

## Small-Scale Organic Hops Production

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E-Organic Webinar  
November 15, 2011



**MICHIGAN STATE UNIVERSITY** | Extension



## Outline

- History
- Natural History and Taxonomy
- Characteristics and Growth Habits
- Production and Growing Requirements
- Pests and Diseases
- Trellising and Processing
- Economics, Market Trends, Brewer Needs
- Research Trials
- Resources



## Hops Gain a Foothold in The U.S.

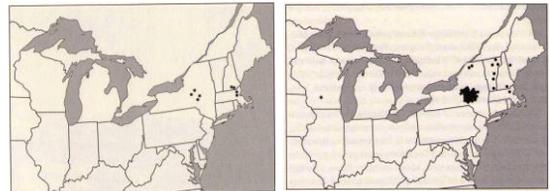
- Dutch probably 1st to bring hops to the New World in early 1600's
- Native hops could be found in woods, but Dutch law required hops to be imported
- New England colonists 1st to establish cultivated hops crops as early as 1628
- Massachusetts promoted "healthy" malted beverages
- Used imported, locally grown and wild hops

Source: *Tinged With Gold, Tomlan, 1992*

## Hops Gain a U.S. Foothold

1839

1859



Each dot represents 100,000 bales (1 bale = 200 lbs. dried hops)

Source: *Tinged With Gold, Tomlan, 1992*

## Hops Gain a U.S. Foothold

1879

1899



By 1920's majority of production had moved west

Source: *Tinged With Gold, Tomlan, 1992*

### HOPS ARE KING!

Wherever raised in the North-West.

JUST PUBLISHED--A Treatise giving Plain Directions and the Practical Details, from the selection and Preparation of the Soil and Setting and Cultivation of the Plants, to Pickling, Drying, Pressing and Marketing the Crop, as practiced in Sauk County, Wisconsin. Every Hop Grower and Farmer in the North-West should have one of these Pamphlets. By D. B. & E. O. RUDD, Practical Hop Growers of eight years' experience in said County.

Enclose Fifty Cents to GEORGE B. BURROWS, No. 100 State Street, Chicago, and he will send by return mail (post paid) a copy of this valuable work. Ten copies to one address, \$4.00; twenty copies to one address, \$7.50.

#### A HOP YARD

— IS —

### More Profitable than a Gold Mine.

The Hop Growers of Wisconsin have averaged for the past two years from \$700.00 to \$800.00 profit per acre.

Sauk County (Wis.) English Cluster Hop Roots for sale by

**Geo. B. Burrows,**

THE

### CULTIVATION OF HOPS,

PREPARATION FOR MARKET.

BY D. B. & E. O. RUDD.

SAUK COUNTY, WISCONSIN.

BERINGHAM, MASS. U.S.A.



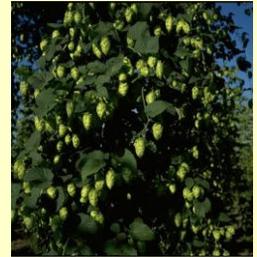
### Natural History and Taxonomy

- *Humulus* is the genus of herbaceous climbing plants that most likely originated in China, but is indigenous to temperate areas of the northern hemisphere including Asia, Europe, and N. America.
- *Humulus* is one of two genera in the Cannabinaceae family, the other being *Cannabis*.
- Though there are three distinct species *H. lupulus*, *H. japonicus*, and *H. yunnanensis* all commercial hops are of the *Humulus lupulus* (common hop) species.



### What are Hops?

- Hops are dioecious, perennial plants that produce annual bines from an overwintering rhizome
- Trichomes
- Only the female flower "strobile" or "cone" is desirable for use in beer production
- Cones (0.5-4 in.) light green, papery, contain Lupulin glands, home to alpha and beta acids, and essential oils



### Lupulin

- Essential oils: contribute to aroma
- Soft resins: beta acids, and the all important alpha acids.



**Hop Propagation from rhizomes**

Rhizomes: horizontal underground stem that emerges from plant roots



### Site and Soil Requirements

- Hops require long day lengths
- Specific chilling requirements (winter temperatures below 40 °F for 1-2 months) that are rarely satisfied below 35 degrees latitude.
- Climate: minimum of 120 frost free days
- Full day sun (8+ hours)
- Good air circulation and drainage to avoid mildew problems
- Sandy loam or well-drained loamy soil
- Poorly drained, strongly alkaline or saline soils should be avoided
- Very shallow bedrock and very shallow water tables to be avoided

### Planting, Thinning, Training, Stripping

- Planted in spring
- Spacing and plants per acre
- Thinning
- Training-Two bines trained up each of the two coconut fiber support strings in a clockwise direction
- Stripping at 7-8 ft, the lowest 2-3 feet of leaves and lateral branches are generally removed (stripping)
- Stripping can be accomplished manually, chemically, or with livestock





## Hop Growing Requirements: Fertility

- Soil Test Before planting
- Tissues Tests and Soil tests
- Recommended fertilization rates:
  - Nitrogen (N) = 120-140 lbs/acre
    - Mid-April with urea (40-0-0) every 2-3 weeks then later come in with triple 16
    - End in late-June
    - No more than 25 lbs/acre at one time
  - Phosphorous (P) = 60-100 lbs/acre
  - Potassium (K) = 100 lbs/acre (potash)



## Organic Hop Growing Requirements: Fertility

### Options

- Manure and compost
- Leguminous cover crops
- Bone meal, feathermeal, bloodmeal, kelp, etc.



## Hop Growing Requirements: Irrigation

### NWMHRS

- RAM Pressure compensating with emitters (.42 g/hour) every 2 ft.
- May-September
- AT LEAST 4 HOURS/DAY & UP TO 8 HOURS PER DAY

### MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY  
SOIL AND PLANT NUTRIENT LABORATORY  
EAST LANSING, MICHIGAN 48824-1325  
(517) 355-0218

SOIL TEST REPORT FOR:				CONSULTANT:			
RUB THORNE SUITE 107 8327 E. GOVERNMENT CENTER DR. SUTTONS BAY MI 49882				LELAND COUNTY MUSE 8327 E. GOVERNMENT CENTER DR., #107 SUTTONS BAY MI 49882 231-256-9888			

DATE	LAB #	COUNTY	Previous Crop	ACRES	FIELD ID	SOIL
7/29/2009	10894	Leelanau	Cherry	1/2	Hops	Mineral

SOIL NUTRIENT LEVELS		Below Optimum	Optimum	Above Optimum
Soil pH 6.8	Limit Index			
Phosphorus (P)	100 ppm			
Potassium (K)	102 ppm			
Magnesium (Mg)	114 ppm			

ADDITIONAL RESULTS:		Optional Tests:						
Calcium (Ca) (ppm)	CEC (cmey100g)	% of Exchangeable Bases	Micronutrients (ppm)				Organic Matter %	Nitrate-N (ppm)
668	4.6	K Mg Ca	B	Cu	Mn	Zn	Fe	
		5.7 20.9 73.4						

RECOMMENDATIONS:		Tillage Depth: 6 inches	
Limestone: NONE	Target pH = 6.5	% Stand: 25	

Year	Crop	Expected Yield	Plant Nutrients:				Micronutrient (Optional)			
			Nitrogen (lb N/A)	Phosphate (lb P <sub>2</sub> O <sub>5</sub> /A)	Potassium (lb K <sub>2</sub> O/A)	Boron (lb B/A)	Manganese (lb Mn/A)	Zinc (lb Zn/A)	Copper (lb Cu/A)	
1	Barley	70 lbs	45	0	20	0.0				

## Pests and Diseases

- **Hop aphid** (*Phorodon humuli*)
- **Downy mildew** (*Pseudoperonospora humuli*)
- **Spider Mites** (*Tetranychus urticae*)
- **Powdery mildew** (*Podosphaera macularis*)
- **Apple Mosaic Virus**
- **Hop Stunt Viroid**






## Spider Mites

- Spider mites damage hop plants by feeding on leaves and cones, sucking plant juices from the cells-bronzing of leaves and reduces plant vigor
- Monitor weekly beginning in mid to late May.
- Provide plants with adequate but not excessive nitrogen fertility and water.
- Reduce dust, especially in hot dry weather.
- Treat to prevent cone infestations using foliar-applied miticides.
- Avoid the use of pyrethroid, organophosphate, carbamate, and Neonicotinoid insecticides, and late-season sulfur applications.
- Can treat when average of one to two female spider mites per leaf in June and early July, or five to 10 mites per leaf after mid-July. But hop plants can tolerate much higher twospotted spider mite populations without suffering economic loss if cones are not infested.
- Spider mite populations can build rapidly, especially in hot, dry conditions, therefore monitoring is important.

Other options

- Prune extra bines in early May, stripping
- If the hops are in the burr stage, a lime sulphur spray may be applied to the whole plant.
- Predaceous insects-Arthropod Bugs/Predatory mites

Source: <http://pm.wsu.edu/files/pdf/HopHandbook2010.pdf>



Twospotted spider mites. (D. G. James)



Spider mite webbing is associated with severe infestations. (D. G. James)



## Aphid control

Aphids (*Phoradon humuli*) – but other aphids as well.

- Biological control-Ladybird beetles, Lacewing, Aphid Midge (*Aphidoletes aphidimyza*)
- Begin monitoring in May when daytime temperatures exceed 58 °F.
- Avoid excessive application of nitrogen.
- Intervene early to prevent aphid establishment in hop cones.
- Rotate chemical classes to avoid resistance.
- Use selective pesticides that preserve natural enemies.
- Monitoring should begin when daytime minimum temperatures exceed 58 to 60° F. A comprehensive economic threshold does not exist for hop aphid. Most growers apply a pesticide when an average five to 10 aphids per leaf are observed before flowering. Generally, aphids are not tolerated after flowering; control with pesticides is difficult once aphids infest cones.



Hop aphids on leaf. (D. G. James)

Source: <http://pm.wsu.edu/field/pdf/HopHandbook2010.pdf>



## Powdery Mildew

- Powdery mildew is caused by the fungus *Podosphaera macularis*
- Extremely readily spread at all stages.
- Good sanitation in the hopyard is key.
- Bines with signs of the infection should be cut and burned away from the hopyard before the hops shatter.
- Stripping off the lower leaves of the vines also helps get rid of any early spores
- Training and pruning the vines so that adequate sunshine and air are admitted to the entire plant will help control the outbreak of Powdery Mildew.
- Avoid heavy doses of nitrogen fertilizer or uncomposted manure- more succulent tissue is more susceptible
- Sulphur-based fungicides control this disease, and can be applied as soon as the first spots of mold are seen on the leaves.
- Works best as a protectant though
- Be careful that liquid sulphur formulations do not include wetting agents prohibited by organic regulations.



Powdery mildew. (D. H. Gent)



Cone with severe browning caused by late season infection by the powdery mildew fungus... (D. H. Gent)

<http://plant-disease.ipcc.corn.edu/>



## Downy Mildew

- The single most devastating disease in Western hopyards.
- Hop Downy Mildew (*Pseudoperonospora humuli*) is specific to hops.
- Typically first noticed as the young vines grow out in spring



Basal apices: Hop shoots systemically infected with the downy mildew pathogen. (D. H. Gent)



Dark brown discoloration of bracts and bracticles on cones severely affected by downy mildew. (B. Engstardt)



Infection of shoots after training. Notice the yellowing, stunting, and downcurling of the leaves. (D. H. Gent)



Angular leaf lesions on hop leaves. The black discoloration is due to sporulation by the pathogen. (D. H. Gent)



## Downy mildew

### Cultural control

- Prune crown before growth starts in the spring or burn back green tissue before training. Complete removal of green tissue or pruning of entire hill is necessary for most effective disease management.
- Remove diseased hills and mark for replanting.
- Train vines early to prevent them from coming in contact with soil.
- Begin suckering as soon as vines are strung. Continue at regular intervals until warm, dry weather prevails (June to July).
- Strip leaves from vines at a height of 4' soon after training to reduce the spread of downy mildew up the canopy.
- Avoid overhead irrigation, especially during and after burr development.
- Avoid over fertilizing with N
- Choose varieties that are resistant

### Chemical Control

- Copper based fungicides
- Make sure whatever you use is registered in your state
- GREENBOOK.NET

Variety	Usage	Disease Susceptibility		
		Powdery Mildew	Downy Mildew	Vermiliform Wilt
Brewers Gold	Bittering	S	MR	MR
Edison	Bittering	S	MR	R
Cascade	Aroma	MR	MR	MR
Cardinal	Bittering	MR	S	U
Chinook	Bittering	MS	MR	R
Columbia	Aroma	MS	MR	S
Conquest	Bittering	R	S	R
Crystal	Aroma	R	S	R
Black Kalm Drinking	Aroma	S	S	MR
First Gold	Bittering	S	S	MR
Fuggles	Aroma	MS	R	S
Galena	Bittering	S	S	R
Goliner	Aroma	S	S	U
Hall Gold	Aroma	MS	R	S
Hall Magnum	Bittering	S	R	MR
Hall Midealth	Aroma	MS	S	S
Hall Tradition	Aroma	MR	R	MR
Heron	Bittering	MS	S	MR
Lake Choke	Aroma	S	S	R
Liberty	Aroma	MR	MR	U
Mt Hood	Aroma	MS	S	S
Newport	Bittering	R	R	U
Northwest Brewer	Bittering	S	S	U
Nugget	Bittering	R	S	S
Olympic	Bittering	S	MS	R
Puma	Aroma	S	R	MR
Pioneer	Bittering	MR	MR	U
Razzer	Aroma	S	MS	S
Spencer SR	Aroma	S	MS	S
Spalter	Aroma	S	R	MR
Stirling	Aroma	MS	MR	U
Tamalete	Aroma	MR	MR	S
Tettnanger	Aroma	MS	MS	S
Willoughby	Aroma	S	S	U
U.S. Tettnanger	Aroma	MS	MS	S
Vanguard	Aroma	S	S	U
Victorville	Aroma	MS	MR	S

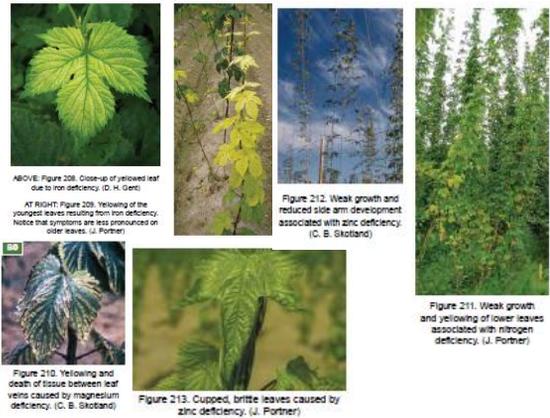
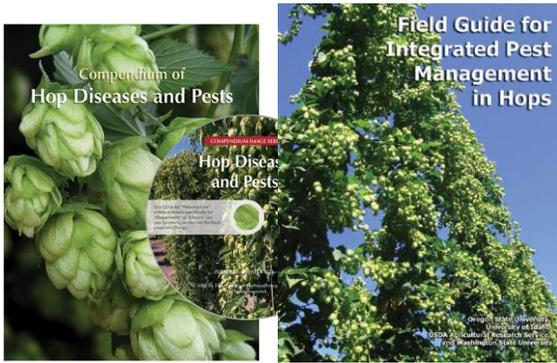
Based on PNW data

- S=susceptible
- MS=moderately susc.
- MR=moderately resist.
- R=resistant
- U=unknown



## New Zealand Example

- Organic producers use dried blood and bone and meal and bone fertilizers
- They also use liquid organic fertilizers
- Rock phosphate and lime (to lower acidity)
- Natural dolomite is used for Mg
- TSSM-controlled with predator mites
- Grass, oats, and clover in alleys-mow and blow into rows (oats mulched, then grass mowed every 5 days) clover feeds sheep and sheep also eat hop suckers.



ABOVE: Figure 208. Close-up of yellowed leaf due to iron deficiency. (D. H. Gent)

AT RIGHT: Figure 209. Yellowing of the youngest leaves resulting from iron deficiency. Notice that symptoms are less pronounced on older leaves. (J. Portner)

Figure 212. Weak growth and reduced side arm development associated with zinc deficiency. (C. B. Skotland)

Figure 211. Weak growth and yellowing of lower leaves associated with nitrogen deficiency. (J. Portner)

Figure 210. Yellowing and death of tissue between leaf veins caused by magnesium deficiency. (C. B. Skotland)

Figure 213. Cupped, brittle leaves caused by zinc deficiency. (J. Portner)



### Conventional High Trellis



### Important to build a Solid Trellis!!



### Short Trellis

- 3' x 8', 9', or 12'
- Labor Reduction
- Lower Establishment Cost
- Lower yields
- Ill-adapted varieties







## Global Trends

WORLD HOP ACREAGE & PERCENT SHARE (acres)

COUNTRY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Germany	46,965 33%	45,318 33%	40,879 32%	43,168 36%	42,404 34%	41,247 36%	41,376 34%	43,269 33%	43,802 33%	44,749 36%
UK-England	5,035 3%	4,681 3%	3,538 3%	3,354 2.7%	2,932 2%	2,609 2%	2,619 2%	2,718 2%	2,669 2%	2,669 2%
Czech Rep.	15,864 11%	14,735 11%	14,417 11%	14,420 12%	14,010 11%	13,109 12%	12,832 11%	12,664 10%	12,479 9%	12,398 10%
Europe (rest)	24,679 17%	23,616 17%	22,217 18%	20,666 17.20%	20,236 16%	19,253 17%	17,313 14%	17,236 13%	16,222 12%	16,186 13%
USA	35,891 25%	29,309 22%	28,669 23%	28,020 23.30%	29,188 24%	29,435 26%	30,911 25%	39,263 29%	40,126 30%	31,247 25%
China	11,884 8%	13,930 10%	13,931 11%	11,697 9.70%	11,846 10%	4,910 4%	13,912 11%	14,322 11%	14,322 11%	14,322 11%
World (rest)	4,139 3%	4,364 3%	3,211 3%	3,607 3%	3,354 3%	2,853 3%	3,047 2%	3,633 3%	3,991 3%	3,941 3%
World Totals	144,457	135,944	126,862	119,943	123,609	113,417	122,010	133,105	133,711	125,512

SOURCE: IHGC Economic Commission November 2010 report. Prepared by HGA.

U.S. HOP ACREAGE BY STATE (10 YEARS - IN ACRES)

YEAR	WASHINGTON	OREGON	IDAHO	TOTAL
2001	26,339	6,103	3,469	35,911
2002	20,333	5,577	3,399	29,309
2003	19,492	5,748	3,429	28,669
2004	19,382	5,107	3,253	27,742
2005	21,013	5,163	3,287	29,463
2006	21,532	5,036	2,797	29,365
2007	22,745	5,270	2,896	30,911
2008	30,595	6,370	3,933	40,898
2009	29,588	6,108	4,030	39,726
2010	24,336	4,622	2,331	31,289

U.S. AVERAGE HOP YIELD (TEN YEARS)

YEAR	POUNDS PER ACRE			TOTAL U.S.
	WASHINGTON	OREGON	IDAHO	
2001	1,928	1,875	1,329	1,861
2002	2,133	1,692	1,624	1,990
2003	2,050	1,636	1,536	1,903
2004	2,137	1,686	1,558	1,990
2005	1,878	1,560	1,640	1,796
2006	2,058	1,757	1,613	1,964
2007	2,049	1,811	1,417	1,949
2008	2,072	1,569	1,841	1,971
2009	2,533	1,948	1,943	2,383
2010	2,147	1,791	2,129	2,093

U.S. HOPS: SEASON AVERAGE PRICE & TOTAL CROP VALUE

Marketing Year	SEASON AVERAGE PRICE				U.S. Production (Lbs. x 1,000)	Total Crop Value (x 1,000)
	Washington	Oregon	Idaho	U.S.		
2001	\$1.81	\$2.15	\$1.59	\$1.91	66,832	\$123,843
2002	\$1.92	\$2.07	\$1.58	\$1.91	58,336	\$111,546
2003	\$1.79	\$2.32	\$1.62	\$1.86	54,565	\$101,637
2004	\$1.83	\$2.31	\$1.60	\$1.88	55,203	\$103,969
2005	\$1.86	\$2.56	\$1.63	\$1.94	52,914	\$102,818
2006	\$1.98	\$2.60	\$1.61	\$2.05	57,672	\$118,008
2007	\$2.94	\$3.31	\$2.77	\$2.99	60,253	\$179,978
2008	\$4.08	\$3.75	\$4.00	\$4.03	80,630	\$325,092
2009	\$3.54	\$3.63	\$3.75	\$3.57	94,678	\$336,375
2010	\$3.08	\$3.78	\$3.30	\$3.19	65,493	\$208,603

SOURCE: USDA-NASS. Prepared by HGA.



### 2010 ESTIMATED COST OF PRODUCING HOPS IN THE YAKIMA VALLEY, WASHINGTON STATE

- 2009-29,588 acres in WA State (79% of US Production)

"Washington hop acreage is expected to decline 30% in the next few years, a consequence of a worldwide oversupply. As a result, the economic climate for Washington hop producers is currently in chaos."

Source: USAhops.org



### 2010 National Summary

- Washington growers produced 80% of the U.S. hop crop.
- US Production 65 mill lbs. down 31% from 2009
- Acreage decreased 42% in ID, 24% in OR, and 18% in WA
- Zeus and Columbus/Tomahawk were the leading varieties in Washington, accounting for 38%
- In Oregon, Nugget and Willamette accounted for 62% of the State's hop production.



### NO SB RULING

- On October 28, 2010, the National Organic Standards Board unanimously voted in favor of the removal of hops from section 205.606 of the National List of Approved and Prohibited Substances, effective January 1, 2013
- Organic beer will have to be made with organic hops starting in 2013



### Market Potential

New Planned Breweries 2011



beervanabuzz.blogspot.com



### Brewer Variety Needs

Top five varieties used by brewers

1. Cascade- 65%
2. Centennial-50%
3. Perle/Saaz/Simcoe – 30%
4. Columbus/N. Brewer/Tettnanger – 25%
5. EK Golding/Willamette – 20%

50 % noted Cascade as #1 variety



### Brewer Variety Needs

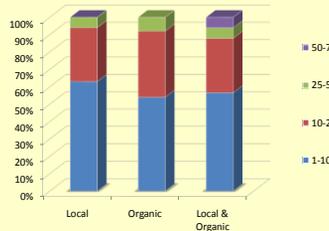
Brewers wish they had more...

1. Amarillo/Simcoe- 35%
2. Summit/Saaz – 15%
3. Note: several brewers said “all varieties”



### Will brewers pay a premium?

Percent Premium by Hop Category



Hop Category	1-10%	10-25%	25-50%	50-75%
Local	~65%	~25%	~10%	~0%
Organic	~55%	~30%	~15%	~0%
Local & Organic	~60%	~25%	~15%	~0%



### Quality Needs

- Hops are generally purchased as extracts, whole flower, or pelletized with quality defined by:
- $\alpha$ -acid, B-acid (as % dry weight)
- Cohumulone content (as %  $\alpha$ -acid)
- Total Oil (as % dry weight)
- Hop Storage Index

Results:

- Pelletized: All but one!!
- $\alpha$ -acid: 80%, cohumulone: 14%
- Storage or packaging: 23%






### Research Trials

- Investigating Hop Varieties for Michigan Production – *(Project GREEN Research Station Variety Trial)*
- Plant Breeding and Agronomic Research for Organic Hop Production Systems- *Organic Research and Extension Initiative Grant with WSU, MSU, UVM (On-Farm)*
- Meeting the Growing Demand for Organic Hops: Low-Trellis Organic Hop Production in the Great Lakes Region - *Michigan Hop Alliance on-farm trial*



### Conventional Hop Variety Trial



### NW and SW Station Hop Variety Trial

- Brewers Gold
- Cascade
- Centennial
- Crystal
- EK Golding
- Glacier
- Perle
- Santiam
- Teamaker
- Tettanager
- Willamette

Item	Quantity/Price	Cost
Rhizomes	800 @ \$4 each	\$3,200
Poles (21 ft)	100 @ \$32 each	\$3,200
Crushed stone	4 yards	\$550
Env. earth anchors	Manta Ray and Duckbill Anchors	\$2,200
Drip irrigation	Materials	\$800
3/16-inch wire	16,000 ft @ \$8.99/ft	\$1,440
5/16-inch wire	2,000 ft @ \$8.21/ft	\$420
Hop twine	Coconut fiber	\$125
Compost	100 yards @ \$10/yard delivered	\$1,000
Misc. supplies	Wire clamps, staples, etc.	\$250
Labor	Hole auger, pole setting, wire	\$3,400
Equipment rental	Installing wire	\$800
<b>Total</b>		<b>\$17,385*</b>

\*Note: This figure may be reduced with less expensive products or if a grower chooses to install the hop yard with his/her own equipment and labor.



### USDA OREI Trial

- 8 Cover Crop Treatments
- 20 hop varieties



### 2010 NCR SARE Farmer/Rancher Grant

#### Objectives

1. Determine the growth habits, yields, quality, and market potential of the hop cultivar "Summit" on a low-trellis system under Great Lakes growing conditions.
2. Assess the effects of understory nitrogen fixing cover crops on soil quality, soil nitrogen levels, hop leaf nitrogen, and weed control.
3. Conduct a cost/benefit analysis of low-trellis vs. hi-trellis organic hop production systems.





## TAKE HOME MESSAGES

- Wolf (picker) \$55,000-\$100,000
- Hammermill & Pelletizer \$8000-15,000
- Vacuum Sealer \$2000-2500
- Dryer \$12,000 +
- Energy (wet hop to pellet) \$1.50 / lb
- Cold Storage \$ ??????
- Annual labor for 14 acres Crew of six (2 months working 10 hour + days) \$600/day
- Quality is crucial
- Hi initial and annual costs with questionable returns
- Don't underestimate the amount of labor required
- Need for picking and processing equipment if you plant >1/2 acre
- Will most likely need a price premium to do organic



## Resources

Soon to be live!  
www.hops.msu.edu



## Resources

- Production**
- Sustainable Hop Production in the Great Lakes Region, Michigan State University Extension Bulletin E-3083, January 2010. [http://www.bookstore.msu.edu/](http://www.bookstore.msu.edu)
  - A Hops Nutrient Management Guide, Oregon State University, FG 79. [http://extension.oregonstate.edu/catalog/pdf/fy\\_dg79](http://extension.oregonstate.edu/catalog/pdf/fy_dg79)
  - Cost of Establishing and Producing Hops Under Drip Irrigation in the Yakima Valley, Washington State University Extension, EB1134. [http://farm-organic.wsu.edu/PDF\\_docs/irrigatedEB1134.pdf](http://farm-organic.wsu.edu/PDF_docs/irrigatedEB1134.pdf)
  - Crop Profile for Hops in Oregon. <http://www.ipmcenters.org/CropProfiles/docs/orhops.html>
  - Growing hops in the backyard. FS 992. Rutgers Cooperative Extension, Barnka, W., and E. Dager. 2002.
  - **Homegrown Hops**, 2nd edition, Reveille Farm, Junction City, OR. Besch, D. 2000.
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  - Hops: Organic Production. George Kaepfer. <http://attra.nat.org/attra-pub/PDF/hop.pdf>
  - Oregon Crop profile, [www.ipmcenters.org/CropProfiles/docs/orhops.pdf](http://www.ipmcenters.org/CropProfiles/docs/orhops.pdf)
  - Small scale and organic hops production. Kneen, Left Fields, British Columbia. Kneen, and Rebecca. 2003. <http://www.cranappales.com/HopsManual.pdf>
  - The Hop Atlas: The History and Geography of the Cultivated Plant. Barth, H.J., C. Klinke, and C. Schmitt. 1994.
  - **Tinged with Gold: Hop Culture in the United States**. Tomlan, M. 2002.
  - USDA Named Hop Variety Descriptions. <http://www.freshops.com/hops/usda-named-hop-variety-descriptions>
  - Washington Crop profile, [www1.ctinfo.wa.edu/~cdm1ek1/profiles/Hops3PM.pdf](http://www1.ctinfo.wa.edu/~cdm1ek1/profiles/Hops3PM.pdf)



## Resources

- Pests and Diseases**
- Compendium of Hop Diseases and Pests. Edited by Walter Mahaffee, Sarah Pethybridge and David Gent. APS Press. 2009. ISBN 978-0-89054-376-4 Available from shopgpress.org
  - Field Guide for Integrated Pest Management in Hops. David Gent, James Barbour, Amy Dreves, David James, Robert Parker, Douglas Walsh. A Cooperative Publication Produced by Oregon State University, University of Idaho, USDA and Washington State University. <http://www.usahops.org/userfiles/file/Research%20Reports%208%20Presentations/HopHandbook2009.pdf>
  - Oregon State University Plant Disease Control Hops. [http://plantdisease.spruce.ac.uk/plant\\_searchResults.cfm?search\\_str=hops&host\\_alpha=Select&host\\_text=hops](http://plantdisease.spruce.ac.uk/plant_searchResults.cfm?search_str=hops&host_alpha=Select&host_text=hops)
- Plant suppliers**
- Great Lakes Hops (Dutch Touch Growers, Inc. 616-875-7416)
  - Sandy Ridge Farms, (Jon VandenHuevel: 616-218-2363, [jon@annualambience.com](mailto:jon@annualambience.com))
  - Summit Plant Laboratories, Inc. (Al Hamm: 800-654-1017; [al@plantlabs.com](mailto:al@plantlabs.com); [www.plantlabs.com](http://www.plantlabs.com))
- Bizzone Sales**
- Adventurers in Home Brewing. [www.homebrewing.org/](http://www.homebrewing.org/)
  - Ebrew. [www.Ebrew.com](http://www.Ebrew.com)
  - Fresh Hops. [www.freshops.com/](http://www.freshops.com/)
  - HopTech. [www.hoptech.com/](http://www.hoptech.com/)
  - Hop Union. [www.hopunion.com/](http://www.hopunion.com/)
  - Michigan Hop Alliance. <http://michiganhopalliance.com/>
  - Midwest Supplies. [www.midwestsupplies.com](http://www.midwestsupplies.com)
  - Thyme Garden. [www.thymegarden.com](http://www.thymegarden.com)



## Resources

- Other Resources (organizations, farms, local processing)**
- American Organic Hop Grower Association. <http://www.usorganichops.com/AOHGA/index.html>
  - American Hop Museum (Some information on varieties). <http://www.americanhopmuseum.org/home.htm>
  - Empire Orchards-Hops and Apple Farm. <http://www.facebook.com/pages/Empire-Orchards-Hops-Apple-Farm/11813325252735>
  - Gorst Valley Hops. <http://www.gorstvalleyhops.com/>
  - Hop Growers of America, a non-profit. <http://www.usahops.org/>
  - Hop Research Council. <http://www.hopresearchcouncil.org/index.html>
  - Hop Union. <http://www.hopunion.com/>
  - Michigan Beer Guide. <http://www.michiganbeeruide.com/>
  - Michigan Brewers Guild. <http://www.michiganbrewersguild.org/>
  - Michigan Hop Alliance. <http://michiganhopalliance.com/>
  - Michigan State University Extension. [www.hops.msu.edu](http://www.hops.msu.edu) Dr. Robert Sirrine. Statewide hops specialist. [sirrine@msu.edu](mailto:sirrine@msu.edu)
  - Old Mission Hop Exchange. <http://oldmissionhops.com/>
  - University of Vermont Hops Project. <http://www.uvm.edu/extension/cropsol/hops>



## Special Thanks

