



The Geographic Dispersion of Hop Production in the United States: Back to the Future?

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Abstract

The U.S. has long been a major producer of hops. Hops were first produced in New England and New York, and then in the Great Lakes Region. Since the late nineteenth century, the Pacific Northwest has been the dominant producer of hops. However, due to the growth of the craft beer industry there has been an increase in hop production in several states, particularly states that were once major producers such as New York and Michigan. However, due to climatic and economic factors, the Pacific Northwest states of Washington, Oregon, and Idaho will likely remain the major producers.

Introduction

Primarily due to an increase in the production of craft beer, there has been an increase in the production of hops. Hops are used to add bitterness and enhance the aroma of beer. Craft beers tend to use more hops than traditional lagers produced by larger brewers. There is also increased interest in locally produced beers that use locally sourced ingredients. One response to this interest is increased geographic dispersion of hop production due to the increased geographic dispersion of craft beer production. The states of Washington, Oregon, and more recently Idaho, continue to dominate hop production. Interestingly, many of the states with new hop acreage were large producers in the late nineteenth century.

In many respects the U.S. hop sector is moving “back to the future”. In addition to the increased interest in locally sourced inputs, most craft beers use more hops than

traditional pilsners produced by large breweries. These trends create opportunities for hop production beyond the U.S. Northwest. If these trends continue they could impact the global hop market because, depending on the year, the U.S. is the largest or second-largest producer in the world.

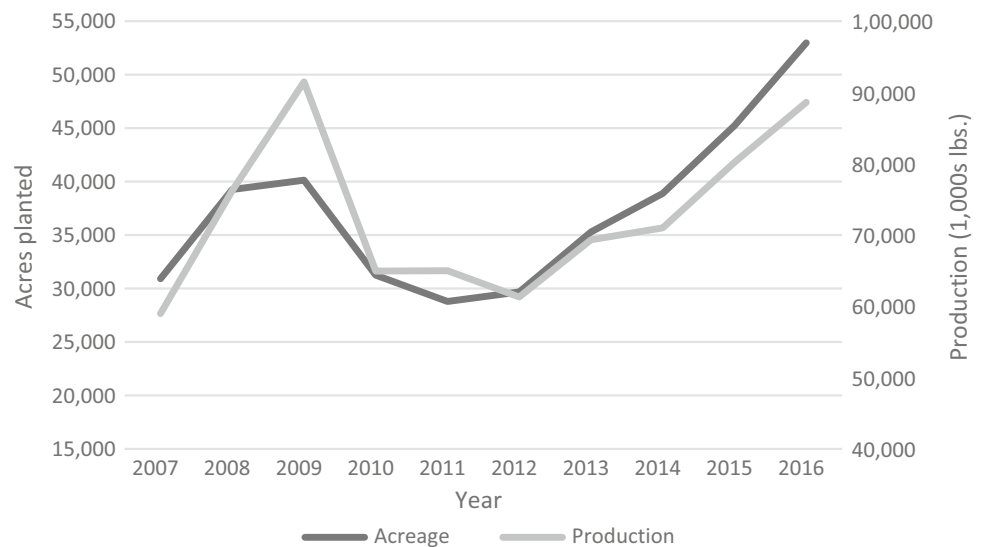
There are climatic and economic factors that may impact the production of hops in the U.S. While the demand for hops is increasing, so is the supply, which raises the potential for overproduction and an associated collapse in the price of hops. This situation has occurred in the past, for example, the farm price of hops fell from more than \$2.00 a pound in 1984 and 1985 to less than \$1.50 a pound in the late 1980s and early 1990s (USDA 1989, 1998). Climatic factors may also play a role in limiting the geographic dispersion of hops. Hops are susceptible to diseases like downy mildew, which are more prevalent in humid growing regions, resulting in greater costs of production. The comparatively low humidity of the Northwest, specifically Washington and Idaho, makes this region exceptionally well suited to hop production, and this region is likely to continue to be the dominant production region. Production in states that at one time were major producers—New York, Michigan, Wisconsin, and California may also successfully develop a commercial scale hop industry. Few other states with the possible exception of Colorado or Minnesota are unlikely to increase production beyond a small or hobby scale.

Increased Demand for and Production of Hops

The demand for hops in the U.S. has been increasing primarily due to the increased production of craft beers. According to the Brewers Association, a craft brewery trade group, in 2017, there were 6,372 breweries and brewpubs in the U.S., an all-time record (Brewers Association 2018). While the craft beer market has been growing for some time,

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Fig. 1 U.S. hops acres planted and production 2007–2016.
Source George (2018)



it is now an important part of the U.S. beer market. In 2016, craft beer sales accounted for 21.8% of all sales in dollar terms and 12.3% in volume terms (Brewers Association). In 2010, only 5.2% of the beer sold in volume terms were craft beers (Intel, p. 30). Within the craft sector, brewpubs, defined as a restaurant-brewery that sells 25% or more of its beer on site, and microbreweries, defined as firms that sell less than 15,000 barrels or 465,000 gallons of beer, are growing the fastest. Additionally, large brewers are also introducing craft style beers that will increase the demand for hops.

Many craft style beers, specifically India Pale Ales (IPAs), use a great deal of hops compared to traditional American pilsners. While craft beer accounts for slightly more than 12% of all beer produced by volume, they account for nearly 50% of total U.S. hop usage (Watson 2016). Another trend in the hop industry is the sheer number of hop varieties used by brewers. In 2009, craft brewers used 90 different hop varieties; by 2014 that figure had risen to 132 (Watson 2016).

Some brewers prefer locally sourced ingredients, such as hops, provided quality standards are maintained and the price for local hops isn't excessive. A 2011 survey of Michigan brewers indicated that 55% would be willing to pay a 1–10% premium for locally grown organic hops (Sirrione et al. 2011). This indicates that producers in emerging regions need to have similar costs of production as established hop producers. Another consideration is the increased geographic dispersion of beer production, which is likely to lead to an increased dispersion of hop production. Many consumers have a preference for locally produced products and this appears to be particularly important for consumers of craft beer (Sirrione 2017).

From 2012 through 2017, U.S. hop acres harvested grew from 29,683 to 55,785 acres, an 88% increase, and production increased from 58.91 million pounds to 106.24 million pounds, an 80% during the same time period (George 2016, 2018). According to the USDA National Agriculture Statistics Service, harvested acreage is expected to increase by an additional 6.4% in 2017. The fact that output has not increased as fast as acreage is due to several factors: (1) growers are producing hops varieties with lower yields (George 2018); (2) recently planted hops (baby hops) produce lower yields; and (3) producers that are new to hop production may lack the management expertise to maximize yields.

Another trend is the alteration in the mix of hops produced. In 2012, approximately 50% of the hops produced were high alpha varieties and 50% were aroma/dual purpose hops (George 2018). By 2016 more than 80% of the hops produced in the U.S. were aroma/dual purpose (George 2018). This is due to the increased demand for aroma hops by craft brewers (Galinto and Tozer 2015).

Figure 1 shows the growth in hop acreage and production in the U.S. from 2007 to 2016.

The left axis shows the number of acres planted in hops from 2007 through 2016, and the right axis shows the level of production. The two lines show that, with the exception of the excellent crop year of 2009, output and acreage track fairly closely. Since 2013, the rate of growth for acreage has increased faster than output. From 2007 through 2016, acres ranged from a low of 28,787 in 2011 to a high of 52,980 in 2016; an increase of more than 84%. There has been a consistent increase in acreage since 2012.

Hop production increased rapidly from 2007 through 2009, declined between 2009 and 2012, primarily due to a

reduction in acreage, and then increased fairly dramatically from 2012 through 2016 where output increased from 61.32 million pounds to 88.62 million pounds. This represents an increase of 44.5%.

The Role of the U.S. in Global Hop Production

Globally, from 2007 through 2016, acreage devoted to hop production increased from 122,010 to 134,700 an increase of 10.4%. All of this increase is due to increased acreage in the U.S., which rose from 30,911 acres in 2007 to 52,980 in 2016. This represents an increase of 71.4%. The trend in hops acreage by major producing countries is shown in Fig. 2.

There was a dramatic increase in acreage in the U.S. from 2014 through 2016, and as a result the U.S. surpassed Germany whose acreage has been comparatively flat. Acreage in Czechia has been relatively constant at slightly higher than 10,000 acres, and the acreage in China has been trending downward, from 11% of global acreage in 2007 to 4% in 2016. Except for a large increase in 2014, acreage in the rest of the world has also been trending down.

In terms of production, the U.S. still slightly trails Germany. In 2016, Germany accounted for 40% of global production while the U.S. trailed slightly behind at 37% (George 2018). From 2007 to 2016, production in the U.S. increased from 59.0 million pounds to 88.6 million, an increase of 50.2% (George 2018). Globally the U.S. share of hop acreage varied from 25% in 2007, 2010, and 2011 to a high of 39% in 2016. The U.S. has long been a major producer of hops, accounting for about 20% of the world output at the turn of the twentieth century (U.S. Census Bureau 1900). Acreage in Germany, the other major producer of hops, has remained stable over the same period at about 33 to 34% of total world acreage. The U.S. is an increasingly important source of global hop production.

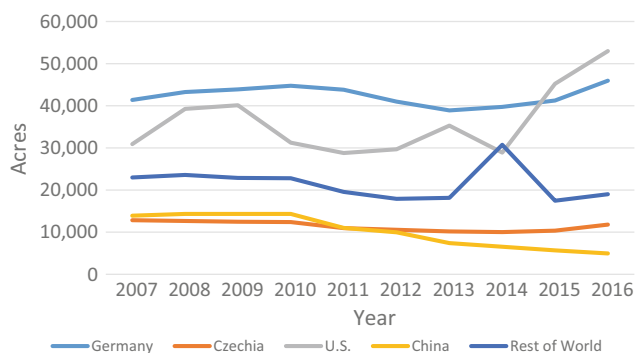


Fig. 2 Hop acreage by county 2007–2016. *Source* George (2016, 2018)

Hop Physiology

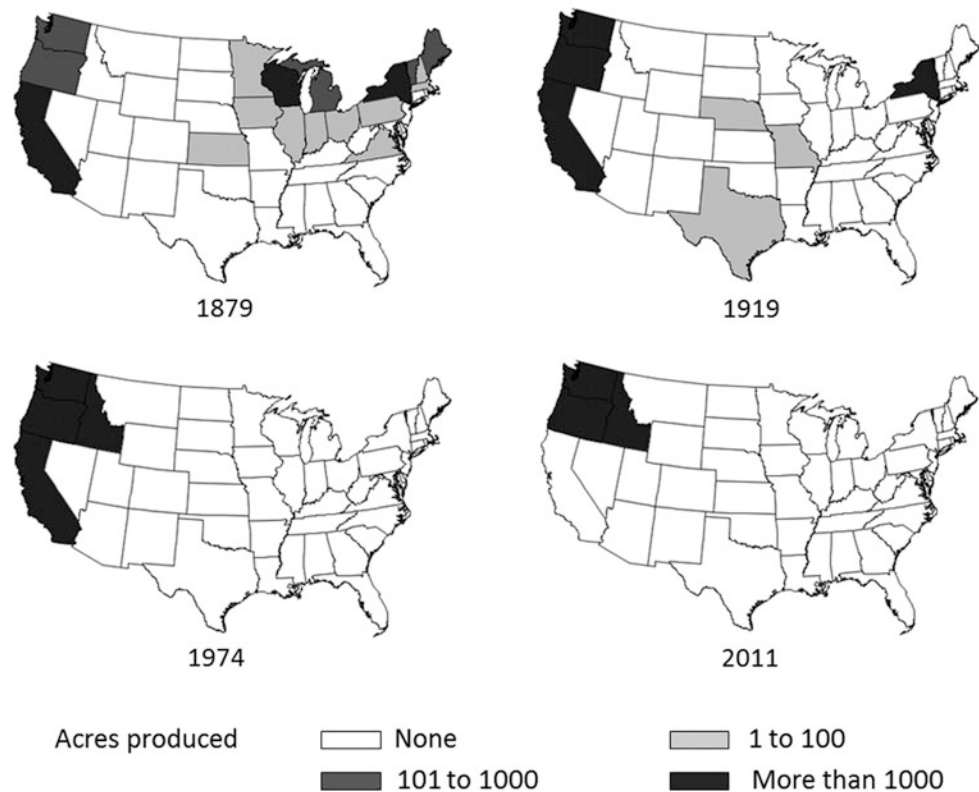
Hops are photoperiod dependent. Daylength determines the annual stages of production (dormancy, emergence and spring regrowth, vegetative growth, reproductive growth, harvest, preparation for dormancy). The timing of each stage can vary by growing location and cultivar. Because day-length throughout the growing season is determined by latitude, latitude plays an important role in hop production. While hops can be grown in nearly every climate, commercial hop production generally occurs between the 35th and 55th parallel (Mahaffee and Pethybridge 2009). Hops also require 5–6 weeks of freezing to near-freezing temperatures for ideal growth and yield. Emergence and spring regrowth is signaled by increasing daylength and temperatures. From May to early July there is vegetative growth in the main vine. From early–mid-July the majority of growth occurs in lateral branches. When vegetative growth ceases and the plant focuses on reproduction, cone production is determined by decreasing hours of daylength and the number of “nodes” on the plant. This usually occurs in late July–August.

Harvest usually occurs from mid-August through late September (Turner et al. 2011, pp. 1646, 1647). Hops grown in latitudes below 35° may achieve the appropriate number of nodes when daylength is short enough in the spring resulting in a “split crop” or top crop resulting in subpar yields. Hops grown in higher latitudes, above 55°, may not have enough time during the vegetative growth period prior to the switch to reproductive growth, resulting in subpar yields.

Historical Geography of U.S. Hop Production

Historically, the majority of commercial hop production in the U.S. has occurred along a narrow band north of the 40th parallel and south of the 50th parallel, with additional limited production in the Sacramento Valley of California. Production in the U.S. extends back to colonial times. Massachusetts led production until 1840, when New York became the dominant producer for several decades. By 1879, there were three major production regions, the Northeast (including New York), the Great Lakes region, and the Northwest. In 1879, New York had the most acreage devoted to hops at 30,072 and Wisconsin was second with 4,430 acres (U.S. Census Bureau 1880). Advances in rail transport allowed for the early establishment of hop production on the West coast. California was the third-largest producer in 1879 and production began increasing in Oregon and Washington. In 1879, Oregon had only been a state for 20 years and Washington was still a territory. By 1909, production had shifted to the Pacific Northwest (including

Fig. 3 Historical U.S. hop production 1879–2011. *Source* U.S. Census Bureau; Census of Agriculture 1880, 1920; U.S. Agricultural Statistics 1975, 2012



Northern California) and New York and Wisconsin declined in importance (U.S. Census Bureau 1910). Worldwide, by the turn of the twentieth century, the U.S. had become the second-largest producer of hops in the world behind Germany (Kopp 2014).

Figure 3 shows the production of hops by state over the past 140 years.

By 1919, production had left the Great Lakes Region and acreage in New York had fallen to 1,024 acres. The largest producer was California with 8,118 acres. Acreage in Oregon increased from 304 acres in 1879 to 5,629 and acreage in Washington more than doubled from 534 to 1,129. In the forty years from 1879 to 1919, acreage and output declined (U.S. Census Bureau 1920). It should be noted that there were several factors for this decline. Disease and insect pressure reduced acreage in the Eastern U.S. and a growing temperance movement culminated in the passage of the 18th Amendment in 1919, which established prohibition, and subsequently reduced the demand for hops.

In the years after the repeal of prohibition, the Northwest remained the dominant producer of hops. Washington state became the leading producer, Idaho increased production, and acreage in California declined. This could be due to several reasons: the Pacific Northwest is less likely to suffer from mildew diseases than more humid climates, there may have also been a disinvestment in hop producing and

harvesting equipment in the Northeast and Midwest during Prohibition; also other crops such as corn may have become more profitable to produce in New York and the Midwest after Prohibition. This is an area for further research. In 1974, Washington accounted for more than 67% of all the hop acreage in the U.S. By the 1987 census, only Washington, Oregon, and Idaho produced hops.

Between 2011 and 2016 there was a fairly dramatic expansion in the number of states that produced hops. This is shown in Fig. 4. This figure may not account for all states that produce hops, there may be other states that currently produce hops on an extremely small scale that are not shown in Fig. 4.

From 2011 to 2016 the number of states that had at least one acre devoted to production rose from three to 28. Former major producers New York, Michigan, Wisconsin, and California each had more than 100 acres devoted to hop production. There is a very good chance that these states will continue to increase the size of their industries if current market trends continue and the number of breweries increase. A headwind to this growth is the apparent decrease in demand of publicly available varieties of hops. Some of these states have large craft beer industries and as Fig. 4 shows, have the proper climatic conditions to grow hops. Colorado is an interesting case. Despite the fact that Colorado is at the southernmost latitude with respect to where

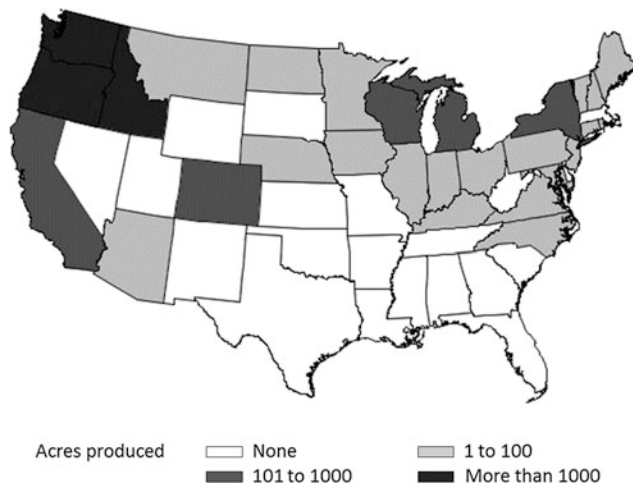


Fig. 4 Acres devoted to hop production 2016. *Source* George (2018)

hops are grown, in 2016, the state had 200 acres in hop production and a vibrant craft beer sector with 387 craft breweries (Hendee 2017).

Figure 5 shows the acreage devoted to hop production from 1992 through 2017. Acreage was steady during the early to mid-1990s and declined in the late 1990s through the mid-2000s. Acreage increased dramatically in 2008 and then declined from 2009 through 2011, from 2013 through 2017 the growth in hops acreage has accelerated.

In 2011 total hop acreage was 29,787, by 2017 it had risen to 55,785 acres. In 2011, all the hops produced in the U.S. were in Washington, Oregon, and Idaho. Most of the increased acreage between 2011 and 2017 occurred in the Pacific Northwest (PNW). This is likely because commercial scaled farms in the PNW were able to take advantage of economies of scale, climatic conditions well suited to hops production, and knowledge of the supply chain to take advantage of the increased demand for hops. Acreage in the other states increased from zero to 2,503; output outside of the PNW now accounts for 4.5% of the nation's total.

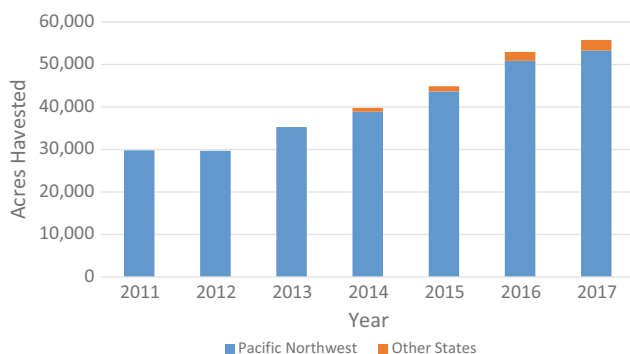


Fig. 5 U.S. hop acres 2011–2017. *Source* George (2016, 2018)

A few states now producing hops do so on an experimental or hobby scale, and their potential for establishing a commercial sized industry is limited. This includes eastern states south of the Ohio River (Kentucky, Virginia, and North Carolina).

The vast majority of hop farms in the U.S are north of the 40th parallel, although there are some producers that grow hops south of the 40th parallel, particularly along the East Coast. There are comparatively few farms in Washington, Oregon, and Idaho, which indicates that they are very large compared to those in other states. The primary growth in the number of farms is in the Great Lake Region including Minnesota, Upstate New York and along the eastern shore of Lake Michigan. These states, especially New York and to a lesser extent Michigan, were major hop producing states in the late nineteenth century. They are located at a latitude that make commercial hop production feasible. The increased interest in locally produced beer from locally sourced ingredients has helped spur the demand for hops in this region.

There are some interesting clusters of hop farms throughout the U.S. In the Midwest, the area around Madison, Wisconsin, and along Interstate 35 from the Twin Cities south has several farms. Wisconsin was also at one time a major hop producing state and there is increased interest in craft beer in that state. Minnesota is an interesting case, while there is also increased interest in locally produced beer, Minnesota has the advantage of having a somewhat less humid climate compared to most other Eastern states. There is also a cluster just East of San Francisco in the Sacramento Valley. In the East there is increased activity in Vermont, and in Virginia relatively close to Washington DC. Most of these farms are very small or hobby operations.

Challenges for Hop Production in Re-emerging Regions

Hops are susceptible to a number of diseases. Downy mildew (*Pseudoperonospora humuli*) and powdery mildew (*Podosphaera macularis*), are the most serious diseases resulting in lower yields and in some cases unmarketable hops (Brown, n.d.). While selection of virus and disease free plants and resistant cultivars can reduce the incidence of some diseases, growers in regions with high humidity and rainfall face a higher incidence of disease compared to growers in arid regions, and must take proactive measures to ensure optimal production.

The most effective way to reduce the impact of disease is through the use of fungicides. There are both conventional fungicides and fungicides that meet organic standards available. Organic fungicides, namely copper, are not labeled for enough applications for it to work in high

pressure years. Improved management techniques can be used to improve the possibility of success in states east of the Mississippi. Also, many new hop producers outside of the (PNW) have limited crop management experience, especially with such a specialized crop, and the potential for lower yields is likely greater than in well-established hop growing regions. This lack of experience puts developing regions at a competitive disadvantage compared to the Pacific Northwest.

The final barrier to the increased dispersion of hop production is the development of proprietary varieties of hops in the Northwest. These varieties are increasingly popular with brewers, and growers in emerging regions cannot obtain access to these varieties without entering into an agreement with the owners of the varieties. The Northwest has a well-established supply chain that other regions of the country are still developing.

Potential Overproduction

Although the craft beer sector has shown tremendous growth over the last several years, this trend will not continue indefinitely. While most, if not all, analysts believe the sector will continue to grow, some believe the rate of growth will decline. IBISWorld estimates that the sector will grow by a compound annual growth rate of 4.4% from 2016 through 2021 (Petrillo 2016). If hop production increases at a faster rate, there will eventually be downward pressure on prices. Downward pressure could also result if consumers move away from beers with a strong hop flavor to varieties that are more malt focused. Another potential source of

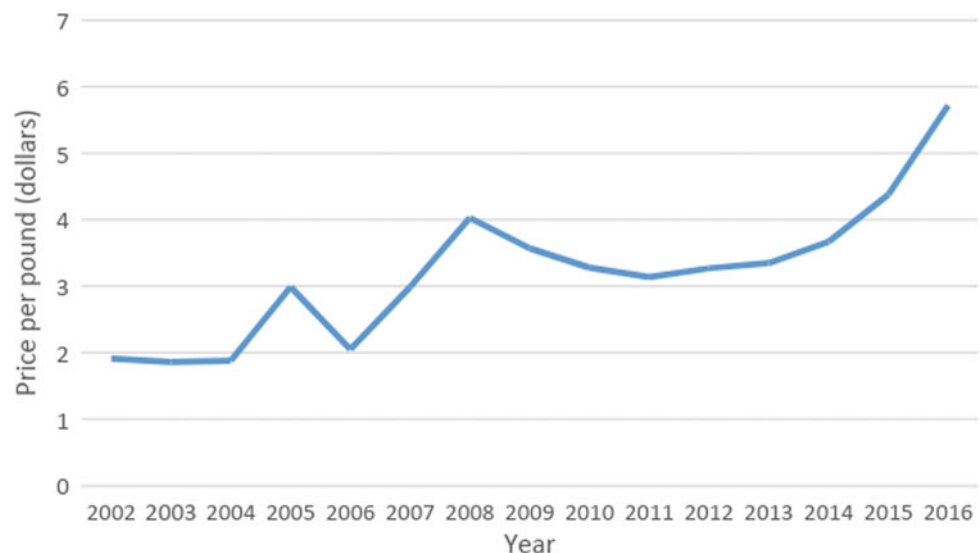
downward pressure on price is the possibility for the increased use of hop extract instead of pellets. This could allow brewers to use hops in a more concentrated form, which would reduce the overall demand for hops. This is already occurring for bittering hops.

Despite this concern, hop prices moved upward in the past five years. The price of hops is shown in Fig. 6.

While Fig. 6 shows the general trend in the price of hops, actual hop prices vary widely depending on the variety. Some varieties appear to be highly profitable, while the price of others may not cover the cost of production. From 2002 to 2016, prices ranged from a low of \$1.86 per pound in 2003 to a high of \$5.72 per pound in 2016. In the early 2000s, prices were below \$2.00 per pound; prices spiked in 2008 due to a shortfall in global production and have steadily increased since 2011. Currently, it appears that strong demand is supporting the price of hops despite the increase in production. The fact that many brewers, especially larger brewers, have multiyear contracts also support hop prices. This is especially true of the more popular, proprietary varieties.

Despite higher prices, hop farming, like most of agriculture, is not a high margin industry. A cost of production study conducted by Washington State University estimated that the break-even price for an established large-scale hopyard was approximately \$5.32 a pound, if the farmer does not own the land outright, and about \$4.94 a pound if the farmer owns the land (Galinto and Tozer 2015). This implies that most hop growers suffered losses in the early 2000s and prices need to be maintained at or near their current levels if output is to be maintained. Cost of production studies conducted on behalf of USA Hops indicate

Fig. 6 The price of hops U.S. 2002–2016. *Source* USDA (2004–2016)



that the break-even price for smaller producers is higher than for larger producers (<https://www.usahops.org/growers/cost-of-production.html> 2015).

Growers in states like New York, Wisconsin, and Michigan may have slightly lower cost of production because in some cases land values are lower than they are in the Yakima Valley of Washington, which should be noted is higher than other parts of the PNC. However, the yields in these re-emerging regions may not be as high for new growers. Conversely, growers in the Northwest possess economies of scale that offset the higher land costs.

In order to assure a stable supply of hops, most brewers enter into contracts with growers. Farmers who decide to grow hops without a contract face the potential of not finding a market for their output. From 1937 to 1985 the U.S. had a marketing order for hops. Marketing orders are designed to manage stocks to insure that there is sufficient stability to prevent wide price and production fluctuations. However, since 1985 contracts have been the primary way farmers find buyers and brewers secure a source of hops.

A growing trend in the beer supply chain is vertical integration of brewers owning hop farms. For example, Anheuser-Busch InBev owns about 30% of the hop acreage in Idaho, and as a result of its purchase of SABMiller, controls the production of hops in the small but growing South African hop market. Rogue brewery, a craft brewer in Oregon, also owns a hop farm.

Conclusion

In many respects, the hop market is reverting to what the industry looked like in the mid to late nineteenth century. While the Pacific Northwest is, and will remain, the dominant production region, and more and more states are producing hops on a commercial scale. States that were major producers in the late nineteenth century, New York, Wisconsin, and Michigan have the best potential to reestablish a commercial hop industry.

The growing geographic dispersion of hop production is due to a number of factors. The first and most important is the growth of the craft beer industry. This has increased the demand for hops disproportionately to their market share because many craft beers feature hops as a major ingredient. This is likely to continue, at least in the near future although it is very unlikely that the current rate of growth of the craft beer segment will continue indefinitely.

Despite these positive market forces, the potential for weed infestations and disease outbreaks are higher in the eastern U.S. than in the Northwest. Higher humidity increases the likelihood of diseases like downy mildew. One reason the Northwest dominates hop production in the U.S. is because it has a climate and latitude well suited to hop

production. Another potential barrier to the growth of hop production is the substitution of hop extract for hops, which could also reduce the demand for hops in the future.

Even though the hop industry in the U.S. is growing, hop production remains a narrow margin business and small changes in supply or demand could lead to large price changes. As a result of this instability, the entire beer system has adopted a number of operating principles. Vertical integration appears to be another emerging technique that is being used by brewers to ensure that they have a supply of hops and that these hops meet their quality and flavor standards.

The U.S. is a major producer of hops ranking either first or second in global production depending on yields. The U.S. has more acres devoted to hop production than any other country. Combined, the U.S. and Germany produce more than 70% of the world's hops. While currently on a small scale, the increased geographic dispersion of U.S. hop production could impact the world hop market.

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