Wisconsin Hop Feasibility Study

An Evaluation to Determine the Feasibility of Growing & Marketing Hops in Wisconsin
Prepared for: The Wisconsin Hop Exchange

May 2016

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Executive Summary

Market Conditions

- Locally grown and sourced hops have a huge marketability potential. Much like the wine industry, the idea of the 'terroir' of hops or the 'Taste of Place' is a highly sought after for brewers and beer enthusiasts.
- Craft brewers often tightly wrap their geographic locations into their corporate Branding and identity, leveraging 'a sense of place' as a distinguishing attribute in their sales and marketing.
- By purchasing locally sourced hops, brewers can further solidify their locally produced marketing message.
- Last summer's hot and dry weather blighted the European hop harvest by over 27%, with hop prices shooting up by 35 to 60 percent depending on type since last summer or they are simply not available. This creates opportunities for U.S hop production to fill that shortage. It is a good time to be a hop producer.

Financial Assumptions

- Based on the research findings, an estimated price of $11.50 per pound of hops would lead to a $24,690.50 revenue per acre of land.
- Variable costs consisting of pre-farming and farming costs amounted to $7,050 per acre.
- This results in Earnings before, taxes, interests, depreciation and amortization or (EBTIDA) would be $17,640.20.
- It was determined, based on the size of farm and Wisconsin price average of $11.50 received per pound of hops, **the breakeven point can be reached between 1.57 and 4.38 years.**
- The estimated costs for the specialty hop harvester would be between $10,125 and $29,750, Hop Yard construction costs are estimated at $11,106, Hop drying machine cost estimate of $1,420 and the pelletizer cost estimate is between $2,500 and $37,500.

Market Demand

- In 2015, craft brewers produced 24.5 million barrels, and saw a 13 percent rise in volume[3] and a 16 percent increase in retail dollar value. Retail dollar value was estimated at $22.3 billion, representing 21 percent market share. The market for hops appears to be a seller's market, with brewers concerned about availability of hops and demand for hops is increasing rapidly.
- Additionally, in 2015 the number of operating breweries in the U.S. grew 15 percent, totaling 4,269 breweries—the most at any time in American history. Small and independent breweries account for 99 percent of the breweries in operation. However, production is also growing. Based on the size of the domestic crop in 2014, 70 million pounds of American hops were used nationwide. Based on the expected growth, it is estimated that 504 million pounds of hops will be used from 2015 through 2020' (Watson, 2015).
- The current growth trends in the craft beer market – more brewers, more market share, and more hoppy beers – have led some in the industry to worry about the hop supply in the future. There is a fear that growing demand will outstrip supply, particularly in the markets for niche varieties (craft brewers are using dozens of them). (Watson, 2015).
- There is reason to expect continued rapid changes in the hops market. In 2009, less than one-third of U.S. hops acres were planted in aroma hops. That has increased to over 60 percent planted in aroma in 2015.
- Through 2020, the hops market will continue to see extraordinary changes in the type of hops varieties grown and the size of acreage dedicated to hops, with U.S. demand for hops growing by an additional 24 million pounds by 2020. If those hops all came from the U.S., that's roughly 12-13,000 new acres of production needed.
- Wisconsin's estimated Hop Market ranges from **138,000 to 247,000 pounds annually.**

Overview

The objective of this research is to assess the feasibility of growing hops in Wisconsin for the Wisconsin Hop exchange to provide additional supply to the hops market. This research will identify target markets for the Wisconsin Hop Exchange to potentially capture.

What are Hops?

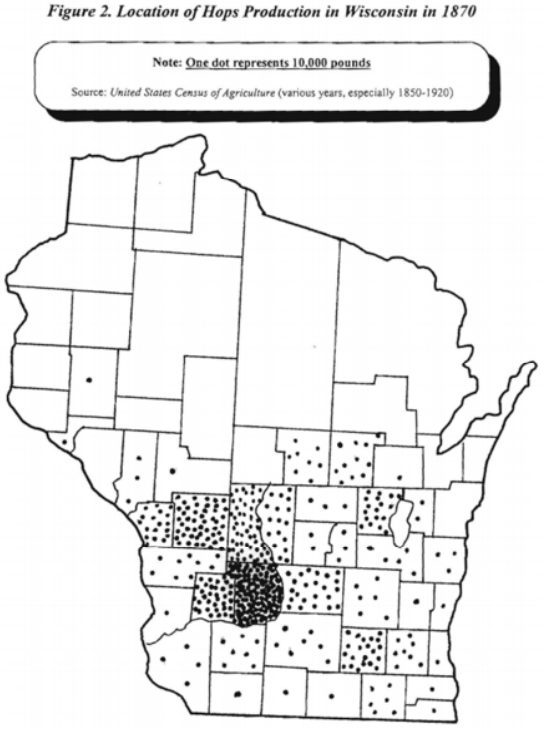
- The hop plant, or *Humulus lupulus*, is a perennial plant of the *Cannabaceae* family. Often referred to as a 'vine,' hops are actually a 'bine,' using a strong stem and stiff hairs, the hop plant can climb upwards as high as 25 feet. The plant has separate male and female bines, but only the female bines develop cones. Hops have been used in the brewing process for well over one thousand years.
- Hops production is generally located in moist temperature climates, with much of the world's production concentrating between the 40th and 50th parallels. Hop plants prefer well drained soil with adequate circulation to prevent molding. Day length during the growing season, as determined by latitude, has a major effect on yield.

- Hop plants can typically live for 20 to 25 years under good conditions. They can be propagated readily after the first year or two, making them economical in the long term.
- Yield percentage reaches 100% in about three to four years after planting and are able to produce upwards of 2 pounds of dried hops per plant under ideal growing conditions.
- The flower of the hop plant (also called seed cones or strobiles) is used in the brewing process. The part of the hop cone most important for the brewing process is the sticky, yellow resin inside the cone known as the lupulin glands. This resin contains alpha acids and essential oils that balance the sweetness of malts with its bitter profile, which contributes to beer's flavor and aroma. The resin is also essential as a preservative and important for 'head' retention.

- In addition to their uses in beer flavoring and aroma, hops have had a long history as a natural medicinal application for anxiety and as a sleep aid. Placed in a pillow, hops have been used as a natural aid for insomnia for centuries.
- According to the 2015 National Hop Report from the USDA, the preliminary 2015 value of production of the United States hop crop is $345.4 million, up 33 percent from the revised 2014 value of $260.6 million.
- Hop production in the United States dates as far back as the colonization of the country, but commercial production only began in the mid-19th century. Some hop varieties are found naturally in the United States, while other varieties were introduced from Europe.

History of Hops in Wisconsin

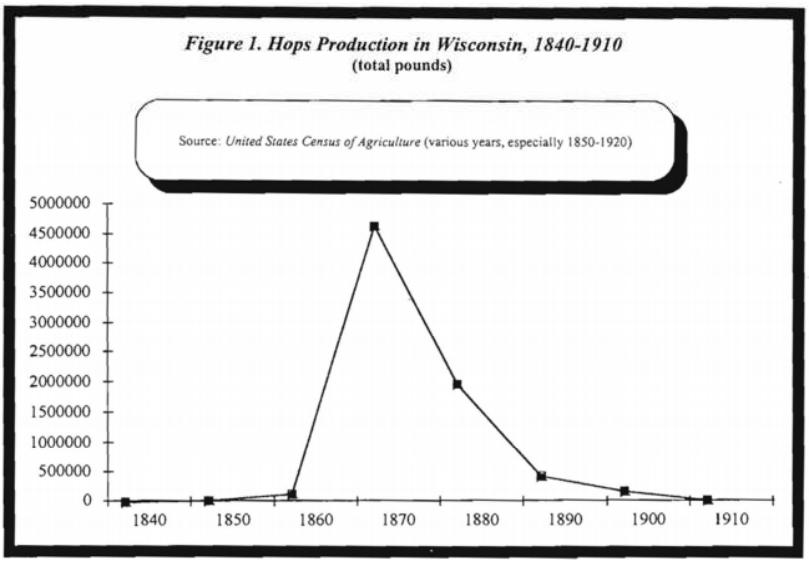
Figure 2. Location of Hops Production in Wisconsin in 1870



The nineteenth century was an exciting period of change and expansion for the United States. An industrial revolution, a civil war, and a push towards new opportunities in western states led families and farmers out of New England to settle in states like Wisconsin. One crop that was viable and able to thrive in this newly settled area was hops. Historically, the majority of commercially grown hops during this time period in the United States were grown in New York. (Rumney, 1997) But higher wages, crop failure due to primitive agricultural techniques, and the desire for new opportunities caused entrepreneurs to establish new businesses west of New England.

By the mid nineteenth century, the demand for beer was growing, breweries in Wisconsin were being established, and the market for commercial hops was created in Wisconsin. Much of the hops grown in Wisconsin from this early period through the heyday of hops cultivation were grown in the Central Plains and along the eastern and northern fringes of the 'Driftless' area of the southwestern part of the state. (Rumney, 1997) (See figure 2) During this brief boom of hop production in the late 1860s, **Wisconsin was producing 5,000,000 pounds of hops per year.** (See figure 1)

Figure 1. Hops Production in Wisconsin, 1840-1910
(total pounds)



But soon after its peak in the 1860s and 1870s, the commercial hops production in Wisconsin found itself in the same position that growers from New England did. Soil exhaustion, high labor costs, urbanization, the development of more profitable alternative crops and new agricultural opportunities like dairying, and a growing preference for lightly hopped 'lagers' quickly made hops less desirable to grow in Wisconsin. (Rumney, 1997)

Products and Uses of Hops

There are more than 100 varieties of hops. Higher alpha acid varieties are often used primarily for bittering and referred to as 'bittering hops.' Other varieties, often lower in alpha acids, possess desirable aromatic qualities and are used primarily to achieve the flavor and aroma character of the beer and are referred to as 'aroma hops'. (Hop Yard Collective, 2015)

Hops can be sold to brewers in whole-leaf, pellet, or extract form. More recently, craft brewers have begun using 'fresh' or 'wet-hops' in their brewing practices. A detailed description written by Michael Agnew from the website *A Perfect Pint* explains each type along with the pros and cons for brewing:

- ***Whole-leaf Hops –*** *Whole-leaf hops are simply the dried hop cones that have been compressed into bales. They are believed to have greater aromatic qualities than the other forms and are easier to strain from wort. However, because they retain more of the vegetative matter greater volumes must be used. They soak up more wort than other forms resulting in greater loss to the brewer. Their bulk also makes them more difficult to store and more susceptible to spoilage.*
- ***Pellets –*** *To make pellet hops the dried cones are shredded, compressed, and extruded into pellets that resemble rabbit food. The shredding process exposes the lupulin glands and removes a percentage of the vegetative matter, meaning smaller volumes can be used in the brewery. Their lighter weight and compressed state also makes them easier to store and less susceptible to spoilage. On the down side, they tend to lose some of their aromatic quality in processing and they create sludge at the bottom of the brew kettle that can be difficult to remove from the wort. The majority of hops used in the craft brewing industry are pellet hops.*
- ***Extract –*** *For hop extracts, the alpha acids and essential oils are pulled from the cones using heat and various solvents. These concentrated liquid extracts can be used in the brewing process just like hops. There are separate extracts for bittering, flavor, and aroma. They are mostly used by large breweries, although they are sometimes used by smaller breweries to reduce wort in highly hopped beers. Hop extracts are easy to store and can be kept for long periods of time without spoilage. Their concentrated state and lack of vegetative matter reduces the amount that must be used and eliminates wort loss. Their concentration can make them difficult to use properly in small batches however, and some claim undesirable flavors from their use.*
- ***Fresh or Wet Hops –*** *Fresh hops are green, unprocessed cones, often added to the beer within hours of harvest. Wet hops give beers an intense, bright hop flavor and aroma. However, because they lack the concentration that comes with drying, a much larger volume is needed to achieve the same result as from dried hops. The additional vegetative matter can lend beer a grassy character and results in greater wort loss for the brewer.* (Agnew, 2008)

Hops have a long history in their use as a natural herbal medicine. Teas, medicinal or 'nutraceuticals,' vine wreaths and hops pillows are all areas where hops growers can find other markets. (Kneen) Hops also have a minor use as an ingredient in shampoo, cheese, soap, chocolate and aftershave. (Hilchey, 2009) Anecdotal evidence has suggested that hops may be used as a natural sleep aid or anti-anxiety remedy. However, the majority of hops are used for brewing purposes.

Chemical Composition

Alpha Acids: The most important chemical compound of hops is the alpha acids. Primary alpha acids in hops include humulone, cohumulone, and adhumulone. Alpha acids have two main purposes in the brewing process: taste/flavor and its antiseptic nature. During wort boiling, the humulones are thermally isomerized into iso-alpha acids or *isohumulones*, which are responsible for the bitter taste of beer. The longer the hop is boiled while brewing, the more alpha acids are transformed into iso-alpha acids, increasing its bitter taste. Brewers can use several different calculations to figure out the amount of hops they need to obtain a certain amount of bitterness in the beer, commonly referred to as IBUs, or International Bittering Units. Many hop varieties are grown to have high alpha acid levels in order to contribute to the bittering of the beer. These hop varieties are referred to as 'bittering' hops and are used specifically for his purpose. (Sewalish, 2009)

In addition to the bittering nature of these acids, alpha acids are important in brewing due to their antiseptic nature. Before the usage of hops, the only way to make beer last a long time was high alcohol content. The addition of hops, specifically the alpha acids, helped prevent the unwanted growth of bacteria while enhancing the ability of yeast to grow and ferment the wort beer. (Sewalish, 2009) This preservative nature is well documented when examining the history of IPAs, or India Pale Ales, a prominent style of beer. The Dutch East India Company in the early 17th century added hops to their pale ales to ensure its preservation during the long journey from England to India. Without the addition of hops, other beer styles would spoil and would not be able endure the trip.

Beta Acids: Hops also contain beta acids which are sensitive to oxidative decomposition and may be detrimental to the taste of beer. For this reason, beta acids are considered a negative factor in brewing and many brewers usually choose hops with a low beta acid content. Primary beta acids include lupulone, colupulone, and adlupulone. (Sewalish, 2009)

Essential Oils: The main components of hops' essential oils are terpene hydrocarbons consisting of myrcene, humulene and caryophyllene. Together, myrcene, humulene, and caryophyllene represent 80 to 90% of the total hops' essential oils. Myrcene is responsible for the pungent smell of fresh hops. Humulene and its oxidative reaction products may give beer its prominent hop aroma smelled in beer. Citrus, piney, earthy, grassy, or spicy are some of the terms and fragrances that essential oils give to the beer. Like high alpha acid or 'bittering' hops, many varieties of hops are grown to have higher amounts of oils and not alpha acids, sometimes referred to 'flavoring' or 'aroma' hops. (Sewalish, 2009)

Conclusions

Locally grown and sourced hops have a huge marketability potential. Much like the wine industry, the idea of 'terrior' hops (the 'Taste of Place' set of environmental characteristics that affect a crop's quality and unique structure or flavor) are a highly sought after commodity for brewers and beer enthusiasts.

Craft brewers often tightly wrap their geographic locations into their corporate identity, leveraging 'a sense of place' as a distinguishing attribute in their sales and marketing. (Wilson, 2010) By purchasing locally sourced hops, brewers can further solidify this marketing message.

Buying from locally sourced ingredients also reduces a breweries carbon footprint. This is something that may appeal to some brewers as the topic of 'going green' is becoming increasingly important. FERC research found an estimated price of $8.95 per pound of hops to lead to a $19,216 revenue per acre of land. Variable costs consisting of pre-farming and farming costs amounted to $7,050 per acre. This results in an Earnings before, taxes, interests, depreciation and amortization (EBTIDA) of $12,165.

EBTIDA Calculation National Average Price	
Total Revenue	$19,216
Total Variable Costs	$7,050
EBTIDA - Earnings Before Interest, Taxes, Depreciation and Amortization	**$12,165**

FERC research found that at a price of $11.50 per pound of hops lead to a $24,690.50 revenue per acre of land. Variable costs consisting of pre-farming and farming costs amounted to $7,050 per acre. This results in an Earnings before, taxes, interests, depreciation and amortization (EBTIDA) of $17,640.20.

EBTIDA Calculation Wisconsin Price	
Total Revenue	$24,690.50
Total Variable Costs	$7,050
EBTIDA - Earnings Before Interest, Taxes, Depreciation and Amortization	**$17,640.20**

It was determined, based on the size of farming and price received per pound of hops, breakeven can be reached between 1.33 and 6.35 years. The specialty hop harvester costs between $10,125 and $29,750, Hop Yard construction costs are estimated at $11,106, Hop drying machine cost estimate of $1,420 and the pelletizer cost estimate is between $2,500 and $37,500. For large scale farms farming equipment is estimated to cost $622,000.

Recommendations

The recommendation by the FERC is for growers and the Wisconsin Hop Exchange to partner with local and regional breweries and home brewing stores to establish relationships and understand the needs of brewers large and small. Encouraging small and mid-sized hop yards will set the foundation for expansion and growth into the commercial hop industry in Wisconsin. Growers should participate in a value-share growing program with The Wisconsin Hop Exchange. This will have the least infrastructure expense, is applicable to growers of all sizes, has low risk, and has the added benefit of pooling knowledge and resources to better supply Wisconsin brewers.

A phased approach is recommended to gradually increase production while simultaneously increasing regional awareness of Wisconsin-grown hops. Starting with multiple 1-10 acres with minimal capital investment and then increasing economies of scale is ideal for expanding growth. In order to reach a reasonable income and rate of return on investment, a commercial grower will need to utilize mechanical harvesting and sorting. In order to minimize crop failure and ensure product availability, growers should stagger harvest times and divide hop yards into different varieties depending on brewers' needs. Outreach to existing growers and farmers is important to establish connections and to help create a uniformed, high-quality product. After the first and second years, production issues should be addressed and rectified in order to obtain the highest efficiency. Increasing the number of breweries using Wisconsin-grown and sourced hops is pivotal for increasing brand awareness of quality 'Wisconsin hops.'

Findings - Breakeven Analysis

Capital Investment

Total capital investment consists of the construction of a Hop yard, the harvester, farming equipment, the hop dryer, and the pelletizer.

Hop yard

The hop yard is where the hops are grown and due to the unique nature of the hops it must be grown on a vine. To support these vines poles must be built as well as supporting structures.

Hop Yard Costs	
Item	**Cost**
Cable	2,395
Poles	2,746
Ground Anchors	474
Miscellaneous (Hardware and Software)	1,748
Irrigation System	1,500
Labor	2,243
Total Costs	**$11,106**

Farming Equipment Costs

Because hops can be picked by hand, farming equipment is not entirely necessary. This Farming equipment will allow the vines of hops to be cut earlier and transported to the harvester. Farming equipment is only needed when farming over 8 acres of hops.

Farming Equipment Costs	
Item	**Cost**
Machine Shop and Shed	150,000
Service Truck	20,000
60-HP Wheel Tractor	65,000
Hyster Loader	40,000
Top Cutter	125,000
Bottom Cutter	30,000
Auger W/3 Bits/Skid steer	10,000
Sled/Twining cart	15,000
T-Bar with Shanks	15,000
12' Cultivator	12,000
Blast Sprayer	30,000
Ground Sprayer	10,000
Mechanical Pruner	25,000
Wire/Tube Roller	5,000
Miscellaneous/shop equipment	50,000
Tools and supplies	20,000
Total Cost	**$622,000**

Hops Dryer Costs

In most cases farmers are expected to dry the hops they grow. This can be done with a hop dryer, which can be built using hardware store items.

Hop Dryer Costs	
Item	**Cost**
Lumber/Hardware	246
Tray Rack	104
Fan	110
Fan Blades	78
Heating element	332
Controls	100
Labor	450
Total	**$1,420**

Pelletizer Machine Cost

Farmers are also sometimes expected to pelletize the hops they grow. These machines turn the hop cone into a small pellet. The cost of these machines range from $2,500 to $37,500.

Harvester

A hops harvester does not cut the hop vines from where they are grown but instead removes all the unneeded materials. The resulting products from a hops harvester are the protective materials and the hop cone. These come in a variety of sizes, but on the low end, a harvester can cost $10,125 while on the high end it can be $29,750.

Variable Costs

Pre-Farming Costs

Before any planting and growing can take place the land must be prepared. Below is a breakdown of these costs.

Pre-Farming Costs	
Item/Task	**Cost**
Disc	23.67
Subsoil	28.40
Plow/Rototill	47.73
Cultipack/Sprtooth	32.73
Fumigate	400.00
Design	30.00
Total	**$562.52**

Farming Costs

Below are the list of expenses faced when farming hops.

Farming Cost	
Item	**Cost**
Fertilizer	395.00
Chemicals	421.67
Consulting	71.67
Licenses	45.00
Parts and Repairs	316.67
Fuel	175.00
Supplies	223.00
Packaging	57.20
Kiln Fuel	166.55
Utilities	90.00
Dryer	104.00
Labor	1966.67
Planting	2362.86
Water	92.50
Total	**$6,487.78**

Price

The price per pound of hops used in this study comes from an average of over 30 varieties of hops market price from 2014. This price is $8.95 per pound and has been used in the financial calculations.

Pro Forma Income Statement

Below is the combination of the Price and costs listed above in the form of a Pro forma Income Statement. Because for small scale farms farming equipment is unneeded a large scale was included with these costs. All number are for one harvest year for one acre of land. A 10 acre example is included to show the benefits of economies of scale.

Pro Forma Income Statement				
Pricing	**National Average**		**Wisconsin Average**	
Operating Capacity	**Small Scale**	**10 acre example**	**Small Scale**	**10 acre example**
Revenue				
Pounds of Hops per acre	2147.00	2147	2147	2147
Price Per Pound of Hops	8.95	8.95	11.50	11.50
Total Revenue	19,215.65	192,156.50	24,690.50	246,905.00
Costs				
Hop yard Costs	11,106.14	11,106.14	11,106	11,106.14
Farming equipment	-	622,000.00	-	622,000.00
Harvester	10,125.00	29,750.00	10,125.00	29,750.00
Hop Dryer	1,420.00	1,420.00	1,420.00	1,420.00
Pelletizer	2,500.00	37,500.00	2,500.00	37,500.00
Total Capital Costs	25,151.14	701,776.14	25,151	701,776.14
Final Total Capital Costs	27,666.26	771,953.76	27,666.26	771,953.76
Variable Costs per acre per year				
Pre-Farming Costs	562.52	5,625.17	562.52	5,625.17
Farming Costs	6,487.78	64,877.80	6,487.78	64,877.80
Total Variable Costs per acre per year	7,050.30	70,502.97	7,050.30	70,502.97
EBITDA	**$12,165.35**	**$121,653.53**	**$17,640.20**	**$176,402.97**
Breakeven Point if EBITDA is constant (in years)	**2.27**	**6.35**	**1.57**	**4.38**

Value Chain

Craft Beer Glossary

Craft Brewer:

1. **Small**: annual production of beer is less than 6 million barrels.

2. **Independent**: less than 25% of the brewery is controlled or owned by an alcoholic beverage industry member who is not themselves a craft brewer.

3. **Traditional**: has an all malt flagship beer or has at least 50% of its volume in either all malt beers or in beers which use adjuncts to enhance rather than lighten the flavor.

Source: Brewers Association website

Types of Craft Brewers:

- **Nanobrewery**: a brewery that produces less than 4 barrels of beer per year.
- **Microbrewery**: a brewery that produces less than 15,000 barrels of beer per year.
- **Brewpubs**: a restaurant-brewery that sells 25% or more of its beer on site.
- **Regional Craft Brewery**: an independent brewery that produces over 15,000 barrels of beer per year and whose flagship or majority of volume is in 'traditional' beers.
- **Contract Brewing Company**: a business that hires another company to produce its beers.

Types of Non-craft Brewers:

-**Regional brewery**: a brewery that produces 15,000 to 6 million barrels of beer per year.
- **Large brewery**: a brewery that produces more than 6 million barrels of beer per year.

Source: Brewers Association website

The Hop Yard

The first step in growing hops is to design and implement a hop yard. A hop yard is the design of a field specifically made for the growth and cultivation for hops. A trellis system is built using poles, roughly 20 feet in height and 6 inches in diameter, wire or cables, turn buckles, some sort of irrigation system, and other various hardware. There must be roughly 20 feet of vertical or trainable climbing space to ensure maximum hop growth and yield (hop vines can grow up to 25 feet in a single season). Less than 10 feet of vertical growth may result in bunched shoots that are susceptible to mildew. Prepare the soil so it is free of weeds and loose enough to plant.

When determining the location for a hop yard, it is important to analyze the ideal growing conditions for hops.

Growing Conditions

According to the Hop Atlas (Barth, et. al., 1994) optimal conditions for growing hops are as follows:

- A latitude between 35-55 degrees north or south
- Average temperature from April through September between 10-19ºC
- Average precipitation from April through September of 64 -569 mm
- Average daylight during these months between 10-19 hrs/day

These findings were derived by taking the climate data for top hop growing regions in the world: George, South Africa; Tasmania and Victoria Australia; Rio Negro Argentina; Oregon and Yakima, US; Hallertau, Germany; Saaz, Czech; and Wye England. (Wilson, 2010)

Based on these suggested conditions, Wisconsin is well suited and capable for growing hops. Additionally, the historic nature of commercial hop growing in Wisconsin further solidifies its capability for success. Therefore, from a very basic feasibility capacity, the right growing conditions exist in Wisconsin:

- Average latitude is in the 40's
- Average temperature from April through September is 16.76 ºC (62.17ºF)
- Average precipitation from April through September is 533mm
- Average daylight hours during these months is 14.1 hrs/day

Soil

Hops prefer a well-drained, sandy loam soil that is loose and porous. Adequate drainage is most important as standing water will rot the roots. Good airflow is important as well for preventing mold and mildew from occurring. If drainage is a concern, a hop hill may be constructed with soil and gravel/sand mixed in to make a looser bed. If vegetables or flowers can grow fairly well in the soil, hop growth should not be an issue. The pH of the soil should be between 5.5 and 7.5 and a general nutrient regiment where the potassium and phosphorus are roughly double the nitrogen content. A fertility similar to corn, beans, potatoes, and alfalfa is suggested.

Planting

There are two types of planting methods when starting a hop yard: hop plants and rhizomes. Hop rhizomes are small roots which are cut from the main root system of a mature female hop plant. It has active sites (buds) along the stem that are dormant until growth is triggered. Rhizomes are the heart of the root system which stores and transfers food from the root system to the bine. A hop rhizome looks like a grape vine or stick, and is used to start new hops plants. (Instructions on How to Grow Hops)

Alternatively, hop plants are softwood cuttings from mature plants that have established a new root system and crown, a process that can take several months. The rate at which hop plants root and form a new crown and rhizome is variety dependent as some take longer to establish than others.

When deciding whether to plant hop plants or rhizomes it is important to consider the pros and cons.
Rhizomes:

- **Pros:**
  - Cheaper to purchase than plants.
  - They have undergone vernalization (the induction of a plant's flowering process for the following season by exposure to the prolonged cold of winter, or by an artificial equivalent) and have had a period of dormancy, which allows for vigorous growth.
- **Cons:**
  - Generally don't grow large enough in one season to flower or produce even minor yields
  - Need to establish a root system and grow shoots (bottom and top growth)
  - Likely not to receive full yield (100%) until the third or fourth season
  - Generally planted two to a hill to ensure at least one plant growth

Plants:

- **Pros:**
  - Undergone same vernalization and dormancy process as rhizomes, allowing for vigorous growth
  - An established root system
  - Likely to flower in the first season allowing for some hop yield
  - Greater likelihood of survival after planting compared to rhizomes
- **Cons:**
  - More expensive than rhizomes
  - Susceptible to transplant shock depending on when it's planted
  - Likely not to receive full yield (100%) until third season

Hop plants are more expensive than rhizomes but generally only need one plant per hill to ensure likelihood of growth and survival. Additionally, it is possible to harvest a minimal yield from hop plants as opposed to rhizomes within the first season. In either case, full hop yield won't be realized until the third or fourth season. It is important to note that hop plants or rhizomes should be bought from reputable sources that test their products for diseases and pests. Failure to obtain well sourced hop plants or rhizomes can result in partial or whole crop failure or the spread of diseases to surrounding crops.

Hop rhizomes can withstand 20°F freezes when planted on a properly mulched hop hill. It is better to plant too early than too late. Hops should be planted when the land is able to be tilled (late April or early May). If there is a late spring thaw, hop rhizomes or plants should be stored in a refrigerator and kept moist until the ground thaws. Some growers will lightly plant the rhizome or hop plant in a pot and store it in a cool location until the soil becomes workable.

Hops are a dioecious plant, meaning the male and female reproductive organs develop on separate plants. Hop yards are made up of the female plant only. Male plants produce a great deal of pollen and contain fewer resins, making them less ideal for brewing. Plant like varieties together and space these 3 feet apart. Space out unlike varieties at least 5 feet apart. Rows are planted about six to eight feet apart. Crowded bines are less productive and susceptible to infestation and mildew. Plant two rhizomes of the same variety to a hop hill to ensure survival or one hop plant to a hill approximately 4 inches deep. For rhizomes, look for any buds growing and position them skyward and position any roots towards the ground. Cover and then pack by hand with soil; plant with approximately one inch of soil covering the top of the rhizome. Applying mulch to the soil surface helps in conserving moisture as well as controlling weeds. Each spring apply a hearty dose of manure as a top dressing or fertilize with a balanced chemical fertilizer that is recommended for garden vegetables. (Hops Planting & Growing Guide)

Growth

As a perennial plant, hops lay dormant during winter and is rather unaffected by freezing temperatures. The time of year when the annual bines break ground, when they flower and when they die back is very much determined by local temperature and day length. In order for the flowering of hops to occur, the weather must be frost free for about 120 days, the plant must have ample moisture, and there must be plenty of long length sunlight. Bines grow vertically in a clockwise direction following the sun, winding around their support system by using tiny hairs on the stems and backs of leaves. Bines grow best and are easier to deal with if they are trained using strong twine that vertically extends from an anchor near the hop hill to the top of the trellis wire. Bines are ready to be trained when they are about 12 inches long and must be gently wrapped, clockwise, onto the string without kinking. (Hops Planting & Growing Guide)

During the first year, growth above ground will be limited to under 6' for rhizomes, while the plant puts its effort into establishing the basis of its extensive root system. Bines grow rapidly in the spring with growth of up to 30 cm (12'') in one day. (Kneen) Vegetative growth continues until approximately mid-July when most hops are either past bloom or in full bloom depending on location and variety.

Each branch supports several clusters of hops cones, usually in little groups of threes. Flowers (burrs) are produced on side arms that develop along the stem which then develop into hop cones or the final hop product. During the 'burr' stage, the flower is approximately 1/4 inch in diameter and is composed of many florets whose styles give it a spiny appearance. (Hops Planting & Growing Guide) The styles eventually fall off and miniature petals grow which gives way to the cone-like structure of the hop.

Hop flowers develop and ripen between mid-August and mid-September depending on location, variety, and weather. Commercial growers actually delay flowering by removing the earliest bines in the spring in order to enhance regrowth and encourage a higher yield of flowers. (Hops Planting & Growing Guide) After the flowers ripen, the bine will continue to build reserves until it totally dies back with the first freezes of fall.

Watering and Pruning

First year plants need to be watered frequently, but caution should be taken to not overwater as this can cause the roots to rot. After a hop plant has been established for the first season, less frequent deep watering is ideal, preferably by drip irrigation. Be careful not to soak the hop bines during watering, as this will encourage diseases.

Allow baby hop plants to grow, do not prune them. 3-4 bines are trained clockwise per string which is staked to the hop hill; it is common to run 2-3 strings per hill. (Hops Planting & Growing Guide) Weaker bines should be cut back to ensure more growth and energy into stronger, trained bines. Lateral side arms grow from the main bine and also produce flowering hops. The goal is to prevent side arms from tangling and to support the bines. In July, the lowest 4 feet of foliage and lateral branches can be removed to aid in air circulation and reduce disease development. (Hops Planting & Growing Guide) Careful consideration must be taken when removing flowers to avoid breaking or kinking the main stem. In August, allow additional bottom growth to remain to promote hardiness of the crown and the plant vigor for next year. (Hops Planting & Growing Guide)

Harvest

Hop harvesting can be one of the most time consuming procedures. Harvest dates vary depending on variety and location, but generally take place during mid-August through the first week of September. At maturity, hop cones will have a yellow color indicating the highest amount of lupulin. Hop aroma will be at its strongest and can be measured by crushing the cone and smelling it. Cones will develop a dryer, somewhat papery feel, and some browning may occur near the lower bracts; a sign of ripeness. Once squeezed, mature hop cones will feel more light and resilient rather than green and hard.

Cutting the bine down is ideal for picking hops as they tend to grow higher on the plant. Hop cutting machines are not widely used except in areas where hops are mass produced, like Washington or Germany. Typically, hop bines are cut 2-3 feet from the base while another worker is lifted to cut the bines from the top and then place them in a trailer.

Once cut and placed into a trailer, the hops need to be picked or stripped from the bine. Small scale hop farms and farmers just starting out may use hand picking methods for separating the hops from the bines but this process can be quite tedious and inefficient. One person can take more than an hour to pick a pound and a half of hops just from one bine. The best approach is to use a hop picker which will strip the hops from the bines and separate any unwanted vegetation. Bines are hooked onto a 'bine feed' and fed into the machine where a finger-like apparatus rotates and separates the hops from the bine. Portable hop pickers can increase productivity and can be shared among small scale farmers or cooperatives.

Drying

Almost immediately after being stripped, hops must be dried. Hops are generally placed in a housed location on top of screens where forced air combined with low heat in a conditioned room create an ideal environment for hop drying; heat temperatures should not exceed 140ºF. (Hops Planting &

Growing Guide) Cooler temperatures take longer but a higher quality product is obtained as overheating can be detrimental to hops. Hops are to be dried to retain approximately 8-10% of their moisture. Higher moisture content adversely affects storage length, chemical composition, and can induce mold. Hops are dry when the inner stem of the cone (strig) is brittle and breaks rather than bends. (Hops Planting & Growing Guide)

Post-Harvest Production

Depending on a grower's capital investment, size, and brewer's needs, post-harvest production techniques vary.

Compacting

As a result of the drying process, hops are very light and fluffy, making them difficult to transport and store. Ideally hops should be compacted down to 10lbs per cubic foot and vacuum sealed and then bailed. (Wilson, 2010) Once compacted and bailed hops can remain in refrigerated storage until sold or pelletized. At present there are no known commercially available compressors specifically designed for small scale hop growers. Existing growers have suggested using a trash compactor, or pressing down on a bag of hops using a screw auger plate, as relatively effective means to compress their hops. (Wilson, 2020)

Nitrogen/CO2 Flushing and Vacuum Sealing

For a more professional and commercial operation one can invest in a food grade nitrogen flushing, vacuum sealing machine. This ensures shelf life and storability as it reduces oxygen which negatively impacts hop quality.

'Wet' or 'Fresh Hops'

'Wet or 'fresh hops' typically have less of a preference for brewers, though they have gained traction in recent years. These hops are green, unprocessed cones that have not been dried. These hops are typically added to the brew within hours of harvest and give beers an intense hoppy aroma. Generally, wet hops require a much larger volume than pelletized or dry hops as they lack the concentration that comes from drying.

Whole Dry Hops

Whole-leaf hops are the dried hop cones that have been compressed into bales. They are believed to have greater aromatic qualities than the other forms and are easier to strain from the wort. Because of the excess vegetative matter, however, greater volumes must be used as they soak up more wort resulting in a greater loss to the brewer. Their bulk also makes them more difficult to store and more susceptible to spoilage.

Pellets

Hop pellets are most preferred for microbreweries. Dried cones are shredded, compressed, and formed into pellets. The shredding process exposes the lupulin glands and removes a percentage of the vegetative matter, meaning smaller volumes can be used in the brewery. Their lighter weight and compressed state also makes them easier to store and less susceptible to spoilage. On the down side, they tend to lose some of their aromatic quality in processing

Product Quality

The process of brewing beer is a well-documented procedure. However, brewers continue to tweak recipes and processes making it both a science and an art form. There are many factors that can affect the final product. Because of this, the ultimate achievement of a brewer is when they can consistently produce the same finished product in taste, aroma, appearance, and mouth-feel, brew after brew, from brew house to brew house. (Wilson, 2010) Because hops create a signature aroma and flavor profile for a beer, hops are a key ingredient in any beer recipe. Because the chemical make-up of hops may change from harvest to harvest depending on growing conditions and geographic region, the more the brewer knows about the make-up of each shipment of hops he receives the more he can adjust his recipe so that the end result will be consistent with prior brews. (Wilson, 2010)

In order to meet brewers' demands for high quality hops and information on their chemical composition, new hops grown in Wisconsin would need to be subjected to chemical analysis and the analysis would need to be accompanied for each hop shipment.

Product Specifications

In order to meet product specifications to be considered a viable alternative, Wisconsin hops would need to be pelletized to a T-90 standard, packaged in Nitrogen flushed, vacuum sealed, foil laminated pouches, and encased in cardboard boxes. (Wilson, 2010) Most brewers prefer a pellet form for their hops as they are easier to use and leave less residue in the beer during the brewing process, which can clog siphons or air locks. In a 2010 study commissioned by the Vermont Agency of Agriculture Food and Markets and the Massachusetts Department of Agricultural Resources into the feasibility of growing commercial hops in New England, researchers sought to find out which form of hops breweries preferred. 83%, 25 of 30 respondents, said they required pelletized hops. 30%, 9 of 30 respondents, said they use or could use dried whole hops. 23%, 7 of 30 respondents, said they could use wet whole hops. (Wilson, 2010) Pellets are milled into a powder and then squeezed through a die. They retain all of the vegetative matter that came in the hop cones and can be used as a full replacement for cone hops. Hop pellets have small relative surface area in relation to cone or whole hops which means they have a lower oxygen per surface area (both light and oxygen are detrimental to hop quality).

Stable Price Point and Supply

Continued growth of the craft brewing industry have put pressure on the hop industry to increase its supply. This is causing states that haven't produced hops in decades to reconsider entering the hop market. In a 2015 article from the Capital Press, an agricultural website, Dan Wheat writes:

> *'Craft breweries are projecting 20 percent annual growth through 2020, according to Ann George, administrator of Hop Growers of America and the Washington Hop Commission in Moxee, Washington. That means hop acreage is likely to keep increasing, she said.'*
>
> *To meet that demand, growers in Washington, Oregon and Idaho have been shifting from alpha variety hops that large brewers prefer to the more profitable aroma varieties that craft brewers want.*

> *Pete Mahony, director of supply chain management and purchasing for John I. Haas Inc. in Yakima, has warned the shift could lead to a shortage of alpha hops.*
>
> *At current trends, there will be a worldwide alpha shortage by 2018, predicted Lynn Kemme, owner of Great Lakes Hops, a hop propagator in Zeeland, Mich.'* (Wheat, 2015)

This poses a problem for craft breweries as brewers of all scale and size compete for access to hops to meet their growing and existing marketing demand. This causes frustration as craft breweries are highly susceptible to volatile price points and product scarcity.

Personal Relationships

Brewers of all sizes take their craft seriously, it is important to them to have connections and personal relationships with those who provide them with their ingredients. This helps in ensuring that their ingredients are of high quality and in turn their final product as well. Having growers that are reliable, personable, and who grow a high quality product will often overshadow price as the ultimate deciding factor.

Local Economic Stimulation

Craft breweries understand more than anyone the importance of stimulating a local economy. Without the patronage of local distributors, bars, grocery stores, liquor stores, and the community in general, small and local craft breweries would not survive. Most of Wisconsin's craft breweries are local or regional producers whose products stay in Wisconsin. For these reasons, keeping their purchasing dollars in state further reinforces the likelihood that their own products will be purchased.

Hop Yard Symbiosis

The tall poles in the trellis system can be ideal resting places for owls, hawks, and other birds of prey who hunt field mice and gophers, both of which can cause havoc in a hop yard. Sheep and chickens can be utilized in a hop yard for grazing. Both perform different services for the hops, and can be rotated at separate times in the year. Sheep keep the growth of smother crops in the alleyways under control, and are used extensively in New Zealand to strip the lower stems of the hops of leaves, assisting in disease and pest control. Chickens are useful early in the season to control weeds, and on hot summers can also be very helpful in controlling grasshoppers. Their scratching also opens the soil around the crowns of mature plants, and can help with disease prevention. With both sheep and chickens, care must be taken that the crowns and growing tips of the plants are not harmed by scratching or direct grazing. (Kneen) Livestock may also aid in the spreading of manure, another valuable benefit in hop production.

Market Research Conducted With Breweries

Target Market

Food To Market (F2M) conducted market research into the potential opportunities for expanded hops sales in Wisconsin through a survey delivered online and conducted by phone. A list of breweries was provided to Food To Market, and additional breweries were located via the Internet. The Wisconsin Brewer's Guild contacted their members to encourage them to participate in the research.

Research Objectives

F2M, on behalf of WHEx, is interested in the market feasibility of expanding sales of hops to micro and craft breweries in Wisconsin. They are interested in understanding the market opportunities and challenges. In particular, they hope to learn about the market need and customer preferences regarding key purchasing decision factors, varieties, volumes, quality requirements and pricing.

Project Tasks:

- Conducted interviews (using the survey script below) and online surveys with breweries to gain insights into potential customer preferences and market trends.
- Using secondary research methods and analysis of interview results, assessed the competitive nature of the market and made a best effort to gauge overall market size and need for hops in the Wisconsin micro and craft brewery market.
- Identified the key competition and, where possible, their revenue and geographic market served. Provided a list of key competitors with contact/company information.
- Compiled summary report and supporting research material and provided electronically.

Survey Used for Interviews

1. How many pounds of each of the following hops varieties do you purchase in a given year? (Brewers Gold, Cascade, Centennial, Chinook, Columbia, Columbus, Crystal, Liberty, Mt. Hood, Nugget, Perle, Santiam, Southern Cross, Sterling, Tahoma, Vanguard, Willamette, Yakima Gold, Other-please specify)
2. About how many total pounds of hops do you purchase each year?
3. Within the next 18 months, do you think that your company will be increasing, decreasing or maintaining the amount of hops you purchase?
4. Who are the leading suppliers of hops for Wisconsin microbreweries?
5. What do you think causes those hops suppliers to be preferred?
6. How many hops suppliers does your company buy from?
7. Please describe how you go about finding and selecting a supplier for hops.
8. How satisfied are you with your current hops supplier(s)? (scale of 1 to 5 with five being extremely satisfied and one being not at all satisfied)
9. What do you like best about your current hops supplier(s)?
10. What challenges have you faced related to sourcing hops for your microbrewery?
11. Are there any hops varieties that you would like to purchase, but have not been able to find a supplier for?
12. If yes, how much demand would there be for that variety in an average year?

13. Would you prefer to purchase hops from regional growers if they had the varieties you needed, or are you fine with sourcing hops from outside the region?
14. If prefer regional growers: Would the regional growers need to be able to supply all of your hops or would you be willing to purchase some from them and use other suppliers for the remainder?
15. When you are considering a hops supplier, which is more important to you, price or quality?
16. Which indicators of hops quality heavily influence your purchasing decisions?
17. What is a reasonable price per pound for a typical hop variety?
18. When purchasing hops, how important are the following factors to your company: (scale of 1 to 5 with five being extremely important and one being not at all important)
    - U.S. grown
    - Regionally grown
    - Other (please specify)
19. What are two trends or issues that are going to affect the way you do business in the next 18 months?
20. Would you be open to considering a new source for hops?

Executive Summary

Target Market

Based on the survey results, F2M recommends that hops producers in Wisconsin target sales to regional micro and craft breweries that are not heavily locked into contracts and prefer to source locally. According to the survey respondents, these breweries are looking for variety, consistency, quality, and availability. All of the breweries that participated in the research said they source many varieties of hops, and they often source from more than one hops supplier. Although some of these breweries are very small and do not purchase a large amount of hops, they are looking for local options to source from that could be profitable with a streamlined system in place to meet customer needs.

Estimated Market Size

Calculating market size for hops in Wisconsin is difficult because revenue information for the microbreweries market includes revenue for non-beer sales. Based on the survey responses received regarding annual hops consumption F2M was able to calculate an average, adjusted average (eliminating highest and lowest values), and median value for the amount of hops used annually per brewery. Among the respondents to the survey, the average volume sourced per year is 2,062 pounds. The adjusted (trimmed) average sourced per year is 1,212 pounds, and the median amount sourced per year is 1,150 pounds. Through secondary research, F2M has established a list of 120 microbreweries in Wisconsin. Multiplying the average and median values by the number of microbreweries in Wisconsin generates the annual range of hops consumption in the state. **This range is 138,000 to 247,000 pounds annually.**

F2M was not able to gather information on revenue and employees for all identified microbreweries; however, a rough market size for microbreweries can be estimated. F2M was able to establish the revenues for 46 of 119 microbreweries listed. This meant that 39 percent of the total market was known. The other 61 percent of the market was estimated. This resulted in a total microbrewery market revenue estimate of $215 million annually.

It is important to understand that many microbreweries also offer food service, and revenue from food and non-beer beverage sales is included in the total revenue. F2M did not use revenue information to estimate market size for hops production because of the inability to determine what percentage of the revenue for each establishment came from beer and non-beer sales. Below is a summary of information that may be helpful in understanding market size:

- The number of hops used annually per microbrewery ranges widely with one microbrewery sourcing over 16,000 pounds while the average is between 1,150 and 2,100 pounds a year.
- Average revenue per pound of hops used is $1,524 (based on all microbreweries in Wisconsin including those that generate revenue from non-beer sales).
- Average revenue per employee is $86,888.63 (based on all microbreweries in Wisconsin including those that generate revenue from non-beer sales).

Growth Opportunities and Challenges

Research indicates that the craft beer market continues to grow in popularity while the overall beer wholesaling and breweries markets are not growing much. Survey responses indicate that there are hops varieties that breweries have trouble sourcing. Local sourcing appears to be a preference for many breweries. Nearly all of the respondents are open to a new source, and they predict that demand for hops is increasing.

Among the hops varieties listed in the survey, Cascade and Liberty are the most popular with about 8,100 lbs. and 4,100 lbs. purchased annually respectively. There were several hops that brewery representatives said they source that were not on the list. Each brewery has specific hops that they use for their beer, and there are desired hops varieties that are unavailable locally, so breweries source from other regions of the United States and from European sources. If it is possible to grow those in Wisconsin, this could be an opportunity to expand market share.

Of the hops varieties that F2M asked respondents about, 11 of the 18 had less than a thousand pounds purchased by the breweries that we interviewed and five were not being sourced at all. The respondents do not purchase the following varieties: Columbia, Santiam, Southern Cross, Tahoma, Vanguard, and Yamaka Gold. Understanding the level of demand for particular varieties and providing as many in-demand varieties as possible will support market growth.

The research uncovered a few challenges in the Wisconsin hops market. One challenge to becoming a new supplier to a company is that survey results indicate a high level of satisfaction with current suppliers. Another challenge is that brewers may be under contract with suppliers and not have an option to change. Finally, consistency in the hops is essential to a beer formula or recipe in order to produce consistent tasting beer, and companies may be reluctant to change suppliers for existing recipes. Companies that regularly create new beers would provide greater opportunity for new suppliers.

Market Research Recommendations

F2M primary research results indicate the following recommendations for increasing market share and competitiveness:

- Make a variety of hops available and devise a method to track relative demand
- Create an efficient process for selling to small breweries
- Consider that breweries typically purchase hops from multiple suppliers
- Ensure and certify high quality for all hops
- Attend and market products at Craft Brewing Conferences /Shows
- Know that most breweries would prefer to source locally when a variety is available
- Target prices in the range of $8-$10 per pound of hops depending on the variety

Matrix of Key Conclusions

Company Name	Approx. Pounds of Hops Purchased Per Year (lbs)	Prefers to Purchase Regionally Grown Hops	What is a reasonable price per pound	Predicted Level of Demand	Open to New Source
Bloomer Brewing	250	Yes	$9	Increasing	Yes
Bull Fall Brewery	1800-2000	Yes	$7-9	Increasing	Yes
Capital Brewing Co., Inc	16,000	Yes	$3-14	Same	No
Hop Haus Brewing	600	Yes	$12	Increasing	Yes
House of Brews	1000	Yes	$7-8	Increasing	Yes
Kozy Yak Brewing	20	No	$11	Same	Yes
Moose Jaw Brewery	1100	Yes	$10-12	Increasing	Yes
One Barrel Brewing Company	2350	Yes	$8-10	Increasing	Yes
Pearl Street Brewery	5000	Yes	$6-12	Increasing	Yes
Rowland Brewery	100	Yes	$6-8	Increasing	Yes
Rustic Road Brewing Company	200	Yes	$8-10	Increasing	Yes
Shipwrecked Brewpub	300	Yes	$10	Same	Yes
South Shore Brewery	1200	Yes	$11	Increasing	Yes
Stone Cellar Brewpub	1400	Yes	$9-10	Increasing	Yes
The Brewing Projekt	1600	Yes	$7-22	Increasing	Yes
Water Street Brewery	1700	Yes	$8-10	Same	Yes

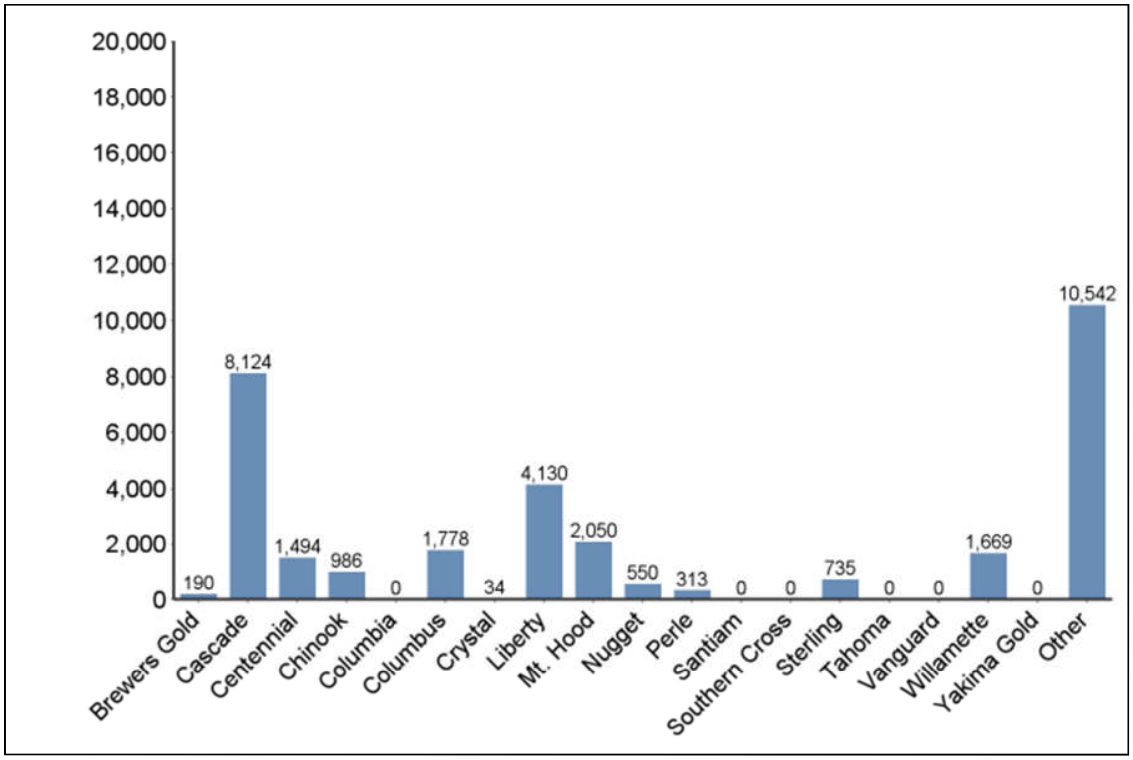
Summary of Business Interviews

Potential Customers Survey Summary

A total of 18 respondents participated in this study. Two chose not to provide brewery names for their responses. They will be referred to as Company A and B for the purposes of this report.

Amount of Hops Purchased in a Year by Variety

Question: How many pounds of each of the following hops varieties do you purchase in a given year?



Based on all of the breweries that answered this question the most popular single hops variety is Cascade. Liberty hops came in second. Many breweries had hops that they purchase that were not on the list, such as Citra, Magnum, and Mosaic. Columbia, Santiam, Southern Cross, Tahoma, Vanguard, and Yakima Gold were the least popular hops among respondents with no interviewed breweries purchasing them.

Total Pounds of Hops Purchased in a Year

Question: About how many total pounds of hops do you purchase each year?

Name of Brewery	Pounds of hops Purchased Annually
Bloomer Brewing	250
Bull Fall Brewery	1900
Capital Brewery Co., Inc.	16,000
Company A	2000
Company B	400
Hop Haus Brewery	600
House of Brews, LLC	1000
Kozy Yak Brewing	20
Moose Jaw	1100
One Barrel Brewing Company	2350
Pearl Street Brewery	5000
Rowland Brewery	100
Rustic Road Brewing Company	200
Shipwrecked Brewpub	300
South Shore Brewery	1200
Stone Cellar Brewpub	1400
The Brewing Projekt	1600
Water Street Brewery	1700
Total	37,120

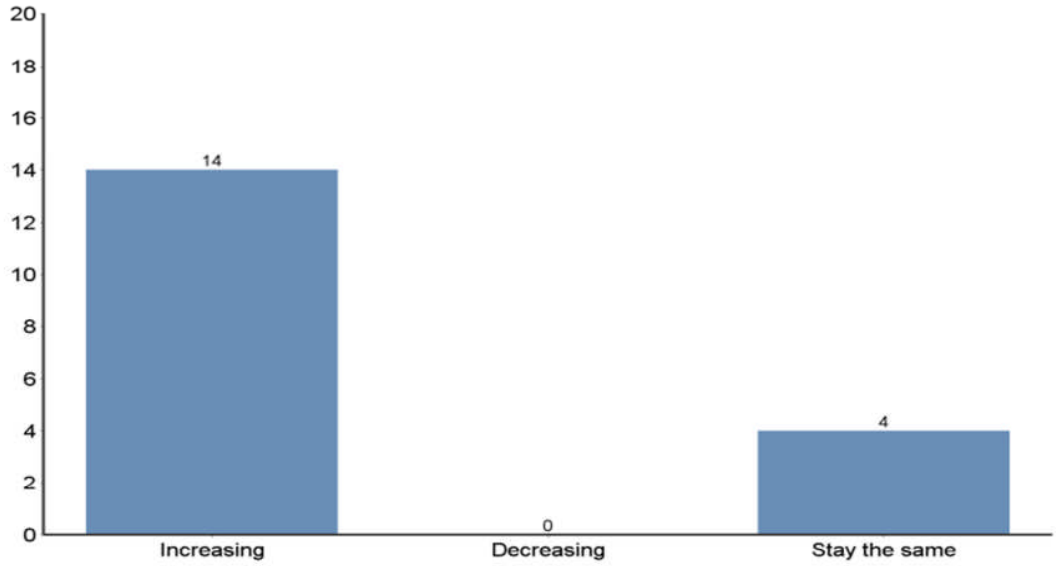
Thirteen of the breweries responded directly to this question. The remaining totals were calculated based on the answers to the number of pound of hops for each variety including 'other.'

- The average volume sourced per year is 2,062 pounds.
- The trimmed average sourced per year is 1,212 pounds.
- The median sourced per year is 1,150 pounds.

Market Growth Perceptions

Question: Within the next 18 months, do you think that your company will be increasing, decreasing or maintaining the amount of hops you purchase?

Predicted Change in Amount of Hops Purchased in Next 18 Months

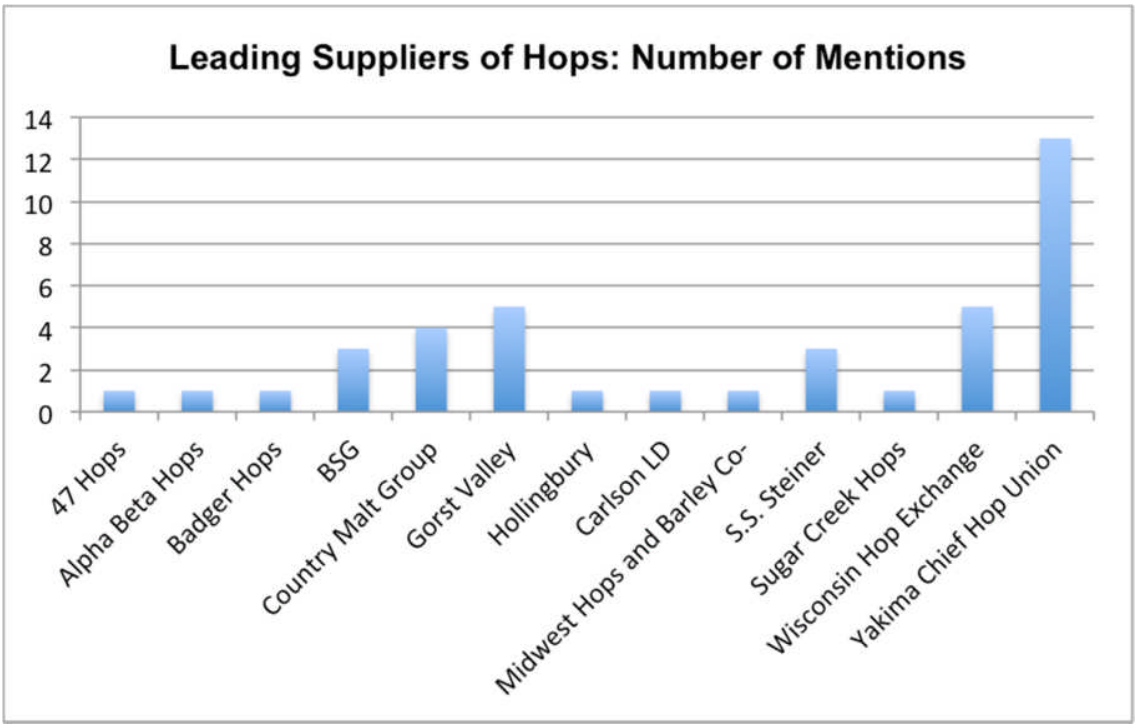


Most of the breweries plan on increasing the amount of hops that they purchase, and a few of the breweries told WISC that they plan on expanding as well as purchasing more equipment. Four of the breweries said that they plan to purchase the same amount of hops in the coming 18 months. None of the breweries said that they plan to decrease the amount of hops purchased.

Leading Suppliers of Hops

Question: Who are the leading suppliers of hops for Wisconsin microbreweries?

As can be seen in the chart below, the suppliers with the most mentions include Yakima Chief Hop Union (13), Gorst Valley (5), and Country Malt Group (4). There were seven suppliers that were mentioned only once, and The Wisconsin Hop Exchange was mentioned five times.



Reasons for Preferred Suppliers

Question: What do you think causes those hops suppliers to be preferred?

The most popular reasons for hops supplier preference among survey respondents were the following:

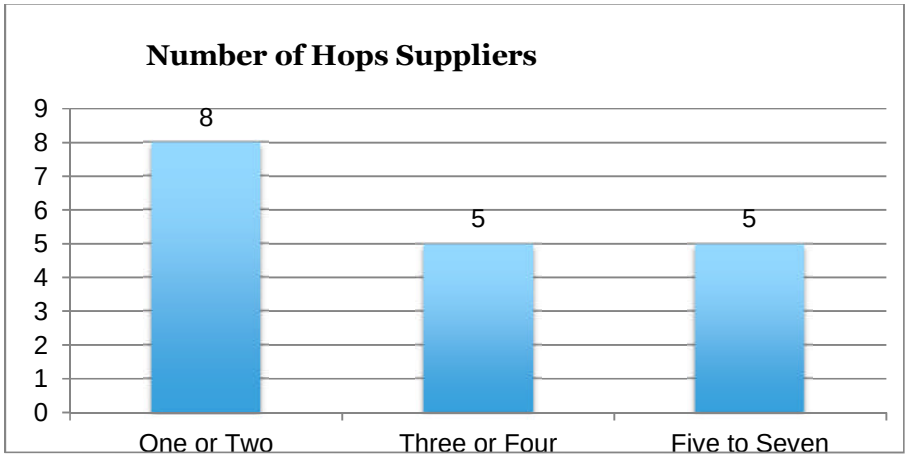
- Local source
- Hop availability in terms of volume and varieties offered
- Competitive pricing

A few other answers related to preferred-supplier traits include consistency, good personal relationships, and quality. A few respondents mentioned that they prefer suppliers with proprietary brands. Individual responses are shown in the table on the following page.

Name of Brewery	What do you think causes those hops suppliers to be preferred?
Bloomer Brewing	Hops Availability
Bull Fall Brewery	Being Local, personal interaction, consistency
Capital Brewery Co., Inc.	I must contract most varieties through Hopsteiner because they can provide the volume I need at the lowest prices
Hop Haus Brewery	If they have hard to get (proprietary) hops such as Citra, Amarillo, Equinox,
Moose Jaw Brewery	Availability of desired variety
Pearl Street Brewery	Great service and long-term free warehousing of contracted hops
Company A	Supply, flexibility
Company B	Hop Union is established and well known, they have a huge selection, they offer spot hops or contracted hops, they are what most home brew shops carry
House of Brews, LLC	Price and varieties offered - especially hot varieties
Kozy Yak Brewing	Convenience
One Barrel Brewing Company	Price, variety, historical suppliers
Rowland Brewery	Sustainability, and location, local is better
Rustic Road Brewing Company	Ability to supply quantities consistently, ease of contract terms
Shipwrecked Brewpub	$$
South Shore Brewery	They are local
Stone Cellar Brewpub	Having good relationships, costumer services, and being local
The Brewing Projekt	Proprietary brands Infrastructure and Quality
Water Street Brewery	

Number of Hops Suppliers

Question: How many hops suppliers does your company buy from?



Breweries	Number of Hop Suppliers
Bull Fall Brewery	4-5
House of Brews	5-7
South Shore Brewery	5
Bloomer Brewing	2
Stone Cellar Brewpub	2
Rowland Brewery	1
Water Street Brewery	2
Hop Haus Brewing	6
Moose Jaw	4
Pearl Street Brewery	5-6
The Brewing Projekt	3
Capital Brewing Co	4+
Shipwrecked Brewpub	2
Kozy Yak Brewing	2
Rustic Brewing	2
One Barrel Brewing Company	3

Out of the 18 breweries that responded to the survey, seven said that they use two hops suppliers. Another 10 said that they use more than two suppliers. A couple breweries use more than six suppliers. Only one brewery said that they use a single supplier for hops.

How Microbreweries Find Suppliers

Question: Please describe how you go about finding and selecting a supplier for hops.

Among the 15 breweries that answered this question, four of them find hops suppliers from searching the Internet, two find them through sales representatives, and three find their suppliers from the Craft Brewers Conference. When it comes to selecting a hops provider, it appears that quality, price, and consistency matter most. Some also said that they use the hops union to help locate suppliers. The following answers provide insights into purchaser preferences and practices for selecting hops suppliers.

Name of Brewery	**How Find and Select Hops Suppliers**
Bloomer Brewing	We were looking for Hallertauer hops
Bull Fall Brewery	We go to the Craft Brewers Conference
Capital Brewery Co., Inc.	I already have a large majority of hops on contract, but I look for new supplies when I am creating a new beer, sometimes this beer might be a project specifically designed along with one of the suppliers (have done a few small batch or experimental projects with WHEx and Gorst) or I have encountered new hop varietals at trade shows or conferences where there are pilot beers made to showcase the new hops
Hop Haus Brewery	Internet
Moose Jaw Brewery	
Pearl Street Brewery	Good products is #1 Consistency and quality.
Company A	
Company B	We use hop union because we started as home brewers and that's the kind of hops the home brew shops had. Plus they are well known and can ship you hops the same day you order. We have also bought from Lupilin Exchange for hops that we can't get from hop union. We have also considered Tenacious Badger Hops which are hops grown in Wisconsin, unfortunately they cannot compete on price and when you are a small brewery just starting out, you don't have a lot of money to necessarily buy local even when you want to
House of Brews, LLC	Web, word of mouth, post cards sent to me.

Name of Brewery	How Find and Select Hops Suppliers
Kozy Yak Brewing	Internet
One Barrel Brewing Company	I ask for a quote from all of the suppliers I use and chose based on a mix of price and available varieties
Rowland Brewery	Internet and past business
Rustic Road Brewing Company	Craft Brewers Conference
Shipwrecked Brewpub	
South Shore Brewery	Connects from the Co-Op
Stone Cellar Brewpub	Trade Shows
The Brewing Projekt	AVAILABILITY!!! Quality, Price. In that order.
Water Street Brewery	Salesman from Oregon

Level of Satisfaction with Current Suppliers

Question: How satisfied are you with your current hops supplier(s)? (scale of 1 to 5 with five being extremely satisfied and one being not at all satisfied)

The average level of satisfaction among respondents to the survey was 3.8 out of 5.0, indicating a high level of satisfaction with current suppliers overall. The lowest score was 3 and the highest was 5. Ten companies indicated a satisfaction level of 4 or greater. Hop Haus, Moose Jaw, Rustic Road and Shipwrecked provide the greatest market opportunity due to their relatively low level of satisfaction with current suppliers. See the individual responses in the Completed Interviews folder for the specific response by brewery.

What Breweries Like Best about Suppliers
Question: What do you like best about your current hops supplier(s)?

The following characteristics appear to be valuable in hops suppliers according to responses to the survey:

- Quality hops
- Hops variety/selection and availability when needed
- Good prices
- Personal interaction, good customer service
- Local
- Quick delivery/fast turnaround on orders

Relationship seems to be key. The response from Capital Brewery stated it well, 'I have several personal contacts with my local suppliers, and I enjoy meeting/seeing them on a regular basis either business related, or otherwise. My larger suppliers have been very accommodating to my needs, and were very helpful when I was new to my position.'

Challenges with Sourcing Hops

Question: What challenges have you faced related to sourcing hops for your microbrewery?

Of the 17 responses to this question, 13 said that lack of variety or lack of availability is the biggest challenge that they face. Some of the other challenges reported include the following:

- High prices
- Suppliers not willing to sell to smaller breweries
- Being over contracted.

Question: Are there any hop varieties that you would like to purchase, but have not been able to find a supplier for?

Of the 17 breweries that answered this question, four told F2M that they could find all of the hop varieties that they needed. The remaining 13 respondents said that they are unable to find certain varieties of hops that they would like to use for their beer. This is a strong indicator of a need in the market, and follow-up contacts to the companies to learn more about unmet demand is recommended. F2M was told that the one of the biggest problems for microbreweries was finding the correct hop variety because of the constant demand for new beer and hop varieties.

When asked how much demand there would be for difficult-to-source varieties, weight responses ranged from 50 to 1000 lbs., with 100 lbs. being the most common response. Additional comments included the following:

- 'I don't know, but we do not have Hallertaue or U.S. Golding locally.'
- 'Ones that are hard to find have more demand than supply. Some growers intentionally limit supply.'
- 'Amarillo and Citra; we would purchase about 150 lbs. of each.'
- 'I use Magnum in all of my beer, so it would be in pretty high demand.'
- 'A lot; I try and get roughly 100 lbs. each of Equinox, Mosaic, and as much Citra as I can find.'
- 'That depends; we are growing from a 1 bbl system to a 10 bbl system, so I am not sure yet.'

Level of Preference for Regional Growers

Question: Would you prefer to purchase hops from regional growers if they had the varieties you needed, (as opposed to being fine with sourcing hops from outside the region)?

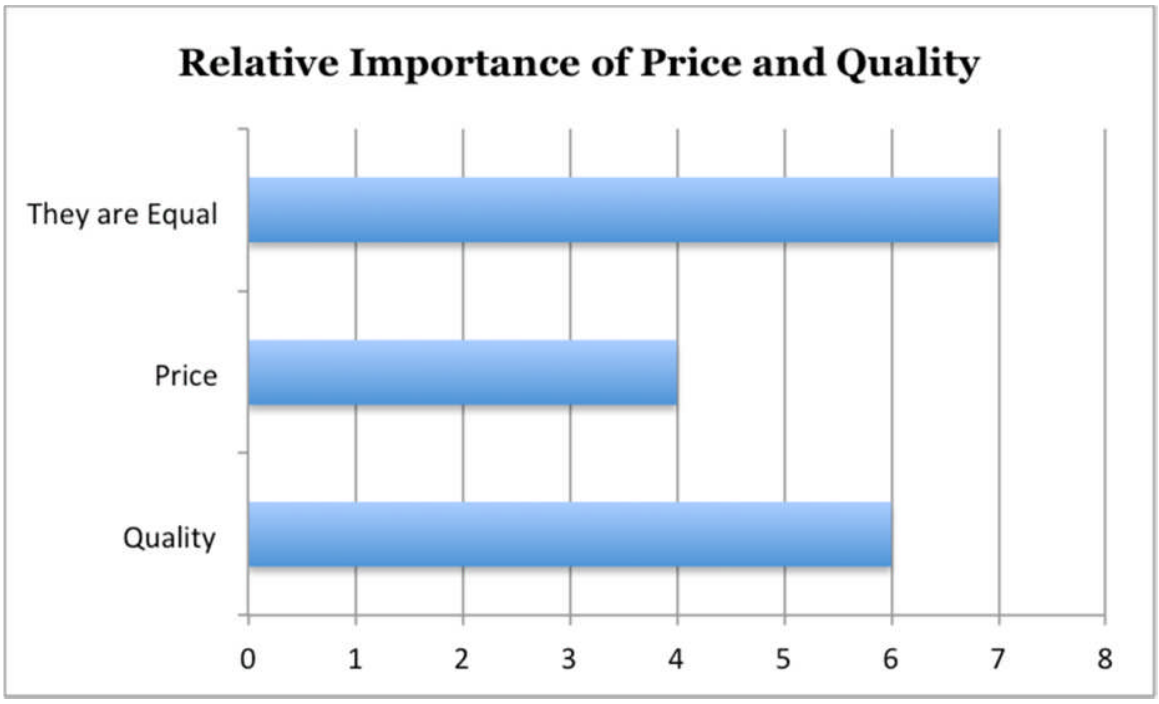
All but one brewery said that they would prefer to buy local hops. This shows a high demand for local hops suppliers when the desired variety can be grown locally at a consistent quality level for a reasonable price.

Question: Would the regional growers need to be able to supply all of your hops or would you be willing to purchase some from them and use other suppliers for the remainder?

The responses to this question were all consistent. The representatives make it clear that there is no need for a supplier to attempt to supply all the hops a brewer needs. Brewers prefer to work with multiple suppliers, and some hops are proprietary and can only be sourced from approved suppliers. See the individual responses in the Completed Interviews folder for the specific response by brewery.

Price Vs. Quality

Question: When you are considering a hops supplier, which is more important, price or quality?



As shown in the chart above right, price and quality appear to be equally important to brewers. Some rank one above the other, and many rank them equally.

Key Indicators of Quality Hops

Question: Which indicators of hops quality heavily influence your purchasing decisions?

Top indications of quality according to survey respondents are the following:

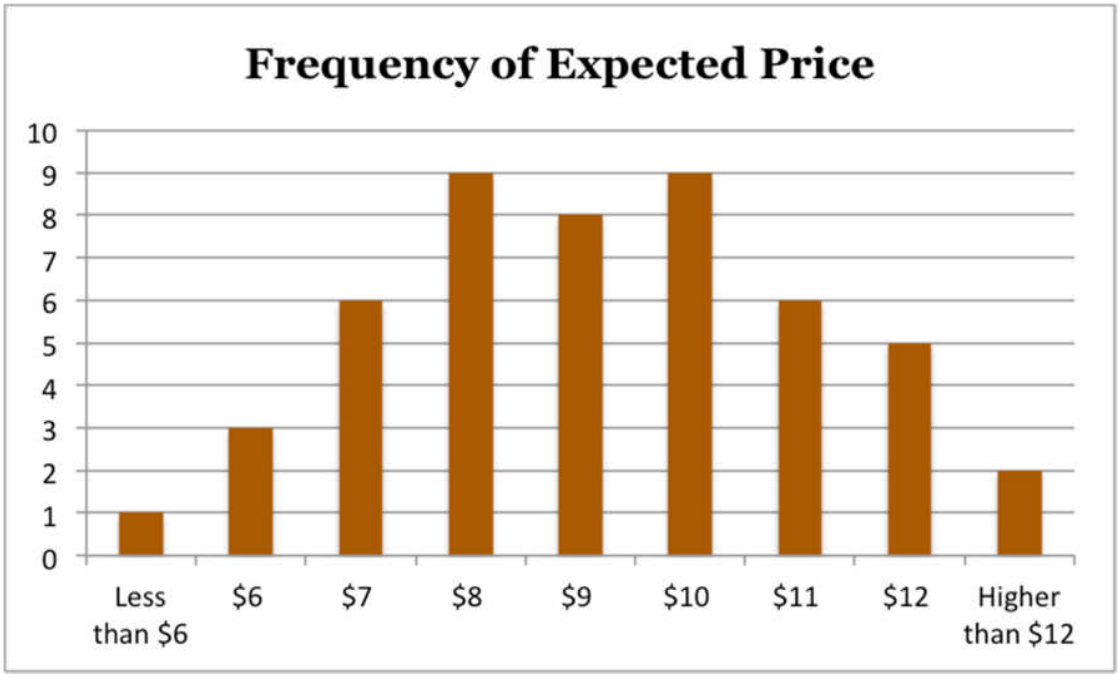
- Positive relationship with the supplier
- Freshness (crop year, packaging and storage) indicated by color, taste, smell
- Oil content
- Terpine content
- Traceability of supply (lot numbering)
- Hardness and smell indicating proper temperature processing and level of oxidation
- Acid quantity
- USDA certification

Specific responses are available in the complete interviews PDF files provided with this report.

Pricing Preferences

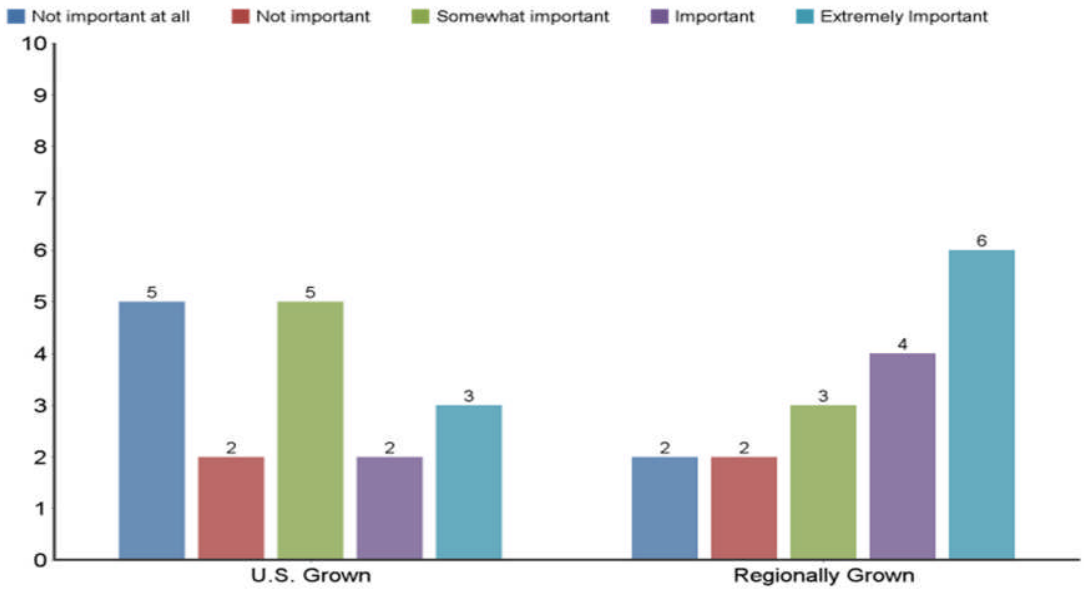
Question: What is a reasonable price per pound for a typical hop variety?

The most commonly mentioned price range is $8 to $10 per pound. The lowest price listed was $3 per pound and the highest was $22 per pound. The chart below shows the frequency of various prices provided in response to this open-ended question.



Importance of Growing Location

Question: When purchasing hops, how important are the following factors to your company: U.S. Grown, Regionally grown, other (specify).



It is interesting to note that, while regionally grown hops were considered important, U.S. grown, by comparison was not as important.

Trends in Next 18 Months

Question: What are two trends or issues that are going to affect the way you do business in the next 18 months?

Four respondents indicated that they are expanding their brewery and that would affect the way they do business. The Capital Brewery representative said that they would like to move to more local hops sources, but they are locked into contracts with non-local suppliers. The Brewing Projekt said, 'Citrus forward aroma hops,' and 'Making sure we have inventory to make our most popular beers is the difference between tens of thousands of dollars in overall sales.' In addition to those comments, the following responses were common:

- Weather and seasonal demand
- Increase in breweries could lead to shortage of hops
- Challenges with hop availability and the pricing increases that accompany that trend
- Customers constantly demand new beers
- Demand for hoppy beers continuing
- Competitors entering the market (on West coast and elsewhere)

Openness to New Source

Question: Would you be open to considering a new source for hops?

Out of the 17 breweries that answered this question, 16 said yes, and only one said no. See the Matrix of Key Conclusions toward the beginning of the report for specific responses.

Individual Business Interviews

Individual responses can be found in the Completed Interviews folder provided electronically with the supporting documentation.

Competitive Analysis

The market for hops appears to be a seller's market in that brewers show concern about availability of hops and demand for hops is increasing rapidly. However, production is also growing. According to the Brewer's Association online article 'The Hops Market' published May, 2015, 'Based on the size of the domestic crop in 2014, usage of American hops is northward of 70 million pounds at the moment. If we assume a linear increase to 2020, that's 504 million pounds of hops from 2015 through 2020' (Watson, 2015).

> The current growth trends in the craft beer market – more brewers, more market share, and more hoppy beers – have led some in the industry to worry about the hop supply in the future. Even with thousands of new acres going in and the now widespread usage of hop contracts by craft brewers, there is a fear that growing demand will outstrip supply, particularly in the markets for niche varieties (craft brewers are using dozens of them). (Watson, 2015).

There is reason to expect continued rapid changes in the hops market. In 2009, less than one-third of U.S. hops acres were planted in aroma hops. That has increased to over 60 percent planted in aroma in 2015. The author predicts that, through 2020, the hops market will continue to see extraordinary changes in the type of hops varieties grown and the size of acreage dedicated to hops, with U.S. demand for hops growing by an additional 24 million pounds by 2020. 'If those hops all came from the U.S., that's roughly 12-13K new acres,' (Watson, 2015). The cost of this expansion is high—estimated at as much as $750 million in new investments. The article predicts a price increase per pound of up to $3 to cover these expansion costs while retaining grower and dealer profit margins.

The weather plays a decisive role in the hops market. 'Weather may be a determining factor in limiting acres/yields, driving short supply and higher costs,' (Watson, 2015). Given the impossibility of accurately predicting long-term weather, this introduces a high degree of uncertainty to the market.

The total hops market includes not only domestic producers, but also global suppliers. There are increasing hops options grown abroad. 'Although domestic hops are clearly the preference for the majority of domestic brewers, foreign hop growers have made their presence clearly felt in the U.S. aroma market in recent years' (Watson, 2015). That said, foreign brewers are also consuming American grown hops. Watson writes, 'Although the current growth suggests over-supply is unlikely in the short to medium term – any growers or dealers found holding American aroma varieties would certainly find

willing buyers and acceptable prices overseas.'

Through the survey tool, F2M identified leading suppliers of hops to Wisconsin microbrewers. The list of suppliers is provided in the following table. Revenue and employee counts have been provided when they were available through the Hoover's business database. See the folder titled 'Competitive Company Information' for files with additional details about the listed businesses.

Companies Supplying Hops to Surveyed Wisconsin Microbreweries

Company Name	City/State	Phone Number	Revenue	Employees
47 Hops	Yakima, WA	509-930-3234	$4 million	8
Alpha Beta Hops	Ashland, OR	541-488-8844	$44,000	3
BSG	Shakopee, MN	800-374-2739	n/a	n/a
Carlson LD	Kent, OH	330-678-7733	$8.45 million	27
Country Malt Group	Champlain, NY	518-298-8901	$560,000	7
Gorst Valley	Mazomanie, WI	608-767-9746	$2.4 million	13
Hollingbery	Yakima, WA	509-248-0887	$4.8 million	12
Midwest Hops and Barley Co-Op	Onalaska, WI	608-386-9430	$10,000	5
S. S. Steiner	New York, NY	212-515-7200	$39 million	18
Sugar Creek Hops	Thorntown, IN	765-436-2199	n/a	n/a
Tenacious Badger Hops	Wisconsin Rapids, WI	715-424-5555	n/a	n/a
Wisconsin Hop Exchange	Waterloo, WI	608-297-2640	$1.35 million	80
Yakima Chief Hop Union	Yakama, WA	509-453-4792	$140 million	154

Market & Industry Analysis

Industry Analysis for the Hops Market

The industry analysis overview below depicts the revenue, profit, annual growth rate (2010-2015), annual growth rate (2015-2020), exports, and number of businesses for the researched industries as reported by IBISWorld. Details for each industry follow.

Industry	Revenue	Profit	Annual Growth 11-16	Annual Growth 16-21	Exports	# of Businesses
Beer Wholesaling	$64.4 billion	$2.8 billion	0.6%	0.9%	N/A	4,136
Breweries in the US	$37.8 billion	$2.6 billion	5.8%	0.4%	$3.5 billion	3,025
Craft Beer	$5 billion	$408 million	18.8%	5.5%	$124 million	3,794
Hay and Crop Farming (includes hops)	$21.3 billion	$1.6 billion	2.5%	0.6%	$1.2 billion	476, 4.6

Current Market: Craft Beer Production is Rising in the US

The craft beer industry includes microbreweries and brewpubs that produce beer for resale or consumption on premises. A microbrewery produces a limited amount of beer, typically up to 6 million barrels of beer per year. A brewpub brews and sells beer on premises as well as prepares and serves food to dining patrons. A brewpub may also be considered a microbrewery if it engages in a significant amount of beer distribution on a regional level. The major products in this industry are amber ales, bocks, fruit beer, IPA's, lagers, pale ales, seasonal beers, and wheat beers.

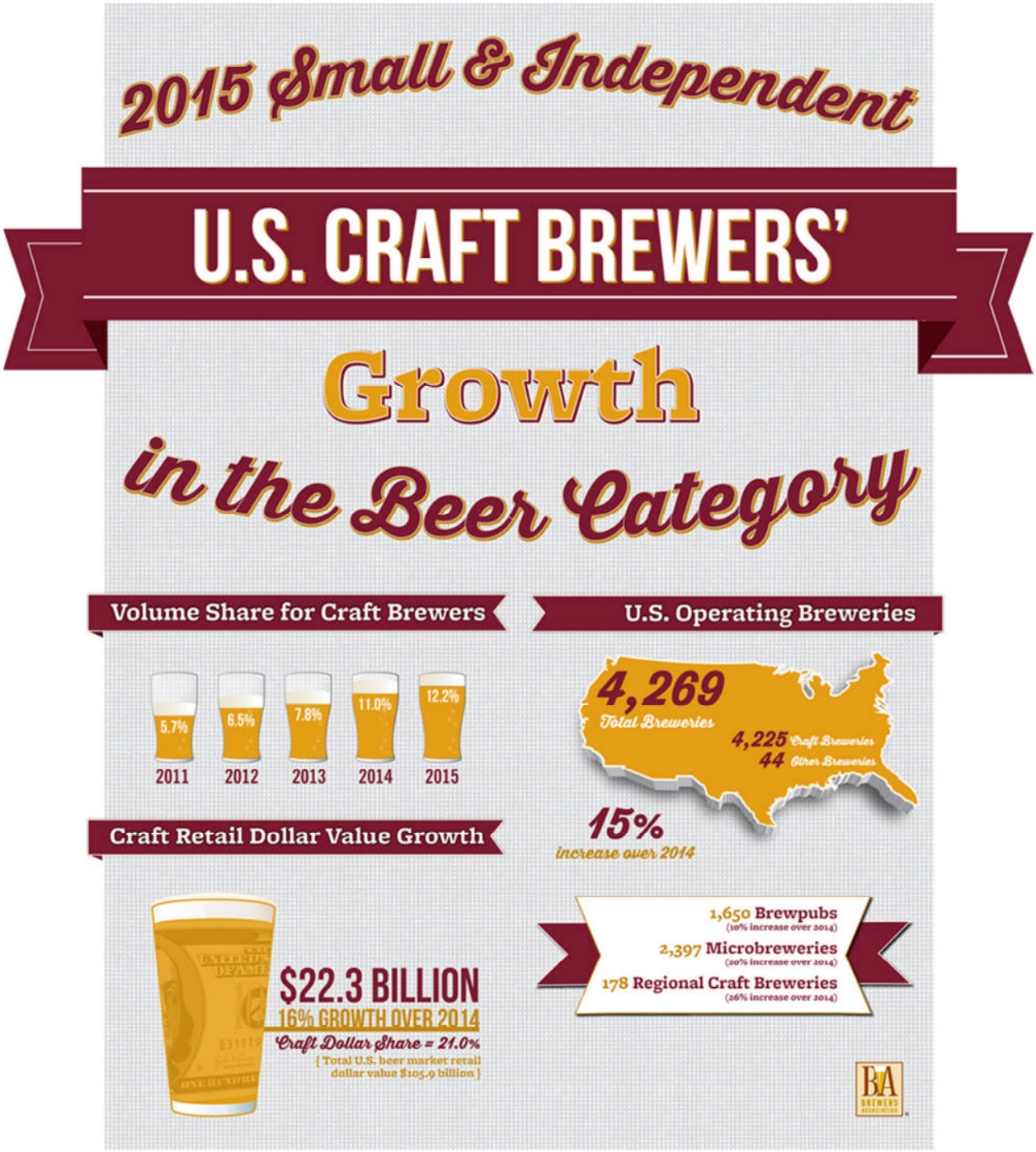
The craft beer industry is a growing and thriving sector of United States commerce. Data from the Beer Institute and the Brewers Association indicate that craft beer production has increased over 82%, from 6.3 million barrels (195 million gallons) in 2005—equal to 3.2% of total beer production—to 13.2 million barrels (408 million gallons) in 2012, equal to 6.7% of total beer production. (Beer Institute, 2011)

In a 2015 economic impact study into the contribution of the craft beer industry, the U.S. generated a total of 1.75 million jobs and had an economic impact of $252.58 billion, approximately 1.5 percent of U.S. GDP. (Dunham, 2015) Americans love beer and they consume it in astronomical quantities.

According to a 2016 article from SmartAsset.com (a financial modeling company), discussing the economics of craft beer:

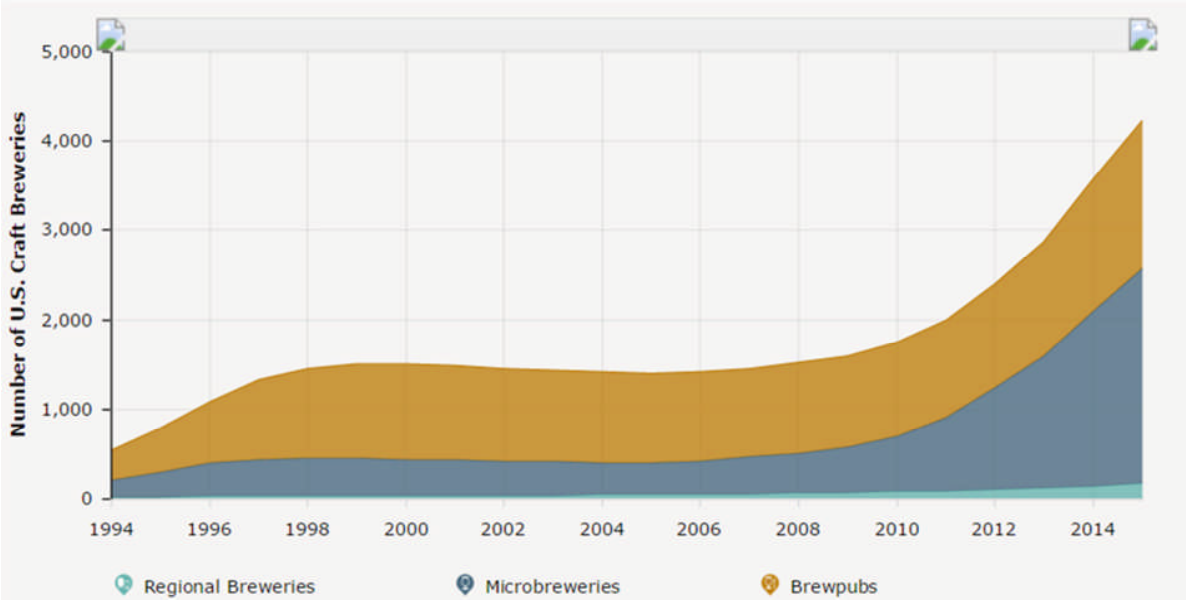
> 'In 2012 over 55.1 billion gallons of beer were sold across the United States, and 14.1012 billion pints were sold in April 2013 alone. 12.61 billion of which were brewed and bottled by just two companies: Annheusuer Busch InBev and SAB Miller. However, this ability to consume mass quantities of beer doesn't exactly correlate to an appreciation of beer. In fact, AB InBev is currently fighting a lawsuit against accusations of deliberately diluting its products. This is great news for smaller craft breweries. While beer drinkers have grown disillusioned with mass produced beers, craft breweries have witnessed as much as 32% growth per year. In the same time while the two heavyweights have seen their market share wither by 7%. This is largely attributed to evolving palates and an increased appreciation of American beer in general." (Godard,2016)

The tastes and preferences of today's beer drinkers have seen a dramatic shift away from less expensive, lighter pilsner products, to higher priced, local, more flavorful "craft" beers in bars and restaurants. In 2015, craft brewers produced 24.5 million barrels, and saw a 13 percent rise in volume and a 16 percent increase in retail dollar value; retail dollar value was estimated at $22.3 billion, representing 21 percent market share. (Cohen, 2016) Additionally, in 2015 the number of operating breweries in the U.S. grew 15 percent, totaling 4,269 breweries—the most at any time in American history; small and independent breweries account for 99 percent of the breweries in operation. (Cohen, 2016)



Source: Brewers Association (https://www.brewersassociation.org/press-releases/small-independent-brewers-continue-grow-double-digits/)

U.S. Craft Brewery Count by Category
Source: https://www.brewersassociation.org/statistics/number-of-breweries/



Craft beer is dominated by IPA's as the highest selling style of beer at 25.2 percent of annual sales. IPA is followed by seasonal beers (23.7 percent), pale ales (17.3 percent), amber ales (10.9 percent), lagers (8.6 percent), wheat beers (6.9 percent), bocks (3.9 percent), and fruit beer (3.5 percent).

Major companies include D.G. Yuengling & Son Inc. (19.3 percent) and Boston Beer Company (18.3 percent). The key external drivers in this industry are demand from beer wholesaling, per capita disposable income, per capita expenditure on alcohol, price of coarse grains, and excise tax on beer (Petrillo, 2015).

Beer Wholesaling in the US

The beer wholesaling industry is comprised of primarily establishments that purchase, store, sell and distribute beer and other fermented malt beverages made by the breweries industry. The industry brought in a $64.4 billion revenue in 2015 and increased at an annual rate of 0.6 percent since 2011. The annual growth is projected to increase over the next five years at an annual rate of 0.9 percent. Cans of beer and ale is the highest selling product in the industry at 46.1 percent, followed by bottles at 36.3 percent, barrels and kegs at 10.4 percent, and other malt beverages and brewing products.

There are no major players in this industry. The key external drivers include demand from beer, wine, and liquor stores, per capita expenditure on alcohol, excise tax on beer, per capita disposable income, price of diesel, and regulation for the alcoholic beverages sector. This industry has 4,136 businesses with an annual profit of $2.8 billion (Petrillo, 2016).

Hay & Crop Farming in the US

The hay and crop farming industry grows hay, sugar, beets, hops, herbs, and a variety of other crops. The industry brought in a $21.3 billion revenue in 2015 and increased at an annual rate of 2.5 percent since 2011. The annual growth is projected to increase over the next five years at a rate of 0.6 percent annually. Hay is the highest selling product in the industry at 86.4 percent. This is followed by beets at 12 percent, hops at 1.1 percent and other crops at 0.5 percent.

There are no major players in this industry. The key external drivers include demand for beef cattle production, demand from food manufacturing, the price of sugar, per capita sugar and sweetener consumption, and the natural disaster index (McCormack, 2015).

Breweries in the US

The breweries industry primarily produces alcoholic beverages that use malted barley and hops such as beer, malt liquor, and non-alcoholic beer. This industry brought in $37.8 billion of revenue in 2015 and increased at an annual rate of 5.8 percent over the last five years. The annual growth is projected to increase at a rate of 0.4 percent over the next five years. The highest selling product is premium beer at 42.1 percent followed by sub-premium at 16.9 percent, craft beer at 15%, super premium beer at 14 percent, progressive adult beverages at 6.4 percent, and malt liquor 5.4 percent.

The major players in the industry are Anheuser-Busch with 43.8 percent of the market share, and MillerCoors LLC with 11.2 percent of the market share. The key external drivers in the industry are per capita disposable income, per capita expenditure on alcohol, price on coarse alcohol, excise tax on beer, trade-weighted index, and demand from wholesaling beer (Petrillo, 2016).

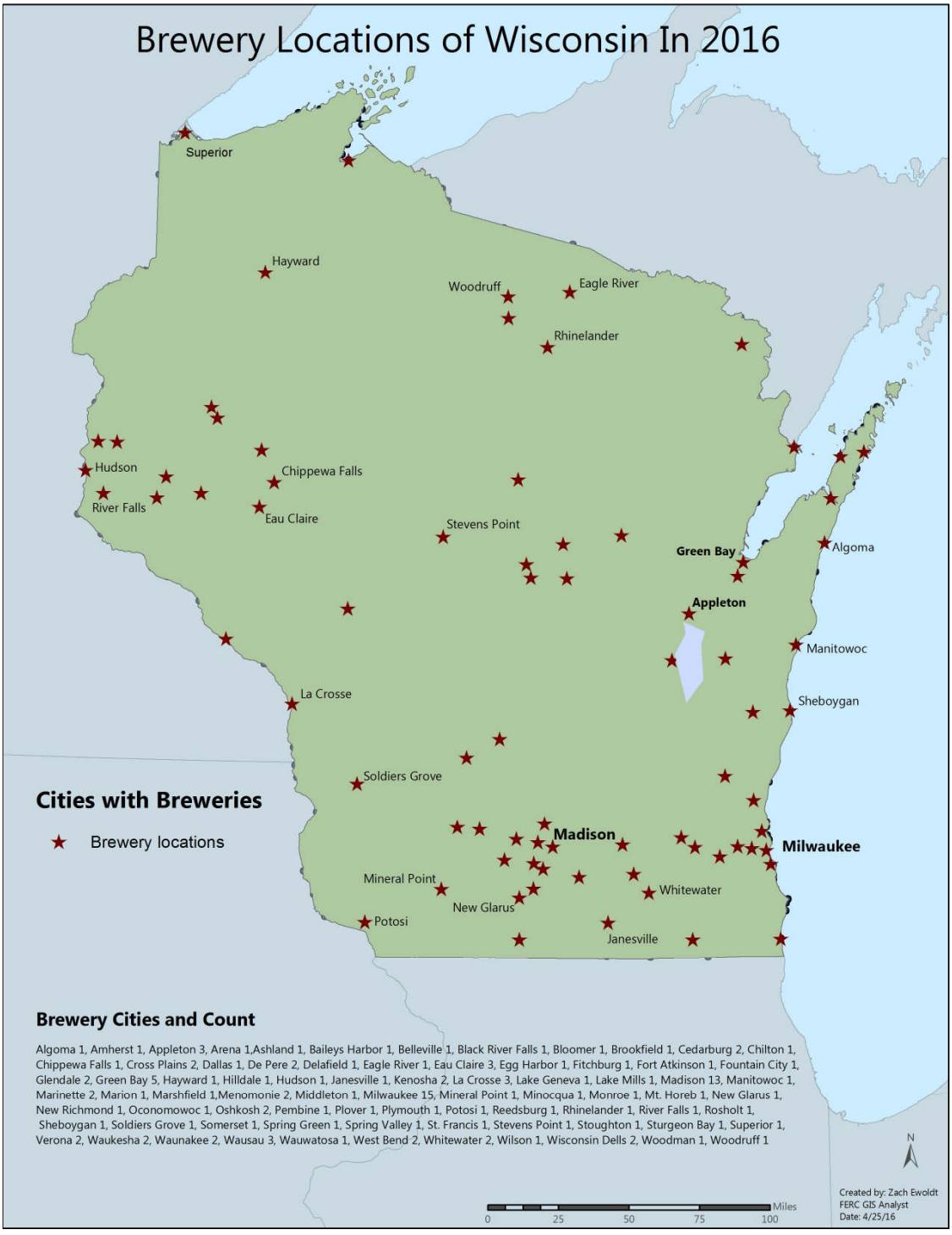
Wisconsin's Craft Brewing Industry

The American craft beer industry had an economic impact of $33.9 billion in 2012, a number expected to increase closer to $50 billion in 2016, according to the Brewers Association. Craft beer had an 11 percent market share of beer sales last year, an impressive figure in an industry dominated by a small number of multinational conglomerates that own a string of brands.

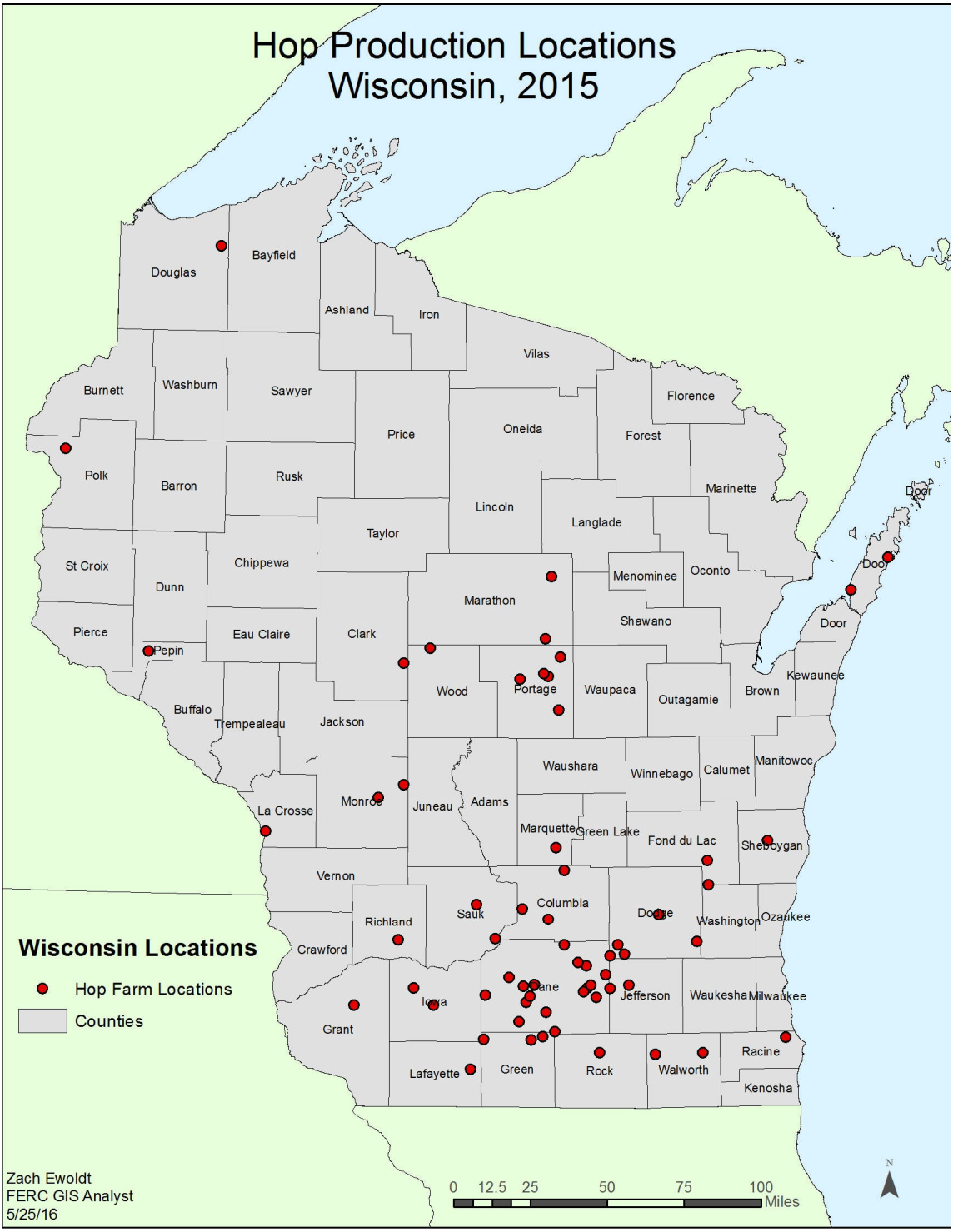
Nationwide, craft beer production grew 18 percent in 2013 and 2014. Production continues to boom. The craft beer industry continues to ride the wave with more than 600 new breweries opening around the nation last year. Wisconsin is seeing similar growth with a 27 percent increase in breweries over the past two years, along with a string of related events, such as Craft Beer Week, festivals, tastings and other events that contribute to the State's tourism and economic impact.

Seventy five percent of 21+-year-old adults live within 10 miles of a brewery, so this is an economic impact not being felt in just a particular city or two, but all over the country."

Craft Breweries in Wisconsin



Wisconsin Hop Exchange Producers in Wisconsin



Interviewed Companies Table

This is a summary list of the companies that participated in the survey by phone or online. All are located in Wisconsin.

Company Name	City	Phone Number	Web Address
Bloomer Brewing Company	Bloomer	715-271-3967	www.bloomerbrewingco.com
The Brewing Projekt	Eau Claire	715-214-3728	www.thebrewingprojekt.com
Bull Fall Brewery	Wausau	715-842-2337	www.bullfallsbrewery.com
Capital Brewery	Middleton	608-836-7100	www.capitalbrewery.com
House of Brews	Madison	608-347-7243	www.houseofbrewsmadison.com
Kozy Yak Brewing	Rosholt	715-677-3082	N/A
One Barrel Brewing Company	Madison	608-630-9286	www.onebarrelbrewing.com
Rowland's Calumet Brewing Company	Chilton	920-849-2534	www.rowlandsbrewery.com
Rustic Road Brewing Company	Kenosha	262-320-7623	www.rusticbrewing.com
Shipwrecked Brew Pub	Egg Harbor	920-868-2767	www.shipwreckedmicrobrew.com
South Shore Brewery	Ashland	715-682-9199	www.southshorebrewery.com

Prospective Companies

The Prospective Companies list includes microbreweries that were not able to be contacted prior to completion of the interview process, but may be potential customers. The full list can be accessed in the 'Prospective Companies' section of the 'Interviewed and Prospective Companies' folder.

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