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Hops

Rob Serrine
MSU Extension
NW MI O & V Show
January 13, 2015



MICHIGAN STATE
UNIVERSITY

Extension



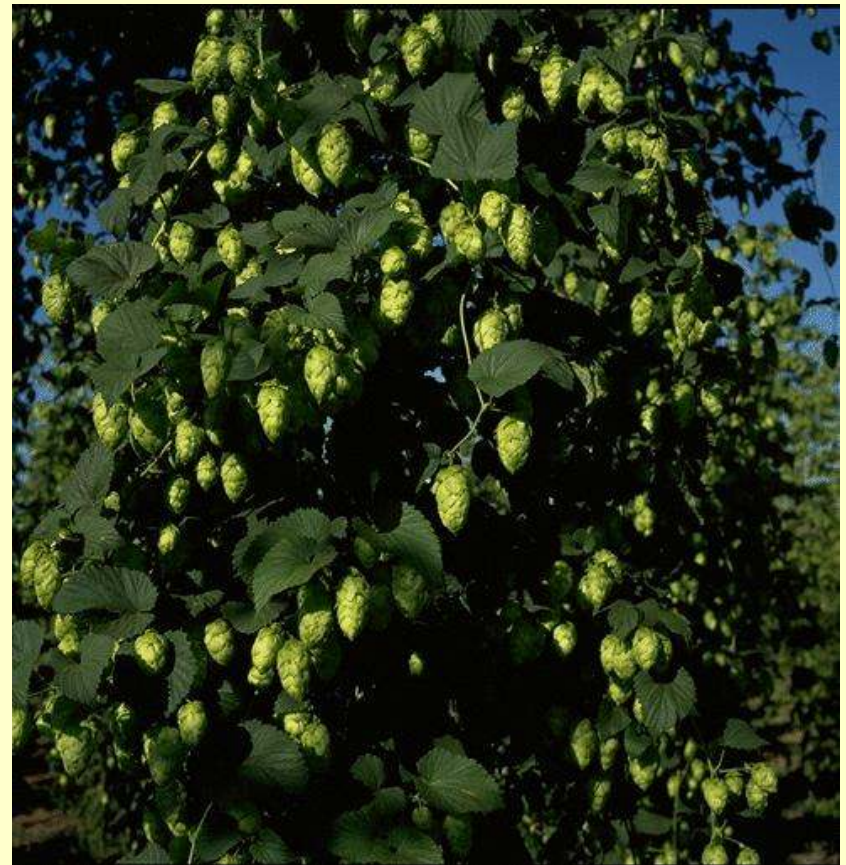
Outline

- Taxonomy
- Characteristics and Growth Habits
- Production Stages
- Cost of Production
- Market Trends
- Resources



What are Hops?

- Hops are dioecious (male and female plants)
- Perennial below ground
- Annual above ground
- Produce annual bines from an overwintering rhizome (below ground stems)





The Cones

- Only the female flower “strobile” or “cone” is desirable for use in beer production
- Male plant-no real commercial value except in breeding programs
- Cones (0.5-4 in.) light green, papery, contain Lupulin glands (modified vine hairs)
- Glands contain the alpha and beta acids, and essential oils





Two Distinct Markets

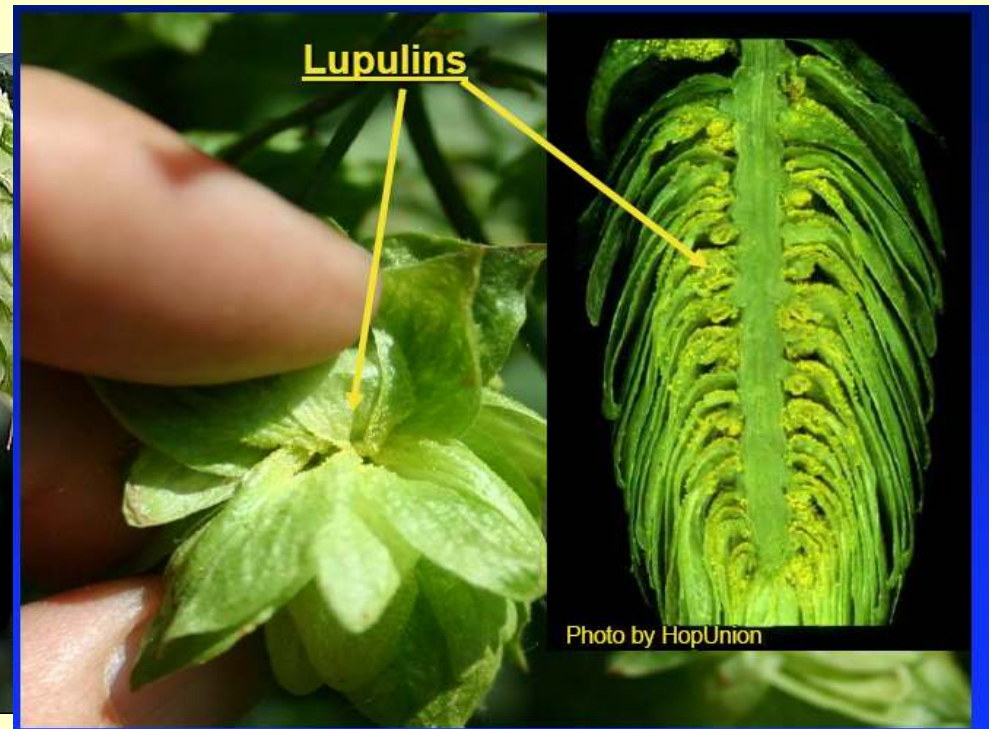
- Alpha/Bitter
 - Processed hops
 - Yield measured in kg. Alpha per acre
 - Typically hi-alpha varieties, increasingly aroma
 - Eg. columbus, nugget
- Aroma
 - Minimal processing
 - Yield measured in lb. per acre
 - Typically aroma varieties
 - Eg. Cascade, crystal, amarillo,





Lupulin

- Essential oils: well over 100 compounds contribute to aroma
- Soft resins: beta acids, and the all important alpha acids.



Hops: Trellis Design



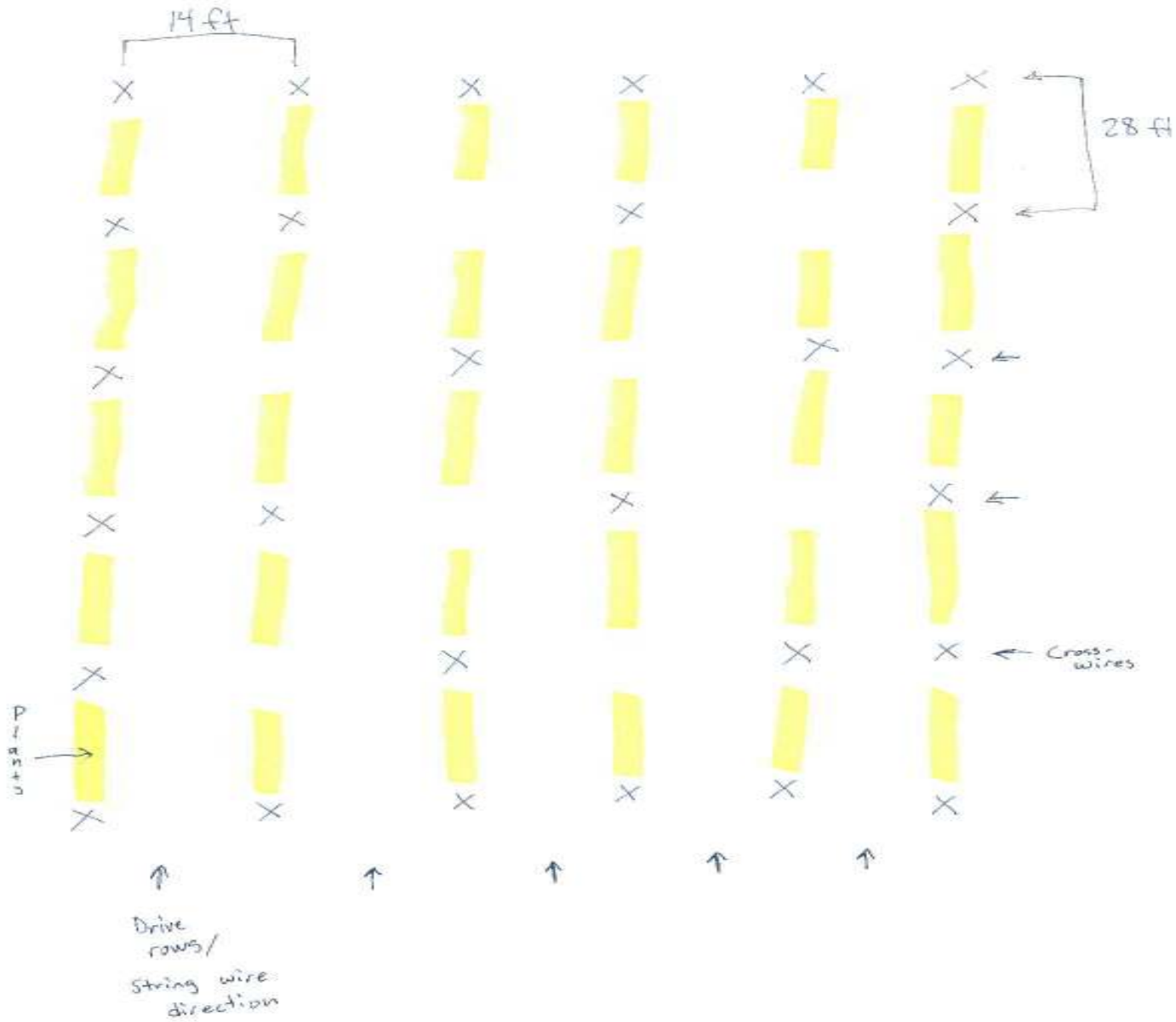


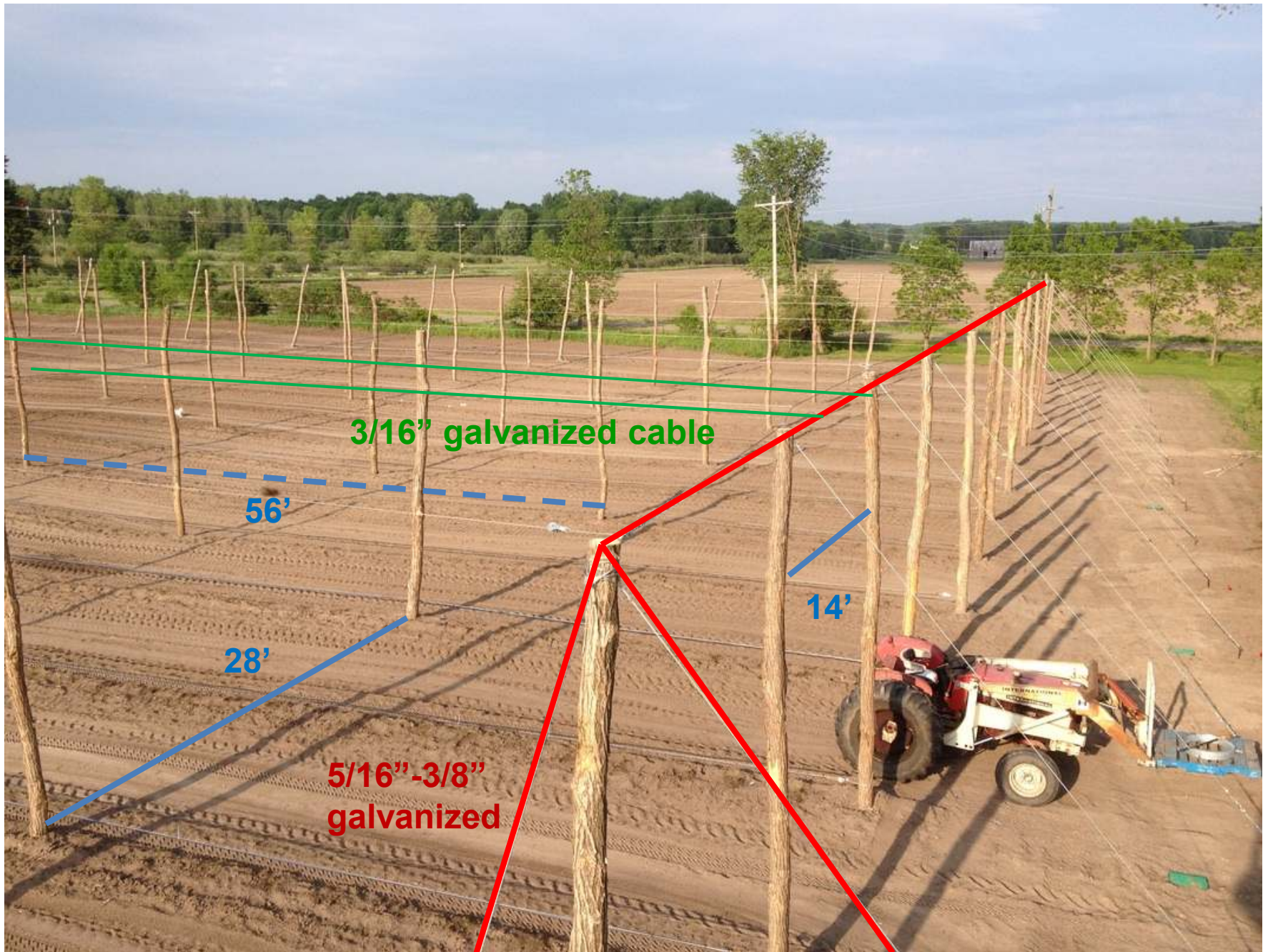
Climbing bines

- Bine climbs with the aid of “Trichomes”
- In the wild-they climb up companion species
- Commercial production- Requires a trellis system for support
- Typical set-up
 - 18’ tall
 - Plants spaced 3’ x 14’
 - 1000-1200 plants/acre
- Vine wraps around string-clockwise-function of phototropism (light) and thigmotropism (touch)



Standard Tall Trellis Hopyard Design





Carr creek hops



Important to build a Solid Trellis!!



Short Trellis

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





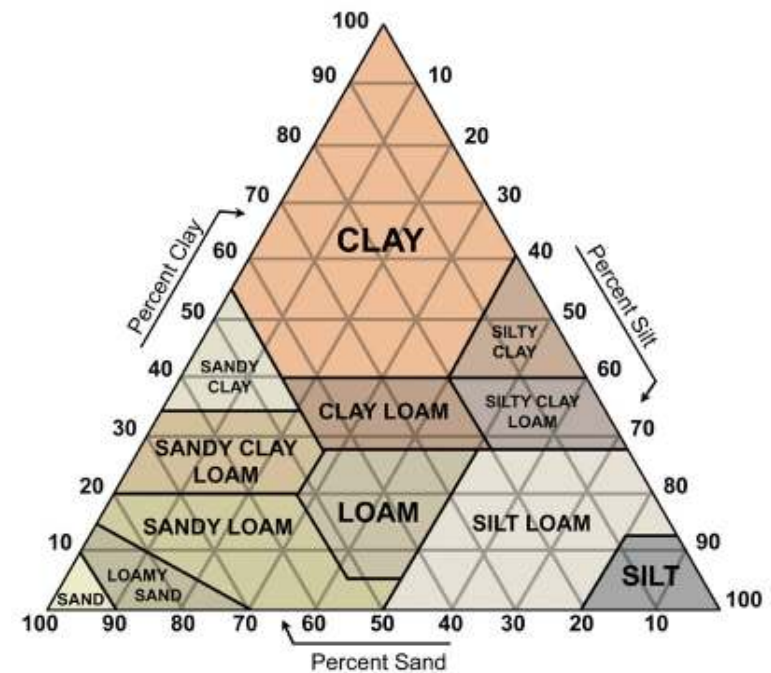
Factors that can impact hop production (growth, yield, and quality)

- Environment (temp, day length, soil texture, weather)
- Production Practices
 - Cultivar
 - Soil fertility
 - Disease, pest, and weed pressure and control
 - Training and timing of training
 - Harvest and harvest timing
 - Irrigation
 - Post-harvest processing and storage



Environment

- Grow in a variety of soils from clay to sand
- Prefer well-drained soils
 - Sandy loam or silt loam
- Problem with heavy, poorly drained soils
 - May delay getting into field
 - Increase disease issues/rotting
- Problem with overly sandy soils
 - Hi input costs

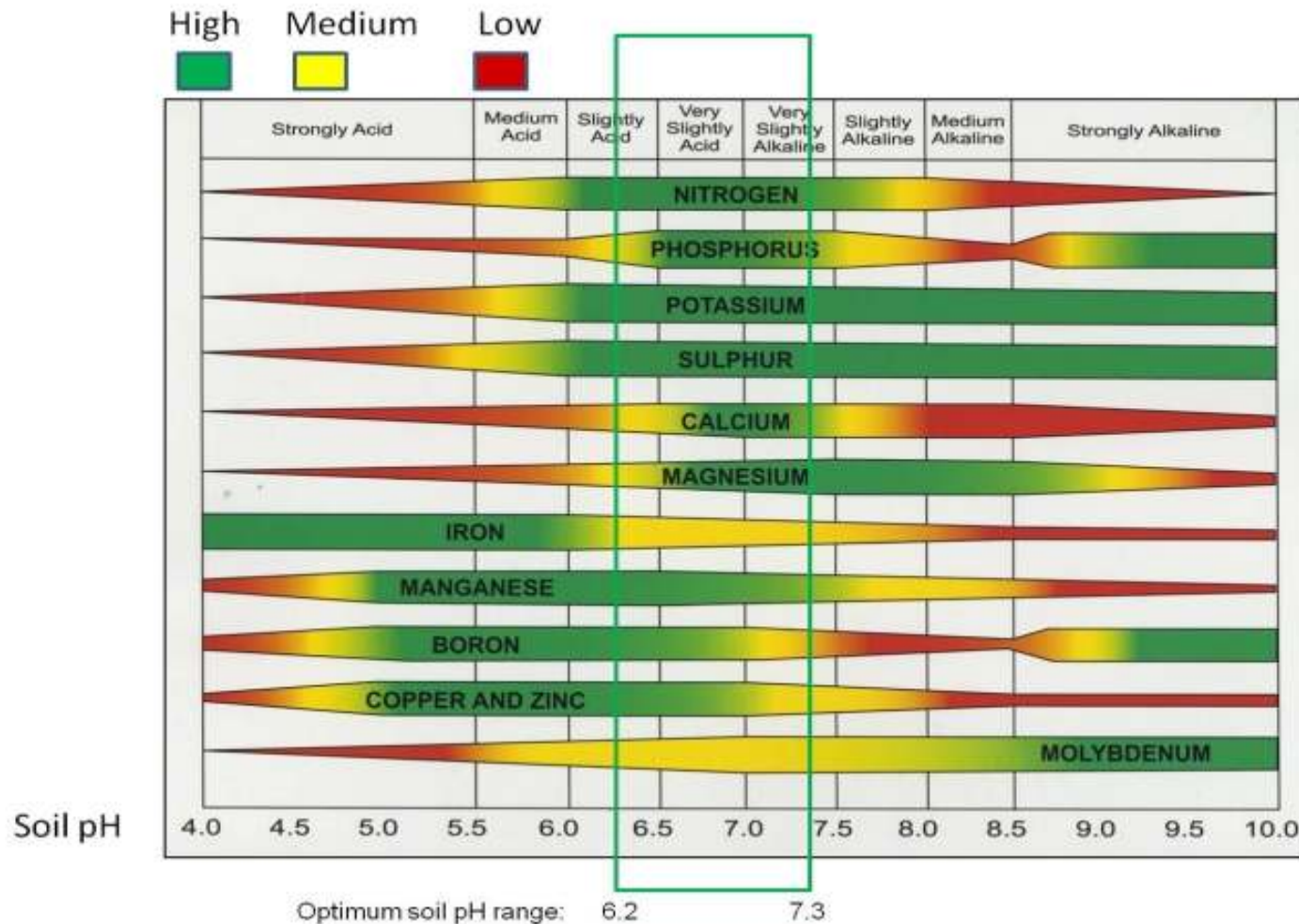


Source: Neve, R.A. Hops. 1991

Hops and pH

- pH optimum(6.2-6.5)
- Lime if too low

How soil pH affects availability of plant nutrients



Topography



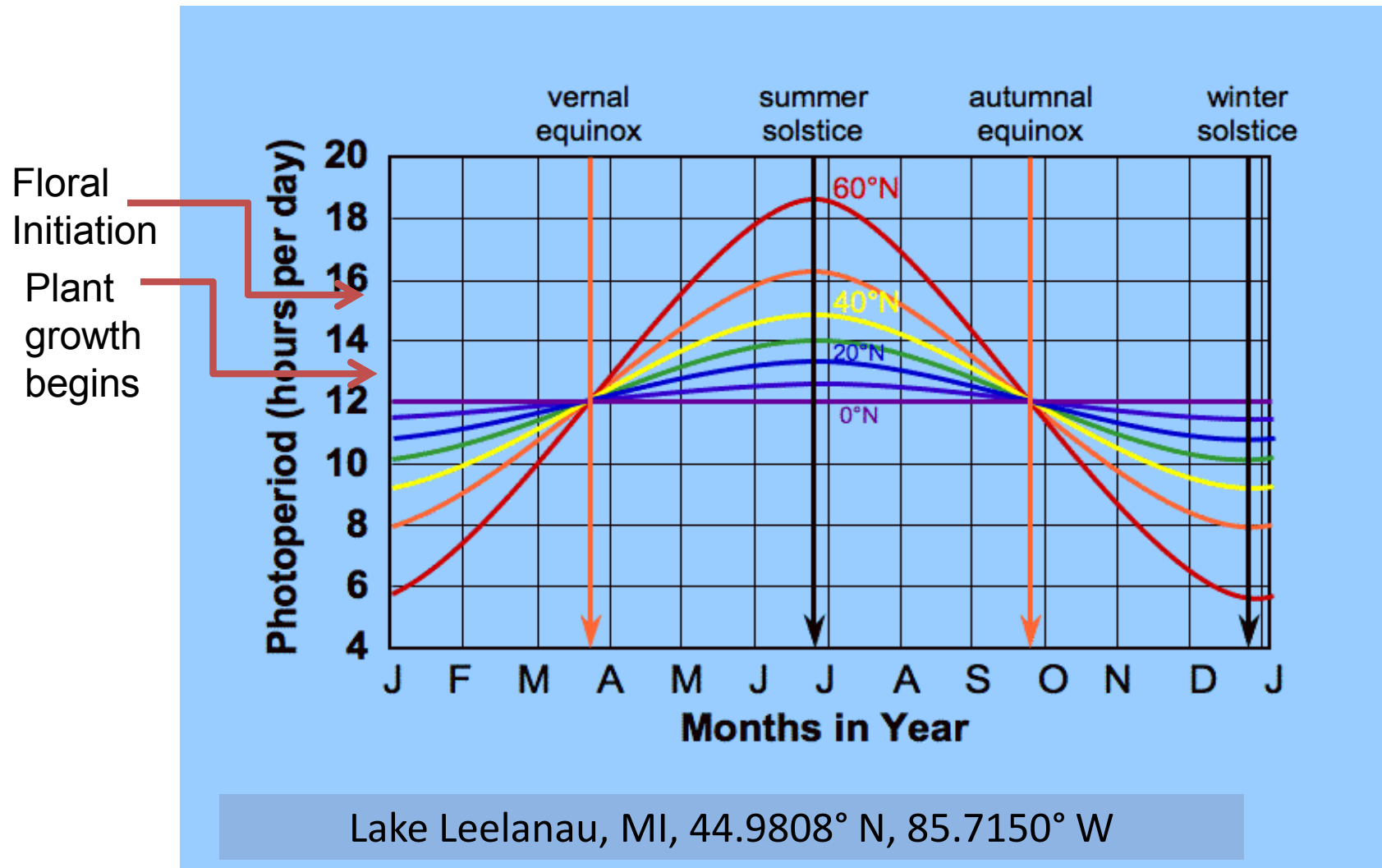
- Photo credit: Maggie Hoffman



Photo: David Warren

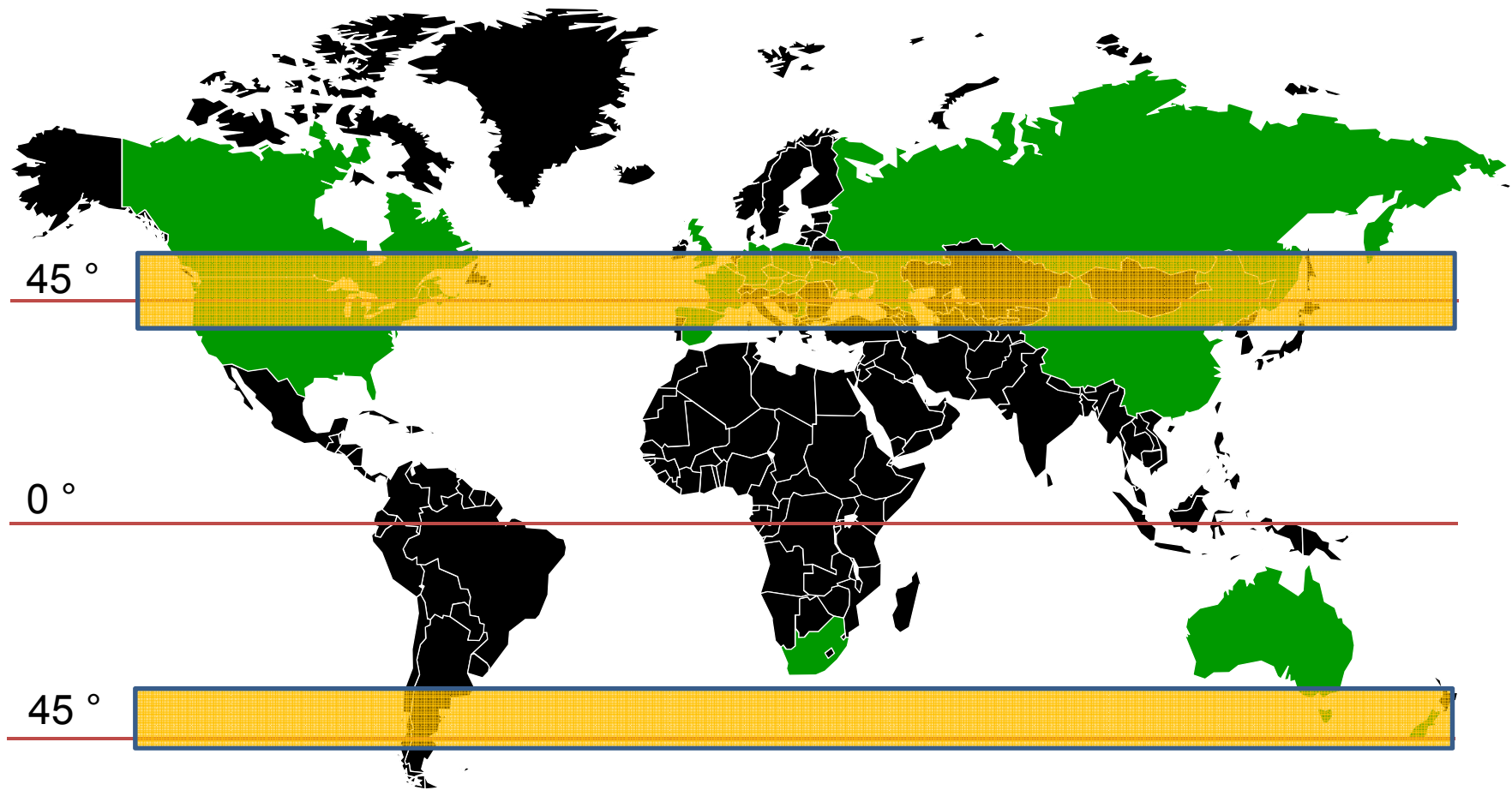


Photoperiod Sensitivity (why location matters)



The switch from vegetative to reproductive development (floral initiation) is dependent on: 1) Cultivar, 2) Number of nodes (part of stem where leaf grows), 3) Day length

Latitude and Daylength





Results in: Hop Production Stages

- Stages of Growth
 - Dormancy
 - Spring regrowth
 - Vegetative growth
 - Reproductive growth
 - Preparation for dormancy
- Each stage requires its own unique management regime

Source: Jason Perrault, Perrault Farms



FALL/WINTER

Dormancy (October-March)

- In late summer the plant allocates photosynthetically derived starches to the storage roots
- Starch is converted into soluble sugars
- Sugars are the energy needed for spring-regrowth
- **In the field**
 - Not much happening
 - **Planning for next season**





What Varieties to plant?

1. What brewers want
2. Yields
3. Disease susceptibility
4. Location-soil type, etc.

Variety	Usage	Disease Susceptibility*		
		Powdery Mildew	Downy Mildew	Verticillium Wilt
Brewers Gold	Bittering	S	MR	MR
Bullion	Bittering	S	MR	R
Cascade	Aroma	MR	MR	MR
Centennial	Bittering	MR	S	U
Chinook	Bittering	MS	MR	R
Columbia	Aroma	MS	MR	S
Comet	Bittering	R	S	R
Crystal	Aroma	R	S	R
East Kent Golding	Aroma	S	S	MR
First Gold	Bittering	R	S	MR
Fuggle	Aroma	MS	R	S
Galena	Bittering	S	S	R
Glacier	Aroma	S	S	U
Hall. Gold	Aroma	MS	R	S
Hall. Magnum	Bittering	S	R	MR
Hall. Mittelfrüh	Aroma	MS	S	S
Hall. Tradition	Aroma	MR	R	MR
Horizon	Bittering	MS	S	MR
Late Cluster	Aroma	S	S	R
Liberty	Aroma	MR	MR	U
Mt. Hood	Aroma	MS	S	S
Newport	Bittering	R	R	U
Northern Brewer	Bittering	S	S	R
Nugget	Bittering	R	S	S
Olympic	Bittering	S	MS	R
Perle	Aroma	S	R	MR
Pioneer	Bittering	MR	MR	U
Saazer	Aroma	S	MS	S
Saazer 36	Aroma	S	MS	S
Spalter	Aroma	S	R	MR
Sterling	Aroma	MS	MR	U
Teamaker	Aroma	MR	MR	S
Tettnanger	Aroma	MS	MS	S
Tolhurst	Aroma	S	S	U
U.S. Tettnanger	Aroma	MS	MS	S
Vanguard	Aroma	S	S	U
Willamette	Aroma	MS	MR	S



SPRING

Spring Regrowth (April-May)

- Increasing day lengths and temperatures - signal for end of dormancy
- Plant uses soluble sugars as energy to emerge from dormancy and begin regrowth
- Initial regrowth occurs-rapidly producing vines unsuitable for production
- Plant relies on energy reserves of the root until end of May, when the starches and sugars reach their lowest points of the year
- Supplemental nutrient management is needed to maximize plant health



Source: Jason Perrault, Perrault Farms

Photo credit: Erin Lizotte



Spring Regrowth (April-May)

- **In the Field**

- Soil Test
- Stringing
- Spring pruning-April (removing initial growth)
 - Encourage more hearty secondary growth
 - Reduce disease
- Weed Control
- Fertilizer application
- Training-one of most important aspects of hop production
 - Timing is varietal specific
 - Generally 3 vines per string
- Irrigation begins

Source: Jason Perrault, Perrault Farms



Hop Growing Requirements: Fertility

- Soil Test Before planting
- Tissues Tests and Soil tests
- Recommended fertilization rates for mature plants:
 - Nitrogen (N) = 150+lbs/acre
 - Spring-broadcast N 2-3 times (30lbs each time) every 2-3 weeks, then the remainder spoonfed through drip.
 - 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)

Pruning/crowning





Planting

- Michigan is moving away from rhizomes
 - Disease
 - Reliability
 - New local supplies of certified plants
- Plant starts can be planted throughout the growing season but generally in spring
- Have your trellis and irrigation in place before planting



Photo Credits: Great Lakes Hops



- At least 2000 strings/acre (2 per plant)
- [Video](#)



<http://roguefarmsblog.wordpress.com/category/crops/hops-crops/>



Meanwhile In Michigan





<http://roguefarmsblog.wordpress.com/category/crops/hops-crops/>



Training

- 3-4 bines
- Clockwise only
- Timing-Cultivar and weather dependent
- Will likely have to re-train



Training Date



- Early training can lead to reduced yield (ex. Galena)
- Training date is variety-specific but usually occurs during May in the Willamette valley.
- Very little information in the literature as research results have been inconclusive

- Source: Townsend, S. Factors affecting hop production and quality.







Irrigation

- 75-80% of total annual hop water use occurs after mid-June
- Greatest daily amounts late July-early August
- Majority of roots are in top 4'
- Hops usually extract 50-60% from top 2', but can extract water from 8' or below
- Overall use around 30 inches/year, depends on season

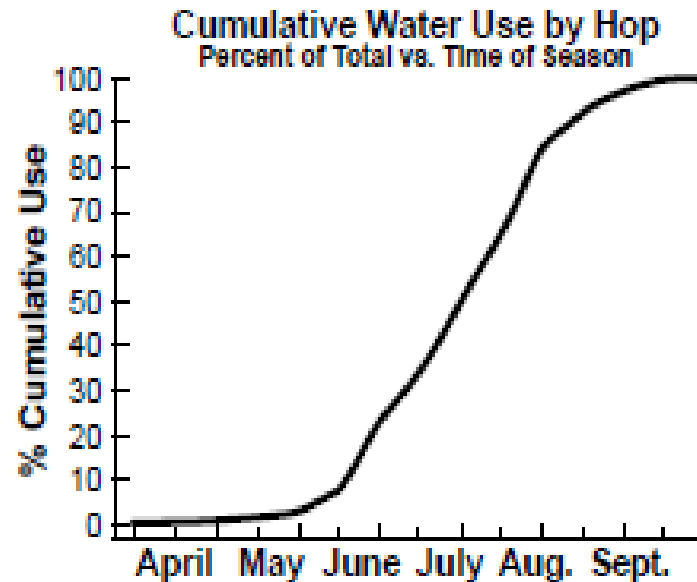


Fig. 1. Cumulative water use of hop during the growing season.



Irrigation: Examples

- Loftus Ranches
- Run two drip tubes per row
- 8 gallons per plant per day in hot season (4 on, 8 off, 4 on)
- ~8000 gallons/acre





Irrigation: Examples

NWMHRC

- Run one drip tube per row
- .42 gallon emitters every two feet
- RAM tubing
- 30 minute flush, 45 minute fertigate, 30 minute flush (every other day)
- **NOT ENOUGH WATER**





EARLY SUMMER

Vegetative Growth(May-July)

- Critical Stage for the purposes of crop production, occurs from end of May-end of July
- Two Phases:
 1. May-early July: Plant growth mainly in main vine and leaves
 2. July: Bulk of above ground growth occurs in the lateral production (side arms)
- Plant reserves used up
- Plant already determining yield
 - Aggressive management!!
 - Maximize health of plant & growth

Source: Jason Perrault, Perrault Farms





Vegetative Growth(May-July)

- In the Field

- IPM-monitor, monitor, monitor
- Pest/Disease/Weed Control
- Fertility Management
- Irrigation



Source: Jason Perrault, Perrault Farms



Weed control



Pests and Diseases

- **Hop aphid** (*Phorodon humuli*)



- **Spider Mites** (*Tetranychus urticae*)



- **Potato Leaf Hopper** (*Empoasca fabae*)



- **Apple Mosaic Virus**

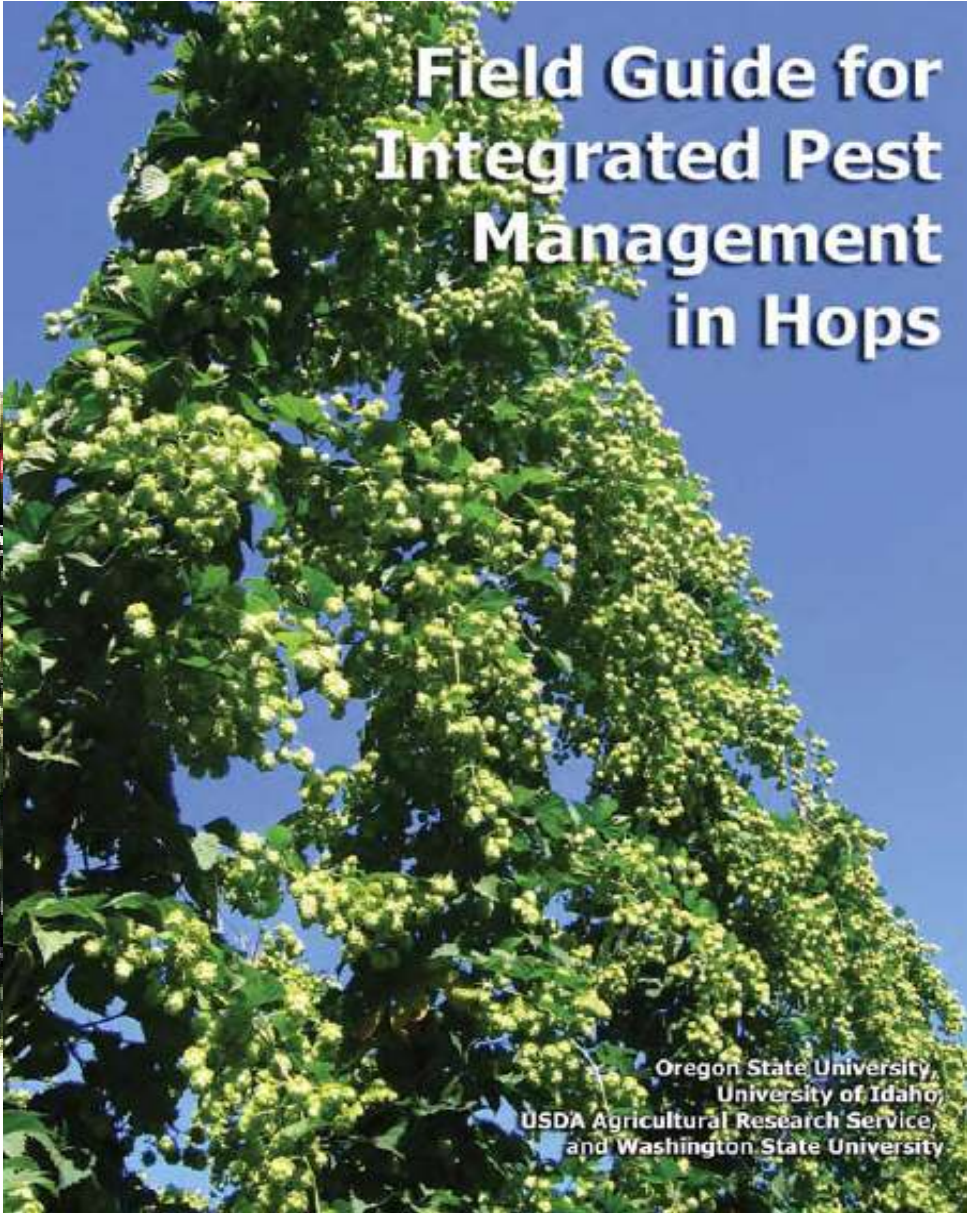
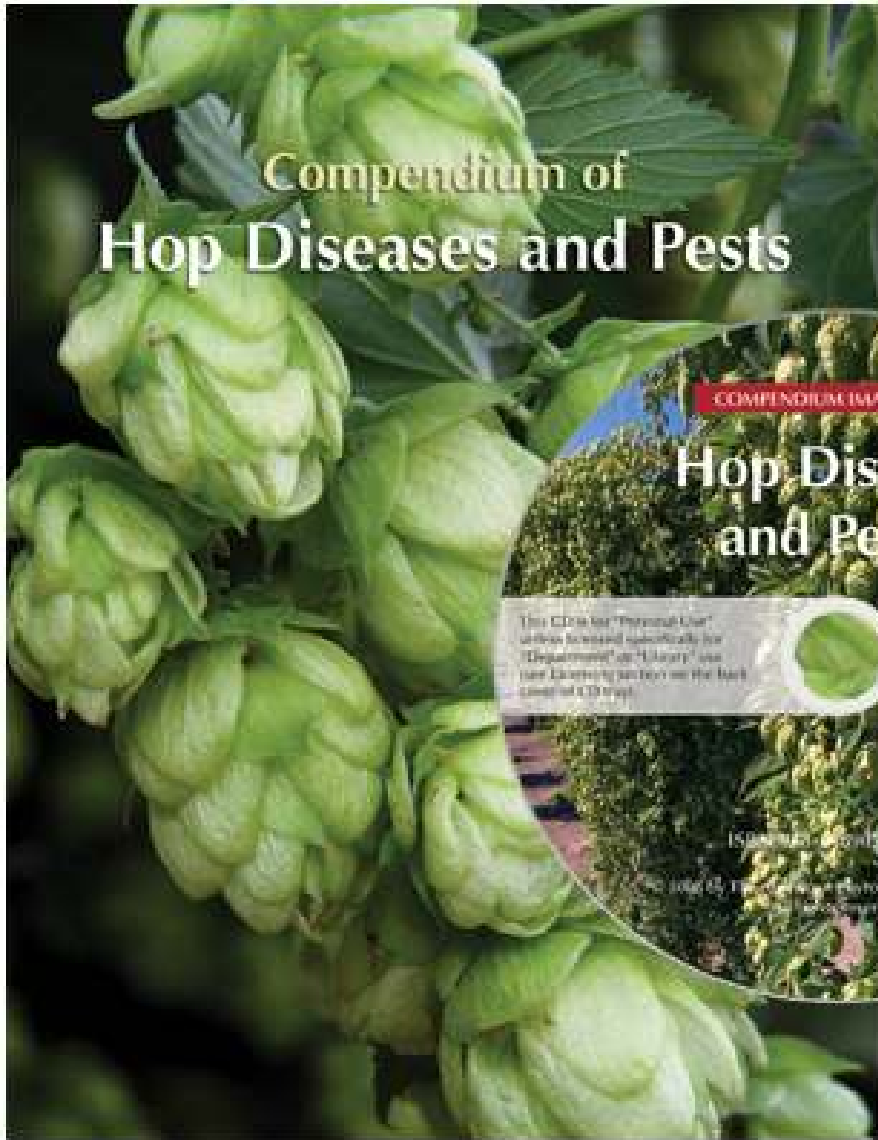


- **Downy mildew**
(*Pseudoperonospora humuli*)



- **Powdery mildew**
(*Podosphaera macularis*)

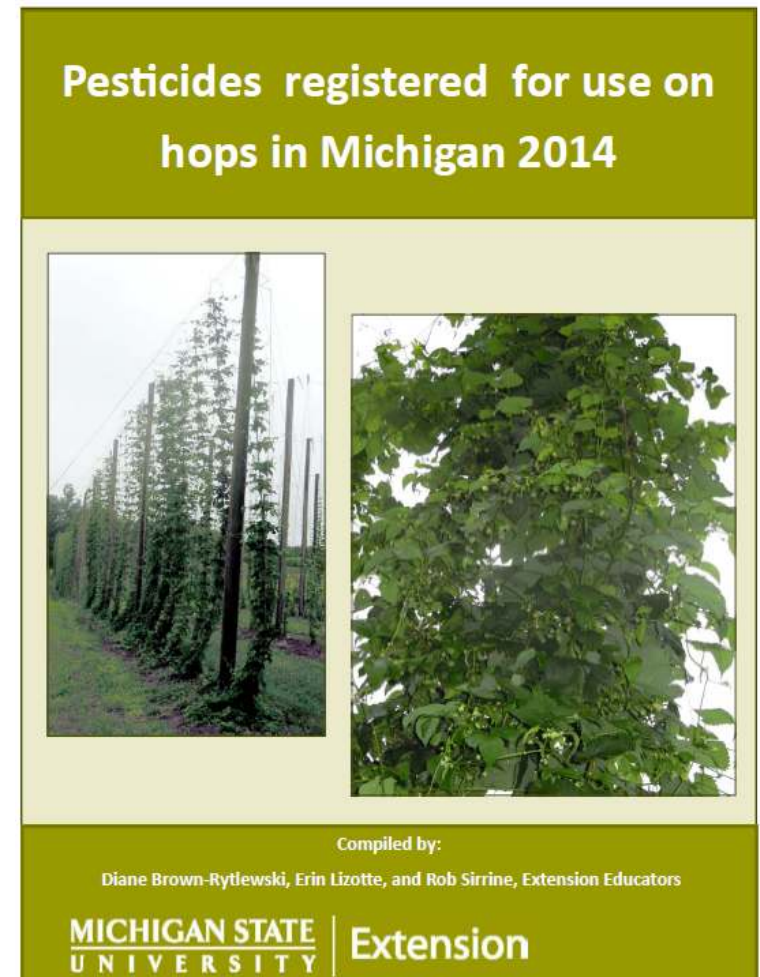






Resources for pesticide labels

- Crop data management systems
 - www.cdms.net
- GREENBOOK
 - www.greenbook.net
- Agrian
 - <http://www.agrian.com/home/label-lookup/overview#>
- New Bulletin →
 - <http://www.hops.msu.edu>





SUMMER

End of July

- Floral Production has commenced
 - Plant shifts energy into cone production
 - Vegetative production is diminished
 - Photosynthetic capacity of the plant is maximized
- Mature cones can account for up to 50% of the total above ground dry matter
- Cannot increase cone numbers
- Focus on: plant health to maximize cone weight and resin/oil content
- Water management-July-August most of H₂O
- Nutrient management-cut off N, add K



Source: Jason Perrault, Perrault Farms



FALL

Preparation for Dormancy (September)

- In the Field
- Harvest!!!!
- Vines cut (bottom then top)
- Laid down into trailer
- Taken to picking machine
- Cones dried for 8-12 hours (10% moisture)
- Dried cones cooled 12-24 hours
- Cold storage



Source: Jason Perrault, Perrault Farms

Hops: Harvesting and Processing















WOLF Hopfenpflückmaschine WHE 513



- Pelletizing



<http://www.makepellets.ca/Hophead%202-1.jpg>

Packaging

N Flush

Vacuum seal

O2 and light proof packaging material



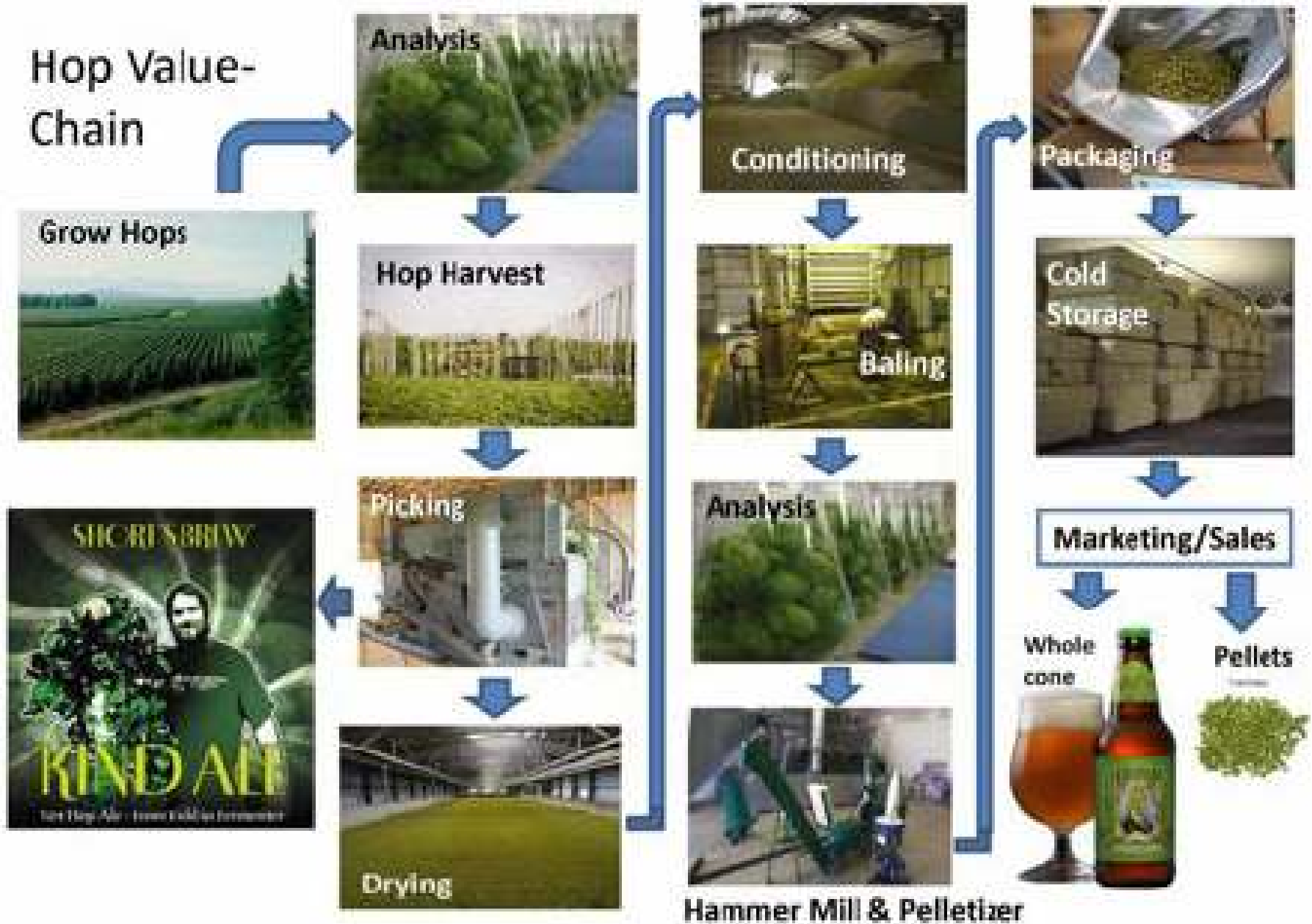
Cold Storage

- For AB-This freezer keeps the hops stored within at a constant 18-26 degrees Fahrenheit at a 70% relative humidity.



<http://www.fwwarehousing.com/divisions/5/cold-storage.html>

Hop Value-Chain



Hops: Cost of Production





Table 1. 2013 Hopyard Preparation and Establishment Costs (Per Acre and Per 5 Acre yard)

Land Preparation	Per Acre	Notes	5 Acre Yard
Disc	\$ 26.00	\$26/acre	\$ 130.00
Establishment			
Post Holes- digging	\$ 312.50	2.5 hrs * \$125/hr (145 hp tractor)	\$ 1,562.50
Post Holes-placement	\$ 750.00	6 hrs * \$125/hr	\$ 3,750.00
Poles-field	\$ 1,590.00	50 @ \$30/pole	\$ 7,950.00
Poles-end~	\$ 1,840.00	46 @ \$40/pole	\$ 5,360.00
Earth Anchor	\$ 650.00	50 per acre @ \$13 each	\$ 3,250.00
Wire	\$ 1,000.00	Galvanized 7 strand (\$800) + #9 (\$200)	\$ 5,000.00
Misc Hardware/supplies	\$ 500.00	staples, etc.	\$ 2,500.00
Labor-poles	\$ 480.00	4 workers- \$10/hr x 12 hrs	\$ 2,400.00
Management	\$ 240.00	12 hrs @ \$20/hr	\$ 1,200.00
Hop Plants	\$ 3,000.00	(\$3/plant, 1000 plants per acre; 14' x 3.5')	\$ 15,000.00
Labor-planting	\$ 700.00	(70 hrs x \$10/hr)	\$ 3,500.00
Irrigation^	\$ 1,500.00	Includes installation	\$ 7,500.00
Well		Variable	
Total Initial Costs	\$ 12,588.50		\$ 59,102.50

~ For a 5 acre yard: 53 field poles/ac & 27 end poles/ac=265 field poles and 134 end poles or 80/acre

^ 50 gallon/min, 2 inch main (no filtration)-cost is variable depending upon needs, # zones, etc.



Table 2. 2013 Hopyard Annual Operating Costs and Returns (Per Acre)

	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Operating Costs					
Coir (1 string yr 1; 2 strings yr 2 +, \$.20/ string; clips \$80)	\$ 240.00	\$ 480.00	\$ 480.00	\$ 480.00	\$ 480.00
Labor-stringing (5 workers x 10 hours X \$10/hr)	\$ 350.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00
Labor-training	\$ 500.00	\$ 750.00	\$ 750.00	\$ 750.00	\$ 750.00
Pest/Disease Chemicals (insecticide/fungicide/herbicide)	\$ 400.00	\$ 600.00	\$ 600.00	\$ 600.00	\$ 600.00
Fertilizer	\$ 250.00	\$ 275.00	\$ 275.00	\$ 275.00	\$ 275.00
IPM Consultant	\$ 25.00	\$ 25.00	\$ 25.00	\$ 25.00	\$ 25.00
Repairs/Parts/Maintenance		\$ 250.00	\$ 250.00	\$ 250.00	\$ 250.00
Machinery/Labor -Stringing	\$ 100.00	\$ 100.00	\$ 100.00	\$ 100.00	\$ 100.00
Machinery/Labor -Fertility	\$ 300.00	\$ 400.00	\$ 400.00	\$ 400.00	\$ 400.00
Machinery/Labor -Mowing/Till	\$ 100.00	\$ 100.00	\$ 100.00	\$ 100.00	\$ 100.00
Machinery/Labor- Spraying	\$ 300.00	\$ 350.00	\$ 350.00	\$ 350.00	\$ 350.00
<i>Subtotal</i>	\$ 2,565.00	\$ 3,830.00	\$ 3,830.00	\$ 3,830.00	\$ 3,830.00
Harvest					
Labor-harvesting (10 hrs, 4 workers-cut, load)		\$ 400.00	\$ 400.00	\$ 400.00	\$ 400.00
Management (\$20/hr* 10 hrs)		\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00
Machinery (\$125/hr)		\$ 1,250.00	\$ 1,250.00	\$ 1,250.00	\$ 1,250.00
<i>Subtotal</i>		\$ 1,850.00	\$ 1,850.00	\$ 1,850.00	\$ 1,850.00
Total Annual Operating Costs	\$ 2,565.00	\$ 5,680.00	\$ 5,680.00	\$ 5,680.00	\$ 5,680.00

- Analysis does not include land cost or overhead like interest on loans, taxes, etc.
- Does include per hour rate for machinery, labor, and management that would be charged if hired out (opportunity cost)
- Standard trellis design is 3.5 x 14 ft ~1000 plants/acre

Hops: Markets



MICHIGAN STATE
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125-Year Brewery Count

(1887 - June 2012)



Source: Brewers Association, *Brewing in America*



U.S. BEER SALES 2013

OVERALL BEER
-1.9%
196,241,321 bbls

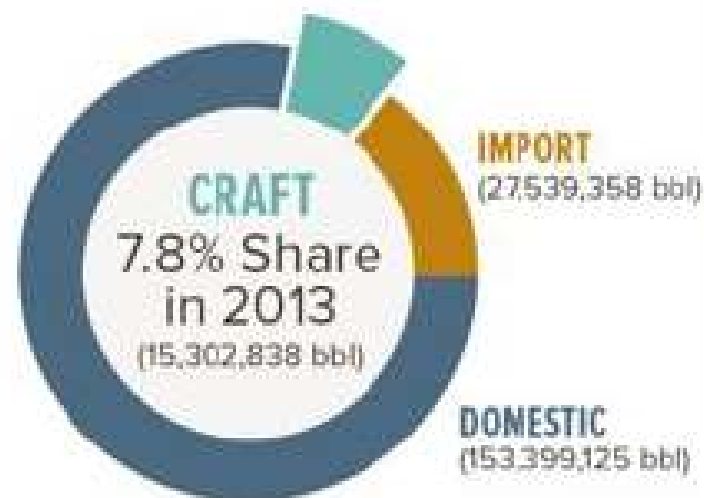
17.2%
CRAFT
15,302,838 bbls

IMPORT BEER
-0.6%
27,539,358 bbls

49%
EXPORT CRAFT BEER
282,526 bbls

OVERALL BEER MARKET
\$100 BILLION

CRAFT BEER MARKET
\$14.3 BILLION
20% DOLLAR SALES GROWTH



Source: Brewers Association, Boulder, CO

2013 Beer Sold in MI (bbls)

All Beer

6,257,864 bbls



All Craft Beer

452,000, 7.2%

MI Craft Beer

297,000, 4.7%



Quality Needs

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

Results:

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





TAKE HOME MESSAGES

- Quality is crucial
 - Do not skimp on establishment
 - You will not get rich growing hops
 - Hi initial and annual costs with questionable returns in the future
- | | |
|--|-------------------|
| • Wolf (picker) | \$50,000+ |
| • Hammermill & Pelletizer | \$15,000-\$60,000 |
| • Vacuum Sealer | \$2500-\$10,000 |
| • 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 |
- Don't underestimate the amount of labor required
 - Need for picking and processing equipment if you plant >1/2 acre
 - Line up supplies well in advance
 - How will you sell your hops?
 - Will most likely need a price premium to do organic



<http://www.hops.msu.edu>

Small scale hop production in the Great Lakes Region - Mozilla Firefox

Small scale hop production in the Great Lakes Region

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Small scale hop production in the Great Lakes Region

Home

- Getting Started
- Pest Management
- Weather and Climate
- Markets
- Resources
- Research
- Images
- Contacts

Interested in growing hops?

Here you will find all you need to know about growing hops in the Great Lakes Region. Recent hop shortages, growing appeal with specialty beers, and the desire for organic and locally sourced agricultural products have resulted in increasing interest in local hop production by farmers, brewers, and backyard enthusiasts throughout Michigan. If you are new to hops production or just interested in learning about this novel crop, please visit the [Getting Started](#) page for information. Finally, the [2012 Hop Growers of America Statistical Report \(pdf\)](#) has been released. Enjoy!

Thanks for visiting, and we hope you will contact us with suggestions to improve this website.

Search for MSUE Hops News past articles [MSUE Field Crops](#) etc.

MSUE Hops News

Registration for the 2013 Integrated Pest Management Academy CLOSING Thursday, Feb. 14!

Registration for this important event closes at midnight on Thursday, Feb. 14, so register NOW to ensure your spot at the 2013 IPM Academy!

Posted on February 13, 2013 3:13pm by Erin Lizotte

Ask an Expert

Question

Location and County

Michigan

Grand Traverse County

Image (optional)

You can upload .jpg, .png or .gif. Max size of 5MB each.

Browse...

Your answer will be sent to sinme@msu.edu

Ask

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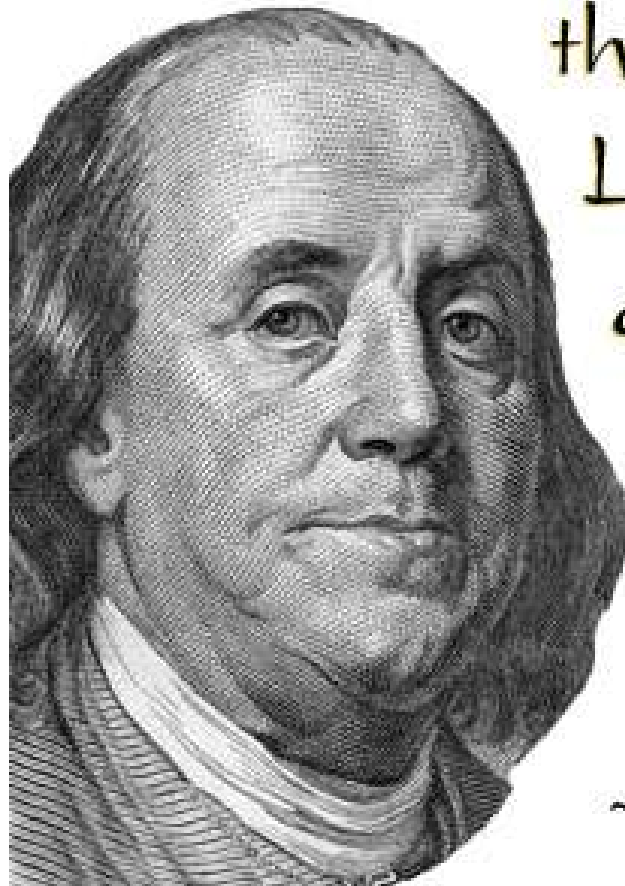


SAVE THE DATE:
**2015 Great Lakes Hop and Barley
Conference**

APRIL 10-11, 2015
Grand Rapids, MI



Beer is living proof
that God
Loves Us
and wants
us to be
Happy



~Benjamin Franklin
© RocketT-shirts.com