

PRODUCER EXPERIENCES WITH PROSO MILLET IN THE INLAND PACIFIC NORTHWEST



Introduction

Since fall 2021, producers, processors, and researchers from Washington State University have been working together to understand the benefits and challenges of integrating proso millet (*Panicum miliaceum* L.) into the regional food system of the Pacific Northwest (PNW), a region where limited research and production of this crop have occurred. This publication draws on interviews with five producers who participated in on-farm trials to highlight key takeaways regarding production and marketing of proso millet in this region. The objective of this publication is to share relevant experiences with future PNW producers who may be interested in working with the crop. Furthermore, experiences of these producers may be relevant to potential adopters in other regions or may apply to other regionally underutilized crops.

This publication contains an overview of proso millet, background on the project under which this research took place, a description of relevant methods, a summary of participant characteristics, and a breakdown of key benefits and challenges of working with proso millet collected from producer participants. Key perceived benefits shared by participating producers include the resilience of the crop, capacity for rotational weed control, and increased opportunity for on-farm diversity. Key perceived challenges shared by participants include timing and logistics of harvest, the lack of a reliable market, insufficient infrastructure for storage, and inconsistent stand. Information regarding planting and management of on-farm trials, summary tables of farm characteristics, field history, and trial management are included in Appendix 1.

What Is Proso Millet?

Millets are small-seeded cereal crops that have been cultivated and used for food, feed, and forage for thousands of years, particularly in the semi-arid tropics of India, China, and Africa (Cheng 2018). Even today, millets are a staple crop for

communities in these regions, ranking sixth among the world's most important cereals and sustaining about one-third of the world's population (Habiyaremye, Matanguihan et al. 2017; Boukail et al. 2021). Millets are recognized for their drought tolerance, low input requirement, and ability to grow in marginal agricultural zones, in addition to their rich nutrient composition (Wang et al. 2018). These grains show such promise for providing food security in the era of climate change that the United Nations declared 2023 “International Year of the Millets” in order to raise awareness and direct policy attention to research, market development, and production of millets globally (Food and Agriculture Organization of the United Nations 2023).

Millets

- Many different species of millets
- Ancient grains—domesticated ~10,000 BP
- Staple crops in China, India, and West Africa
- United Nations declared 2023 “International Year of Millets” because of promise as climate resilient crops

There are many different species of millets that vary widely in plant shape, seed color, and seed size. Some commonly cultivated species include pearl millet, finger millet, kodo millet, foxtail millet, little millet, and barnyard millet, but the most commonly cultivated species for human consumption in the United States (US) is proso millet (Myers 2018; Das et al. 2019). Even so, proso millet is underutilized in the US and is primarily channeled into the birdseed market, despite desirable agronomic and nutritional characteristics (Das et al. 2019).

Proso millet is a warm-season grass with a short growing season of 60–100 days (Habiyaremye, Matanguihan et al. 2017) (Figure 1). It is typically planted in the late spring or early summer, making it compatible in rotation with winter annual crops (such as winter wheat), or suitable as a replacement for summer fallow or a “catch crop” if an earlier crop were to fail (Lyon et al. 2014; Ventura et al. 2020). It has a shallow root system, and as a C4 species is water efficient and well-adapted



to dryland cropping systems (Lyon et al. 2014; Nielsen and Vigil 2017).



Figure 1. Maturing proso millet panicle. Photo: T. Reinman.

Proso Millet Points of Interest

As a crop

- Highly water efficient and drought tolerant
- Grows in shallow, low fertility soil
- Controls annual grassy weeds, reduces insect and disease pressure, preserves moisture deep in the soil

As a food

- Comparable nutritional profile to other major cereals
- High-fiber, low glycemic index
- Rich bioactive compounds
- Gluten free

Proso millet's capacity to grow with limited water, in marginal soil, and with minimal agronomic inputs, in addition to its short growing season, make it a valuable prospect for producers in the Inland PNW (Santra 2013). This region is characterized by a semi-arid environment with hot, dry summers that are predicted to be exacerbated by climate change (Pan et al. 2016). The

Inland PNW is dominated by dryland wheat production, and when added to a rotation, proso millet has been shown to increase wheat yields by controlling winter annual grassy weeds, reducing insect and disease pressures, and preserving moisture deep in the soil (Santra 2013; Lyon et al. 2014). Proso millet is compatible with the well-drained loamy soils characteristic of the region, and there are not currently any other warm season grasses commonly planted in this region, making it a niche opportunity for producers looking to diversify their rotations (Habiyaemye, Matanguihan et al. 2017).

Historically, North American proso millet has been grown and researched in the Central Great Plains region of Colorado, Nebraska, and South Dakota, which are also dominated by dryland wheat production, but little research has been conducted to understand the performance of varieties developed for the Great Plains for use in the Inland PNW (Habiyaemye, Matanguihan et al. 2017).

Proso Millet in the Inland PNW

- Compatible with regional climate and soils
- Short-season summer crop, could fit into rotation with wheat
- Replace summer fallow or serve as a "catch crop"

Project Background: New Grains Northwest

The 2022 on-farm, producer-run variety trials were conducted under a Western Sustainable Agriculture Research and Education (SARE) funded project called New Grains Northwest (SW21-926). New Grains Northwest is an interdisciplinary project that aims to increase diversity of the PNW food system by exploring the opportunity to integrate underutilized crops into regional cropping systems and food products. Proso millet was selected as one of the crops of interest based on its compatibility with regional cropping systems, desirable nutritional profile, and varied food applications. This work builds on previous research at WSU that tested diverse proso millet accessions (originating from Bulgaria, Czech Republic, Morocco, the former Soviet Union, Turkey, and the United States) for suitability to be grown in the irrigated and dryland conditions in the Palouse (Habiyaemye, Barth et al. 2017).

To identify best-suited varieties for the region, researchers used commercially available proso millet varieties to conduct a small-scale replicated plot variety trial and facilitated a series of large-scale, on-farm, producer-led variety trials (Figure 2). In addition to allowing participants to observe agronomic performance of proso millet varieties, these trials provided an opportunity to interview participants about the benefits and challenges of adopting proso millet in the Inland PNW.



Figure 2. Mature, on-farm proso millet trial in Edwall, Washington. Photo: T. Reinman.

Methods

Participant recruitment for the proso millet variety trials began at the end of 2021. The WSU research team conducted outreach through social media, organizational LISTSERVs, meeting announcements, and personal networks to recruit grain producers with access to full-scale equipment in the Inland PNW. Producers were offered a \$500 stipend for the growing season, a 50-pound bag of seed for each test variety (between three and seven, depending on the producer's preference), and a packet of management recommendations based on publicly available Extension publications from other regions (McDonald et al. 2003; Lyon et al. 2014). While general guidance was provided, each participant was tasked with individual management decisions around planting, fertilizing, weed management, and harvest based on field history and personal preference. See Appendix 1 for details regarding farm characteristics, field history, and trial management for each trial. Specific instructions were provided regarding trial layout, with varieties planted in long, unreplicated, parallel strips (one to two drill passes) using full-scale planting equipment.

Research Outline

- Five producer participants planted on-farm proso millet trials in the Inland PNW in 2021
- Used full-scale equipment to plant strips of several proso millet varieties
- Interviews were conducted with participants before and after the growing season to understand producer experiences working with the crop
- Benefits and challenges that participants discussed regarding their experience working with proso millet are summarized below

A group of five producers participated in the on-farm trials. We conducted hour-long, preseason interviews via Zoom or phone with each participant to gather information regarding farm characteristics, producer knowledge of the crop, and expectations for the project. Interviews were recorded and transcribed for later reference. Additionally, preplant questionnaires regarding field history (e.g., previous crops, recent chemical application, and soil characteristics) and intended trial management (e.g., fertilizer application, seeding depth and spacing) were distributed and collected from each producer.

Seed was distributed to participants in May 2022, at which time researchers conducted an initial visit to trial sites. Seed for six of seven proso millet varieties (Dawn, Earlybird, Horizon, Plateau, and Sunrise) was purchased from Kriesel Certified Seed in Gurley, Nebraska, and the seventh variety (Sunup) was purchased from Perry Brothers Seed Inc. in Otis, Colorado. Researchers conducted a final site visit at each farm in late September, shortly before trials were harvested, and hand-collected five quadrat samples and phenotypic data from each variety. After samples were collected, producer participants were free to harvest and use or sell seed as they wished.

In January 2023, we conducted individual postseason interviews with each producer participant via Zoom or phone call regarding in-season management decisions, crop performance, and trial experience. Additionally, a group Zoom call was conducted with all five participants in which producers were able to share their trial experiences and discuss management decisions and overall takeaways with one another. Individual interviews and the group call were recorded and transcribed.

Transcriptions from preseason interviews, postseason interviews, and the group grower call were reviewed and relevant quotes were selected and organized by recurring themes. These themes were grouped as benefits of working with proso millet (resilience, weed control, and diversity) and challenges of working with proso millet (market, harvest, storage, and inconsistent stand). Summaries of each theme and relevant quotes are compiled in the Producer Experiences and Perspectives section, below.

Producer Characteristics

Of the five producers who ultimately planted on-farm trials, three had never worked with proso millet before, but all five had experience with similar small-seeded or spring-planted crops. Producers managed between 1,500 and 16,000 acres. Three participants were located in Genesee, Idaho (average rainfall: 22 in/year), one in Edwall, Washington (average rainfall: 11 in/year), and one in Chelan, Washington (average rainfall: 7.4 in/year). The nature of this project attracted producers who were exploring a range of practices to increase sustainability of their farms. All five participants practiced some degree of no-till production and were working to implement diverse cropping rotations, three used integrated livestock, and three used cover

crops (Figure 3). Three growers were [Food Alliance](#) certified, three were [Farmed Smart certified](#), and three partner with a regional wheat company called [Shepherd's Grain](#) that verifies regenerative practices.



Figure 3. No-till proso millet planting into wheat stubble in Genesee, Idaho. Photo: Producer 5.

Producer Experiences and Perspectives

Throughout the course of the 2022 trials, producers learned a great deal about the benefits and challenges of working with proso millet and honed their management strategies. Key points from one-on-one interviews with each of the producers, in addition to a group call with all producers, are summarized below.

Benefits

Overall, participants were pleasantly surprised with the performance of proso millet in their fields. Four of the participants planned to plant a second trial in the 2023 growing season. The most prominent perceived benefits voiced during post-season interviews were the resilience of the crop, rotational weed control, and increased opportunity for on-farm diversity.

Key Benefits

- Resilience of the crop
- Rotational weed control
- Increased opportunity for on-farm diversity

Resilience

Four participants commented on the resilience that proso millet showed in undesirable growing conditions (Figure 4). Two of

those participants expected a complete crop failure because of poor weather at planting but were surprised to see a productive crop later in the season. In 2022, the PNW had an uncharacteristically cold and wet spring. Washington State experienced its third coldest June on record, and April, May, and June brought above average precipitation across the PNW (National Centers for Environmental Information 2022). However, later in the season, Washington, Oregon, and Idaho all experienced their hottest August temperatures on record (National Centers for Environmental Information 2022). These climatic anomalies not only put stress on crops in the field, but also threw off typical planting and harvesting schedules and put additional stress on producers. Given the conditions, participants were generally pleased with the performance of the crop and took note of its capacity to withstand high temperatures.



Figure 4. Maturing proso millet crop in Edwall, Washington, on September 1, 2022. Photo: Grower 1.

Participant Quotes: Resilience

“When we got our heat wave this year the millet looked like it was happy as a clam out there. The crop really took off in August and September. It looked like a nice crop, not like one of my weird experiments.” – Producer 1

“Seeded it and then got 1–1.5 inches of rain on June 4 in 45 minutes. I wrote the crop off. It was hard as a rock. Probably didn’t even go back up there until the 1st of July and here I had a stand of everything, a beautiful stand [. . .] I was amazed that a seed that small had that much vigor.” – Producer 2

“Once the heat hit, I loved driving around seeing something green. It just took off.” – Producer 2

“For seeding it on June 22—very, very late—it did all right. I would not want to do that normally or as a general practice, but it showed that you can seed it extremely late and still get a crop.” – Producer 3

“As little attention as I gave it, I really mismanaged it, and it still lived and did okay. I think it increased my likelihood of continuing to work with this crop.” – Producer 5

Weed Control

Because proso millet is typically planted in the late spring, participants found that including it in a cropping rotation creates a valuable opportunity to control secondary flushes of weeds that typically emerge once their spring crop has already been planted. Due to herbicide resistance, many of these weeds are increasingly difficult to control with available chemicals. All five participants used this opportunity to spray a late application of glyphosate (Roundup) before planting, which helped them control problem weeds such as Italian rye grass (*Lolium multiflorum* Lam.) and mayweed chamomile (*Anthemis cotula* L.).

Participant Quotes: Weed Control

“I felt like the weed control was much better than I expected it to be. There weren’t that many weeds out there.” – Producer 1

“I was able to hit that one last time and it really made a big difference. I had so much [mayweed chamomile], I was dreading putting something in there, and that second Roundup application really cleaned it up.” – Producer 1

“It also addressed weed resistance issues. The number one weed I have problems with is Italian ryegrass, and because I’m able to seed [proso millet] quite a bit later, I am able to control later season flushes with preplanting application of Roundup and then just rely on good crop canopy to control it in-season rather than relying on herbicide.” – Producer 3

“It did seem pretty competitive canopy-wise once it got up and got going, even though at the beginning it didn’t look like it was really going to compete much.” – Producer 4

“I didn’t even put a broadleaf herbicide on it. I Roundup-ed it before we seeded it, seeded it, and didn’t touch it the rest of the season. I wanted to see how well it competed against the weeds that we have, and I was very impressed. I think it did a good job competing. But I still think it would need an [in-season] herbicide application.” – Producer 5

On-Farm Diversity

The producers who volunteered to participate in these trials were interested in adding diversity to their cropping systems. At the conclusion of the trials, an increase in diversity was seen as one of the most notable benefits of working with proso millet. Proso millet is a warm season grass, which fills a rotational niche that is currently vacant in the Inland PNW. Proso millet can be integrated into Inland PNW cropping systems as a replacement for summer fallow, or as one producer noted, as a catch crop in the case of poor conditions for earlier spring plantings. In

addition to crop diversity, two participants noted an increase in insect and wildlife activity that they welcomed on their land.

Participant Quotes: On-Farm Diversity

“We are starting to grow a lot of cover crops, so I see it as my own market. I’ll just turn right around and it keeps that seed in my microbiome that I am trying to keep as a closed system, so I couldn’t be more thrilled.” – Producer 2

“You can’t quantify that but it just had a buzz, there were insects and grouse[. . .] I had never seen anything that big in a crop.” – Producer 2

“You’re getting to have in rotation a warm season grass which we do not have on the Palouse, so having another leg in crop rotation for no-till direct seeding is very important.” – Producer 3

“In 2017 there was a lot of preventative planting around here. People couldn’t get crops in at a normal time. It could be an emergency fit for something like that, if it’s like ‘alright, I’ve got 100 acres and I couldn’t meet planting deadlines for everything else[. . .] I could see this as a fit as a rescue.” – Producer 4

“I personally noticed a whole bunch more birds, doves, pheasants—they really liked that, and it’s just something different on the ground, so I was pretty excited to just watch it, and I’m excited to see what it looks like in years to come.” – Producer 5

Challenges

While participants saw notable benefits of working with proso millet, they also experienced some significant challenges that could limit their ability to continue working with the crop. Among challenges most frequently discussed were timing and logistics of harvest, the lack of a reliable market, insufficient infrastructure for storage, and inconsistent stand.

Key Challenges

- Timing and logistics of harvest
- Lack of a reliable market
- Insufficient infrastructure for storage
- Inconsistent stand

Harvest Logistics

Proso millet must be left in the field long enough to fully mature, but it also must be harvested before the Inland PNW’s rainy season begins in the fall. This window is different each year depending on the weather and can be difficult to predict. Additionally, proso millet harvest must be managed around other key seasonal activities. Typically for producers in this region, proso millet can be harvested later than other crops and will not interfere with other harvest activities, however, this late harvest

can interfere with planting activities for winter crops. To navigate this limited harvest window, producers may choose to expedite dry-down of the crop by swathing or chemically desiccating. One participant in the 2022 trial chose to swath while one chose to chemically desiccate. Two growers who direct harvested (Figure 5) experienced issues with high moisture in their harvested seed.



Figure 5. Proso millet direct harvest in Genesee, Idaho. Photo: T. Reinman.

Lack of a Reliable Market

Producer Quotes: Harvest Logistics

“The harvest timing is right when I should be putting in my winter wheat crop. I thought it would be nice to spread out my acres having different times but I forgot that I’m going to have to do seeding at the same time.” – Producer 1

“I have swathed before when I thought it was going to be a food grade market. Since then I have used [chemical desiccant] and that has worked out pretty well.” – Producer 3

“If we could cut it earlier that would help. The seeding isn’t too bad because that time of year we aren’t really pressed to do something else. We have things we normally do, we grow hay crops, but the harvest was the tough one because we need to be

on tractors doing wheat just like everybody else I’m sure.” – Producer 4

“Man if we just had another month in the fall, I think we would be set around here.” – Producer 4

“Comes down to buying two more pieces of equipment, a [pickup] header for a combine and a swather.” – Producer 4

“I’m not crazy about desiccation, swathing would be an option [. . .] We desiccate [garbanzo beans] sometimes, so it’s not the end of the world but I try to eliminate it. I think the less [chemicals] we can use the better.” – Producer 5

“Some of the concern I have with swathing it is if we get a big windstorm and you have a bunch of millet swathed. Where I farm out on my rim, we’ve raised blue grass and hay in the past and had it blow in the canyon and lose all of it. So, desiccation would be probably the most realistic on larger scale, or an earlier maturing variety that will yield.” – Producer 5

A producer’s decision to grow proso millet hinges on the market and whether or not they can sell their crop. Some may be able to justify production based on their own needs for forage or cover crop seed, but most, especially at any significant scale, need a reliable buyer with adequate prices in the region. Currently, the most prominent market for proso millet in the US is bird seed. Some participants have explored selling to a bird seed company in Spokane, Washington, Global Harvest Foods, but for others, this was not an attractive enough prospect to warrant working with the crop. One participant was confident in the prospect of selling to a nearby cover crop company, while others did not find competitive pricing at the cover crop seed companies in their area. Producers briefly explored the prospect of selling to a regional malting facility but it shut down unexpectedly in 2022 and that option disappeared. Clearly, producers are willing to get creative in finding outlets for proso millet seed, but adoption will likely remain limited until a more lucrative market emerges in the PNW.

Participant Quotes: Lack of a Reliable Market

“I have no qualms growing it, the problem is selling it. The market. I need it to make financial sense to do it.” – Producer 1

“If it’s lower [in price] than the current commodities, then it will be a really hard sell. Certain people might see the rotational or the soil health benefit that would go through the extra trouble to grow this, but at a loss, I would have to sell that to my landlord.” – Producer 1

“If it’s ever going to work [there would have to be market demand for a very large scale], around 400 acres for a grain bin (quick rough math). That would be the size and scale that it would be worth considering buying a swather and a pickup header.” – Producer 4

“The biggest challenge is definitely finding a local market and use for it [. . .] if it’s something we can at least break even on for a rotational-type crop or grazing, I think people will do it. That’s like a lot of this stuff [. . .] you can raise all of the [cover crops] you want but if you’re not getting a [return on investment] then it doesn’t make much sense to do it. We kind of have to make money. It is a business unfortunately.” – Producer 5

Infrastructure limitations are another notable factor stymying the regional market. Millet has a hull that must be removed for consumption (Figure 6), and there is not currently a dehulling facility in the PNW. This makes it more difficult for food processors to adopt regionally grown millet into their products, limiting demand from this sector of regional processors. Additionally, while proso millet could be adopted into the niche gluten-free market, producers have been unable to identify a regional cleaning facility that can clean grain without significant risk of gluten contamination. Without these important pieces of infrastructure, the regional supply chain cannot function effectively from farm to end-use.



Figure 6. Dehusked proso millet seed. Photo: T. Reinman.

Storage Infrastructure

Participants experienced challenges storing proso millet seed after harvest. In February 2023, several months after the 2022 harvest, all five participants reported that their harvested proso millet had been left in covered trucks, and two of those participants reported that seed turned sour because of high moisture content and lack of ventilation. Both of these participants had intended to use their proso millet crop for livestock feed but were ultimately unable to. For those who intended to sell their proso millet seed, they still needed somewhere to keep it covered and at an acceptable moisture level until they found a suitable buyer. Part of this obstacle has to do with scale. As one participant expressed: many producers have their grain hoppers with capacity for either a small-scale crop or a large-scale crop, and nothing in between.

Participant Quotes: Storage Infrastructure

“On our farm we have either home storage (500-bushel hopper bottom bins that we use for hog food) or a 10,000 bushel grain bin. This crop is currently somewhere in between those. If we went big, we would have to budget using a 10,000 bushel grain bin which is a lot of acres of millet [. . .] basically, five acres is the limit unless we can get to 400 [acres].” – Producer 4

“We cut it all, put it in the truck, put it in the shop, and it kind of went sour. We raise hogs during the summer but we didn’t feel like we should put it in the pig pen, so we just dumped it.” – Producer 4

“My hope [was to feed it to the cows] but it’s still sitting in my trailer. The tarps rolled, I haven’t rolled the tarp and looked at it. I’m afraid to. I’m sure mine is sour and was not dry enough.” – Producer 5

Inconsistent Stand

Participant Quotes: Inconsistent Stand

“My stand was very spotty, some that were up mid-chest level and some that were five to six inches tall and didn’t even look like they made a head. It didn’t seem to have rhyme or reason, there were spots that it looked like it should have had moisture but it was short and [. . .] I don’t know it seemed kind of hit and miss.” – Producer 1

“[I planted into variable soil and] it was more sensitive to soil than probably anything else that I have. I’ve never seen anything follow the contour (for lack of a better term).” – Producer 2

“I think it all came down to moisture. Areas where it was thin stand it was just way too wet. The opposite can happen if the whole field is too dry.” – Producer 3

“I need to use different rollers [. . .] that may have also contributed to the uneven stand. If I used different rollers, it might be more even.” – Producer 3

“Where I noticed the inconsistent stand heights is 100% related to soil depth. I have been doing mine on the rim where its either rock or good dirt.” – Producer 5

Most participants noticed an inconsistent stand in their proso millet trials across all varieties. However, participants attributed the inconsistencies to a range of factors, including moisture, soil depth, and equipment. One producer who has grown proso millet many times in the past noted that this year seemed much more inconsistent than usual.

Conclusion

Working with producer participants through the 2022 on-farm proso millet variety trials created a unique opportunity to understand the benefits and challenges of working with this crop in the Inland PNW, a region where limited research has been conducted.

Pre- and postseason interviews indicated that participants saw the resilience of the crop, weed control potential, and the opportunity to increase diversity in their rotations as the most prominent benefits of working with proso millet. These benefits are particularly desirable in the era of climate change, as resilience will help crops withstand severe weather conditions, and increased diversity within cropping rotations can increase food security. Weed control potential is also critical for producers struggling with herbicide resistance.

However, producers also discussed challenges of working with proso millet, including timing and logistics of harvest, the lack of a reliable market, insufficient infrastructure for storage, and inconsistent stand. In particular, absence of market demand stands out as a prominent issue, as equipment to improve harvest, storage, and management could be justified with proper financial incentive. Market development is a complex objective that will require strategizing and cooperation across producers, researchers, government entities, and processors from private industry. However, at the regional scale, just one substantial buyer could dramatically shift the dynamic of demand and create financial incentive for producers to troubleshoot challenges and integrate proso millet into their rotations. While reliable market and regional management recommendations have yet to be established, the participation of the producers in this study was a valuable first step in understanding the opportunity for adoption of proso millet in the Inland PNW. Furthermore, these producer experiences can help us better understand some of the benefits and challenges that producers who are attempting to increase the diversity of their farms may experience in other regions and with other crops.

Acknowledgements

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Appendix 1

Table 1. Farm characteristics.

	Producer 1	Producer 2	Producer 3	Producer 4	Producer 5
Location	Edwall, WA	Mansfield, WA	Genesee, ID	Genesee, ID	Genesee, ID
Acreage	<2,000	>1,000	2,000–5,000	2,000–5,000	2,000–5,000
Certifications	NA	Farmed Smart	Food Alliance, Farmed Smart	Food Alliance, Shepherd's Grain	Food Alliance, Farmed Smart
Management Style	No till, some conservation farming	No till, diverse crop rotation	No till, cover crop, diverse crop rotation	No till and minimum till	No till, cover crop, integrated livestock, some biological
Annual Precipitation	11 in	6–9 in	22 in	18–22 in	22 in

Table 2. Field history.

	Producer 1	Producer 2	Producer 3	Producer 4	Producer 5
Trial Size	4.5 acres	3.5 acres	5 acres	2.9 acres	8.3 acres
Landscape Position	SW-NE; ditches, hilly	Flat /rocky	Draw	Slight N slope	Slope
Previous Crop (most recent to least recent)	Spring wheat, spring wheat, winter wheat	Winter wheat, canola, sunflower, spring wheat	Spring wheat	Soft white winter wheat (rotation: fall grain, spring grain, legume, fall grain, legume)	Fall wheat
Recent Chemical History	No in-crop herb in '21 drought year, 24 oz RT3 + molasses	Roundup 2 weeks ago—12 oz with reverse osmosis water	114.3 lb N; 31.9 lb S; 6.18 lb P. 22 oz Roundup and 1.5 oz sharpen	Last fall—120 lb N; this spring—15 lb P, 30 lb S	NA
Soil					
Texture	Silt loam	Sandy loam	Silt loam	Loamy silt, a little clay	NA
Drainage	Before no-till (15 years ago) lots of pooling, but not any more	Never rains, slopes south	Poorly drained	Corner wet spot, but otherwise well-drained	NA
Fertility	Low in calcium and high in manganese/magnesium; usually apply zinc and boron	No known issues; added biosolids in 2014	NA	Low on zinc and magnesium	NA
Organic Matter	2.7%	Up to 2%	3.5%	3% range	NA
Weeds	Most severe: mayweed and cheat grass; Manageable: China lettuce and wild oats	NA	Italian ryegrass	Italian ryegrass	NA

Table 3. Trial management.

	Producer 1	Producer 2	Producer 3	Producer 4	Producer 5
Planting Date	6/12/22	6/1/2022	6/20/2022	5/26/2022	5/24/2022
Harvest Date	10/4/22	10/15/22	9/27/2022	9/28/2022	9/13/2022
Residue Management	No till	No till	No till	Till with fertilizer close to seeding (9 in shank, 3–4 in deep)	No till
Fertilizer					
Product	2 gal UAN, 2 gal orthophos + molasses	100 lb N, 15 lb P, 20 lb S; gypsum, humic, sugar; manganese, magnesium, and seed water	100 lb N, 15 lb P, 20 lb S	100 lb N, 10 lb P, Zn	50 lb N, 15 lb S, 20 lb P
Placement	Paired row 3", banded in middle 1" below	Ran through drill; came over the top	NA	Through drill kit	NA
Timing	At planting	At planting	NA	At planting	At planting
Preplant Herbicide					
Product	Roundup	Roundup	Clarity (experimental use, not labeled for use in WA state)	NA	NA
Rate	24 oz days before planting	Single application one month before planting	4 oz	NA	NA
In-season Herbicide	NA	NA	NA	2,4-D Amine	NA
Seeding Rate	25 lb/acre	15 lb/acre	30 lb/acre	11 lb/acre	35 lb/acre
Row Spacing	9.5 in paired rows	9 in paired rows	4.5 in paired rows	7.5 in	12 in
Seeding Depth	0.5–0.75 in	1.5 in	1" (varies in rocky ground)	0.75–1.25 in	0.75 in
Harvest Method	Swath/pickup	Direct	Chemical dry down, direct	Direct	Direct
Harvest Equipment	NA	John Deere S780 combine with 45' Mac Don FD240 draper header	Case 9120 combine with draper head	John Deere S680 combine	John Deere S680 with direct cut normal wheat header
Average Yield Across Varieties (lb/acre)	NA	961	861	1,700	NA

References

Boukail, S., M. Mercy, M. Miculan, A. Masoni, A. Calami, and E. Palchetti. 2021. Genome Wide Association Study of Agronomic and Seed Traits in a World Collection of Proso Millet (*Panicum miliaceum* L.). *BMC Plant Biology* 21(1): 1–12. DOI: 10.1186/s12870-021-03111-5.

Cheng, A. 2018. Review: Shaping a Sustainable Food Future by Rediscovering Long-Forgotten Ancient Grains. *Plant Science* 269: 136–142. DOI: 10.1016/j.plantsci.2018.01.018.

Das, S., R. Khound, S. Meenakshi, and D.K. Santra. 2019. Beyond Bird Feed: Proso Millet for Human Health and Environment. *Agriculture (Switzerland)* 9(64): 1–19. DOI: 10.3390/agriculture9030064.

Food and Agriculture Organization of the United Nations. 2023. [International Year of Millets 2023](#). United Nations General Assembly.

- Habiyaremye, C., V. Barth, K. Highet, T. Coffey, and K.M. Murphy. 2017. Phenotypic Responses of Twenty Diverse Proso Millet (*Panicum miliaceum* L.) Accessions to Irrigation. *Sustainability (Switzerland)* 9(389): 1–14. DOI: 10.3390/su9030389.
- Habiyaremye, C., J.B. Matanguihan, J. D'Alpoim Guedes, G.M. Ganjyal, M.R. Whiteman, K.K. Kidwell, and K.M. Murphy. 2017. Proso Millet (*Panicum miliaceum* L.) and Its Potential for Cultivation in the Pacific Northwest, U.S.: A Review. *Frontiers in Plant Science* 7: 1961. DOI: 10.3389/fpls.2016.01961.
- Lyon, D., P.A. Burgener, K.L. DeBoer, R.M. Harveson, G.L. Hein, G.W. Hergert, T.L. Holman, et al. 2014. [Producing and Marketing Proso Millet in the Great Plains](#). *University of Nebraska Extension Publication EC137*: 1–20. University of Nebraska, Lincoln.
- McDonald, S.K., L. Hofsteen, and L. Downey. 2003. [Crop Profile for Proso Millet in Colorado](#).
- Myers, R. 2018. [Growing Millets for Grain, Forage or Cover Crop Use](#). *University of Missouri Extension Publication G4163* 1–7. University of Missouri.
- National Centers for Environmental Information. 2022. [Monthly National Climate Report for May 2022](#). National Oceanic and Atmospheric Administration.
- Nielsen, D.C., and M.F. Vigil. 2017. Water Use and Environmental Parameters Influence Proso Millet Yield. *Field Crops Research* 212: 34–44. DOI: 10.1016/j.fcr.2017.06.025.
- Pan, W.L., F.L. Young, T.M. Maaz, and D.R. Huggins. 2016. Canola Integration into Semi-arid Wheat Cropping Systems of the Inland Pacific Northwestern USA. *Crop and Pasture Science* 67(3–4): 253–265. DOI: 10.1071/CP15217.
- Santra, D.K. 2013. [Proso Millet Varieties for Western Nebraska](#). *University of Nebraska Extension G2219*. University of Nebraska, Lincoln.
- Ventura, F., M. Vignudelli, G.M. Poggi, L. Negri, and G. Dinelli. 2020. Phenological Stages of Proso Millet (*Panicum miliaceum* L.) Encoded in BBCH Scale. *International Journal of Biometeorology* 64(7): 1167–1181. DOI: 10.1007/s00484-020-01891-3.
- Wang, S., Z. Wang, S. Li, C. Diao, L. Liu, X. Hui, M. Huang, L. Luo, G. He, H. Cao, R. Yu, and S.S. Malhi. 2018. Identification of High-Yield and High-Zn Wheat Cultivars for Overcoming “Yield Dilution” in Dryland Cultivation. *European Journal of Agronomy* 101: 57–62. DOI: 10.1016/j.eja.2018.08.008.

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