



From Seed to Sip—A Small Batch Hop Experiment

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Due to COVID-19 related lock downs, there's been a resurgence of gardening, cooking and other home-related activities. Although it's unlikely your small home garden will be enough to support the total nutritional needs of your family, it's a healthy activity that provides some element of control in uncertain times¹. Many areas temporarily shut down breweries, and with time on their hands, people became interested in home brewing as well². Both activities were combined (with some help on brewing from Stillwater brewery Iron Monk Brewing Company) to see if hops could be successfully grown in Oklahoma to produce beer. This fact sheet guide you through growing hops in Oklahoma, the harvest and preparation of the hops, the brewing techniques used by the professionals and a short budget to will help prepare your own hop experiment.

History of Hops

Although beer drinking has a long history (5,500 years) using hops to produce beer was recorded only as early as 790 AD³ in the Carolingian Empire⁴. Today the standard ingredients of beer include water, barley malt, hops and yeast. In the past gruit was used instead of hops. Gruit is a collection of various dried herbs, like rosemary, flowers and horehound. Hops also were used for other purposes. Ancient Romans used it for flavoring and medicine and would consume the young plant just as it emerged in spring, the same way asparagus is harvested. Between the Carolingian era and the Reformation, hops grew in popularity only slowly and in select areas. At the time Martin Luther presented his 95 theses, gruit was more common in certain areas and taxed by the Catholic Church. So when the Reformation began, some of these regions switched to hops in protest and it became so popular it currently is used in the vast majority of all beer brewed.^{13,4}

Hops contribute to beer through the resins in the female plant's flowers. When extracted during boiling of the wort (the liquid containing malt sugars that yeast will subsequently convert to alcohol), these resins prevent the growth of various bacteria and fungi, helping to preserve the beer. As beer often was consumed as a safe alternative to water, hops allowed the production of beer with a lower alcohol content, helping to give rise to the "weak" beer early U.S. settlers and their children could drink throughout the day. In fact, a major reason the Pilgrims settled for Plymouth Rock instead of searching



Hops (*Humulus lupulus*) belong to the hemp family of plants. Each plant produces either male or female flowers, but only the unfertilized female flowers produce quality resin. While they look like vines, they are technically called bines, as they use stout stems for climbing. Because it is a perennial, a single hop plant may live for decades. A hop plant with superior genetics can be cloned by removing one of its rhizomes and planting it elsewhere.

for a better location was that they were out of beer.⁴ When English soldiers were transported by ship to India in the 18th century, they found the beer would often spoil before reaching their destination. The solution was to add more hops, and this beer was given the name 'India Pale Ale' and became the IPAs craft beer drinkers cherish today.

Brewers eventually learned that different varieties of hops could give rise to distinct tastes, leading to the wide variety of beers available today. The famous Pilsners in the Czech Republic rely on the Saaz variety of hops. The noble hops class are the traditional varieties of hops used to make early European beers and includes: Hallertau, Saaz, Spalt and Tettnang. America's greatest contribution to beer is arguably the 'Cascade' hops developed by Oregon State University and released in 1972, used today in many pale ales. As the flavor of hops extends partly through its aroma, and because there are an endless number of possible aromas, hops today serve as a foundation for new beer recipes.

Growing Hops

The first commercial production occurred in the New Netherlands in 1629, reaching Virginia in 1649 and the west coast in the 19th century¹⁴. In 2019, the majority of commercial hops were grown in Washington, Idaho and Oregon⁵.

Hops are typically planted from an underground stem cutting called a rhizome³. Seeds are not preferred because they provide less uniformity and ripening time will vary³. Plus, the genetic uncertainty of hops grown from seed means brewers cannot predict in advance how the beer will taste. You cannot plant the seed of a 'Cascade' hop and expect it to always have the taste characteristics of its parents. The first step to growing hops is identifying which of the more than 120 varieties you want to plant. Choose a variety based on taste preferences (if you will be brewing and consuming your own beer), the ease of finding the rhizome and what will grow best in your location. The [USDA](#) provides detailed descriptions of available hop varieties⁶.

Hops are grown commercially in two different ways, either on poles or on wires³. Most commercial operations use the wire trellis system, where wires are run over poles or stakes for about 18 feet³. Without commercial aspirations, the home grower can use any method that works in their space, keeping in mind that hop plants can live 25 to 50 years⁷. The best location is sunny, well-drained soil and some shade during the hottest hours of the afternoon to prevent scorching⁷.

In the research, the hops grew up a water tank already located on the property and proliferated despite little care. The water tank is one example of how using existing structures can decrease the supplies needed to begin growing hops.

Hops' ability to climb a variety of surfaces and their interesting green flowers means they can be used as a decorative landscape ornamental as well. Households building arbors in their yard for shade may find hops an ideal plant for quickly covering the structure. Though the aerial parts of the plant die in the winter, hops are perennials and are one of the first plants to emerge in the spring, climbing quickly from last year's dead stems. It is said that bamboo is the only plant that grows faster than hops.¹²

Hops actually have a long history of being used for decoration. In the Russian novel *Quiet Flows the Don*, hops are described being used as decoration for weddings and in Ukrainian weddings today the newlyweds are sometimes showered with hops for good luck. Another use is drying the vines with the flowers and using it as a garland for indoor décor.

Once the location has been established, you need to prepare the soil. Hops prefer a soil with a pH between 6.0 and 7.5. If unsure of the soil pH, contact your [local Extension office](#)⁸ for more information on soil testing and advice on correcting the pH, if needed. The research hops did not require additional fertilization and no pest problems were observed in its four years of growth. Individual experiences will differ, with some areas requiring additional fertilizer or pest control to be successful. Once the pH is determined and corrected, plant the rhizomes carefully so the shoots are pointing upwards. Rhizomes should be planted 3 to 5 feet apart⁷. It is recommended that mycorrhizal inoculum is included in the hole with the rhizome to aid in nutrient uptake⁷. Training begins when the hops are about 2 feet tall³. Twine can be used to help the vines grow in the desired way, for example up an established pole or structure³. Coir or jute are common materials used

for hop twine. (Note: while hops are actually 'bines' it is more common to call them 'vines'). Once the vines have been trained, a procedure called stripping (removing the lowest pair of leaves) is traditionally done to help prevent the spread of downy mildew³. Hops in the Pacific Northwest typically require 24 to 28 inches of water per growing season⁹. The amount of water your hops need will depend on how much rainfall is received and the requirements of the variety chosen. Hops are typically fertilized at the first sprout, two weeks later, at mid-summer and the beginning stages of flowering⁷.

While these directions should be followed carefully if growing commercially, hops will grow in a wide variety of soils and locations with little care. In fact, the most difficult part of growing hops can be keeping it from spreading to other areas as their rhizomes naturally spread out and will produce new hop plants. Left unattended, they can quickly take over an area and smother other plants. Although hops can be harvested in year one, a more mature plant is likely to be hardier and have greater productivity.

Hop Harvest and Preparation

Hops should be picked once they are fully mature³. Lupulin, a gland which contains the essential oil, is not fully developed in unripe hops and they will contain less resin and essential oil³. Ripe hops are usually bright green, aromatic, sticky and crisp or papery to the touch³. The leaves may be starting to turn slightly brown, but do not wait for lots of brown leaves to appear. Once hops are mature, remove all the hops from the vine. Be sure to use gloves and long clothing as some people may become irritated from the plant.

One method of brewing called 'wet hopping' involves adding the hops to the wort as soon as it is harvested. Otherwise the hops will need drying to preserve freshness until it is used. Freshly picked hops contain between 76% to 84% moisture and must be dried to approximately 8% to 10% moisture for storage⁹. Most hops will be made into pellets and frozen after drying, but this is not necessary⁷. There are many options for drying including ovens, kilns, racks and dehydrators⁷. An electric dehydrator was used to dehydrate hops in the research.



Harvest when the hop cones are dry and slightly starting to turn brown. Dry a sample in a dehydrator until all moisture is gone. You can then calculate how long the total amount should remain in the dehydrator to reach a desired moisture content of 8% to 10%. Freeze until used.

<i>Item</i>	<i>Cost per unit</i>	<i>Total number of units</i>	<i>Total Cost</i>
Hop posts or trellis*	A (\$/post)	B (number of posts)	A*B
Soil test	C (\$/test)		C
Chemicals to correct soil imbalances	D (\$/chemicals)		D
Rhizome	E (\$/rhizome)	F (number of rhizomes)	E*F
Fertilizer	G (\$/lb)	H (number of lbs needed)	G*H
Water	I (\$/Gallon)	J (number of gallons needed)	I*J
Dehydrator*	L (\$/item)		L
Gardening supplies such as gloves, shovels, trimmers etc.	M (\$/item)		M
Total Cost	= (A*B)+C+D+(E*F)+(G*H)+(I*J)+L+M		

*Indicates optional item or item you may already own.

Research project budget

<i>Item</i>	<i>Cost per unit</i>	<i>Total number of units</i>	<i>Total Cost</i>
Hop posts or trellis*	\$35.98 16-foot 4X4	1 post	\$35.98
Soil test	\$11.70	1 test	\$11.70
Chemicals to correct soil imbalances	\$0	0	\$0
Rhizome	\$6.99	2 rhizomes	\$13.98
Fertilizer	\$0	0	\$0
Water	\$0.0006	12 gallons	\$.01
Dehydrator*	\$0	0	\$0
Gardening supplies such as gloves, shovels, trimmers etc.	\$7.98 (twine)	1 ball 219-foot of twine	
	\$3.98 (gloves)	1 pair of gloves	
	\$12.98 (pruner)	1 pruner	\$24.94
Total Cost			\$86.61

Your budget

<i>Item</i>	<i>Cost per unit</i>	<i>Total number of units</i>	<i>Total Cost</i>
Hop posts or trellis*	____ (\$/post)	B (number of posts)	_____
Soil test	____ (\$/test)		_____
Chemicals to correct soil imbalances	____ (\$/chemicals)		_____
Rhizome	____ (\$/rhizome)	____ (number of rhizomes)	_____
Fertilizer	____ (\$/lb)	____ (number of lbs)	_____
Water	____ (\$/gallon)	____ (number of gallons)	_____
Dehydrator*	____ (\$/item)		_____
Gardening supplies such as gloves, shovels, trimmers etc.	____ (\$/item)		_____
Total Cost	_____		_____

Achieving this targeted moisture content requires a few calculations. First, place a sample of hops in a bag and weight it. This is the 'wet weight' and suppose it is 50 grams. Place the bag in the dehydrator and proceed, weighing it regularly. Once the bag reaches its minimum weight (its 'dry weight')¹⁰ its moisture content is zero and thus the moisture content of the original sample before drying can be calculated as:

$$MC + 100 - \frac{\text{dry weight}}{\text{wet weight}} \times 100$$

For example, if the dry weight (not including the weight of the bag) is 10 grams, the original moisture content was:

$$100 - \frac{10}{50} \times 100 = 80\%$$

To dry a batch of hops take another 50-gram sample of fresh hops, place it in a bag and dry it along with a batch of hops. Weigh this sample regularly until its weight equals (subtract out the weight of the bag):

$$1 - \frac{\frac{10 \text{ grams}}{(\text{targeted moisture content})}}{100} = \frac{10 \text{ grams}}{1 - 0.08} = 10.869$$

Once drying is complete, the hops should be refrigerated or preferably frozen, but can be stored at room temperature for a while without losing much quality. Vacuum sealing prior to refrigeration or freezing also is a good preservation procedure.

Brewing with Hops

Brewing entails extracting sugars from the malt by dissolving it in warm water, producing a mixture referred to as a wort. The wort is then boiled for at least one hour to kill all microorganisms, then cooled. Yeast is added to convert the sugars into carbon dioxide and alcohol. The carbon dioxide leaves as a gas, while the alcohol remains.¹³

For almost all beers, hops are added at two stages of the wort boil. 'Bittering hops' are added at the beginning, because it takes about an hour of boiling to properly convert the resins of the hops into the compound perceived as bitter. These hops will only provide a bitter taste. Any aromas the hops may have will have dissipated. 'Aromatic hops' are added in the last few minutes of the boil. Because the resins are not converted to the bittering compound, the aromas will remain in the liquid. These hops imbue the wort with a variety of aromas that remain until consumption. For example, a pale ale recipe may call for 'Centennial' hops at the beginning of the boil and 'Cascade' hops at the end—one hop variety chosen for its desirable bitterness qualities and the other for its desirable aromas.

A number of other hopping practices can be used. Dry hopping involves adding hops after the boil is complete and after the beer has fermented. Wet hopping, mentioned previously, involves adding freshly picked hops and may be added

at any time during the brewing process. For the research, Iron Monk Brewery used a combination of different malted grains consisting mainly of barley. Once the malt and water boiled for roughly an hour, the dried hops were added in combination with some pelleted hops. Although the exact style of beer created is unknown, as it is an experimental beer, it is likely to have many characteristics of a doppelbock.

Simple Budget

Please note this is a simple budget for the first year of an at-home hop project. More extensive commercial hop enterprise budgets are available through [MSU Extension](#)¹¹, [University of Nebraska Extension](#)¹⁵ and [NCSU Extension](#)¹⁶.

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