MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, sex, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

El Servicio de Extensión (Extension Service) de MSU ofrece programas educativos, actividades, y materiales sin discriminación basada sobre edad, color, incapacidades, identidad o expresión de identidad sexual, información genética, estado matrimonial, origen nacional, raza, religión, sexo, orientación sexual, o estado de veterano.

Hop production in re-emerging growing regions: lessons & considerations

Rob Sirrine

Cornell Hop Conference

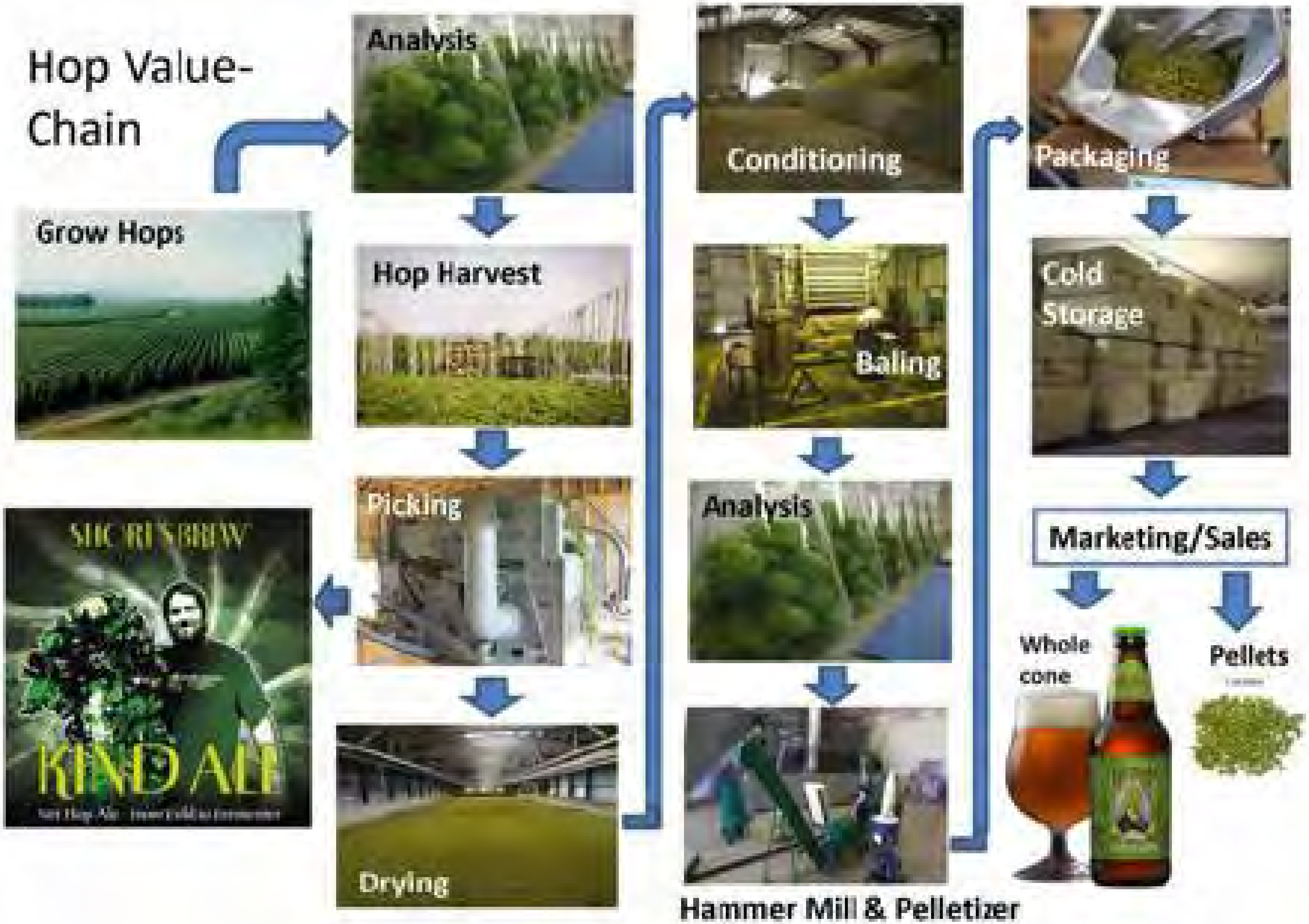
December 5, 2015

MICHIGAN STATE UNIVERSITY | Extensio

Outline

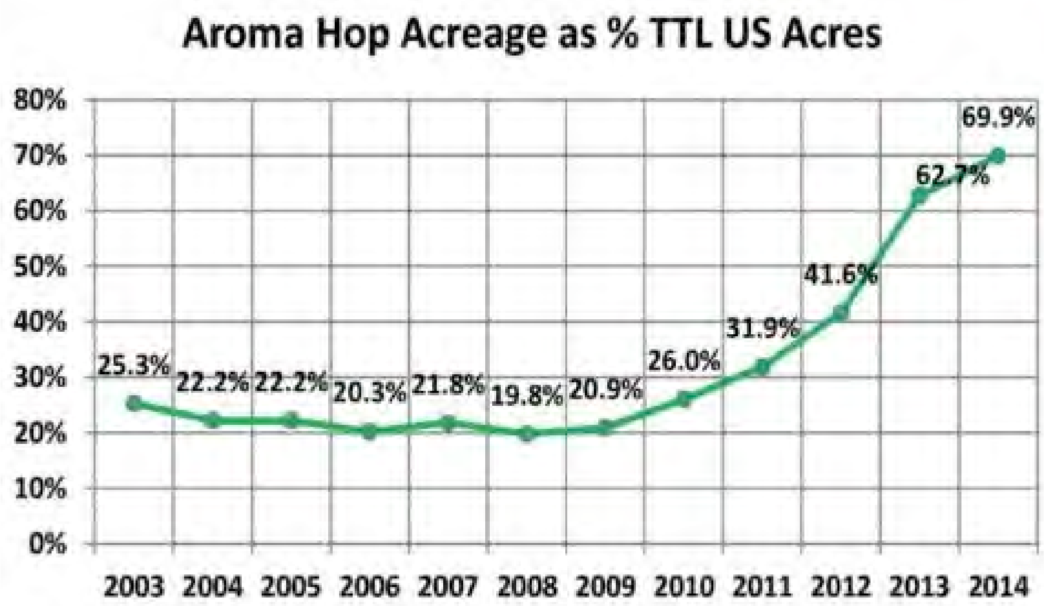
- Hops Value Chain
- Michigan 2008-present
- Market potential 2020
- Lessons Learned
- Germany 2015
- Food safety (GHP)

Hop Value-Chain

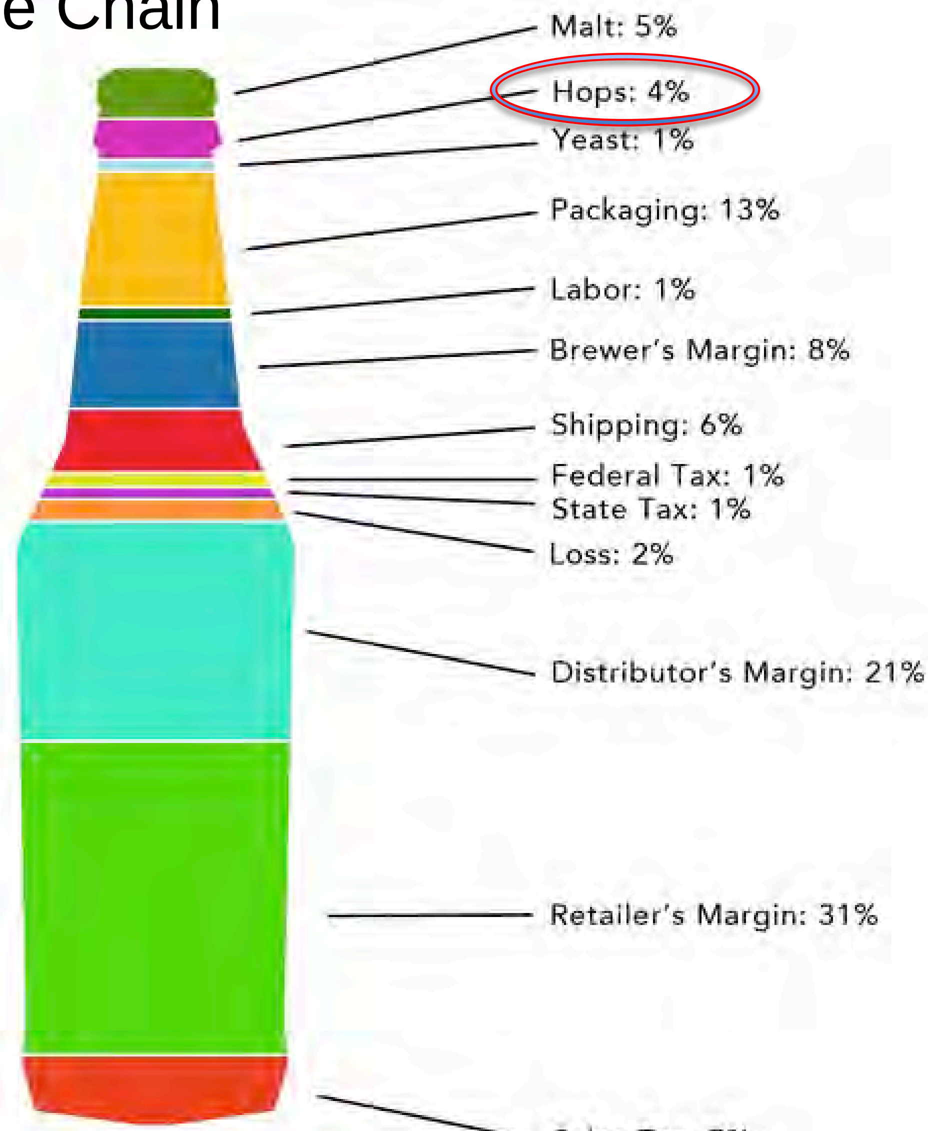


Two Distinct Markets

- 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, amarillo, simcoe, centennial, etc.



Craft Beer Value Chain



Huffingtonpost.com 9/12/14

Blue Stars - Growers who have confirmed hop varieties and contact information.

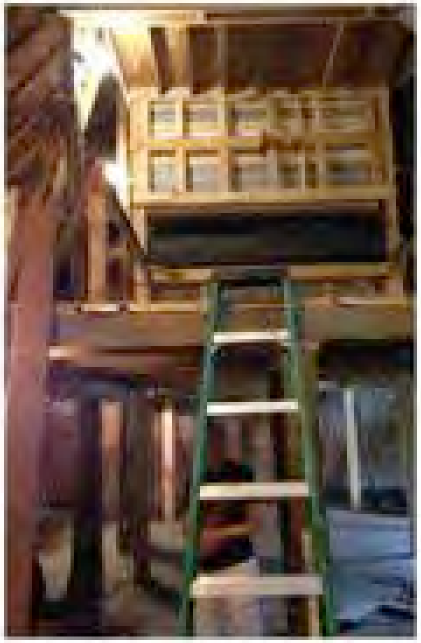
Green Stars - Growers who have more than 10,000 plants and have confirmed hop varieties.

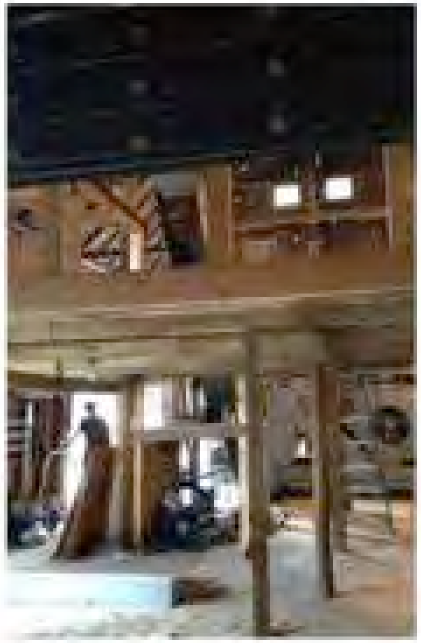
Yellow Stars - Great Lakes Hops!

Diamonds - Research centers and Universities.

Circles - Growers who have not yet confirmed data. (Turn me into a star!)

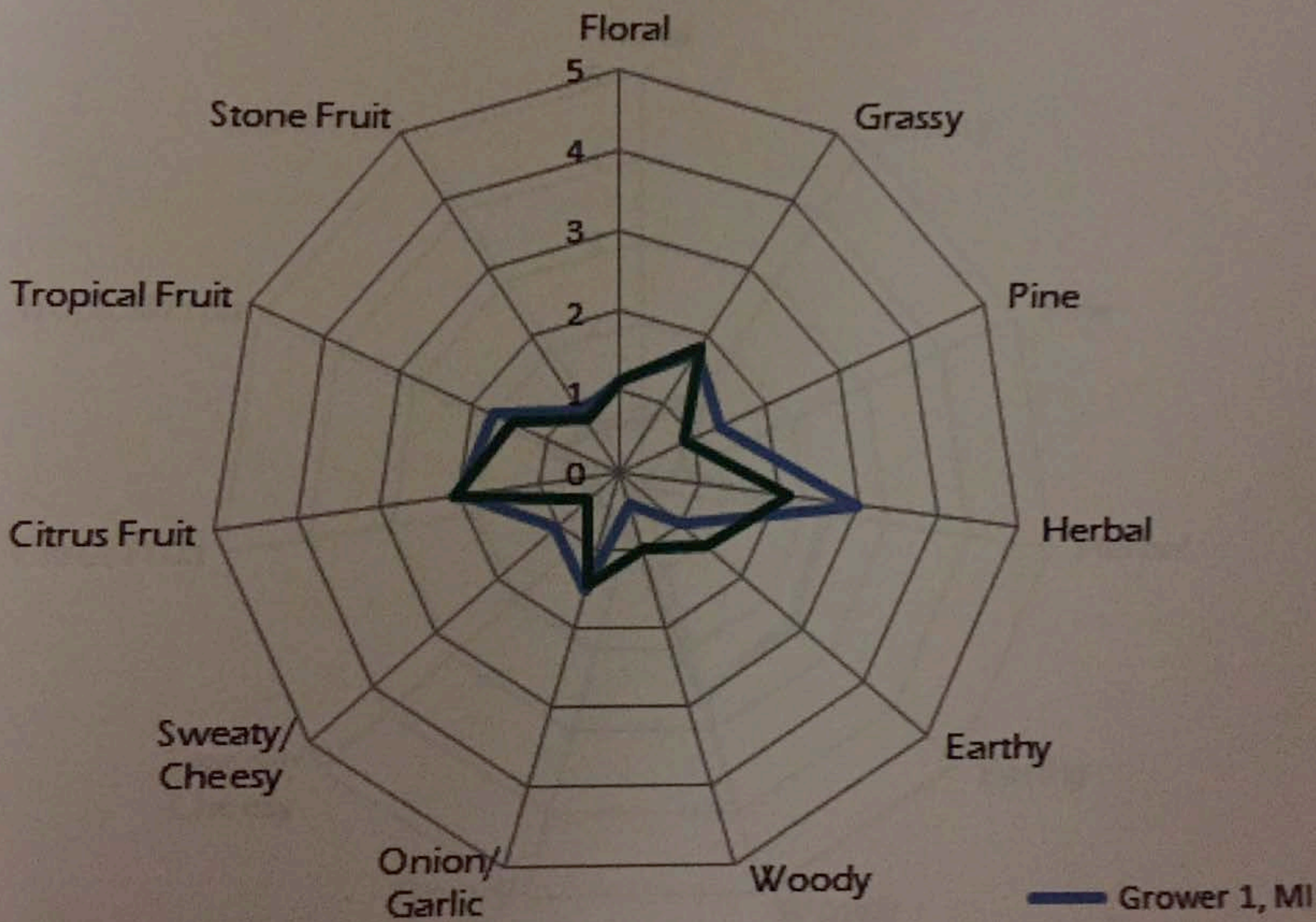
Scaffold of doom

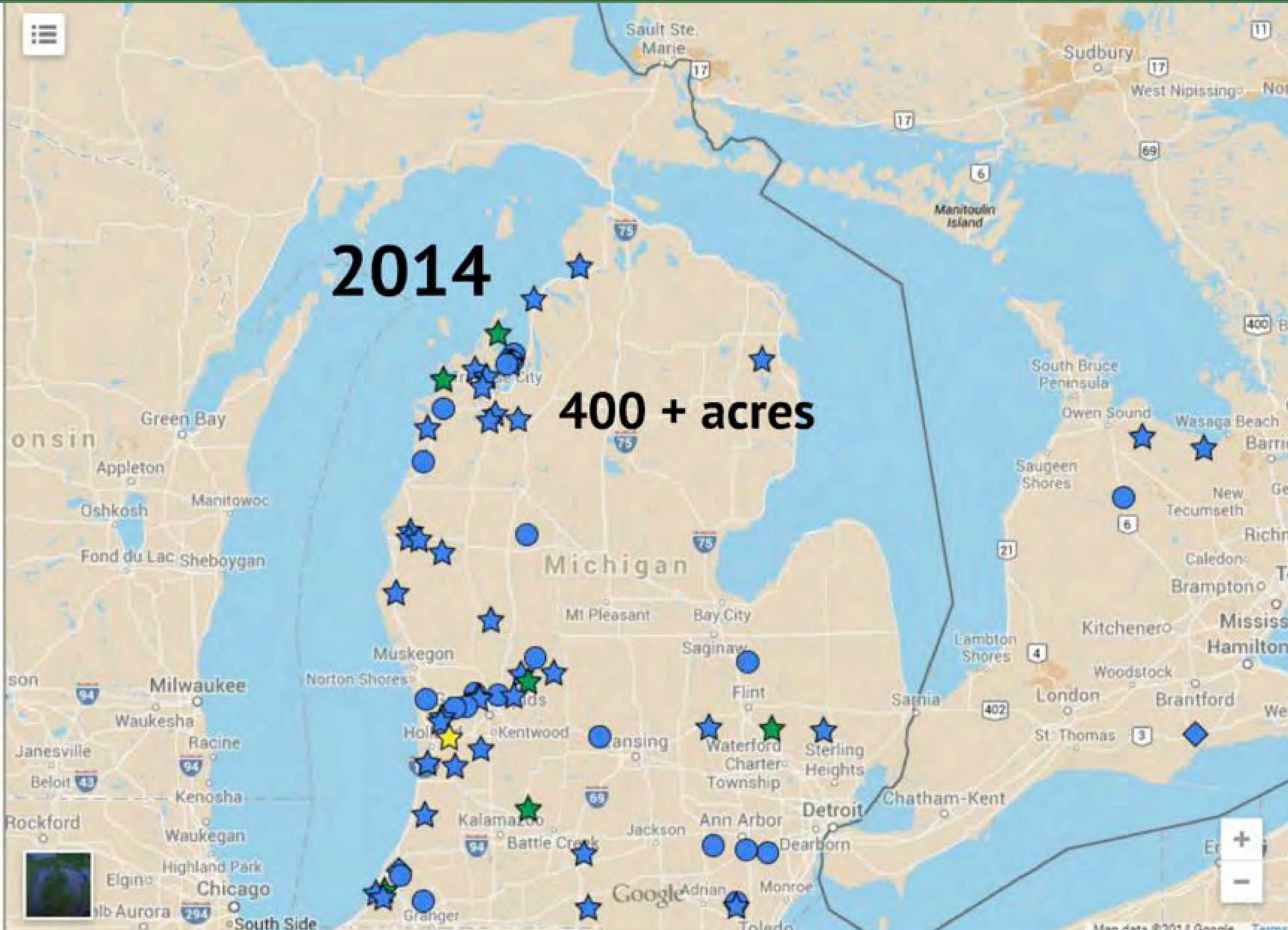





HOP HEAD FARMS
QUALITY MIDWEST HOPS

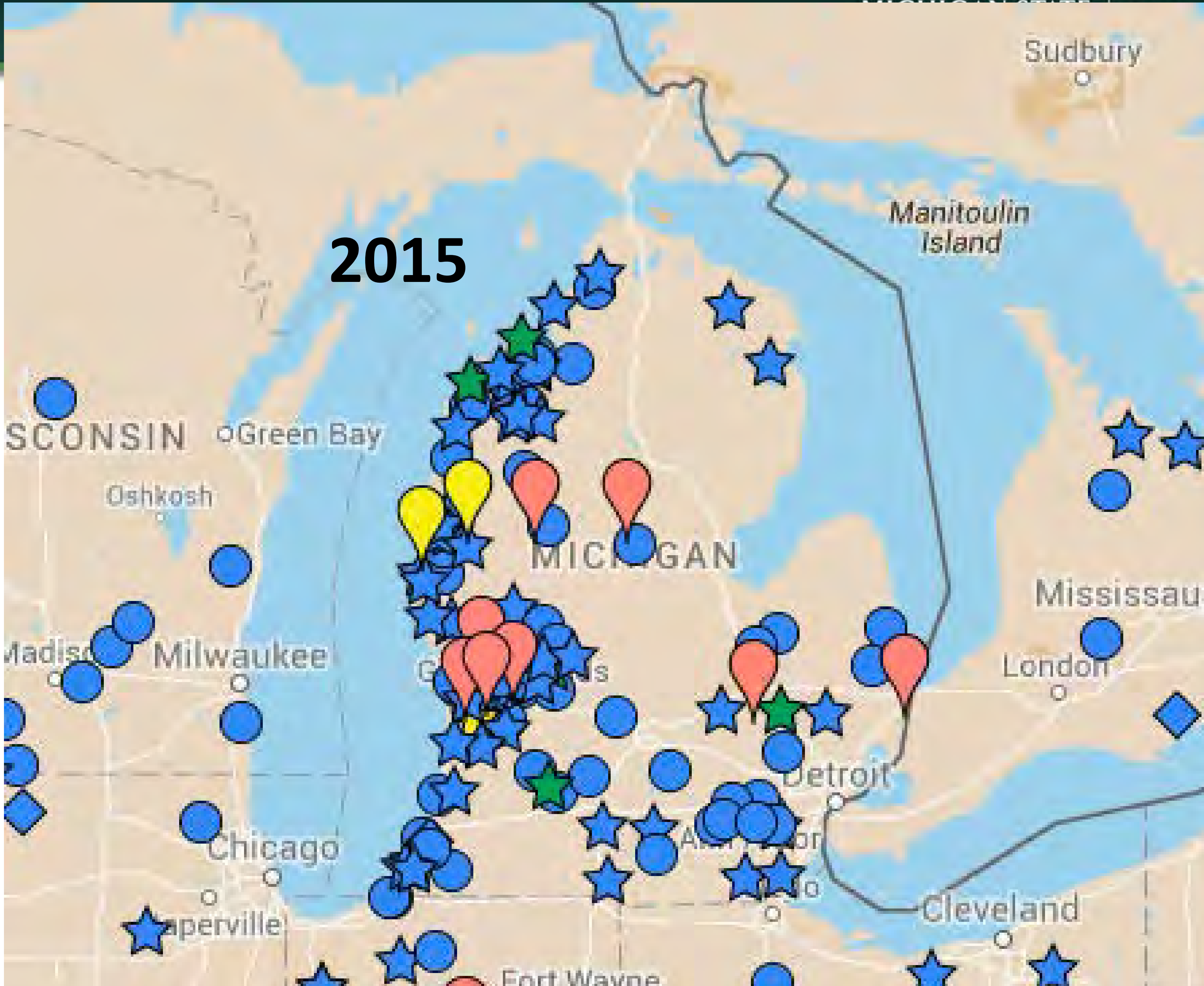
Comparison of Centennial hops





Blue Stars - Growers who have confirmed hop varieties and contact information.

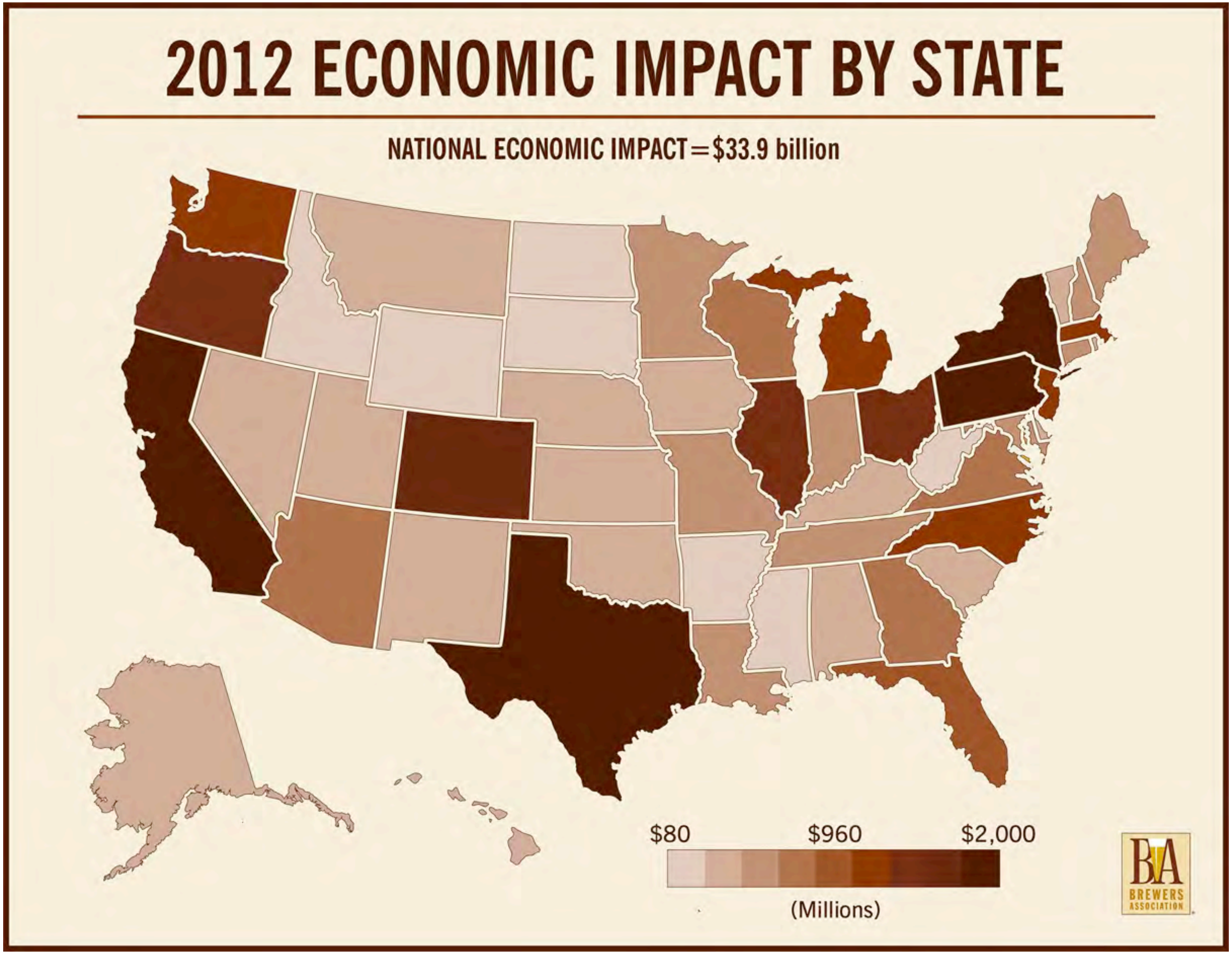
Diamonds - Research centers and Universities.


2015
Sudbury
Manitoulin Island
SCONSIN
Green Bay
Oshkosh
MICHIGAN
Mississaug
Milwaukee
London
Detroit
Chicago
aperville
Cleveland
Fort Wayne


Herman's
JCB
(231) 256-0065


MI LOCAL HOPS
Photo by Mike Moran

Hops: Markets



A new brewery is opening in the U.S. every 16 hours

U.S. BEER SALES VOLUME GROWTH 2014

OVERALL BEER
0.5%
197,124,407 bbls

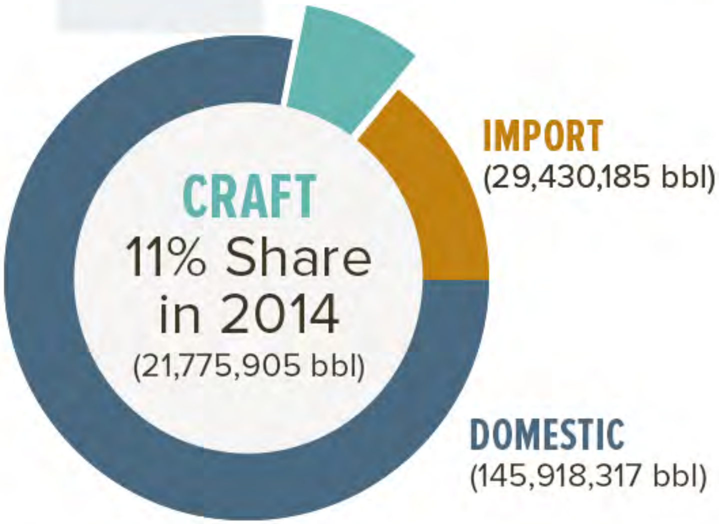
17.6%
CRAFT
21,775,905 bbls

IMPORT BEER
6.9%
29,430,185 bbls

36%
EXPORT CRAFT BEER
383,422 bbls

OVERALL BEER MARKET
$101.5 BILLION

CRAFT BEER MARKET
$19.6 BILLION
22% DOLLAR SALES GROWTH

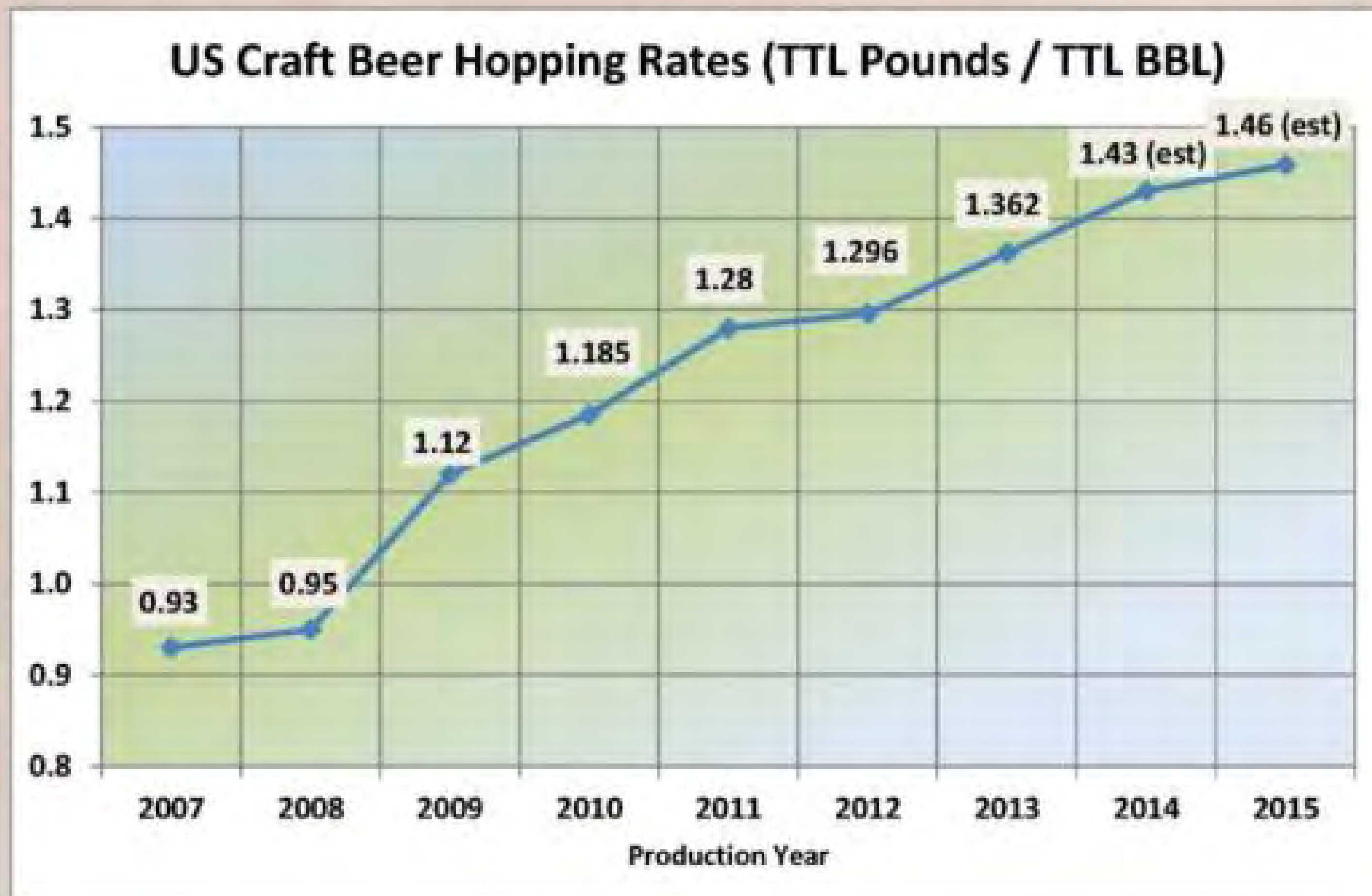


Source: Brewers Association, Boulder, CO


5:53:09

MICHIGAN STATE UNIVERSITY | Extension

Hopping Rates



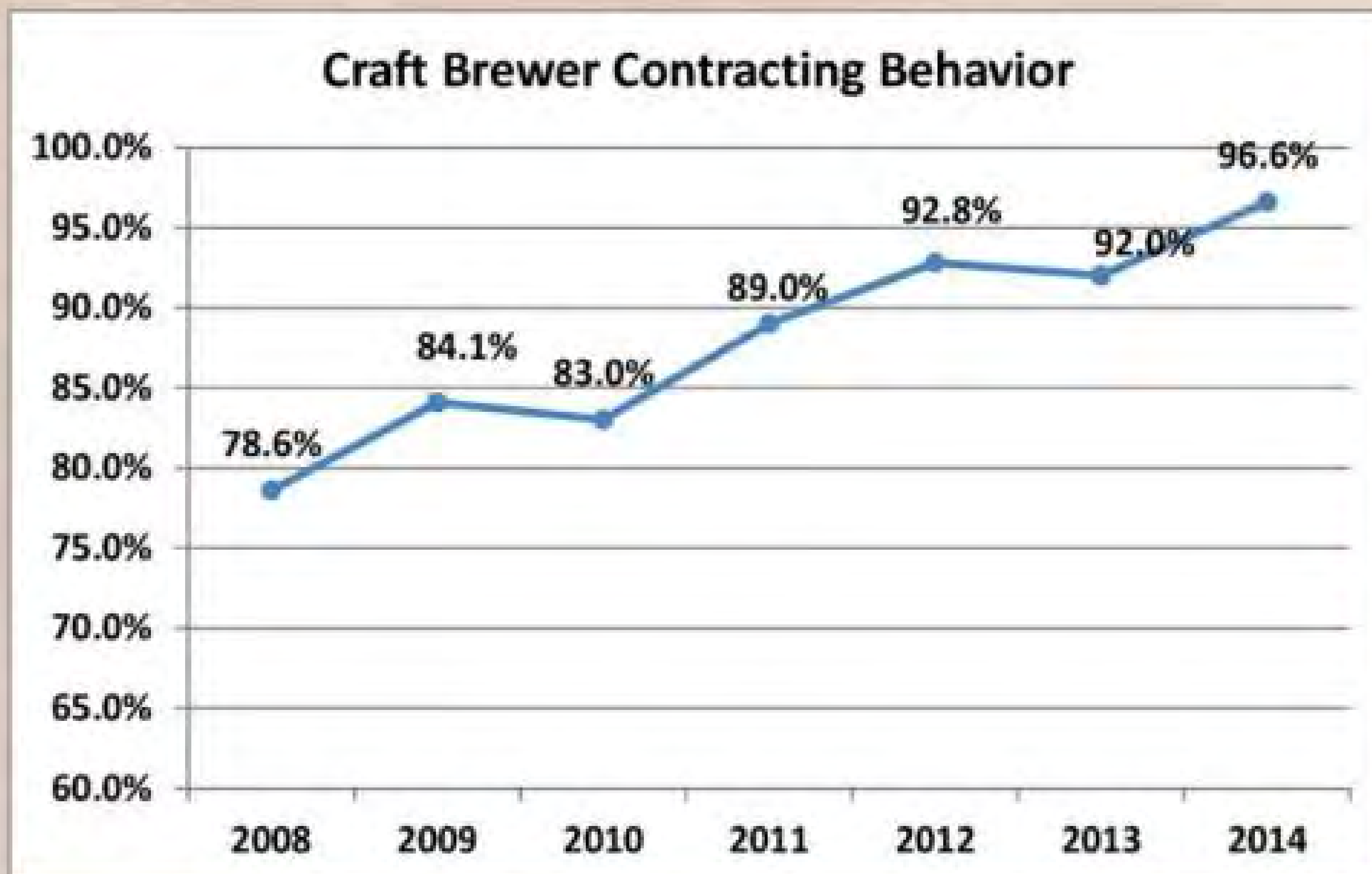
CS26

BREWERS ASSOCIATION

Craft Brewer Hop Usage
Top Ten Varieties

2010 2011	2011 2012	2012 2013	2013 2014
Cascade	Cascade	Cascade	Cascade
Centennial	Centennial	Centennial	Centennial
Chinook	Chinook	Chinook	Simcoe
Amarillo	Willamette	CTZ	Chinook
Willamette	Simcoe	Simcoe	CTZ
CTZ	CTZ	Amarillo	Amarillo
Crystal	US Golding	Crystal	Crystal
Simcoe	Crystal	Willamette	Willamette
US Golding	Amarillo	Saaz (CZ)	Citra
Ahtanum	Ahtanum	US Golding	Saaz (CZ)

Contract Or Die



Getting to 20/20 – Hops

Dr. Bart Watson, Brewers Association

-12,000 new acres?

-$180 million minimum in acreage investments?

-25 million more pounds of hops

-Pelletizing infrastructure

-Storage (even at 25 cents/lb. it adds up)

-Growers have been expanding and investing

3 Beer Sold in MI (bbls)

Beer 6,257,864 bbls

ft Beer 452,000, 7.2%

aft Beer 297,000, 4.7%

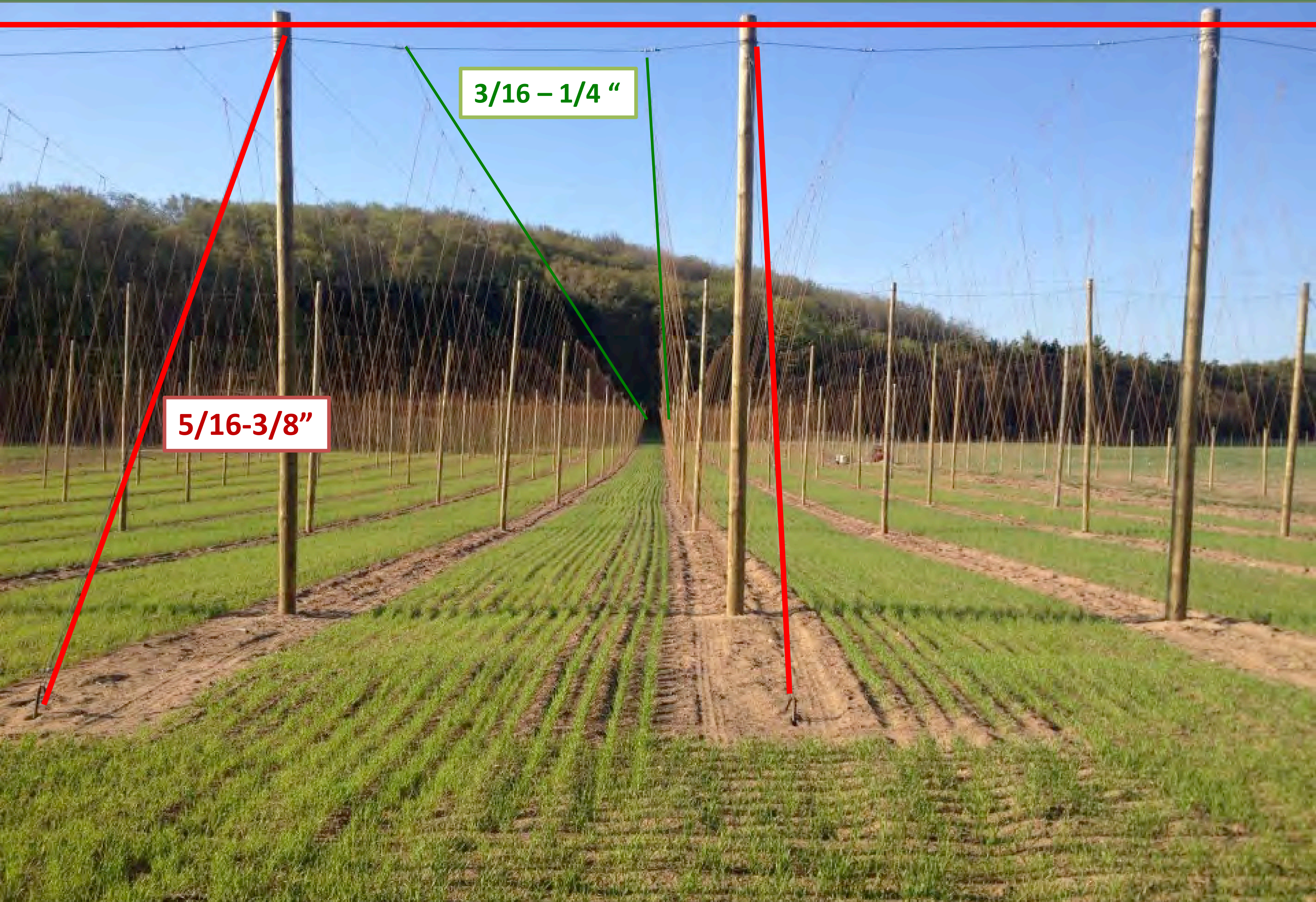
Source: 2014 MSU Hop Industry Needs Assessment (Survey Monkey, n=122) and expected hop acreage as reported by growers, Hop Growers of America, & the Michigan Brewers Guild

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

- Environment (temp, day length, soil texture, weather)
  - Day length drives production stages (photoperiod sensitive)
  - Latitude determines day length
  - Heat determines growth during each stage

- 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

Lessons Learned: Don’t skimp on infrastructure


3/16 – 1/4 “
5/16-3/8”

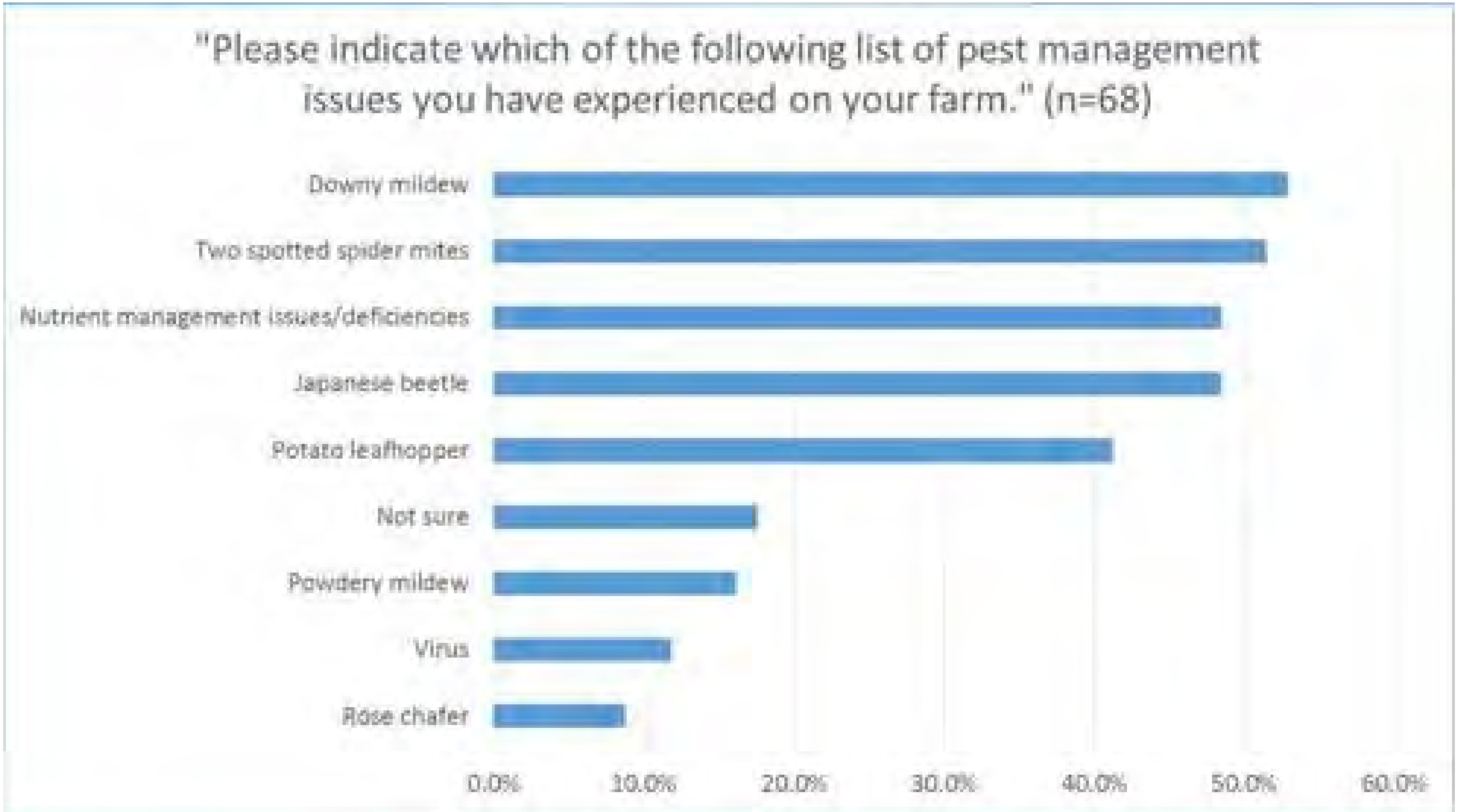
Traverse City, MI , August 2, 2015

Storm Name: Chuck Norris

Lesson Learned:

Chuck Norris can kick your ass

Lessons: 2015 DM control every 7-10 days



Lessons Learned: Training Date

1970-1973 Studied the effect of the date of training

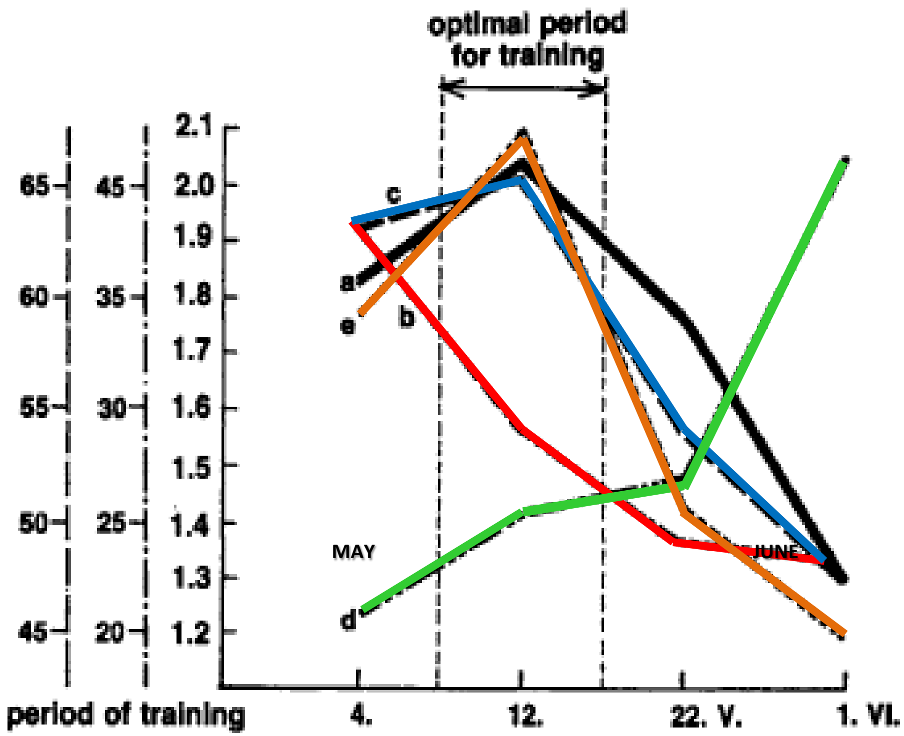
a. Yield

b. Length of cones

c. Number of shoots

d. Density of setting (# cones per 10cm of shoot)

e. Mean length of shoots



Yield Reductions

Late training (June 1) = 38.5 %
Early training (May 4) = 10.3%

TAKE HOME: the date of training principally affects the yield of cones and their quality

RybaCek, V. 1991. Hop Production. Developments in Crop Science 16. Pg. 205

Lessons Learned: 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
- $-right size your well, different zones for different cultivars

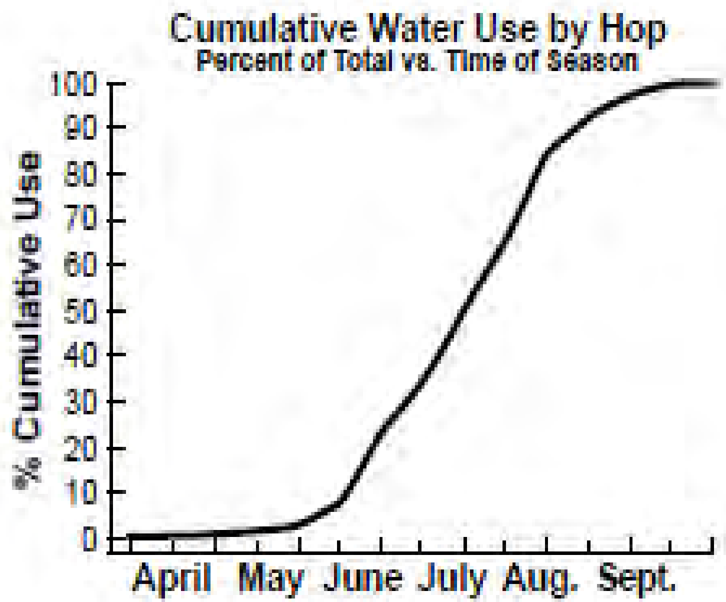


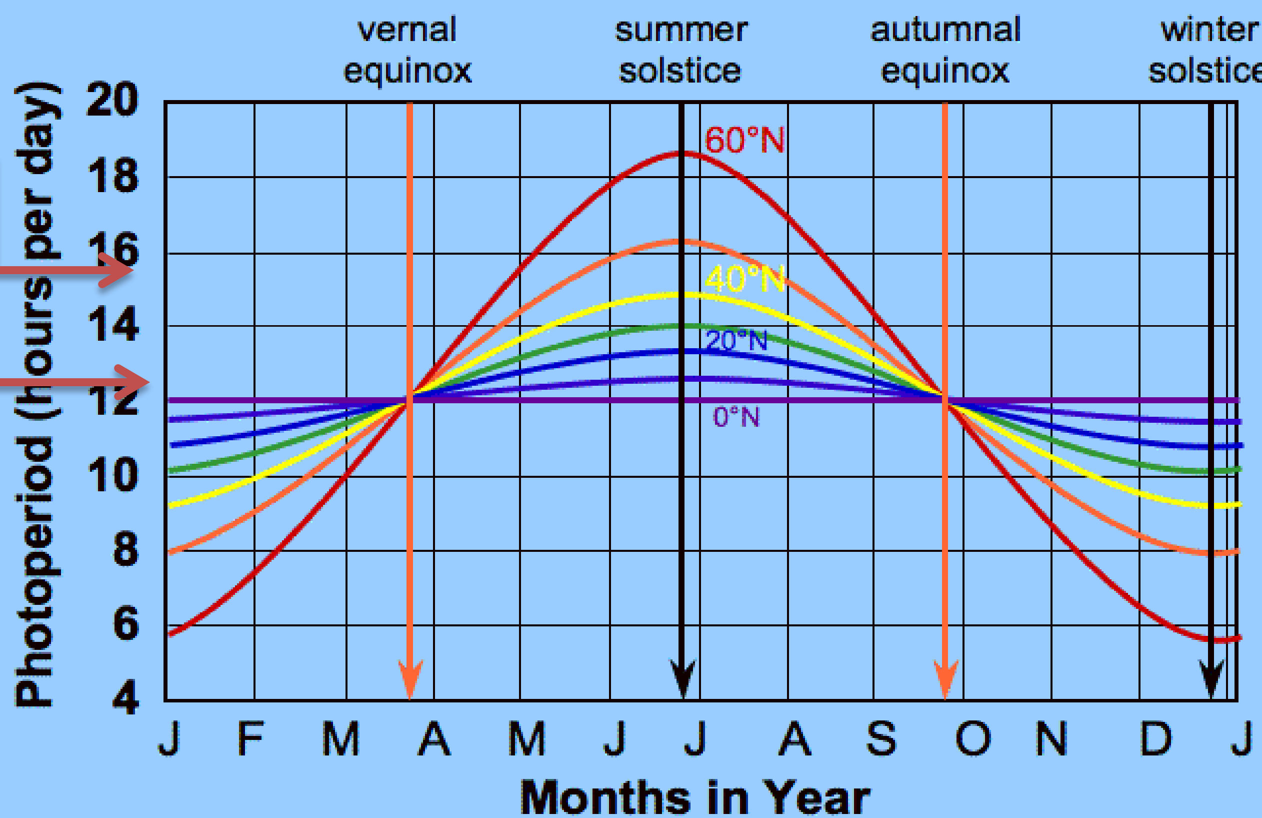
Fig. 1. Cumulative water use of hop during the growing season.

Evans, R. 2003. Hop Management in water short periods. EM4816. WSU Extension Bulletin

Photoperiod Sensitivity (why location matters)

Floral Initiation

Plant growth begins



Traverse City, MI : ~45 degrees N

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 (15 hrs of light)

Irrigation: Examples

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

Lessons Learned: Fertility

- Tissues tests and Soil tests
- Recommended fertilization rates:
- Nitrogen (N) = 150-200 lbs/acre total
- April-May with urea (40-0-0) every week (100 lbs: 25 lbs each week)
- Mid-May: Triple 16
- End-May-burn/prune back flag shoots
- June-75-100 lbs liquid N (28N solution)
- Boron, Iron, Manganese, Zinc, Copper
- Phosphorous (P) = 60-100 lbs/acre
- Potassium (K) = 100 lbs/acre (potash)

PLOT ID: G3F7Y

Kinsey Agricultural Services, Inc.

297 County Highway 357 - Charleston, MO 63834
Phone 573-683-3880 Fax 573-683-6227 e-mail neal@kinseyag.com

Client: MICHIGAN STATE UNIVERSITY EXTENS City : SUTTONS BAY , MI Date : 12-Sep-12

		Previous Analyses & Applications
Location	HORT STATION	
Crop	HOPS / HOPS	
Field / Sample	N	
Lab No.	B0103	
Total Exchange Capacity (M.E.)	7.56	
Desired Ca : Mg, Percent	66 : 14	
pH of Soil Sample	7.0	
Humus Content, Percent	1.9	

BASE SATURATION PERCENT		%	%	%
Calcium (60 to 70%) } 80%	76.15			
Magnesium (10 to 20%)	15.67			
Potassium (2 to 5%)	2.88			
Sodium (.5 to 3%)	0.92			
Other Bases (Variable)	4.38			
EXCHANGEABLE HYDROGEN (10 to 15%)	0.00			

				FOR ORGANIC RECOMMENDATIONS Amendment	Lbs/Acre	FOR CONVENTIONAL	Lbs/Acre
ANIONS	NITROGEN Lbs/Acre	ENR Value	58	FEATHER MEAL 13-0-0 (a) FEATHER MEAL 13-0-0 (b) COMPOST	450 375	UREA 46-0-0 (c) AMSULF 21-0-0-24 (d) CAN 17 N (e) (See Note Below) LIQUID N 32% (f)	40 125 50 125
	SULFATE - S p.p.m.	Value Found	16	SULFUR 90-92% (g)	75	SULFUR 90-92% (g)	75
	PHOSPHATES as (P2O5) Lbs/Acre	Desired Value Olsen Value Value Found Deficit/Surplus	750 636 -114				
						Amend / added	
CATIONS	CALCIUM Lbs/Acre	Desired Value Value Found Deficit/Surplus	2062 2309 +247	NONE			
	MAGNESIUM Lbs/Acre	Desired Value Value Found Deficit/Surplus	250 285 +35	NONE			
	POTASSIUM Lbs/Acre	Desired Value Value Found Deficit/Surplus	443 170 -273	POT SULFATE 0-0-50 (h)	250	POT SULFATE 0-0-50 (h)	250
	SODIUM Lbs/Acre	Desired Value Value Found Deficit/Surplus	35 32 -3				
						P.P.M	
TRACES	Boron	p.p.m.	0.88	BORAX 11%	20	BORON 14.3%	15
	Iron	p.p.m.	411				
	Manganese	p.p.m.	63	MANG SULF 28%	50	MANG SULF 28%	50
	Copper	p.p.m.	1.40	CU SULFATE 23%	20	(Or 5 lbs/acre per year for 4 years.)	20
	Zinc	p.p.m.	8.50	ZINC SULFATE 36%	35	ZINC SULFATE 36%	35

(a) Apply 1 week or so before spring growth begins.

Lesson: Weed control-especially w/ babies

Lesson: Harvest Timing Variety Dependent

Hops are harvested upon reaching the "technical ripeness" (highest brewing value), not at full or "physiological" maturity. **Each variety has its own specific, genetically determined optimal time of harvest. Varies by the weather, location, biological window, and the cutting time.**

Harvest time crucially affects:

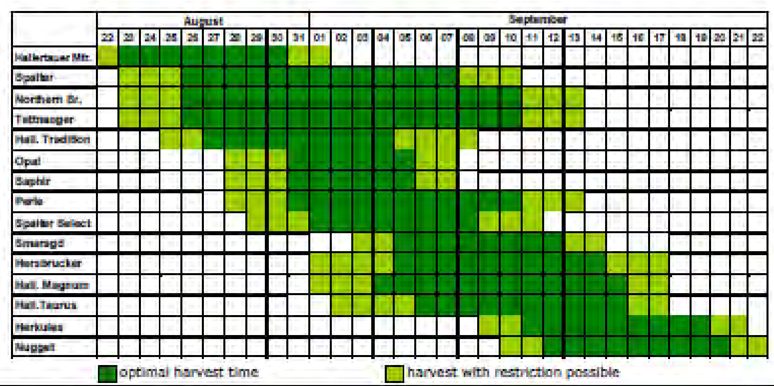
- α-acid contents
- yield
- external quality (color and shine, infection with diseases and pests, shattering)
- aroma (aroma intensity, oil content and composition)
- vigor and vitality of the plant (in the next season)

↓

Economic interest of hop growers, traders and brewers

Results from harvest time studies

- 5 – 8 harvest times (2 dates / week), 4 replications with 20 bines each
- 3- 4-year-trials (climate, health and vitality)
- data for yield, α-acid contents, aroma, external quality, shortcomings assessed



Lutz et al. 2009. The Right Time to Harvest Optimal Yield and Quality. Bav. State Research Center for Agriculture. Institute for Crop Science and Plant Breeding Hop Research Center Hüll

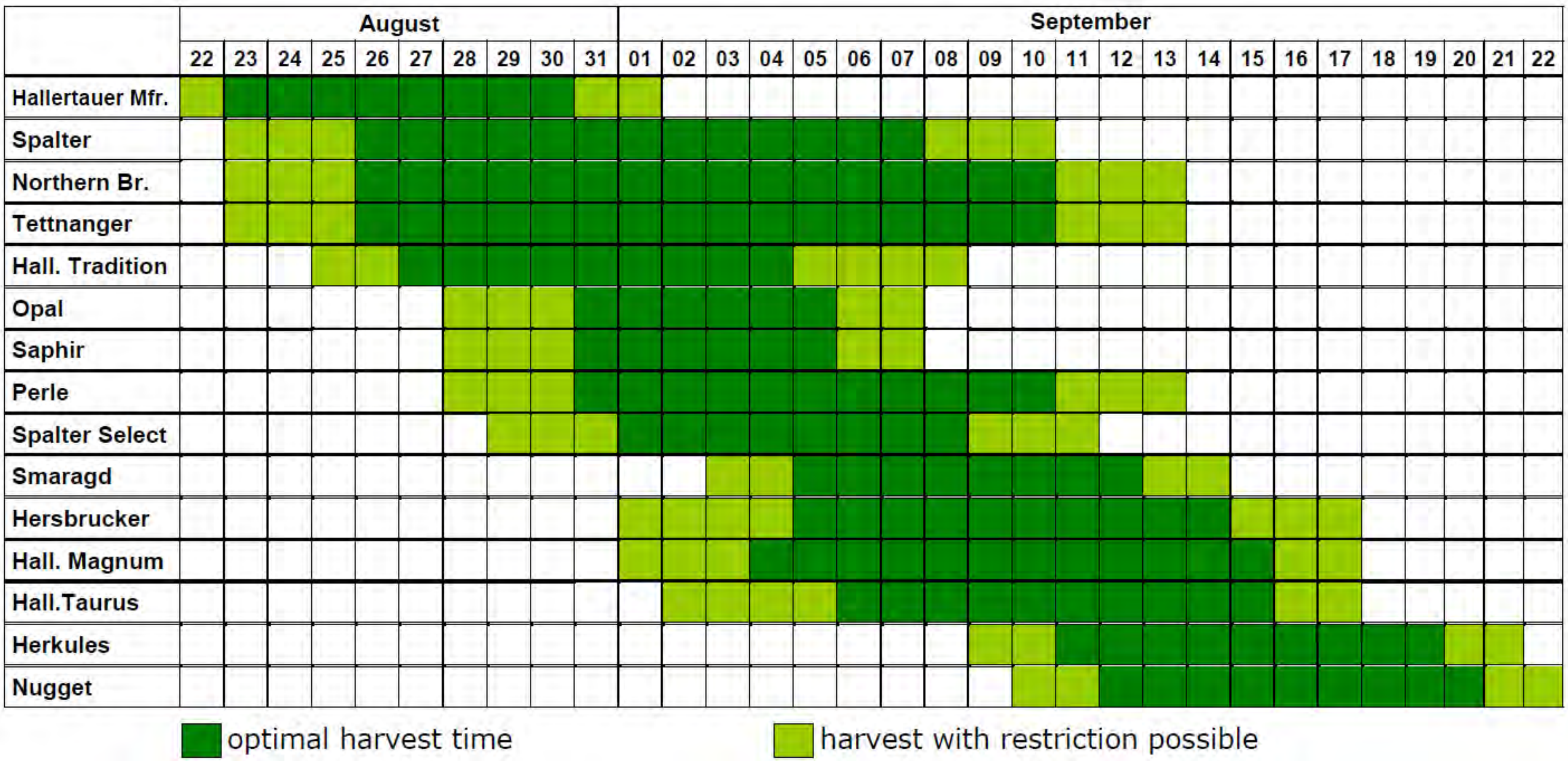
LfL Pflanzenbau

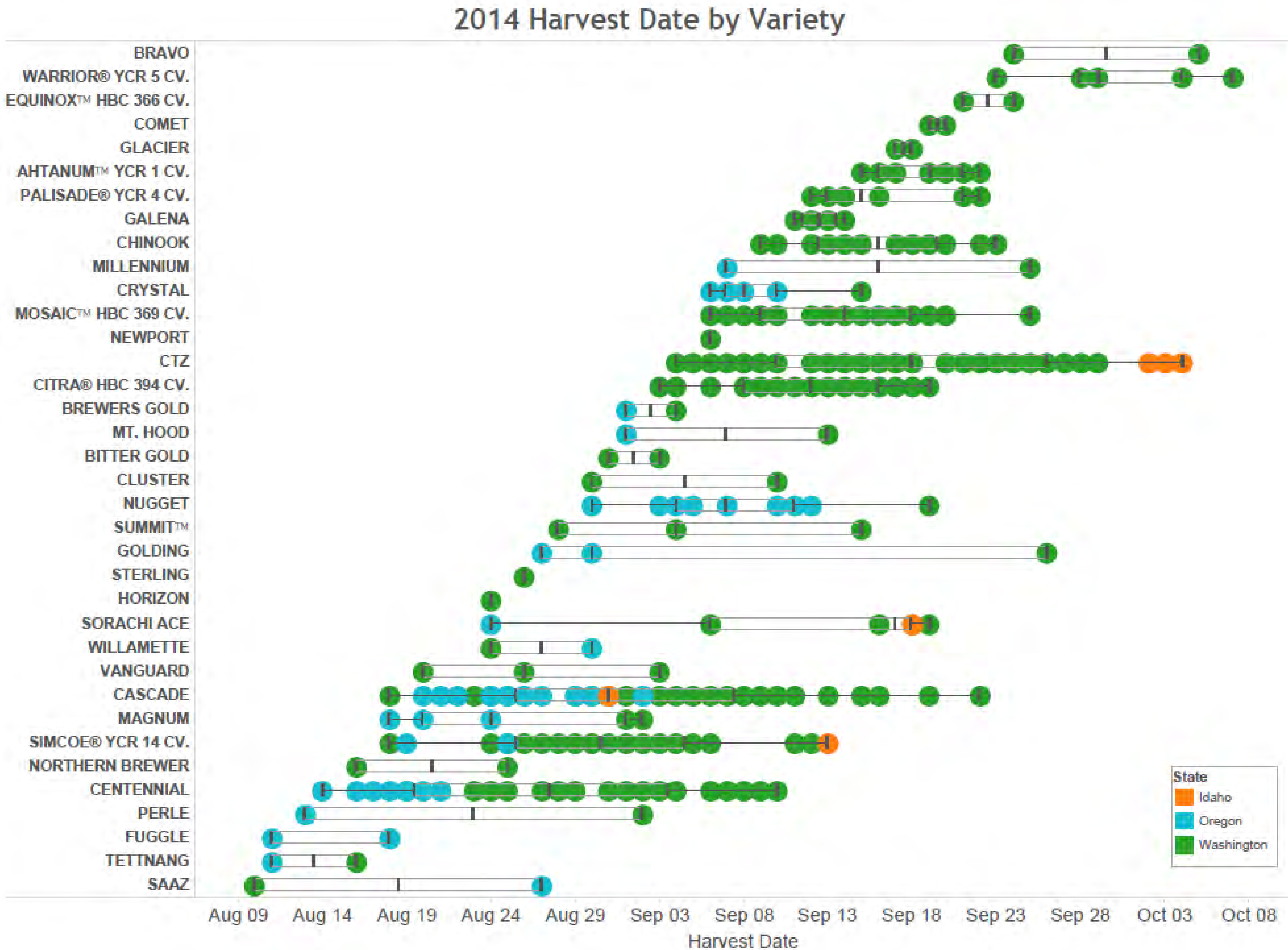
Bav. State Research Center for Agriculture

Institute for Crop Science and Plant Breeding
Hop Research Center Hüll

The Right Time to Harvest Optimal Yield and Quality

A. Lutz, J. Kneidl, E. Seigner , and K. Kammhuber




2014 Harvest Date by Variety
BRAVO
WARRIOR® YCR 5 CV.
EQUINOX™ HBC 366 CV.
COMET
GLACIER
AHTANUM™ YCR 1 CV.
PALISADE® YCR 4 CV.
GALENA
CHINOOK
MILLENNIUM
CRYSTAL
MOSAIC™ HBC 369 CV.
NEWPORT
CTZ
CITRA® HBC 394 CV.
BREWERS GOLD
MT. HOOD
BITTER GOLD
CLUSTER
NUGGET
SUMMIT™
GOLDING
STERLING
HORIZON
SORACHI ACE
WILLAMETTE
VANGUARD
CASCADE
MAGNUM
SIMCOE® YCR 14 CV.
NORTHERN BREWER
CENTENNIAL
PERLE
FUGGLE
TETTNANG
SAAZ
Aug 09
Aug 14
Aug 19
Aug 24
Aug 29
Sep 03
Sep 08
Sep 13
Sep 18
Sep 23
Sep 28
Oct 03
Oct 08
Harvest Date
State
Idaho
Oregon
Washington

Sensory Evaluation (Taste Test)

Table 6: Summary data for consumer acceptance testing of Typical and Late Harvest Hopped Beers

Attribute	*Typical*	*Late*
Overall Liking*	7.11 [a]	6.26 [b]
(SD)	(0.83)	(1.61)
Aroma Liking*	6.92 [a]	5.82 [b]
(SD)	(1.31)	(1.96)
Flavor Liking	6.98 [a]	6.23 [b]
(SD)	(1.03)	(1.68)

**, ***Attribute Significant at $p<0.01$, and 0.001, respectively. Means within a row with different letters are significantly different from one another at $p<0.05$ by Tukey's HSD. Standard deviations are shown in parentheses below means. Scale: 1 = dislike extremely, 9 = like extremely.

"Beers brewed with typical harvested Cascade hops were significantly distinguishable in sensory analysis and preferred by consumers over late harvested cascade hops."

Sharp et al. 2013. Conclusions

- Increased oil may be desirable for aroma type hops, other properties should be considered to determine the overall quality
- Later harvested hops had a higher tendency to shatter or break apart during processing.
- Earlier the harvest date = greener cones
- These observations could have commercial significance since brewers often use color as an indicator of high quality hops

TAKE HOME: Timing is very important

Lessons Learned: Transport to the Picker

Degradation potential

- Distance?
- Humidity level?
- Time of harvest (early a.m. or noon)?
- Temperature at harvest?
- Cost

In terms of the drying process picked hop cones can be regarded as a living organism whose basic life processes, particularly respiration, are continuing. They first react to being removed from the plant by a higher intensity of respiration. Rybacek, 1991.

Lessons Learned: Hop Picking Capacity

Picker	bines/hour	total
• 140	140	15a
• 170	170	20a
• 220/230	220	32a
• WHE 513	500	80-100a
• WSZ 1000	800-1150	
• Danhauer	1.5 acres	a lot

513 video

Lessons Learned: Drying

Drying is regarded as the most important operation in the harvesting process.

- The basic process around which the hop harvest should be organized
- Therefore, the preceding operations, both in time and volume, should be matched to the speed of the drier.

Rybacek, V. (ed). 1991. Developments in crop science 16: Hop Production. Elsevier. Amsterdam.

Factors that influence drying

1. air velocity
2. air moisture content
3. bed depth
4. air temperature

Contribute to the effectiveness of drying and the resulting aromatic, physical, and storing properties of dried hops.

Dryer Types

- Bed
- Louvered

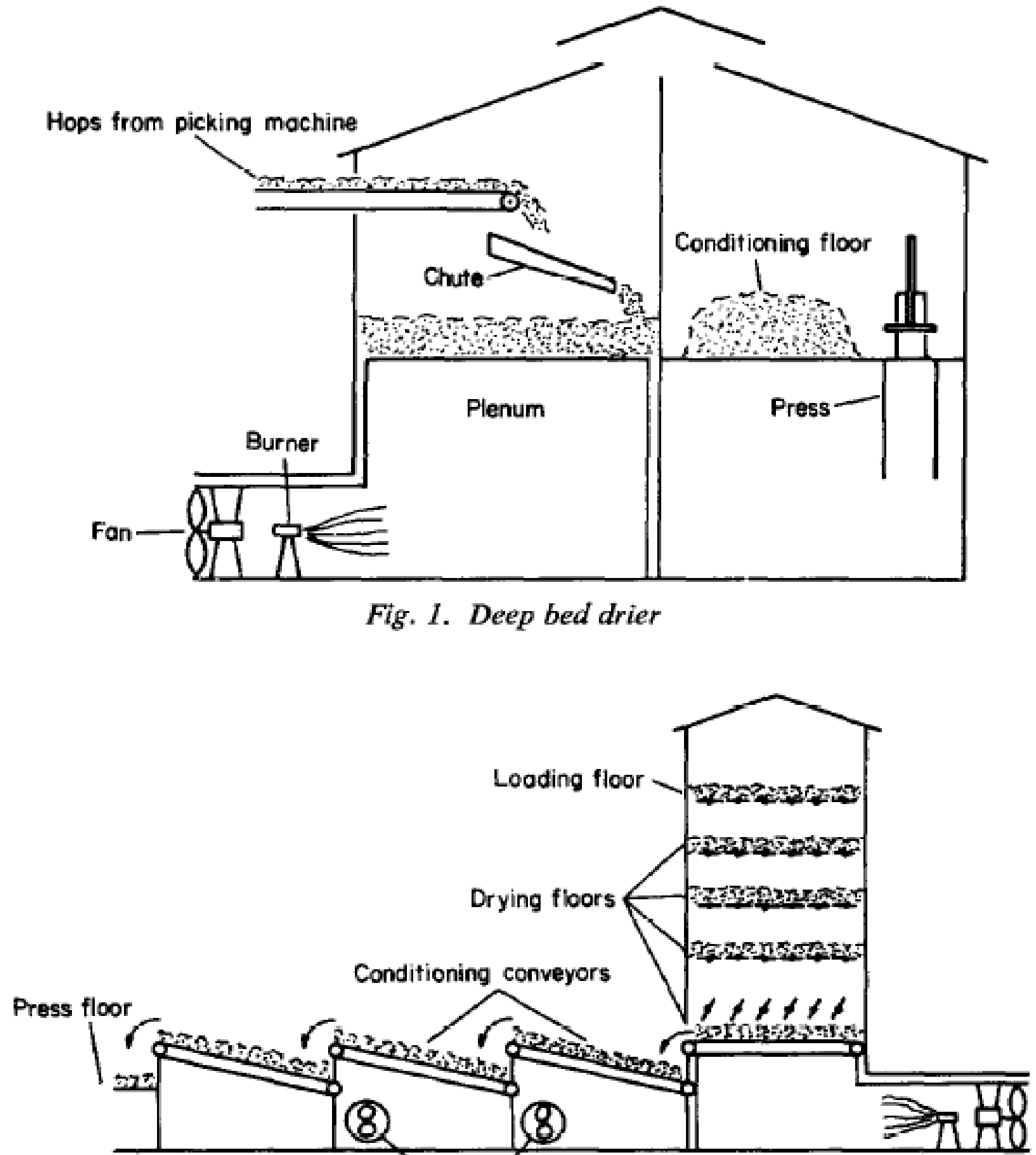
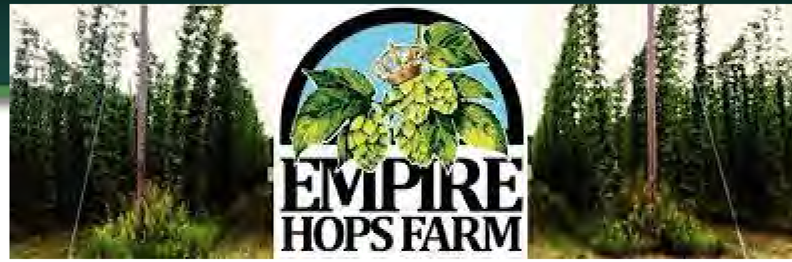


Fig. 1. Deep bed drier

Fig. 2. Falling bed drier

Dryer Types: Bed Dryer

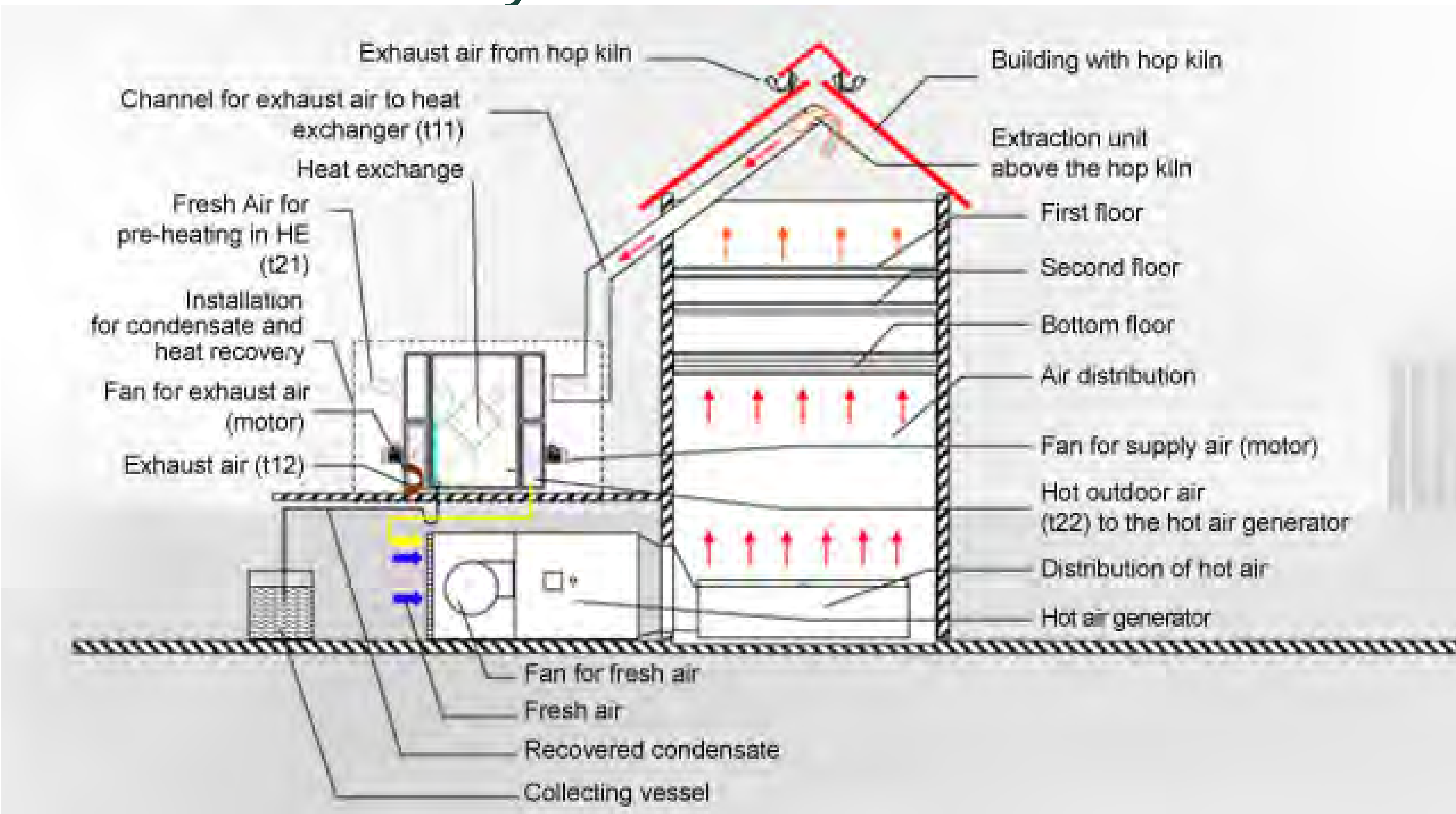
The current practice is to load the whole floor before starting the fan and burner. The hops dry progressively from the bottom of the bed to the top in around 8-12 hours.


EMPIRE
HOPS FARM

Louvered, multilevel Hop Dryers

- Louvered Dryers are exceptional space savers and easy to use.
- The drying process typically takes place on three levels, on two shelves and in louvered drawer.

Wolf-Modern system



- *The interdependence of picking and drying* is very difficult to accommodate, it requires a matched efficiency and similar operation rate of both parts.
- The efficiency of the whole centre depends on the drier, which influences the other components.

Rybacek, V. (ed). 1991. Developments in crop science 16: Hop Production. Elsevier. Amsterdam.

- Matched to the WHE-513, 30-40 Ha
- 180-360kg/per drawer
- Each drying cycle about 4 hours
- Two yr, 2 phased project ~$3 million dollars


WOLF


Empty
Full
OAST FLOOR
Middle
Drawer
WOLF
WOLF
WOLF
Hop-Control

The effect of kilning air temperature on hop essential oil content and aroma

Presenter: Thomas P. Nielsen, Sierra Nevada Brewing Co., Chico, CA
Coauthors: Val Peacock, Hop Solutions, Inc., Edwardsville, IL; Scott Garden, John I. Haas, Yakima, WA; Patrick Smith, Loftus Ranches, Moxee, WA

2013 MBAA Conference

- Presented results of 2012 Hop drying study conducted in Yakima
- Funded by HQG and John I. Haas
- Compared drying temps of 130 F vs. 150 F
- Citra and Cascade hops
- Sampled top, middle, and bottom of the beds in 3 different locations in each kiln

Cascade – Loftus Ranches

Bed depth 27" – 30 " – deeper at back of kiln

130° F Moisture Data

	Bottom Avg	Middle Avg.	Top Avg.
Kiln #1	6.04%	14.22%	20.51%
Kiln #3	7.83%	12.05%	15.95%
Kiln #5	6.70%	9.33%	13.44%
Avg	6.86%	11.87%	16.63%

150° F Moisture Data

	Bottom Avg	Middle Avg	Top Avg
Kiln #2	3.75%	8.45%	15.97%
Kiln #4	4.58%	9.61%	17.98%
Kiln #6	4.24%	11.59%	16.48%
Avg	4.19%	9.88%	16.81%

Citra® - Haas Golding Farm

Bed Depth 26 inches

130° F Moisture Data

	Bottom Avg.	Middle Avg.	Top Avg.
Kiln #7	7.80%	13.66%	21.70%
Kiln #9	5.99%	10.39%	18.09%
Kiln #11	4.76%	8.66%	20.10%
Avg	6.18%	10.90%	19.96%

150° F Moisture Data

	Bottom Avg.	Middle Avg.	Top Avg
Kiln #8	7.47%	11.83%	24.13%
Kiln #10	3.51%	3.20%	12.39%
Kiln #12	2.96%	6.39%	19.36%
Avg	4.65%	7.14%	18.63%

Conclusions for Growers

- Uniformity in Commercial American Operations terrible. Germany much better!
- Lower drying temp results in less garlic aroma, a smaller moisture gradient, and a longer window to turn off the heat.
- Down-side: Longer drying times – but same fuel consumption. It takes so many BTUs to evaporate so much water!

Peacock, Hop Quality 102, UW-Extension, Wisconsin Dells, March 2, 2013

Indicators of overheating

- If heated properly, lupulin remains lemon yellow.
- Too hot- lupulin color changes to brown
- This indicator has a direct relationship with the hop chemical content
- Eg. Chemical analysis will show that hi-temps= greater content of hard resins = reduced quality

Lessons Learned: Conditioning

Considerations

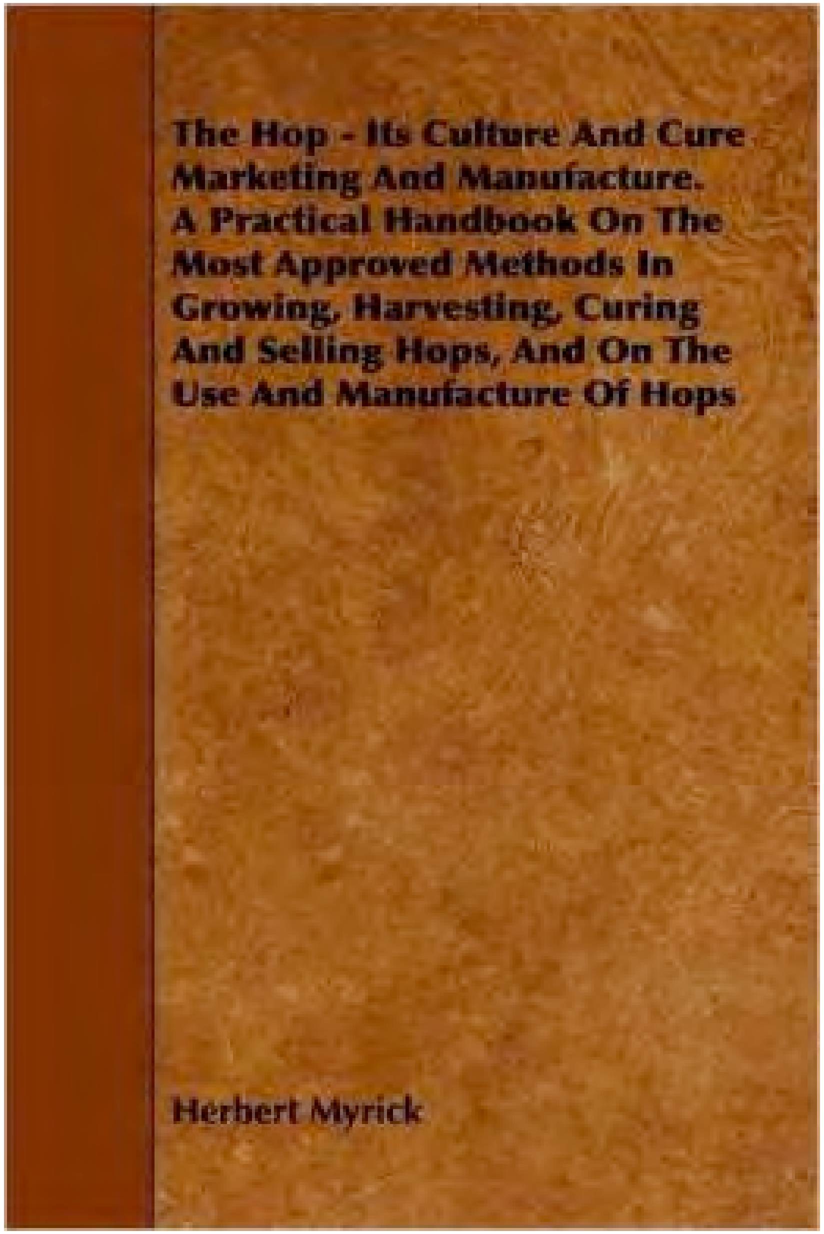
- Throughput and timing
- Space requirements
- Humidity

- "the hops are left in these heaps for 12 hours in a staged process known as "conditioning".
- The heaps are re-piled for a further 12 hours across the floor in which time the moisture level continues to equilibrate to ensure consistency across the kiln prior to baling.
- Target moisture level for our hops is around 9.5 % (+/- 1 %) which requires a high level of patience and skill to achieve.
- The hops pictured here are Cascades on the kiln floor at Machops in Motueka and are a beautiful sample."

Under-drying

Slack or under-drying: a slack hop is under-dried.

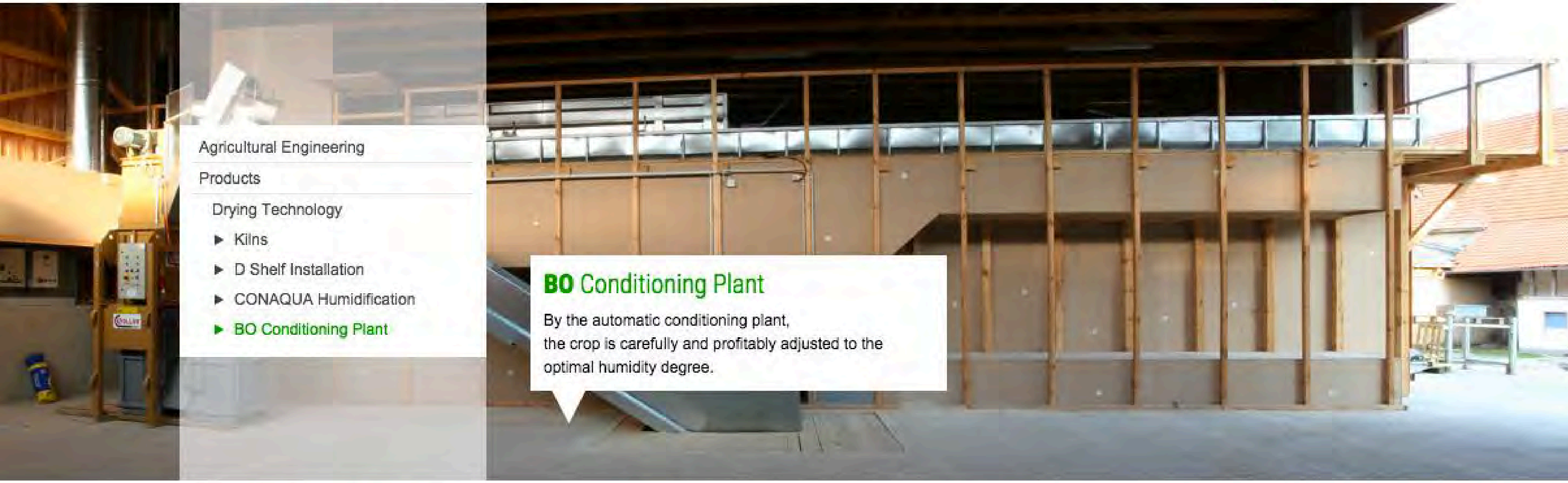
- Hops heat or sour, depending on the degree of slackness and storage condition.
- Heating (rotting) can occur in even a handful of slack hops
- Can quickly affect the entire bale, and even surrounding bales if closely stored.



Company | Career | Downloads | Contact | Support

English

Agricultural Engineering ▾ Current ▾ Products Sales References **Spirit of Air®**



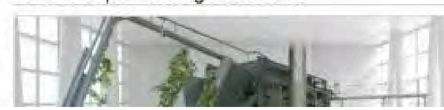
You are here: ▶ Home | ▶ Agricultural Engineering | ▶ Products | ▶ Drying Technology | BO Conditioning Plant

BO Conditioning Plant

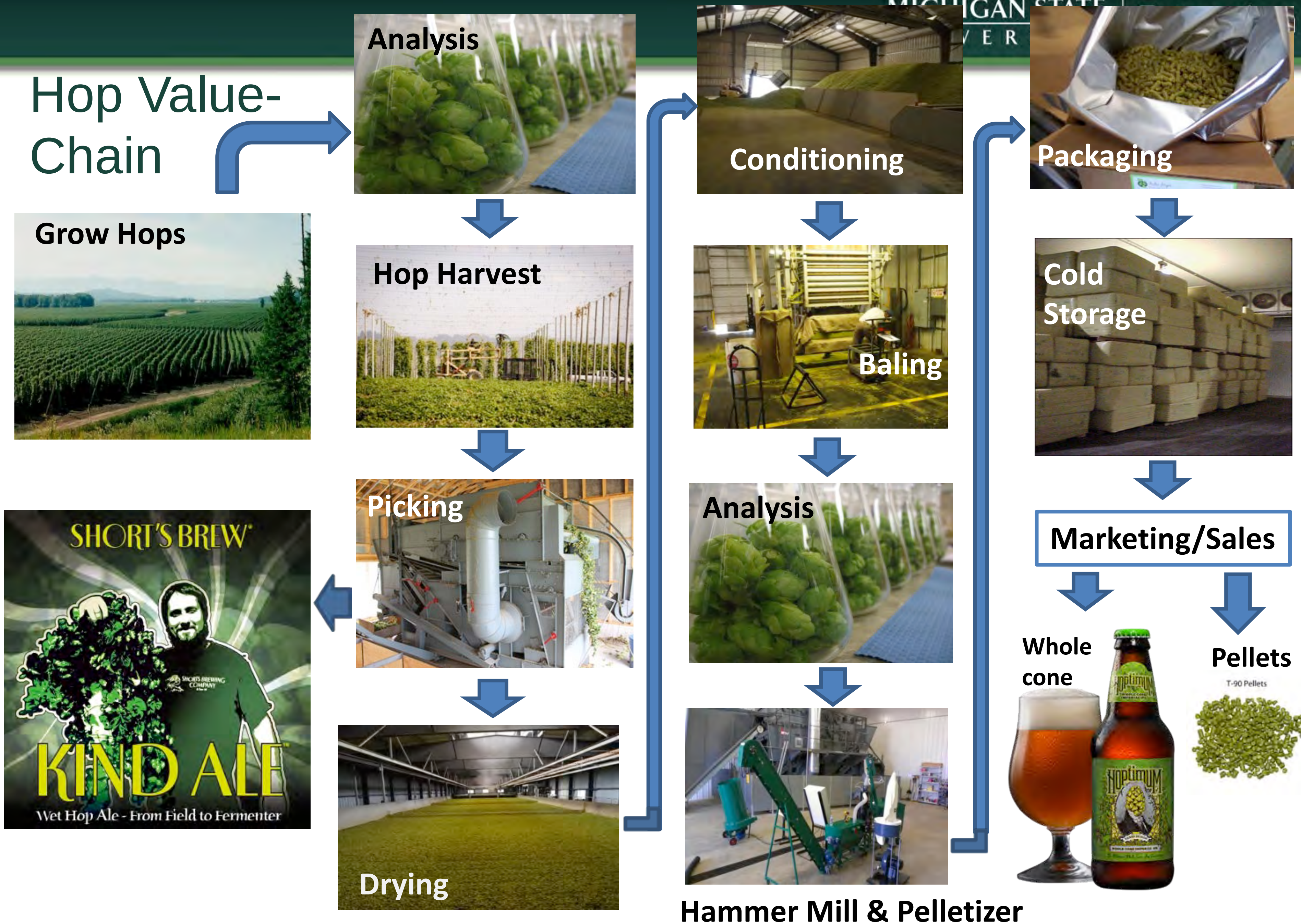
Automatic Conditioning Plants

More Profit with Technology

WHE Hop-Picking Machine



Hop Value-Chain



Lessons Learned: Pelletizing

Considerations

- Temperature
- Time
- Final product (eg. t-90)
- Machine type
- Machine $$
- Facility-certified

Pelletizing Lesson: Throughput efficiency

- Michigan Hop Alliance
- Buskirk-75 lbs/hour

- New Buskirk
- Capacity-600 lbs/hour

Pelletizing

- Lawson Mills
- 800-1200 lbs/hour
- Max- 50 C / 120 F
- Cool Die Press
- Bagging and packaging is what slows things down

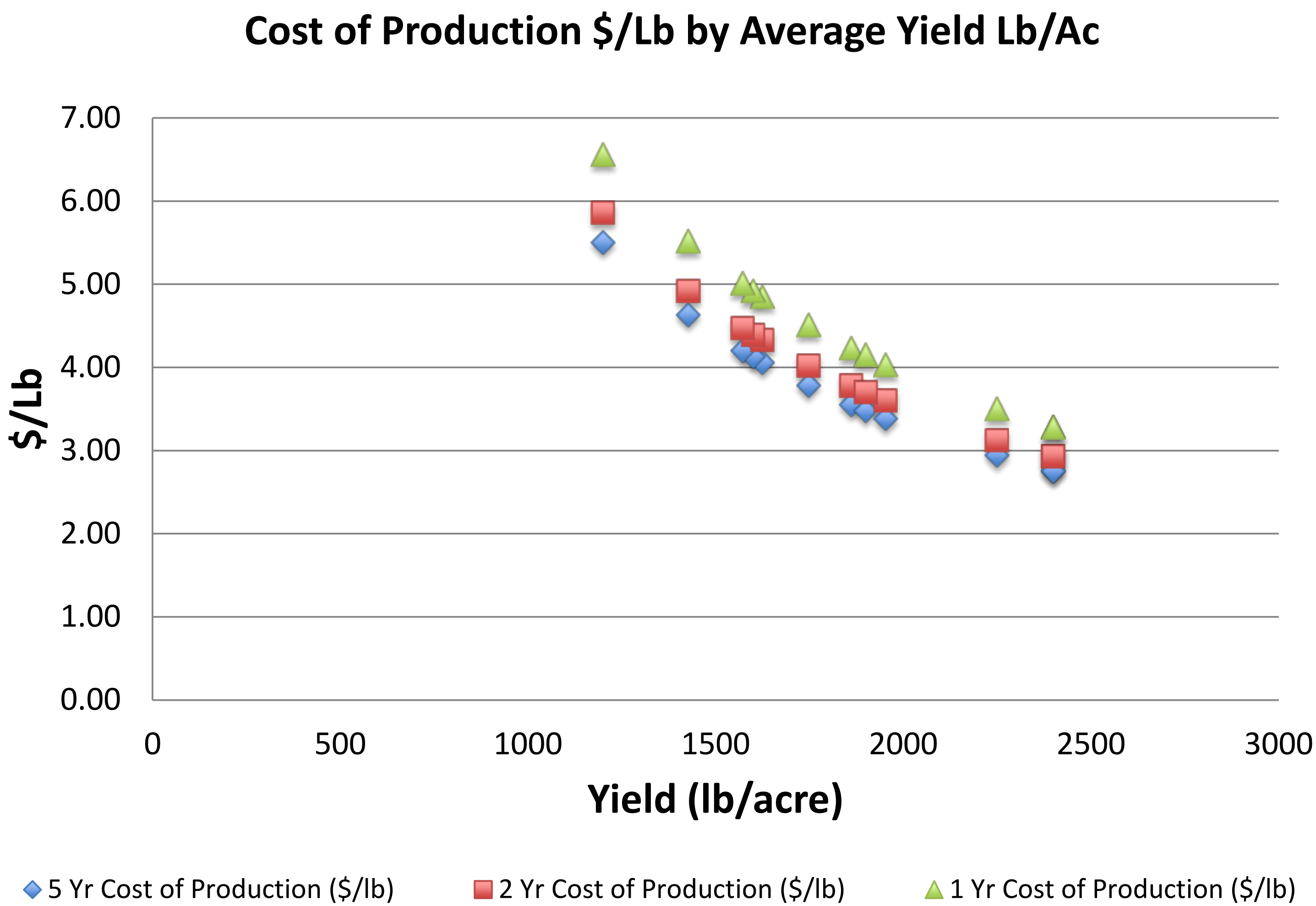
MICHIGAN STATE UNIVERSITY | Extension

Indie Hops

The holy grail of hop pelleting is to convert the form of the whole cone without sacrificing essential oils and acids. Heat, in a word, kills. The industry standard hovers around 130F. We've clocked our hops at the pellet die consistently at or under 110F.

Freshness Never Smelled So Hoppy!
Final pellets ready for an inert environment and 26F storage until it's their turn to show off at your local brewery.

Lessons Learned: Cost of Production/pound by variety



- $R^2 = .95$, $p < 0.0001$

Hop Variety	Yield (lb/acre)	5 Yr Cost of Production ($/lb)	2 Yr Cost of Production ($/lb)	1 Yr Cost of Production ($/lb)
Ahtanum	1862	3.55	3.78	4.23
Cascade	1748	3.78	4.02	4.51
Centennial	1625	4.06	4.33	4.85
Chinook	1953	3.38	3.60	4.03
Citra	1428	4.63	4.92	5.52
Columbus	2250	2.94	3.12	3.50
Crystal	1600	4.13	4.39	4.92
US Northern Brewer	1200	5.50	5.86	6.56
Simcoe	2400	2.75	2.93	3.28
Sterling	1900	3.48	3.70	4.15
Warrior	2400	2.75	2.93	3.28
Willamette	1572	4.20	4.47	5.01

http://www.brewersassociation.org/best-practices/hops/cost-of-hop-production

Lessons Learned: Marketing and Sales

- What brewers are looking for
  - Quality *Craft* product
  - Consistent supply
  - Sustainable pricing for them
  - Local relationships with hop farms

What information will a brewer want to know?

- Lot number (variety/location)
- Lot weight of bales
- Weight of finished pellets (% loss)
- AA% (of bales AND pellets)
- BA% (of bales AND pellets)
- Moisture (of bales AND pellets)
- HSI (of bales AND pellets)
- Pellet die and screen size used
- Pellet density (lbs. / cubic foot)
- Oxygen content
- Pellet temperature
- Essential oils?

Lessons from Germany Summer 2015


MITTERER
FENDT


MASSEY FERGUSON
3065 S



WOLF

Harvesting, drying, conditioning, and baling video-WOLF

Lesson: Food Safety (GHP)

ROY FARMS, INC

MOXEE WA USA

Are Roy Farms hops traceable back to field origin and chemical treatment?

Absolutely!

Back about 10 years ago it became apparent that brewers wanted to know more about food safety issues related to their hops—what chemicals had been applied, how close to harvest they had been applied and more.

Traceability and food safety concerns (and data gathering) do not end at harvest, our attention to data gathering and reporting are core elements of assigning harvested crop to inventory and logistical planning for sales.

GLOBALG.A.P.

OTCO

USDA ORGANIC

K

SALMON SAFE

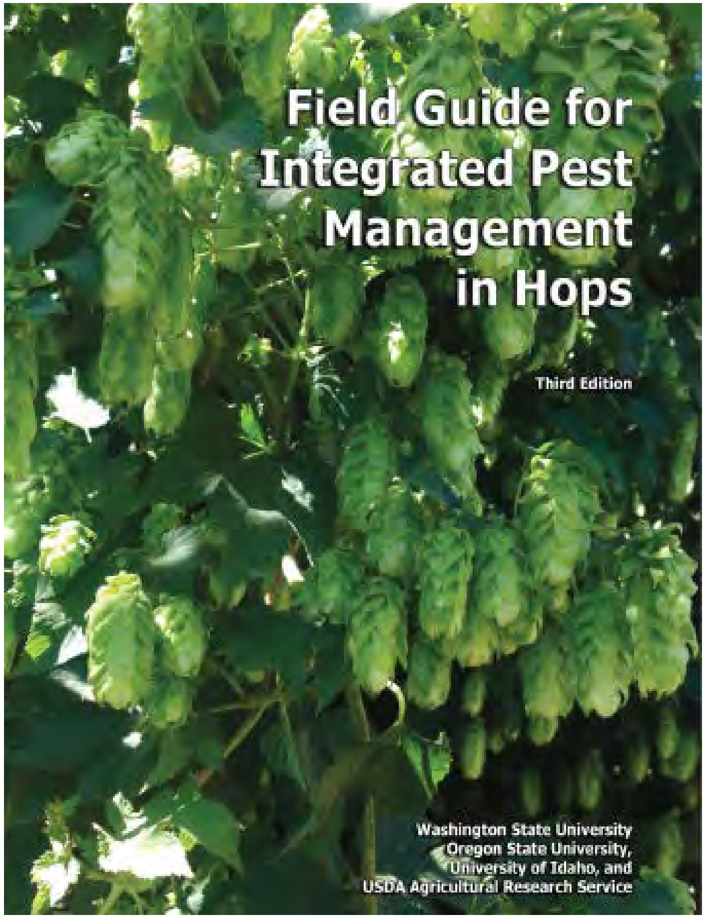
Take Home Messages

- Make sure you are well capitalized
  - Initial input costs ($12,000-$15,000/ac)
  - Harvest/Post-Harvest Infrastructure costs
  - Picking, drying, baling, pelletizing, storage
- Training date, Disease, Irrigation, Fertility affect yields and $
- The above + transport, picking, drying, conditioning, pelletizing can affect quality
- Not every grower should be processing their own hops
- Technological investments in drying and conditioning could improve quality and consistency
- Food Safety and GHP will be increasingly important

MICHIGAN STATE UNIVERSITY | Extension

Resources

- www.hops.msu.edu
- USA Hops
- Brewers Association

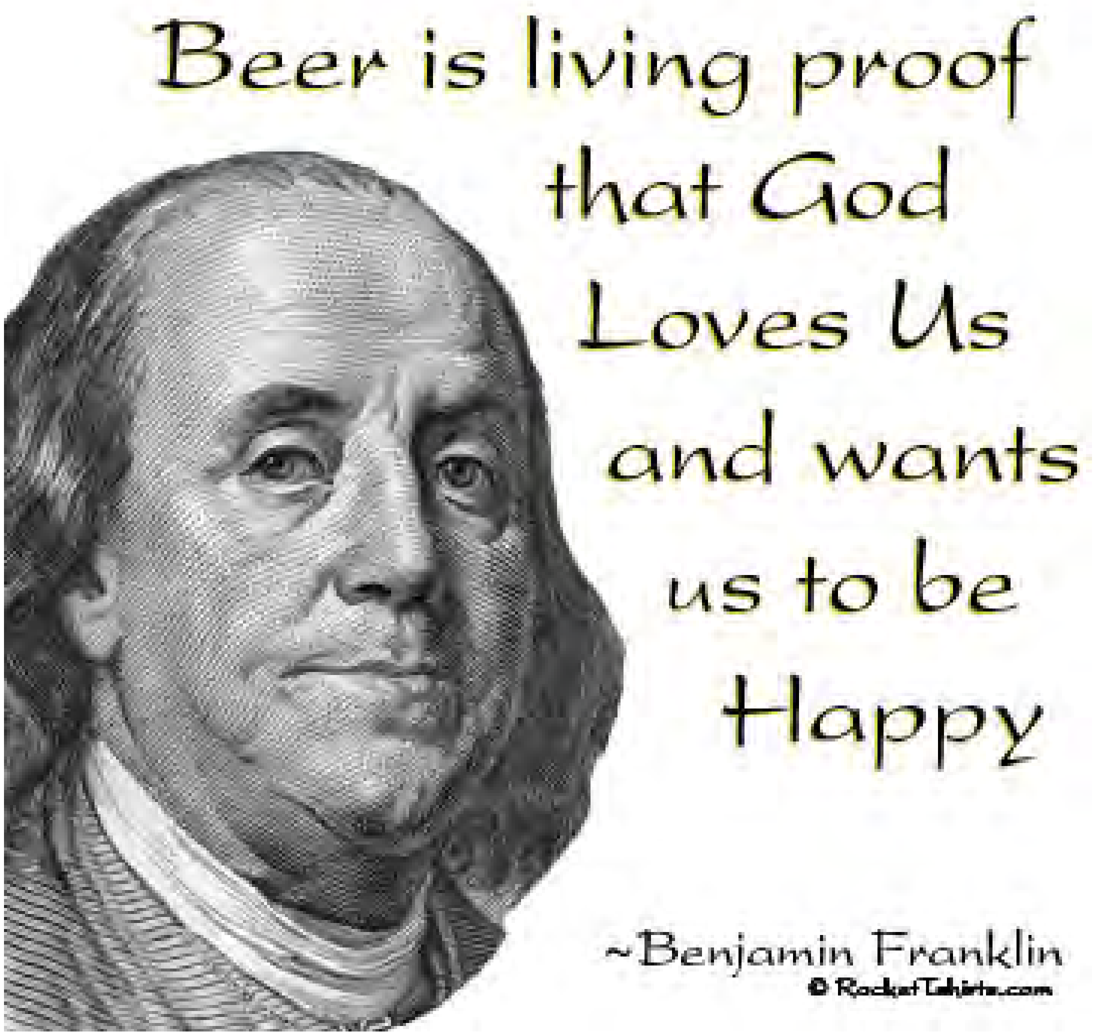



Great Lakes Hop and Barley Conference
Outcome Report, 2015
Ashley McFarland, Rob Sirrine, Erin Lizotte

GREAT LAKES HOP AND BARLEY CONFERENCE

MICHIGAN STATE UNIVERSITY Extension
island
Michigan State University AgBioResearch

March 16-17, 2016
Traverse City, MI



www.hops.msu.edu

sirrine@msu.edu

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
Subtotal	*$ 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
Subtotal		*$ 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