]	Irrigation	Fertility	Planting Date	Harvest Date	Production Notes
Powell	'CDC Origin' Spelt	153	4299	2622	Furrow	75N	5/18/18	9/8/18	
	'Lucile' Emmer	141	5000	3550	Furrow	50N	5/10/18	9/5/18	
	'Lucile' Emmer	64	2290	1626	Pivot	75N	5/10/18	9/5/18	
	'CDC Origin' Spelt	158	4435	2705	Furrow	60N-20P	4/3/19	8/28/19	
	'CDC Origin' Spelt	170	4766	2907	Furrow	130N-120P-30S	3/26/20	8/25/20	
	'CDC Origin' Spelt	70	1960	1196	Furrow	No fertilizer	3/31/20	8/25/20	Certified Organic; planted at 160 lbs/ac; substantial emmer loss due to late harvest (mechanical)
	'Lucile' Emmer	36	1514	1075	Furrow	No fertilizer	3/31/21	9/15/20	
	'CDC Origin' Spelt	153	4307	2627	Pivot	185N-100P	3/25/21	8/23/21	15% lodging loss likely caused by sprinkler
	'CDC Origin' Spelt	129	3626	2212	Furrow	185N-100P	3/25/21	8/5/21	
Sheridan	'CDC Origin' Spelt	49	1370	836	Pivot	No fertilizer	5/10/18	9/6/18	Hail and wildlife damage
	'Lucile' Emmer		No harvest		Pivot	No fertilizer	5/10/18	No harvest	Failed harvest due to hail and wildlife
Lingle	'CDC Origin' Spelt	62	1737	1060	Pivot	75N-40P-40S-6.5 SO_4^--1Zn	6/7/18	8/17/18	Swathed on 8/17 and combined 10 days later
	'Lucile' Emmer	41	1471	1044	Pivot	75N-40P-40S-6.5 SO_4^--1Zn	6/7/18	8/17/18	
	'CDC Origin' Spelt	52	1459	890	Pivot	76N-50P-20S-8.1SO_4^--1.2Zn	4/26/19	8/29/19	Direct harvest
	'Stone Age' Einkorn	52	1520	927	Pivot	65N-20P-10S-2Zn	4/19/20	9/20/20	Direct harvest

[1]Based on average test weights and kernel loss values reported in Table 2.

The additional hull weight and volume will also affect planting rate conversions. Table 1 shows the significant variation in seeding rates when einkorn, emmer, spelt, and wheat were planted at the same rate (lbs/A). Additional research on ideal seeding rates for einkorn, emmer, and spelt is still needed.

Wyoming Research

Field trials with einkorn, emmer, and spelt were conducted in Wyoming in 2018, 2019, 2020, and 2021 (Table 4). On-farm trials were planted at rates near 100 lbs per acre for irrigated and 60 lbs/A for dryland (unless otherwise noted). Due to the varying ability of planters to handle the larger hulls, imprecise planter settings, and farmer preference, there was likely a wide range in actual seeding rates.

Production field trials were conducted at UW Research and Extension Centers in Powell (PREC), Sheridan (ShREC), and Lingle (James C. Hageman Sustainable Agriculture Research And Extension Center or SAREC) (Table 5, page 9). UW research station trials were planted at 100 lbs per acre for irrigated and 60 lbs/A for dryland. Days to heading was not recorded for Wyoming field trials. Table 6, page 11, includes yield and days to heading data for trials in North Dakota.

In the Big Horn Basin, producers should expect these grains to mature after malting barley. Based on observations from field trials, emmer will likely mature first, followed by spelt and then einkorn.

Wyoming trials conducted from 2018 through 2021 did not find improved nitrogen or water use efficiency of spelt, emmer, or einkorn relative to modern wheat. All four crops were grown under low, medium, and high nitrogen treatments and none of the crops showed any yield or grain protein response to the added nitrogen.

Normalized Difference Vegetation Index (NDVI), a measure of crop density and health, was measured on einkorn, emmer, spelt, and wheat under irrigation at SAREC. A higher NDVI score indicates more chlorophyll (ie. more vegetation). NDVI scores

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Test plot of spelt at the Powell Research and Extension Station, Powell, Wyoming.

Table 6. Yield, days to heading, and test weight for dryland organic trials conducted at North Dakota State University 2018–2020.

	Yield bu/A (hulled grain)			Range of Days to Heading
	2018	2019	2020	
Einkorn[1]	61	83	27	52–61
Emmer[1]	62	79	32	54–60
Spelt	77[2]	-	48[3]	53–56

[1] Values include four varieties over three years.
[2] Two varieties
[3] Three varieties
(https://www.ag.ndsu.edu/varietytrials)

Table 7. Forage Analysis of Einkorn, Emmer, Spelt, Oats, and Barley Grown in Washakie County

	Crude Protein	ADF	TDN	Net Energy (gain)	Iron	Sodium
	----------%----------			Mcal/lb	ppm	%
Worland$_1$						
'EverLeaf®' Oats	31.5	28.2	70.4	0.45	88	0.75
'Stockford' Barley	31.6	29.6	68.8	0.43	85	0.77
'CDC Origin' Spelt	32.0	28.1	70.5	0.45	112	0.15
'Lucile' Emmer	26.8	32.5	65.5	0.38	122	0.32
Ten Sleep$_2$						
'EverLeaf®' Oats	21.7	28.8	69.7	0.44	100	0.60
'Stockford' Barley	16.7	30.9	67.3	0.41	80	0.31
'CDC Origin' Spelt	28.2	28.0	70.6	0.46	103	0.11
'Lucile' Emmer	20.0	33.8	64.0	0.36	85	0.08

Planted 7/12/21; sampled for analysis 8/27/21 (46 days)
Planted 7/28/21; sampled for analysis 9/13/21 (47 days)

Table 8. Potential Fodder Value of Einkorn, Emmer, Spelt, and Barley

	Crude Protein	ADF	TDN	Net Energy (gain)	Iron	Manganese
	----------%----------			Mcal/lb	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

at jointing were: wheat < einkorn < emmer < spelt. NDVI at flag leaf were: einkorn < wheat < emmer = spelt.

Based on field observations from farm trial participants, emmer was noted to be the most competitive with weeds due to its rapid early growth. Emmer early growth tends to be more upright, while spelt has a more prostrate growth pattern. In Wyoming, einkorn was the tallest of the three ancient wheats at maturity and produced a high-quality straw that was very appealing to cattle.

The straw from ancient wheat should be considered an additional marketable product. In 2021, spelt grown at PREC produced 4 times the amount of straw per acre as malting barley. In preliminary forage trials, emmer and spelt plants were notably lower in sodium than oats and barley (Table 7, page 11).

It may be necessary to adjust combine settings when harvesting these grains. Depending on equipment, some growers found that the long awns on einkorn and emmer did not allow for harvesting it standing. They instead found it more effective to first swath the grain, and then thresh it with a pickup header on the combine. Significant yield loss due to broken grains was observed when emmer and spelt were harvested with an axial flow combine and the grain was kept in the rotor too long. Producers in Washakie and Hot Springs counties found that the grain harvested well with a slower fan and cylinder speed than malt barley. Conversely, the spelt spikelets tend to stick together when harvested with a conventional combine if the settings are not adjusted appropriately. This could cause yield loss later during screening and cleaning of the grain.

BJ Edwards

Using spelt as chicken fodder.

Emmer and spelt have potential as forage and fodder crops. They were both panted as forage crops in July of 2021 in a non-replicated trial at two locations in Washakie County and compared to Everleaf® forage oats and Stockford hay barley. Emmer demonstrated very rapid early growth compared to the other cool season grains. Spelt has a more prostrate early growth pattern than emmer (similar to wheat) and was a little bit slower to get started. Unlike emmer, spelt does not have awns. This was not a replicated trial. However, it is worth noting that the emmer and spelt trended higher in zinc and iron and

lower in sodium than the barley and oats. In grain trials, einkorn produced a very tall and highly palatable straw.

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) refers to the sum of the fiber, protein, carbohydrates, and lipids.

Einkorn, emmer, and spelt were also compared to barley for suitability as a fodder grain (Table 8, page 11). Barley trended lower in iron and manganese than the ancient wheats and higher in energy. The higher ADF in the fodder made with ancient wheats is likely due to the larger hulls.

In a fodder system, small grains (typically barley) are sprouted in trays for approximately one week and then fed to livestock. This allows for year-around fresh feed for livestock when fresh forage is not otherwise available. As the grains sprout, the nutrition and digestibility changes. Observations from a non-replicated forage trial using einkorn, emmer, and spelt are included in Table 8, page 11. Emmer fodder was notably higher in protein than any of the other grains, while spelt and barley were comparable. Einkorn had the lowest protein content. The iron and manganese content of einkorn and emmer was nearly double that of barley.

Additional Resources

www.grownyc.org/grains/technicalassistance

www.npsas.org/resources/educational-resources

madagriculture.org/grain-revival-guide

hort.purdue.edu/newcrop/proceedings1996/V3-156.html

northerngraingrowers.org

www.ag.ndsu.edu/varietytrials

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