



**ROCKY MOUNTAIN
SEED ALLIANCE**

**HERITAGE GRAIN TRIALS PROGRAM
Heritage Grain Guidebook**



Rocky Mountain Heritage Grain Trials

HERITAGE GRAIN GUIDEBOOK

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Summary

From 2016 through 2021, Rocky Mountain Seed Alliance (RMSA) worked with a grassroots network of nearly 200 grain growers in varying climates, initially across the Western United States and eventually growing nationally and globally, in trialing over 250 varieties of ancient and heritage grains including Indigenous and alternative (pseudo) grains to determine varieties that can thrive in the changing climate conditions of the 21st century. Through this effort, 20 of the most adaptive and resilient varieties of cereal grains, including wheat, barley, and rye, of which there was enough seed stock, were selected for formal replicated research trials at four locations in the Mountain West.

Results of both the participatory grassroots trials and the research trials, including grower and grain profiles, are documented in this manual in an effort to inform and inspire others to grow these unique varieties of grains, and to support regionalized grain networks and localized food systems.

Acknowledgements

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Additional Resources *Growing Grains: Fighting Climate Change for over 10,000 Years*

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Rocky Mountain Seed Alliance's vision supports regionalized seed and food systems:

A resilient and healthy planet with every region, watershed, and community alive with a diversity of inspired seed savers and vibrant food cultures.

We envision a world where communities are connected through their food cultures. Seed stewards from all cultures should be supported as they honor their foods that come from seeds. Seeds should be preserved for past, present, and future generations and purposes.

Chapter 1: Introduction to Rocky Mountain Seed Alliance's Heritage Grain Trials Program

Farmers in the Mountain West are facing pressures from climate change including even shorter seasons, diminishing water supplies, and increased pest and weed pressures. Economic instability and degraded ecological health of soils and watersheds present additional concerns for the security and resiliency of regional food systems. Local food movements offer powerful responses to these challenging conditions. As small farmers shift toward sustainable, regenerative and localized food production, older crop varieties and traditional growing practices are re-gaining favor. Likewise, consumers are becoming more interested in ancient and heritage grains and their nutritional and flavor profiles.

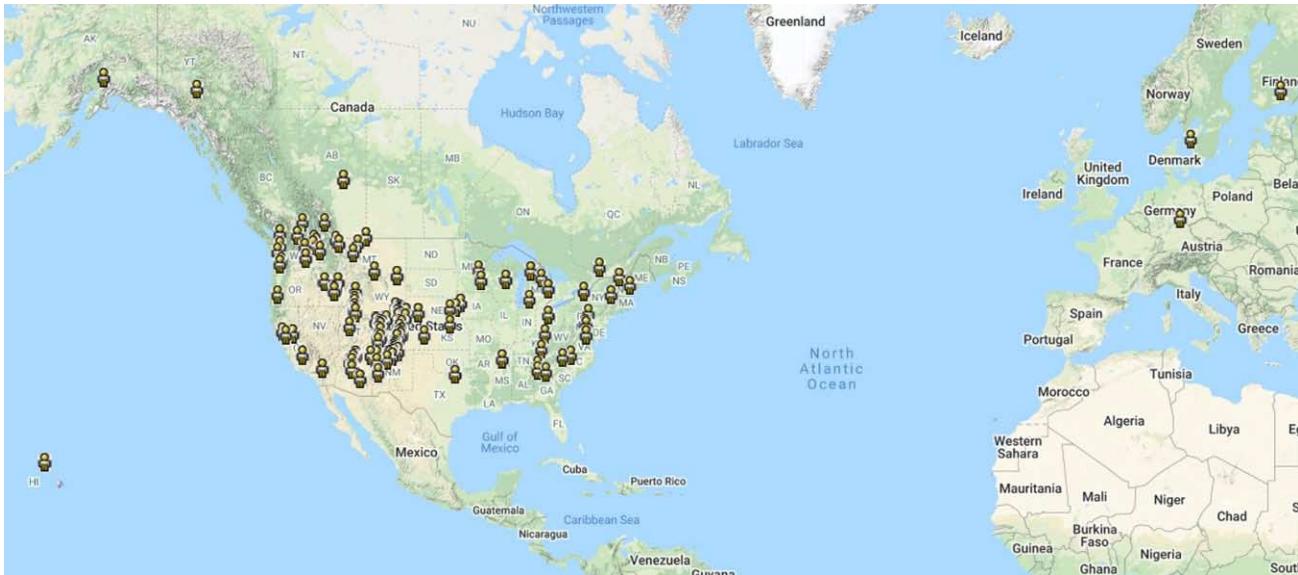
The Rocky Mountain Heritage Grain Trials project was launched in 2016 with the goal to identify and trial heritage and ancient grain varieties for new, resilient, local grain economies. The project was designed to use citizen science for assessing grains and adapting seed stock. Crowdsourcing allowed for broad data collection across varied ecological zones and production scales, with a focus on conditions found in the Rocky Mountain West. As the trials grew, so did the geographic range and scope, and much of what we found applicable to the Mountain West was relevant to many other regions as well. The intention of this guidebook is to offer grain insight beyond boundaries and borders.

Indigenous and alternative grains were included in the grassroots grain trials, however they represent a gap in the formal 2021 research. The research study was designed to incorporate adapted seed stock directly from the grassroots trials, and thus selections were dependent on varieties that offered enough stock for the research trial plots (approximately 2 pounds of each variety), and adequate grassroots trial data. This project also falls short of a deeper inquiry into the origin and migration stories of each of the trial grains.

For the Heritage Grain Trials Project, we wanted to cast a wide net of genetic biodiversity to see what would be most resilient, most adaptive, and most appealing to farmers, gardeners, bakers, and consumers. This, in turn, would encourage a greater

selection of stewards, interests, and practices in the trials. For cereal grains, we began our inquiry with historical lists of popular grains grown in the Mountain West region before World War II to identify potential varieties that were conducive to pre-industrialized practices in an effort to find grains that would complement smaller-scale and organic operations. The original selection of grain varieties was determined from the United States Department of Agriculture's Bulletin No. 1074: Classification of American Wheat Varieties, published in 1922. By searching for varieties growing in the Western United States up until that printing, an initial list of 20 wheat varieties were pursued, with many acquired through the USDA's Germplasm Resources Information Network (GRIN) and the National Small Grains Collection in Aberdeen, Idaho at two to five grams per packet. Additional varieties were suggested by committed heritage grain growers, and shared by seed stewards and other grain enthusiasts who assisted us on this journey. For instance, we received a collection of quinoa from Emigdio Ballon who had stewarded quinoa in his homeland of Bolivia, and amaranth from the Garden's Edge and Qachuu Aloom (see www.gardensedge.org). We also received a landrace wheat from Joseph Lofthouse who is a grandson of the Lofthouse wheat breeder referenced in the 1922 Classification of American Wheat Varieties.

The number of grain varieties and trialists grew exponentially alongside the seeds themselves. In our initial growing season of 2016, 25 wheat trialists grew a total of 27 varieties of landrace and ancient wheats. In that first year, ten of the trialists returned seed from 21 of the wheat varieties, thus starting the seed increase from single packets of 50 seeds to several packets of 100 seeds for circulation in the next year. At the conclusion of the Heritage Grain Trials Program in late 2021, we had a grassroots network of 196 grain trialists, and 262 varieties of grains and alternative grains in circulation. Trialists were primarily from the Mountain West, though also from around the globe, and they operated at scales from backyard garden plots to small farms of two to 20 acres.



Heritage Grain Trials

Heritage Grain Trials Directory (196 participants)

By 2020, thanks to the help of the trialists, we had data and seed for 20 varieties of wheat, hulless barley, and rye (for varieties, see Chapter 2: *Top 20*) that were identified as adaptive, resilient and marketable grains for the arid and higher altitude conditions of the Mountain West of the United States. We then added a formal research component to focus specifically on these *Top 20* varieties through continued grassroots trials and through formal research at four research sites conducting randomized replicated block design trials. Data on field performance and yields was collected, and lab analyses were conducted on grain quality and baking performance in “pup loaf tests.” Research points included both quantitative and qualitative data as follows:

1. Planting dates (fall and spring plantings)
2. Height at harvest
3. Overall vigor
4. Plot yield
5. Test weight
6. Lodging
7. Disease
8. Weed competition
9. Pest damage
10. Winter survival (for facultative capacities)
11. Moisture
12. Protein
13. 1,000 kernel weight
14. Stalk nitrogen
15. Falling number (wheat only)

16. Wet Gluten (wheat only)
17. Gluten index (wheat only)
18. Alveographs (wheat only)
19. Pup loaf analyses (wheat only)

Since seed for many of the *Top 20* varieties was still only available in small quantities, the secondary goal of the project was to scale up foundational seed to share freely with farmers interested in growing these grains and supporting local food systems.

With just one year of trial data from the formal research (both fall and spring plantings), the results are not conclusive. However the data does offer a snapshot of the grains relative to the four trial sites, and offers comparative analyses for the 2021 growing season. The trial findings also point towards areas of further study including:

- * Water measurements and irrigation schedules
- * Drought tolerance and seed adaptation to drought tolerance
- * Integrating pre and post soil samples
- * Cover crop rotations with heritage grains
- * Infrastructure analysis and cooperative equipment options
- * Sustainability and regenerative agriculture values including carbon analyses
- * Malting characteristics for barley
- * Climate data and snowpack data (winter and facultative grains, snow insulation)
- * Allelopathy and weed suppression

Chapter 1: Introduction to Rocky Mountain Seed Alliance's Heritage Grain Trials Program



Inspiration

We were inspired and assisted along the way by many individuals, groups and organizations. This is a snapshot of the collaborators who have been directly involved in or have inspired the Heritage Grain Trials Project. Also note that this is not a complete map or list, rather highlights some of the folks that informed our journey.

Grain Galvanizers and Collaborators

Farmers: Hardy Seeds, Ashland, OR. Zephyros Farm and Garden, Paonia, CO. River Farm, Buhl, ID. Uprising Seeds, Bellingham WA. Great Lakes Staple Seeds, Ortonville, MI. Sherwood Mountain Farm, Nederland, CO. Agraria Center for Regenerative Practice, Yellow Springs, OH. Laughing Wolf Farm, Mancos, CO. Sherck Seeds, Bristol, IN. Winnower Farm, Boise, ID. Kings Crown Organic Farm, King Hill, ID. Jon Birck,

Ridgefield, WA. Singing Nettle Farm, Palmer, AK. Pie Ranch, Pescadero, CA. Sustainable Seed Company, Mendocino County, CA. Salt Spring Seeds, British Columbia, Canada.

Research: The Land Institute, Salina, KS. Whole Grain Connection, Ojai, CA. Sterling College, Craftsbury, VT. Antioch College, Yellow Springs, OH. Occidental Arts and Ecology Center, Occidental, CA. Heritage Grains Conservancy, Colrain, MA. Southwestern Colorado Research Center, Yellow Jacket, CO. Rio Grande Grain, Northern NM.

Bakers: Blue Grouse Bread, Norwood, CO. Barn Own Bakery, Lopez Island, WA. Bread, Durango, CO. Barrio Bread, Tucson, AZ. Mountain Oven Organic Bakery, Paonia, CO.

Mills: Anson Mills, Columbia, SC. Barton Springs Mill, Barton Springs, TX. BKW Farms Inc, Marana, AZ. Hayden Flour Mills, Queen Creek, AZ. 1000 Springs Mill, Buhl, ID.

Chapter 2: The *Top 20* Varieties for 2020

The following varieties were selected for further research based on quantities of seed available, along with valuable observations and data offered in the grassroots grain trials that suggested traits and potential for adaptations across a wide range of climates, soils, and practices.

Arabian Blue Barley	Ethiopian Blue-Tinged Wheat*	Sangaste Rye
Black Barley	Khorasan (Kamut™)	Sin El Pheel
Iraq Durum	Marquis Wheat	Sonoran White Wheat
Einkorn	Pima Club	Spelt
Einkorn, Black	Purple Dolma Barley	Tibetan Purple Barley (6-row)
Emmer (Vernal)	Red Fife	Turkey Red Winter Wheat
Emmer, Black	Rouge de Bordeaux	

Following is additional information on each variety, adapted from Taylor Scarpelli's literature review for the *Top 20* Trials project. Included are sample protein measurements from the *Top 20* research (other than the hulled varieties of Emmer, Einkorn, and Black Einkorn). For more information on the research farms, please visit the profiles.

Arabian Blue Barley: *Hordeum vulgare*, hulless, bearded, spring

Arabian Blue barley is an ancient 6-row variety with lineage from the fertile crescent. It came to the states from Western Australia after being used in a cross with Greenough at the Merredin Research Station to create the M119 variety, which was discarded because of poor yields. This is a rare variety with very little information available on its history or origins. It is a hulless variety, which makes it easy to extract and clean. It is considered easy to grow, and reaches a height of around 3 to 4 feet when mature, and averages about 48 grains per head. The ears and kernels are a beautiful purplish blue. It offers a nice flavor as flour, or as a pilaf simply cooked over low heat. (Protein: 15.36% – Zephyros Farm)



Black Barley: *Hordeum vulgare*, hulless, bearded, spring, possibly winter in mild climates

Black Barley is a fairly productive and adaptive hulless barley that has potential of overwintering. Considered to originate in Ethiopia, it has been grown for centuries as a nutritious staple crop throughout the world and more recently in the United States. It has plump grains that are very nutritious and used in pilafs and stews, and is also used in teas. (Protein: 17.96% – Southwestern Colorado Research Center)

*At the time of the writing of this guidebook, we learned that Ethiopian Blue-Tinged is not technically an emmer, rather the taxonomy suggests it is a free-threshing tetraploid, hence a durum (*Triticum turgidum* ssp. *durum*). We are in the process of updating our data and information accordingly.

Chapter 2: The Top 20 Varieties for 2020

Iraq Durum: *Triticum turgidum* ssp. *durum*, bearded, spring

Iraq Durum is a free-threshing landrace from Iraq that was popularized in California by Monica Spiller, founder of The Whole Grain Connection. It offers a golden color and mild sweet character to pastas and breads, and the striking dark awns and large heads make it a lovely addition to dried arrangements. (Protein: 13.41% – Zephyros Farm)



Einkorn: *Triticum monococcum*, bearded, spring

Einkorn is the first-known domesticated wheat, having fourteen chromosomes. Wild Einkorn was harvested in the late Paleolithic and early Mesolithic Ages, 16,000-15,000 BC. Cultivated Einkorn was found in Karaca Dag-Mountains of southeast Turkey. It was cultivated in the Tigris and Euphrates (modern day Turkey and Iraq) of ancient Mesopotamia to ancient Jericho from 7600 BC and gradually spread to Asia Minor and Europe. The first wheat mentioned in the Bible was Einkorn, and the name means “one” or “first” grain. Einkorn has survived through time in remote village fields due to its ability to draw nutrients from stony soils. It is higher in protein (18.2 g per 100 grams of flour according to Eli Rogosa and the Heritage Grain Conservancy) and minerals than modern wheat, and higher in phosphorus, potassium, B6, lutein, beta-carotene, and antioxidants (see nutritional chart at <http://growseed.org/einkorn.html>). It is very difficult to dehull and requires equipment for farm scale dehulling. Traditionally, the grain was submerged in water to allow the swelling grain to burst through the hull. Popular for lower-gluten baking and cooking. Einkorn flour has become a popular substitute for traditional wheat flour, with its significantly more protein content and less starch. It has a lower yield than modern wheat.



Einkorn was grown out by 45 trialists.

Einkorn, Black: *Triticum monococcum*, bearded, winter

Black Einkorn grows similar to other grains seeded in fall for overwintering. It is slower to germinate, so planting in the fall can help it outpace weeds in the spring. *Triticum monococcum* is considered the earliest domesticated wheat, stemming from the wild variety *Triticum boeoticum*. The main difference between the two is how they disperse their seeds. The head of the wild variety of einkorn burst as a way to spread the seeds while the cultivated einkorn seed heads stay intact, likely a trait of selection as it was easier for early humans to collect and therefore plant.



Chapter 2: The Top 20 Varieties for 2020

Emmer: *Triticum dicoccum*; bearded, spring

With 28 chromosomes, Emmer is a tetraploid, and was one of the first wheat crops domesticated after einkorn making it a parent of modern wheat. Once widely cultivated in the ancient world, it is now a relict crop (previously with a widespread geography) in marginal mountainous regions of Europe and Asia, and also grown commercially in Minnesota, North Dakota, South Dakota, and Idaho. Its value lies in its ability to give good yields on poor soils, and its resistance to fungal diseases such as stem rust that are prevalent in wet areas. Its main use is for human food, though it is also used for animal feed. In recent years, Emmer has been enjoying a resurgence in popularity among gourmets and the health-conscious, who sing the grain's praises for its high nutritional value and adore the hearty, flavorful taste. However it is difficult to remove the hull, making it hard to clean and process for home use. It has excellent flavor as whole grain, and is high in iron and dietary fiber.



Emmer, Black : *Triticum dicoccum*, bearded, winter

Black Winter Emmer was originally collected by Vilmorin-Andriex & Cie in France in 1903 and introduced to US farmers by the Department of Agriculture in 1904. Black Winter Emmer is stunning in the garden — reaching over 5 feet tall, its amber straw carries majestic black awned heads. Black Winter Emmer is adaptable to drought or heavy rain, and fusarium resistant. Its kernels do not generally thresh free from their hulls, so special equipment for mass threshing is needed, though free-threshing grains have been present in our trials, so unlike the other hulled varieties, we were able to conduct lab analyses on it. Savored in soups, as bulgur, breakfast cereal or in flatbreads and pasta. Highly nutritious. (Protein: 17.88% – King's Crown)



Black Emmer was grown out by 35 trialists.

Ethiopian Blue-Tinged Wheat: *Triticum turgidum* ssp. *durum*, bearded, spring

Two decades ago, Dan Jason of Salt Spring Seeds in BC brought back two seed heads of a variety of wheat from an agricultural visit to Ethiopia. He received them from a farmer about 60 kilometers south of Addis Ababa, grew it out for a few years and sent some to Whole Grain Connection in California. It is now grown on significant acreage all across Canada and the U.S. An excellent yielding variety that matures earlier than other ancient wheat varieties, it has an interesting bluish hue to the berries and seed heads. The grain has very high protein content at up to 16% but does not generally develop enough usable gluten to make it a good stand-alone bread flour. It is wonderfully flavorful cooked as a whole grain and is even being used commercially by at least one company for pasta. Grows to about 4 feet in height. Unlike other emmers, it is easy to thresh, delicious cooked as a whole grain, and makes great sprouted wheat berries. (Protein: 14.67% – Zephyros Farm)



Chapter 2: The *Top 20* Varieties for 2020

Khorasan (Kamut™): *Triticum turgidum* ssp. *turanicum*, bearded, spring

The history of the Kamut™ brand traces to a World War II story of a U.S. Airman who received the grain from a man who claimed to take it from an Egyptian tomb, though Khorasan is a region historically known as the Iranian Plateau that includes parts of present-day Afghanistan, Iran and Central Asia. While the grain's journey has been mysterious, it did eventually land in Montana where it is grown, marketed, and trademarked as Kamut. Most scientists believe it probably survived the years as an obscure grain kept alive by the diversity of crops common to small peasant farmers. It is thought to have evolved contemporarily with the free-threshing tetraploid wheats. It is a *Triticum turgidum* which includes durum wheat. It has a very beautiful, silvery blue seed head as well as a characteristic gooseneck wave in its stalk. The kernels are twice the size of regular wheat. Khorasan contains more protein and more lipids than common wheat. It measures much higher in vitamins and minerals. As a cooked whole grain, it has a rich corn-like flavor.

(Protein: 15.05% – Zephyros Farm)

(Protein: 15.05% – Zephyros Farm)



Khorasan was grown out by 19 trialists.

Marquis Wheat: *Triticum aestivum* ssp. *aestivum*, beardless, facultative (winter and spring)

Created from a cross between Red Fife (Ukrainian Halychanka) and Hard Red Calcutta, Marquis was developed by Charles Saunders at the Central Experimental Farm in Ottawa, Canada. Introduced around 1903, it quickly became the dominant spring wheat in both Canada and the US by 1918 with North Dakota farmers being the first to import and grow the seeds. The development of the variety, famous for its milling and baking qualities, created great agricultural and economic prosperity and exponentially expanded wheat production at a crucial time in the development of America. This is a high-yielding spring wheat that performs as a winter variety in mild climates. It's one of the best varieties for milling and bread making. Its high yield and popularity are due principally to its early maturity, which helps it to escape stem rust and drought. Matures 7-10 days earlier than Red Fife. (Protein:13.65% – Laughing Wolf Farm)



Chapter 2: The Top 20 Varieties for 2020

Pima Club Wheat: *Triticum aestivum*, beardless, spring, winter in milder climates

Pima Club is an heirloom wheat of the Akimel O'odham (Pima) Nation on the Gila River in what is now called Arizona. The soft white spring wheat is known for the delicious, fine flour it produces. This heirloom grain is enjoying popularity with both home gardeners and bakers. Pima Club produces compact, flattened, beardless seed heads with plump kernels that are easy to separate from the chaff. For areas with mild winter climates, Pima Club is planted and sprouts in the fall and winter, from approximately November to January and harvested in May or June before the onset of the summer rains. Plant in the spring in other areas. The soft grain grinds easily to a lower gluten flour that's well-suited for making delicate cookies and pastries. Requires little attention and is adaptable to a range of soil types. Visit Ramona Farms website (ramonafarms.com) to learn more about the history and uses of this landrace wheat. (Protein: 13.91% – Laughing Wolf Farm)



Purple Dolma Barley: *Hordeum vulgare*, bearded, hulless, spring

Purple Dolma Barley is a delicious and beautiful hulless barley. It came to our collection through many hands that received it from the late great seed saver Anpetu Oihankesni who collected it in Kinnaur, India, a Himalayan region in Himachal Pradesh state, bordering Tibet. Barley is a staple of this region in both its solid and liquid form. It is one of the few crops not imported and is instead locally grown and marketed. This barley was a top-performing variety in the Heritage Grain Trials. It thrives in drier, mountainous regions, and is a high-yielding spring-planted barley, ripening in 90 to 100 days. In warmer climates, it might work as a winter barley as well. Fun fact: Three grains of barley, dry and round, placed end to end lengthwise was the model to standardize the size of an inch back in 1324 AD (snakeriverseeds.com). (Protein: 15.92% – Laughing Wolf Farm)



Red Fife: *Triticum aestivum* ssp. *aestivum*, beardless, spring, hard red

Red Fife (Halychanka) was the first heritage wheat nominated into the Slow Foods Ark of Taste. This fantastic heirloom boasts superior flavor and a fascinating history. While the exact origins of Red Fife are unknown, it is believed to have been grown by Mennonite farmers in Poland and brought to Canada in the early 1800s. Red Fife rose to become the favorite wheat of the baking and milling industry during the late 1800s entering the US in the mid 1850's. It was the standard of wheat in Canada from 1860 to 1900, though it nearly disappeared. According to Canadian seed grower Dan Jason, it is the grandma of all Canadian wheats. A landrace variety, it has broad genetic diversity, making it widely adaptable to many different growing conditions in North America. This is a superb bread flour with a nutty flavor and honey overtones. An excellent choice for a gardener's first wheat crop. (Protein: 17.52% – Southwest Colorado Research Center)



Chapter 2: The Top 20 Varieties for 2020

Rouge de Bordeaux: *Triticum aestivum* ssp. *aestivum*, beardless, spring, hard red

A 19th Century French awnless wheat favored for bread for generations in France. It is a hard red variety with a rich, nutty flavor. Not as productive in the trials as the Turkey Red, though still a popular bread wheat for bakers with its high protein content and baking qualities. Slower to mature and dry down in the field. (Protein: 12.7% – Zephyros Farm)



Rouge de Bordeaux was grown out by 21 trialists.

Sangaste Rye: *Secale cereale*, bearded, winter

Sangaste Rye is currently the world's oldest registered continuously grown winter rye variety. In Estonia, 1875 Friedrich Georg Magnus Von Berg developed this variety from the cross pollination of local rye landraces and a German rye, Probstei. It won Gold in the 1889 World Fair in Paris and First Prize at the world exhibit in Chicago in 1893. It has since been the basis of multiple breeding programs and is currently a protected cultural staple in Estonia where it is used for both bread and vodka. It made its way into the states through John Sherck (www.SherckSeeds.com) who was gifted seeds by a friend in Estonia. This is a tall variety, sometimes reaching up to 7 feet. It has strong stalks, large and light in color seeds, large heads, and is fairly lodging-resistant, and has been a prolific producer. Since rye is cross-pollinating, this was the only rye in the Top 20 trials. (Protein 10.5% – Zephyros Farm)



Sin El Pheel: *Triticum turgidum* ssp. *polonicum*, bearded, spring

Sin El-Pheel is an ancient landrace from Iraq collected by H.W. Springfield in the 1950s. Springfield was part of the US Operations Mission to Iraq following World War II. He collected dozens of seed accessions, many of which can still be requested from the USDA. This sub-species — *Triticum turgidum* subsp. *polonicum*, also known as Polish wheat — is an uncommon species of wheat, found in disparate places around the world including Ethiopia, Portugal, Russia, Iraq, Hungary, Romania, Chile, Ecuador, Cyprus, and of course Poland. The name means “tooth of the elephant” due to its large grains, and it’s more like khorasan and durums than standard bread wheat. It is said to make excellent pasta, though not as favorable for bread, and is high in gluten. Grows 3 to 5 feet tall. (Protein: 14.63% – Zephyros Farm)



Chapter 2: The Top 20 Varieties for 2020

Sonoran White Wheat: *Triticum aestivum* ssp. *aestivum*, beardless, spring, winter in mild climates

According to historical records, Sonoran wheat came into the U.S. from Magdalena Mission in northern Sonora, Mexico where it has been grown since around 1670. It is common among the Pima and Yuma people who became large-scale wheat farmers of this variety, and are credited with the prevention of starvation among both the Union and Confederate soldiers during the Civil War when millions of pounds of Sonoran wheat were produced and exported east. The flour gave rise to the flour tortillas. The compact head is medium long, with a soft kernel. It is highly adaptable, nutritious, delicious, and versatile in the kitchen. The soft kernels are easy to grind and better for using in pastry and tortillas due to its lower protein content. When milled, it produces a light, white flour with a slightly sweet taste. For areas with mild winter climates, White Sonora is planted and sprouts in the fall, from approximately November to December and is harvested in June before the onset of the summer rains. The hulls are easy to remove without specialized equipment, making it a good option for small garden operations. It is one of the wheats on the Slow Food Ark of Taste. (Protein: 12.45% – Laughing Wolf Farm)



Sonoran White Wheat was grown out by 37 trialists.

Spelt: *Triticum aestivum* ssp. *spelta*, beardless, winter

Known as *Dinkel* in Germany, Spelt is an ancient hulled wheat variety originating in the Fertile Crescent over 9,000 years ago. Spelt, once incredibly popular in Europe, fell out of favor once wheat breeding programs increased the yield of bread wheat and as mills became more industrialized and eliminated de-hulling equipment. It has been experiencing a resurgence since the 1980's, with a revival of landrace varieties, such as *Oberkulmer Rotkorn*. There are breeding programs in Germany dedicated to spelt improvement. Favored by many for its hearty, nutty flavor, Spelt is known for a less glutinous flour compared to other wheats. It is tightly hulled and very difficult to thresh. Keep kernels in hulls when planting to assist in germination. (Protein: 12.22% – King's Crown Farm)



Spelt was grown out by 26 trialists.

Chapter 2: The Top 20 Varieties for 2020

Tibetan Purple Barley: *Hordeum vulgare*, hulless, bearded, spring and possible winter

This rare barley is a lower gluten grain and grows 3-4 feet tall. It comes from Tibet, an ancient center of barley domestication. It is easy to grow, harvest, and process. This variety of purple barley was first brought to the United States almost 100 years ago and tucked away for decades in a seed vault. Luckily its reputation spurred a revival in interest for this heirloom grain, and now we get to enjoy its superior flavor and nutrition. Tibetan barley is high energy, with iridescent violet grains that are high in phytocyanins, and richly flavored. Grain stalks are prone to lodging when grown too high, and to weed competition. Very adaptable. Sow in early August for an overwintering cover crop if your winter is mild enough or wait until early spring. (Protein: 15.05% – King's Crown Farm)



Tibetan Purple Barley was grown out by 39 trialists.



Turkey Red Winter Wheat: bearded, winter

Turkey Red can be traced to Crimea between the Black Sea and the Sea of Azov in the early 19th century and earlier to Turkey to the south of the Black Sea. It was introduced to Kansas in 1873, carried by Mennonite immigrants from Crimea in the Ukraine, fleeing Russian forced military service. In the mid-1880s, grainsman Bernard Warkentin imported 10,000 bushels of Turkey seed from the Ukraine, the first commercially available to the general public. It became the dominant hard red winter wheat in Kansas and throughout the Great Plains in the 1920s, and became a staple in America's breadbasket. This has a taller growth habit, later maturity, and can tolerate poor soils because of its larger root system. Turkey Red has an excellent flavor, and is very popular for milling and baking. (Protein: 12.76% – Zephyros Farm)



Turkey Red Wheat was grown out by 25 trialists.



Chapter 3: Farmer and Grower Stories and Profiles

In this chapter, growers share their climate considerations, favorite grains, and lessons learned in their own voices. While we are highlighting a small selection of our trialists, our gratitude goes out to each and every grower and participant in the Rocky Mountain Grain Trials program who have been the truest blessing of this project. The observations, knowledge, and seeds so generously shared are gifts that will continue forward.

The trialists have been as unique and delightful as the grains themselves. Each of the highlighted growers was dedicated to the greater vision of revitalizing local grain economies and played a

key role in their communities and regions to support this renaissance. They were diligent about sharing data and seeds with the greater community, and have been role models in their efforts.

Trialists voluntarily collected data on planting and harvest dates, height, pest impacts, yield, etc. (see sample data sheet and trialists' data sheets in appendix). Most importantly in the first year, we wanted to know if the trialist liked the variety, whether they would grow it again, and if they had seed to return and share.

Heritage Grain Trialists

Rio Grande Grain *La Villita, New Mexico* www.RioGrandeGrain.org

Elevation: 5,000 feet **Climate zone:** 6 **Precipitation:** 10 +/- inches annually

The Rio Grande Grain Team is a group of grain enthusiasts from the Rio Grande Valley in Northern New Mexico. The members of the group jumped into the grain trials with a fervor for grains from their own personal kitchen experiences and from their connections with one another as gardeners and seed savers. They definitely put the fun into the grain trials despite the challenges they faced with this new endeavor.

Rio Grande Grain began their adventure by growing grain trials at Los Luceros Historic Ranch in Northern New Mexico where they teamed up with farmer Ron Boyd of nearby La Villita who assisted the group with equipment and land for growing the grains. Ron also served as a farm mentor, which was helpful with the dynamics of larger scale growing, such as acequia watering and harvesting considerations.

Most of the Rio Grande Grain Team live around Santa Fe, which is approximately 45 minutes from Los Luceros Historic Ranch and Ron's farm in La Villita. This distance from the grain trials proved challenging for tending the grains, though their determination proved fruitful. By the end of the first growing season, they identified the grains they were most interested in pursuing, and also continued trialing new varieties with the goals of scaling up on their own seed and eventually growing enough seed to support baking interests in their own kitchens and commercially. Along the way, they offered educational events and networking activities that have resulted



in a true grain revival in the region. Through the project, they created a networking organization that is sharing grains and knowledge about these heritage crops.

Environmental/climate details and observations: Adjacent to Rio Grande River with unlimited irrigation water from river and acequia. Mostly sandy soil in fields that previously were pasture or not in use for decades.

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Farm and farmer background story: Grassroots organization of gardeners and one farmer who generously provided farmland, irrigation, expertise, tools, and machinery.

Why and how did grains interest you? We all connected at University of Colorado- Colorado Springs Grain School in February 2018 and decided we wanted to work together to trial ancient/heritage grains and help to restore a local grain economy to Northern New Mexico.

Grains trialed: We have trialed over 60 varieties over 5 growing seasons so far. Our primary seed increase has focused on Sonoran White, Turkey Red, Einkorn, Spelt, Sirvinta, Tibetan Purple Barley, Khorasan, Pueblo White, Ryes and Triticale.

Grains that worked well, why: See above. These grains are well adapted to winter which is our preferred growing season because soil retains more moisture and weed pressure is reduced. Also these seem to be more resilient to more arid conditions. Rye is especially drought tolerant and tough in general. We have grown most of these for several seasons so the seeds are becoming locally adapted.

Grains that didn't work well, why: We have tried repeatedly to grow Jammu with little success. Same with Emmer and Rouge de Bordeaux. And frankly Khorasan has been rather middling

for us. These and others may not have done well because they are spring grains and not facultative (conducive to both winter and spring growing); altitude & weather, and lean, sandy soil (may have been problematic). By contrast, the previous fall we planted ¼ acre in well-amended, rich soil and everything did quite well. But we recognize that few farmers in our area are likely to have access to or the ability to enrich their soil to that extent. Also some of the grains that didn't work well were seeds from growers in very different regions — Oregon and Idaho, for example. The ones that work well we have grown for several seasons so they are becoming locally adapted.

Information about the grains mentioned above: We got into this mostly because we want to bake with these grains. We have learned that Sonoran White was introduced to what is now New Mexico by the Spanish colonizers in 1599 and it has proven to be a wonderful flour for its drought resistance and its nutty taste in pastries and tortillas. Turkey Red and spelt are sturdy, nutty bread flours. Tibetan Purple Barley produces a tasty purple grain that adds interest to breads and salads. We love the ryes — they are super resilient, grow tall and are easy to clean and are wonderful in baked goods. Khorasan (aka Kamut) is wonderful for pasta, but it's not yet adapted to our winters, meaning lowish yield compared with other grains, but we hope to keep trying to adapt it.

Rio Grande Grain Goals:

INCREASE the seed stock of ancient/heirloom grains; determine which varieties thrive in our region; share cultural data and seeds with local farmers.

ENGAGE in outreach and education to create awareness of and demand for locally grown grains.

DEMONSTRATE the viability and marketability of a large variety of grains and pseudo grains in Northern New Mexico.

SUPPORT Northern New Mexico's culture of small family farms and our rural economy.

ENCOURAGE regenerative agriculture practices by including winter-grown grains into crop rotation.

CREATE an appetite for breads and foodstuffs made with heritage grains and flours through demonstration and recipes.

CONNECT farmers, artisan bakers, brewers, malters, and millers around a dynamic heritage grain network.

State of your regional grain economy and your connections to other growers, millers, bakers, brewers, etc.:

Our group has worked alongside our farmer to plant, weed, harvest, clean our grains. At the same time we have made outreach a priority. We have hosted field days, tastings, presentations to farmers and consumers; we have connected with and shared our grain with local farmers; we have networked with local bakers using local grains; taught workshops on baking with local grains; sold freshly milled heritage flour at a community farmstand; and created a website with educational materials, videos and resources for growers, millers, bakers, brewers, and consumers.

Lessons learned & other observations: Grains are easy to grow organically given enough water and decent soil. The most difficult issues are climate change and drought in the Southwest; how to prepare a field with the least disturbance in accordance with healthy soil principles; and given that New Mexico typically has only 5–10 acre fields or less, how to procure specialized equipment needed for this crop. Very little modern equipment is the appropriate scale for small fields and small quantities of grain. Determining scale and the appropriate equipment and

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where/how to acquire it is probably the most limiting factor in promoting local grains.

Takeaways, and inspirations, words of advice to new growers:

We are joining with a nationwide movement to use locally produced grains, and especially non-hybridized heritage varieties that have flavor, health, and environmental benefits. Some of these grains are close to disappearing and need and deserve to be saved and shared. As Estevan Arellano has said, “The best way to save a seed is to grow it.” This has been a rewarding project, to engage with the magic of seeds, to be taught and guided by the seeds to learn from them what they need, and to stand in the middle of an acre of golden, swaying

fully ripe seed heads and swoon with delight at what can come of a small handful of seeds over just a few growing seasons.

Related Resources:

Website: www.RioGrandeGrain.org

“No Seeds, No Dough”

<https://www.youtube.com/watch?v=lM87piYlpq>

Seed Broadcast: <http://seedbroadcast.blogspot.com/2020/04/rio-grande-grain-christine-salem.html>

New Mexico Healthy Soil:

<https://www.nmhealthysoil.org/2021/07/13/rio-grande-grain-is-reviving-new-mexicos-local-grain-economy/>

Chris Hardy Ashland, Oregon www.GrowHardySeeds.com

Elevation: 1,950 ft., 2,100 ft. Climate Zone: 6b/7a Precipitation: 22.9"

Outside of the Mountain West in Ashland, Oregon lives one of the most enthusiastic heritage grain enthusiasts in our trials — Chris Hardy of Hardy Seeds. Simply put, Chris is an inspiration in everything he endeavors. He is motivated and heart-driven. His seed company, Hardy Seeds, is a reflection of his passion for his work towards food secure communities, as well as a seed album of places and cultures he has experienced.

Environmental / climate details and observations: We are experiencing super dry conditions in the winter that quickly become super wet when we receive crazy moisture all at one time. The plants become stressed in a strange way and are inclined to lodge. Evenings are mild and warm, almost like t-shirt weather. This promotes plant growth and a drying out of the soil. We need precipitation to offset the evaporation.

Warmer and drier conditions have been a trend for the past 7 years, with 2021 being the absolute driest. We farm in the bioregion that is officially experiencing a 500-year drought. In a historic drought, growing anything will be against the odds, but we have so much faith in our seeds and planting diversity is what they teach us to do.

Farm and farmer background story: My grandfather was an organic farmer in Dubuque, Iowa, where he raised animals including organic buffalo, corn, and alfalfa on 300 acres. My mother was the oldest of 11 children that grew up supporting the farm, putting up hay, feeding animals, milking cows, and tending to the domestic garden full of vegetables. My memories of Iowa are as rich as the landscape, the hills and the soil. Being



in nature and exploring around the Mississippi River was absolutely central and foundational to my growth.

When I was about 15, I came into contact with big ag and big chemical. I would walk the bean fields cutting up weeds for hundreds of acres by foot. Eventually this turned into spraying glyphosate on a bean buggy. Big ag decided it would be easier to spray herbicide and pesticide rather than walking cutting weeds with a machete. I went into the military and traveled around the world 5 times which changed my life profoundly. I spent time in farming communities in Armenia and Pakistan and observed

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how things were done there and noticed a complete happiness and richness in their way of being. I realized that my perception of normal, coming from western culture, was totally off. I studied pre-med and was close to getting my doctorate in Physical Therapy but I stopped that after returning from a travel to India, Nepal, China, Peru, Chile. I noticed how people were living in the mountains, on the earth, in stone huts and had agriculture systems in these challenging climates conditions.

I moved to Bozeman, Montana and started farming in backyards. I made \$10,000 from 3,500 square feet from May to September. I couldn't grow enough food. I delivered by bicycle to co-ops and restaurants. The soil there was untouched, super rich volcanic bottom ground. I started the Bozeman farmers market which is still very successful. I stayed in Montana for about 15–16 years before going to Oregon to visit a girl who left Montana for school and have been in Oregon ever since.

I was involved in the early days of Farm to School development which is now the Rogue Valley Farm to School Program. I am on the Board of the Organic Seed Growers and Trade Association. I'm with the Jackson County Non-GMO Movement who has defeated Monsanto three times and has eliminated GMOs from Jackson County completely.

Why and how did grains interest you? My Grandfather grew oats, barley, and peas. I visited farms like Wheat Montana where there was no biocide usage. My mother would always buy fresh bread from local bakers. Great Harvest Bread is out there baking beautiful bread now. In 2015 I started to intentionally grow wheat for cover crop function. I connected with RMSA in Santa Fe, NM at the Seed Summit. Shortly after I returned from the seed summit, I received my seeds from the Heritage Grain Trial Program in the mail and the rest is history.

Grains trialed, Warm weather: 2 Amaranth varieties, 3 Corn varieties, 3 Millet varieties, 2 Quinoa varieties, Ba Yi Qi and Mennonite Sorghum, 23 Dryland Rice varieties, Hulless Oats from Barn Owl Bakery. **Cool weather:** 25 Wheat varieties, 14 Barley varieties, Hulless Oats from Barn Owl Bakery, 4 Wheat varieties, 6 Einkorn varieties, 8 Emmer varieties, Sangaste Rye

Grains that worked well, why: Turmoki Wheat (pictured) — club variety, epic amazing grain because of its biomass, doesn't have lodging characteristic, Tibetan Purple Barley, Alaskan Wheat, Ukrainka Wheat, Rusak Wheat, Banatka — we've grown



it since 2015, it is outstanding, grows really tall, stiff straw, Uli Hache Rye, Rouge De Bourdeaux wheat is a favorite for production, vigor, and lodging resistance, Rinpoche Barley from Greg Schoen — low lodging, high yield, deep purples, feels wholesome like it will be our friend on the farm for a long time

Grains that didn't work well, why: Turkey Red wheat was a heavy lodger, I love Tibetan Black, but it needs some selection clean up, Emmer produced a lot of biomass, needs to be hulled, not a strong yield but dense nutrients, Burbank Barley lodged badly. I'm standing in my field and just seeing what's growing. We continue to grow things that do well and show promise and give the ones that don't do well another chance.

State of your regional grain economy and connection to other growers, millers, bakers, etc.: Rise Up Bakery in Ashland, Oregon does a phenomenal job. They're connected to a local farmer that grows wheat for them. I am working with a dozen growers to expand the seed stock in the community through a seed library. We're running it similar to the Heritage Grain Trial Program where we ask people to return some seeds back to the library after they grow them out and save seeds from them.

Lessons learned, other observations: We grew, hand-harvested and processed two pre-industrial types of wheat this year with no irrigation water, no fertilizer, no-till.....a 100 ft bed produced enough grain to make 1 loaf of bread/wk for 20 weeks with 10 hrs of work.

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Landrace and heritage varieties of grains have evolved in environments with low nutrient availability and interact with soil biology in a way that humans do not yet understand. They return more carbon biomass to the soil, invest in deeper root development and have greater mycorrhizal associations which afford them vastly greater capacity to scavenge nutrients in low fertility soils, have higher leaf transpiration efficiencies to use less water and have vastly greater leaf surface area for photosynthesis and ability to outcompete weeds and better able to fend off pests and disease.

The processing of ALL commercial grain flour (organic or conventional) removes the nutritious germ and bran to increase shelf life for months in the U.S. food supply, and is why most

breads on the market today must add “vitamins” back into their recipe.

Takeaways, inspirations, and final words of advice to new growers: Never lose faith in the potential of a seed. Every year is a different year, every seed is a different seed. Put that together and put one foot in front of the other and you learn that what you thought might not be how things turn out. You never know until you try to grow it.

Related Resources:

<https://growhardyseeds.com/>

<https://www.mailtribune.com/top-stories/2021/08/13/food-forest-offers-hands-on-education-about-food-systems/>

Kirsi Aryan-Edwardson *Elizabeth, Colorado*

Elevation: 6,800 ft Climate Zone: 4 Precipitation: 12" per year (in 2021). I monitor my farm's weather for The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS, <https://www.cocorahs.org/>) so my precipitation records are accurate for my own piece of land.

Born in Denmark, Kirsi brought her grain heritage with her to the Heritage Grain Trials. She's been an enthusiastic trialist in the field and in the kitchen, and she has been sharing her enthusiasm and her seeds generously in her community. Her knowledge from years of gardening has been aptly applied in the grain trials where the student quickly has become the teacher.

Environmental/climate details and observations: Being on a high prairie, I experience early frost. April 2021 was very cold, slowing down the germination of spring grains. I didn't have to battle hail, disease, or grasshoppers in great numbers. We experienced more rain than usual during the late spring/early summer.

Farm and farmer background story: I fell in love with the country and farming life as a child, when I spent summers with my family in a cabin by a lake and played with kids from nearby farms. I have been a lifelong backyard gardener, but was able to garden and start saving seeds full-time only after my retirement four years ago.

Why and how did grains interest you? While I was taking the RMSA Farmer's Seed Saving class in 2020, Lee-Ann Hill suggested that I try growing ancient and heritage grains. I planted my first Sangaste winter rye seeds too deep and too late,



in November 2020, but 30 out of 100 seeds germinated in April 2021 and gave me a nice small crop.

Grains trialed: I grew my first spring grains in 2021, on a former alpaca pasture. I planted 16 varieties of heritage and ancient rye, oats, barley and wheat on Easter Sunday in April. I started the seedlings with help of drip tape irrigation, but stopped irrigating as the grains started heading. I also planted other grains like organic quinoa, amaranth, sorghum, camelina,

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corn, sunflowers and pulses, as I have done in the years past. Sangaste Rye, Kochfield Rye, Reader Oats, Terra Oats, Amber Oats, Burbank Barley, Purple Dolma Barley, Tibetan Barley, Kamut, Emmer, Iraq Durum, Black Einkorn, Marquis Wheat, Sonoran White Wheat, Red Fife Wheat

Grains that worked well, why: All heritage and ancient grains produced well.

Grains that didn't work well, why: Kochfield rye sprouted but didn't bloom. I concluded a lack of vernalization as the reason. I was not experienced enough to see the need to vernalize my new spring rye berries.

State of your regional grain economy and your connections to other growers, millers, bakers, brewers, etc.: Eastern Colorado is a wheat, hay and Triticale country. Most farmers use traditional, non-organic methods of fertilizing, weed control and irrigation. However, organic growing methods are gaining ground, thanks to three large universities in the area with agriculture programs, and the demands from local microbreweries and artisan bakeries for organic and heritage grains. Colorado Grain Chain is actively promoting and educating small organic grain growers.

Lessons learned, other observations, or advice to share: Lodging was something I had not experienced before. I think I planted too tight, the alpaca pasture had too much manure and I drip-irrigated too long. I didn't expect grasshoppers, since I usually don't have many. They loved my Emmer and Einkorn, but didn't do much damage. The bunnies loved only Einkorn. I was not prepared for the ancient grains to ripen so unevenly. It was difficult to decide when to harvest. I was worried about the birds, grains dropping on the ground and seeds germinating in the heads. Thank goodness we had dry weather in July, August and September, so germination was not an issue. I was surprised how much work processing the grains manually can be. Harvesting, drying and threshing were not too bad, but dehulling hulled grains was slow and difficult without a dehuller. It would make sense to invest in machines to be shared by many small-scale grain growers in the area. The grain mill is



reasonable enough for everyone to own. I planted cover crops of cowpeas and buckwheat on the harvested, untilled grain fields. They germinated well, but the buckwheat was more aggressive and shaded the cowpeas too much. The first frost killed both before they could make seed.

Takeaways and inspirations: As a novice, growing heritage and ancient grains was one of the most satisfying experiences I have had and I cannot wait to see how my winter grains and Kernza will survive this dry winter. I plan to trial 15-20 additional rye and wheat varieties this spring, including two varieties of upland rice. I don't have much need for barley or oats in my bread recipes, so I will plant less this summer. Personally, I don't have a huge farm to grow ancient and heritage grains in a large scale, but plan to continue to trial different grain varieties, experiment with cover crops, interplanting, companion planting, protection planting (shading with compatible, tall crops), crop rotation and applying Joseph Lofthouse's landrace gardening principles in some crops. I will also educate my friends and neighbors about growing ancient and heritage grains, share seeds and continue to bake bread with my own grains. Many of my friends are interested in growing grains and two of them with large farms are planning to grow heritage grains this spring. One of them is in Calhan, Colorado (at 6535 ft. elevation) and the other in Salida, Colorado (at 7083 ft. elevation). I am excited to see how my grains will grow on their farms.

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Garden's Edge and Qachuu Aloom Association www.gardensedge.org Albuquerque, New Mexico; California; and Rabinal, Guatemala

Amaranth has been a popular grain in the grain trials and we have been blessed to collaborate with The Garden's Edge and Association Qachuu Aloom to learn more about this sacred crop. Garden's Edge and Qachuu Aloom have joined us in Grain Schools and seed gatherings to bring awareness to this life sustaining plant that was once banned from the people who have grown it for millenia.

Grain: The three colors, Green, Orange, and Red flowered *Amaranthus cruentus*, is a versatile plant that can grow well in many different climates.

Climate, rainfall: This variety does well in the high mountains of Northern New Mexico at 6,532', Albuquerque at 5,000', coastal San Diego at 42'; Los Angeles at 85'; in over 100 degrees fahrenheit with little water, and in Oakland, California at 43'.

Farm and farmer background story: This variety, native to MesoAmerica was gifted to Maya Achi farmers in Rabinal, Guatemala at the Association Qachuu Aloom, from a group of Kaqchikel, Maya women from San José Poaquil, Guatemala in 2003. We planted the seeds at Qachuu Aloom from small handfuls and now grow thousands of pounds a year. We share the seeds with other farmers and process the seed into nutritious cereal bars, grind it into flour to make a traditional drink called Atolé and pop it into a delicious snack to offer as healthy snacks at schools and village stores. Colorful fields are planted across the arid dry mountains, standing in stark contrast to the brown, deforested hillsides.

Through our partnership with The Garden's Edge, members of Qachuu Aloom have traveled to New Mexico, Arizona, and California to share our seeds and knowledge about Amaranth. We learned that the seed was loved and remembered in many communities across the Southwest as well as in some immigrant communities from Central America, Mexico, China, India, the Philippines, Congo and Sudan. In Guatemala it's known as Lab'ises, or Tez, in the Congo as Lenga-Lenga and some places in the Caribbean as Callaloo.

How you got into grains and why: Amaranth was traditionally a part of the diet and spiritual practices across many parts of MesoAmerica. Banned by the Spanish because of its importance to diet, culture and spirituality, it survived in hidden plots, seed jars, and growing wild. Qachuu Aloom and The Garden's Edge



Olga Burrero Guanche from Qachuu Aloom Association and the Gardener's Edge demonstrates amaranth seed cleaning at Grain School in Albuquerque, July 2019.

are dedicated to preserving a diverse variety of native seeds, and sharing them with others. We do this to create vibrant food systems but also to heal and deepen relationships between plants and people.

Grains you have/are growing: Amaranth, corn, beans, wheat, sorghum

State of the regional grain economy and their connections to other growers, millers, bakers, brewers, etc.: At Association Qachuu Aloom, we have a small community kitchen, with a machine we designed ourselves to pop the seed for commercial and community use. Traditionally the seed is popped on a comal over a fire, and then the seeds are ground into flour. Popped seeds are soft enough to mill in a coffee grinder for home use. We also have a commercial mill. We have a connection to other growers in Guatemala through the National Network for the Defense of Food Sovereignty in Guatemala — REDSAG — and in the Southwest through The Garden's Edge, Traditional Native American Farmers Association, and Seed Travels partner gardens.

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Lessons learned, other observations or advice to share:

The leaves can be eaten as a green when harvested in the first two months of the plant's growth. The seeds are highly nutritious. With the threats of climate change, Amaranth is a significant plant to pay attention to because it can survive in a wide range of climates and altitudes. It grows just as well on a roadside, out of a crack in the sidewalk or planted in a field.

Our native seeds are sacred from our Maya worldview. We often say when you lose a seed variety, you lose a ceremony, because the two are so deeply tied to each other. We realize that you cannot preserve your seeds without preserving the cultural practices that connect the two because they are joined together and are part of each other. There have been many threats to our seeds, starting with the Spanish invasion. During the Guatemala armed conflict that lasted more than 30 years, many families abandoned their land and lost many seeds. We have also lost the connection to our seeds through paternalistic government policies such as the distribution of hybrid seeds, even in the most isolated communities in Guatemala. These factors of imposition and colonization have contributed to the fact that our spirituality and our divine relationship with the elements of the universe and with Mother Nature have begun to disappear. We work with many Maya villages so that the elders can transfer



Amaranth was grown by 17 trialists.

the knowledge of how to care for our seeds, a fundamental part of life, and to live in harmony with all the agrobiodiversity.

Takeaways, and inspirations, words of advice to new growers:

We have learned through sharing Amaranth, that it is much more than a healthy food source. It carries the history of the people in its heart, and it reminds us to be strong, resistant and adaptable. It helps rekindle that deep relationship that people had with plants and nature. Be prepared to fall in love with this ancient and wise plant.

In gratitude, Association Qachuu Aloom and The Garden's Edge

Evan Sofro The River Farm, Buhl, Idaho

Evan Sofro was the key to scaling up the grain supplies for trialists, farmers and researchers. A friend to all seeds, Evan is a seedkeeper at heart and an experimental farmer who has a special touch with everything he grows. Previously the Farm Manager at the Native Seeds/SEARCH farm in Patagonia, Arizona, Evan has interest in arid land crops and adapts his practices accordingly.

Evan's agricultural vision involves connecting the heart with the land and the seeds that sustain us. He generously grew out our complete original collection of hulless barley that we received from seed steward Thumb's Heath so that we had enough stock to share more widely in the trials, and so that we also had backup supplies. As the trials grew, so did Evan's ambitions for the grain seeds. Evan became the Farm Director for a blossoming endeavor in Buhl, Idaho where he put his love for seeds, the land, and grains together and grew out our *Top 20* varieties from handfuls to pounds so we could embark on our formal research. Evan also trialed new to the collection varieties to bring stock up to amounts that could be circulated amongst trialists, and to share his observations. We are forever grateful to Evan and his contributions to the Heritage Grain Trials Project.



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Research Farmers

Wilder Jones King's Crown Organic Farm *King Hill/Glenns Ferry, Idaho* www.kingscrownorganics.com
Elevation: 2,356 ft. **Climate Zone:** 6b/7a **Precipitation:** 9" **Irrigation:** Overhead

Wilder Jones farms with his father, Nate, along the Snake River about one hour southeast of Boise, Idaho. His father is a third generation farmer and rancher who established one of the first organic farms in Idaho. With abundant water for irrigation from the river and the aquifer, Wilder incorporated overhead watering throughout his grain trials. His results were quite different from the research farms in Paonia, CO and Mancos, CO that used drip and flood irrigation with limited water availability during the heat of the 2021 growing season.

Environmental/climate details and observations:

Ecosystem type is sagebrush steppe, very similar to the Great Basin to the south. The agriculture in southern Idaho is a product of the extensive irrigation projects that were developed in the early 1900s. Dryland agriculture would be relatively hard and unpredictable year to year in this area. Due to the plentiful water supply, the most common crops in southern Idaho include potatoes, alfalfa, corn, and sugar beets. Small grains are more prevalent in eastern Idaho where barley is grown for large corporate breweries. Weeds are getting worse! Likely caused in 2021 by unseasonably high temps early season followed by significant rain events. Grains were shorter in 2021, which exacerbated the weed pressure.

Farm and farmer background story: The land was purchased by my grandfather in 1950. My grandfather, Stanley Jones, was a jack-of-all-trades; he built houses and did some farming on the side. He grew some sweet corn and hay while also backgrounding some cattle in a small feedlot he built. King's Crown Organic Farm was started by my father upon his return to the family farm in the late 70's. My father, Nathan Jones, worked multiple jobs to supplement his farming enterprise. He grew a rotation of hay, dry edible beans, and the occasional wheat crop, while also raising a small cow-calf herd.

My father lived through several farming crises and witnessed many of his neighbors go out-of-business and sell. He knew that his 125-acre farm would have to do something drastic in order to support itself in the increasingly "cut throat" world of modern industrialized agriculture. He landed on the idea of growing a niche crop. Something special that he could receive a large payout from. Through a series of conversations with other farmers, he decided to try his hand at growing garlic. He reached



out to a farmer in the town of Buhl, Idaho. Rick Ihler became my father's mentor for garlic growing. He agreed to teach him how to grow the crop and that he could even throw it in with his carrot crop to ship to California. The only catch was that he would have to grow it organically. Organic was a fringe topic at the time of the late 1980s and for the most part was only practiced in states like California and Vermont. No national standards or organic certification had been adopted at the time. As I have been told, my father grew "one hell of a garlic crop". He worked tirelessly to weed, harvest, and cure his garlic. It was such a financial success that he decided to grow and market all his crops as organic. He joined other farmers in Idaho to lobby the state's department of agriculture to create an organic sector. He is proudly one of the original eleven Idaho growers to sign up for organic certification the first year of the program's existence, "grower number six" he likes to boast.

Fast forward twenty-five years later and he has two children in their twenties and an organic farming empire just under 600 acres. I left high school and attended several universities out of state. I was attending Montana State University studying rangeland ecology when I began to value where my food came from. I was also working at the food co-op in Bozeman, Montana. I began to argue with my peers that chemical

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agriculture was not sustainable, and in fact could be replicated at scale and that my family farm was living proof. I began to resent the university and started scouring the internet for anything involving sustainable agriculture, holistic grazing management, and permaculture. My rebellious streak led me to drop out and attend a permaculture course in Costa Rica. It was there that I realized I needed a place to grow my own food, and that southern Idaho would be my canvas. I have been at King's Crown Organic Farm since 2016 and have since finished my education at the University of Montana where I received a Bachelor of Science in Natural Resource Conservation. Currently I am starting my own enterprise to produce organic grass-fed raw milk at my own farm — Wild Spaces Farm.

Why and how did grains interest you? King's Crown Organic Farm has grown wheat in the past, however, several rejected loads of wheat due to weevil infestation led my father to exclude grains from his rotation. We participated in the heritage grain growing trial partly by accident. Another grain grower and friend, Evan Sofro, encouraged the experimentation on our farm, and we liked the idea of seed supply grow out.

Grains trialed: We do grow organic feed corn for local dairies, and rye/oats for our own cover cropping. Of course, dry beans have remained a cornerstone of our rotation and profitability. We will be continuing our relationship with heritage grains by growing out larger plantings of Sangaste Rye and Turkey Red Winter Wheat.

Grains that worked well, why: The Sangaste Rye, Tibetan Purple Barley, Black Emmer, and Turkey Red Winter Wheat are the varieties that did well. We had more success with the fall planted varieties. This was to be expected because our rather mild winter climate favors these grains. Our spring is short, hot, and often dry. Leading to unfavorable conditions for spring grain planting and establishment regardless of ample irrigation.

Grains that didn't work well, why: The grains that seemed to not work well were the Durums. We believe the overhead sprinkler irrigation led to disease and unfavorable growing conditions. Perhaps a more curated irrigation schedule could be conducive to their growth, however, we watered all our trials with the same prescription we would use to grow our own oats or rye.

State of your regional grain economy and their connections to other growers, millers, bakers, brewers, etc.: It is my belief that the regional grain economy is growing into a more resilient, diversified, and decentralized system. Currently, two nearby mills accommodate heritage varieties with



prescriptive milling capacities — Hillside Grain and 1,000 Springs Mill. The market for heritage grains rests upon demand from brewers, bakers, and consumers within the region. Like many agricultural products, the capacity to grow the product is not the pinch point. Manufacturers and consumers must collectively begin to produce and consume the unconventional products that we as farmers all love and cherish. My best example beyond heritage grain is hemp. Every farmer from Virginia to Oregon could grow hemp, however, we need factories and plants that produce the hemp alternative i.e. toilet paper, disposable cups, linens etc. in order to realize hemp's potential.

Lessons learned, other observations or advice to share: The biggest lesson I learned was to ask for help. Growing grains without scale and mechanization is a difficult and labor-intensive process. I think as farmers we believe that our body is an infinite resource. It is important when growing on a small scale to include others and ask for help. Small scale doesn't make things easier.

Takeaways and inspirations, words of advice to new growers: Nature demands a diversity of organisms. Our cultural landscapes, crop rotation, and diets should not be an exception. I encourage everyone to welcome diversity into their gardens, fields, and kitchens. Growing and eating varieties that have not been a part of the industrial agricultural machine can benefit your farm and life in unimaginable ways. I encourage you to buck the trend of growing the same varieties for the same marginalized price to the same monopolized processors. Join the revolution, go against the grain, and grow heritage grains.

Chapter 3: Farmer and Grower Stories and Profiles

Emily Lockard Agriculture Agent, Colorado State University Extension, Montezuma County, Colorado, and former Research Associate, Southwestern Colorado Research Center; Yellow Jacket, Colorado
Elevation: 6,900 ft. **Climate Zone:** 6a **Precipitation:** 15" (USDA/NOAA 30 year period 1991-2020)
Irrigation: Sideroll overhead sprinkler

Environmental/climate details and observations: The Southwest and Southwestern Colorado is experiencing a multi year drought and during the 2021 growing season we had very little irrigation water compared to other years. We were able to irrigate the grains with about 6 inches of water but our water was turned off at the end of June so grain fill was reduced and general productivity was likely impacted.

Farm and farmer background story: Southwestern Colorado Research Center conducts both irrigated and dryland crop research on a 148 acre farm located in Yellow Jacket, Colorado. Emily Lockard was a research associate there during this project and she now works for Extension in Montezuma County. The reason heritage grains were trialed is to explore drought tolerant grains that could receive price premiums.

Why and how did grains interest you? Niche products that can succeed during a drought are what brought me to the idea of trialing heritage grains. The interest in grains from the local community also brought my attention to the multiple needs for a successful enterprise from farming skill to availability of equipment.

Grains trialed:

Fall Planted Grains

Sangaste Rye
Spelt — destroyed by squirrels
Black Emmer — low production
Marquis — destroyed by squirrels
Turkey Red Winter Wheat
Tibetan Purple Barley (winter trial)

Spring Planted Grains

Sonoran White Wheat	Pima Club
Iraq Durum	Ethiopian Blue-Tinged Wheat
Red Fife	Purple Dolma
Pacific Bluestem	Einkorn
Khorasan	Tibetan Purple Barley
Emmer	Duralis Durum
Sin El Pheel	Duramonte Durum
Black Einkorn	
Arabian Blue Varley	



Grains that worked well, why: We don't have conclusive results from one year of growing grains but the top 5 spring planted producers were Duralis (spring durum sourced from Suedwestsaat Seed Breeding Company), Pacific Bluestem, Red Fife, Emmer and Khorasan. In the fall planted grains top three were Turkey Red, Sangaste Rye and Emmer.

Grains that didn't work well, why: Einkorn is very late maturing which can be tricky in our region due to monsoons that could either cause crop loss or pushes maturity so late in the season it's difficult for field management. We also learned about preparing grains for our planting equipment and completely removing awns was really important for planting but difficult to achieve with our equipment.

State of your regional grain economy and their connections to other growers, millers, bakers, brewers, etc.: Southwestern Colorado has a few mills of varying sizes. There is a community mill in Norwood, Colorado and commercial mills in Cortez and Towaoc. While Southwest Colorado is a very rural area we have bakeries that are very interested in using heritage grains in their products.

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Lessons learned, other observations or advice to share:

Heritage grains have the potential to thrive in Southwest Colorado but more research needs to be done to develop variety recommendations for the region, availability of larger amounts of seed is another barrier for farmers to grow heritage grains that could be addressed by enterprising farmers. Our region does have most of the equipment needed for growing and processing grains but developing sharing agreements or

increasing the availability of specialized equipment would help to support a heritage grain economy in our region.

Takeaways and inspirations, words of advice to new growers:

I would advise growers to identify buyers for grains and then decide what you might want to grow. Visit with millers and bakers to know what they are looking for in grains. I would start small, visit with other farmers and have fun visiting with the generous community of heritage grain growers.

Don Lareau Zephyros Farm Paonia, Colorado www.zephyrosfarmandgarden.com
Elevation: 5,600 ft. Climate Zone: 5b/6a Precipitation: 10-12" Irrigation: Overhead and drip

Don Lareau was an early participant in the Heritage Grain Trials Program. Don and his wife Daphne Yannakakis have an organic farm on the Western Slope of Colorado in the North Fork Valley of the Gunnison River called Zephyros Farm. They both have a high sense of quality and a deep knowledge of beauty, taste and flavor from experimenting, testing, and trialing thousands of different vegetables and flowers. Don was asked to participate in the *Top 20* trials to help assess the field and production values of the grains on a working organic farm, and to determine if grains would be a valuable addition to a vegetable and flower farm portfolio.

At Zephyros Farm they rotate crops and integrate polycropping practices to support the biodiversity of the farm. The area has a rich agricultural heritage and is also renowned for fishing and rafting in the Gunnison River Gorge. The “farm to table” culture is vibrant in the region, supporting local farms, local restaurants, and local bakers, like Chris Whitcomb and Dana Sullivan of Mountain Oven Organic Bakery who have been staunch supporters of a local grain revival (see MountainOven.com for their story).

Don has organized and led seed saving courses at his farm, and both he and Daphne are devout seed savers. The farm employs several workers during the farm season. With its focus on flowers and high value vegetables (think tomatoes), Zephyros Farm is abundant in beautiful and bold gifts of the earth and in spirit.



Environmental/climate details and observations: High desert environment at 5,600', where winds can be high and overall a very hot and dry location. Last frost is usually 5/1; first frost 10/15 but fluctuates a lot.

Farm and farmer background story: We are a small, diversified family farm on 35 acres located on the Western Slope of Colorado in the North Fork Valley. We grow Certified Organic flowers and vegetables for Farmers' Markets, restaurants, florists, wholesale and our unique Flower CSA (Community Supported Agriculture). In the spring we provide a wide selection of Certified Organic vegetable and herb starts, as well as fun fruits and perennials just right for Western Colorado. We are not only flower growers but also passionate designers, so we offer wedding and event flowers through our design studio, Studio Z Flowers.

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Zephyros Farm and Garden was founded seventeen years ago as a small certified organic farm run by the owners. Over the years we have grown from a small half acre of production to over eight acres of production and many full-time employees. We have gone from feeding a few people to growing tens of thousands of pounds of food each year. Originally, the flowers were something we did on the side because we loved them. Following that passion has led us to being one of the largest producers of cut flowers on the Western Slope.

Why and how did grains interest you? My interest in grains comes from a saving seed point of view. We started growing a variety of odd grains — teff, colored wheats, unique sorghums — all for our cut flower operation, and I became interested in growing grain for ourselves on a small scale. I went to the first grain school at UCCS and then started participating in the grain trials.

Grains trialed: We continue to grow the “odd” grains mentioned above and may begin to add a few of the varieties we grew in this trial such as Black Emmer.

Grains that worked well, why: The grain that stuck out the most in the 2021 grain trial was the winter (fall 2020 planted) Sangaste Rye. It was very tall, with very healthy heads and despite how tall it was it did not lodge. Many of the winter planted grains did very well and had a good yield. The Turkey Red Wheat was also very successful. I think that the winter planted grain was more successful for us in general because they were mechanically weeded many times before they were too tall. This prevented weeds from growing as they were able to shade weeds at a certain point. As well, the winter plot had lots of overhead water in the early Spring before the drip line was laid down. With these two factors combined, I believe the overhead watering brought up small weeds, while the cultivator was able to immediately kill these weeds, giving the grain a better headstart.

Grains that didn't work well, why: In general, our spring planted grain did not do as well as the winter planted grain. The Einkorn consistently rated the lowest. We did have an Einkorn patch in the Winter planting, but it was completely overtaken by

weeds since it is a much slower growing grain. I think a reason that the spring planted grain was less successful than the winter is because these grains did not have as many opportunities for mechanical cultivation. As such, they became too tall for mechanical cultivation and the weeds were much worse in the spring as opposed to the winter plot. Also, many of the spring grains lodged due to an extreme high wind event (on June 25th) that nearly flattened many of the varieties.

State of your regional grain economy and connections

with growers, millers, bakers, brewers, etc.: We have a burgeoning grain economy in the North Fork Valley that has only started in the last 5–10 years. We are very connected to our local grain growers in the valley as there are only a handful that operate on a small scale. The grain economy is scaling up and farmers are growing more heritage grains. In the last few years a local bakery, Mountain Oven, has inspired more engagement from the farmers in the valley to begin to grow an increased quantity of heritage grains. Since two years ago, the grain economy around bread baking has grown a lot and has much more room for growth as Mountain Oven recently installed a large stone mill in their bakery. We look forward to how the mill will change our local grain economy even more!

There is also a brewery, Chrysalis Barrel Aged Beer, in town that grows much of the grain they need for their operations. They also work with many local orchards to flavor their beers.

Lessons learned and other observations: As a small-scale market farm, with little extra resources to dedicate to trials, it became apparent that executing such a trial to the best of our ability is more than we have resources for at the moment. We were hugely lucky to borrow a small combine from our local research station. This was an enormous help as we were harvesting the grains at the height of our Farmer's Market season, which is full of every task imaginable on the farm. The combine saved us many hours of threshing. We still harvested the heads by hand, but were able to hand feed the combine. For a farm that is not set up to harvest/clean grain, and has lots of other moving parts at that time of year I think we did as well as we could have!

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Lee-Ann Hill Laughing Wolf Farm Mancos, Colorado

Elevation: 7,000 ft. Climate Zone: 6a Precipitation: 18" (less in recent years) Irrigation: Drip and flood

Environmental/climate details and observations:

Laughing Wolf Farm is in a high desert environment at the base of the La Plata Mountains, with monsoon rain showers in the summer if we are fortunate. The past several summers (2017–2021) the rain at the farm has been minimal. Rain showers in our region tend to be “isolated,” and the farm has been in a “rain shadow.” The last freeze has also been fluctuating wildly, with a snowstorm and killing frost in 2019 on summer solstice, June 20th, followed by a September 24th hard freeze that same year, though generally June 6 marks the safe planting date for summer crops, and the first freeze is around October 10th. Most winters we have enough snow to offer an insulating layer for the grains, which enables both fall planted and “ facultative” grains to succeed, though some winters are remiss to offer that snowpack, resulting in “winter kill” of both winter and “ facultative” grains. This is not only a problem with heritage and ancient grains, but also for the conventional wheat that has been a staple crop in our region that has been the source for Cortez Millings’ renowned “Blue Bird” and “Red Rose” flours.

Farm and farmer background story: After volunteering, interning, and working at farms in New Mexico and Costa Rica, I began Laughing Wolf Farm in 2013 through an incubator program at Ft. Lewis College in Durango, and then on a historic farm property that my partner and I purchased that same year. The property was quite “run down” and riddled with weeds. Although it had historic water rights, the ditch rights had been long ago sold, and it was a barren and dry parcel, aside from the weeds. Thus began the restoration and stewardship that would inform my practices and integrate the values of arid land farming, which are fortunately also a good match for grains! Arid land farming is not, however, a great match for vegetables, which was also part of the farm enterprise portfolio. From the start, my interest was on crops that were conducive to the environment I was farming, so grains, beans, and corn, i.e.; staple crops, also became the staple crops at the farm though they were not a lucrative enterprise at my scale (2 acres), so vegetables offered the “working” revenue through a CSA (Community Supported Agriculture) program, farmers markets, and wholesale accounts. Eventually, I offered grains, beans, cornmeal, and seeds to my CSA and at farmers markets.



Why and how did grains interest you: My journey with grains began when I decided to attend Grain School at Native Seed/SEARCH offered by Bill McDorman and Belle Starr. I had pursued a masters degree in cultural ecology, with a focus on sustainable food systems. Seeds and grains came into my world alongside farming, all of which led me to Grain School where my mind was truly “lit up” by the wonders of heritage and ancient grains. I was particularly interested in their adaptations, and curious about drought tolerance and regenerative field values alongside other crops. This exploration became a ten-year pursuit, so far, with more exploration and adventures to come. In the meantime, I began working with Bill and Belle at Rocky Mountain Seed Alliance and had the great pleasure of helping to create and direct the Heritage Grain Trials Program where I worked closely with over 250 varieties of grains and over 100 grain trialists. The observations I have heard and collected from trialists, alongside my own experiences, have been eye-opening, and I was excited to expand on our research through this grain research project. I also had the great fortune of meeting incredible grain experts who we invited to teach at our various Grain Schools and grain events through the years, including bakers and chefs who brought these unique and critical staple

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foods to the table to complete the journey from field to plate. Heritage grains continue to pique my interest in new ways, and I believe the education grains offer is endless.

Grains trialed: I began my grain growing experiment with Turkey Red Winter Wheat, and over the course of my work with the Heritage Grain Trials Program, I trialed over 100 varieties of heritage and ancient grains. For this “20 to 20 in 2020” project, I trialed our Top 20 grains as identified in this manual.

Grains that worked well and why: Alongside the results shared in this manual for the Top 20 grains, the grains overall through the years that have been most successful at Laughing Wolf Farm include the following.

Turkey Red Winter Wheat: Turkey Red Winter Wheat (photo this page) was my gateway into growing heritage grains, and it was a great success the first season. Through the years, Turkey Red was a fairly good performer in the field as a winter grain, though I found it to prefer and perform much better in soils that were nutrient rich, and less effective as a “regenerative” crop (one of my objectives at the farm was to find suitable grains for restoring the soil between vegetable rotations). I’ve tried planting it from early September to early November and found it adaptable to any of the planting times, which is a bonus for crop rotations, busy farmer schedules, and fluctuating weather patterns. I try to plant my winter grains with the fall rains, and some seasons we just haven’t had any. Planting later in the fall with the early snow has worked for Turkey Red, though not for other varieties.

Emmer: I’ve had luck with both fall and spring plantings of emmer, though for a reliable crop spring planting is best for the white emmer varieties, which are actually called “vernal” emmers, and winter proves best for the black emmers. Considered an “ancient wheat,” emmer is such a delightful and gorgeous wheat that harkens the ancient tradition of grain growing with a distinct look from conventional varieties with a strong hull that makes cleaning the grain for the kitchen quite difficult. For seed, it is best not to remove the hull, so that enables easy seed crops. I’ve also been experimenting with “free threshing” emmer by selecting the grains that fall freely from the hull in hopes of encouraging a variation that will be easier to bring to the kitchen.

Khorasan: This was a true winner during the 2017 growing season, however it has been a real lure to grasshoppers, even with its mighty awns, and was thus a challenging and devastated crop in subsequent years, much to my dismay as it is a true



beauty with its overly-large heads of grain with long dark awns. Khorasan is really a site to behold!

Sonoran: Like Turkey Red, I found Sonoran White Wheat to perform best in nutrient rich soils, which I found surprising as its reputation precedes it as an easy to grow and adaptive grain. It was adaptive in drought conditions at my farm, though I heard from other trialists that it did not perform well in drought conditions. I believe there are a lot of variables when growing Sonoran, including planting times, soil conditions, and overall weather.

Marquis: In my search for a heritage grain variety for my region, I discovered Marquis wheat., which is the claim to fame of the Mancos Grain Elevator that was built in 1934. Marquis wheat was historically a dryland wheat that appears to be facultative (can be planted in fall or spring), though was planted historically in the Mancos Valley as a winter wheat, however I’ve had success with both spring and fall plantings.

Sangaste Rye: Sangaste Rye was a variety that was offered to the trials through an incredible grain steward, John Sherck, who had received it from a friend in Estonia, and is considered to be one of the oldest cultivated varieties of rye in the world. It is used for making bread and vodka, and its field virtues are outstanding. It’s the tallest grain I’ve grown, growing as tall as 7 feet, and it is lodging resistant despite the height. It has also been disease resistant in my fields, as most of my grains which seems to be likely due to our dry climate, and it appears to have allelopathic

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traits as the weeds are minimal in the Sangaste rye. Also, it is a high yielder so I have used it in breads and pilafs, shared the seed abundantly in the trials, and used it for replanting as cover crop and for seed and food after only a few years of growing it, which is exciting since I generally need to focus on seed increase for many years.

Grains that didn't work well and why: Einkorn is slow to germinate, slow to grow, shorter in stature, slow to mature, and very difficult to thresh for consumer use. With my organic practices, weeds are a challenge for slow growers as the weeds will outpace the crop making einkorn incredibly difficult to grow in my fields. Other shorter in stature grains, like some of the barleys, were also difficult to grow at Laughing Wolf Farm, particularly with the classic "drooping heads" of most barley varieties, which make them all the more vulnerable to climbing weeds like bindweed.

State of your regional grain economy and their connections to other growers, millers, bakers, brewers, etc.: Our region has slowly and surely been gravitating towards a revival of heritage and ancient grains. With an arid and cool climate conducive to growing, harvesting, and storing grains, wheat has already been a staple crop in Southwest Colorado. With popular ski towns in our region, including Telluride and Durango, we have clientele and economies that can help support the costs of growing specialty grains. Many bakers in these tourist towns have studied European breads and are also

accustomed or at least intrigued to try ancient and heritage grains that are renowned in Europe. The challenge is the increased cost of the grains, and the milling. Bakers we have worked with in the kitchen trials, including Mountain Oven and Blue Grouse Bread, have invested in their own mills to overcome this challenge, which has also offered the freedom of testing new varieties in small batches, or milling specifically for different products. The revival of localized milling is necessary for the revival of a regional grain economy. Brewers in our region have been more reluctant to take the plunge into heritage grains, as they feel that the yields for production and consistency in product cannot be met at this time, and more time testing batches is needed, as well as a localized malting. More support including infrastructure and expertise/mentorship are needed.

Lessons learned, other observations or advice to share: As Bill McDorman says, never give up on a seed! If there is a variety that is speaking to you, and with all varieties you want to grow, give them several growing seasons, and even trial them in different seasons, depending on your climate. We are finding that many of the grains are more adaptable than expected (and others, not so much).

Each variety has its own distinct personality regarding soils, seasons, climate, and practices. Hence, trialing is not only a fun way to approach growing heritage grains, but a very practical way to start the journey.



Blue Grouse Bread Norwood Colorado

Cousins Ben and Hannah Rossman own and operate Blue Grouse Bread in Norwood, Colorado. Their passion for the local food movement, baking breads and heritage grains have transformed the local grain economy. They forged relationships with growers in their rural community who are now providing heritage wheat for their bread, and they helped secure a community mill and sifter to further support the field to plate revival. Nearby ski town Telluride, CO, offers a viable clientele for their products. Their incredible breads are turning heads and awakening palates for heritage grains across the Western Slope of Colorado.

Chapter 4: Kitchen Trials

Alongside the growers trials and research trials, we also offered kitchen trials with varieties that we were able to acquire as flour and as a whole grain option for millers including Einkorn, Emmer, Sonoran White Wheat, Red Fife, Khorasan, and Durum. We had 44 participants, including four professional bakers. Trialists received a data sheet to track findings on aroma, crumb taste, texture and flavor, volume, loft, and loaf color. These data sets complement the pup loaf analyses (see appendix) conducted in the research trials. We invited participants to try a 50/50 flour blend with all purpose or bread flour and the whole grain flour, unsifted (see recipe in the appendix). The complexity and richness of flavors coming from the heirloom wheat varieties make for a rewarding and exciting baking experience, and trialists were excited about the opportunity.



Kitchen Trials Directory

Ellen Jantzen Santa Fe, New Mexico **Elevation:** 7,200 ft.

Season you were baking: Early Summer

Baking experience: Quite experienced

Yeast or levain: Levain

Did you follow the Kitchen Trial recipe? Yes

Did you make any modifications? No

Favorite flour to work with, why? Emmer and Einkorn. All were pretty equal to work with except the Khorasan and Durum were a bit stiff and could have used a bit more water.

Mill used: Flour was already milled

Cookware used: Cast iron Dutch oven and banneton

State of local/regional food economy regarding local grains, fresh flour movements: Santa Fe seems quite enthusiastic about local grains.

Word of advice to folks interested in getting involved, new bakers, gardens, etc.: Don't be afraid to fail.... Test and try!



Chapter 4: Kitchen Trials

Tomoe Natori Cortez, Colorado Elevation: 6,200 ft.

Baking experience: Homebaker — I bake weekly

Yeast or levain: Levain

Did you follow the Kitchen Trial recipe? Did you make any modifications? I followed the recipe for the first loaf, and it was made of emmer with 50% all-purpose flour. From the second loaf on, I modified the recipe to increase the proofing and baking times and also to use only heritage flours — eliminating all-purpose flour.

Favorite flour to work with, why? All varieties are fine flours for sourdough bread and delicious in their own ways. But, I have grown einkorn and white sonora for a while and am partial to them. They make such soft and sweet flours, and I love baking with them.

Mill used: No mill set up at home; used already milled flours in this kitchen trial.

Cookware used: I like using a glass measuring cup to start levain so I can see through it bubbling up and how much. My dough rests in a wicker basket lined with a floured cotton cloth. To bake: a combination of an old cast iron pot and a frying pan that fit somewhat are preheated in the oven. These misfits give more loft than a “dutch oven” I own and work great. I like flipping the rested dough out onto a parchment paper and sliding the paper right into the heated pot and putting the hot pan over upside down. Two layers of 100% cotton work gloves protect my hands.

State of local/regional food economy regarding local grains, fresh flour movements: I used to buy turkey red from a friend, but he's no longer growing. Continuing my search for locally-grown heritage grains. Meanwhile, I depend on the mill-to-order organic heritage grain growers like Bluebird Farm in Washington.

Word of advice to folks interested in getting involved, new bakers, gardens, etc.: Breadmaking is an ancient practice, just as gardening and seed saving. Raising and preparing food we eat, even for a bowl of cereal or a handful of seeds for next year, emulate our ancestors' steps and revive them in us, connecting



Durum loaf



Red Fife loaf

us to them. My favorite part is raising sourdough ferments to nurture an invisible world of diverse microorganisms — not unlike raising soil for growing food. I keep three kinds of mothers in the fridge and bake single-grain and three ingredient (flour, water and salt) bread regularly, though blending flours and/or experimenting with oils and sugars also are a lot of fun. Enjoy!

Recommended Read: *Wild Bread: Sourdough Reinvented* by MaryJane Butter

Chapter 4: Kitchen Trials

Ashley Overstreet Lafayette, Colorado Elevation: 5,250 ft.

Season you were baking: Fall

Baking experience: Experienced home baker (some professional experience)

Yeast or levain: Levain

Did you follow the Kitchen Trial recipe? Did you make any modifications? I followed the Kitchen Trials recipe without any modifications.

Favorite flour to work with, why? My favorite flour changes frequently, but I consistently like einkorn flour. I'd heard that it was hard to work with, but I haven't found that to be the case. Granted, I'm combining it 50/50 with bread flour when making loaves, but even when I've used 100% einkorn in pancakes, scones, and biscuits, they've turned out nicely.

Mill used: Komo XL Plus

Cookware used: Challenger Bread Pan

State of local/regional food economy regarding local grains, fresh flour movements: There's a budding grain movement in Colorado. There are a couple of organizations that are working in this area — Rocky Mountain Seed Alliance, of course, but also Colorado Grain Chain and Mad Agriculture. Additionally, there are some mills that have sprung up from bakeries, Dry Storage's Mill and Moxie Bread Co's The Mill Site, plus several bakeries and farms growing and using heritage grains. Another example of the local grain movement in Colorado can be found in Pastificio Boulder, which makes fresh



Khorasan loaf

pasta from heirloom wheat (locally when possible) and is gaining some national attention.

Word of advice to folks interested in getting involved, new bakers, gardens, etc.: Dive right in. There's a natural inclination when doing something new to hesitate or to worry that you have to learn the exact way of doing it. The beauty of growing grains and/or baking bread is that there isn't one correct way. Try things until you find what works for you. Then keep expanding and learning more. Also, see what's going on in your area and get involved however you can, whether that's taking a course, joining an organization, or just supporting local businesses involved in this movement.

Chapter 4: Kitchen Trials

Dana Whitcomb and Chris Sullivan Mountain Oven Organic Bakery Paonia, Colorado

Climate zone, rainfall, environmental/climate

details and observations: The North Fork Valley is where the desert meets the mountains. This landscape is undergoing a process of aridification and receives about 13 inches of rain annually. We belong to the Lower Gunnison Watershed. Our valley is well suited to grain growing given the dryer climate and ability to irrigate with the mountain runoff filling our rivers which feed the irrigation ditches.

Background Story: Mountain Oven is an organic bakery located in Paonia, CO operating since 2010. We provide artisan sourdough breads & pastries at farmers markets, weekly sales events from our facility, and through regional wholesale distribution.

We uphold the ancient art of sourdough baking and cherish the sharing of food that is nourishing and embodies locality from seed to table. Stone-ground flours freshly milled in-house, local heritage grains, high-spirited bounty of the North Fork, and love for this place and farmers invigorate and inspire our work. We work directly with farmers to imbue our creations with locality, character, and seasonality of our valley. This has been at the heart of our work for the past 12 years.

Mountain Oven is a vessel for us to share our values and vision. Through the bakery and mill house, we seek to honor the earth, build community, and create a resilient localized food system. The mission, through work as millers and bakers, is to create a sustaining local grain economy for our region. We seek to strengthen relationships between community, farmers and fertile land, bolster regional food security, and illuminate the vitality and resiliency created when producers work together.

How you got into bread and why: Chris fell in love with baking bread during high school, lured in by the aroma and warmth of fresh baked bread at his best friend's childhood home. Later on, a fascination with fermentation led Chris to sourdough. Breaking bread brings us together and ties us to our community and our home-place.

Grains you are using: North Fork Valley grown: Hard Red Spring Wheat, Rouge de Bordeaux, Sonoran, Polish Durum, Hulless Oats, Rye, Burbank Barley. We mill on a 48" New American Stone Mills mill with integrated sifter and use high extraction flour in most of our breads.



Dana Whitcomb, Lee-Ann Hill, and Chris Sullivan (from left) at Zephyro's Grain Day in Paonia, Colorado; August 2021.

Grains that worked well, why: All of the above grains have served us very well. Each grain has its own particularities, strengths and weaknesses, and appropriate application. As our bread is mostly in the style of French naturally leavened, we have the best application for wheats that have sufficient protein for bread baking. We use other grains for their flavor and nutritional benefits.

State of their regional grain economy and their connections to other growers, millers, bakers, brewers, etc.: The regional grain economy in Colorado is growing quickly. We aim to work hyper-locally with farmers in the North Fork Valley and the grain economy here is very new. We are trying to work alongside our farmers to figure out which varieties and what quantities of grain we need on an annual basis. We connect regularly with Blue Grouse Bread and Moxie Bread, two other Colorado bakeries who work with fresh-milled Colorado grown flour and produce exceptional bread.

Lessons learned, other observations or advice to share: We are very early in the process of learning how to find our place in the local grain economy here. We are trying to learn alongside our farmers which varieties and what quantities work best for the bakery on an annual basis. We are still learning a lot about milling as well. We advise to be patient, this is slow work that takes years to develop and is built on the trust between farmers, millers, and bakers.

Chapter 4: Kitchen Trials

Takeaways, and inspirations, words of advice to new bakers: The world of baking is infinite — there is always more to learn, discover, experiment with, and

enjoy. Have fun and follow the questions that come to you as you work.

Wendy Temple Del Rey, California Elevation: Sea level

Season you were baking: Late summer

Baking experience: I've been baking for many years...for as long as I can remember.

Yeast or levain: Levain!!!! (I rarely use yeast....but sometimes recipes call for it). I followed the Kitchen Trial recipe.

Favorite flour to work with, why? My go-to flour is Central Milling Artisan Bakers Craft Unbleached White Wheat Flour, Organic (commonly referred to as "ABC") along with 100% Bread Flour Whole White Wheat Unifine), Organic. These are already milled. However, I like to play around with lots of other flours that I mix in like Spelt, Malted, Kamut, and Einkorn. But I would love to get more Emmer, because from the trial, I loved it.

Mill used: I used first a Vitamix special milling blender then the MockMill attachment to my Kitchen Aid. Notes on this combo: The Vitamix was good for the initial milling, but did make the flour a little warm/hot which I've heard might take some nutrients out of the flour, so I don't know that I'd use it again. But, it did make the MockMill process faster and easier. In general the MockMill is not fast. If I can save up the \$\$\$, I might shoot for one of the fancier models that might be more efficient. Need to do more research on that.

Cookware used: I use Dutch ovens. A Cuisinart 2.0 (qt) and a Zelanico (I received as a gift) which is only slightly larger. I started out with the Lodge cast iron process but found my breads didn't rise as highly as I wanted, so I switched to the Dutch ovens.

State of local/regional food economy regarding local grains, fresh flour movements: I buy my flours from two basic sources, except for when I go to events where flour is showcased and I'll buy some there. My sources are Azure Standard (azurestandard.com) and/or from a local grain seller — King's Roost (kingsroost.com). Plus, I'm part of a group — LA Bread Bakers (LABB). We have monthly community bread bakes (and pizza bakes beforehand in the hotter temp) in a pizza oven built for community use at a local church.

Word of advice to folks interested in getting involved, new bakers, gardens, etc.: Unfortunately, I don't have enough space to grow wheat myself. I'm more of a food, tree, and low



From left: Einkorn and Emmer loaves

drought gardener. I do follow several Facebook sourdough groups. I'm kind of currently hooked on a sourdough scoring site. Very inspiring, somewhat demoralizing, but worth trying! And that's the key with bread baking. Keep trying. Try all sorts of flours and techniques. I have been a pretty loyal Tartine sourdough baking technique person. It takes much longer than other techniques — a good reason to be at home for several hours. Everyone loves home baked bread. It makes the home smell delicious. And, the most fun is even if it seems to be a flop, I bet it still tastes good and just call it flatbread or make croutons or breadcrumbs! You know what they say about making lemonade out of lemons! Also, to see if there's any bread baking group to join....there is NOTHING like the bread baking community. I learn something new every time I meet up with them...and I've found that bread bakers love to share...no secrets, all joy!

Notes: I have been baking sourdough breads for several years. I think my oven bakes bread a bit on the lighter side. I generally bake with 10-20% varieties of wheat (Hard Red, Einkorn, Kamut, Spelt, Malt) and 80-90% Artisan Bakers Craft (ABC) bread flour. So, my loaves are generally lighter in color and weight and have a crispier crust and also not so less dense than this loaf turned out. I am part of the steering committee of The Learning Garden at Venice High School in LA. David King and Julie Man were the ones that introduced me to Rocky Mountain Seed Alliance. In the gardens, David started an Ancient Grain section with grains that he got from the Heritage Grain Trials Program.

Chapter 4: Kitchen Trials

Table 1. Kitchen Trials Assessments

Variety	Aroma	Crumb Taste	Crumb Texture	Crust Flavor	Volume	Loft	Color	Trialist
Durum	grainy	sour/dairy	dense	toasty	848g	medium	2	Ellen Jantzen
	bold	sweet/dairy	heavy and dense	sweet toffee	481g	5.7"	2	Tomoe Natori
	sweet, nutty, molasses		dense	toffee	517g	3"	3	Shawna Ritz

Notes: Ellen noted the Durum didn't rise as much as the Einkorn or Emmer during bulk ferment but recovered its rise in the oven. She suggests modifying the recipe to include more water because the flour absorbed a lot of it and the dough was stiff.

Einkorn	sour	sour	airy	resinous	913g	3.5"	2	Ashley Overstreet
	slightly sour	slightly sour	moist but airy	roasted	824g	low	3	Ellen Jantzen
	sour	sour/dairy	light and airy	roasted	418g	5.2"	3	Tomoe Natori
	grainy	sour/dairy	dense		910g	3.75"	1	Wendy Temple
	nutty	sour	dense		512.5g	2"	4	Shawna Ritz

Notes: Einkorn is Ashley's favorite and then ranks Emmer and Red Fife as close seconds! Tomoe modified the recipe by omitting the AP flour and halved the remaining ingredients. She let the dough autolyze for 1 hour and then bulk rise for 2 hours after adding salt. She increased the bake time 5 minutes with lid on and 3 mins with the lid off. Wendy noted that Einkorn was denser than Emmer and possibly denser than the Red Fife. She noticed the flour had a grainy feeling and that the dough was wet and loose (pre-bake). Ranked as #2 or #3 with #1 being Emmer.

Emmer	grainy	sweet	heavy	fruity	919g	3.375"	2	Ashley Overstreet
	grainy	sweet	airy but dense	toasty	862g	low	3	Ellen Jantzen
	fruity	sweet/ dairy	half air, half dense	resinous	839g	6.2"	1	Tomoe Natori
	wheaty/grainy	sweet/ wheaty	dense, but not as dense as einkorn	toasty/nutty	898g	3.75"	4	Wendy Temple
	balsamic		airy but dense	malty	508g	2"	2	Shawna Ritz

Notes: Wendy noted that the Emmer was a stronger dough and held its shape better when wet (pre-bake). Emmer was one of Shawna's best performers, along with Khorasan.

Khorasan	sour	sour/dairy	light	fruity	901g	3.375"		Ashley Overstreet
	grainy	sour/dairy	heavy	toasty	887g	low	2	Ellen Jantzen
	malty		dense	nutty	517g	4"	3	Shawna Ritz

Notes: Ellen followed the recipe but added 10g more water because of a stiff stretch and fold. Tomoe modified the recipe by omitting the AP flour and halving the remaining ingredients. She let the flour and water autolyze for 1 hour, let the flour and dough rise for 1 hour, and then added salt. The dough sat for several hours before stretching and folding 3 times and shaping as the recipe indicated. Khorasan was one of Shawna's best performers along with Emmer.

Red Fife	grainy	sweet	airy	roasted	890g	3"	3	Ashley Overstreet
	toasty/grainy	grainy/sour	airy and heavy	roasted	883g	low	2	Ellen Jantzen
	grainy	sweet	light and airy	sweet butterscotch	445g	6.9"	4	Tomoe Natori
	wheaty/grainy	nutty, sour	soft	toasty, malty	1020g	4.5"	light	Wendy Temple
	toasty		dense	resinous	508g	3"	5	Shawna Ritz

Notes: Tomoe modified the recipe by omitting the AP flour, increasing the Red Fife by 40g, and halving the remaining ingredients. She let the dough autolyze for 1 hour and then bulk rise for 2 hours after adding salt. She increased the baking time 2 mins with lid on and decreased it by 2 mins with lid off. Wendy ranked Red Fife as #2 or #3 with Emmer being #1.

Chapter 5: Research and Results

The scope of the research in this chapter is based on one year of trials at four sites in the 2021 growing season with varying biological, climatic and site-specific conditions, and is not conclusive within that time frame. More research is required to show trends and conclusions. Future research we propose would include longer term data collection on the same data sets, over 3–5 additional years, including pre and post soil samples, varied irrigation rates, and across multiple climates.

Trials were conducted at the participating farmers King's Crown Farm in Glenn's Ferry, ID, Zephyros Farm in Paonia, CO and Laughing Wolf Farm in Mancos, CO. Additional trials were also conducted at the Southwestern Colorado Research Center (SWCRC) in Yellow Jacket, CO. We will describe trials and results at all locations as well as results specifically from SWCRC in this section.

Objectives

1. Identify and collect qualitative and quantitative data on 20 grains that are appearing to be adaptive, resilient, and marketable (based on grain quality, and field and kitchen performance) in the Heritage Grain Trials Project, to determine which varieties are best suited to support regionalized grain economies.
2. Increase regionally adapted seed of these varieties to have available for farmers and growers in the Western US with a target of at least 20 pounds of each variety to have available as foundational seed stock.

Methodology: Grower Field Trials

Research methods and experimental design were co-developed with farmer collaborators and scientific council M. Benjamin Samuelson, M.S. Participating farmers at King's Crown Farm in Glenn's Ferry, ID, Zephyros Farm in Paonia, CO and Laughing Wolf Farm in Mancos, CO cultivated (40) 32ft x 4ft plots with one foot between-plot buffers. Total area of the study at each site was approximately 0.15 acres. The experimental design is an augmented design with replicated blocks consisting of three rows each, distributed across the field allowing five cultivars to



Emily Lockard and Jerry Mahaffey at the Southwestern Colorado Research Center using a Hege plot combine to thresh grains.

be grown in replicates for estimation of variance, while the remaining 15 plots were assigned an unreplicated cultivar. Varieties were planted at 4 inch in-line spacing and 12 inch between-line spacing for ease of cultivation and because generous spacing is recommended for older cereals (Rogosa, Eli; *Restoring Heritage Grains: The Culture, Biodiversity, Resilience, and Cuisine of Ancient Wheats*; Chelsea Green Publishing, 2016).

Overall Methods

The purpose of the trial designs was to test hypotheses comparing yield and plant height among all 20 cultivars. Analysis of both yield and plant height at harvest supported equal variance among the cultivars. The grower trial design was recommended because it simplifies the experiment compared to a completely replicated design, while working within a reasonable assumption of equal variation across all cultivars within each site.

Plant height data was collected in the form of pictures taken with a yardstick and integrated into a data sheet. Yield data was collected after harvest and cleaning of the grains. Qualitative assessments of weed suppression, lodging, vigor, pest, and disease tolerance were also requested of trialists.

Chapter 5: Research and Results

Additional bioregional quantitative lab testing was conducted to assess grain quality from each variety per site for moisture content, test weight, 1,000 seed count, falling number, and protein content. Wet gluten and gluten index data was collected on each wheat sample and a pup loaf analysis was done on each variety. Stalk nitrogen testing was conducted on samples from the participating research farm and the Colorado State University — Southwestern Colorado Research Center (SWCRC) in Yellow Jacket, CO. SWCRC also conducted a seeding rate trial that will help address the question of best seeding rates for these unique grain varieties.

Alongside the formal research, grassroots trials continued with growers who self-selected varieties of interest. In the grassroots trials, data was harder to acquire and quantify from the majority of trialists, however many trialists were deeply engaged in sharing their observations and results. These trials were primarily qualitative, asking participants which varieties they liked best and why.

Results and Discussion

Varieties in the trials are listed here from highest yielding to lowest in pounds per acre. This order also generally reflects weed and pest pressure resistance.

Sangaste Rye
Spelt
Black Emmer
Marquis
Turkey Red Winter Wheat
Sonoran White Wheat
Iraq Durum
Red Fife*
Pacific Bluestem*
Tibetan Purple Barley (winter trial)
Khorasan
Emmer
Sin El Pheel
Black Einkorn
Arabian Blue Barley

Pima Club
Ethiopian Blue-Tinged Wheat
Purple Dolma*
Rouge de Bordeaux*
Einkorn

The yield analyses and the qualitative observations from the research trials reflect results from the grassroots trials. Challenges are also consistent between the research and grassroots trials with weed suppression as a key data set and setback for growers who are reporting more weed competition along with more pest pressures. Einkorn and Tibetan Purple Barley were significantly impacted by weeds to the point of crop failures, though winter plantings of Tibetan Purple Barley and Black Einkorn offered enough of a “head start” on the weeds to result in a successful harvest. Einkorn is notoriously slow in germination so weeds generally outpace the growth of this variety. The Tibetan Purple Barley, while much quicker to germinate, is shorter in stature and thus is also often outpaced by competing plants. And the hulled varieties (Spelt, Emmer, and Einkorn) have the additional challenge of needing specialized equipment for dehulling, which adds time and cost considerations to the final product.

Pup loaf analyses were conducted on all wheat varieties, and the results between varieties were surprisingly similar despite varying gluten and protein contents. However, the tests were based on conventional loaf standards using yeast rather than artisan breads using sourdough, which is likely the more common bread application for these specialty grains. Data is available from the trials on gluten strength, volume, flour and crumb character, and other factors that bakers may find helpful and translatable for their own purposes. All in all, the pup loaf analyses also reflected our grassroots kitchen trials, which involved professional and at-home bakers.

Data suggests that the top 5 varieties mentioned above (Durum, Einkorn, Emmer, Khorason, Red Fife), are most adaptive and resilient in the field, best yielding, and best performing against weeds and pests. The highest-ranking grain for the bakers who provided feedback was Emmer for the flavor and the sourdough bread performance, and professional bakers showed an additional interest in Khorasan, Rye, and Durum as localized products, along with interest in local Sonoran White and Turkey Red wheats, though those varieties are available in the greater Western region at a price that would likely be more competitive from larger regionalized growers than smaller local growers.

*Limited regionalized seed stock at the onset of the trials of Rouge de Bordeaux, Red Fife, Pacific Bluestem, and Purple Dolma Barley prevented trialing those varieties at each of the four sites, though each of the varieties was tested at a minimum of one site.

*Spring and winter trials were combined prior to submitting to the lab, so seasonal results are inconclusive.

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Grower Field Trial Results – Comparative Analysis of Field Data by Steve Alston

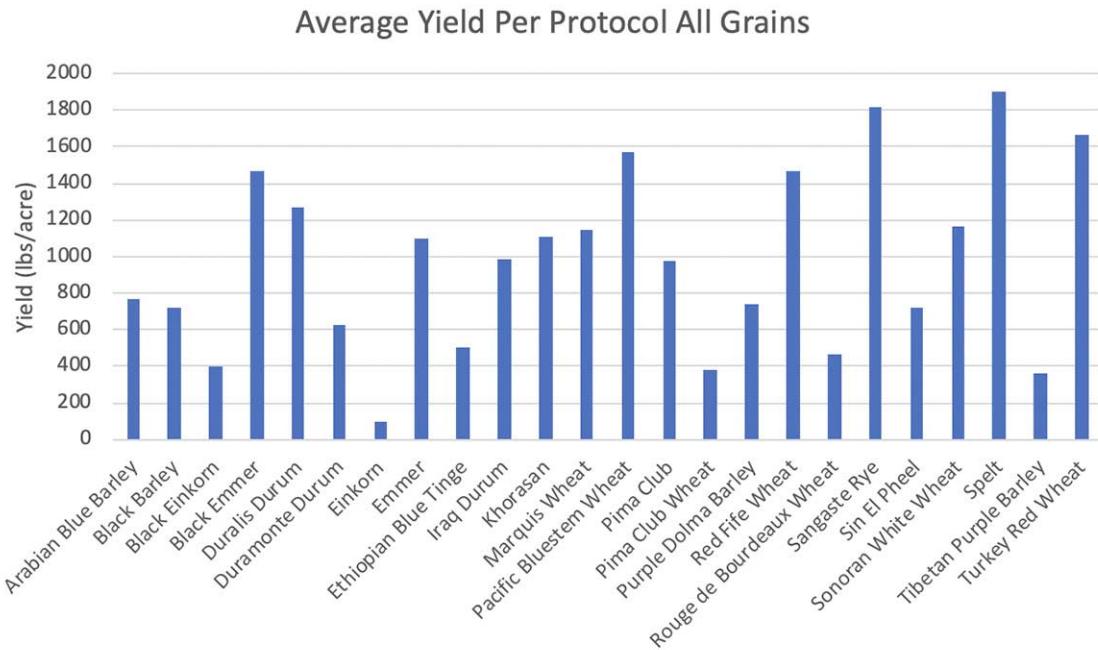


Figure 1. Average Yield “Per Protocol” includes plots where yield was 0 lbs/acre (due to plot failures from weed competition, lodging, and disease/mildew concerns).

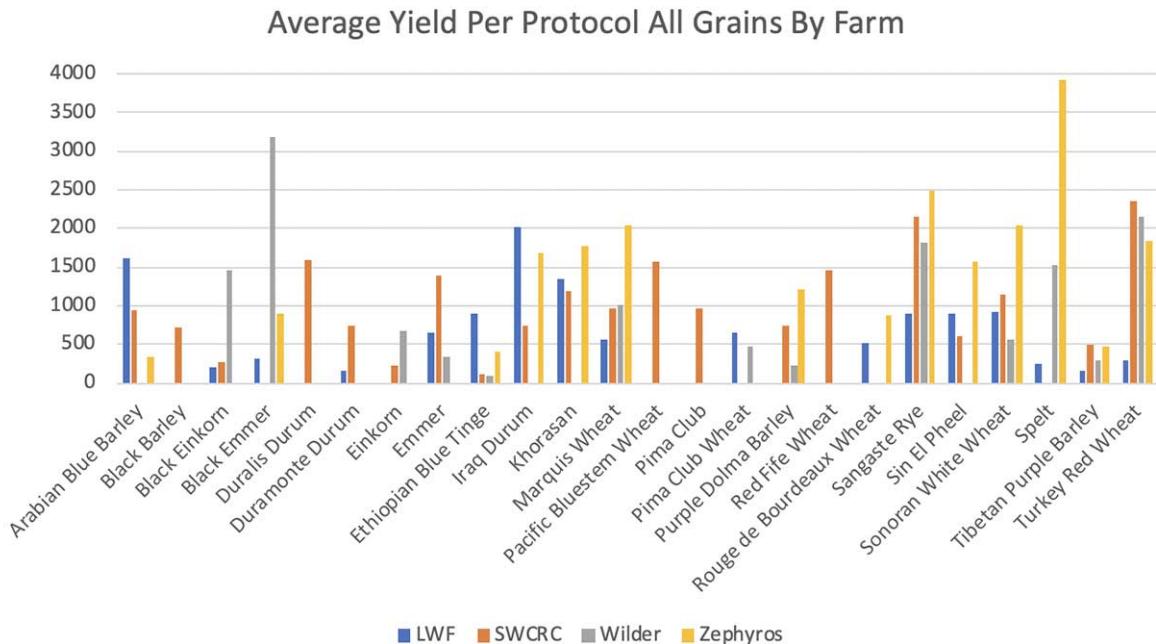


Figure 2. While there was no significant difference in yields when comparing varieties we include these graphs to show the variation in production between varieties and location. A difference we saw was that Zephyros Farm had statistically higher yields than all other grower participants ($p=0.007$). More supporting data is needed to further understand why. Factors such as irrigation calculations, soil samples, crop rotations and other on-farm practices, and climate data could contribute to these differences.

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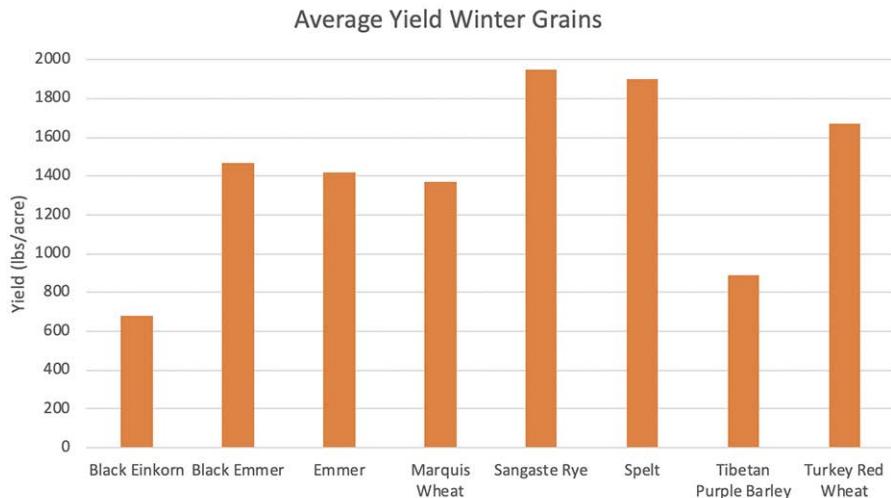


Figure 3. Average Yield Winter Gain Yields.

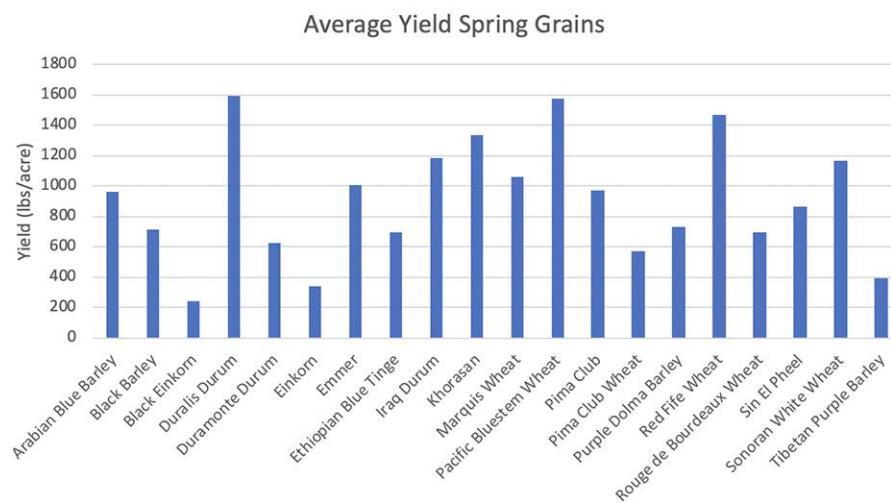


Figure 4. Average Yield Spring Grains. Yields varied between varieties and based on planting time. Soil moisture can be a concern during drought which may have influenced yields in 2021. Highest yielding varieties from the "Top 20" are Sangaste Rye, Spelt, and Turkey Red Winter Wheat. (Duralis Durum and Pacific Bluestem were additional varieties trialed at SWCRC.)

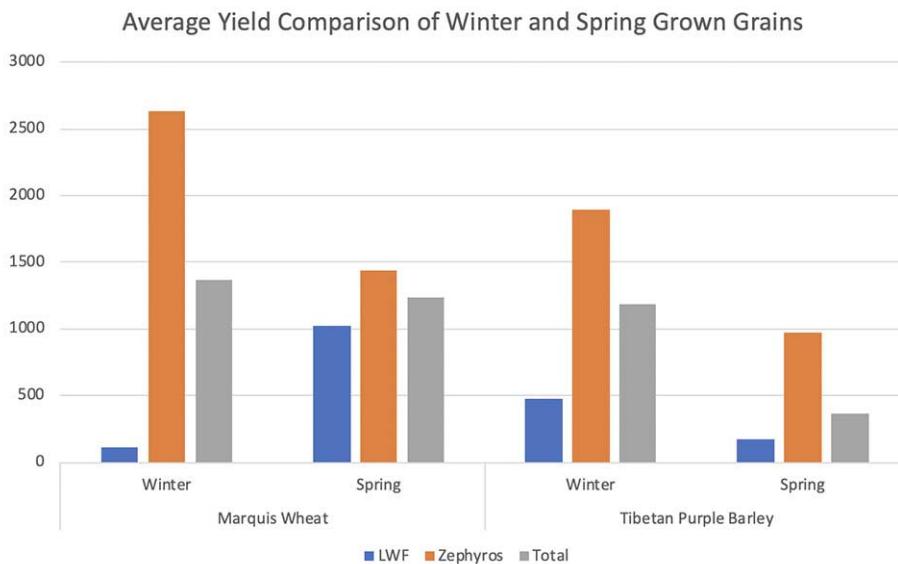


Figure 5. Laughing Wolf Farm and Zephyros show the same trend for Tibetan Purple with a higher yield when grown in winter, and an opposite trend for Marquis with a higher yield in spring for Laughing Wolf Farm and higher yield in winter for Zephyros. *Need more data to understand if these observations are causal.

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Through casual survey with professional bakers who were milling their grains, the price point for local grains was \$2 per pound for clean whole grains.

Field Data Analysis

The data in this report should be evaluated together in a holistic approach. While the above chart does include yields in the “Top 5,” it also considers vigor, weed competition, and winter survivability all of which are key considerations in farming and all the more critical with changing climates, increasing pest and weed pressures, erratic temperatures and dramatic temperature swings, though other considerations are missing. Further research is needed on irrigation times and measurements, soil health and nutrient availability, and overall farm practices to further assess how these components factor into the overall results. With just one year of trials, even with four participating sites, this data is not conclusive, rather it is a snapshot of the 2021 growing season. Also, some data was not reported by each participating farm. Nonetheless, this report offers valuable

information for farmers when embarking on growing heritage grains with organic practices. Soil conditions and water regimes were possible factors in yields, however irrigation measurements and soil samples were not taken at all sites to allow for comparisons. This would be helpful for subsequent research of these grains. Stalk nitrogen samples were conducted to assess how grains utilize nitrogen but did not show significant differences.

Yields

Yield data is only one of many valuable data points for growing heritage grains, however it is the top data set requested by farmers. In this project, yields vary considerably between varieties and between sites. Black Emmer, for instance, was a particularly inconsistent variety. Planted in the fall in the same size plots (4 ft. x 33 ft.) at all three farm locations, it yielded best in Idaho at 4,240 grams while at Zephyros Farm in Paonia, CO it yielded 1,212 grams, and at Laughing Wolf Farm in Southwest Colorado it yielded only 410 grams.

Research Trials at Southwestern Colorado Research Center Yellow Jacket, CO

The Southwestern Colorado Research Center in Yellow Jacket trialed heritage grains for this study. Grains were planted in Fall 2020 and Spring 2021.

Fall 2020

The fall variety trial was planted September 29, 2020, with a 6-row plot planter in randomized complete block design with 6 ft by 30 ft individual plots in a field that is certified organic. For varieties with at least 1 lb. of seed, at least three replications were planted. Varieties such as Black Emmer, Marquis and Spelt were in short supply so only one replication

Table 2. Average yields of fall planted grains at Southwestern Colorado Research Center. While there were differences in production rates of varieties they were not statistically significant.

Variety	Avg. lb/ac	Notes
Emmer	1299	Negatively impacted by early fall frost but rebounded well in spring
Sangaste Rye	1936	
Tibetan Purple Barley	521	Testing winter facultative abilities, poor winter survival
Turkey Red	2111	
Marquis	0	Squirrel damage
Black Einkorn	0	Squirrel damage
Spelt	0	Squirrel damage

Chapter 5: Research and Results

was planted. Because the field was certified organic, weeds were managed by hand hoeing. Plots were harvested with a Hege plot combine on July 28, 2021.

Fall varieties planted:

Emmer
Sangaste
Tibetan purple barley
Turkey Red
Marquis
Black Einkorn
Spelt

Spring 2021

Both the spring variety trial and spring seeding rate trial were planted on April 20, 2021, with a 6-row plot planter in a randomized complete block design. The variety trial plots were 6 ft by 30 ft and the spring seeding rate trial plots were 6 ft by 15 ft. These plantings were to the east of the fall planted grains in a field that is certified organic. Weeds were managed with hand hoeing and both trials were harvested on August 12, 2021, using a Hege plot combine.

Spring varieties planted:

Arabian Blue
Black Barley
Black Einkorn
Einkorn
Emmer
Ethiopian Blue-Tinged Emmer
Iraq Durum
Khorasan
Marquis
Pacific Bluestem
Pima Club
Purple Dolma Barley
Red Fife
Sin El Pheel
Sonoran White
Spring Durum 'Duralis'
Spring Durum 'Duramonte'
Tibetan Purple Barley

Table 3. Average production of spring planted variety trial plots at Southwestern Colorado Research Center. No significant differences between the production of the spring planted varieties was found in this growing year. As this was the first year of trials we look forward to learning more as these varieties are tested in the Southwestern region. To illustrate production differences the average production is included in the table below.

Variety	Avg. lb/ac
Arabian Blue	839
Black Barley	1228
Black Einkorn	227
Einkorn	209
Emmer	1263
Ethiopian Blue-Tinged Emmer	109
Iraq Durum	628
Khorasan	1012
Marquis	838
Pacific Bluestem	1379
Pima Club	852
Purple Dolma Barley	620
Red Fife	1265
Sin El Pheel	535
Sonoran White	746
Spring durum 'Duralis'	1381
Spring durum 'Duramonte'	637
Tibetan Purple Barley	359

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Spring Seeding Rate Trial

We evaluated the differences between seeding rates in production of heritage grains. We selected four varieties (Durum, Emmer, Marquis, and Sonora) and three seeding rates (10, 40, and 80 lb/ac). This trial was planted on April 20, 2021, with a 6-row plot planter in a randomized complete block design. The seeding rate trial plots were 6 ft by 15 ft. The trial was harvested on August 12, 2021, using a Hege plot combine.

There is a slight indication that a lower seeding rate increased the production rate, but the result is not statistically significant.

While these results suggest a lower seeding rate may result in higher production, other considerations, which are not reflected in this data such as weed competition, should also be considered. We recommend that this trial could be continued for both spring and winter planted varieties of heritage grains to develop variety and seeding rate recommendations.

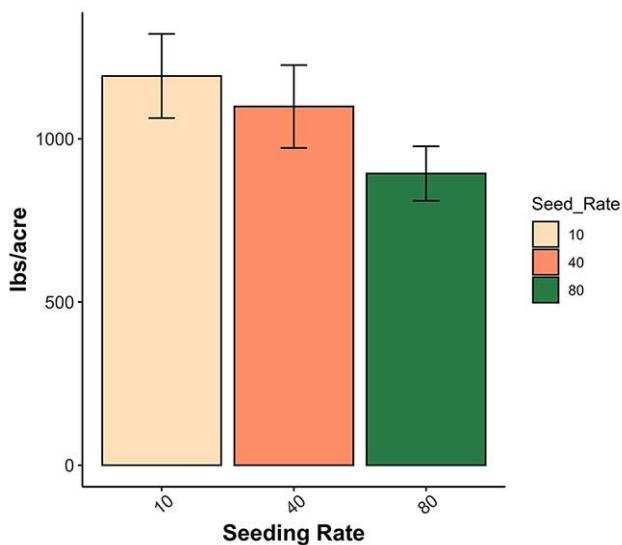


Figure 6. Production of heritage grains at three seeding rates, for four varieties.

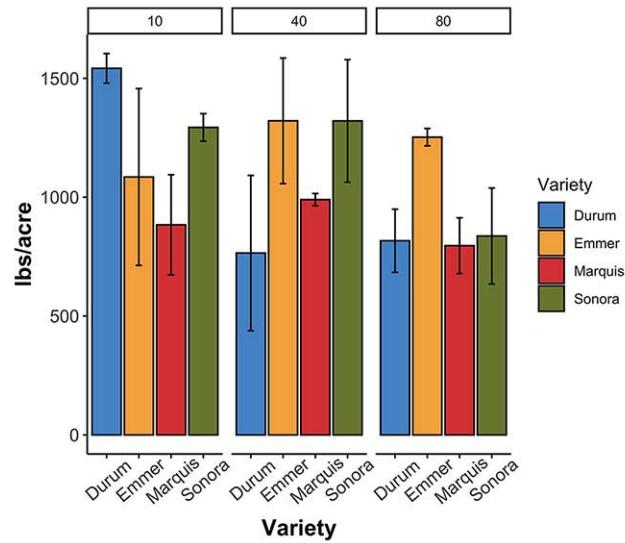


Figure 7. Production by Variety and Seeding Rate.

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Weed Competition

2021 was considered by many farmers and growers as one of the worst years for weeds in their experiences and memories, which was attributed to high early season temperatures followed by heavy mid-summer rains. As such, weed suppression was a key data set in the field research, and is becoming an ever-more valuable trait. Overall, varieties planted in the fall had a “head start” in the spring to outpace the weeds, and spring varieties with the most vigor and height also performed better than shorter and less vigorous varieties. However, another key observation by trialists and research farmers alike was that grains were not growing as tall this year overall. Allelopathy warrants more attention, and may have lent to the greater performance of the Sangaste Rye. Weeds outpaced many of the grain varieties in the research trials, particularly those spring planted that were slow to germinate like the Einkorn and Emmers, and the shorter varieties of barleys, to the degree that the grains couldn’t be harvested. Further, we are hearing from more farmers a greater interest in winter grains, specifically because of their greater chance at outcompeting weeds, thus the data on facultative and winter tolerant varieties.

Grains that did not sustain the weed impacts included Einkorn, which was very slow to germinate and grow, enabling fast-growing spring weeds to outpace the plants and in some cases overtake the plots entirely, and Tibetan Purple Barley that grew shorter with heavy heads. Weeds outgrew this variety, particularly spring planted, and pulled the heavy heads down, decreasing optimal performance for harvest, which would be especially challenging for mechanical harvest.

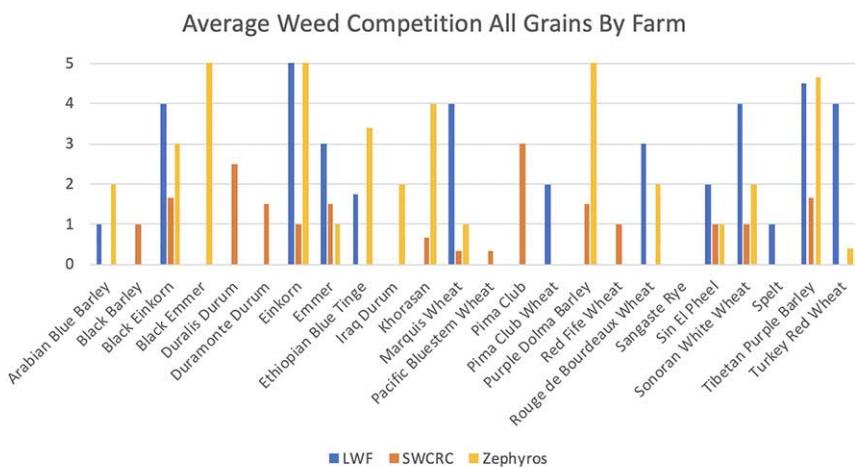


Figure 8. Winter-grown Einkorn and Tibetan Purple Barley had the highest weed competition. The higher the weed competition score, the worse the weeds. 5=crop failure from weeds. Sangaste Rye had no weed competition at all farms.

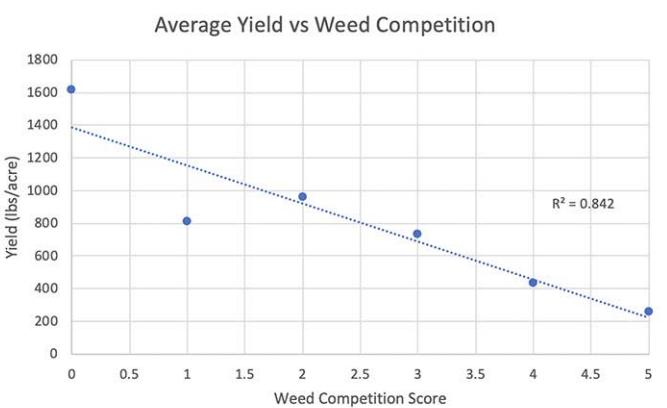


Figure 9. As could be expected we observed that average yield strongly correlated with weed competition; 5=crop failure from weeds.

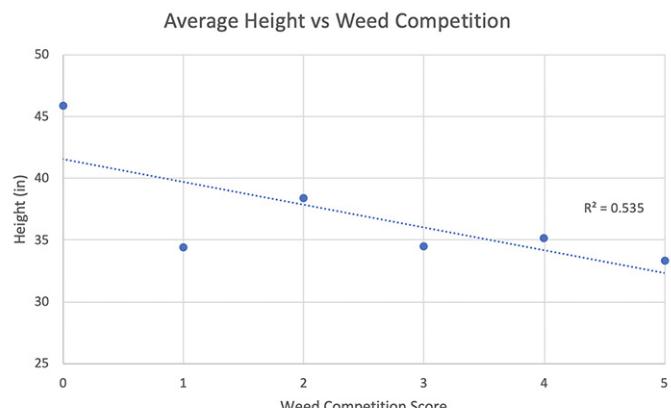


Figure 10. There was a moderate correlation between height and weed competition; tallest grains have no weed competition (further data needed to assess causation).

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Height and Lodging

Height is a key consideration for mechanical cultivation, harvest, and potential lodging, though was not necessarily a factor in lodging during this project.

Height was not the primary factor in lodging at Zephyros where the tallest grain, Sangaste Rye, remained upright after a storm devastated the field on June 25th, within weeks of harvest. Many of the grains lodged including top performers at other sites.

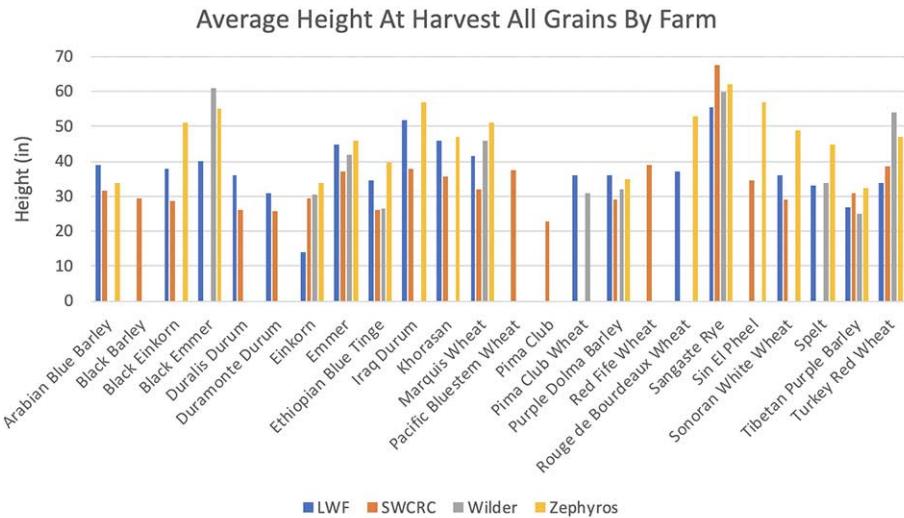


Figure 11. Height between farms is statistically different ($p=0.0015$). Zephyros statistically taller than LWF ($p=0.004$) and SWCRC ($p=0.0001$). Need more data to understand including irrigation times and amounts, soil health and composition, crop rotations and farm practices, etc.

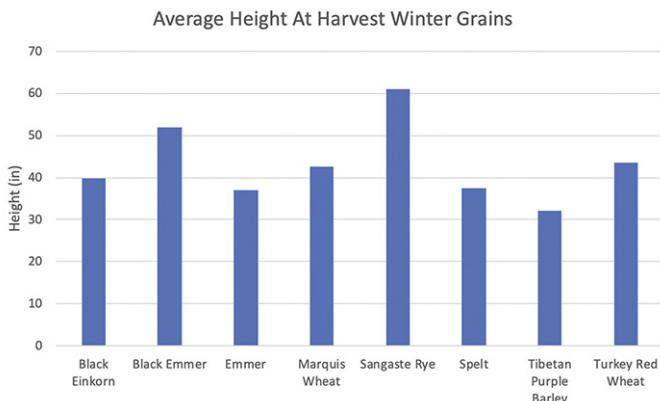


Figure 12. Average Height at Harvest for fall planted grains. The tallest fall planted variety is Sangaste Rye which on average is over 60 inches tall, with a max height reported of 70 inches.

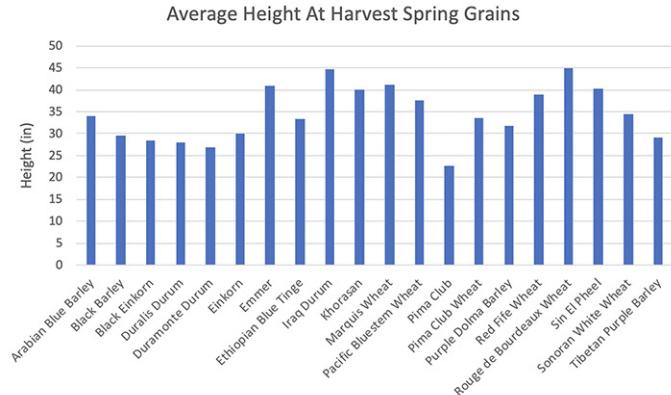


Figure 13. Average height at harvest for spring planted grains. Of note is that Sangaste Rye was the tallest variety at all farms and experienced no lodging issues.

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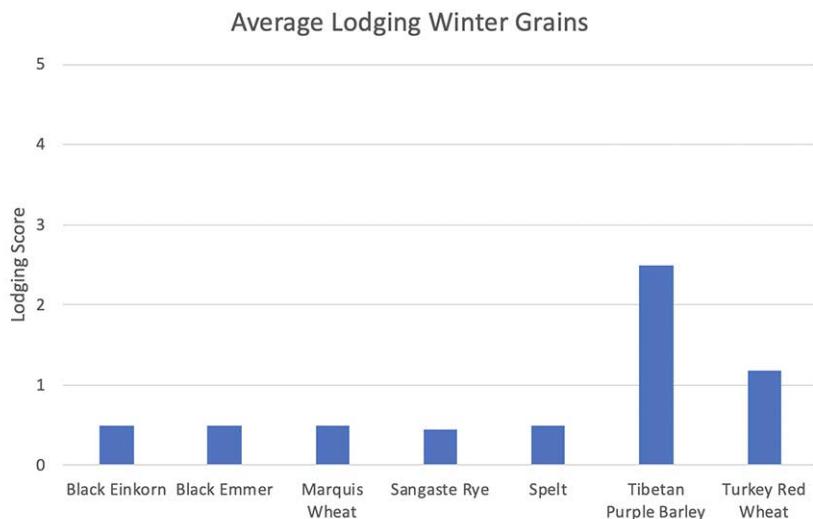


Figure 14. Average lodging observed in fall planted grains. Winter grains appear to have less lodging than spring grains.

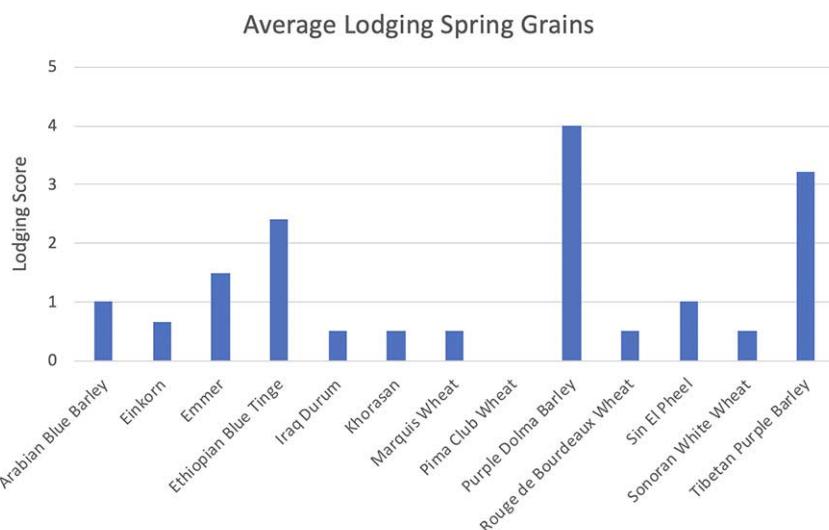


Figure 15. Average lodging observed in spring planted grains.

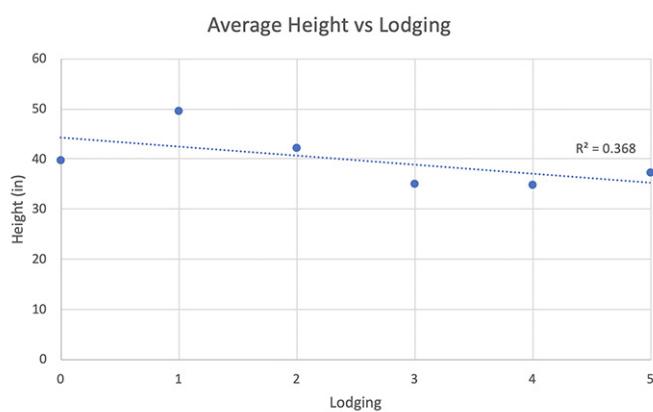


Figure 16. Average yield and average height are weakly correlated with lodging.

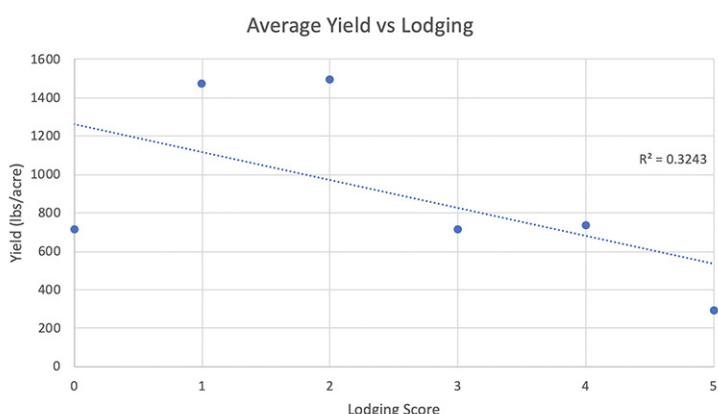


Figure 17. Average yield as it relates to observed lodging.

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Pest Pressures

Pest pressures of greatest interest in both the grassroots and research trials are from birds, grasshoppers, squirrels and rabbits. Pest pressures were minimal at the Zephyros Farm in Paonia, Colorado and at King's Crown Farm in Idaho, however grasshoppers have been an increasingly destructive factor at Laughing Wolf Farm in Mancos, Colorado to the point of crop failures. Farmers in that area are moving or changing crop foci because of the grasshopper devastation to crops. Southwest Colorado Research Center had impacts from squirrels, however that has not been tracked in this data. No correlation between height and insect/bird damage was evident in the data. The average yield weakly correlated with insect/bird damage. Further studies are needed on pest impacts re: awned vs. awnless varieties.

Disease

With the drier climate and primarily ground level irrigation practices with the grains, disease pressures in Colorado have thus far been non-existent. In Idaho, overhead watering was employed and the durum varieties including Iraq Durum, Sin El Pheel, Khorasan, and Ethiopian Blue-Tinged¹ exhibited signs of mold and shriveled grains. These varieties were not harvested at the Idaho site.

¹At the time of the final writing of this report, we have been alerted that Ethiopian Blue-Tinged is not technically an emmer, rather the taxonomy suggests it is tetraploid and free threshing, hence a durum (*Triticum turgidum* ssp. *durum*). We are in the process of updating our data and information accordingly.

Average Yield vs Insect/Bird Damage

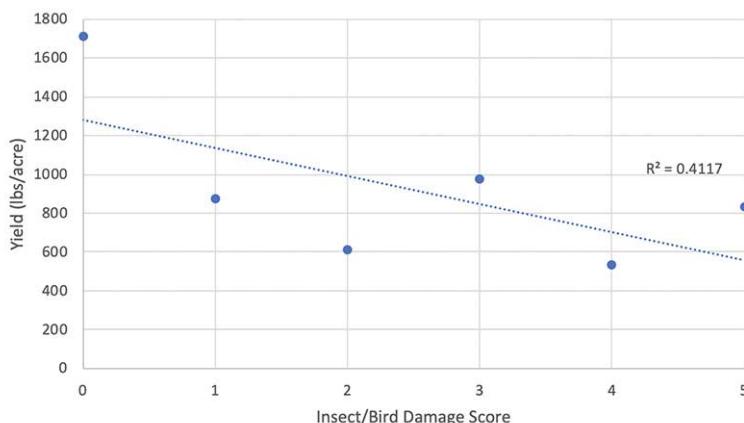


Figure 18. Average yield as it relates to insect and bird damage.

Average Insect/Bird Damage All Grains By Farm

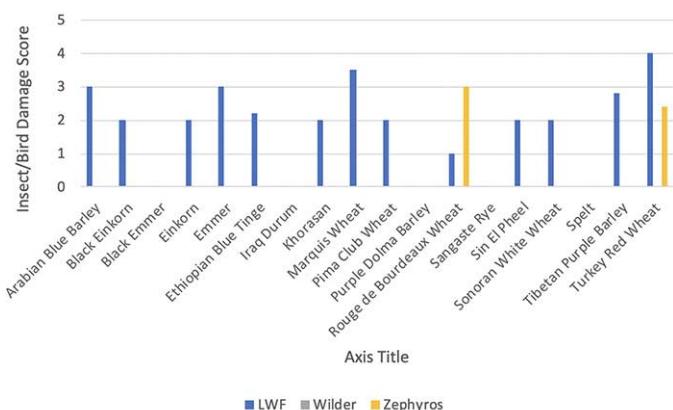


Figure 19. Insect and bird damage score (0 none, 5 severe) by variety recorded at farms. Marquis and Turkey Red winter grains had highest average insect/bird damage; Turkey Red has awns and Marquis is predominantly awnless. Both are hard red wheats.

Chapter 5: Research and Results

Climate Conditions

More data is warranted on climate conditions including temperature ranges and precipitation (both rainfall and snowpack). For fall planted grains that have the recommended plant growth of 3-5 inches prior to dormancy, cold temperatures can induce “winter kill,” particularly if the plants are exposed rather than under a layer of snow that provides insulation and protection. Temperature data during flowering time (May through July, depending on the variety) is valuable for assessing if pollination is compromised in higher or lower temperatures. “Blank heads” are grain heads that do not produce grain, which can be a result of freeze damage during a very specific time of grain formation. More studies on climate and temperature impacts are warranted. Following is a chart of the nearest weather station data for each farm, however the weather centers are not located in the specified towns so data is inconclusive and portrays a regional average, at best. The Mountain West is notorious for its microclimates and microstorm events, so this chart should only be used as a general snapshot of each bioregion. Data was collected from NOAA and Weatherspark.

Table 4. Observed temperatures near trial locations.

Location	Month	Temperatures (F)			Precip. (IN)
		High	Low	Average	
Mancos, CO	January, 2021	50	24	37.03	.70
Paonia, CO	January, 2021	54	23	37.84	.26
Glenn's Ferry, ID	January, 2021	51	31	39.94	.48
Mancos, CO	April, 2021	76	47	63.5	.13
Paonia, CO	April, 2021	79	49	64.67	.13
Glenn's Ferry, ID	April, 2021	86	43	60.57	.33
Mancos, CO	May, 2021	80	61	71.71	1.25
Paonia, CO	May, 2021	83	51	73.13	.38
Glenn's Ferry, ID	May, 2021	85	52	68.55	.37
Mancos, CO	June, 2021	97	73	85.43	.47
Paonia, CO	June, 2021	99	75	88.13	.82
Glenn's Ferry, ID	June, 2021	99	58	87.17	.02
Mancos, CO	July, 2021	98	75	86.65	2.64
Paonia, CO	July, 2021	100	76	90.74	1.04
Glenn's Ferry, ID	July, 2021	100	85	92.9	.04

Challenges

Data is inconclusive. The farmers involved in the project were also market farmers, or had multiple job foci, with little time available for data tracking and cultivating the grains. The project was designed to be integrated into polycropping market farming practices, and the participating farmers were encouraged to grow and cultivate the grains as they would in their usual systems. One farmer shared that it was hard to prioritize harvesting the grain when they needed to harvest the tomatoes at that same time, which are one of their primary cash crops. Participating farmers indicated that the trial plots were neglected. Weed competition and impacts were significant, and some varieties were completely overtaken by the weeds, as illustrated in the data analysis. The lodging at Zephyros Farm in Paonia, Colorado was a significant issue that was devastating to the trials and the morale. While weeds and lodging were challenging, this was helpful information as the varieties that handled the impacts best are likely the better candidates for commercial organic growing.

Chapter 5: Research and Results

Varying results:

1. Turkey Red Winter Wheat was a top performer in Idaho and also performed well at Zephyros Farm, though a poor performer in Southwest Colorado with birds and grasshoppers impacting the crop early.
2. Both Einkorn varieties performed well in Idaho despite late germination and maturation, though did not perform well in Colorado because of weed and pest competition with the later growth.

While Einkorn has increasing market popularity, the yields are lower and the weed competition is significant which impacts the organic marketability unless mechanical cultivation practices are employed. Spelt was the most productive of the ancient hulled varieties, though requires dehulling equipment, as does the Black Emmer that also produced and performed well.

Heritage Grain Enterprise Budget

While passion can drive enthusiasm around growing heritage grains, the ability to be profitable in a farming operation can help to ensure the longevity of an enterprise. We set out to create materials that will help producers evaluate the profitability of an operation. To accomplish this we surveyed farmers and created enterprise budgets to help heritage grain growers evaluate their profitability. Simply said, an enterprise budget is the listing of all income and expenses associated with growing one type of crop. We interviewed farmers to gather a range of costs and prices associated with growing heritage grains. When exact numbers were not available, we asked for estimates based on their experience. The information gathered is a starting point and further investigation is needed to help determine the exact profitability of growing heritage grains. Important factors that we observed that determine the profitability or lack of in an operation was the ability to identify a stable and well-priced market, the ability to process grains (cleaning, dehulling) at a low cost and having superior knowledge of growing practices that result in higher than average yields. A factor missing from these calculations is the value of farmer labor. The true cost of labor is not included in this report as many farmers do not consider their own labor an expense, nor do they pay themselves wages. We have included examples of breakeven analysis and resources for establishing an enterprise budget for a farm and resources to assist in calculating an enterprise budget for a heritage grain operation.

Breakeven analysis

The breakeven analysis below shows the per acre returns over total direct costs (\$/ACRE) for an operation. This analysis shows that with differences (+/-) in prices and differences in yields (+/-) how the breakeven price shifts. We include these charts that result from different enterprise budget calculations to illustrate the influence of costs, product price and yields.

Enterprise Budget

We surveyed farmers growing heritage grains and recorded their estimates of receipts and costs related to the production of heritage grains. We did not have enough data to list individual types of grains so we have combined numbers as general ranges for heritage grains. Ranges of data are included where enough data existed. Not all producers

A Reflection on the Project from Zephyros Farm

In summary, best candidates for weed competition were related to taller heights. Highest yields were related to lower weed competition and were winter-planted varieties:

1. Sangaste Rye: Quick growth with top height range of 52–69 inches, along with potential allelopathic traits make this variety a top performer. Fairly easy to clean; favored by sourdough bakers who are looking for local rye sources.
2. Black Emmer: Also tall and vigorous with a height range of 40–44 inches in Colorado to 61 inches in Idaho, with thick stalks and abundant tillers that help shade out weeds. This is a hulled variety that requires dehulling equipment for processing, which is costly.
3. Spelt: Favored for lower gluten content and flavor, and with high yields, spelt is popular in the field and in the kitchen, though also requires dehulling equipment for processing.
4. Turkey Red: This hard red winter wheat adapts well in situ and has a long-standing reputation for flavor as well as field and kitchen performance.

This we surveyed farmers and created enterprise budgets to help heritage grain growers evaluate their profitability. Simply said, an enterprise budget is the listing of all income and expenses associated with growing one type of crop. We interviewed farmers to gather a range of costs and prices associated with growing heritage grains. When exact numbers were not available, we asked for estimates based on their experience. The information gathered is a starting point and further investigation is needed to help determine the exact profitability of growing heritage grains. Important factors that we observed that determine the profitability or lack of in an operation was the ability to identify a stable and well-priced market, the ability to process grains (cleaning, dehulling) at a low cost and having superior knowledge of growing practices that result in higher than average yields. A factor missing from these calculations is the value of farmer labor. The true cost of labor is not included in this report as many farmers do not consider their own labor an expense, nor do they pay themselves wages. We have included examples of breakeven analysis and resources for establishing an enterprise budget for a farm and resources to assist in calculating an enterprise budget for a heritage grain operation.

Chapter 5: Research and Results

have the same types of receipts or expenses and our survey was limited in size, so use this as an illustration. Do not fully depend on this information as it may change depending on the specifics of an operation.

To prepare an enterprise budget use the blank form found in the appendix. Easy to use enterprise budget calculators from Colorado State University can be found here and can be adjusted for heritage grains:

<https://abm.extension.colostate.edu/enterprise-budgets>. See Appendix for Enterprise budget form.

Table 5. Breakeven analysis — per acre returns over total direct costs (\$/ACRE) for an operation with higher costs, lower product price and lower production. This operation is not profitable.

		Alternative prices (\$/bu)				
		-25%	-10%	10%	25%	
Alternative Yields		\$7.50	\$9.00	\$10.00	\$11.00	\$12.50
-25%	45.0	(\$625.75)	(\$558.25)	(\$513.25)	(\$468.25)	(\$400.75)
-10%	54.0	(\$558.25)	(\$477.25)	(\$423.25)	(\$369.25)	(\$288.25)
Bu/acre	60.0	(\$513.25)	(\$423.25)	(\$363.25)	(\$303.25)	(\$213.25)
10%	66.0	(\$468.25)	(\$369.25)	(\$303.25)	(\$237.25)	(\$138.25)
25%	75.0	(\$400.75)	(\$288.25)	(\$213.25)	(\$138.25)	(\$25.75)

Table 6. Breakeven analysis — per acre returns over total direct costs (\$/ACRE) for an operation with lower costs, higher product price and higher production. This operation is profitable.

		Alternative prices (\$/bu)				
		-25%	-10%	10%	25%	
Alternative Yields		\$22.50	\$27.00	\$30.00	\$33.00	\$37.50
-25%	92.3	\$1,299.42	\$1,714.55	\$1,991.30	\$2,268.05	\$2,683.17
-10%	110.7	\$1,714.55	\$2,212.70	\$2,544.80	\$2,876.90	\$3,375.05
Bu/acre	123.0	\$1,991.30	\$2,544.80	\$2,913.80	\$3,282.80	\$3,836.30
10%	135.3	\$2,268.05	\$2,876.90	\$3,282.80	\$3,688.70	\$4,297.55
25%	153.8	\$2,683.17	\$3,375.05	\$3,836.30	\$4,297.55	\$4,989.42

Chapter 5: Research and Results

Table 7. Ranges of estimated production costs and returns based on discussions with heritage grain farmers in Summer of 2022.

REPORTED GROSS RECEIPTS FROM PRODUCTION

Gross Receipts	Range	UNIT
Heritage grains (spelt, emmer, etc.)	\$.3-8	\$/lb

DIRECT COSTS

Operating Pre-harvest

Seed	0-100	\$/acre
Fertilizer	0-125	\$/acre
Herbicide (Applied)	0-30	\$/acre
Repair & Maintenance	68-275	\$/acre
Irrigation	63-110	\$/acre
Labor (custom work ex: harvesting)	30-35	\$/acre

Harvest Costs

Fuel	5-25	\$/acre
Hauling, cleaning, dehulling, storage	136-276	\$/acre

Property and Ownership Costs

General Farm Overhead	52-203	\$/acre
Real Estate Taxes	30-36	\$/acre
Factor Payments for Land	192-240	\$/acre



Chapter 6: Conclusions

Production

We didn't find significant differences between grains related to production rates. Continued trials are needed to develop stronger recommendations, especially for specific climates. We hope the information presented is a starting point for continued research on heritage grains.

Seeding rates

The small trials and preliminary work reported in this guide related to seeding rates shows there may be some value to planting at a lower rate when focused on production. More research is needed for further recommendations as producers face individualized challenges such as unique climate variability, weed pressure, and changes in irrigation water availability.

Weeds

As heritage grains are often grown with organic growing methods, weed control can be an issue that impacts production. In observations, grains that were planted at higher rates competed better against weeds. Grains like einkorn can appear as a thinner stand when compared with other more robustly growing grains such as Sangaste Rye. And so, they may experience more weed competition compared with other grains. As could be expected, these trials showed that as rates of weed competition increased, yield decreased.

Lodging

Heritage and ancient grains can be taller than modern varieties of grains and warnings about lodging are widespread. Judicious irrigation and fertilization is often recommended to minimize lodging. Lodging was not a major issue experienced during this

project but we did observe more lodging in spring grains compared to winter grains.

Plant height

Plant height varied greatly with Sangaste Rye being the tallest variety trialed. Harvesting equipment used by trialists was able to adjust easily to different heights for harvest.

Pest pressures

The issue of pests came as a surprise when squirrels so severely destroyed plots in Yellow Jacket. The Mancos Valley in Colorado is having continued issues with grasshoppers and that was a major pest for the farm in Mancos. Theories related to pests avoiding awned vs awnless varieties need to be explored further to see if there is a relation.

Profitability

Heritage grain producers have a variety of production methods as well as varied costs and incomes. Important factors that we observed that determined the profitability or lack of in an operation was the ability to identify a stable and well priced market, the ability to process grains (cleaning, dehulling) at a low cost and to have superior knowledge of growing practices that result in higher than average production rates.

Research Summary

The research and trials presented in this document shows the need for continued work related to heritage grains. Our hope is for this information to be used as baseline information so that future research can build on the information reported in this document. There are grains that we find intriguing for their potential but we cannot make definitive conclusions from this short period of research.

Appendices

Grain Manual

<https://www.facebook.com/groups/heritage.grain.trials/files/files>

Grain Trials Data Sheet Template

<https://www.facebook.com/groups/heritage.grain.trials/files/files>

Trialists Data Sheets

Field Planting Log										Shante	Farm/Field	acres	Year
plant date	DS/TP	BED #	Crop	Variety	Seed/Plant Source	by hand or with Hoss/EW Seeder	planting depth	In-row Spacing/Seeder plate	seed amt/# of plants	# of rows	Bed length FT	Notes	
11/24	4		OATS Hullless Provençal	Pokeme Farms Botanical Gardens	Pokeme EW	"	"		4	12			
			OATS Tesuque	Amiguel Ballon	"	"	"		4	13			
			OATS Barn Owl Bakery	Lopez, Isla, WA	"	"			34	8+8 more feet into next bed!			
			OATS Hullless Provera	UCCS Colorado 17	"	"			3	8 only 3 East side rows			
5	Rye	yi Hache	RMSA	"	"	"	"		3	33			
6	Wheat	Termoki	Zephyros 17	"	"	"	"		4	15			
	Wheat	Red Fife	Couzillij	Prairie Heritage									
	Wheat	Tibetan	RMSA	"	"	"	"		4	12	salt spring		
	Wheat	Rusak	RMSA	"	"	"	"		4	12	Jacob Couzillij - Prairie Heritage Farm		
	Wheat	Ukrainka, Winter	Sheruk Seed	"	"	"	"		4	12			
	Wheat	Tiompheevii	Sheruk	by hand	"	"	"		4	6			
	Rye	Rebel	Monk Berger										
	Wheat	Alaskan, Winter	UCCS	with seeder	"	"	"		4	8			
7	Rye	Rebel	Monk Berger	"	"	"	"		3	20	Monument or Monk Berger		
	Rye	Sangaster	Jon Bird	"	"	"	"		3	20	Ridge Field, WA		
	Rye	Coché Valley	Joseph Loftus	"	"	"	"		3	16	(Joseph Loftus) suinert		
	Rye	Swiss Mtg.	Nanna Meyer	"	"	"	"		3	12	Co Springs UCCS		
8	Emmer	Winter Black	Sherck	Hand	3/4	3/4			4	8	Georgian Ukraine -		
	Emmer	Tapioszale	Sherck		3/4	5/4			4	8			
	Emmer	Black	Greg Schub		3/4	3/4			4	8	Silver City NM		
	Wheat	Rougeha	Baukem	Barton Mill	"	"			3	20	Bougede, Bourdeaux		
	Wheat	CHAC Evolution			"	"			3	30	cooker		
9	Einkorn	Peliti Grace	HS19		"	"			4	13	EMF Popcorn Plate - 2 passes (2x)		
	Einkorn	Black	HS19		"	"			3	13	EMF (seed hungry) 3 passes (3)		
	Wheat	Turkey Red	HS19		"	"			2	40	1 pass		

Data Sheet: Chris Hardy, Ashland, OR

Trialists Data Sheets continued

Rocky Mountain Seed Alliance GRAIN TRIALS ASSESSMENT SHEET SPRING 2021 GRAIN TRIALS (except one winter rye from 11/20)										
PARTICIPANT NAME and LOCATION:		ELIZABETH, COLORADO AT: 6750 feet elevation								
Trial Varieties (list across) (THINNED LATER)	WINTER RYE SANGUINE	SPRING RYE GRANITE	SPRING RYE KUCH FIELDS	OAT REDGER	OAT TERRA	OAT MONTGOMERY	BARLEY BULBARY	BARLEY PURPLE OVAL	BARLEY TIGER	WHEAT KAMUT
Amount of Seed Planted	10.8 - 13.0	100+	100+	100+	100+	100+	100+	100+	100+	100+
Date Planted	4/1/20	4/4/21	4/1/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21
Germination Date	3/15/21	4/25/21	4/25	4/25	4/26	5/11/21	4/22	4/22	5/10/21	4/22
Heading Date	6/8/21	6/14	N/A	6/15	6/24 (SLOW)	6/24	6/10	6/10	6/24	6/15
Date of flowering (approx.)	6/8 - 7/11	6/20	N/A	7/10	7/10	7/15	6/20	6/20	7/10	6/25
Harvest Date	7/20 - 8/15	8/15	N/A	8/14	8/14	8/15	8/15	8/15	8/15	8/14
Crop Traits choose and prioritize traits that interest you; scale of 1-5 with 1 being "low" and 5 being "high" is an easy and acceptable way to approach many of these. Think 5 star for the best rating, 1 star for low rating.										
Early emergence										
Germination rate %	25	80	90	95	45-50%	85	95	85	90	95
Plant vigor	3	5	N/A	5	4	5	5	5	5	5
Tillers per plant (numbers)	25-30	30-85		30-35	30-35	30+	35	35	25-30	25-30
Plant height (feet)	3	4		4	4	3	3	3	3	5
Color	4	5		5	5	5	5	5	5	5
Lodging (5=all upright, 3=50% at 45°, 1=100% are at 90°)	4	5		5	4	5	2	1	1	3 ✓ BENT BACK TO 4-5
Rust, disease resistance	5	5		5	5	5	5	5	5	5
Pest resistance	5	5		4	4	5	5	5	5	5
Drought and heat resistance	5	5		5	5	5	5	5	5	5
Winter hardiness (if applicable)	1 (PLANTED 100%)									
Yield grams	100	780	N/A	600	(FROM 600g)	125	1100	1680	355	1900
1,000 kernel weight (g)	30g	30g	N/A	25g	20g	20g	30g	40g	40g	70g
Other: EVEN RIDDING (5= GOOD)	2	4	N/A	4	4	3	3	3	3	4
Other: SOURCE	RMSA MANCOS, CO	RMSA MOUNTAIN VIEW CA	RMSA BUHL, ID	RMSA BUHL, ID	RMSA MANCOS, CO	JOSEPH ADAMS MANCOS, CO	RMSA MANCOS, CO	RMSA MANCOS, CO	HIGH GENS MANCOS, CO	RMSA MANCOS, CO
Culinary Traits										
Flavor and aroma										
Gluten strength by chewing										
Loaf volume										
Texture, mouth-feel										
Color	90% germination									
GERMINATION TEST 10/2021	PLANTED IN A PREPARED BED	100%	N/A	100%	100%	100%	100%	100%	100%	100%
SPACING	TOO LATE, TOO DEEP	ALL GRAINS	WERE THINNED TO 6"	APART IN SPRING (MAY 2021)						
- ALL SPRING GRAINS WERE PLANTED IN 5'x8' BEDS ON AN OLD (FORMER) ALPACA RUN/ENCLOSURE										
- AFTER HARVEST THE UNTILLED BEDS WERE PLANTED WITH THE COVER CROPS OF BUCKWHEAT AND COWPEAS										
- THE AGGRESSIVE BUCKWHEAT SHAMED THE COWPEAS AND THE GRAINS REGREW OR RESEEDDED										
- Drip tape was used to irrigate the fields, supplemented with hand watering (H2O)										

Rocky Mountain Seed Alliance GRAIN TRIALS ASSESSMENT SHEET 7 KIRSI ARYAN - EDWARDSON ELIZABETH, COLORADO AT: 6750 feet elevation											
PARTICIPANT NAME and LOCATION:		ELIZABETH, COLORADO AT: 6750 feet elevation									
Trial Varieties (list across) (THINNED LATER)	WHEAT EMERICA 1249 DURUM	WHEAT BLACK TINKER	EINKORN	WHEAT MARQUIS	WHEAT SONORIAN WHITE	WHEAT RED FIFE	WHEAT MOUNTAIN PEAK GOLD AS COUPA- RISON				
Amount of Seed Planted	100+	100+	150+	100+	100+	100+	100+	100+	100+	100+	
Date Planted	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	4/4/21	
Germination Date	4/23	4/25	4/26/21	4/25	4/22	4/23	4/22	4/23	4/23	4/23	
Heading Date	6/27	6/20	7/9	6/20	6/20	6/12	6/20	6/14	6/20	6/20	
Date of flowering (approx.)	7/4	6/25	7/20	7/10	6/25	6/24	6/28	6/28	6/28	6/28	
Harvest Date	8/22	8/15	9/4	8/27-28	8/15	8/15	9/15	8/15	8/15	8/15	
Crop Traits choose and prioritize traits that interest you; scale of 1-5 with 1 being "low" and 5 being "high" is an easy and acceptable way to approach many of these. Think 5 star for the best rating, 1 star for low rating.											
Early emergence											
Germination rate percent	90%	70%	90%	90%	85%	95%	90%	95%	95%	95%	
Plant vigor	4	5	5	5	5	5	5	5	5	5	
Tillers per plant (numbers)	25-30	25-30	20-25	20-25	30-35	35-40	30-35	35-40	35-40	35-40	
Plant height (feet)	4	5	4	4	4	3	4	3	4	3	
Color	5	5	5	6	5	6	5	5	5	5	
Lodging (5=all upright, 3=50% at 45°, 1=100% are at 90°)	4	3	4	3	5	4	5	4	5	5	
Rust, disease resistance	5	5	5	5	5	5	5	5	5	5	
Pest resistance	4	5	3	4	5	5	5	5	5	5	
Drought and heat resistance	5	5	6	5	5	5	5	5	5	5	
Winter hardiness (if applicable)											
Yield grams	1320										
1,000 kernel weight	50g (1/2")	45g (1/2")	20g (1/2")	20g (1/2")	30g (1/2")	60g	40g	40g	40g	40g	
Other: EVEN RIDDING (5= GOOD)	4	4	3	3	4	4	4	4	4	4	
Other: SOURCE	RMSA MANCOS, CO	RMSA MOUNTAIN VIEW CA	RMSA BUHL, ID	ADAPTIVE SEEDS	RMSA MANCOS, CO	ALBERT MANCOS, CO	ANN P. COLORADO	VIT. OFFICE ORG. NON-GMO			
Culinary Traits											
Flavor and aroma											
Gluten strength by chewing											
Loaf volume											
Texture, mouth-feel											
Color	GERMINATION TEST 10/2021										
Other: SPACING	100%	100%	70%	100%	100%	100%	100%	100%	100%	100%	
ALL GRAINS WERE THINNED TO 6" APART IN SPRING (MAY 2021)											
BUNNIES LOVED BLACK TINKER, ESPECIALLY. GINKORN WAS ALSO EATEN A LITTLE. NO OTHER GRAINS WERE EATEN BY THE BUNNIES, SINCE THEY WERE FURTHER ALONG W/ GROWTH,											

Data Sheets: Kirsi Aryan-Edwardson, Elizabeth, CO

Trialists Data Sheets continued

2019 Fall Rio Grande Grain Trials

Location: La Villita Farms, Alcalde, NM

Report Date: 08.05.20

Grain	Source	Increase/Test	Plant Date	Lbs. Planted Yield		Germ Date	Ht 12/14	Harvest	Comment
				# seeds	in lbs*				
Kamut	Fall 2018 LLGT***	Increase	8-Oct	0.154		0.00	14-Oct	6.5"	TBD
Rebel Rye	Fall 2018 LLGT	Increase	8-Oct	0.14	15	107.14	21-Oct	4"	4-Jul-20
Emmer	Fall 2018 LLGT	Increase	8-Oct	0.38	6.00	15.73	21-Oct	4"	11-Jul
Swiss Mtn Rye	Fall 2018 LLGT	Increase	8-Oct	0.11	25	227.27	21-Oct	4.25"	4-Jul-20
Turkey Red Wheat	Fall 2018 LLGT	Increase	8-Oct	0.17	14.00	83.56	21-Oct	4.25"	11-Jul
Tibetan Purple Barley	Fall 2018 LLGT	Increase	8-Oct	0.40	17.23	43.53	21-Oct	6.5"	11-Jul
White Einkorn	Fall 2018 LLGT	Increase	8-Oct	0.12	9.25	79.16	21-Oct	2-3" to 5"	7/18 & 7/20
Spelt	Fall 2018 LLGT	Increase	10-Oct	0.16	19	118.75	21-Oct	3"	18-Jul
Sonoran White Wheat	Fall 2018 LLGT	Increase	10-Oct	0.18	14.75	81.94	21-Oct	5.25"	18-Jul
Uli Hache Rye	Fall 2018 LLGT	Increase	21-Oct	0.095	10	105.49		4.75"	4-Jul-20
Red Fife	Fall 2018 LLGT	Increase	21-Oct	0.154	7.250	46.98		4.5"	11-Jul
Marquis Wheat	Fall 2018 LLGT	Increase	21-Oct	0.115	4.750	41.43		3"	11-Jul
Rouge de Bordeaux	R. Roberts/MOFGA	Test	21-Oct	100		0.00	TBD	2"	4-Jul-20
Sirvinta	R. Roberts/MOFGA	Test	21-Oct	100		0.00	TBD	1"	4-Jul-20
Polvatka	R. Roberts/MOFGA	Test	21-Oct	100		0.00	TBD	2"	4-Jul-20
Black Emmer	R. Roberts/MOFGA	Test	21-Oct	48		0.00	TBD	2"	4-Jul-20
Jammu	Pie Ranch	Test	21-Oct	100		0.00	TBD	2"	4-Jul-20
Alba Barley	Ron Boyd	Test	21-Oct	100		0.00	TBD	1"	4-Jul-20
Abruzzi Rye	Ron Boyd	Test	21-Oct	100		0.00	TBD	3"	4-Jul-20

142.23

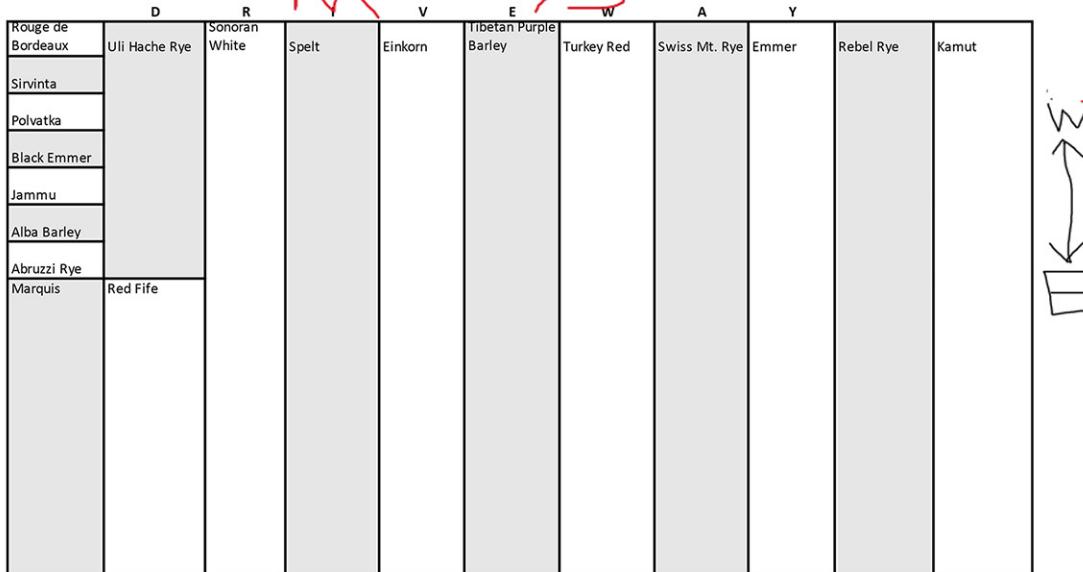
*Yield is net of estimated chaff weight; purple is double checked for planted weight; red is confirmed start wt but can't confirm post planting wt.

**Discrepancy on beginning wt for spelt -- 1.62 lb vs 1.44 lb

***LLGT is Los Luceros Grain Trials--seed from the prior year's planting at nearby Los Luceros Historic Farm and Ranch

2019 Fall Planting Schematic

Rio Grande Grain Team
Mer-Girl Gardens



Data Sheets: Rio Grande Grain, Alcalde, NM

Heritage Grain Growing Equipment as used by Ron Boyd and the Rio Grande Grain Team

- A. 1949 Pull-behind Case A6 Combine Flat-head 4 cylinder Wisconsin engine: Reaps and threshes the grain
- B. Late 40s/Early 50s Grain Drill: Not efficient for small-scale field seeding because it requires hundreds of pounds of seed in hopper to function properly
- C. Combine Harvester from Alibaba (China)

All photos by Ron Boyd



Heritage Grain Growing Equipment as used by Ron Boyd and the Rio Grande Grain Team continued

D. Pedal Thresher (foot driver): Cleans sheaves of grain. Made in Tennessee by Jim, Back to the Land

E. Antique Corn Sheller

F. DIY Leaf and Twig Chipper: Used to clean beans and wheat

G. Clipper Seed Cleaner

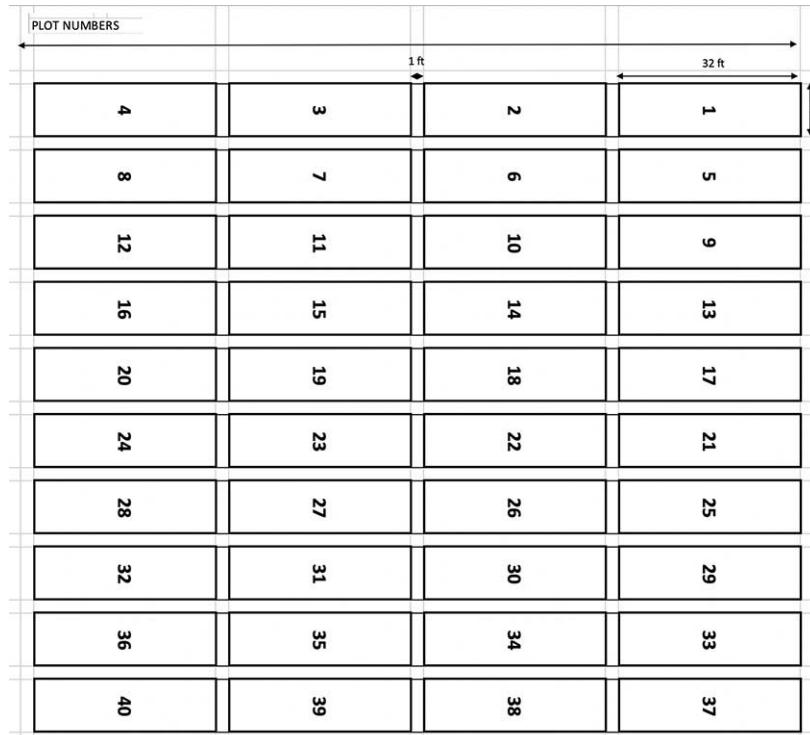
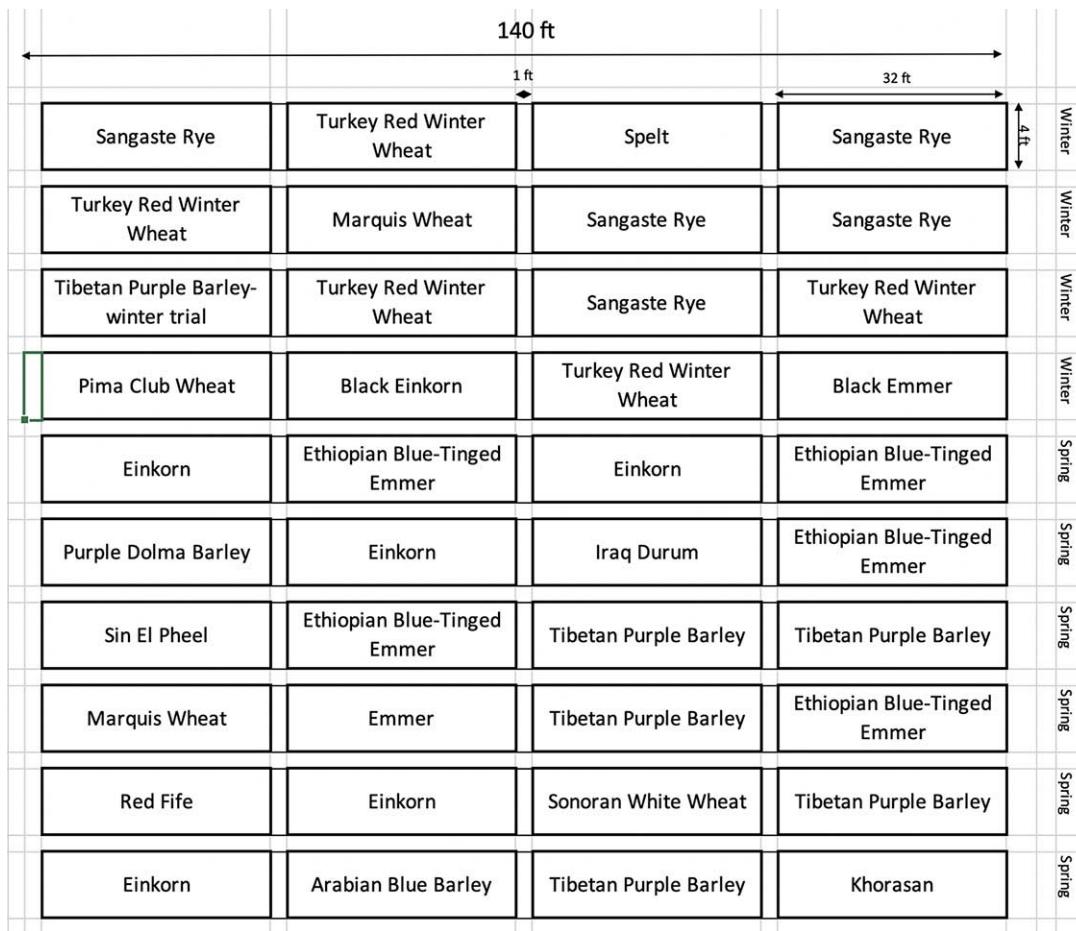
H. Grain Grader and Cleaning Machine

All photos by Ron Boyd



Research and Analysis: Plot design

Zephyros Farm



Research and Analysis: Plot design continued

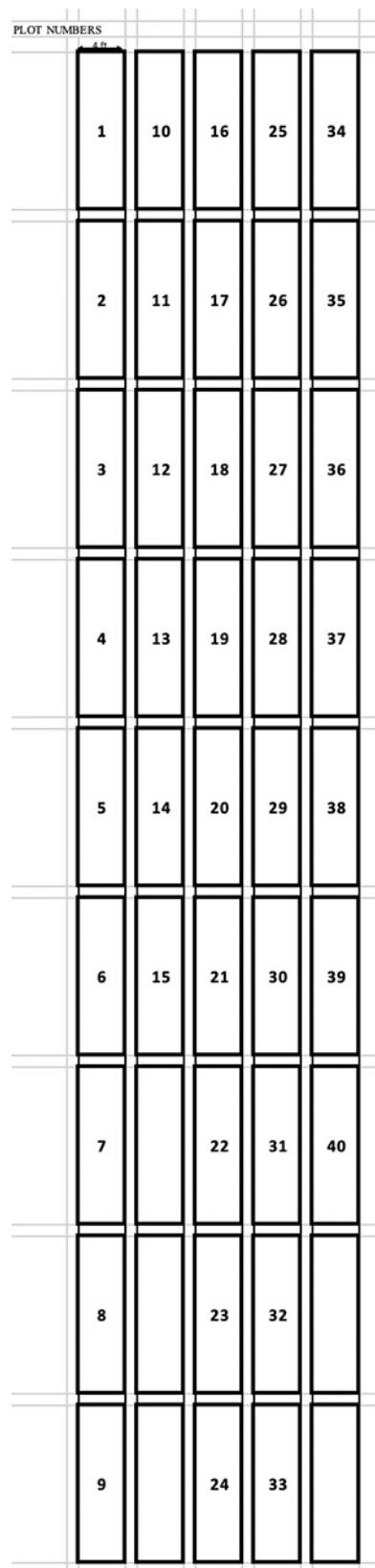
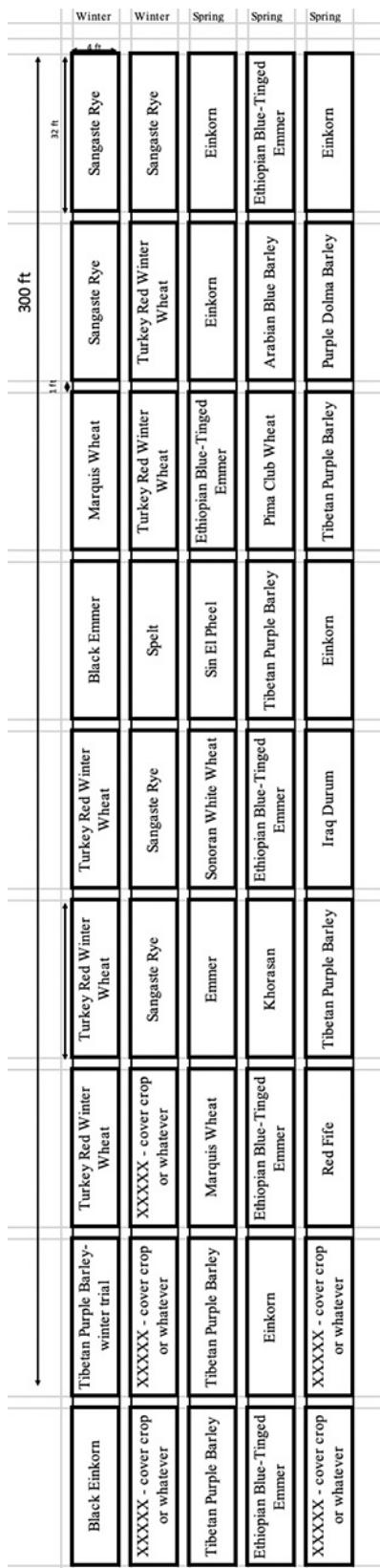
Laughing Wolf Farm

				99 ft	99 ft				
1 ft		1 ft		32 ft		4 ft			
Turkey Red Winter Wheat	Black Einkorn	Turkey Red Winter Wheat	Sangaste Rye					Winter	Winter
Turkey Red Winter Wheat	Tibetan Purple Barley-winter trial	Sangaste Rye	Turkey Red Winter Wheat					Winter	Winter
Marquis Wheat	Sangaste Rye	Sangaste Rye	Sangaste Rye					Winter	Winter
XXXXX - cover crop or whatever	Turkey Red Winter Wheat	Black Emmer	Spelt					Winter	Winter
Ethiopian Blue-Tinged Emmer	Sonoran White Wheat	Tibetan Purple Barley	Einkorn					Winter	Winter
Ethiopian Blue-Tinged Emmer	Tibetan Purple Barley	Khorasan	Tibetan Purple Barley					Spring	Spring
Einkorn	Einkorn	Purple Dolma Barley	Einkorn					Spring	Spring
Red Fife	Emmer	Marquis Wheat	Tibetan Purple Barley					Spring	Spring
Iraq Durum	Ethiopian Blue-Tinged Emmer	Einkorn	Tibetan Purple Barley					Spring	Spring
Pima Club Wheat	Arabian Blue Barley	Ethiopian Blue-Tinged Emmer	Ethiopian Blue-Tinged Emmer					Spring	Spring
XXXXX - cover crop or whatever	XXXXX - cover crop or whatever	XXXXX - cover crop or whatever	Sin El Pheel					Spring	Spring

PLOT NUMBERS		1 ft	1 ft	1 ft	32 ft	32 ft	4 ft
4		3		2		1	
8		7		6		5	
12		11		10		9	
		15		14		13	
19		18		17		16	
23		22		21		20	
27		26		25		24	
31		30		29		28	
35		34		33		32	
39		38		37		36	
						40	

Research and Analysis: Plot design continued

King's Crown Organic Farm



Enterprise Budget Form

Heritage Grain

Estimated Production Costs & Returns

GROSS RECEIPTS FROM PRODUCTION					
GROSS RECEIPTS	UNIT	PRICE	YIELD	PER ACRE	FARM COSTS
Please report in pounds or specify pounds in a bushel for different grains.					
Grain Type (example: spelt, emmer, etc.)					
Heritage grains (spelt, emmer, etc.)					
Gross receipts from crop insurance					
Crop Insurance					
Federal payments					
Total gross receipts					
DIRECT COSTS					
OPERATING PREHARVEST	UNIT	COST PER UNIT	QUANTITY	PER ACRE	FARM COSTS
Seed					
Fertilizer					
Herbicide (Applied)					
Repair & Maintenance					
Irrigation					
Crop Insurance					
Labor (hired paid)					
Labor (custom work ex: harvesting)					
Interest					
Tillage					
Plowing					
Other land prep.					
HARVEST COSTS					
Fuel					
Labor					
Hauling, cleaning, dehulling, storage					
PROPERTY & OWNERSHIP COSTS					
General Farm Overhead					
Machinery Ownership Costs					
Real Estate Taxes					
Factor Payments for Land					
DIRECT MARKETING COSTS					
Processing (list costs for each step)					
Packing					
Marketing/ advertising					
Other					
GRAND TOTAL					

Video Links

Introduction to the Heritage Grain Trials: https://www.youtube.com/watch?v=amTP-iwf_1g

How to be a Heritage Grain Farmer: A Case Study: Tyler Willbanks: <https://www.youtube.com/watch?v=aJKbt6F2PsQ>

How Heritage Grain Farmers Work With Businesses: A Case Study with Blue Grouse Bread:

<https://www.youtube.com/watch?v=SNuOvqHOUb0>

Harvesting and Cleaning Heritage Grains: <https://www.youtube.com/watch?v=1ZTklUb18j4>

Research Photos



Above from left: Zephyros Farm Winter Trials; Paonia, CO, May 4, 2021 * Winter grains at Laughing Wolf Farm (LWF); Mancos, CO, June 9, 2021 * Zephyros Farm Winter Trials; June 23, 2021 * Southwest Colorado Research Center (SWCRC), Yellowjacket, CO, June 24, 2021



Above from left: SWCRC Winter Trial Plots; June 24, 2021 * LWF height measurements; June 29, 2021 * Sin El Pheel; LWF, July 26, 2021 * Black einkorn; LWF, July 26, 2021



Left: Pedal threshing demo at Zephyros Farm Grain Day in Paonia, CO, August 4, 2021



Above from left: SWCRC Trials; July 26, 2021 * SWCRC Grain Day; July 27, 2021



Above from left: Mountain Oven Heritage Grain Baking Presentation at Zephyros Farm Field Day in Paonia, CO, August 4, 2021
* King's Crown Farm; Glenn's Ferry, ID, Sept. 9, 2021 * Harvesting at King's Crown Grain Trials; Glenn's Ferry, ID, Sept. 9, 2021



Clockwise from left: Tasting the grains at Laughing Wolf Farm Grain Day; Aug 12, 2022
* Grain Day at Laughing Wolf Farm in Mancos, CO; August 12, 2021 * Grain Day at King's Crown Farm; Glenn's Ferry, ID, Sept. 9, 2021

Kitchen Trials: Sourdough Recipe

Ingredients

100g Levain
250g Bread Flour
10g Salt (not iodized)
250g Home Milled Whole Wheat Flour
375g Water

Method

Build Levain the night before, letting it set covered at room temperature for 6–10 hours
Mix 50g Bread Flour, 50g water, and 1 Tbsp Starter
Mill whole wheat flours to desired texture
Mix flours (250g Bread Flour and 250g Whole Wheat Flour); hand mix flour with 360g water and 100g Levain
Autolyze for 30–45 mins (Autolysis is a resting period that allows flour to absorb moisture. Enzymes are activated and the gluten proteins, gliadin and glutenin, are assimilated into the dough)
Incorporate <15g water and 10g salt into dough
Stretch and fold to strengthen dough and develop gluten network
Stretch and fold 3–6 times in 30-minute increments
Preshape dough on floured surface and let Bench Rest for 30 mins.
Preshaping is done by folding the edges of the dough into the center to a circular shape. Flip the seam side down and cover with a towel or plastic to Bench Rest
Final Shape and place bread in banneton or loaf pan with parchment paper
Proof bread for 1–3 hours (Bread will be proofed when the microbes in your dough have fully leavened the loaf. Poke the dough with finger, if the impression slowly bounces back, your bread is proved and ready to bake)
Score the top of the loaf with razor, lame or scissors to allow for steam release
If using a Dutch Oven, Preheat Dutch Oven for 20 minutes at 500°F
If using a loaf pan, preheat oven to 450°F
Place bread on parchment paper that has been lightly dusted with cornmeal or flour
Turn heat down to 450°F and bake for 20 minutes with Dutch Oven lid on
If using a loaf pan, put a pan of water in the oven to create steam and encourage crust development. Bake loaf for 32–40 mins, taking water pan out at 20 minutes
Take Dutch oven lid off at 20 minutes and bake for 15–18 minutes longer
Let bread cool to room temperature before slicing and serving

Kitchen Trials: Yeast Recipe

Ingredients

200g Home Milled Whole Wheat Flour

½ tsp Saf instant yeast

200g Bread or AP Flour

1.5 tsp Salt (not iodized)

300g Water

Method

Mix all ingredients together with 300 grams of water and knead it briefly in the bowl or on the counter to incorporate all the flour. If needed, add a few drops of water

Let rest in floured banneton, covered to let rise for 1 ½–2 hours

After it rises, put in refrigerator for 24 hours

Score the top of the loaf with razor, lame or scissors to allow for steam release

If using a Dutch Oven, Preheat Dutch Oven for 20 minutes at 500°F

If using a loaf pan, preheat oven to 450°F

Place bread on parchment paper that has been lightly dusted with cornmeal or flour

Turn heat down to 450°F and bake for 20 minutes with Dutch Oven lid on

If using a loaf pan, put a pan of water in the oven to create steam and encourage crust development. Bake loaf for 32–40 mins, taking water pan out at 20 minutes

Take Dutch oven lid off at 20 minutes and bake for 15–18 minutes longer

Let bread cool to room temperature before slicing and serving.



Rocky Mountain Seed Alliance's vision supports regionalized seed and food systems:

A resilient and healthy planet with every region, watershed, and community alive with a diversity of inspired seed savers and vibrant food cultures.

We envision a world where communities are connected through their food cultures. Seed stewards from all cultures should be supported as they honor their foods that come from seeds. Seeds should be preserved for past, present, and future generations and purposes.