

# Hops

## Introduction

Hop (*Humulus lupulus*) is an herbaceous plant with a perennial crown and annual climbing stems. The crowns can survive for 25 years or more; however the fast growing vines (or bines) die back to the ground each winter. Vines can reach a height of 15 to 30 feet in a single growing season. Hops are valued for its female cones which contain the resins and essential oils used to provide the distinctive flavor and aroma to beer.

Hop is a largely untested crop for Kentucky, so prospective growers would be wise to proceed cautiously. Interested growers should start small, planting at least several different cultivars in trial plantings. Larger plantings should not be attempted until the crop has been evaluated over several seasons and growers have test-marketed their product.

## Marketing and Market Outlook

Major U.S. breweries generally purchase domestic hops from wholesale brokers. This market is usually only available to producers who can supply large quantities of hop cones. However, the increasing numbers of microbreweries and brewpubs in the U.S. has created a potential market for small growers. Microbreweries are smaller breweries that produce less than 15,000 barrels annually and typically sell their product off-premises. Brewpubs, on the other hand, are small breweries that are connected with a restaurant and/or bar. Both generally produce specialty or craft beers, often with regional appeal. The



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small-scale grower may be in a good position to provide these specialty breweries with the desired cultivars of high quality, freshly harvested or processed hops not currently available to the small brewery. Hop varieties are selected based on their essential oil content, alpha acid content, and aroma. Direct sales to these smaller breweries will generally require establishing an on-going business relationship from production to harvest. Growers with small acreages could also market their product directly to home brew shops, hobby brewers, and specialty stores.

The increased popularity of organic products has also fueled the demand for organic beer. It has been reported that sales of organic beers are booming nationwide, often at a rate faster than the organic industry as a whole. Organic hops production has not been able to keep up with demand from organic brewers. Organic pricing may be as much as three times that of the conventionally grown product. Certified organic growers may be able to take advantage of this flourishing industry.



Traditionally, dried hops have been used in making beer; however, a recent trend in brewing with fresh hops has created a demand for a non-processed product. Processing and storage of at least some of the crop, however, can extend the market season for small-scale producers.

While most hops are grown for making beer, some innovative growers have developed other markets for hops. A grower in New York uses the cones to make soap, condiments, and snacks that are sold on-line and at an on-farm store. After cone harvest, vines can be made into seasonal wreaths and sold to craftsmen, artisans, and craft stores. The vines have also been used for their fiber in paper and cloth production. The reported mild sedative quality of hop cones has been exploited in making pillows and teas for the treatment of insomnia.

## **Production Considerations**

### *Site selection and preparation*

Planning a hop yard can be likened to planning an orchard because of the long term nature of the enterprise. Although hops plants may survive 25 years or more, growers often choose to re-plant after about 10 to 15 years. Because of the longevity of the hopyard, careful thought and preparation needs to go into selecting and preparing a suitable site.

Select a fertile, well-drained, sunny site with access to water for drip irrigation. Hops require plenty of water during the growing season, but it is critical to avoid wetting the plants themselves due to some potentially devastating disease problems. While winds in the spring to mid-summer provide good air circulation and thus allow plant foliage to dry, winds later in the season can damage the ripening cones. Therefore it is important to situate the planting with the prevailing winds to your advantage. If necessary, wind breaks can aid in preventing excessive cone injury.

Fields should be well-prepared the year prior to planting the yard by improving the soil and controlling weeds. This is also the time to set up the trellis system.

### *Trellis system*

Hops must be grown on a trellis system to obtain high yields. Vines growing vertically produce more flowers than those growing horizontally; thus, taller trellis systems result in more vertical plant growth and, therefore, more flowers. The overhead trellis system is most often used for commercial production, particularly in hopyards over one-half acre. This elaborate 16- to 18-foot high system consists of a number of wooden poles buried 3 feet into the ground approximately every 5 plants. Cedar poles are most frequently used; however, fir or pine poles treated with a preservative are also common. Since organic growers can not use treated poles, the end buried in the ground is charred prior to installation to retard decay.

The poles are connected by overhead wire cables that run both down and across the rows. Edge poles, which are generally thicker than interior poles, are installed at a 60- to 65-degree angle outward. Guy wires attached to edge poles are securely fastened to deep-set anchors in the ground. Approximately 55 poles are required per acre.



EDGE POLES AND 18-FOOT TRELLISED HOP PLANTS IN OREGON.

Horizontal trellising involves the use of relatively short (8- to 9-foot) poles that are set in each planting hill. The hops vines grow vertically up each pole and then horizontally along the twine that connects the tops of the poles. However, since hops cones are mainly produced on the vertically growing portion of the plant, lower yields can be expected with this trellising method.

A single pole trellising system that has been used with some success for backyard production and small hopyards is the tent training system. It consists of a central pole around which several hops are planted in a circle. Supporting twine attached to the top of the pole extends down to each crown, thus giving the appearance of a 'teepee.' A dense clumping of cones is produced at the peak of the 'teepee' with this method.

Research into the production of hops on lower trellises is underway in several states. These systems require varieties that have been bred for their shorter vine growth. Several dwarf cultivars have been developed in Europe; however, there are currently few American dwarf varieties available for commercial production. Breeding programs in the Pacific Northwest are expected to result in additional varieties suitable for low trellis production.

Setting up the trellis system, which is quite time consuming, should be accomplished prior to planting. The poles can be installed with a hand or motorized auger. It is critical to place the poles deep enough to avoid trellis collapse. Poles will need to be replaced approximately every 5 years.

#### *Cultivar selection*

There is currently no local research data upon which to base cultivar recommendations for hops in Kentucky. Some of the cultivars that have been grown successfully in backyard plantings include Willamette, Cascade, and Centennial. Summit is a dwarf hop bred for U.S. production; however, its performance in Kentucky is unknown. Observations from local home growers, as well as research from neighboring states, may reveal additional cultivars suitable for trial plantings here. When selecting varieties, consideration needs to be given to winter hardiness, disease resistance, and the hops qualities required by the buyer. Choosing cultivars with high disease resistance to downy mildew and powdery mildew should be an important consideration for organic producers.

#### *Propagation and planting*

Hops are vegetatively propagated using rhizomes or runners produced by the crown. Because only female flowers are used in brewing, only rhizomes from female plants are propagated and planted. Rhizomes may be purchased from a reputable supplier or removed from an established planting. New plants are started from 6- to 8-inch rhizome pieces bearing buds. Rhizomes can be potted-up in a greenhouse or hoop house prior to planting in the field. Some growers initially plant the rhizomes in a nursery bed, and then transplant them to the field the following year. Organic growers report difficulty in locating organic planting stock in the varieties they require.

Fields should be well-tilled and weed-free prior to planting. Hops rhizomes are planted in hills as early in the spring as possible. Some growers ditch the area between the rows instead of planting in hills. Plant spacing preferences vary; however, yards are generally planted with approximately 900 plants per acre. Composted material should be added to each planting hole and plants well-watered. Organic mulch surrounding the crowns can be used to control weeds and conserve soil moisture.

In the overhead trellis system, two to four lengths of biodegradable twine are attached from the overhead cable to each crown as a support for the growing vines. Coir (made from coconut fiber) and untreated sisal twine are the most commonly used materials. Once shoots have reached a height of 2 feet, several of the most vigorous shoots are selected for trellising and the remainder removed. Two vines will be trained to wind clockwise up each of the twine supports.

#### *Crop management*

Spring maintenance in an established hop yard consists of root pruning crowns, pruning out the diseased and less vigorous shoots, securing new twine to the cables, and training the selected vines. Spring is also the time when rhizomes can be divided to start additional plantings.

Summer activities include scouting the yard regularly for pests and diseases, pruning out unwanted new shoots, managing weeds, and irrigating. In addition, the trellis itself could require annual maintenance, such as tightening cables.

After harvest, all vines should be removed from plants prior to winter. The harvested vines can be shredded for mulch or composted; however, diseased vines should be destroyed.

#### *Pest management*

Pest problems and their levels are unknown for commercial hops grown in Kentucky. The following information is based on reports from other states.

Downy mildew and powdery mildew have a history of causing serious damage in all the hops growing regions of the U.S. The development of improved varieties with resistance to downy mildew has helped to reduce this threat. Cultural practices, such as sanitation, avoiding heavy nitrogen fertilization, improving air circulation, and the judicious use of fungicides may also help to manage these diseases. Fields with a history of the soil-borne *Verticillium* wilt disease occurring on brambles, eggplant, potatoes, tomatoes, or strawberry should be avoided. Other potential disease problems include *Sclerotinia* wilt and *Cercospora* leaf spot. Hop plants and cones are attractive to a number of insect pests including aphids, spider mites, wireworms, root weevils, corn earworms, and cutworms. Scouting to monitor populations can help the grower determine when and how often insecticides should be applied. The hopyard should be as weed-free as possible prior to planting and weeds need to be kept under control with mulch and/or regular cultivation.

#### *Harvest, packaging, and storage*

It normally takes 2 to 3 years for hops to come into full production. Large acreages of hops are mechanically harvested with very specialized equipment. Small acreages are generally hand-

harvested by either removing individual cones as they mature or by cutting entire vines in a once-over-harvest. Picking from the trellised vines will require a ladder or cherry picker. For a once-over-harvest, vines are cut at the ground first. The hanging vines are then removed from the overhead wires and carted to the harvest area.

Hops harvest season begins in August and ends in September, depending on the variety and location. Determining when the cones are ripe involves cone appearance, feel, and smell. Hops are harvested when they are most aromatic and the cones are just beginning to feel dry. Color can be another indicator of ripeness; hops fade in color from a bright green to a paler green as they mature. Sunburn, wind injury, and disease can cause the cones to become discolored or streaky; these cones are unacceptable. Ripe hop cones have a harvest window of approximately 5 to 10 days.

Hop cones need to be dried for markets requiring a processed product and/or for storage. Curing is accomplished using an even supply of heat along with good air flow. Once dry, cones are cooled for packing/processing. To prevent the rapid deterioration that can occur in the presence of light, oxygen, and warm temperatures, dried cones may be vacuum-packed in opaque bags and stored in a cooler (below 40°F). Larger breweries prefer baled or pelleted hops, which will require further processing.

#### *Labor requirements*

Hops production is very labor intensive with the majority of activities in the spring and at harvest. Labor is required for planting, root pruning, digging rhizomes, stringing vines, and harvest. Many aspects of this enterprise, such as harvest, require skilled labor.

Labor needs per acre are approximately 30 hours for production, 70 to 150 hours for harvest, and 50 to 100 hours for packing/grading. Labor needs depend on the extent to which mechanization is used in harvest.

## Economic Considerations

Hop production can be both profitable and risky. The largest investments in hop production include the purchase and set-up of the trellis system, as well as the purchase of plant material. Other start-up costs include land preparation and installation of an irrigation system. Establishment costs for one acre of hops using a high trellis system are estimated at \$5,300 per acre for 2009.

Production costs for irrigated hops production are estimated at \$1,800 per acre, with harvest and marketing costs at \$1,250 per acre. Note that hops postharvest processing and marketing could range considerably more than this estimate. Total expenses per acre, including both variable and fixed, would come to approximately \$4,800. Presuming gross returns of \$4,960 per acre, returns to land, capital, and management would be approximately \$160 per acre. This assumes a price of \$2.50 per pound for hops. Hops prices have been highly variable in recent years.

Since returns vary depending on actual yields and market prices, the following per acre returns to land and management estimates are based on three different scenarios. Conservative figures represent University of Kentucky estimates for 2009.

PESSIMISTIC (\$1.40 per lb)	CONSERVATIVE (\$2.50 per lb)	OPTIMISTIC (\$4.00 per lb)
\$(2,185)*	\$ 160	\$ 1,200

\*Parentheses indicate a negative number, i.e. a net loss.

## Selected Resources

- Alternative Field Crops Manual: Hop (University of Wisconsin & University of Minnesota, 1990)  
<http://www.hort.purdue.edu/newcrop/afcm/hop.html>

- Commercial Organic Hops Production Trial (SARE Farmer/Rancher Project, 1999)  
[http://www.sare.org/reporting/report\\_viewer.asp?pn=FNE98-195&ry=1998&rf=0cfm?fuseaction=hop\\_farming&pageID=2](http://www.sare.org/reporting/report_viewer.asp?pn=FNE98-195&ry=1998&rf=0cfm?fuseaction=hop_farming&pageID=2)
- Diseases and Pests of Hops (Cornell University) 7 MB file  
<http://www.nysaes.cornell.edu/pp/extension/tfabp/present/hopsrev/frame.htm>
- Foothill Hops (*commercial hops farm in NY*)  
<http://www.foothillhops.com/Index.html>
- Hop Cultivar Descriptions (USDA-ARS)  
<http://www.ars.usda.gov/pandp/docs.htm?docid=14772>
- Hops: Organic Production (ATTRA, 2005)  
<http://attra.ncat.org/attra-pub/hop.html>
- Hops Trellising and Budgets (Colorado State University, 2008) 9.7 MB file  
[http://soilcrop.colostate.edu/godin/pdf\\_files/Hop\\_Trellis\\_Budget.pdf](http://soilcrop.colostate.edu/godin/pdf_files/Hop_Trellis_Budget.pdf)
- Lower Hop Trellises for Higher Profits (USDA-ARS, 2008)  
<http://www.ars.usda.gov/is/pr/2008/080110.htm>
- Market for Northeastern-Grown Hops (Cornell University & Northeast Hop Alliance)  
<http://media.cce.cornell.edu/hosts/agfoodcommunity/fap/NeHAFinalReport.pdf>
- Northeast Hop Alliance  
<http://www.northeasthopalliance.org/home.html>
- Oregon Hops Commission  
<http://oregonhops.org/index.html>
- Small Scale and Organic Hops Production (Left Fields, British Columbia)  
<http://www.crannogales.com/HopsManual.pdf>
- Sustainable Hop Growing Workshop (Colorado State University, 2008) 1.7 MB file  
[http://tri-river.ext.colostate.edu/Sustainable\\_Hop\\_Growing\\_Workshop\\_2008/Growing\\_Hop\\_Ron\\_Godin.pdf](http://tri-river.ext.colostate.edu/Sustainable_Hop_Growing_Workshop_2008/Growing_Hop_Ron_Godin.pdf)

*The inclusion of a commercial Web site as a resource does not represent an endorsement of the company or its products by the University of Kentucky.*

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*Photos courtesy of Win Dunwell (hopyard) and Dewayne Ingram (hop cones), University of Kentucky*

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