UNIVERSITY OF KENTUCKY
College of Agriculture, Food and Environment

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT
Center for Crop Diversification Crop Profile

Hops

Cheryl Kaiser[1] and Matt Ernst[2]

Introduction

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

The University of Kentucky Robinson Center for Appalachian Resource Sustainability initiated a hops research project in 2011; however, this crop is still largely untested for commercial production in Kentucky. Interested growers should contact the Horticulture Program at the Robinson Center for the latest research information. As with any new enterprise of this nature, prospective growers would be wise to proceed cautiously by starting small. Larger plantings should not be attempted until the crop has been evaluated over several seasons and the product has been test-marketed.

Marketing and Market Outlook

Hops have a limited, yet potentially profitable market in Kentucky. 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 number 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

Hop cones

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 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 otherwise available to the small brewery. 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 faster rate than the organic industry as a whole. Organic hop production has not been able to keep up with demand from organic brewers. Organic pricing may

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[1]Cheryl Kaiser is a former Extension Associate with the Center for Crop Diversification.
[2]Matt Ernst is an independent contractor with the Department of Agricultural Economics.

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 online and at their farm store. The reported mild sedative quality of hop cones has been exploited in making pillows and teas for the treatment of insomnia. After cone harvest, bines can be made into seasonal wreaths and sold to craftsmen, artisans, and craft stores. The bines have also been used for their fiber in paper and cloth production.

Site selection and preparation

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

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

Hops must be grown on a trellis system to obtain high yields. Bines 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 of more than 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 five plants. Cedar poles are most frequently used; however, fir or pine poles treated with a preservative are also common. Because

Hopyard trellis system

organic growers cannot 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, although some growers just run the wires down 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. Horizontal trellising involves the use of relatively short (8- to 9-foot) poles that are set in each planting hill. The hop bines grow vertically up each pole and then horizontally along the twine that connects the tops of the poles. However, because hop 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 bine 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

The research trial at the Robinson Center is evaluating yield, disease resistance, and other characteristics of several hop cultivars (Chinook, Cascade, Mt. Hood, Nugget, and Newport). As of the 2012 growing season, Cascade had the top yield. Other cultivars that have reportedly been grown successfully in backyard plantings in Kentucky include Willamette 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 the first 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 hoophouse prior to planting in the field. Some growers initially plant 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. Hop 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; however, hilling is often easier. It is important to remove any possibility of standing water since hops can be susceptible to root rots. 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 bines. 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 bines will be trained to wind clockwise up each of the twine supports.

Crop management

Spring maintenance in an established hopyard consists of root pruning crowns, pruning out the diseased and less vigorous shoots, securing new twine to the cables, and training the selected bines. Spring is also the time when rhizomes can be divided to start additional plantings. In addition, the trellis itself could require annual maintenance, such as tightening cables. Summer activities include scouting the yard regularly for pests and diseases, pruning out unwanted new shoots, managing weeds, and irrigating. After harvest, all bines should be removed from plants prior to winter. The harvested bines can be shredded for mulch or composted; however, diseased bines should be destroyed.

Pest management

Mycosphaerella leaf spot has been diagnosed at the Robinson Center, and Japanese beetles have been observed feeding on leaves in research plots. However, the extent of pest problems and their levels are currently 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 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 removing individual cones as they mature. A ladder or cherry picker can be used when picking cones from trellised bines. Alternately, bines can be cut for a once-over harvest. UK researchers found that cutting the bines at shoulder height and pulling them down at harvest was quicker and easier than using a lift. Alternately, bines can be cut at the ground, which also entails removing hanging bines from the overhead wires. Cut bines are then carted to the harvest area where cones are removed.

Hop 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 hops 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 good airflow, and occasionally an even supply of heat is needed. Screen racks placed in a dark room with box fans for circulation is one possible setup for drying cones. 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

Hop 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 bines, weed management, 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 include the purchase and setup 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.

A North Carolina project estimated detailed production costs for small-scale (¼-acre) hops production in 2012. The total initial investment for ¼-acre was estimated at $6,500, with annual production costs at $3,350. The North Carolina budget estimated a breakeven price of about $35 per pound for 400 pounds of wet hops produced from ¼-acre. A link to this detailed production cost spreadsheet is included in the Selected Resources section below.

Commercial-scale hop production, such as that in the Pacific Northwest, can reduce establishment costs due to larger areas in cultivation. Costs for 1 acre of hops, based on a system of several hundred acres, using a high trellis system, were estimated at $5,300 per acre for 2012. These costs are much less than small-scale hop production because of the cost savings from large-scale production. Production costs for irrigated

hop production are estimated at $1,800 per acre, with harvest and marketing costs at $1,250 per acre. Note that hop 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. Hop 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 2012.

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

- Robinson Center for Appalachian Resource Sustainability
http://www2.ca.uky.edu/rcars/
- Alternative Field Crops Manual: Hop (University of Wisconsin and University of Minnesota, 1990)
http://www.hort.purdue.edu/newcrop/afcm/hop.html
- Commercial Organic Hops Production Trial, Project Number FNE98-198 (SARE Farmer/Rancher Project, 1999)
http://www.sare.org/MySare/ProjectReport.aspx?do=viewRept&pn=FNE98-195&y=1998&t=0
- Enterprise Budget: Small-Scale Commercial Hops Production in North Carolina (North Carolina State University, 2010)
http://www.ces.ncsu.edu/fletcher/programs/nchops/budget.html
- Estimated Cost of Producing Hops in the Yakima Valley, Washington (Washington State University, 2010)
http://cru.cahe.wsu.edu/CEPublications/FS028E/FS028E.pdf
- Foothill Hops (commercial hops farm in NY)
http://www.foothillhops.com
- Growing Organic Hops for the Local Market, Project Number FS09-237 (SARE Farmer/Rancher Projects, North Carolina, 2009)
http://www.sare.org/MySare/ProjectReport.aspx?do=viewRept&pn=FS09-237&y=2009&t=2
- Hop Cultivar Descriptions (USDA-ARS)
http://www.ars.usda.gov/pandp/docs.htm?docid=14772
- Hops: Organic Production (ATTRA, 2005)
https://attra.ncat.org/attra-pub/summaries/summary.php?pub=87
- Lower Hop Trellises for Higher Profits (USDA-ARS, 2008)
http://www.ars.usda.gov/is/pr/2008/080110.htm
- Market for Northeastern-Grown Hops (Northeast Hop Alliance & Cornell University)
http://www.newleafnet.com/docs/New_Leaf_Brief002_Hops_Market_Study.pdf
- Northeast Hop Alliance
http://www.northeasthopalliance.org/
- Oregon Hop Commission
http://oregonhops.org/index.html
- Small Scale and Organic Hops Production (Left Fields, British Columbia)
http://www.crannogales.com/HopsManual.pdf
- Sustainable Hop Production in the Great Lakes Region (Michigan State Univesity, 2010) *4.09 MB file* http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Sirrine-Sustainable-Hop-Production-in-the-Great-Lakes-Region.pdf

Webinars

- Hops 101, with Dr. Shawn Wright (University of Kentucky, 2015) http://video.ca.uky.edu/search/?q=hops&x=0&y=0
- Starting Up Small Scale Organic Hops Production (eXtension, 2011) http://www.extension.org/pages/60945/starting-up-small-scale-organic-hops-production

Podcast

- Farmer Scott Eidson discusses growing hops.
http://www.uky.edu/Ag/CCD/podcasts/hops.mp3

Commercial Web sites listed in the resources are provided for information purposes only and their inclusion does not represent an endorsement of the company or its products by the University of Kentucky.

Reviewed by Shawn Wright, Horticulture Specialist (Revised 2012)
Photos by H. Zell (hop cones), Wikimedia Commons, and Shawn Wright (hopyard), UK **November 2012**