Extension
UNIVERSITY OF WISCONSIN-MADISON

Supporting Emerging Crops in Wisconsin

Strategic Priorities to Accelerate Development of Emerging Crops in Wisconsin

November 2024

Authors:
Jason Fischbach
Steffen Mirsky

go.wisc.edu/emergingcrops

Executive Summary

The University of Wisconsin Emerging Crops Team was formed in 2022 with the purpose of accelerating the development of emerging crops in Wisconsin. Our work focuses on crops in four categories:

Joining us in our work is the Wisconsin Emerging Crops Coalition, which is a group of stakeholder organizations, grower groups and government entities working to support crop diversification, economic development, and soil and water stewardship in Wisconsin. The Coalition has four main objectives:

1. To serve as a communication and coordination mechanism for organizations working to develop and support new and emerging crops in Wisconsin.
2. To advocate for state and federal policies that advance the development of new and emerging crops in Wisconsin.
3. To secure public and private funding sources to support development of new and emerging crops in Wisconsin.
4. To provide advice and guidance to the research and development programs of the University of Wisconsin's Emerging Crops Team.

This WI Emerging Crops Strategic Plan is both a snapshot in time, providing an overview of each crop in our portfolio as of November 2024, and a path forward, outlining specific steps necessary to advance each crop and industry.

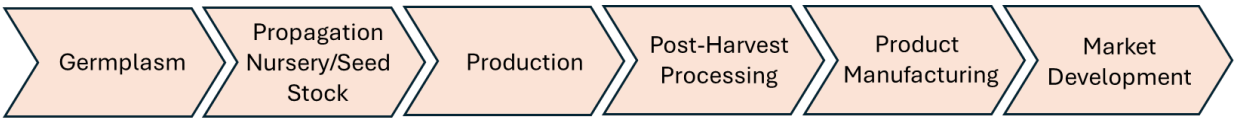
Further, this Strategic Plan is a call to action. It is a call to "do" new crop development in a different way. It is also a call with increasing urgency as climate change, seemingly intractable soil and water problems, and ongoing economic simplification have made the need for new crops, new solutions, and new opportunities even greater.

Methodology

The information and strategic priorities included in this Plan are based primarily on interviews conducted from November 2023 through October 2024 with stakeholders involved in each of the crops. The strategic priorities presented are the opinions of the Plan's authors on what is necessary to develop the crop's value-chain. Individual stakeholders may have different strategic priorities for their own organization and their unique place in the value-chain. **WARNING:** Each crop covered in this Plan is rapidly evolving and the information contained herein may not be current at the time you read it. Like any strategic plan we will update this document periodically. As such, any comments or corrections are appreciated and should be directed to Jason Fischbach, jason.fischbach@wisc.edu.

Building a New Crop Requires Building a Complete Value-Chain

Building a viable new crop and associated industry requires construction of a value-chain with each link aligned and economically viable. The value-chain consists of: 1) Germplasm sufficient to support commercially-viable production, 2) Nursery or seed stock production scaled to meet grower demand, 3) A grower base and production system capable of meeting buyer specifications at a price that works for both buyer and seller, 4) Post-harvest processing to convert raw agricultural products to saleable ingredients, 5) End-use products with a defensible value-proposition and product-market fit, 6) Consumer demand for those products sufficient to support financially viable links 1-5.



The challenge for new crops is all links in the value-chain must be built concurrently for the crop and industry to succeed. "Aligning the cart and the horse" and "solving the chicken-or-egg dilemma" are common cliches used in new crop development. Both refer to the never-ending challenge of building and scaling the value-chain links concurrently.

A New Approach to New Crop Development: Stewardship-Based Development

We argue for a Stewardship-based approach to new crop development with five key components:

1. Stakeholder meetings to identify the necessary links in the value-chain to ensure that all stakeholders understand what is necessary for a sustainable and equitable value-chain.
2. Stakeholder needs assessments to identify the key bottlenecks faced by the industry and develop a short and long-term strategic plan to overcome those value-chain bottlenecks.
3. Stakeholders, intermediaries, and early-entrants working together to build each link in the value-chain concurrently and collaboratively.
4. A person or team of people (crop Stewards) hired by a third-party intermediary to provide long-term leadership to advance development of the value-chain.
5. A venture studio to more rapidly cultivate and develop entrepreneurs operating businesses and organizations as part of the value-chain.

Though each crop will vary depending on the state of the value-chain and specifics of post-harvest processing, the Stewardship-based model should work to build the following:

1. A research and development program to provide improved germplasm, agronomic, harvest, and post-harvest processing best management practices, and product development assistance.
2. A geographically-clustered and socially-networked group of growers supported with research-based information and outreach education. The group should also include an intermediary Steward(s) to assist the growers in sharing information, pooling buying power, working together to reduce costs, aggregating production volumes to achieve economies of scale with post-harvest processing, and helping connect the growers with buyers.
3. A public-private partnership to subsidize fee-for-serve post-harvest processing to provide an open-access path to market without gatekeepers.
4. A diverse marketplace with business-to-business (B2B) ingredient sales and business-to-consumer (B2C) product sales.

Aligning Intermediaries and Early-Entrants to Be Crop-Centric and Collaborative

Third-party intermediary organizations, such as universities and non-profits, can be highly effective in supporting value-chain development. However, fundraising and staffing is typically done at the organizational level and the risk is these intermediary organizations become siloed and/or competitors as they fundraise around their own organizations and own initiatives. This organization-first approach contrasts with the coordinated crop-specific approach where the specific crop's value-chain is centered and the intermediary organizations and stakeholders work together on fundraising and development efforts to advance the crop's value-chain. This is particularly important as interest from philanthropists and impact investors in new crops continues to grow, especially crops providing climate resilience or mitigation.

Intermediary organizations should also organize their staffing around specific crops rather than problems facing multiple crops. For example, current organizations like the Forever Green Initiative, Savanna Institute, and even our UW-Emerging Crops Team have created positions with multiple crops in their portfolio. Positions like Director of Commercialization, Emerging Crops Outreach Specialist, or Director of Agroforestry Innovation are created out of financial necessity but become spread so thin over multiple crops that achieving anything becomes a challenge. Instead, we argue that organizations should collaborate to hire emerging-crop Stewards, each tasked with providing leadership on development of the value-chain of a *single* crop.

Moving to a network of crop-specific Stewards would not be cheap and is why we have multi-crop positions. For example, providing a Steward for each of the 13 crops covered in this strategic plan, at an annual cost of $150k per Steward, would be $1.95million per year. Expensive, yes, but definitely doable, especially if existing foundations and high net worth individuals already operating in the regenerative space collaborate on their philanthropy and impact investing.

<u>The Upper Midwest Hazelnut Development Initiative (UMHDI) Stewardship-Model Case Study</u>

The UMHDI is a good case study of how the Crop-Centric, Stewardship-Based Development approach can work. In 2007, stakeholders came together and developed a strategic plan for development of a hazelnut value-chain in the Upper Midwest. The UMHDI started with a staff and budget of zero, but today is a comprehensive R&D and industry development program with activities in each link of the chain. It has built a multi-stakeholder breeding program to deliver improved germplasm to growers. It has created a steward-owned company to manage the propagation bottleneck and facilitate development of supported grower clusters. It has built and subsidizes a shelling facility open to all growers. It launched and supports a grower-owned value-added product and marketing company. It has been largely successful for three reasons. First, the UMHDI is a true partnership with many entities working together toward a common goal. Second, fundraising efforts have been collaborative, not competitive, and targeted to value-chain bottlenecks. Third, the UMHDI has had strong and sustained leadership from two Stewards working nearly full-time on just hazelnuts.

Market Development Considerations

Finding a scalable product-market fit is key for developing a new crop but finding that fit can be challenging when the crop is entirely new to the marketplace. At a minimum, entrepreneurs must develop products with the right use-case and defensible value-proposition for a specific buyer. Businesses selling food products to consumers must go a step further by also developing an effective brand for the consumer packaged goods (CPGs).

Business to Business

Typically, market development follows one of two paths. The simplest is to find a pre-existing company willing to buy the crop as an ingredient via a business-to-business (B2B) transaction. This can work well when the buyer already has a successful product made with that ingredient and just needs more of that ingredient or is looking for a better version of that ingredient, such as a baker looking for culinary wheat flour with better flavor. This B2B approach can also be used when working to create entirely new products, such as encouraging a baker to make Kernza crackers. However, a new product must have a defensible value-proposition, genuine product-market fit, and, most importantly, passionate people that believe in the virtues of the product and are willing to engage in the relentless grind of trade shows, sales calls, samplings, focus groups, and buyer meetings. It is through this grind that a product-market fit and brand is honed. In other words, developing products isn't enough. A product needs an entrepreneur to be successful. This can be a long and risky process with no guarantee of success and is why incumbent food businesses rely so heavily on start-up acquisitions to do innovation.

Business to Consumer

Because it can be difficult for incumbent food companies to launch entirely new products, it is important for new crop development efforts to also pursue the second market development approach, which is to enable and support the passionate entrepreneurs that are doing the grind of developing their own consumer products. The support should include the usual education and training as well as the support of a venture studio, which can assist in assembling a team of co-founders with the complimentary skills necessary to run the business, helping the entrepreneur make connections with funding partners, and helping to optimize the product-market fit.

Grower Ownership of the Value-Chain

Agriculture has a long history of growers receiving the smallest portion of the retail food dollar, especially when they primarily are involved in B2B sale of raw ingredients. A stewardship-based approach to new crop development should work to foster grower-ownership of the value-chain through B2C business development. It is certainly easier to find ingredient markets than to create consumer products, but long-term, growers can be more economically-secure (and the value-chain more durable) if growers are selling products rather than relying entirely on other businesses to sell products. This is especially true early on when markets are more volatile and B2B contracts can be tenuous.

Crop-Specific Strategic Development Priorities

The following pages provide an overview of each link in the value-chain for the crops currently in the UW Emerging Crops Team portfolio. For each link, there are recommended action items to address bottlenecks, if applicable. For each crop we also provide a graphic communicating a priority rating for each link and a list of the most important action items for advancing the crop.

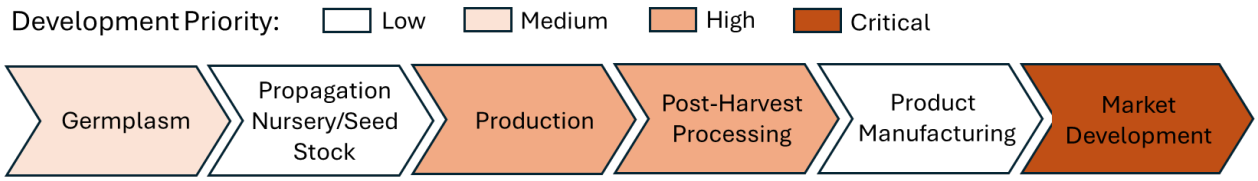
A ***Low*** priority indicates the link does not currently pose a bottleneck to the industry either because there is already sufficient activity or success, such as existence of proven cultivars for a crop, or because the bottleneck can be easily overcome using existing technologies, knowledge, or infrastructure from another crop. For example, fruit growers in Wisconsin already have a good understanding of how to handle and clean soft fruit on a small scale. Thus, the post-harvest processing link for fresh-market honeyberries does not pose a significant bottleneck to the emerging honeyberry industry.

A ***Medium*** priority indicates the link is a current bottleneck, but there is ongoing work to address it, it is relatively easy to overcome, and/or it is not as urgent a priority as other bottlenecks in the value-chain. For example, though the ideal black currant varieties have not yet been identified for WI growers, there are many available varieties and there are variety trials underway.

A ***High*** priority indicates the link is a serious bottleneck to developing the industry and either entirely new actions or increased assistance to existing actions are required to overcome it.

A ***Critical*** priority indicates the link is the primary bottleneck holding back the crop and until it is overcome, the industry cannot expand. An example of this is hazelnut propagation. Further development of a hazelnut industry in Wisconsin is on hold until high-throughput propagation methods are developed and plants of the new UMHDI cultivars are more widely available.

Example Development Priority Graphic



Strategic Development Priorities Summary

Each crop in our emerging crops portfolio has unique bottlenecks and challenges that must be overcome for the industry to develop. Below is a graphical summary highlighting the relative development priority of each link in the value-chain for each crop.

It's a Long List, Who Does What?

This is an overwhelming document with a long list of actions necessary to advance a long list of new crops. No one person, organization, or business can or should try to do it all. We envision this document being used in three ways:

First, we hope the stakeholders involved in each single crop will come together and make a plan for implementing the development priorities identified in this document. We hope the intermediary organizations supporting a given crop will rally behind the proposed crop-centric, stewardship-based development approach with a crop Steward(s) providing leadership and facilitation to help each crop.

Second, we hope the WI Emerging Crops Coalition can be a means for the key stakeholders involved in individual crops to come together and find mutually beneficial ways to overcome common challenges and bottlenecks. For example, can the superfruits be marketed together with a single consumer awareness campaign? Can fiber flax and hemp find ways to share post-harvest processing infrastructure? Also, we hope the Emerging Crops Coalition can help develop a funding and policy structure in WI that is more conductive to new crop development. For example, Wisconsin used to have an Agricultural Development and Diversification Grant program to support new crops. Can that program be revitalized? Can a private-public fund be pulled together that makes targeted investments through grant programs and impact investments?

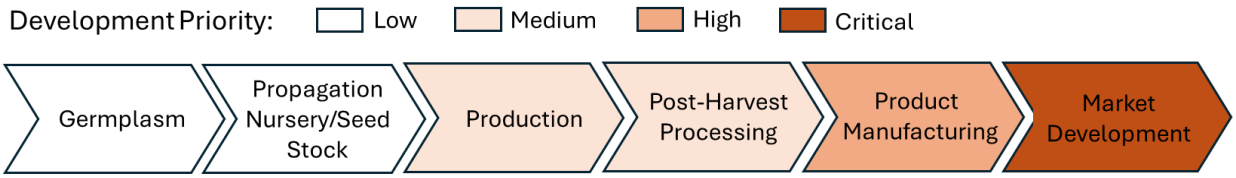
Third, the UW Emerging Crops Team will continue to conduct applied research and education, particularly around germplasm improvement and agronomics. The Team should also be expanded to provide assistance with product, market, and entrepreneur development.

<u>Development priorities for the UW Emerging Crop Team include:</u>

- Expand the Team to include other UW faculty and staff working on product, market, and entrepreneur development.
- Develop a visible and coordinated new crops development presence on one or more UW research stations to better align resources, administrative support, and collaboration around emerging crop germplasm and agronomic field trials.
- Create and resource a public-private fund specifically for new crop development and crop diversification research at UW.

Aronia

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

Support Entrepreneur-Driven Product Development

- Assist WI entrepreneurs in developing branded CPGs to help build demand for aronia products.
- Conduct consumer demand focus groups and total addressable market studies to identify which aronia product categories (beverages, health supplements, snacks, etc.) are most likely to succeed.

Develop Ingredient Markets

- Develop Midwest aronia quality standards equal to or better than imported aronia and train growers on best management practices to achieve those standards.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown aronia are superior to imported berries and ingredients.
- Provide industry coordination to help align supply with market demand.

Introduction

Aronia (*Aronia melanocarpa*) is a perennial shrub native to North America. It is one of a handful of new "superfruit" crops being developed in the Midwest for their high levels of antioxidants and other polyphenols. Aronia berries from existing cultivars are highly astringent and not palatable as a fresh eating fruit. Instead, they are processed and used primarily as a nutraceutical and/or colorant ingredient in juices, gummies, and other manufactured foods. The aronia plant is relatively easy to grow and produces high yields. The challenge in the US has been developing markets with scaled and sustained demand.

The US currently has an estimated 2,400 acres in production, with most of it in Iowa, Nebraska, South Dakota, Wisconsin and Missouri. Iowa alone has 1,200 acres (NASS 2022). Commercial aronia production in Northern and Eastern Europe exceeds 60,000 acres, with Poland producing about 80% of the world's crop. The global aronia market was valued at $525 million in 2022 and is projected to reach $946 million by 2031 (Straits Research).

Wisconsin at a Glance (NASS 2022):
Number of farms: 74

Number of acres: 180

Breeding

Unlike other new crops, which are often constrained by inferior germplasm, there are a number of high-producing aronia cultivars already available for WI. Two of the most commonly grown are ‘Viking’ and ‘McKenzie’. There are currently no public aronia breeding programs in the Midwest. Breeding programs are expensive to operate as they require long-term investment in staffing, particularly if the goal is to combine traits through cross-pollinations. Further, breeding objectives have not been clearly articulated by growers or downstream food manufacturers. For example, breeding for less astringent berries might make the berries more palatable, but if the primary use-case is as a nutraceutical, then breeding for enhanced polyphenols and antioxidants (and increased astringency) might be a higher priority.

Strategic Breeding Priorities:

- Though germplasm improvements can always be made, breeding is not currently a primary limitation to expanding WI aronia production.
- Conduct stakeholder needs-assessments to identify strengths and weaknesses of currently available cultivars.

Propagation and Nursery Stock

Propagation and nursery stock availability are currently not barriers to industry development. Aronia are easily propagated by rooting softwood stem cuttings and plants are available from nurseries throughout the United States. Though further industry expansion is dependent on market development, if new production acres are needed it would be helpful for growers to aggregate plant needs and negotiate with nurseries on pricing and plant need projections.

Strategic Propagation/Nursery Stock Priorities:

- Enable grower cooperation to pool plant orders to negotiate with nurseries on pricing, standardize nursery stock quality and size, and align nursery stock production with demand projections.

Production

Aronia plants are vigorous, tolerant of a range of soil conditions, and relatively free of major insect and disease pests. The plants are consistently productive and can be harvested by hand or with existing over-the-row straddle-harvesters. Weed management is similar to other bush-type crops with growers using a combination of cultivation, herbicides, and mulches. The wide adaptability and relative ease of production has made it easy for production to get ahead of markets and the Midwest has seen a number of plantings go unharvested or removed.

Aronia growers generally fall into one of two categories: small-scale producers that hand harvest and sell to local markets or large-scale producers that machine harvest and sell wholesale to processors.

The large majority of aronia growers in Wisconsin are small-scale producers with an acre or less. The ease of production makes aronia popular with smaller growers, especially smaller diversified growers

with business models based on selling small volumes of many different products. These growers typically sell fresh or frozen berries to local markets and/or make value-added products such as jams, jellies, and juice.

Large scale aronia growers are far fewer in number but account for the majority of acreage in Wisconsin. These growers machine-harvest their crop with over-the-row harvesters or have it custom harvested and aggregate it with berries from across the Upper Midwest to access wholesale markets. Large scale growers have had much more difficulty finding markets for their crops, and many report not harvesting their crop in recent years.

Even though Aronia is relatively easy to grow, consistent production of high-quality berries has been a challenge for some growers, with adverse downstream effects in the value chain. Berry quality, especially brix and astringency, can vary significantly based on weather conditions, management, and harvest timing. Processors have expressed frustration at receiving low-quality or poorly cleaned fruit.

New crops are often appealing to independent-minded or new growers who may be hesitant to work with others. However, with a processing crop like aronia, growers would benefit by producing together as a cooperative (or other entity), in order to develop product standards, offtake agreements with buyers, and implement supply-side management strategies to align supply with demand.

***Strategic Production Priorities*:**

- Provide grower outreach education and training on production best management practices.
- Develop enterprise budgets and decision-making tools to help WI growers determine and ensure profitability.
- Assist growers and buyers in developing, understanding and meeting berry-quality standards.

Post-Harvest Processing

Post-harvest processing methods depend upon the scale of production. Small-scale aronia growers usually process by hand, picking berries off their stems and washing them in personal home kitchens or small washing stations. An advantage aronia berries have over other berries is their storage quality - they will keep in the refrigerator for several weeks without significant loss in quality.

Larger-scale growers need industrial scale processing equipment to de-stem and clean their berries. Some growers have their own equipment, while others pay to have their berries de-stemmed and cleaned. Cleaning lines are often repurposed from the blueberry or cranberry industries. After berries are cleaned, they are frozen and stored in cold storage facilities. Frozen berries are then processed into functional ingredients such as juice, powder, extract, and concentrate.

There are very few aronia cleaning lines currently in operation in the Midwest. This is due in large part to the lack of secure markets. Several cleaning lines have been mothballed because many growers are not harvesting their crop.

The presence of the cranberry industry in Wisconsin provides significant opportunities for a WI aronia industry, but further development will depend on markets. Several companies, such as Northern Lights Food Processing and Badger State Fruit Processing, that work primarily with cranberries have been contracted by aronia growers and grower groups to produce products such as powders, dried whole berries, juice, and juice concentrate. However, a major barrier to contracting with these companies is the very large minimum order quantities (MOQs) needed to run the equipment. Aronia supply could easily be scaled to meet the MOQs, but markets do not yet exist for these quantities of aronia, as they do for cranberries and other more mainstream fruit. Arise Nutrition has provided cleaning services for growers in recent years but has recently focused on manufacturing ingredients.

Strategic Post-Harvest Processing Priorities:

- Facilitate coordination between growers and buyers to develop equitable, mutually beneficial and sustainable production contracts.
- Assist geographic clusters of smaller-scale growers in building and operating right-sized processing and cleaning lines to enable their continued direct marketing and product development operations.

Products and Markets

The market for direct-to-consumer fresh and frozen berries is limited due to the strong astringency of the fruit. As such, most growers need to make their own value-added products, wholesale the berries to a food or beverage manufacturer, or sell into a regional aronia supply chain. Some WI growers have vertically integrated and are making jam, jelly, juice, applesauce, baked goods, and other products for sale direct to consumers or to local wholesale accounts. A number of WI breweries, cideries, creameries, and bakeries have used aronia in their product lines, but volumes have been low compared to other incumbent fruits. Wholesaling berries requires additional capital costs for cleaning and freezing, which in turn require sufficient sales volume to justify the investment. Such volumes often require mechanical harvesting, which combined with the cleaning and storage equipment, is often too much capital and a barrier to expansion for many growers.

Expanding aronia production in WI will require developing a supply chain into which growers can sell large volumes of fresh fruit. An aronia supply chain would include: 1) A core grower base with economies of scale sufficient to provide aronia at a competitive price and consistent berry quality, 2) Receiving stations to clean and store the berries, 3) Ingredient manufacturers, and most importantly, 4) Food companies capable of generating sufficient sell-through of branded products to the end consumer.

Building a sustainable supply chain requires that all four links be aligned AND that all links are fairly compensated and profitable. Typically, such supply chains will form either from the top down with a food company calling for more supply or the bottom-up with growers incrementally building markets and capacity to supply those markets. Each link can be a separate business or a single vertically-integrated business can do all four. Prior efforts to develop a value-chain in the region have all taken a bottom-up approach where an aggregator, such as a single buyer of bulk berries or a grower organization, looks for a company to buy the fruit to make a food or beverage product. Unfortunately, none of these efforts have yet been able to find stable buyers. Further, because growers planted so many acres before having

markets, the stakes have been high to move that fruit, and the repeated failures have greatly damaged morale and stressed relationships in the industry.

Consistent berry quality has been a challenge for Midwest growers. Many larger growers do not yet have the quality control and production standards to meet the exacting specifications of ingredient producers. Companies with an interest in sourcing berries from the Midwest have mentioned the lack of consistent high-quality berries as a factor in their decision to source product elsewhere. Quality standards and nutritional specifications that buyers are looking for have not been developed or enforced to a large extent by grower groups or suppliers. The aronia industry and ingredient suppliers, in particular, would benefit from agronomists who work with growers to achieve high berry quality standards.

Finding market partners for Midwest producers is further challenged by aronia imports from Europe, usually in the form of juice concentrate, which are about 25-30% of the price of domestic aronia. Poland, which produces about 80% of the world's crop, subsidizes aronia production. The Polish government also taxes fruit sales through a check-off program to help pay for marketing.

The single biggest challenge for food manufacturers is finding a product-market fit that can enable expanded sales. Small-scale growers are able to sell limited quantities of berries to local markets such as farmers markets, u-pick, food coops, and other busineses where they can do their own marketing, but given the choice, most consumers will opt for the sweeter incumbents: strawberries, blueberries, raspberries, cherries. Smaller growers can also make value-added products, but creating a profitable food product is often beyond the scope or ambition of most small aronia growers, and it's even more difficult when most consumers have little if any awareness of aronia.

A google search will show many branded aronia powders, juices, gummies, and other nutraceuticals currently on the market, but the nutraceutical food category is crowded and aronia has not yet broken through sufficiently in the US market to support expanded production in the Midwest.

As with other new crops, marketing associations and coordinated regional product awareness campaigns would help generate consumer demand, but such campaigns are expensive and the industry isn't yet large enough to adequately fund them through check-off programs or association dues. Further, there must first be aronia products with proven product-market fit available in sufficient supply to capitalize on a general consumer awareness campaign.

Large incumbent food and beverage producers often struggle to develop products with good product-market fit and branding. Instead, they rely heavily on acquisition of innovative food and beverage brands created by entrepreneurs. Thus, relying on the big food companies to advance aronia may not be the best approach. Instead, the industry may be better served by creating the enabling conditions for entrepreneurial brand and product innovation around aronia to occur.

Strategic Product Development and Marketing Priorities:

- Conduct consumer demand focus groups and total addressable market studies to identify which aronia product categories (beverages, health supplements, baked goods, etc) are most likely to succeed

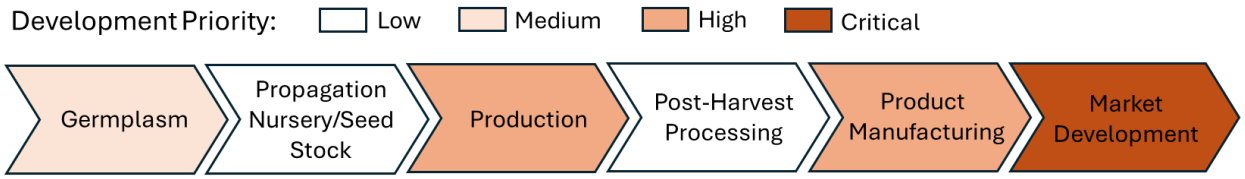
- Assist WI entrepreneurs in developing branded CPGs to help build demand for aronia products
- Work with mid-tier ingredient producers and mid-scale food companies to develop and test aronia products
- Help the industry develop a strong value-proposition for why WI and Midwest-grown aronia are superior to imported berries and ingredients.
- Provide industry coordination to help develop a stable supply chain in WI
- Develop production best management practices for WI production regions paired with industry standard specifications for berry cleaning, brix, acids, and size.
- Work with WI growers to develop grower cooperatives or other entities as a means to collectively work with buyers and manage supply and demand.
- Support growers, growers associations, and stakeholders in developing, funding, and implementing a consumer awareness campaign about the health-benefits and ecosystem services of aronia.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Roberta Barham (Barham Gardens), Bradley Bolling (UW-Madison Department of Food Science), PJ Connolly (Savanna Institute), Dean Duval (Farmer, Board Member, American Aronia Berry Association), Todd Heeg (Northern Lights Food Processing), Dale Hilgenkamp (Farmer, Board Chair, American Aronia Berry Association), Blake Johnson (A3 Aronia), Bernie Lager III (Arise Nutrition), Vicki Nemitz (JR Nemitz Cranberry and Aronia), Bill O'Brien (Bellbrook Berry Farm), Cory Secher (Carandale Farm), Craig Solverson (Solverson Aronia Farm), and Dean Tranel (Tranel Aronia Products).

Currants

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

Support Entrepreneur-Driven Product Development

- Utilize an entrepreneur-in-residence program to develop value-added currant products and businesses.
- Support the entrepreneurs with consumer focus groups to identify which food product categories and brand messaging are most likely to succeed..

Launch a Comprehensive Value-Chain Development Programrm

- Assemble a support team of intermediary Stewards to travel to Europe to learn mechanized production, processing, and product standards for both black and red currants.
- Develop a core grower network building off initial efforts of the Savanna Institute and Canopy Farm Management.
- Launch a collaborative Midwest Currant Initiative to shepherd development of a currant industry through concurrent development of each link in the value-chain.

Introduction

Currants have been popular in Europe for centuries but have never been a major part of North American fruit consumption, in part due to the preference for sweeter fruit (strawberries, raspberries, blueberries) and in part due to regulations prohibiting the production of some currants due to their association with white pine blister rust. Red, white, and pink currants (*Ribes rubrum*) are usually eaten fresh or processed into jams and jellies. Black currants (*Ribes nigrum*), with their pronounced earthy or musky flavor and astringency, are a processing berry most often used for juice, but also valued for jam, jelly, wine, liqueurs, and nutraceutical products. Currants, and especially black currants, are promoted as a “superfruit” due to high levels of Vitamin C and other antioxidants.

The different flavor and plant characteristics of these two types of currants lend themselves to different production systems, products, and supply chains, with large implications on the potential scale of the industries in Wisconsin. White and pink currants produce numerous but small and fragile berry clusters (strigs) that are not economically viable to pick by hand except at the smallest scale and do not machine harvest well due to the fragile berries. Red currants produce larger strigs with more durable berries and are harvested both by hand and mechanically. With a slightly sweeter taste, red currants are sold both

for fresh eating and for processing. Black currants are a firmer berry with a thicker skin and uneven ripening along the stems. Their growth habit and berry presentation are similar to blueberries and aronia and can be managed and harvested in much the same way.

The US has an estimated 457 acres in currant production (black and red), with Washington and New York leading the way. Wisconsin has 33 acres spread across 92 farms (NASS 2022). Russia and Europe lead the world in currant production. Europe produces an estimated 140,000 acres of black currants, with Poland accounting for about 78% of production. About three quarters of black currants produced in Europe are for the juice market.

Wisconsin at a Glance (NASS 2022):
Number of acres: 33
Number of farms: 92
Acres of currants per farm: 0-1 acre; a few 1-10 acres

Breeding

As with Aronia, there are many cultivars of both red and black currants available that can support commercial production. As such, breeding and germplasm are not major bottlenecks for expanding a WI currant industry. There is no public currant breeding program in Wisconsin as of 2024, but the Savanna Institute in Spring Green has recently started a program for black currants using the germplasm from the breeding program of McGinnis Berry Crops, formerly based out of British Columbia.

Strategic Breeding Priorities:

- Though germplasm improvements can always be made, breeding is not currently a primary limitation to expanding WI currant production.

Propagation and Nursery Stock

Currants are easily propagated via stem cuttings. Nursery stock is available from nurseries in Wisconsin and throughout the US. As such, propagation and nursery stock are currently not major limitations to industry expansion. That said, once other limitations are addressed and demand for plant material growers it will be helpful for growers and nurseries to work together to align supply and demand.

Strategic Propagation/Nursery Stock Priorities:

- Enable grower cooperation to aggregate plant orders and negotiate with nurseries on pricing, standardize nursery stock quality and size, and align nursery stock production with demand projections.

Production

As with the other new superfruits (elderberry, aronia) most currants in Wisconsin are grown on a small scale, less than an acre, and hand harvested. In general, as like aronia, currants are relatively easy to grow. The plants do prefer cooler summers and can sometimes struggle in southern WI. They are tolerant to partial shade. Weed management is similar to other bush-type crops with growers using a

combination of cultivation, herbicides, and mulches. The plants do require periodic pruning to remove old wood and thin younger fruiting wood. Labor for hand harvesting is by far the biggest challenge. Hand harvesting can account for 75% or more of total labor needs. Trellising can improve harvest efficiency, but time and resources to build the trellis should be weighed against potential benefits. Leaf disease has been an issue for some growers, particularly powdery mildew.

A few growers in Wisconsin are producing black currants on a larger scale. These growers use domestic blueberry harvesters or mechanical harvesters imported from Europe, such as the Joanna. Such harvesters can also be used for other berries like aronia and honeyberry.

As with all crops, there is a learning curve to growing currants, but there are educational resources to help guide growers. That said, there are many questions to be answered as to optimizing fertility and pruning strategies. Chris McGuire, of Blue Roof Orchard, recently completed a grant-funded, on-farm research project comparing trellised currants with freestanding, untrellised bushes. Data was collected on material costs, labor, time, yield, and fruit size for trellised and untrellised plants from 2020 through 2023. Efforts are underway by Savanna Institute and Canopy Farm Management to plant large acreages of black currants together with chestnuts in alley cropping systems in southwestern Wisconsin for the juice market. Cleaning and processing capacity, product development, and markets will need to be scaled with production. UW-Madison has conducted research on cultivar performance, trellis techniques, and harvest methods but does not currently have any on-going research.

In many ways, currants face the same challenge as aronia. The crop is relatively easy to grow, but markets are not yet sufficient to support significant production. Also, hand-harvesting a processing crop is not typically financially viable, which means production acreage must be large enough to support a mechanical harvester. If consumer demand in the US does grow, there will be pressure from European imports where there is already a well-established industry. Currants are different than aronia, however, as the fruit is far less astringent and, therefore, has a wider use-case, which should make it easier to find markets.

Strategic Production Priorities:

- Provide grower outreach education and training on production best management practices.
- Develop enterprise budgets and decision-making tools to help growers determine and ensure profitability.
- Assist growers in understanding and meeting berry-quality standards.

Post-Harvest Processing

Red currants are either picked as whole strigs and sold fresh with no post-harvest processing or are de-stemmed. Black currants usually separate from the stem at harvest if the berries are picked at the right time. Otherwise, cleaning lines used for other small fruits like blueberries can be used for black currants. Access to efficient cleaning and processing equipment is a common challenge cited by small scale growers. Cleaning and sorting infrastructure used by the cranberry industry would also work for black currants, but meeting minimum quantities for customer cleaning and sorting can be a challenge for smaller-scale growers.

Large scale black currant growers who machine-harvest have struggled to find cleaning services. Growers have found that blueberry cleaners have not been willing to clean black currants. Their only option has been a single processor, Arise Nutrition in Wisconsin Rapids, who operates an industrial cleaning line, primarily for aronia growers. This cleaning line has the capacity to handle black currants in the quantities these growers produce. Berries are then kept frozen in cold storage, sometimes in Wisconsin Rapids, which has a large facility, or closer to the farm.

Strategic Post-Harvest Processing Priorities:

- There is sufficient post-harvest processing and storage capacity in Wisconsin to serve larger-scale growers once markets are sufficient to support larger-scale production.
- Facilitate coordination between growers and buyers to develop equitable and mutually beneficial and sustainable production contracts.
- Assist geographic clusters of smaller-scale growers in building and operating right-sized processing and cleaning lines to enable their continued direct marketing and product development operations.

Products and Markets

The Wisconsin currant industry consists of small-scale producers selling direct to consumers and a few larger-scale producers wholesaling fruit to value-added processors, mainly local wineries and cideries. No known value-added currant products produced in WI have achieved national or regional distribution and certainly none have yet achieved the kind of scale to support significantly expanded currant production.

Unlike aronia, there is likely opportunity for WI growers to expand production for sale of fresh-fruit direct to consumers and via wholesale to local outlets, especially for red currants. Some growers are having success with red currants on a trellis in high tunnel greenhouses, similar to production systems in Europe. The strigs and berries are larger in a high tunnel and hand-harvest is more cost-effective. A first step is for growers to target customer groups more familiar with currants, such as immigrants from regions where currants are part of the food culture. Reaching those without prior experience will take consumer education and sampling, as most consumers have never tried them.

As primarily a processing fruit, growing a black currant industry in WI requires the same value-chain development as aronia. The industry will need a core group of professional growers, receiving and storage capacity, ingredient manufacturers, and value-added products with regional and national distribution. Whether a single entity does this via vertical integration, such as a growers cooperative, or multiple businesses work together, the efforts will need to be coordinated to ensure the supply chain links stay aligned and all parties benefit.

Strategic Product Development and Marketing Priorities:

- Develop an entrepreneur-in-residence program specifically to develop currant products and businesses. Support the entrepreneurs with consumer demand focus groups and total

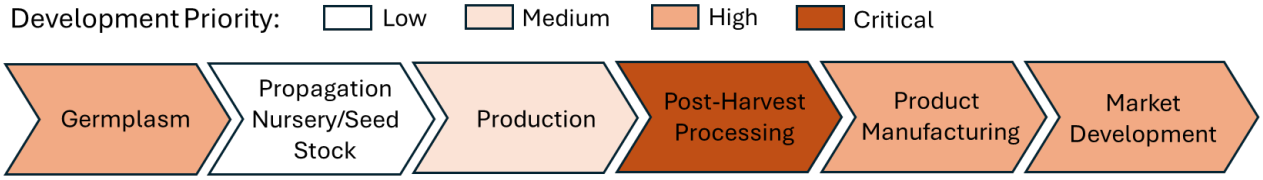
addressable market studies to identify which currant product categories (beverages, health supplements, baked goods, etc) are most likely to succeed.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown currants are superior to imported berries and ingredients.
- Provide industry coordination to help develop a stable value-chain in WI.
- Develop production best management practices for WI production regions paired with industry standard specifications for berry cleaning, brix, acids, and size.
- Work with WI growers to develop regional production clusters to make aggregation and cooperation easier.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Tony DiMaggio (Sacred Blossom Farm), Erik Hagan (Savanna Institute), Lily Hislop (Savanna Institute), Ben McAvoy (Blue Fruit Farm), Chris McGuire (Blue Roof Orchard), John Middleton (Canopy Farm Management), Wandy Peralta (Branches and Berries), and Rick Schwendiger (Lancashire Farm), and Eric Wolske (Canopy Farm Management).

Elderberry

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop new cultivars with more uniform ripening and reliable yields.
- Conduct research on post-harvest handling to better understand options for de-stemming, refrigerating and freezing elderberries.
- Develop regional processing hubs with de-stemming, cleaning, freezing, and drying equipment, as well as cold storage, to serve clusters of growers in Wisconsin.
- Assist WI entrepreneurs in developing branded CPGs to help build demand for elderberry products.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown elderberries are superior to imported elderberries and ingredients.
- Establish a Midwest Elderberry Initiative with stakeholders, researchers, and growers to steward development and expansion of the elderberry value-chain.
- Support the Midwest Elderberry Cooperative to facilitate marketing relationships with mid-tier product manufacturing companies.

Introduction

The American elderberry (*Sambucus canadensis*) is native to much of eastern North America and can be found growing wild throughout Wisconsin. While elderberry has been wild harvested in the US for centuries, its cultivation as a commercial crop is much more recent, beginning mainly in the 1990s. Elderberry remains underdeveloped as a commercial crop and significant potential exists for genetic improvement and industry growth. Elderberry is unique among the emerging berries in that mechanical harvest is not yet possible.

The global market for elderberries is estimated at $350 million per year. The US market for elderberries is estimated at $75 million in sales annually. The majority of elderberries are grown in Europe, with about 30,000 acres under cultivation, primarily in Poland, Bulgaria and Croatia. The US imports roughly 95% of the elderberries sold in the US. The US has about 1700 acres of elderberries under cultivation, with the largest cluster of growers in Missouri, producing about 600 acres statewide. The University of Missouri has conducted the majority of research and breeding work in the US, most recently through its USDA-funded Advancing American Elderberry project.

Most elderberry production in Wisconsin is small-scale, with a few larger scale entrepreneurs. Growers are typically vertically integrated, participating in multiple steps of the value chain such as propagation, production, and manufacture and sale of value-added products such as syrups, jellies, and wine. Most marketing is direct-to-consumer and/or wholesale to local businesses. The Midwest Elderberry Cooperative helps broker sales for growers that want to focus primarily on production. Demand for elderberry has increased in recent years as consumers increasingly look for local and healthy food products.

Wisconsin at a Glance (NASS 2022):
Number of Farms: 132
Number of Acres: 67
Acres of Elderberries per Farm: 0-1 acres; a few in the 1-5 acre range

Breeding

Most elderberry cultivars grown in Wisconsin are selections from wild plants found in Missouri and released by the University of Missouri. Performance of these cultivars is highly variable among growers around the state. Growers report inconsistent production from year-to-year with no clear cause. There are no widely available cultivars that have been selected for Wisconsin conditions and evaluated in replicated trials. In addition, ripening of the cymes on a single plant is not uniform, which means the same plant is harvested multiple times per year. There is no public breeding program in Wisconsin, but the Savanna Institute has recently launched a breeding program to develop improved commercial cultivars.

Strategic Breeding Priorities:

- Develop cultivars with more uniform ripening and more consistent production from year-to-year.

Propagation and Nursery Stock

Elderberries are easily propagated through stem cuttings. Most growers propagate their own plants or source cuttings from other growers. As of 2024, propagation and plant availability were not significant barriers to industry expansion.

Production

Elderberry is widely adapted and relatively easy to establish. However, significant production challenges exist. Grower report highly variable production with yields often below expectations. Labor for harvest is also a major barrier. Elderberries are hand-harvested by clipping the cymes when berries have ripened - machine harvest is not currently possible without significant damage to the berries. Plants ripen their berries over the course of 2-4 weeks, depending on the cultivar and management. The non-uniform ripening of cymes means growers must harvest each plant multiple times throughout the harvest season. These challenges have limited the size of most elderberry plantings to an acre or less, with the exception of a few growers who have access to a large, reliable labor force.

Though plants are relatively easy to establish and fast-growing, growers report challenges with weed management, insect pest control (particularly spotted wing drosophila), and bird predation. Also, it is not clear which soil types and growing regions are best suited for commercially viable production and consistent yields. Growers also seek information on optimal pruning and fertilization strategies.

Strategic Production Priorities:

- Implement agronomic production trials to develop BMPs for elderberry production in different production regions of WI.
- Develop regionally-specific crop production enterprise budgets with research-based yield evaluations.
- Conduct germplasm evaluation trials at multiple locations in WI to help identify optimal production regions in WI.
- Develop a grower education and training program for growers in Wisconsin to provide research-based production information.

Post-Harvest Processing

The current practice is for elderberries to be harvested and frozen within 24 hours to maintain fruit quality. This requires growers to have their own on-farm processing equipment or convenient access to shared equipment.

The first step in processing is removing the berries from their stems, known as de-stemming. This step is a major bottleneck in elderberry production. On a small scale, generally ¼ acre or less, growers can de-stem by hand by freezing the berries on the cymes and then knocking the frozen berries off by mechanical agitation. Another method of de-stemming by hand is pushing berries through holes in a perforated tray and into a basket, leaving the stems behind. Custom built trays are available for about $200. These methods are inexpensive but labor intensive.

At a larger scale, about ¼ acre or more, a mechanical de-stemmer is required. Mechanical de-stemmers are cost prohibitive for most growers. There are several models commercially available in the US, ranging in price from about $7,000 to $10,000. These de-stemmers run at an estimated capacity of 300-500 lbs/hr. A few growers have imported and retrofitted small-scale grape de-stemmers from Europe. After de-stemming, berries are sanitized, rinsed and drained using a series of utility sinks.

After berries have been cleaned, they are usually frozen. Some growers will freeze-dry or juice fresh berries using small scale equipment. On-site cold storage is a common challenge among small growers.

Lack of processing equipment has been a significant barrier for the Midwest Elderberry Cooperative in securing large wholesale contracts. Chris Patton, President of MEC, says individually quick frozen (IQF) is the preferred method to preserve elderberries for the functional foods market. This freezing method retains the shape, color, smell, taste, and nutritional qualities far better than other methods, and IQF berries can be individually poured for more precise volumes, unlike bulk frozen berries which tend to stick together. IQF equipment is expensive and there may be other options, such as blast freezing, that is more cost-effective at the current scale of production.

The Midwest Elderberry Cooperative, along with partner organizations including Savanna Institute, Food Finance Institute and Renewing the Countryside, is exploring the feasibility of building a processing and shipping hub with a shared continuous flow de-stemmer (1000-2000 lbs/hour), IQF equipment, and aggregated cold storage.

Strategic Post-Harvest Processing Priorities:

- Develop small-scale, affordable de-stemmers for growers to do on-farm processing.
- Conduct research on post-harvest handling to better understand options for refrigerating and freezing elderberries.
- As with other new crops, develop geographic clusters of growers specifically to share post-harvest processing infrastructure.
- Establish a subsidized processing facility to overcome the chicken-or-egg dilemma of not enough berries to support a commercial facility, but with no commercial facility growers are hesitant to grow more berries.
- Work with existing partners to create a Midwest Elderberry Initiative to coordinate efforts to steward the industry.

Products and Markets

Elderberry has generated much enthusiasm in part due to the many use-cases. The berries can be sold frozen or processed into syrup, juice, wine, concentrate, jam, jelly, vinegar, sauces, salad dressing, beverages, cordials, juice blends, yogurt, baked goods, and more. As a superfruit, elderberries are also processed into functional ingredients and used in health supplements and nutraceuticals. In addition to the berries, the flowers are dried (elderflower) and sold as an ingredient in nutraceutical products.

Growers not wanting to sell direct or make their own value-added products can sell through the Midwest Elderberry Cooperative (MEC). MEC arranges wholesale contracts for growers but does not aggregate or process the berries. Elderberries are sold bulk-frozen, freeze-dried, thermally dried, and as frozen juice. Elderflowers are sold dried. This decentralized, regional hub strategy helps minimize freight charges but puts the onus of aggregation, de-stemming, and freezing on growers. The hub strategy can be strengthened by supporting geographic clusters of growers cooperating on post-harvest processing and aggregation, similar to a receiving station model used in mature crops.

One challenge that MEC has encountered in accessing markets is that larger buyers often prefer elderberries in forms that are not currently available in large quantities, such as pourable IQF and dried elderberries. Many larger growers have bulk-frozen elderberries in 25lb buckets, a system that is easy and inexpensive for growers. However, these 25lb buckets of bulk-frozen elderberries are more difficult for buyers to use, since they take considerable time to thaw and release juice. This has resulted in a backlog of inventory, with as much as 100,000lbs of bulk-frozen elderberries in storage in northern Illinois. Due to the oversupply, MEC is currently recommending that growers only produce as much as they can sell directly to consumers.

A major challenge in accessing larger markets is competition with European elderberries. The US imports approximately 95% of elderberries sold in the US. The domestic market for elderberries is large, but MEC is challenged to pay growers as much as it would like in order to compete with comparatively low-priced imported European elderberries and other specialty fruit ingredients. This competitive situation also exists for crops like aronia berry and black currants. Certified organic berries in the US are also undercut by imports, because wild harvested berries in Europe are considered organic by the EU.

The Midwest Elderberry Cooperative is working with Agricultural Utilization Research Institute (AURI) in Minnesota to research the nutrient profiles of American elderberry cultivars. The objective is to develop specification sheets to justify a cost premium over European elderberries. This project, funded by a Specialty Crop Block Grant, will finish in winter 2024-2025.

Strategic Product Development and Marketing Priorities:

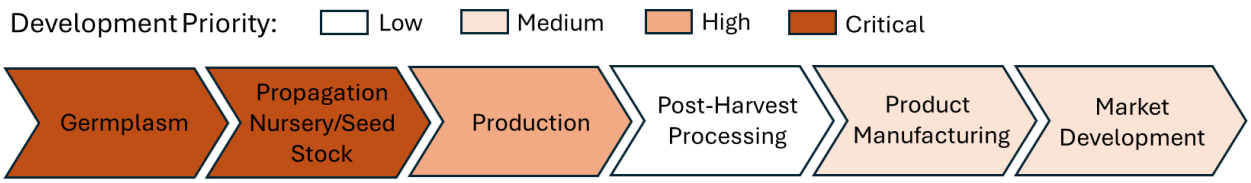
- Help the industry develop a strong value-proposition for why WI and Midwest-grown elderberries are superior to imported elderberries and ingredients.
- Support the Midwest Elderberry Cooperative to facilitate marketing relationships
- Work with early-adopter growers and food manufacturers to identify and develop elderberry products with good product-market fit.
- Support growers, growers associations, and stakeholders in developing, funding, and implementing consumer awareness campaigns about the health-benefits and ecosystem services of elderberry.
- Conduct consumer demand focus groups to identify which elderberry product categories (beverages, health supplements, baked goods, etc) are most appealing.
- Assist companies in developing branded CPGs to help drive consumer awareness and consumption.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Mike Breckel (Ocooch Mountain Elderberries), PJ Connolly (Savanna Institute), Bill Davison (Savanna Institute), Tony DiMaggio (Sacred Blossom Farm), Erik Hagan (Savanna Institute), Nick Knighton (Half Moon Farm), Ben McAvoy (Blue Fruit Farm), Chris Patton (Midwest Elderberry Cooperative), Wandy Peralta (Branches and Berries), Jason Robinson (Agricultural Utilization Research Institute), Sheri Scott (Driftless Berry Growers), and Natasha Simeon (Regeneration Acres).

Honeyberry

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Evaluate available cultivars to generate locally-relevant performance data.
- Work with regional nurseries to produce bareroot dormant rootstock of the top performing varieties.
- Develop a grower education and training program for growers in Wisconsin to increase knowledge of honeyberry production and harvest practices.
- Support growers and stakeholders in developing, funding, and implementing consumer awareness campaigns about the health-benefits and unique flavor of honeyberries.
- Provide training to growers on best practices for handling, storing, and selling soft-fruit like honeyberry.
- Fund an industry coordinator position to help shepherd development of the value-chain to support sale of fresh fruit and value-added products.

Introduction

Honeyberries, also known as haskaps, are a promising new berry crop for Wisconsin. They are a member of the honeysuckle family native to the boreal forests of Russia, Japan, North America, and the Kuril Islands, a Russian archipelago north of Japan. Fruit are born on multi-stemmed perennial shrubs that are widely adapted to Wisconsin growing conditions. Honeyberries are high in antioxidants, making them highly nutritious and giving them “superfruit” status.

Honeyberries have been cultivated in Japan and Russia since at least the 1800s. Jim Gilbert is generally credited with introducing honeyberries to the United States in the 1990s through his nursery, One Green World, after collection trips to Russia.

The main areas of production worldwide are Russia, Japan, Poland, Canada, China, and the United Kingdom, where large scale farms are machine harvested. In Wisconsin, and the United States more generally, honeyberry remains a small-scale crop that is hand harvested for local fresh markets. A few growers are exploring large scale production with mechanical harvesting along with aronia and black currants. Because the berries ripen early in the season, they have so far not suffered significant damage from spotted wing drosophila (SWD), which is a huge appeal to berry growers that have suffered

significant SWD damage to their raspberry and blueberry crops in recent years. Whether the SWD lifecycle adapts to increasing honeyberry production remains to be seen.

Wisconsin at a Glance (NASS 2022):
No available data

Breeding

Two breeding programs in North America have been primarily responsible for advancing honeyberry production in the United States: one led by the late Dr. Maxine Thompson in Oregon and the other by Dr. Bob Bors of the University of Saskatchewan.

Maxine Thompson focused on using Japanese plant material to develop varieties suited for the Pacific Northwest climate. The breeding program at the University of Saskatchewan is developing varieties for cold temperate climates such as Wisconsin, with a focus on mechanical harvesting. 'Aurora'(2012), 'Boreal Beauty'(2016), 'Boreal Beast'(2018), and 'Boreal Blizzard'(2016) were released by Saskatchewan and are becoming popular with growers. A third breeding program at Berries Unlimited, based in northwest Arkansas, has released many new varieties, with mixed reviews among growers.

While Montana State University and North Dakota State University have well established variety trials, there is limited information on variety performance in the Upper Midwest. The only publicly available data we are aware of is from a project funded by Minnesota's AGRI Sustainable Agriculture Demonstration Grant Program that looked at yield from seven different cultivars at three farms in Minnesota from 2021-2023. The University of Wisconsin-Extension is currently establishing replicated performance trials with the most recently released honeyberry cultivars to help growers identify top cultivars for WI. UW Extension is also partnering with North Dakota State University, Montana State University, University of Saskatchewan, and SeedLinked to establish collaborative honeyberry trials with nearly 30 growers to build collective knowledge on cultivar performance on farms throughout the Midwest and Great Plains.

Strategic Breeding Priorities:

- Continue to evaluate top honeyberry cultivars to identify the best germplasm for WI.
- Identify the most important traits for improvement and work with breeders to improve those traits.

Propagation/Nursery Stock

Honeyberry plants are offered by nurseries throughout the US, but finding some varieties can be challenging. Some nurseries have exclusive licenses for varieties from Maxine Thompson's breeding program. Plants are easily propagated from dormant stem cuttings. Many companies in the US and Canada wholesale plants derived from tissue culture. All honeyberry varieties available in the US are patented (except for Czech #17, aka Berry Blue), and vegetative propagation of these varieties without permission is illegal.

Nursery plants are currently sold both bareroot and containerized, but are highly variable across the nurseries selling them. Growers report struggling with establishment, which is likely influenced by nursery stock.

Strategic Propagation/Nursery Stock Priorities:

- Conduct establishment trials with different nursery stock of the same cultivars to determine optimal plant nursery stock type (bareroot or containerized), container size, growing media, and plant age.
- Conduct planting season trials to determine whether fall or spring planting is optimal.
- Help growers aggregate their plant orders to align supply and demand with nurseries, negotiate on pricing, and standardize nursery stock production

Production

Plants are widely adapted, easy to grow, and largely free of pests and diseases. They ripen very early, beginning in early June, avoiding spotted wing drosophila and most other insect pests. However, bird predation is a major concern among growers. Cedar waxwings are notorious for decimating honeyberry plantings. Bird netting is the only reliable form of control.

Labor required for hand harvest is also a major challenge for growers. Depending on the cultivar, honeyberry plants can be bushy and have a range of berry sizes, making hand harvest time consuming. Growers use a number of different semi-mechanical harvesters to increase efficiency by shaking berries off the plants onto a tarp or container using tools such as reciprocating harvesting forks and olive harvesters. Leaves and other debris are blown off using leaf blowers or vacuum systems. Growers have reported mixed success with these tools.

Growers also report difficulty in finding information on production practices and a prevalence of misinformation. North Dakota State University and Montana State University have the only significant honeyberry research programs in the United States. Growers commonly cite gaps in knowledge on pollination requirements, harvest timing, harvest methods, and cultivar performance.

Honeyberries have the potential to be grown at scale and machine harvested in Wisconsin, along with other “superfruits” such as aronia and black currants. However, honeyberry is a relatively soft fruit and, though successful mechanical harvest has been done in Saskatchewan, breeders are working to breed firmer-fruited varieties.

Strategic Production Priorities:

- Develop a grower education and training program for growers in Wisconsin to increase knowledge of honeyberry production and harvest practices
- Implement agronomic production trials to develop BMPs for honeyberry production in different regions of WI.

Processing

Honeyberries have a relatively short storage life and must be rapidly cooled after harvest and then shipped to market as soon as possible. As with other small fruits, mechanical harvest will require a

cleaning line to sort out debris, damaged fruit, and un-ripe fruit. Because honeyberry ripens earlier than other bush fruit, the same harvesting and cleaning equipment can be used.

Product and Markets

Of all the new superfruit, honeyberries have the sweetest flavor and can be sold as fresh fruit with no additional processing. Customer acceptance is high with some describing the flavor as a cross between a blueberry and a raspberry. Because they ripen before other fruits, they can be a good addition to existing pick-your-own operations and other growers looking to extend their season. Like other small fruits, honeyberries have excellent qualities for processing into value-added products. Their flavor, color, and nutritional qualities lend themselves well to jam, wine, juice and liqueur. As a result, growers are reporting success selling value-added products direct to customers.

Expanding into wholesale is a bit more challenging with honeyberry due to the relatively soft fruit and short shelf-life, especially if selling fresh fruit to retailers. Beginning growers with experience selling honeyberry have recommended that growers start by delivering direct to retailers the same or next day and avoiding working with a distributor where the fruit may sit in storage for too long. Those exploring wholesale accounts have generally found good acceptance, especially among food and beverage companies used to working with berries.

Some of the early varieties of honeyberry had less than optimal flavor, but new cultivars, notably Aurora, have greatly improved flavor and market acceptance.

Strategic Product Development and Marketing Priorities:

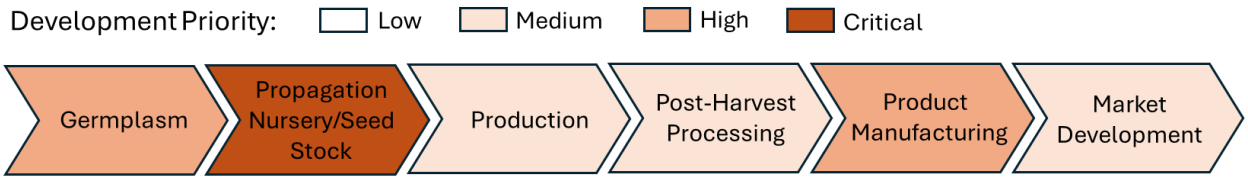
- Support growers and stakeholders in developing, funding, and implementing consumer awareness campaigns about the health-benefits and ecosystem services of honeyberry.
- Provide training to growers on best practices for handling, storing, and selling soft fruit like honeyberry.
- Work with early-adopter growers and food manufacturers to identify and develop honeyberry products with good product-market fit.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Jason Amundsen (Lola Farms), Bob Bors (University of Saskatchewan), Rachel Henderson (Mary Dirty Face Farm), Clare Hintz (Elsewhere Farm), Bernis Ingvaldson (Honeyberry USA), Ben McAvoy (Blue Fruit Farm), Zachariah Miller (Montana State University), Jim Riddle (Blue Fruit Farm), Gerry Schoen (Schoen Valley Orchard), Jeff Sindelar (Little Deb's Berry Farm), George Terwey (Haskap Minnesota), Mark Villars (Homestead 36), and Kathleen Wiederholt (North Dakota State University).

Hazelnut

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop protocols for the successful micropropagation of hybrid hazelnuts to support large scale growth of the industry.
- Develop propagation expertise at multiple nurseries in WI and the Upper Midwest to provide high-quality and low-cost nursery stock for growers.
- Develop geographic clusters of growers to share mechanical harvesting, de-husking, drying, and storage capacity.
- Continue to improve and operate the UMHDI Processing Pilot Line as a subsidized pilot processing line as a means to overcome the chicken-or-egg dilemma of not having enough nuts to support a commercial processing line, but without a processing line growers can't expand their production.
- Assist the American Hazelnut Company and other product manufacturers in determining optimal product-market fit for Midwest-grown hazelnuts.

Introduction

Hazelnuts grow wild throughout the Upper Midwest. The American hazelnut (*Corylus americana*) is widely distributed and has small nuts with thick shells. The beaked hazelnut (*Corylus cornuta*) is more shade tolerant and grows in the forest understory. Hazelnuts are not yet widely grown in the Upper Midwest as a food crop.

Turkey is the largest producer of hazelnuts worldwide, accounting for about 75% of global production. Turkey grows the European hazelnut (*Corylus avellana*), which has high yields of large nuts. In the United States, hazelnut production is almost exclusively limited to the Willamette Valley in Oregon, where 87,000 acres are planted, up more than 30% from five years ago (NASS 2022). Oregon State University runs a breeding program that has released several high-quality cultivars. However, these cultivars are not sufficiently well adapted to the Upper Midwest for commercial production, lacking the cold hardiness and disease resistance to eastern filbert blight, an endemic fungal disease that can be fatal.

The Upper Midwest Hazelnut Development Initiative (UMHDI), a collaboration between University of Wisconsin and University of Minnesota, has been working to develop a hazelnut industry in the Upper

Midwest since 2007 through germplasm improvement and supply chain development. Breeding efforts have focused on combining the winter hardiness and disease resistance of the native American hazelnut with the large nut size and kernel quality of the European hazelnut. After nearly two decades of breeding work, new cultivars are giving rise to a fledgling industry in the Upper Midwest. In addition to breeding, the UMHDI is supporting the emerging industry through agronomic research, testing harvest equipment, developing processing capacity, and providing grower outreach education. UMHDI was instrumental in the formation of the American Hazelnut Company in 2014, a grower-owned business based in Viroqua, Wisconsin that aggregates, processes and markets Midwest-grown hazelnuts.

Wisconsin at a Glance (NASS, 2022)
Total Acreage: 223
Number of growers: 141
Number of Acres per Farm: 0-5, a few larger than 5

Breeding

Unlike the superfruits, the hazelnut industry in WI is limited primarily by lack of proven germplasm that can support commercial production. Ongoing efforts are changing that. After a decade of evaluating candidate hybrid germplasm in replicated performance trials, the UMHDI identified a group of plants, collectively called the UMHDI 1st generation selections, that performed well enough in replicated trials at sites throughout Wisconsin and Minnesota to support commercial production. The 1st generation selections are currently being propagated by nurseries in Wisconsin and Minnesota for wider commercial production. Lois Braun with the University of Minnesota has been making crosses since 2014 between high-performing selections from the Midwest with plant material from Oregon State University and Rutgers University to develop phase 2 breeding populations. The top plants from the early crosses have been identified and are being propagated for replicated evaluation. The top plants from these trials will likely be released as cultivars sometime after 2030. Much larger progeny families have been established since 2022 to support phase 3 breeding efforts, which includes University of Wisconsin, Savanna Institute and a network of Go-First Hazelnut Farms.

The Hybrid Hazelnut Consortium has a breeding program led by Oregon State University, Rutgers University, and the University of Missouri aimed at developing high-yielding hazelnut cultivars that are widely adapted and have durable resistance to eastern filbert blight (EFB). Several cultivars released by this consortium are currently being evaluated by UMHDI in joint performance trials in the Upper Midwest.

Private nurseries, such as Grimo Nut Nursery in southern Ontario and Z's Nutty Ridge in the Finger Lakes region of New York, have been breeding hybrid hazelnuts for decades. Grimo Nut Nursery has released a number of cultivars that are currently being evaluated in UMHDI's joint performance trials throughout Wisconsin and Minnesota.

Strategic Breeding Priorities:

- Secure funding to continue the ongoing UMHDI breeding program.
- Conduct replicated trials of candidate germplasm from the UMHDI, Consortium, and private breeding programs.

Propagation and Nursery Stock

Propagating hybrid hazelnuts is the single biggest bottleneck in the Midwest hazelnut industry. While growing plants from seed is easy, and many nurseries sell seed-origin plants, such plants have been too variable and average yields too low to support commercial production. Thus, current efforts are focused on a variety of clonal propagation methods for the UMHDI 1st Gen plants, including stem cuttings, stool bed layering, and micropropagation.

Several nurseries with the rights to propagate plant material from the UMHDI, including Savanna Institute in Spring Green, Wisconsin, Hauser's Superior View Farm in Bayfield, Wisconsin, and Gertens Nursery in Inver Grove Heights, Minnesota, are using these techniques to generate field-ready plants for growers, but progress with these methods is slow as it takes time to build up sufficient stock plant numbers.

Micropropagation is seen as the most efficient method of clonally propagating plants to support a commercial industry. While the European hazelnut has been successfully propagated through tissue culture for many years, hybrid hazelnuts have proven more challenging. UMHDI partners, including Dr. Jerry Cohen's lab at U of MN and Dr. Amaya Atucha's lab at UW-Madison are working to develop protocols for the hybrids. The Atucha lab has made considerable progress in the last year working with the UMHDI 1st generation selections. However, because each cultivar behaves differently in tissue culture and requires its own protocol, sustained investment will likely be needed for several more years before plant material will be widely available.

Strategic Propagation Strategies:

- Develop protocols for the successful micropropagation of hybrid hazelnuts to support large scale growth of the industry.
- Develop propagation expertise at multiple nurseries in WI and the Upper Midwest to provide high-quality and low-cost nursery stock for growers.

Production

Hazelnuts grown in the Upper Midwest are predominantly shrub-type plants grown in solid hedgerows. The plants typically begin to bear in the 3rd or 4th year after planting with full production starting in year 6. The nuts are in clusters or 2-8 nuts/cluster and are ready for harvest from the middle of August to the end of October, depending on the genotype. Site preparation, planting, and weed control are typical for other shrub-type crops. Primary insect pests are nut weevils and big bud mite. The major disease of concern is a fungal disease, Eastern Filbert Blight (EFB), that is native to WI and the Upper Midwest. Wild American hazelnut and most of the hybrid seedling-type hazelnuts currently being grown are tolerant of the disease. New cultivars are tested extensively against a range of EFB strains to confirm tolerance. Nut predation from blue jays and rodents can be extensive, especially in small plantings adjacent to woodlots.

Surveys conducted by the UMHDI in 2010 showed that there were roughly two hundred hazelnut growers with a combined 200 acres in the Upper Midwest. However, these growers were almost entirely hobby growers, with nuts hand-harvested for personal consumption or grown to improve wildlife habitat,

biodiversity, and soil and water quality. Thanks to the efforts of the UMHDI over the last two decades, a small but increasing number of producers are growing hazelnuts commercially in the Upper Midwest.

Currently, most commercial orchards are less than five acres and consist of seedling plants due to the lack of availability of improved cultivars. These orchards are variable for yield, kernel quality and other important traits for commercial production. Most growers harvest their crop by hand, which is extremely labor intensive. A few larger growers have acquired used machine harvesters, such as straddle-type blueberry harvesters. These harvesters work reasonably well, but are not optimized for hazelnuts, cost-prohibitive for most growers, and difficult to transport for custom harvesting. The University of Wisconsin has evaluated different harvest machines and found that straddle-harvesting is feasible, but will require relatively compact shrubs with a narrow base and orchards designed to accommodate the equipment operations.

In order to establish best agronomic practices on a commercial scale for the hedgerow production system and help kickstart the hazelnut industry, the UMHDI is establishing a network of Go-First Hazelnut Farms in the Upper Midwest. These farms will serve as strategic hubs of hazelnut commercialization and be operated in partnership with UMHDI. Partners on Go-First-Farms will be dedicated to helping build supply chains and working with UMHDI to demonstrate proof of concept production. The farms are being planted with UMHDI progeny families for evaluation along with rows of each 1st Generation selections. Go-First Farms have been sited at six locations in WI so far including: Ashland, Spooner, Finley, Merrill, Adell, Chippewa Falls, and Spring Green.

Strategic Production Priorities

- While nursery stock supplies are low, prioritize planting to Go First Farms to demonstrate hedgerow hazelnut in multiple locations in WI.
- Support early production with grower outreach education and training.
- Connect growers with USDA, State, and local cost-share programs to help reduce establishment costs.

Pre-Processing

In Oregon, the hazelnuts fall from the husks and are harvested from the orchard floor. This requires intensive orchard floor management to remove vegetation or manage low-growing turfgrass. It is also feasible as the harvest season in Oregon is typically dry. In WI, where the ground is likely to be wet in the fall and growers want perennial herbaceous cover on the orchard floor, hazelnuts are harvested directly from the shrub. This requires, though, that the husks must be removed after harvest. Most de-husking equipment available to growers is only effective after the husks have dried. The drying step is time, labor, and space intensive. Growers lay out their green nut clusters for a period of several weeks in a covered space with good airflow, such as a greenhouse or shed. Growers then use a variety of de-husking machines, ranging from simple DIY models, such as bucket and barrel de-huskers, to commercial units such as the Hasatsan or Pendragon X12, to remove the husks. After de-husking, nuts are winnowed using an aspirator to separate the husks from in-shell nuts. This winnowing step is often built into commercial de-huskers.

Strategic Pre-Processing Priorities:

- Continue to evaluate and improve de-husker units to increase efficacy and throughput
- Work with growers to create receiving stations where de-husking, drying, and storage equipment can be shared
- Develop geographic clusters for growers that can share pre-processing equipment and make it easier to aggregate production

Aggregation and Processing

After nuts have been de-husked and dried to 6% moisture, they can be stored and sold as in-shell nuts. Most buyers want kernel, however, which requires cracking the in-shell nuts and separating the kernel from the shell fragments. In Wisconsin, this process requires a Food Processing Plant license from DATCP. Obtaining such a license requires using food-safe equipment in facilities that meet food code. This creates a major hurdle for individual growers and was the motivation behind creating the UMHDI Processing Accelerator located at Northland College in Ashland, WI. The Processing Accelerator is an open access facility managed by the University of Wisconsin, providing processing capacity for any Midwest growers seeking to turn their in-shell nuts into kernels. Processing equipment was acquired through a combination of grants and lease agreements with private individuals. When running at full capacity, the Accelerator can easily process the entire Midwest hazelnut crop with room to grow.

***Strategic Processing Strategies*:**

- Continue to improve and operate the UMHDI Processing Accelerator as a subsidized pilot processing line as a means to overcome the chicken-or-egg dilemma of not having enough nuts to support a commercial processing line, but without a processing line growers can't expand their production.
- Aggregate in-shell supplies from individual and groups of growers to maximize utilization of the Accelerator and reduce per unit processing costs.

Products and Markets

The simplest option for growers is to sell in-shell nuts. De-husking is considered part of the harvest process, thus no license is required to sell in-shell nuts. The nuts have a shelf-life of 18-24 months if stored at room temperature or below as long as the nuts are dried to 6% moisture. However, as most nuts in the Midwest right now are harvested from seed-origin plants there is a huge diversity in nut size, % kernel, and flavor. Thus, every nut a customer cracks open will be different. As a result, most hazelnuts in the Midwest are shelled and sold whole, used as an ingredient in a variety of foods and beverages, or processed further into oil and flour. The hazelnut oil is rich in vitamin E and can be used in cosmetics and skin and hair-care products. Though some growers have been processing their own hazelnuts and selling direct, due to the costs involved in shelling, most hazelnuts produced in the Upper Midwest right now are going to the American Hazelnut Company, who buys in-shell nuts from member and non-member growers, processes them at the facility in Ashland, and manufactures a range of food products at the Food Enterprise Center in Viroqua, WI.

The AHC currently has 40 members, but most are either very small producers with less than an acre of production or have just recently planted hazelnuts. The AHC can sell everything it producers, but the AHC is not yet profitable due to supply constraints and is still in start-up phase with support from grant

and member investments. They are working with partners to increase supply. In addition, they are developing new product lines to use hazelnuts as an ingredient as a means to increase revenues.

Strategic Product Development and Marketing Priorities:

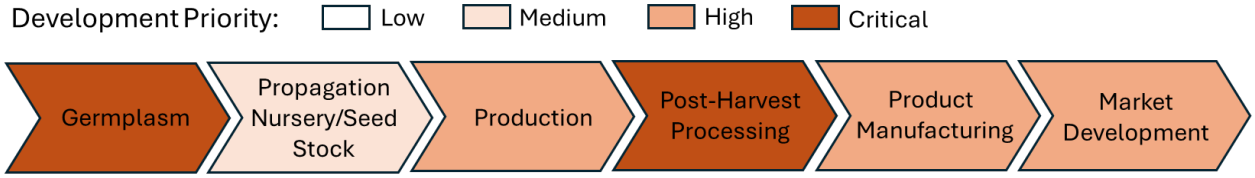
- Help the industry develop a strong value-proposition for why WI and Midwest-grown hazelnuts are superior to imported hazelnuts and ingredients.
- Support growers and stakeholders in developing, funding, and implementing consumer awareness campaigns about the health-benefits and ecosystem services of hazelnuts.
- Assist the AHC and other food manufacturers in determining optimal product-market fit for Midwest-grown hazelnuts

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Amaya Atucha (UW-Madison), Dave Bohnhoff (UW-Madison), Lois Braun (University of Minnesota), Wil Crombie (Organic Compound), Jason Fischbach (UW-Madison), Erik Hagan (Savanna Institute), Mike Lilja (American Hazelnut Company), Pam Saunders (American Hazelnut Company), Senay Ugur (UW-Madison), and Tony Wells (Tree Range Farms).

Fiber Flax

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Evaluate available fiber flax varieties to generate locally-relevant performance data.
- Develop a grower education and training program for growers in Wisconsin to increase knowledge of fiber flax production and harvest practices.
- Fund an industry coordinator position to help shepherd development of the value-chain with a focus on developing clusters of growers, sourcing shared-harvesting equipment, and building a regional processing hub for decorticating, hackling, and spinning.
- Assist WI entrepreneurs in developing fiber flax products to help build demand for flax production.

Introduction

Flax can be grown for multiple products, including seed, meal, seed oil (linseed), and fiber. While flax is still grown for seed in the United States, mainly in Montana and North Dakota, fiber flax production all but ended by the 1950s due to the introduction of synthetic fibers and large amounts of inexpensive cotton. Fiber can be extracted from flax grown for seed, however, the quality is considered too low for apparel and other high-value woven textiles. Such fibers are most commonly used for specialty paper, but the majority is burned or chopped to spread on fields. This report focuses on flax grown for high-value bast fiber used to make linen for textiles.

About 80% of the flax grown for bast fiber is cultivated in Europe, particularly Belgium, France, and the Netherlands. Most of the remainder is grown in China. There has been a growing interest in reviving a fiber flax industry in North America. The value proposition for flax is based primarily on its sustainability credentials. It doesn't require high fertility inputs, irrigation or pesticides and has the potential to help reduce greenhouse gas emissions. At the end of its useful life, linen is biodegradable, unlike synthetic fibers, which account for as much as 30% of microplastic pollution. Co-products from processing flax have a range of uses including as construction materials and animal bedding. In addition, flax fiber is a high value product that is in short supply due to recent extreme weather events in France and Belgium that damaged harvests, reduced seed stocks, and inflated prices for raw materials.

The fiber flax industry in the United States faces many hurdles, but there are a number of organizations across the country that are collaborating to organize farmers, expand production, build processing mills,

and partner with textile manufacturers to rebuild the farm-to-linen supply chain. Some conduct work nationally and across borders, such as the North American Linen Association and Fibershed. Many more are trying to rebuild regional textile economies, such as the Pennsylvania Flax Project, Fibrevolution, and ChicoFlax. In Wisconsin, the Wisconsin Linen Revival as well as several affiliate Fibershed groups (Heartland Fibershed, Three Rivers Fibershed, and Northern Pines Fibershed), are working to bring fiber flax back to Wisconsin.

Wisonsin at a Glance:
Number of Farmers: ~10-20
Total Acreage: less than 5
Acres of Flax per Farm: Small, hand-scale plots of 0.1 acres or less

Breeding

Though fiber flax production has been dormant for decades, there are a number of varieties commercially available from Europe. In addition, the USDA plant materials collection has a wide range of fiber flax in its collections. Wisconsin Linen Revival is screening the USDA collection for flax varieties that perform well in Wisconsin and will yield high quality fiber. In 2024, WLR grew 53 flax varieties in small plots at a location in Dane County in collaboration with farmers. Information was recorded on germination, bloom date, plant height, lodging resistance, and disease resistance. Seed from 16 of the top varieties was saved for more evaluation and seed increases in 2025.

Strategic Breeding Priorities:

- Continue working to evaluate existing fiber flax varieties across a range of locations in WI to identify promising varieties and flaws in those varieties that could be addressed through breeding.

Propagation and Seed Stock

Most fiber flax seed is imported from Europe. Recent extreme weather events in the main seed producing regions of Belgium and France have created a seed shortage and severely limited exports in 2024. The lack of reliable supply, high cost, and delays associated with importing seed from Europe underscore the importance of building a domestic supply of seed.

Seed production is just beginning to scale up in the US. Fiberevolution, based in Oregon, has successfully built out the variety ‘Linore’ developed by University of Oregon in the 1950s, and in doing so, became the only domestic seed supplier of a flax fiber variety. Fibrevolution continues to work closely with the University of Oregon and is developing new varieties. The Pennsylvania Flax Project is also conducting seed trials to select a variety best suited to their region and make it available to growers.

Strategic Propagation/Seed Stock Priorities:

- Evaluate existing fiber flax varieties in WI to identify those that perform well.
- Develop a domestic supply of regionally adapted fiber flax seed.

Production

There is very little fiber flax production in Wisconsin and all of it is hand cultivated on a very small scale. One major limiting factor for mechanical cultivation is the lack of harvest equipment. Flax is harvested by pulling the plants up by its roots using a machine called a puller or grubber. None of these exist in Wisconsin, and there are very few in the United States - Fibrevolution and the Pennsylvania Flax Project may have the only two in the United States. Used grubbers may be available from Europe, but at $65,000, they are cost prohibitive. The Wisconsin Linen Revival is investigating the use of cutting plants at the base with sickle bar mowers or other equipment as a short-term solution. However, this has the disadvantages of reducing the length of the fiber, laying the stalks in random directions in the field rather than neat parallel rows, and can bind up the mower. Wisconsin will need to build or acquire a puller/grubber in order to scale up flax production beyond what is possible on a hand scale (<0.1 acre)

Strategic Production Priorities:

- Work with early-adopter WI growers to acquire a puller/grubber to assist with harvest.
- Investigate alternative harvesting methods that maintain fiber length but don't disturb the soil.

Post-Harvest Processing

Pre-processing

After flax is pulled, it is left in the field to ret, a natural decomposition process in which bacteria break down the pectin that binds the bast fiber with the shive. The process requires expertise and careful management, as it greatly affects downstream processing and the quality of the bast fiber. Proper retting will be achieved through a combination of research and trial and error by growers. Agronomists and university extension will have important roles to play in helping growers "assess the ret" to unlock the greatest value from the flax straw.

Machines called "turners" help the flax dry evenly. After the straw is retted, it is dried and baled, ready to be stored or sold for processing. Wisconsin does not have flax turners or balers and very few exist in the United States (Fibrevolution acquired a puller, turned and baler in 2023 and the PAFP acquired them in 2024).

Aggregation and Processing

Primary processing of flax separates retted flax into a usable form for spinning mills to make yarn. This processing is done in a scutching mill. The bast fibers are first separated from the shive (broken pieces of flax straw that remain after the fiber is extracted from the straw) in a process called scutching. This process is similar to decortication in hemp, in which mechanical force is used to break apart the fibers. Bast fibers are then drawn through a series of metal combs to remove the last of the shive and short fibers (tow) in a process known as hackling. The end result is slivers - long, light gray fibers which resemble human hair and are spun into yarn.

While flax for fiber is grown and hand processed on a small scale in the United States for artisanal purposes, there is no commercial-scale flax fiber processing in the United States at this time. Due to the

high cost of transporting flax bales, Wisconsin will need a regional processing facility to scale up flax production.

Wisconsin Linen Revival is beginning to explore ways to fund and build a regional processing hub. Leslie Schroeder of WLR recently applied for the Mechanical Engineering Keystone Project at UW-Madison to have engineering students build a fiber mill using open source plans from Fantasy Fiber Mill in Scotland. The Agricultural Utilization Research Institute (AURI) in Minnesota has worked with flax to develop processing protocols and fiber quality standards. They have a pilot scale decorticator that has been optimized for flax and is available for non-Minnesota residents to use for a fee. The Pennsylvania Flax Project received an Organic Market Development Grant in 2023 for $1.7 million. Funds will be used to build a processing facility and acquire harvesting equipment.

Strategic Post-Harvest Processing Priorities:

- Work with early-adopter growers to acquire a flax turner and baler to assist growers with pre-processing
- Work with early-adopter growers to build a pilot-scale processing facility to enable early-adopter growers to scale up production and product innovation
- Develop an outreach education program to help educated and train growers on harvest, retting, and fiber separation
- Bring growers and processors together to begin setting product standards and expectations

Products and Markets

The fiber flax product option with the lowest capital cost to growers is selling the standing crop to other growers that have harvesting equipment or to a cooperative or business that does the harvesting and retting. As of writing, there were no known buyers or cooperatives in WI buying standing fiber flax, except possibly on a very local level. If not the standing crop, then growers could do the harvesting and retting and sell retted straw. Again, except possibly at a very local level in small quantities there are no known markets for retted straw in WI. If not retted straw, then growers would have to invest in a processing facility to do the scutching and hackling to produce slivers. The slivers can be sold to crafters and retailers that can spin the slivers into yarn for knitting, weaving, and textiles. Though such buyers exist in WI, their purchase volumes are relatively low and customer acquisition costs will likely be high. There are currently no textile mills that spin yarn or make linen textiles on a commercial scale in WI. The few weaving mills that do exist in North America operate on flax imported from Europe. Wisconsin Linen Revival is hoping to change that by exploring ways to build a processing facility for spinning and weaving Wisconsin-grown flax fibers.

Although Wisconsin Linen Revival and other fiber flax groups in Wisconsin are primarily interested in long line bast fiber for textiles, growers and processors can also sell coproducts to reduce waste and generate additional sources of revenue. Co-products from fiber flax processing can be made into many different products. The shive, which can represent 60-85% of the total weight of the straw, can be used in construction materials, mulch, animal bedding, automotive parts, paper, and bioplastics. Short fiber, called tow, which usually breaks off from the top and bottom of the long line fiber can also be spun. It can be used for erosion control products, carpet batting, and insulation.

Linen and textiles have opportunities for many downstream value-added products, but launching a fiber flax industry in Wisconsin will first require solving the chicken-or-egg dilemma of not enough fiber or markets to support a processing facility, yet without a processing facility no one can grow fiber flax or make products with which to build markets.

Strategic Product Development and Marketing Priorities:

- Construct and operate a subsidized flax fiber processing facility through a private-public partnership.
- Assist crafters and other end-users in working together to identify product specifications and pool purchasing power. In other words, buyers and sellers need to work together to make it easier to find each other.
- Assist the industry in developing consumer awareness campaigns as to the benefits and quality of fiber flax.
- Assist processors and value-added manufacturers in finding the right product-market fit for flax products made in WI
- Advocate for fiber flax to be included as a “specialty crop” by DATCP to make it eligible for funding through the USDA. Currently, flax grown for seed is considered a specialty crop but not fiber flax.

Acknowledgements

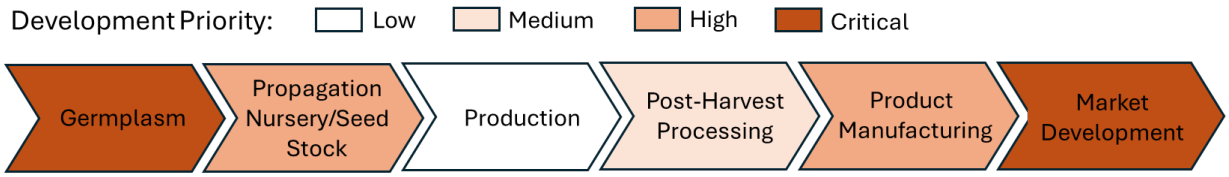
A special thank you to Leslie Schroeder (Wisconsin Linen Revival) for sharing her expertise and making this report possible.

References

https://northamericanlinen.org/
https://www.fibre-evolution.com/
https://paflaxproject.com/
https://www.wisconsinlinenrevival.org/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4403609/
https://www.textileworld.com/textile-world/features/2024/07/bringing-flax-growing-back-to-the-united-states/
https://modernfarmer.com/2024/09/why-flax-grow-north-america/

Hemp
(high cannabinoid)

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Regulatory clarity is essential for high cannabinoid hemp markets to develop and stabilize.
- Identify and develop low-THC strains of high cannabinoid hemp that comply with regulations while meeting market demand.
- Facilitate value-chain planning and development with industry stakeholders to help align production and processing capacity to market demand.

Introduction

Hemp is a generic term encompassing different cultivars of the *Cannabis sativa* species. Marijuana cultivars are bred for psychoactive THC and are currently not legal to grow in Wisconsin. Industrial hemp cultivars are bred for bast fiber and co-products. High cannabinoid cultivars are bred for a range of medical compounds such as CBD. Food cultivars are bred for grain for a use in a wide range of food products.

High cannabinoid hemp is grown as a horticulture crop with plants individually harvested and dried for cannabinoid extraction. Though the crop is relatively easy to grow, the supply chain infrastructure and markets are extremely dynamic right now as regulations and consumer preferences are rapidly evolving.

Wisconsin at a Glance (NASS 2022)

Total Acreage: 68 acres

- Rough estimate of ~150 acres based on conversations with growers
- One large biomass grower with 100+ acres accounts for most of this production.

Number of growers: 57

- 392 total hemp producers with active licenses in 2024 according to the USDA (figure does not distinguish between CBD, grain and fiber). Many of these license holders are not actively growing.

Acres of CBD Hemp per Farm:

- Most growers have less than one acre and report size in terms of number of plants (~5,000 plants or fewer). One large producer grows over 100 acres for biomass.

Breeding

There are currently no high cannabinoid hemp breeding programs in Wisconsin, however, the Wisconsin Crop Innovation Center (WCIC) is conducting genetic engineering on hemp. WCIC released the first ever genetically modified hemp variety last year, known as Badger G, engineered to produce elevated levels of CBG and suppress THC and CBD production. Badger G was recently certified by the USDA and is currently undergoing field evaluations at the Arlington Agricultural Research Station. WCIC is in the seed production phase and seeds are not yet publicly available to growers.

The high-cannabinoid hemp industry is highly dynamic right now with both changing regulations and changes in the marketplace as to which cannabinoids are most important. This makes breeding very challenging. As a result, UW-Madison researchers are primarily focused on breeding for grain and fiber, which has far more regulatory and marketplace certainty.

That said, the University of Wisconsin-Madison is involved in a grant project with the University of Minnesota to collect, characterize and preserve feral hemp populations from around the Midwest. The goal is to collect a geographically distributed range of genetically diverse and THC-compliant hemp germplasm that will be made publicly available in order to enhance research and breeding efforts. Genetic sequencing and phenotyping of the germplasm will help determine the genetic control of traits such as THC and CBD production, seed shattering, and flowering time which are important for breeding purposes.

Key Breeding Priorities:

- Focus on grain and fiber hemp while also assembling genetically diverse breeding populations for potential future high cannabinoid breeding.
- Continue to develop hemp strains with low THC content

Propagation and Seed/Nursery Stock

For high cannabinoid hemp, seeds are available online from a variety of suppliers throughout the US. However, finding high-quality seed can be challenging and confusing for growers. Lack of varietal uniformity, low vigor, poor germination, and inaccurate feminization rate claims are some of the issues experienced by growers. Purchasing from reputable seed companies is critically important. Growers should verify that the company has been around for at least a few years and has good customer reviews. It’s also best to buy seeds directly from the originator, not a seed resale company, to ensure you are receiving the true strain rather than imitations with similar but inferior genetics.

One mark of quality is seed certification. Certified hemp seed is seed that has been grown according to AOSCA standards and verified by a 3rd party. The purpose of seed certification is to preserve genetic purity and varietal identity. Each state has a member agency to carry out the seed certification program. In Wisconsin, that agency is the Wisconsin Crop Improvement Association. Seed lots that complete the seed certification possess the official “blue” certified seed tag, indicating that the seed has met the standards for genetic purity and varietal identity. There is a relatively small amount of certified hemp seed lots that have been produced in the US. AOSCA is yet to publish standards for the production of certified feminized hemp seed. Therefore, claims on feminization rates should be validated by 3rd party data.

Another option for growers is to purchase or produce their own clones. Clones are produced by taking cuttings from a mother plant and rooting them in a soil medium. There are pros and cons of starting with clones rather than seeds. Clones are genetically identical to the mother plant and will be much more uniform than plants started from seed. This will make harvest timing more predictable, help growers manage risk associated with compliance, and eliminate the risk of pollination from monoecious plants or rogue males. On the other hand, clones may carry deleterious mutations, bad traits, pests, and diseases from the mother plant. They may be more susceptible to pests and diseases due to their limited genetic diversity. They also tend to be more fragile because they don’t develop as robust a root system. Finally, the varietal diversity of clones commercially available from retailers is much more limited than the thousands of options from seeds.

The Midwest Hemp Research Collaborative, consisting of partners at UW-Madison, Michigan State University, Purdue University, and University of Illinois at Champaign-Urbana, has been evaluating high cannabinoid hemp varieties through its Cultivar Check Program since 2020. Varieties are provided by reputable seed suppliers from around the country. Trials are conducted at university research stations and on farms with grower cooperators. Participants evaluate traits such as genetic uniformity, performance, best management practices, grower satisfaction, and THC compliance. Data is made publicly available through the Midwest Hemp Database to help growers make more informed purchasing decisions. The program will continue at least through 2025.

Strategic Propagation/Seed Priorities:

- Continue to conduct variety trials in WI to help identify high-performing and THC-compliant varieties for Wisconsin’s different growing regions
- Once varieties are identified, assist WI growers and seed companies in expanding 3rd-party certified seed production to meet grower needs

Production

CBD hemp went through a classic new crop boom and bust cycle in 2019 and 2020 after its legalization in the 2018 Farm Bill. Growers were lured by the promise of earning thousands of dollars per acre. Markets did not materialize for many growers and the resulting oversupply of CBD caused a dramatic decline in the price and number of producers after 2020. Today, there are relatively few commercial CBD hemp growers in the state - the number of growers with active licenses in Wisconsin has fallen from a peak of 1,251 in 2019 (and 1,249 in 2020) to 392 in 2024.

Almost all CBD hemp producers are small-scale, craft flower growers with a few acres of production or less. Many are hobby growers, grow for research purposes, or grow for their own consumption. Commercial growers almost always have some degree of vertical integration by doing their own processing, creating value-added products, and/or retailing products. Many outsource the extraction to other companies since equipment is very expensive. Given prices for cannabinoid hemp, it is very difficult to make a profit in the business without being vertically integrated from plant production through retail sale of value-added products.

A different model of production that may be profitable for a few growers is large-scale contracted production on hundreds of acres or more for biomass (stems, stalks, leaves). At the time of writing, there is only one grower in Wisconsin growing biomass for CBD extraction on an industrial scale. This grower accounts for the majority of CBD hemp acreage grown in the state. However, few companies offer forward contracts for large scale biomass production due to market volatility, regulatory uncertainty, and lack of experienced, reputable growers.

CBD hemp is a highly labor intensive crop to grow and should be treated as a horticultural or specialty crop. Plants are usually started indoors from seed and transplanted, though some growers plant clones (softwood stem cuttings) from mother plants. Planting, cultivation and harvest are usually done by hand. Most production is outdoors, though indoor production can produce higher quality plants, especially for high THCa flower. However, smokable flower is often sourced from out of state. At harvest, whole plants are cut at the base, usually with a machete, and transported to a drying/curing facility. Growers in Wisconsin are required to hold a hemp production license to grow and sell hemp. In addition, the standing hemp crop must be tested for THC. If the THC is low enough to meet standards, growers then have 30 days after compliance testing to harvest the crop. It can take many hands and long hours to harvest the crop before the 30-day deadline.

In 2021, Wisconsin transitioned its state-run hemp program to the USDA. Starting January 1, 2022, hemp growers are licensed through the USDA and hemp processors no longer need a DATCP license to process hemp. However, hemp processors still remain under DATCP's current authority for consumer and food products.

The most common production challenges described relate to the high cost of seed, poor seed quality (especially low germination), compliance testing, weed management, and harvest labor. One grower interviewed has had issues with pollination from feral hemp impacting CBD production. The development of triploid (sterile) varieties may offer a solution to growers, though seed is currently limited and expensive.

Hemp is a new crop for both growers and researchers in Wisconsin and many questions remain as to best management practices. The Ellison lab at UW-Madison is conducting pest surveys to share information on pest populations and management strategies. The lab is also conducting disease surveys to gain a better understanding of the plant pathogens affecting hemp fields across Wisconsin.

***Strategic Production Priorities*:**

- Continue working with early-adopter growers to better understand knowledge and training needs to optimize high-cannabinoid hemp production
- Expand agronomic trials to generate research-based information and best management practices
- Provide research-based information to growers via field days, webinars, and training programs
- Facilitate formation of geographic clusters of producers to help share information and collaborate on production, harvest, and post-harvest processing

Post-Harvest Processing

Drying and Bucking

After harvest, plant material is transported to a drying facility and hung to dry. The flowers are then trimmed and/or bucked to remove stems and leaves, leaving only the CBD rich flower. Trimming can also be done prior to drying to speed up the drying process, reduce space requirements, and prevent mold issues. Flower intended for smoking is then cured and packaged. Flower for CBD extraction does not need to be cured and is usually shredded/ground into smaller particles after drying to save space and improve extraction efficiency.

Most growers dry, trim, and cure flower by hand on their farms. The process is highly labor intensive and requires large buildings for drying, such as a barn or shed. Equipment such as bucking machines can help speed up the process, but these can be cost prohibitive for small growers. Availability of labor rather than optimal harvest date for cannabinoid production often determines when exactly growers harvest their crop.

Cannabinoid Extraction

After plant material is dry, it can be sent off for CBD extraction. Ethanol, CO_2 and hydrocarbons are most commonly used to extract crude oil, which can then be used in products or refined further into distillates and isolates. Most growers do not do their own extraction since equipment is expensive and the process is highly specialized. Some growers have rosin presses, screw presses, or make dry sift, which are less expensive processing methods but produce a less concentrated and refined product. Extraction can be a bottleneck for growers, especially those who are new to the industry, as processors can be difficult to find. Growers should line up a processor before planting.

As with hemp production, there was a rapid increase in the number of extraction and processing facilities after the 2018 farm bill, followed by a decrease when the speculation bubble burst. Growers report that many of the remaining processors have stopped doing toll processing - processing on a fee-for-service basis for growers - for a variety of reasons. Some cite the lack of growers, others aren't scaled appropriately for small growers, costs are prohibitive for growers, and excess inventory from 2-3 years ago has lowered demand. Some only process their own material while others process from a few contract growers that they have established relationships with. Processors often manufacture and retail their own products and offer white and private labeling services to retailers.

The emerging cannabinoid hemp industry has many things in common with the aronia industry. Both crops are relatively easy to produce, but there remains considerable uncertainty in supply chain infrastructure and markets.

Strategic Processing Priorities

- Work with stakeholders and growers to better understand annual production and demand levels to help align supply and demand
- Facilitate supply chain planning with industry stakeholders to work toward a more stable supply chain infrastructure

Product and Markets

High cannabinoid hemp products are sold online, at stores and dispensaries, farmers markets, and, to a limited extent, through on-farm sales. The CBD hemp market is highly volatile and ever-changing. Retailers are forced to respond to the latest consumer trends and abide by a complex patchwork of state and federal regulations.

The most important factor affecting the CBD hemp supply chain in Wisconsin is state and federal policy. The 2018 Farm Bill legalized hemp and hemp products containing less than 0.3% delta 9 THC on a dry weight basis. The focus on delta 9 THC in the farm bill, rather than total THC or other cannabinoids, created loopholes with regard to other psychoactive cannabinoids such as delta 8 and delta 10, which are synthesized from CBD. It also left the door open for products containing high concentrations of THCa, especially flower, which is seeing a surge in demand. Even though recreational marijuana is illegal in Wisconsin, these loopholes essentially allow companies in Wisconsin to legally sell the same products as other states where recreational marijuana is legal.

With the 2018 Farm Bill set to expire in 2024, there is significant uncertainty about the future legality of cannabinoids such as THCa and delta 8 THC. As of September 2024, an amendment put forward by Congresswoman Mary Miller (R-IL) would close the loophole that allows the sale of delta 8 THC and THCa products by requiring products to contain less than 0.3% *total* THC rather than *delta 9* THC. These efforts are supported by large cannabis companies and may have significant negative impacts on small producers, processors, and retailers selling a range of products that are currently legal. Until there is clarity on policy at the state and federal levels, the CBD hemp industry will continue to suffer from lack of quality control, health and safety issues, high volatility, unpredictability, lack of transparency, out of state competition, and exploitation.

With the lack of regulation around the health and safety of products and accuracy of labeling, consumers are left vulnerable. Reputable companies usually provide 3rd party lab tests from DEA certified labs on all their products showing the cannabinoid profile and verifying that they contain less than 0.3% THC. Gas stations and convenience stores selling CBD products are notorious for inaccurate labeling and poor product quality. Many specialty cannabis retailers try to gain a competitive advantage by promoting their quality standards, being transparent about their supply chain, and demonstrating strict compliance with state and federal regulations.

Retailers consistently face challenges accessing banking and credit services because of the high risk of the industry and the classification of marijuana as a Schedule 1 controlled substance. Marketing through social media and online retailers such as Amazon has also been challenging, as many of these platforms

forbid the sale of cannabis products and will regularly kick retailers off with little notice. Online sales can also be difficult because many payment processors, such as PayPal and Venmo, do not work with cannabis companies, including CBD only retailers. Those that do, such as Square, usually charge a significantly higher commission. They have also been known to audit customer product reviews for illegal health claims to deny access to retailers.

Key Product Development and Marketing Priorities:

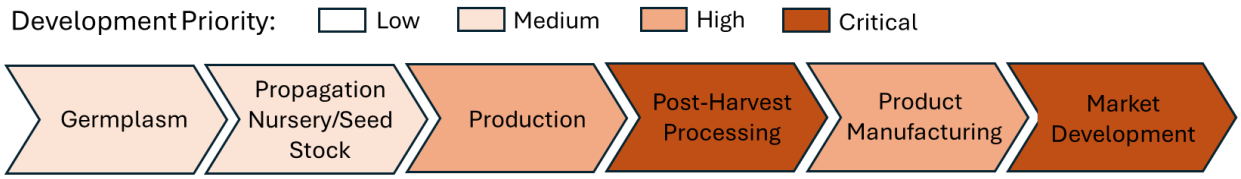
- Until regulatory clarity is provided, it is difficult for the University and other stakeholder groups to provide targeted assistance to growers, processors, and product manufacturers.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Dr. Shelby Ellison (UW-Madison), Phillip Alberti (UW-Madison), Marguerite Bolt (Purdue University), Phillip Scott (Crone Apothecary/Badger Hemp), Stacy McCaskill (Hempstock Pharms Limited), Kayleigh Jump (Ceilidh's Cannabis Conjurations), and the folks at Madison Extracts, Goodland Extracts, Cannavera, Steve’s Hemp, 3 Tall Pines, The Cannidote, Dank of America, C&C Hilltop Farm, and Herbal Aspect.

Hemp (fiber)

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop processing capacity for decortication and degumming to provide a path to market for early-entrant growers in WI.
- Facilitate formation of geographic clusters of producers to help share information and collaborate on production, harvest, and post-harvest processing.
- Work with product manufacturers to determine fiber hemp needs and help develop a core group of professional growers linked with appropriately-scaled processing capacity.
- Facilitate value-chain planning and development with industry stakeholders to help align production and processing capacity to market demand.

Introduction

China is by far the largest producer of fiber hemp in the world and most hemp fiber used in the United States is imported from China. However, fiber hemp is seeing significant growth in the US, driven by a number of factors including a resurgence of interest in the crop among farmers, public and private investment, companies seeking sustainability credentials, and the superior performance of hemp in certain product applications.

Wisconsin does not yet have a fiber hemp industry. Most importantly, it lacks the processors needed to turn the hemp plants into the bast fiber and co-products used by manufacturers. Regional processing infrastructure, such as industrial scale decorticators, is needed because transporting fiber hemp more than a few hundred miles is cost prohibitive. However, processing and storage infrastructure is highly capital intensive and the Wisconsin industry currently faces the classic chicken-or-egg dilemma common to so many crops. Without enough fiber hemp it isn't economically feasible to build a processing plant, but without a processing plant growers can't grow more fiber hemp. Public investment in the form of grants and subsidies and public-private partnerships will be key to acquiring the infrastructure and begin developing a fiber hemp industry in Wisconsin.

Wisconsin at a Glance (NASS 2022)

Total Acreage: Withheld to avoid disclosing data for individual operations.

- There is very little commercial production of fiber hemp in Wisconsin.

- Secondhand report of 15-20 grower contracts for Wisconsin Battery Company, however, these contracts are under non-disclosure agreements.

Number of growers: 2

- Estimated at 25 or fewer.

Acres of Fiber Hemp per Farm: NA

Breeding

Investing in hemp breeding and genetics is an important part of developing the fiber hemp industry in the United States. Most breeding is happening at public universities, including Cornell University, UC-Davis, University of Minnesota and Oregon State University. There are few private breeding programs in the US (IND Hemp in Fort Benton, Montana may be the only one as of writing). Current breeding efforts are targeting fiber yield, plant performance, regional adaptation, disease and insect resistance, development of autoflowering varieties, and compliance with federal regulations for THC content.

The University of Wisconsin does not have a fiber hemp breeding program but is involved in a grant project with the University of Minnesota to collect, characterize and preserve feral hemp populations from around the Midwest. The goal is to collect a geographically distributed range of genetically diverse and THC-compliant hemp germplasm that will be made publicly available in order to enhance research and breeding efforts. Genetic sequencing and phenotyping of the germplasm will help determine the genetic control of traits such as THC and CBD production, seed shattering, and flowering time which are important for breeding purposes.

Strategic Breeding Strategies:

- Evaluate existing fiber hemp varieties in replicated field trials in WI to identify top-performing varieties and identify the most important traits for improvement through targeted breeding

Propagation and Seed Stock

Most fiber hemp seed is currently imported from China and Europe, particularly France, Italy, and Poland. Seed is often difficult to import, expensive, and poor quality. Some seeds, especially those from China, tend to exceed THC thresholds. The lack of domestic seed and regionally appropriate varieties is a challenge for growers. Varieties from different latitudes and geographies are often not well adapted to Wisconsin. Increasing the supply of regional appropriate varieties is important to reduce cost, increase availability, and improve quality and performance. Recently, there has been an increase in local suppliers in the US for grain and fiber varieties. A few suppliers are beginning to offer AOSCA certified seeds, which indicates that the seed has met standards for genetic and varietal purity.

Strategic Propagation/Seed Priorities:

- Continue to conduct variety trials in WI to help identify high-performing and THC-compliant varieties for Wisconsin's different growing regions
- Once varieties are identified, assist WI growers and seed companies in expanding 3rd-party certified seed production to meet grower needs

Production

Fiber hemp is grown like other field crops in rows 12-30” apart with a seeding rate of 25-30 lbs per acre. The seed can be planted with a standard seed drill and cultivated with existing field crop equipment. However, as a result of the long-time ban on fiber hemp production, there is a lack of knowledge on production practices and systems. Information can be gleaned from other countries with a longer history of hemp cultivation, but best management practices (BMPs) will have to be optimized for Wisconsin growing conditions. Many universities around the Midwest, including UW-Madison, are conducting agronomic research on fiber hemp. Key areas of research include planting density, nutrient management, weed management, irrigation, and harvest timing. Weed management strategies are particularly important because there is only one registered herbicide (Sonalan) currently approved for use on hemp. Additionally, sustainable production practices, such as minimal tillage, cover crops, and crop rotations will be important to reduce input costs for growers and boost hemp’s sustainability profile. Developing dual purpose cropping systems for grain and fiber hemp will help enable the use of all plant material and maximize profits for growers.

Currently, many manufacturers/buyers who contract with growers employ agronomists to provide grower support throughout the season. Many also provide custom harvesting services, since harvesting requires specialized knowledge and equipment to ensure that the crop meets manufacturer specifications. Industry agronomists and University Extension staff will be critical to helping growers get up to speed on best management practices for this new crop.

The Midwest Hemp Research Collaborative, consisting of the University of Illinois, University of Wisconsin, Michigan State University, Michael Fields Agricultural Institute, and Purdue University, runs a series of collaborative variety trials looking at variety performance, seeding rates, inputs (N rates), relative maturity, compliance, and agronomic best management practices for grain and fiber hemp. The program began in 2022 and will continue at least until 2025. Data is made available to the public through the Midwest Hemp Database.

***Strategic Production Priorities*:**

- Continue working with early-adopter growers to better understand knowledge and training needs to optimize fiber hemp production
- Expand agronomic trials to generate research-based information and best management practices
- Provide research-based information to growers via field days, webinars, and training programs
- Facilitate formation of geographic clusters of producers to help share information and collaborate on production, harvest, and post-harvest processing

Post-Harvest Processing

<u>Pre-Processing</u>

Fiber hemp stalks are harvested by cutting plants at the base and then leaving them in the field to ret, a process that breaks down the pectin and makes it easier to separate bast fibers from the hurd during decortication. Field, or dew retting, has a large impact on the quality of the fiber and downstream processing. Retting is highly dependent on environmental conditions and is an important area of research. After retting, stalks can be baled and stored.

Aggregation and Processing

Processors and manufacturers aggregate bales and process fiber hemp stalks into coproducts that are either processed further or used in the manufacture of products. After field/dew retting, stalks are run through a decorticator to separate bast fibers from the hurd. Hurd material can be chopped and bagged for use in different products such as animal bedding and hempcrete. Bast fibers undergo further processing depending on their end use, such as degumming and hackling.

Developing processing capabilities close to areas of fiber hemp production is critical for industry development. Shipping fiber hemp is very expensive, and distances greater than ~200 miles can be cost prohibitive. Wisconsin law allows farmers to drive a commercial motor vehicle within 150 miles of the farm without a CDL, an exemption that may factor into grower contract considerations. In addition, greater proximity of growers to processors ensures that industry agronomists can better provide on-farm support for growers. While distributed processing is necessary for the fiber hemp industry, achieving economies of scale is equally crucial for profitability, as processing equipment is very expensive. This duality will help shape the evolution of fiber hemp supply chains.

Wisconsin does not currently have any large-scale hemp fiber processors. This means there is still time to develop the processing infrastructure with an eye toward long-term stability. As with most new crops, fiber hemp will need a stable and mutually beneficial supply chain with three key links: professional growers, processing facilities to turn retted hemp into high-quality bast fibers and co-products, and companies to make products with the fiber and co-products with sufficient sell-through to support the industry. As an industrial-scale product with potential for significant returns to capital, development of a supply chain will likely be top-down with a product manufacturer contracting for production directly or through a processing intermediary. As such, it will be important to develop contracting relationships and production standards that are mutually beneficial to the growers and buyer(s).

Strategic Processing Priorities:

- Work with product manufacturers to determine fiber hemp needs and help develop a core group of professional growers linked with appropriately-scaled processing capacity

Products and Markets

Though no clear use-case for hemp has yet to emerge, companies are pursing many different options including textiles, insulation, bio-plastics, animal bedding, industry absorbents, batteries, hempcrete, paper, mulch, erosion control blankets, flooring, and carbon nanosheets. All these are industry products requiring at-scale production and post-harvest processing that is likely out of reach for most small growers, unless they are part of a cooperative or other aggregation-focused company.

Enabling fiber hemp production in Wisconsin will require creating favorable conditions for end-users to locate and operate in Wisconsin. Much of this work will require and tax incentive discussions at the state and local level through economic development organizations. However, perhaps the best enabling condition is a professional grower base committed to high quality fiber production. This will required

identifying top-performing varieties that meet buyer specifications along with best management practices for consistent and profitable production.

The 2018 Farm Bill legalized the production of hemp that tests below 0.3% THC content. However, growing hemp is burdensome and risky for growers. In order to comply with federal law, farmers need to obtain licenses, background checks, pay fees, and comply with THC testing regulations.

A bipartisan bill introduced in March 2023 in the US House of Representatives known as The Industrial Hemp Act of 2023 proposed distinguishing between hemp varieties grown for fiber or grain (industrial hemp) and those grown for cannabinoid or floral purposes (CBD and cannabis applications). The bill would remove the need for farmers to do a background check for growing industrial hemp and replace sampling and testing with visual inspection checks. A bill such as this would help reduce the burden and risk for growers of fiber hemp.

Strategic Product Development and Marketing Activities:

- Develop state and local initiatives to encourage hemp product manufacturers to locate and operate in WI.
- Facilitate development of geographic clusters of hemp growers to supply processors and product manufacturers.

Acknowledgements

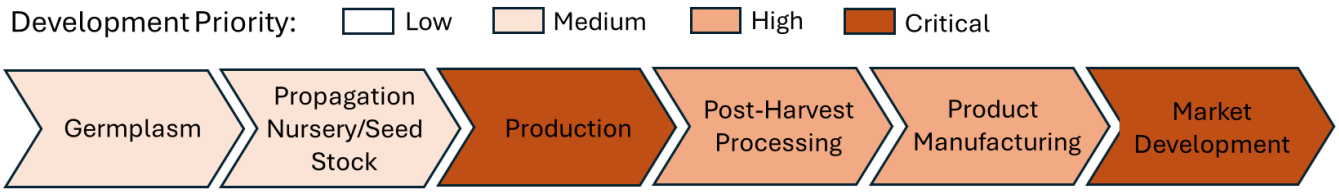
A special thank you to the following people for sharing their expertise and making this report possible: Dr. Shelby Ellison (UW-Madison), Phillip Alberti (UW-Madison), Marguerite Bolt (Purdue University), and Kelly Burke (KifCure).

References

- Cornell Hemp Webinar Series:
    - https://www.youtube.com/playlist?list=PLHPXm2Es8aQBLgffVFV-cKY9RT31RgE_L
- https://thehia.org/hemp-fiber-and-hurd-map/
- https://dunagrohempgroup.com/processing/
- https://www.agweek.com/crops/other-crops/minnesota-field-day-shows-potential-for-growing-hemp-in-regionhttps://grist.org/indigenous/hempcrete-lower-sioux-housing/
- https://www.midwestfarmreport.com/2024/04/11/portage-welcomes-hemp-batteries/
- https://www.usda.gov/sites/default/files/documents/hemp-research-needs-roadmap.pdf
- https://drive.google.com/file/d/1i_i1SWirbVBNNl3BO9x-P1iRIkods568/view

Hemp (grain)

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop and support core groups of growers that are geographically-clustered and socially-networked in order to share production knowledge, share production and harvest costs, and collaborate on post-harvest process and marketing.
- Support entrepreneurs making products from hemp grain in WI.
- Develop and evaluate brand messaging around hemp and hemp products that most resonate with target consumer groups.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown hemp is superior to imported hemp and ingredients.
- Provide outreach education on best management practices of the harvest, drying, and cleaning of hemp grain.

Introduction

In addition to fiber and cannabinoids, industrial hemp can be grown for its seeds as a highly nutritious oilseed consisting of 25% protein and 30-35% oil, with high levels of omega-3 and omega-6 polyunsaturated fatty acids. The dehulled seed (hemp hearts) can be eaten whole similar to wheat berries or pressed for oil with the press cake milled into a high protein flour.

Unlike fiber and cannabinoids, the hemp grain market is relatively mature and stable - a consequence of Canada being the world's largest producer of hemp grain, where it has been legal for over 25 years. There were an estimated 55,000 acres planted to industrial hemp in Canada in 2023, almost all of which was for grain production. Alberta, Saskatchewan and Manitoba accounted for 99% of this production. US acreage is difficult to estimate but was speculated to be around 30,000 acres in 2020. Montana is the largest producer of grain hemp in the United States with significant acreage in North Dakota, Colorado, Kentucky, and Washington. Production is concentrated in northern latitudes in the US because most varieties were developed in Canada and perform better in northern areas. In addition, grain hemp uses much of the same equipment as other oilseed crops such as flax and canola, which are more commonly grown in these states.

Grain hemp is not a significant crop in Wisconsin. However, there are emerging opportunities for Wisconsin growers as several processors in the Midwest are interested in contracting for Wisconsin grown grain. Because Canada dominates production, it also sets market prices. Canada growers also have the advantages of adapted varieties and more experience. However, the recent approval of grain hemp as a feed ingredient for laying hens by the Association of American Feed Control Officials could significantly expand markets for seed meal in the US. Approval for fish feed looks to be about 2-3 years away. In addition, consumer trends toward plant-based proteins and sustainability provide opportunities for hemp grain markets.

Key Metrics for Wisconsin (NASS 2022)
Total Acreage: 11
Number of growers: 5
Acres of Grain Hemp per Farm: NA

Breeding

Most grain hemp varieties grown in the United States were developed in Canada. There are a few established grain hemp breeding programs in the private and public sectors in the US that are developing improved varieties for northern latitudes. In the private sector, IND Hemp in Montana and New West Genetics in Colorado have grain hemp breeding programs and provide seed for trials at UW-Madison. In the public sector, Cornell University and Colorado State University run breeding programs. The breeding program at Cornell recently patented a new dual-purpose variety (Ursa® 'Grande'), which will be distributed by International Hemp, sometime around 2025. Breeding efforts for grain are targeting grain yield, oil yield, uniformity in plant height, shorter plants, low fiber production, pest and disease resistance and THC compliance.

Strategic Breeding Strategies:

- Continue the UW variety trials to evaluate existing grain hemp varieties to identify promising germplasm for different production regions in WI.

Propagation and Seed Stock

Although the domestic seed supply for grain hemp is improving, the majority of grain hemp seed still comes from overseas, particularly Canada and Europe. Seed supply and quality for the UW-Madison variety trials was poor initially but has been improving annually with improved pipelines for imported seed stock and the shift toward domestic suppliers. Seed for 2024 UW-Madison variety trials came from Canada, the Czech Republic, and suppliers in Colorado, Delaware, Illinois, Michigan, Montana, and Kansas.

Strategic Propagation/Seed Priorities:

- Once the top varieties for WI are identified, work with seed companies to develop a seed supply in WI for WI growers
- Provide compiled information on varieties and seed suppliers so growers don't have to search far and wide for such information

Production

Grain hemp grows well in Wisconsin when grown with the same care and attention of any other cash crop. Hemp grain production is highly mechanized and utilizes much of the same equipment as small grains and other oilseed crops, such as grain drills, combines with draper headers, and grain bins. Yields can vary significantly depending on management and conditions, with yields reported between 600 to 2,000 pounds per acre. Most growers contract production with processors for a minimum of 40 acres. Assuming average yields of 1,200 to 1,500 pounds per acre, 40 acres will fill a semi-truck and make transport more economical. The majority of grain grown is non-organic, however there is growing interest among some buyers in certified organic and Regenerative Organic Certified (ROC) hemp grain.

The main challenges in production involve weed control and harvesting. Weed control can be a problem due to the lack of herbicide approvals; Sonolan (Ethalfluralin) is the only herbicide currently approved for use with hemp, with other options likely becoming available in the next 2-3 years. Good emergence and quick canopy cover are important for limiting weed pressure. Soil crusting and low soil temperatures during seeding are common causes of poor emergence. Well prepared, firm seed beds are recommended to improve establishment and uniformity.

Harvesting the grain also poses challenges because of the strong fibers in the stalk. These fibers can bind up combines. Combines should be set to cut directly below the seed heads to limit fiber intake. Plant height uniformity and shorter plants are important breeding objectives to help reduce fiber handling problems in harvest equipment.

Harvest timing can also be a challenge. Hemp has indeterminate growth with seeds maturing from the bottom of the seed head and moving upwards. Once mature, grain can shatter easily. Thus, grain should be harvested at 70-80% maturity to maximize seed yield and quality. Delaying harvest can also lead to more problems with fiber wrapping and bird predation. Many processors who offer grower contracts will provide some level of agronomic support to help growers navigate these challenges. Some will also help growers enroll in programs to reduce risk and cost-share production, such as the USDA’s Climate Smart Commodities Grant and carbon credit markets.

Although hemp can be grown as a dual-purpose grain and fiber crop, production systems are usually geared to producing either fiber or grain. While production systems geared toward grain will not produce the high quality bast fibers desired in textile production, it will still yield some shorter fibers that can be used for products such as animal bedding, construction materials, insulation and paper pulp. Some grain processors accept fiber bales and have equipment such as bale busters and trommels to process the fiber.

The Midwest Hemp Research Collaborative, a joint effort of four land grant universities (University of Wisconsin-Madison, University of Illinois at Urbana-Champaign, Michigan State University, Purdue University) and one non-profit (Michael Fields Agricultural Institute), runs variety trials for grain, fiber and dual-purpose grain/fiber hemp, studies variety performance, seeding rates, fertility, and best management practices. Grower collaborators evaluate traits such as grain yield, relative maturity and compliance. Grain samples are analyzed for cannabinoid, protein and oil concentration.

The Ellison lab at UW-Madison is conducting pest and disease surveys to gain a better understanding of the pests and diseases affecting hemp fields across Wisconsin and develop management strategies.

Strategic Production Priorities

- Develop best management practices for grain hemp production in key WI production regions
- Provide outreach education and grower training to WI growers
- Develop geographic clusters of growers and facilitate their cooperation on information sharing, equipment sharing, and production aggregation.

Pre-processing

Hemp grain spoils very quickly because it must be harvested before seed shattering occurs when the moisture content is still high (15-30%). Grain should begin drying in full aeration bins within four hours of harvest. Grain may need to be stirred initially to prevent hot spots from developing. As an oilseed, hemp grain requires low-heat dryers similar to flax and canola. After the grain has been dried to 8%, hemp seed processors require a bin grain sample to test for quality, microbes, and purity. Purity can be a key issue with hemp seed, as some processors try to meet gluten-free status. Testing for microbes is important because hemp is a raw food and does not have a pasteurization or “kill step.” As of this publication, there are no fungicides labeled for use on hemp. The seed must also be cleaned after drying. Hemp seed is often very dirty, containing immature seed, cracked seeds, and bits of stem. Growers usually ship their uncleaned seed to processors for cleaning. Hemp grain must be handled with care throughout the transport, storage, and drying process because its thin hulls are easily damaged.

Strategic Processing Priorities:

- Provide outreach education on best management practices of the harvest, drying, and cleaning of hemp grain
- Help develop clusters of growers that can work together on post-harvest processing

Products and Markets

Whole grain can be dehulled to extract hemp hearts or it can be cold-pressed directly for hemp seed oil. The seed cake, or seed meal, is a byproduct of oil pressing and can be milled into high-protein flour. Hemp grain and its co-products have a variety of applications in food and beverage products, cosmetics, and health supplements. Hemp hearts are commonly used in smoothies, bars, cookies, and granola. Hemp protein powder can be used in many of the same products, as well as dressings, health supplements, and baked goods. Hemp seed oil is commonly used as an edible oil, in health supplements, personal care products and industrial applications such as paints and lubricants. Whole grain can be roasted and seasoned as a crunchy snack or sold into secondary markets such as birdseed. Byproducts and residues from processing, such as hemp hulls and heart fines, may also have certain applications, such as fortifying foods with antioxidants and dietary fiber.

A major milestone was recently achieved with the approval of hemp seed meal as a feed ingredient for laying hens by the Association of American Feed Control Officials (with an inclusion rate of up to 20%). This new ruling has the potential to significantly expand markets for hemp seed meal.

Strategic Product and Market Development Priorities

- Develop enterprise budgeting tools for hemp grain production in WI using data from UW variety and production trials. The tools can help grain producers determine viable pricing and negotiate equitable production contracts with buyers.
- Convene growers and buyers to develop quality standards and explore ways to aggregate production volumes and most efficiently meet customer needs
- Assist entrepreneurs in WI making CPGs with hemp grain/oil by:
    - Conducting consumer demand focus groups to identify which hemp product categories (hemp heart snacks, oil, flour) are most appealing.
    - Developing and evaluating brand messaging around hemp and hemp products that most resonate with target consumer groups
    - Assisting with business development through a venture-studio model.
- Assist the overall industry by:
    - Supporting growers, growers associations, and stakeholders in developing, funding, and implementing consumer awareness campaigns about the health-benefits and ecosystem services of hemp grain.
    - Help the industry develop a strong value-proposition for why WI and Midwest-grown hemp is superior to imported hemp and ingredients.
    - Exploring dual-production models where growers are producing both fiber and hemp grain from the same fields

Acknowledgements

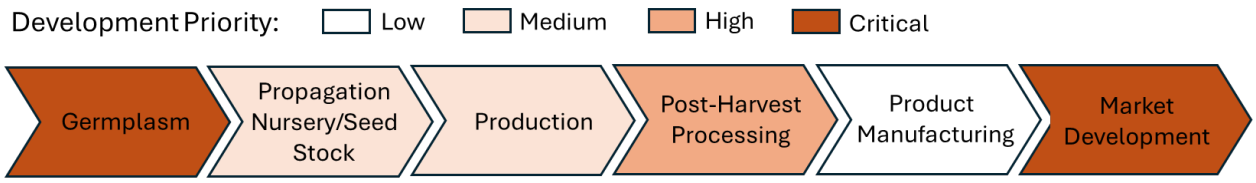
A special thank you to the following people for sharing their expertise and making this report possible: Dr. Shelby Ellison (UW-Madison), Phillip Alberti (UW-Madison), Marguerite Bolt (Purdue University), Kelly Burke (KifCure), Roger Gussiaas and Karen Gussiaas-Smith (Healthy Oilseeds), Sarah Selmon (Midwest Hemp Technology), Charles Levine (Hemp Acres) and Derrick Dohmann (Horizon Hemp Seeds).

References

https://cropsandsoils.extension.wisc.edu/files/2023/08/Industrial-Hemp-Grain-Production.pdf
https://cropwatch.unl.edu/2019/hemp-production-fiber-or-grain
https://agnr.osu.edu/sites/agnr/files/imce/pdfs/events/Growing%20Hemp%20for%20Fiber%20or%20Seed.pdf
https://jcannabisresearch.biomedcentral.com/articles/10.1186/s42238-022-00156-7
https://ograin.cals.wisc.edu/wp-content/uploads/sites/65/2020/04/Industrial-hemp-production.pdf
https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop15539/$file/HempHarvestStorage.pdf
https://www.hempbenchmarks.com/hemp-market-insider/introduction-to-grain-hemp/
https://hempfeedcoalition.org/2024/01/24/hemp-seed-meal-achieves-monumental-milestone-on-path-to-federal-approval/
https://www.poultryproducer.com/aafco-approves-hempseed-meal-for-laying-hens-marking-a-milestone-for-u-s-poultry-feed/
https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Update%20on%20Industrial%20Hemp%20Production%20Trade%20and%20Regulation_Ottawa_Canada_CA2023-0034#:~:text=In%202022%2C%20there%20were%2076%2C900,percent%20from%202022%20to%202023.

Hops

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop disease resistant hop varieties to reduce intensity and cost of WI disease control programs.
- Support the hop growers and grower organizations in producing hops that meet or exceed the quality of hops grown in the Pacific Northwest.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown hops are superior to hops from other regions.
- Increase the supply of hop varieties in demand by brewers through new grower recruitment and expansion of existing hop yards.
- Facilitate value-chain planning and development with industry stakeholders to help align production and processing capacity to market demand.

Introduction

Hops (*Humulus lupulus*) is a vine plant in the *Cannabinaceae* family that produces cones used primarily for aroma and bittering in the brewing industry. The cones contain a yellow powder called lupulin, which contains alpha acids as well as many oils. These acids and oils are what provide the aroma and flavoring for brewers. The many varieties of hops offer brewers the opportunity to create a wide array of flavor combinations in beer for consumers.

Hops are managed to produce annual shoots (known as bines) on perennial crowns. Vines are trained to grow on trellises 16-20 feet tall. Hops take about three years to reach full production. Wisconsin used to be a major producer of hops until production shifted to the drier climate in the Pacific Northwest. There has been renewed interest in local WI production driven by the expansion of the craft brew industry and their desire for unique and locally-produced hops.

The United States accounts for about 44% of global hop production, ahead of Germany with 32%. The US has an estimated 63,000 acres of hops. 98% of the hops grown in the US comes from the Pacific Northwest states of Washington, Oregon and Idaho. Washington state alone produces 71% of the total US crop. Hop yards in the Pacific Northwest are large, ranging in size from 100 acres to 4,000 acres.

Wisconsin has about 90 acres of hops on 36 farms, ranging in size from ¼ acre to 5 acres, with a few exceeding 10 acres (NASS 2022). The value of hop production in the US was estimated at $618 million in 2022. The value of WI hops is not currently known.

Wisconsin at a Glance (NASS 2022)
Number of acres: 90
Number of farms: 36
Average size of hop yards: 0.25-5 acres; a few in the 5-15 acre range

Breeding

The vast majority of hop varieties grown in Wisconsin were developed by the USDA's public breeding program. The USDA currently funds two breeding programs, at Washington State University and Oregon State University. These programs release a new variety every few years. However, these varieties were not bred for Wisconsin growing conditions and do not necessarily perform well here.

There are over 20 private hop breeders throughout the United States, primarily in the Pacific Northwest. These companies employ vast resources, the best breeders in the world, and restrict access to their varieties to their growers and supplier networks. A single company, Hop Breeding Company, holds the patent for the two most popular hop varieties on the market, Citra and Mosaic, which account for about 31% of total US hop acreage. Contracts for these proprietary varieties are out of reach for Wisconsin growers. Additionally, merchants and brokers with access to these proprietary varieties tie or bundle them to public hops, requiring a brewery to purchase a public variety to get access to a proprietary variety. This results in smaller growers and sellers not being able to sell in-demand public varieties to breweries who use them, because they cannot provide access to the proprietary varieties.

The reason hop production shifted away from the Midwest to the Pacific Northwest is the same challenge facing the new growers in WI today. The humid and wet summer climate of WI and the Midwest result in significant disease pressure on hops which requires considerable fungicide inputs.

To address this, the University of Minnesota has a hop breeding program based at the St. Paul campus aimed at developing locally-adapted and disease resistant varieties (downy and powdery mildew). Breeding lines are being evaluated by grower cooperators, but no varieties have yet been released. Great Lakes Hops, based in Zeeland, Michigan, offers proprietary varieties on contract with growers. However, none of their varieties have been recognized as "unique new selections (germplasm) that have been developed and released for commercial production" by Hop Grower of America, an industry trade organization. Rather than breeding new, improved varieties, they are renaming existing varieties for marketing purposes.

Strategic Breeding Objectives:

- Develop locally-adapted and disease resistant varieties for WI and the Upper Midwest

Propagation and Nursery Stock

Hops are available from many sources online. However, growers should source disease-free planting stock from reputable sources to avoid introducing viruses and other diseases to their hop yard. The safest way to purchase hops is from the National Clean Plant Center Northwest (CPCNW) at Washington State University. The CPCNW maintains and propagates a collection of virus-tested hop varieties for hop growers throughout the United States. Plant material can be sourced directly from the CPCNW, including rhizomes, rooted and unrooted cuttings, and tissue culture plantlets. This program distributes nearly 50 different varieties.

Eric Anderson, of St. Croix Valley Hops, is the only commercial source for hop plants in Wisconsin. He offers rooted cuttings of 20 different public varieties, including traditional European landraces. Eric evaluates these varieties in a trial area in his hop yard and makes the data available through his website. Two Michigan based companies, Sandy Ridge Farms and Great Lakes Hops, also sell planting stock.

Established growers often propagate their own plants through rhizome cuttings as an inexpensive way of expanding their hop yard and replacing plants without the risk of introducing disease.

Strategic Propagation and Nursery Stock Objectives:

Production

Growing hops in Wisconsin is challenging for many reasons. Start-up capital costs are perhaps the biggest barrier. Hops are grown on trellises 16-20’ tall. Estimates for hop yard establishment range from $10,000 to $15,000 or more per acre. Growers must also invest in harvesting and processing equipment, including harvesters, dryers, balers, and cool storage. Annual operating costs can be expensive as well, particularly for twine, pest management, and labor.

The lack of affordable equipment is also a barrier for growers. Many small growers in Wisconsin use Hops Harvesters, portable harvesters designed for small hop yards by a company in New York. These cost about $20,000 new. Larger growers use Wolf harvesters, imported from Europe, ranging in cost from $40,000 to $70,000. Several members of the Wisconsin Hop Exchange who have Wolf harvesters offer custom harvesting, but transportation costs and time constraints of harvesting and processing at peak quality make this challenging.

Hops are susceptible to a number of pests and diseases. Spider mites, Japanese beetles, potato leafhoppers, and aphids can all be problematic. Fungal diseases, such as powdery mildew, downy mildew, and fusarium also present major challenges. Phoma, also known as halo blight, is a new disease that has begun to affect the Midwest and is of significant concern. Growers employ a number of IPM strategies to deal with these diseases, but routine fungicide spraying every 7-10 days is typical. There are no commercial organic hop yards in Wisconsin.

Labor is another challenge for many growers at certain times of year. Labor demands are high in spring for stringing and throughout the harvest season from mid-August to mid-September. Harvest timing is crucial for producing high quality hops, as the cones have to be picked at just the right time. Growers

submit samples of wet hops to AAR Labs in Madison, Wisconsin to help determine precise harvest timing. Weed and sucker management also require timely attention, especially from spring to early summer.

Low yields are another concern. Yields among Wisconsin growers range from 600-1000 pounds per acre, with a few growers achieving higher. Increasing average yield above 1000 pounds per acre is important for the industry. Yields in the Pacific Northwest average 1500-1700 pounds per acre. While it's unlikely that Wisconsin growers will ever be able to achieve these yields, some Wisconsin brewers are willing to pay a premium for Wisconsin hops based on quality and to support local, diversified supply chains.

Understanding the many aspects of hops production presents a steep learning curve for new growers. Education and outreach events are critical to help new growers understand equipment and infrastructure needs, IPM strategies, fertility needs, harvest timing, and how to achieve quality standards. The Wisconsin Hop Exchange and UW-Madison Extension have filled this role by organizing field days, an annual conference, and webinars to help overcome knowledge gaps. In addition, a few experienced hop growers are considered mentors in the Wisconsin hop community.

Producing quality hops is very important for the Wisconsin hop industry. The quality of hops sold through the Wisconsin Hop Exchange has improved dramatically over the past several years, with quality metrics matching and sometimes exceeding those for hops from the Pacific Northwest and Europe. This is due in large part to the guidance and counsel of Dan Carey, Co-Founder and President of New Glarus, who has worked with growers, Wisconsin Hop Exchange and Legacy Hill Hop Supply, the processor for the Wisconsin Hop Exchange, to improve systems and implement standards throughout the supply chain. Overcoming the perception that Wisconsin hops are of inferior quality among a segment of brewers remains a challenge for the Wisconsin Hop Exchange to expand sales into that segment.

UW Madison Extension does not have a research hop yard but partners with farmer collaborators to conduct research on agronomic best management practices. Current research includes trials on how fertility and soil pH affect yield, plant biomass and cone quality. Extension has also played an important role in organizing outreach activities, such as field days and an annual hop conference, to help close knowledge gaps among growers.

***Strategic Production Priorities**:*

- Hops are a knowledge-intensive crop, thus it is important for the industry to provide new growers with research-based information and training before and after establishment of their hop yard
- Continue to implement agronomic research to develop optimized fertility management, pest management, and production best management practices.

Processing

Drying

Except for a very small percentage of the harvest sold as fresh hops, most growers in WI process their cones into bales before transporting them to a central processing facility in Wisconsin Rapids. This

process begins with immediately putting harvested wet cones into an oast drier. Drying takes between 24 hours and three days depending upon the quantity of cones, initial moisture content, temperature and relative humidity. Cones are dried to a moisture content of 8-12% and then conditioned to allow the different parts of the cones to equilibrate. Dried cones are then compacted into bales weighing about 85-90 pounds each and stored between 33-40 degrees Fahrenheit. At the end of the harvest season, or as cold storage space fills up, bales are transported to Wisconsin Rapids for further processing.

High capital costs for on-farm processing equipment is a major hurdle for growers. Most growers need to invest in their own dryers, conditioning room, baler, and cold storage. Although a few growers are able to share equipment, the need to quickly process the crop after harvest to preserve quality makes sharing difficult. Drying capacity is sometimes a bottleneck during the narrow one-month harvest window. Wisconsin growers are not constrained by a large volume of hops, so they are able to dry hops at a slower rate, using lower temperatures, than industry standards in the PNW. While this improves quality by preserving the volatile oils, it slows down the drying process. On-farm cold storage capacity can be a limiting factor as well, forcing some growers to make multiple trips to Wisconsin Rapids as their cooler fills up.

Pelletizing

A few growers in Wisconsin have their own pelletizer and sell a portion of their hops directly to breweries. However, most growers contract with the Wisconsin Hop Exchange to process their bales into pellets. Growers transport their bales to a processing facility in Wisconsin Rapids beginning in late August. Bales are stored in four refrigerated trucks until they are processed, an expensive solution that is not scalable with significant increase in supply. The Wisconsin Hop Exchange subcontracts with Legacy Hill Hop Supply, a private hop business based in Wisconsin Rapids with its own 14-acre hop yard, to do the pelletizing, packaging, storage, and fulfillment. Pellets are kept in a cold storage facility in Wisconsin Rapids until they are distributed to brewers.

The Wisconsin Hop Exchange helps oversee processing and quality control through its quality review board and by sending samples in for testing at AAR Labs. It engages with brewers to understand quality specifications and makes adjustments to ensure these standards are being met.

The centralized processing and cold storage in Wisconsin Rapids has benefits and disadvantages. The centralized intake enables blending to homogenize hops of the same variety, from multiple farms — that have met quality standards — to provide a more consistent product to breweries who purchase larger volumes throughout the year. Additionally, the technical expertise and quality control that Legacy Hill Hop Supply provides as the sole processor for all the hops sold through the exchange has significantly helped to improve the quality of the end-product. However, the centralized cold storage location and situation poses risks and challenges. Access to long-term cold storage is facilitated by Legacy Hill Hop Supply, courtesy of their connections in the cranberry industry. Though this provides reasonable storage rates it adds transportations costs for the industry compared to a more decentralized storage network.

For now, the current supply chain in WI appears to be meeting the needs of growers and markets. As such, other challenges are higher priority for growing the industry.

Strategic Processing Priorities:

- Continue to survey the WI hop supply chain to identify needed improvements to on-farm drying, cone storage, finished pellet storage, and order fulfillment.

Product and Markets

WI hops have primarily just one use-case, as a bittering and flavor agent for breweries in Wisconsin looking for a local source of hops. Growers can vertically integrate to supply finished pellets, but most choose to sell dried cones to the Wisconsin Hops Exchange. About 25,000 pounds of hops were sold through the Wisconsin Hop Exchange in 2023, roughly 80% of the total crop in Wisconsin. The Hop Exchange is a growers' cooperative with about 20 members and two part-time staff. In the past 3 years, the Hop Exchange has sold products to 103 Wisconsin breweries out of a total of 249 breweries statewide. During that period, 90% of coop sales were to Wisconsin breweries, with 50% of sales to just three breweries: New Glarus, Octopi, and Molson Coors's Leinenkugel. According to Matt Janzen, Marketing and Sales Manager for the exchange, interest in buying local hops is growing among Wisconsin brewers, even though the craft brewing industry as a whole has contracted in the last few years.

The Wisconsin Hop Exchange has been an important asset to Wisconsin hop growers and the industry as a whole. It has been very effective in developing relationships with brewers and recruiting buyers of Wisconsin hops. Staff provide the crucial link between growers and brewers that helps coordinate supply and demand and inform growers on what varieties to plant. The exchange has also made great strides in improving the quality of Wisconsin hops by setting standards that meet brewer specifications and creating a quality review board to enforce those standards. Dan Carey, Co-Founder and President of New Glarus, has been a driving force in supporting hops production in Wisconsin. Carey has worked closely with exchange staff and growers to improve quality, contract production, and provide expertise from a brewer perspective.

Supply for desired varieties is currently the main factor limiting sales, and grower recruitment is a top priority. The exchange is looking to expand membership to include growers in Minnesota, northern Illinois, and Michigan to help boost supply. Increasing the percentage of hops grown on contract, currently at 20%, would help attract growers and reduce inventory backlogs of varieties that are in lower demand. Prospective growers are also demanding cost of production information and UW-Madison is currently engaged with growers in an effort to gather this data.

Wisconsin Hop Exchange staff are supported by grant funding from the USDA Value Added Producer Grant program. According to Matt Janzen, the hop exchange would need to increase sales three to four times current levels to support one full time staff without grant funding. Current grant funds run out in summer 2024, but the Hop Exchange is in the process of reapplying for the Value-Added Producer Grant.

Besides the Wisconsin Hop Exchange, growers have relatively few other options for selling their hops. Some growers sell a portion of their hops directly to brewers who they have developed relationships with. The Wisconsin Hop Exchange helps facilitate some of these grower-brewer connections. Wet hops are

often sold this way, but they usually account for a very small percentage of the total crop. Growers who have their own pelletizers can sell their dry hops directly to brewers or through the Lupulin Exchange, a national buyer/seller marketplace for spot hops.

The Wisconsin Hops and Barley Coop also purchases hops from growers. Founded in 2007, this buyer's cooperative was founded by Wisconsin brewers who were interested in buying local hops. Currently, there are four brewery members and two growers that sell to the coop. Randy Urness of Fine Bine Farms is the primary contact and supplier of hops to the coop. Sales volumes through this coop are relatively small due to decreased demand among brewery members.

Strategic Product Development and Marketing Priorities:

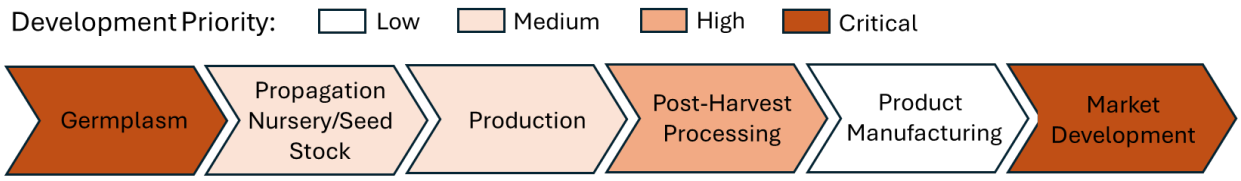
- Conduct a total addressable market (TAM) study to determine the market potential of WI-grown hops and what challenges must be overcome to capture more of that market. Use this information to project acreage and processing needs.
- Support the hop growers and grower organizations in producing hops that meet or exceed the quality of hops grown in the Pacific Northwest.
- Assist the hops industry in developing and implementing consumer awareness campaigns about the importance of buying beer made with WI-produced ingredients.

Acknowledgements

Thank you to the following people for sharing their expertise and making this report possible: Scott Alne (Hoppertunity Farms), Eric Anderson (St. Croix Valley Hops), David Buss (Davali Ridge), Jerome Clark (UW-Madison Extension), Julia Cravens (Four Winds Farm), Joey Dunscombe (Four Winds Farm), Josh Havill (University of Minnesota), Matthew Janzen (Wisconsin Hop Exchange), MaryAnne McKenzie (Four Winds Farm), and Randy Urness (Fine Bine Farms).

Table Grapes

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Evaluate new table grape cultivars at multiple locations in WI to generate locally-relevant performance data and enterprise budgets.
- Help the industry develop a strong value-proposition for why WI and Midwest-grown table grapes are superior to table grapes imported from CA and elsewhere.
- Work with WI grocers and retailers to taste and sample WI-grown table grapes to help develop market partners.
- Develop geographic clusters of growers that can share information, pool buying power on inputs, and aggregate production to meet market demand.

Introduction

Thanks to the work of a pioneering grape breeder, Elmer Swenson, there is a sizeable grape and wine industry in Wisconsin and the Upper Midwest. The University of Minnesota carried forth his work and released a series of wine grape varieties that have enabled production of premium quality wines. Table grapes offer similar potential, but widespread production in WI and the Upper Midwest has been limited by lack of proven seedless cultivars. Soon to be released seedless table grape varieties from the Minnesota are poised to change that.

Breeding

Though the University of Wisconsin does not have a grape breeding program, Extension and UW-Madison researchers have been actively involved in evaluating both wine and table grape cultivars in replicated trials since the 1990s. The first round of trials found that ‘Mars’, ‘Reliance’, ‘Somerset Seedless’, and ‘Montreal Blue’ were the most reliably winter hardy of the available cultivars. New trials established in 2020 and 2022 are evaluating these four varieties plus the new selections from Minnesota: ‘MN 1369, MN 1296, and MN 1325. Preliminary results are exciting.

Strategic Breeding Priorities:

- Continue the UW table grape cultivar trials to generate survival, yield, and fruit quality data

Propagation and Nursery Stock

Grapes are very easy to propagate through stem cuttings and tissue culture. As such, propagation is not a limitation to industry development. Aligning supply of nursery stock with grower demand can be a challenge but can be overcome by facilitating communication between nurseries and growers. It is also not yet clear from Minnesota to whom they will license the propagation and production of their new varieties.

Strategic Propagation and Nursery Stock Priorities:

- Work with the WI Grape Growers Association and other fruit grower groups in WI to pool plant orders to negotiate on pricing and specify nursery stock standards with WI nurseries.

Production and Post-Harvest Processing

Table grape production is very similar to wine grape production. As such, there is considerable expertise and experience in Wisconsin and it is relatively seamless for wine grape growers to add table grapes. The major difference is the post-harvest handling and storage required to sell whole grape clusters as fresh fruit.

Post-harvest processing of table grapes requires washing, inspecting, and cold storage. The shelf life can be many weeks, but growers will need a plan to move all the fruit within the first week or so after harvest depending on time and conditions of storage in transit to markets.

Strategic Production Priorities:

- Conduct research to determine optimal trellising, pruning, and fertility strategies for the top table grape varieties.
- Develop enterprise budgets to determine minimum planting sizes for profitability.
- Provide training to growers on post-harvest handing, storage, and sale of fresh table grapes.

Product and Markets

Though table grapes are widely consumed, there has been little to no sale of Wisconsin-grown table grapes. As such, consumers and retailers will require education to get to know the new varieties. There is potential for significant growth of the market as the California-grown green and red standards are not particularly flavorful compared to the WI-grown varieties. Growers will likely have success initially selling direct to consumer via farmers markets and farm stands. Retailers that feature locally-grown items, such as cooperative grocery stores, have shown interest in the new varieties. To access larger retail grocery chains, growers will likely need to aggregate production volumes. As such, early growers should consider working together as a cooperative or other formal entity much like the Wisconsin Hops Exchange or the American Hazelnut Company.

The challenge with seedless table grapes, is markets will demand superior fruit quality without defects to the clusters or individual berries. If pollination and fruit set are poor, growers will need alternative markets for the grapes. One option is to juice the seconds either for sale to wineries or to make non-alcoholic

grape juice. The grape juice industry is dominated by Welch's and the Concorde grape. The new varieties of seedless table grapes could disrupt that market by offering new flavors and blends.

Kids love grapes and schools could be a good market for growers. However, because the grapes can ripen in July in southern Wisconsin, the school opportunity might be better suited for growers in northern Wisconsin.

Strategic Product Development and Marketing Priorities:

- Work with the Grape Growers Association and early-adopter growers to produce customer awareness campaigns to introduce consumers to WI-grown seedless table grapes.
- Evaluate the use and potential of juice from the new seedless table grapes for other products such as non-alcoholic juice or gummies.
- Work with growers and retailers to identify the optimal packaging and branding for WI-grown table grapes.
- Interview school districts to determine demand for school lunch and/or healthy snack programs

Acknowledgements

Thank you to the following people for sharing their expertise and making this report possible: Amaya Atucha (UW-Extension), Matt Clark (University of Minnesota), Soon Li Teh (University of Minnesota)

Culinary Grains

Industry Assessment and Strategic Development Priorities

Note: Although food-grade grains are included in the UW Emerging Crops program, there is a pre-existing Artisan Grains Collaborative that has been working to develop food-grade grains in Wisconsin. They will be publishing a strategic plan in January 2025 for their work with key breeding, supply chain, and market development priorities. We refer readers to that plan. The information below provides a general overview of food-grade grains and considerations in developing new grain varieties for specialty and niche markets.

Introduction

Unlike commodity grains that have been developed primarily to maximize yield across broad geographic areas, new “culinary grains” are being developed for regional markets in collaboration with growers, artisanal food and beverage makers, and consumers. These food-grade grains include, but are not limited to, cereal grains (wheat, oats, rye, barley); pseudocereals (buckwheat, millet, quinoa); pulses (lentils, dry beans, soybeans); wheat relatives often called “ancient grains” (emmer, einkorn, spelt); and corn and sorghum. There is often a focus on developing markets for grains with environmental benefits or that can diversify crop rotations, such as oats, buckwheat, winter grains and perennial grains such as Kernza.

Bringing these culinary grains to market requires creating entirely new supply chains tailored to their unique needs, such as smaller scale of production, preserving the identity of specific varieties, meeting more stringent quality standards, and responding to changing consumer preferences. Many stakeholders from throughout the supply chain, including breeders, growers, processors, makers, and consumers need to play an active role in facilitating these dynamic supply chains. Several intermediary organizations in Wisconsin are working to facilitate these relationships including: the Artisan Grain Collaborative, UW-Madison’s Organic Grain Resource and Information Network (OGRAIN) and Seed to Kitchen Collaborative, and Michael Fields Agricultural Institute. The ultimate goal is to develop new varieties (or identify old varieties) of the grain crops with a focus on flavor and sustainability, promote the unique value proposition to buyers, and build out a supply chain to supply those buyers.

Breeding

UW-Madison is leading breeding and research efforts in Wisconsin with an emphasis on breeding for organic systems and local/regional markets. Major priorities include the development of hard winter wheats for bread baking and hulless barley and oats for new food products. UW-Madison is set to release a new variety of hard winter wheat in 2025 that was bred for bread baking quality, flavor, and disease resistance. Breeding efforts have been highly collaborative, with input from farmers, bakers, and consumers guiding the selection process along the way.

The University of Minnesota is breeding new varieties of hard red spring wheat with a focus on straw strength, disease resistance and yield. UMN is also developing new varieties of spring and winter barley

with improved cold hardiness, malting quality, and free threshing. UW Extension has been collaborating with UMN to test winter barley selections for winter survival and malting qualities.

The University of Illinois is breeding new varieties of soft red winter wheat with higher yield, early maturity, higher test-weight, and resistance to fusarium head blight.

Propagation and Seed Stock

Many varieties of food-grade grains are available through specialty seed retailers. UW-Madison's OGRAIN maintains a list of organic grain seed sources. Heirloom, heritage, and other traditional varieties of grains can be found in limited quantities from small seed companies. Growers can also save their own seed year after year, which is more common with rare, traditional varieties.

Production

Food-grade grains generally fall into one of four categories: winter, spring (cool-season), summer (warm-season) and perennial. Each category of grains has different production systems and characteristics.

Winter grains are sown in the fall, grow for a short time before going dormant, and then resume growth in the spring before flowering and going to seed in summer. Winter grains have advantages over spring grains, such as being easier to plant due to better field conditions in the fall versus spring; higher yields; better competition with weeds in the spring; and earlier maturity the following year, opening up more options for a succession crop. Winter rye and winter wheat are the most common winter grains grown in Wisconsin.

Spring grains are sown in the early spring and harvested mid-summer. Spring grains can have a higher price point than winter grains because of their quality characteristics. However, they are planted in more challenging field conditions and are more susceptible to weed pressure. The most common spring grains in Wisconsin include wheat, oats, and barley.

Summer grains, such as corn and soybeans, are sown in late spring and mature in September-October in Wisconsin. These grains need warmer soil temperatures to germinate and require the entire growing season to reach maturity. Dry beans, sorghum, and buckwheat are also summer grains.

Perennial grains such as Kernza, are typically sown in the fall, go dormant in the winter, and produce their first grain crop the following summer. The crop continues to produce grain in following years without the need for replanting, until the yield declines substantially around year four and needs to be replanted.

Before planting food-grade grains, growers should seek out buyers and gather information on what they are looking for. End buyers will have different specifications for grain depending on end use. For example, bakers will require a high protein content for baking bread, while brewers will be interested in low protein and beta-glucan levels. Only certain varieties will be able to achieve these specifications, and growers should use this information to help guide variety selection. Some buyers may want specific varieties. It's highly recommended that growers sign a contract with buyers before planting to avoid the risk of not finding a market.

Other considerations for variety selection and management include disease resistance, yield, crop rotations, and weed control. Each category of grain and specific varieties have advantages and disadvantages. Disease can be a significant challenge in Wisconsin's warm, humid summer climate. Fusarium head blight can infect grains and cause high levels of mycotoxin, making them unfit for food grade markets. Resistance to fusarium is a top breeding priority and significant gains have been made. Yield potential can vary significantly between varieties and from winter to spring grains. Yield potential should be considered in combination with other qualities such as disease resistance, quality characteristics, and crop rotations. In addition, careful consideration should be given to planning a crop rotation that gives the grain crop the best chance of meeting spec. For winter grains and perennial grains, growers need to think ahead because these grains are fall planted and need enough growing season to germinate and put on some green growth. They are also harvested early enough the following season to plant a second crop, such as a cover crop.

Processing

Planning for post-harvest storage and handling is essential before planting food-grade grains. Food-grade grains need to be handled with care and attention to maintain their quality for high-value food markets. Grain needs to be cleaned, dried, and stored in specific conditions to exclude pests, prevent spoilage, and maintain quality parameters for buyers. Culinary grains often require different sets of equipment than commodity grains for these processes because of the smaller scale of production, grain characteristics, and more stringent buyer specifications. For some growers, it may make sense to invest in their own equipment, while others may want to share or rent equipment or pay a custom processor. Cleaning grain and maintaining its quality in storage can be challenging and a steep learning curve for growers. Growers should explore secondary markets or applications for their grain in case it doesn't meet the specs of their initial intended buyer.

Products and Markets

Selling culinary grains requires significant effort on the part of the farmer. However, the higher prices for these grains can make it worth the effort, especially for smaller and mid-scale farmers who need to make higher profits per acre on their land. It's highly advised for farmers to contract production with an end-buyer before planting and explore secondary markets if their grain does not meet spec, especially for beginning growers. Many higher value markets are found in larger metropolitan areas with breweries, bakeries, and distilleries with an interest in local grains. Markets are still developing and shifting to meet changing consumer preferences. Product development and marketing are relationship-intensive processes. Connecting with support organizations such as Artisan Grain Collaborative and UW Madison's OGRAIN is extremely valuable to help facilitate these relationships and find resources to increase success.

Current work

Artisan Grain Collaborative, based in Madison, WI, works to create and strengthen relationships along the grain supply chain throughout the Midwest. ACG connects farmers, processors, makers, and advocates, develops resources, and builds awareness of about a dozen different regional grains.

Major programs/initiatives of AGC include: working groups, development of outreach materials, coordination of variety trials with end users, and market research. They will be launching a new microgrant program in fall 2024 to make professional development opportunities available to producers.

AGC has done extensive research on food grade grain supply chains in the Upper Midwest and has published several assessments over the past three years.

Grains to Institution in the Midwest: A Wisconsin Case Study, November 2022
The State of Mobile Grain Processing in the Upper Midwest, August 2023
Drivers and Deterrents of Small Grain Adoption in the Upper Midwest, September 2023

- 2-page Summary

The New Growers' Guide To Producing Organic Food-Grade Grains In The Upper Midwest, 2023

AGC will publish a new strategic plan in January 2025 covering four main topics: accelerating the food grade grain supply chain; helping stakeholders share knowledge and develop relationships; helping tell farmer stories to develop markets; and systems resourcing for continuing the work of AGC as an organization.

UW-Madison has several initiatives that support food grain production in Wisconsin, including UW-Madison Extension's Emerging Crops Accelerator, the Organic Grain Research and Information Network (OGRAIN), the Cereals Breeding and Quantitative Genetics Lab, and faculty in the College of Agricultural and Life Sciences (CALS).

- *UW-Madison Extension* conducts research and education outreach programming to highlight activities at UW, producers growing food-grade grains, and the work of other organizations in the Upper Midwest.

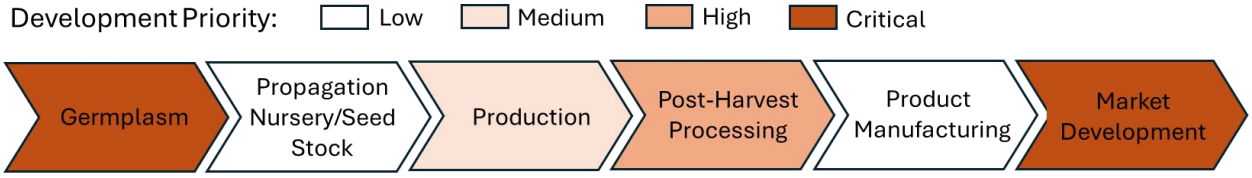
- Major priorities for faculty in *UW-Madison CALS* and the *Cereals Breeding and Quantitative Genetics Lab* include development of improved winter wheats for artisan bread and exploration of hulless barley and oats to create new food products. Developing varieties and production systems for organic systems is a particular area of focus. There is also an emphasis on developing markets for grains with environmental benefits or that can diversify rotational practices. Variety trial reports are published annually.

- *OGRAIN* conducts agronomic research on a wide variety of grains for organic systems. They host field days on farms and research stations and organize an annual winter conference for producers.

Michael Fields Agricultural Institute conducts research and trials on a wide variety of food-grade grains. Their education and outreach programs focus on bringing producers together for peer-to-peer learning. MFAI also works at the grassroots level to organize with policymakers, non-profit leaders and farmers to support conservation practices and address socioeconomic barriers in agriculture at the state and federal levels.

Kernza®

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Develop improved varieties with better seed size and yield than MN Clearwater.
- Develop and facilitate geographic clusters of growers in WI to share production knowledge, efficiently develop and support post-harvest processing capacity, and aggregate grain to more efficiently access markets.
- Better develop and articulate the value proposition of Kernza grain beyond its environmental benefits.
- Assist WI entrepreneurs in developing branded CPGs to help build demand for Kernza products.
- Connect WI growers with ongoing regional market and supply-chain development efforts to access grain buyers.

Introduction

Kernza, the trademarked name for improved varieties of intermediate wheatgrass (*Thinopyrum intermedium L.*), is the world's first commercially viable perennial grain. Kernza breeding began in the late 1980s at the Rodale Institute. The Land Institute took over breeding efforts in 2003, which continue today among a collaborative network of international partners, including the University of Minnesota. In 2019, the University of Minnesota released the first ever variety of Kernza, called MN Clearwater.

Compared to its annual grain crop relatives, Kernza perennial grain offers numerous ecosystem services. Its roots grow up to 12 feet deep, several times the depth of annual wheat. These roots hold soil in place, add organic matter, and help water infiltrate the soil after heavy rainfalls. They can also reach water and nutrients from deep in the soil profile, helping reduce the risk of nitrate leaching into drinking water sources and making the plant more drought tolerant.

Kernza is an emerging crop that is currently being grown on a small scale for niche markets, but has potential to revolutionize the way we grow grains, using perennial plants instead of annual plants. Kernza has captured the interest of chefs, bakers, and food companies looking to source more environmentally-friendly ingredients. It can also be grown as a dual-purpose crop for grain and herbaceous forage for livestock, offering multiple revenue sources for growers. As the genetics and agronomic understanding of the crop improve, the goal is for Kernza® to be widely grown throughout the northern United States.

The USDA SAS CAP program funded a five-year grant running from September 2020 through September 2025 to help develop and deploy Kernza perennial grain. The grant supports researchers, graduate students, business leaders, nonprofit professionals, and farmers in nine states. As part of the grant, the University of Wisconsin-Madison is conducting agronomic research, education and outreach, and supply chain development. Other organizations, such as Michael Fields Agricultural Institute, Green Lands Blue Waters and Clean Wisconsin, are also involved in research, supply chain development, and advocacy in Wisconsin.

Wisconsin at a Glance (2023 Supply Report)
Total Acreage: 154
Number of growers: 14
Number of Acres per Farm: 0.2 - 5 acres, with a few over 5 acres

Breeding

There are currently five Kernza breeding programs worldwide, but only two of them have released varieties so far: The Land Institute and the University of Minnesota. USDA-Utah, the University of Manitoba, University of Uruguay, and the Swedish University of Agricultural Sciences also have Kernza breeding programs and may release varieties in the future. UMN released its first variety, MN Clearwater, in 2019 with a second variety (MN-1603) set to be released in limited quantities by summer/fall 2024. Current breeding objectives are increased grain yield, sustained grain yield over multiple years, increased seed size, better shatter resistance, improved threshability, larger spike length and width, plant height, lodging resistance, and disease resistance. End-use quality is being assessed but is not being selected for directly. Breeders have transitioned to using genomic selection to shorten breeding cycles from four years under conventional breeding to six months (two generations per year). This has allowed for rapid improvement of certain traits, such as threshability and shatter resistance.

Though the University of Wisconsin does not currently have a Kernza breeding program, researchers are involved in variety evaluations, agronomic trials, and industry development.

Strategic Breeding Priorities:

- In Wisconsin, evaluate released germplasm in replicated performance trials in candidate production regions where the dual-purpose use of Kernza has the highest ecosystem services value.

Propagation and Seed Stock

Growers must be licensed to grow Kernza. Applications can be found on www.kernza.org and will be reviewed by staff at The Land Institute. Growers who meet the criteria will need to sign a trademark licensing agreement in order to be eligible to purchase seed from an approved supplier. Only licensed growers are able to purchase seed.

There are three licensed Kernza seed dealers in the Upper Midwest, Albert Lea Seed, Minnesota Native Landscapes and Arcola Farms. These suppliers exclusively sell the variety MN Clearwater and nearly all growers in the Upper Midwest are growing this variety.

Strategic Propagation and Seed Stock Priorities:

- Seed supply and increase are being managed by the Land Institute and University of Minnesota and are currently not major limitations to growth of the Kernza industry in Wisconsin. That may change, however, if consumer demand starts to grow.

Production

The Land Institute tracks the number of Kernza growers through its licensing process and requires them to submit basic production data at the end of every year. At the end of 2023, there were 72 total growers in 15 states with 2,405 combined acres throughout the United States. In Wisconsin, there are 14 licensees that are actively growing Kernza on 154 total acres. 23 of these acres were planted in 2023 by a new cohort of growers recruited by the Valentin Picasso Lab at UW-Madison as part of a study looking at Kernza's effects on water quality. About half the total acres in Wisconsin are conventional and half are organic.

Kernza can be grown for multiple products. Grain is the most common, but it can also be used as forage by grazing livestock and harvested for hay and straw. Although the economics of Kernza production are improved when grown as a dual use crop, the majority of growers in Wisconsin and the Upper Midwest grow Kernza for grain only. This is mainly because of the lack of livestock on their farms and the forage generally not being high enough quality for dairy cows. As of the end of 2023, there was about 73,000 lbs of bin-run (uncleaned) Kernza in storage, with about 90% being conventionally grown.

Kernza is most commonly planted in the fall as the vernalization of the plant over the winter is required to flower and set grain the next year. Site preparation and establishment practices are similar to other winter grain crops. The U of MN publishes best management practices for managing Kernza for grain, forage, or both. KernzaCAP collaborators, including the Valentin Picasso lab at UW-Madison, are conducting trials and hosting field days to enhance agronomic and on-farm knowledge. Current research includes studying how row spacing and legume intercropping affect growth, yield, and yield longevity; and how nitrogen application rates, timing, and source, and phosphorus and potassium rates, affect grain and forage.

As a new crop, Kernza presents growers with many challenges. Foremost is the relatively low yield compared to annual cereal crops. Yields in the Midwest average 334 lbs/acre of bin-run grain. With an average of 40% loss during processing, this amounts to about 200 lbs of clean grain per acre. At these yields and the current market price Kernza can support, the opportunity cost of planting Kernza rather than corn or other commodity crops is significant. Although the perenniality of Kernza reduces input costs in the second and third years, these savings do not overcome the yield gap. Minimizing the steep yield decline after year three will help bridge the gap in profit potential. Some growers are waiting for UMN to release a new cultivar before planting new acres to achieve larger yields.

Growers also report challenges with weed management, especially in the establishment year and first harvest year. Problem weeds in the establishment year include volunteer plants from a prior crop and fall germinating weeds. Winter annuals such as pennycress can compete with Kernza the following spring

before young the Kernza plants have a chance to grow. Another challenge often cited by growers is managing nitrogen in organic systems with respect to timing and application rates to maximize yield while limiting lodging.

Harvesting also poses a number of challenges. Determining harvest timing is tricky, as Kernza grain does not ripen uniformly on the spikes. Harvest timing is relatively subjective and requires experience and frequent observation as seed heads begin to mature. Optimal harvest timing will minimize grain loss due to shattering while allowing grain to fully mature on the spikes to maximize quality. Growers report a steep learning curve in optimizing combine settings to achieve the right balance between grain cleanliness and minimizing loss out of the back of the combine. Kernza's small seed size means growers often have to use the extreme lowest setting on their combine to maximize threshing power. Finally, some growers have been challenged to achieve optimal moisture content for harvest and storage, which greatly affects the quality of the grain.

Strategic Production Priorities:

- Continue to conduct agronomic research to develop best management practices for growing Kernza in Wisconsin's main agricultural zones/soil types.
- Continue to provide researcher-based information and training to growers on how to establish and manage Kernza
- Facilitate development of geographic clusters of growers to enable knowledge and equipment sharing, and aggregation of yields

Processing

<u>Cleaning, Dehulling</u>

One of the major bottlenecks in the Kernza value chain is the lack of processors to clean and dehull harvested grain. Processing Kernza is expensive and requires specialized knowledge and equipment. Currently, the only Kernza processor in Wisconsin is Rooster Milling in East Troy. So far, Rooster Milling has only processed Kernza grown by Michael Fields Agricultural Institute. They may operate as a toll cleaner for other growers in the future, charging per pound of clean grain. However, the time and labor involved in switching equipment to clean Kernza will likely require a minimum order quantity that will be achieved through aggregation of grain from multiple growers.

Arcola Farms is an emerging business in the production, processing, and marketing areas of the Kernza value chain in Wisconsin and Minnesota. Arcola is partnering with a seed processor based in Minnesota to trial Kernza processing with grain grown at their own farm in Minnesota and a Wisconsin farm. Arcola hopes to buy a significant portion of the Kernza grown in Wisconsin, have it processed, and market it through distilleries. Arcola became the newest certified Kernza seed dealer in 2024.

Outside of Wisconsin, processing options are also limited. Healthy Food Ingredients, based in Minnesota, invested in processing equipment but could not make money and recently shut down. Perennial Promise Growers Cooperative (PPGC) aggregates Kernza grain from its grower members in the Midwest and contracts with its own processor, Stengel Seed and Grain, based in South Dakota. A few Kernza CPG companies, such as Sprowt Labs/Perennial Pantry in Northfield, Minnesota and

Sustain-a-Grain in Kansas are vertically integrated and operate their own processing equipment but do not offer toll cleaning services to growers outside of their network. A few other processors have expressed interest in processing Kernza, but until acreage and volume increase, it's unlikely more processors will develop the capacity to clean Kernza.

Milling, Flaking, Malting

Kernza can be sold as a whole grain or processed further into different forms, such as flaked, rolled, puffed, malted, cracked, or milled, depending on the end use. There are few secondary processors who have worked with Kernza in Wisconsin. Rooster Milling in East Troy, Wisconsin has milled Kernza for Michael Fields Agricultural Institute and may offer its services to other growers in the future. Briess Malting has flaking capacity and recently flaked a batch of Kernza for Lakefront Brewery to use as an adjunct grain in a wheat beer. Meadowlark Organics has milled Kernza grown on their own farm but is not currently working with it.

In Minnesota, there are several additional processors, such as Perennial Pantry and Baker's Field. Most processors mill for their own use or work exclusively with grower groups, such as the Perennial Promise Growers Cooperative. Some of the challenges for millers in working with Kernza are equipment setup costs, type of equipment needed and minimum volumes of grain needed. By and large, however, milling has been successful and additional milling partners likely exist.

Strategic Processing Priorities:

- Processing challenges with Kernza are primarily related to aligning supply and demand as market development work proceeds. As such, continue to facilitate conversations between growers, processors, and buyers to align supply and demand.

Products and Markets

Kernza has been used as an ingredient in over 50 different products, including whiskey, beer, pancake mix, pilaf, cereal, crackers, pasta, sourdough bread and many more. Minnesota has been the epicenter of Kernza commercialization in the Midwest, with numerous local and regional businesses, such as breweries, distilleries, bakeries, and CPG companies experimenting with and selling Kernza products. The University of Minnesota's Forever Green Initiative and Agricultural Utilization Research Institute - which has conducted extensive research and developed technical sheets for different end uses for Kernza - have been instrumental in supporting Kernza industry development. Several Kernza products have stood out for their flavor and early marketing success, particularly beer and whiskey, as well as crackers, pancake mix, and flatbread/naan.

There has been comparatively little Kernza product development or industry support in Wisconsin. Most Kernza retail products made in Wisconsin have been limited-run products from a few enterprising businesses who have partnered with UW-Madison and non-profits such as Michael Fields Agricultural Institute, Clean Wisconsin, and Artisan Grain Collaborative, on special projects. The only Kernza products currently available from Wisconsin based companies are beer from Lakefront Brewery in Milwaukee ('Pretzel Wheat'), flour from Michael Fields Agricultural Institute, and cookies and crackers from Simple Food Group in Lake Geneva. With more industry support, Wisconsin has untapped potential

to develop Kernza markets, especially in the craft brewing and distilling industries. However, significant barriers exist that will limit adoption of Kernza, most notably its high cost, inadequate or inconsistent supply, and uncertainty in how to use Kernza among end-buyers.

Wholesale options for Wisconsin growers are limited to the Perennial Promise Growers Cooperative (PPGC), which is open to any Kernza grower in the Midwest. PPGC is a farmer-led cooperative and ingredients company that markets whole grain, flour and flaked Kernza. PPGC provides its members with access to cleaning and processing facilities and aggregates the grain to access larger markets. Growers must pay to have their grain shipped and cleaned/dehulled at PPGC's processor, Stengel Seed and Grain, based in South Dakota. The distance to the processor makes this option cost prohibitive for many Wisconsin growers. Growers must also be able to store the cleaned grain on their farm until it is sold.

PPGC has been working closely with MadAgriculture to develop Kernza markets. Patagonia Provisions is one of its main buyers and has bought all of its current inventory of Regenerative Organic Certified (ROC) grain, primarily for a collaborative brewing project, as well as a Kernza pasta. Markets for certified organic grain through PPGC are also relatively strong, while there is a glut of conventional grain.

A few national CPG companies, such as Patagonia Provisions, Cascadian Farm and Kodiac Cakes, offer Kernza products that can be found on the shelves of large grocery chains. Notably, Patagonia Provisions teamed up with craft breweries across the country in 2023 to help brew and market a Kernza Lager. Owing to the program's success, they recently expanded the number of breweries they are partnering with (none of which are in Wisconsin). Patagonia works exclusively with the Perennial Promise Growers Cooperative to source its grain, and has purchased all current inventory of Regenerative Organic Certified grain.

The major bottleneck and challenge to increasing the Kernza industry in WI and the Upper Midwest right now is product-market fit. Though consumers want and support environmental sustainability in their food, their purchasing decisions are still driven primarily by price and product quality. Until seed yields and economies of scale improve, Kernza and Kernza products will be more expensive than comparable grains like wheat. Also, food producers have not yet found a use-case for Kernza that offers superior product quality over comparable grains. Thus, the TAM for Kernza remains the narrow slice of consumers with both the spending power and strong support for perenniality. It's possible that voluntary carbon markets and Scope 3 considerations will change the market landscape for Kerna, but until then the industry will need to focus on convincing consumers to pay more for environmental attributes.

Strategic Product Development and Marketing Priorities:

- Better develop and articulate the value proposition of Kernza grain beyond its environmental benefits.
- Raise consumer awareness, focusing on sustainability, flavor, nutrition, and farmer connection of Wisconsin grown Kernza

Acknowledgements

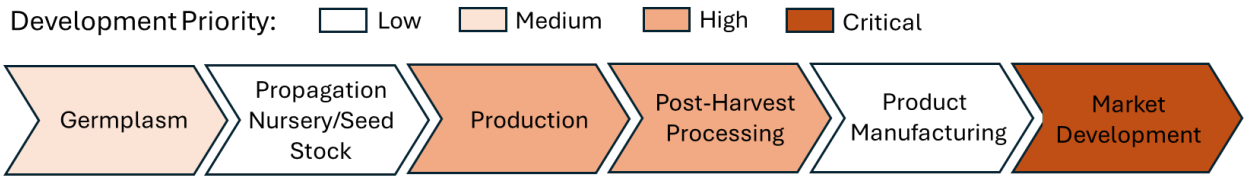
A special thank you to the following people for sharing their expertise and making this report possible: Nicole Tautges, Katharine Chute, Amy Teller, Erica Shoenberger, Valentin Picasso, Kata Young, David Stennes, Jake Busse, Hana Fancher

References

- Kernza® Perennial Grain Market Scan, “Overview of Current Market Conditions and Opportunities for Growth,” April 3, 2024, Katharine Chute, Product and Market Development Specialist, UMN Forever Green Initiative
- AURI, Kernza® Perennial Grain Value Chain Development in Central Minnesota, August 2022
    - https://auri.org/wp-content/uploads/2023/01/2022-AURI-Kernza-Perennial-Grain-Report.pdf
- Kernza Growers Guide, Nicole Tautges, Alison Detjens, and Jacob Jungers, May 2023
    - https://kernza.org/wp-content/uploads/Grower-guide_final.pdf
- Kernza Cafe Chats, Forever Green Initiative:
    - Marketing
    - Dual Use
    - Intro to Kernza Breeding and Licensing
    - Harvesting
    - Planting and Management
- AURI, The Process of Cleaning Kernza® Perennial Grain
    - https://www.youtube.com/watch?v=kDX2i1u3nBw
- 2023 Kernza® Planting and Harvest Report
    - https://kernza.org/2023-kernza-supply-review-now-available/
- Kernza®CAP Year 3 Annual Report, Prepared December 2023
    - https://kernza.org/kernzacap-releases-year-3-annual-report/
- 2023 Kernza Con lightning talks
    - https://mediaspace.umn.edu/media/t/1_mef56t0d

Winter Camelina

Industry Assessment and Strategic Development Priorities



Key Industry Development Priorities

- Establish winter camelina variety trials at multiple locations in WI to identify top performing varieties and generate performance data and enterprise budgets.
- Develop and implement a multi-disciplinary applied research and outreach education system to optimize winter camelina production in Wisconsin in a relay and/or double cropping system.
- Work with early-adopter growers and stakeholders in Wisconsin to replicate the UMN's pilot production program.
- Facilitate value-chain development with industry stakeholders and early-entrants to help align production and processing capacity to market demand.

Introduction

Winter camelina (*Camelina sativa*) is a promising new crop with potential to revolutionize cover cropping. It is a winter annual that flowers and produces oil-rich seeds very early in the spring. Its short season coupled with winter hardiness means that it can be grown in conjunction with traditional row crops such as soybeans, providing an additional cash crop for farmers to grow on land that would otherwise be fallow in winter. As such, winter camelina has enormous potential as it essentially becomes a cover crop that is a cash crop rather than a cash expense.

Camelina seeds contain about 36-45% oil, which is well-suited for both food and industrial uses. Much of the recent interest in large-scale production has come from the biodiesel and renewable aviation fuel industries. Jet fuel and biodiesel derived from camelina oil is showing great promise as a low carbon alternative to petroleum-based biofuels. Camelina oil is also very high in omega-3 fatty acids, as well as gamma-tocopherol (vitamin E), making it a heart-healthy oil for human consumption. The fatty acid profile of the oil and high protein content of the meal also makes camelina a high-value feed for livestock and the pet food industry. In addition, unique properties of the oil are attracting the attention of large biotech companies for its use in creating renewable bioplastics.

The University of Minnesota's Forever Green Initiative is leading the development of new germplasm, production systems, and supply chains for winter camelina in the Upper Midwest. It is still very early in the commercial development of the crop with the Forever Green Initiative partnering with growers and other stakeholders to pilot large scale production and invest in postharvest handling, storage, cleaning and processing facilities. With its new product applications, improved sustainability of existing corn and

soybean rotations, income diversification, and environmental benefits across supply chains, winter camelina has the potential to be grown on millions of acres across the Upper Midwest.

Wisconsin at a Glance
Number of acres: NA
Number of growers: NA
Number of acres per farm: NA

Breeding

The University of Minnesota launched its winter camelina breeding program in 2016 with the main objectives of selecting for cold tolerance and earlier maturity for relay and double cropping with soybeans and other row crops. The program has identified a line that matures 7-10 days earlier than currently available varieties. UMN will be harvesting its 2nd year of multi-location field trials in 2024, with a third year planned for 2024-2025. The line is expected to be released in 2-3 years. Future breeding targets include higher oil content, reduced glucosinolate content, higher yields and larger seeds to ease challenges with seed handling. Researchers are using genomic sequencing to find genetic markers linked to some of these traits to make trait introgression more efficient.

Large biotech companies, such as Yield10 Bioscience, Smart Earth, and Sustainable Oils also have winter camelina breeding programs using genetic engineering techniques. These companies are breeding winter camelina for traits such as improved winter hardiness, herbicide resistance, larger seeds, higher yields, and disease resistance. Varieties developed by these companies are proprietary and are only available to growers under contract.

Strategic Breeding Priorities:

- Wisconsin lags far behind in supporting adoption of winter camelina. Winter camelina variety trials should be established as soon as possible to identify top genetics for WI climate/soils.

Propagation and Seed Stock

Winter camelina seed can be purchased from seed dealers around the Midwest. Most seed is marketed as cover crop seed and the variety is often not stated (VNS). ‘Joelle’ is an original public camelina variety and most VNS seed is ‘Joelle.’ Private biotech companies have developed proprietary varieties but only make their seed available to growers under contract. These companies are primarily working with growers in Minnesota, Montana, the Great Plains, and Pacific Northwest. The University of Minnesota expects to release a new publicly available variety in 2026 or 2027.

Strategic Propagation/Seed Stock Priorities:

- Bring interested WI growers and stakeholders together to explore production contracts and secure access to seed.

Production

Winter camelina can be grown as a cover crop or an oilseed cash crop. The huge potential of winter camelina lies in its ability to be grown as an oilseed cash crop, providing economic returns to the grower without displacing traditional row crops. In 2022, the University of Minnesota's Forever Green Initiative partnered with MBOLD, a coalition of leading food and agriculture companies in Minnesota, to recruit a cohort of growers in Minnesota to pilot winter camelina oilseed production in conventional corn and soybean rotations. Approximately 2,000 acres of winter camelina were established in Minnesota across 14 farms in the fall of 2023. All of these acres are under contract with Cargill.

Other biotech companies offer contracts to growers in regions such as the Great Plains, Montana, and the Pacific Northwest, where there is a long history of growing spring camelina. They will likely expand to growers in the Upper Midwest to meet demand as winter camelina production systems are optimized.

Camelina oil for sustainable aviation fuel is the primary driver of winter camelina as an oilseed crop, with the meal as a byproduct for animal feed. Though acreage is currently limited to a few contracts led by the University of Minnesota's Forever Green Initiative, a 2023 study by Ecotone Analytics estimated production of winter annual oilseeds (winter camelina and pennycress) at 5.5 million acres in Minnesota alone by 2050.

In addition to oilseed production, a few hundred acres of winter camelina are grown for cover crop seed. Many more acres of camelina are planted as a cover crop. Farmers interested in growing winter camelina as an oilseed cash crop would benefit from growing it as a cover crop first to help overcome the learning curve.

The production system being developed for the Upper Midwest is relay cropping where the winter camelina is planted in September after a small grain or corn silage harvest. Once the camelina resumes growth in the spring, soybeans are no-till seeded into the camelina and the camelina is harvested a month or so later releasing the soybeans. A number of research projects are underway to optimize the system including:

- UW-Madison conducted trials in 2022-2023 comparing monocropped winter camelina with soybean relay cropped camelina in organic systems. Trials in 2023-2024 are looking at monocropped camelina and camelina double cropped with dry beans.
- USDA-ARS researchers at the Dairy Forage Research Center based in Madison, WI are studying winter camelina's use as a multi-functional cover crop; for use as a forage in dairy cow diets, as a pollinator resource, and for soil nutrient uptake.
- UW-Madison Extension is conducting a research project investigating winter camelina's cover crop potential before corn with four farmer collaborators. Measurements are being taken on winter survivability, establishment success, and biomass production of camelina. The study is also looking at nitrate leaching potential under winter rye vs camelina and corn yield after both cover crops.
- The Forever Green Initiative (FGI) at the University of Minnesota is conducting research into best management practices for double- and relay-cropping winter camelina with soybean; piloting new

dual cropping systems with winter camelina; and evaluating the environmental benefits of using camelina as a cover crop. FGI was recently awarded a $2.5 million five-year grant from the Cargill Foundation to support research in winter camelina and domesticated pennycress. Forever Green is also partnering with Cargill on a winter camelina on-farm pilot program, which resulted in winter camelina being established on approximately two thousand acres across the region in fall 2023.

Strategic Production Priorities

- Develop and implement a multi-disciplinary research and outreach education system to optimize winter camelina production in Wisconsin in a relay and/or double cropping system
- Work with early-adopter growers and stakeholders in Wisconsin to replicate the UMN's pilot production program

Processing, Products, Markets

Winter camelina seed can be difficult for growers to clean to the standards needed by processors because of its small size and lack of suitable equipment. Cleaning hubs provide a site to aggregate, clean, dry, and store grain for the short term, making smaller scale production more economically viable for growers. An aggregation site in Chatfield, MN is nearly completed and will be available to Wisconsin growers on a toll-process basis as long as growers are willing to pay for transport

Processing winter camelina for biofuels requires seed to be crushed and pressed for oil and then refined into fuels. Most oilseed crushers in the United States handle soybeans and are not set up for winter camelina, with its tiny seed. Only a handful of soft seed, flexible crush plants in North Dakota, Minnesota and Canada can process camelina. Significant increases in production of winter camelina will require a large investment in crush facility infrastructure to meet demand for oil. Researchers with the University of Minnesota's Forever Green Initiative are actively partnering with companies such as Cargill which operate crush plants to ensure market access for growers involved in large-scale pilot production through contract agreements. Downstream of oil extraction, there is significantly more capacity for refining vegetable oils than what is produced in the United States today.

The sustainable biofuels industry is pursuing a wide range of end uses and co-products for winter camelina. The largest market driving industry growth is as a low carbon biofuel for airplanes (sustainable aviation fuel) and other hard-to-electrify vehicles. Camelina meal is a high protein and high fiber co-product of oil extraction for animal feed. The meal is currently approved in the US and Canada for broiler chickens, laying hens, and cattle up to 10% inclusion[1] and is being explored for other feed applications, such as aquaculture. Camelina oil is also an edible, heart healthy oil for human consumption, with high levels of omega-3 fatty acids and tocopherol (vitamin E). The oil is also being researched in applications for PHA bioplastics and lubricants.

Large biotech companies, such as Yield10 Bioscience, Cargill, VISION Bioenergy Oilseeds and Sustainable Oils, are investing heavily in camelina research and development and building the capacity for more large-scale production contracts. They are also investing in infrastructure for pressing seed and, in some cases, refining the oil (Sustainable Oils). These companies are partnering with large energy companies, such as ExxonMobil, Shell and Marathon, who have signed offtake agreements for feedstock

oil and biodiesel. Cargill has offered contracts for oilseed production to growers in Minnesota, Wisconsin and North Dakota. Terms for their contracts are being developed for fall 2024.

Strategic Processing, Product Development, and Marketing Priorities:

- Given the financial capacity of the players involved in the camelina industry right now, developing processing capacity, products, and markets are not of strategic priority for the WI Emerging Crops program. Instead, the priority is making sure growers and processors are involved in the industry and have the opportunity to participate.

Acknowledgements

A special thank you to the following people for sharing their expertise and making this report possible: Matt Leavitt (University of Minnesota Forever Green Initiative), Will Fulwider (UW-Madison Extension), and Sam Bibby (UW-Madison Extension).