"AND
JUSTICE
FOR ALL"
Hops

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

N
Carr creek hops

5/16”-3/8” galvanized cable

3/16” galvanized cable

28’

56’

14’
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
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

Source: Jason Perrault, Perrault Farms
What Varieties to plant?

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

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<thead>
<tr>
<th>Variety</th>
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<td>MR</td>
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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
• At least 2000 strings/acre (2 per plant)

• Video

http://roguefarmsblog.wordpress.com/category/crops/hops-crops/
Meanwhile In Michigan
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

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
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](http://www.cdms.net)
- GREENBOOK
  - [www.greenbook.net](http://www.greenbook.net)
- Agrian
- New Bulletin
  - [http://www.hops.msu.edu](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**

[Image: 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
Hops: Cost of Production
Table 1. 2013 Hopyard Preparation and Establishment Costs (Per Acre and Per 5 Acre yard)

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

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<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
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<td>Coir (1 string yr 1; 2 strings yr 2 +, $.20/ string; clips $80)</td>
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<td>$ 480.00</td>
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<td>Management ($20/hr* 10 hrs)</td>
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- 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
Post Harvest Costs

Picking processing fees ($6/lb.) (energy, supplies, labor, etc.)
Transport to processor (variable)
Interest on Equipment (picking machine, hammer mill, pelletizer)
Sales Costs (Commission, transportation, shipping, etc.)

Subtotal

Gross Revenue/acre

Percent of total yield- (full production 1500 lbs. dried/acre)
Total yield in pounds dried/acre
Fresh wholecone wet ($5-6 /lb.)
Wholecone dried ($10-12/lb.)
Pellitized ($12-14/lb.)

Net Revenue/acre

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<td>$9,000.00</td>
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</tr>
<tr>
<td>Transport to processor (variable)</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$500.00</td>
</tr>
<tr>
<td>Interest on Equipment (picking machine, hammer mill, pelletizer)</td>
<td></td>
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<tr>
<td>Sales Costs (Commission, transportation, shipping, etc.)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Subtotal</td>
<td>0</td>
<td>$5,000.00</td>
<td>$7,250.00</td>
<td>$9,500.00</td>
<td>$9,500.00</td>
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<thead>
<tr>
<th></th>
<th>0</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of total yield- (full production 1500 lbs. dried/acre)</td>
<td>0</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Total yield in pounds dried/acre</td>
<td>0</td>
<td>750</td>
<td>1125</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Fresh wholecone wet ($5-6 /lb.)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wholecone dried ($10-12/lb.)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Pellitized ($12-14/lb.)</td>
<td>0</td>
<td>$10,500.00</td>
<td>$15,750.00</td>
<td>$21,000.00</td>
<td>$21,000.00</td>
</tr>
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</thead>
<tbody>
<tr>
<td>Gross Revenue/acre</td>
<td>0</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Total yield in pounds dried/acre</td>
<td>0</td>
<td>750</td>
<td>1125</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Fresh wholecone wet ($5-6 /lb.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<td></td>
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<tr>
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</thead>
<tbody>
<tr>
<td>Net Revenue/acre</td>
<td>$ (2,565.00)</td>
<td>$ (180.00)</td>
<td>$ 2,820.00</td>
<td>$ 5,820.00</td>
<td>$ 5,820.00</td>
</tr>
</tbody>
</table>

- UVM-$1.60/lb for picking only
- A couple of MI processors- ~$5.50/lb (including a 10% sales commission)
- Ontario $4.50/lb (no sales or marketing)
- Quebec and BC- (they charge 35% of sales amount) or currently $5.50/lb since they are selling for close to $16/lb (including access to mechanized harvester + dryer) and post-harvest services (including pelletization, packaging, commercialization)
- A group in Wisconsin was charging $4/lb just for pelletizing, packaging, and selling.
- **Depends on your assumptions (lbs per acre, cost of labor, payment on debt, etc.), but it looks like things are shaking out at around $5/lb for the process of picking through selling.**
Hops: Markets
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

CRAFT
7.8% Share in 2013
(15,302,838 bbl)

IMPORT
(27,539,358 bbl)

DOMESTIC
(153,399,125 bbl)

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, β-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 $600/day
    Crew of six (2 months working 10 hour + days)

• 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
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

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