NC STATE UNIVERSITY

Growing Hops in the Southeast

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Why is there so much interest in growing hops in the Southeast?

- Proliferation of craft breweries.
- Home brewing increasing.
- Need for organic hops.
- Fresh hops for seasonal brews.
- Locally grown movement.

Will hops grow here?

- Sure they will!
- We have plenty of people doing it now!
- There once was an industry in this region.
- Home brewers grow their own.

The hop plant
(Humulus lupulus)

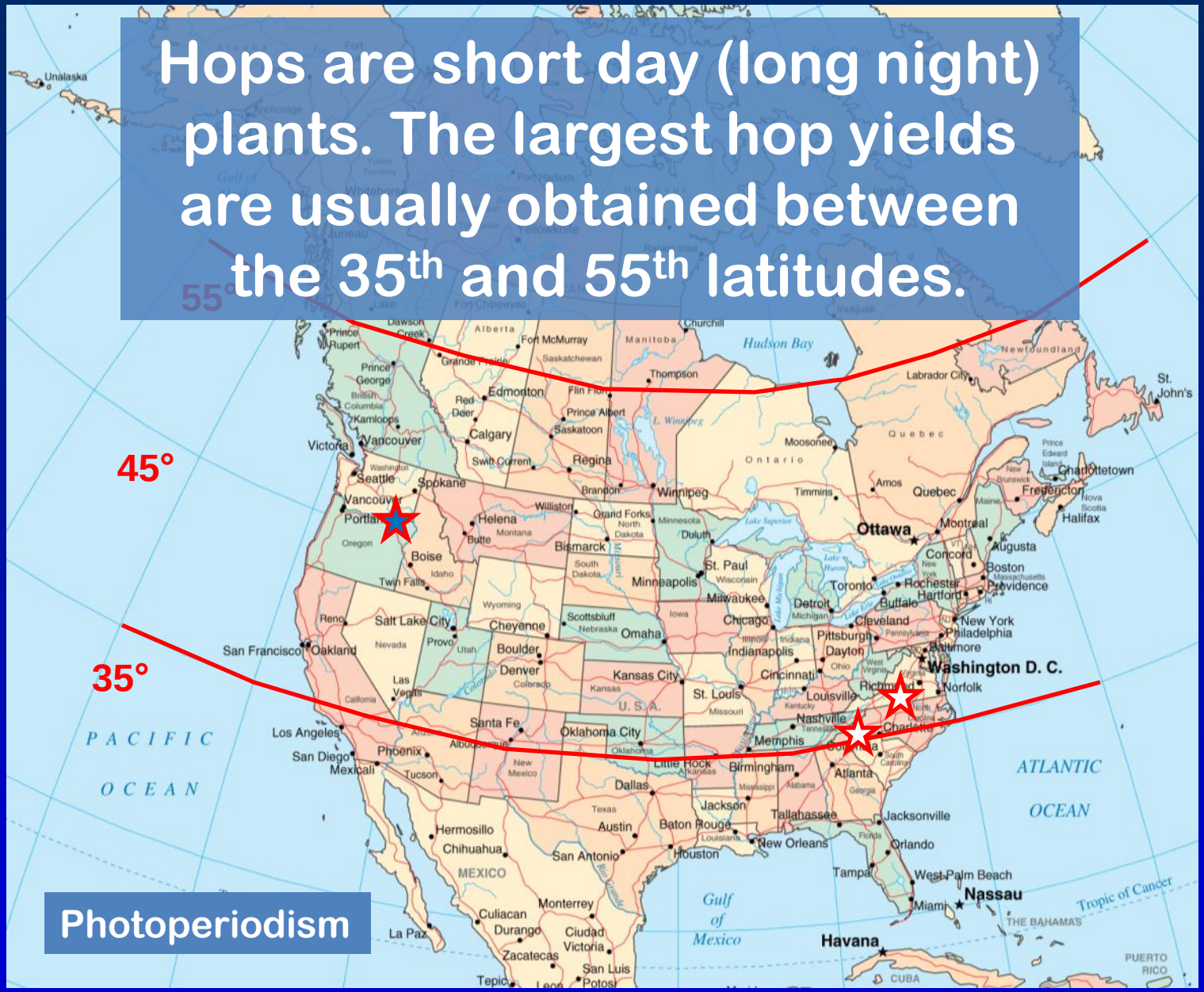
- Long-lived perennial plants (10-25 years).
- Commercial plants are all female.
- Bines grow each year to be about 25 feet long.
- Dies back to the crown each fall.
- Establish by planting rhizomes, cuttings, or micro-propagated plants.

Crown puts out lots of shoots; bines

Burrs and cones

The mature cone has lupulin (oil) glands containing alpha and beta acids, and essential oils.

Hops are short day (long night) plants. The largest hop yields are usually obtained between the 35th and 55th latitudes.



Map: www.geographicguide.com/north-america-map.htm

Need ≥ 15 hour daylength for highest yields

- Berlin, Germany 16 hrs 50 min
- Yakima Valley, WA 15 hrs 51 min
- Charlottesville, VA 14 hrs 49 min
- Asheville, NC 14 hrs 33 min

Charlottesville, VA
Asheville, NC

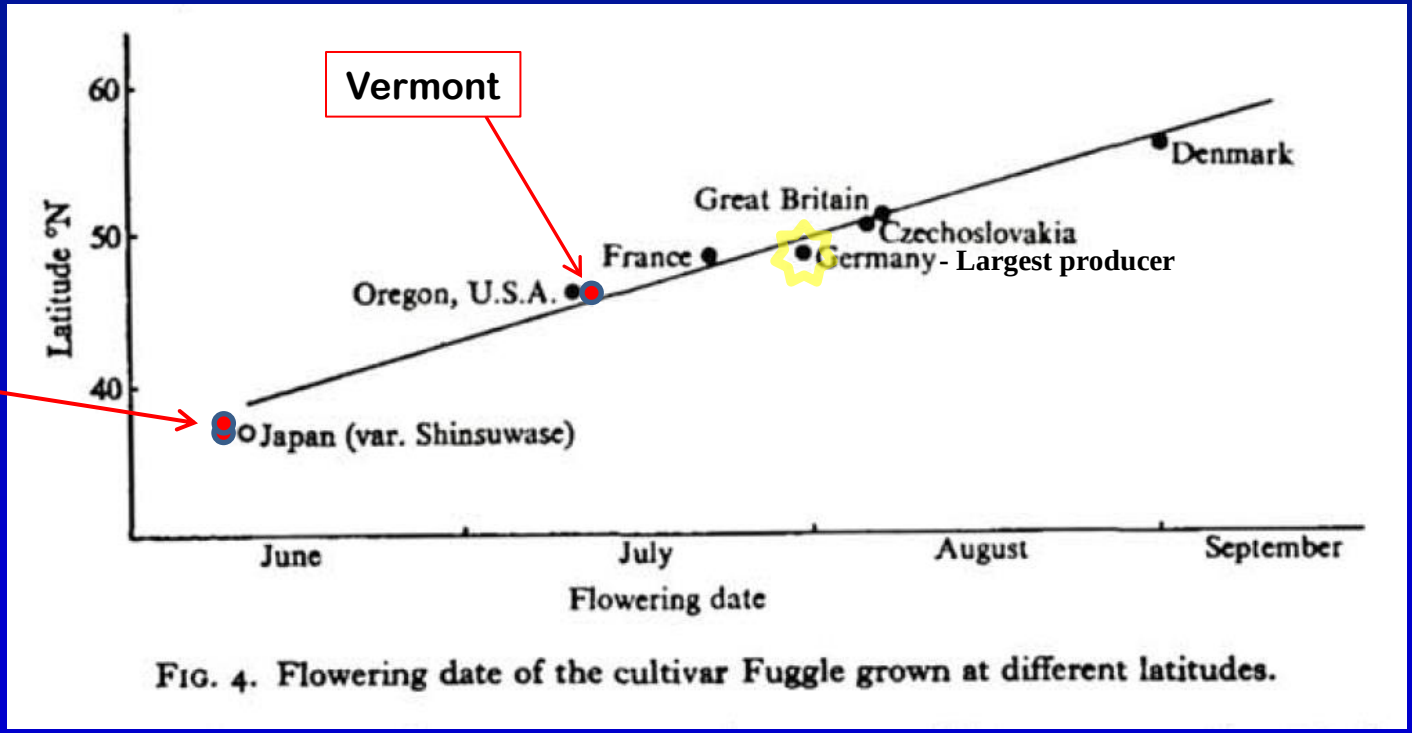


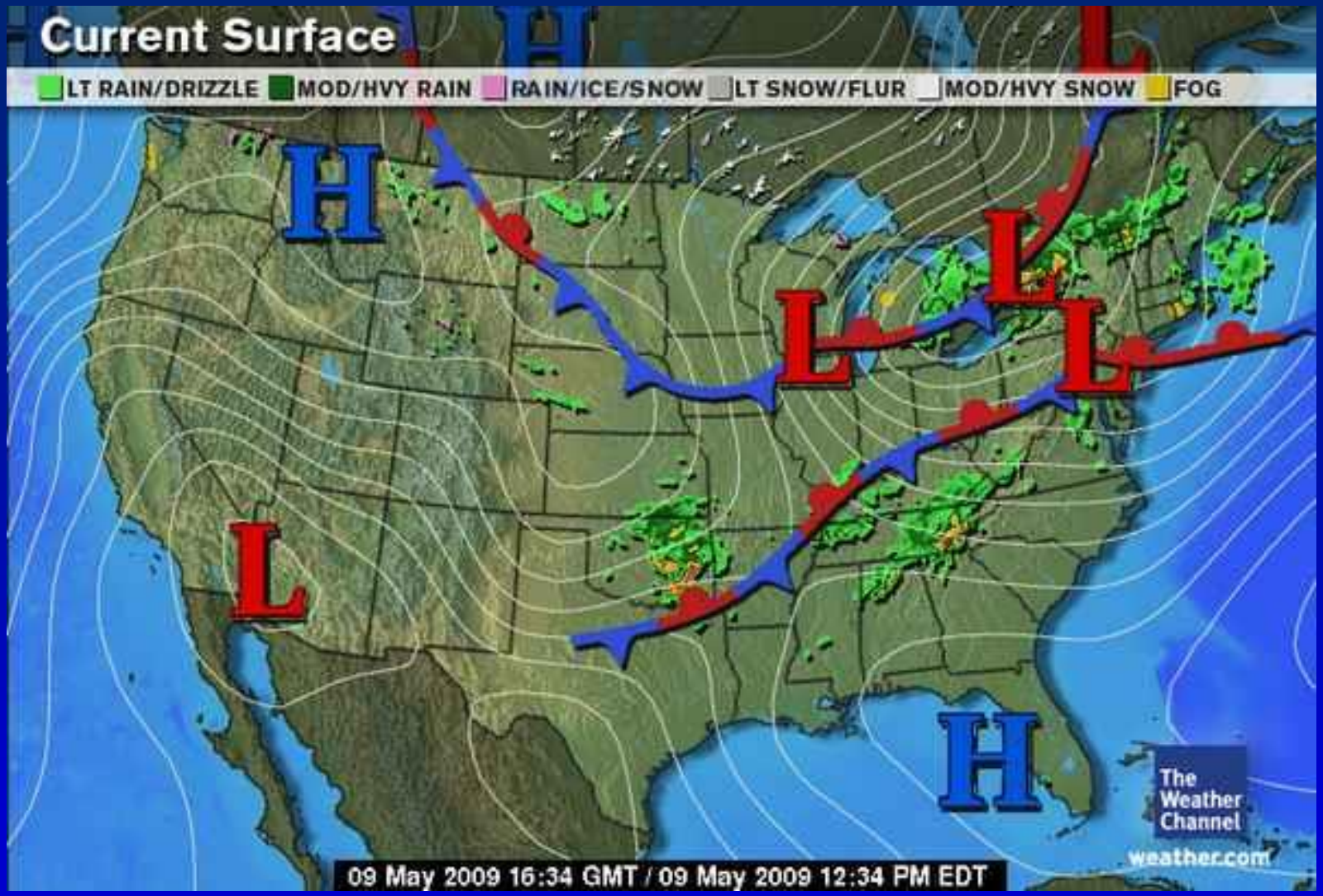
FIG. 4. Flowering date of the cultivar Fuggle grown at different latitudes.

Graph from Thomas and Schwabe, 1969

Day Length Issues

- Hops grow vigorously during long summer days and set flowers as days shorten in late June.
- Flower initiation is also node number, cultivar, and temperature dependent.
- Where day length is too short, flowering occurs when node number is met, but before the plants have put on a lot of growth.
- Without intervention, this significantly reduces our yields.

Humidity and high rainfall presents challenges for East Coast producers



Graphic from the Weather Channel website

About six years ago farmers started seriously planting hops in VA and NC

NC State started a hops research and extension program in 2010

- Soil Science and Horticulture
- Conducted variety trials
- Developed production guidelines
- Looked at economics

Photos from S. King and R. Austin program

Basics of Hops Production

Step 1. Site selection

- Fertile, well-drained soil.
- Good air circulation.
- Good drainage.

Photo from J. Davis program

Step 2. Take soil samples

- The NC Dept of Agriculture & Consumer Services has a code for hops.

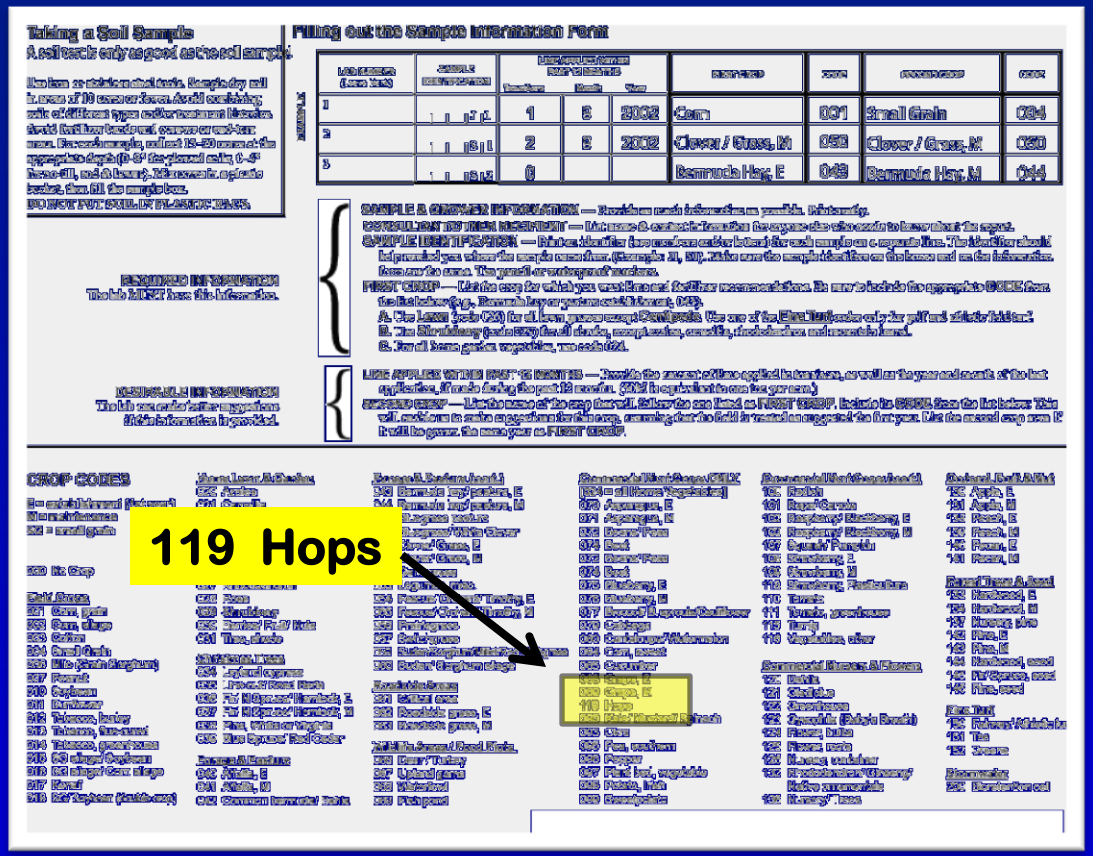
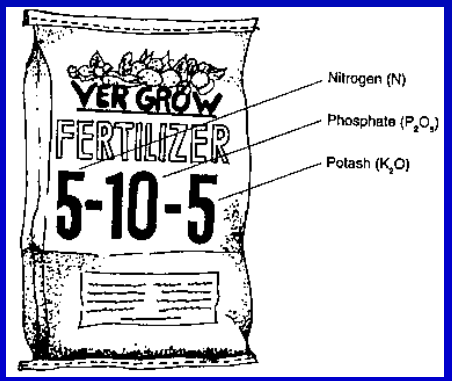


Photo from S. King and R. Austin program

Nutrient Management for Hops in NC

- Hops are big feeders – require fairly large amounts of N/P/K
- Early spring and early summer – split applications of N/P/K.
- pH 6.0 to 6.5

Nitrogen: 125 to 150 lbs/acre
Phosphorus: if soil index is 0: 150 lbs/acre
Potassium: if soil index is 0: 150 lbs/acre
Sulfur: if soil index is 0: ≈ 20 lbs/acre
Boron recommend 1 lb/acre
Soil pH between 6.0 and 6.5.



Graphic from ces.ncsu.edu

Step 3. Disk and apply any recommended amendments

Photos from S. King and R. Austin program

Step 4. Construct Trellis

Hobby or small-scale trellising

Photos from Battleground Brewers, Red Hill Brewery, and S. King and R. Austin program

Short Trellis Construction

Easy to construct & manage, 12 feet tall; limits yields.

Photos from S. King and R. Austin program

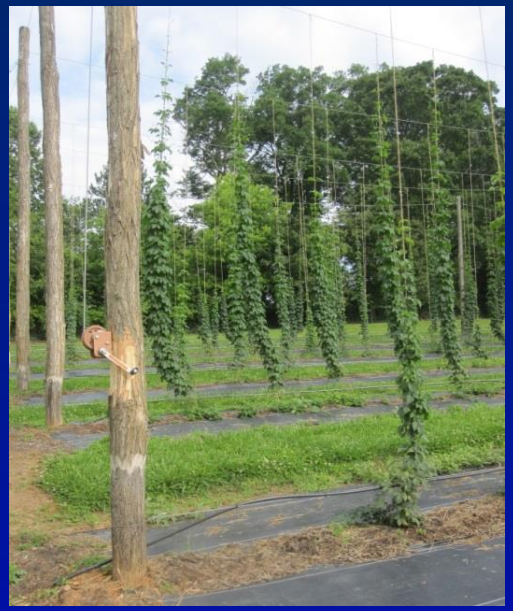
Construction of a traditional tall trellis (16 to 20 feet)






Photos from J. Davis program

Top wire can be raised and lowered



Photos from J. Davis program

No ladders or cherry pickers needed.

Step 5. Install irrigation

Photos from J. Davis, S.. King and R. Austin programs

Step 6. Plan for weed control

Photos from J. Davis program

Step 7. Plant hops in spring

March and April

Photos from J. Davis, S. King, and R. Austin programs

Quality of hop rhizomes

- Try to get certified disease free.
- Buy disease resistant varieties.
- Be cautious of buying from other growers; see the plants in growth.
- Check out your sources carefully.
- There are many viruses, viroids, and mildews that can be brought into your yard on rhizomes.

Photos from J. Davis program

What does it cost to establish a hop yard?

Estimated costs per Acre

- Trellis establishment $5-6,000
- Drip Irrigation system $1,200
  - (not including source)
- Rhizomes or plants $2-4,000
- Land Prep (fert.,seed,coir) $1,000
- Labor $3-4,000

Total $12-16,000/A

From Getting Started in Hops presentation by Steve Miller , Cornell, with NE Hops Alliance

Step 7a in some est. yards: root pruning

- Rhizomes will spread out and take over yard.
- Cut around the crowns in early spring.

Photos from plantmanagementnetwork.org

Step 7b in est. yards: Cutting back to ground

- Remove early shoots to manage disease and control flowering.
- Early shoots may be infected with powdery and downy mildew spores.
- We cut back until May 1.

Step 8. Put up strings and train






Coir versus sisal twine

Photos from J. Davis program

Step 9. Strip bottom of plants

Photos from J. Davis program

Step 9. Manage for diseases and insects






Photos from Sue Colucci's blog , J. Davis program, and Oregon State University,

Monitor your yard daily!

- Plant disease resistant varieties.
- Learn what the insects and diseases look like.
- Take lots of pictures.
- Practice prevention: clean rootstock, spring pruning, farmscaping, etc.
- Take notes so you can do better next year.

Photos from J. Davis program

Downy Mildew

Step 11. Harvest

Photos from J. Davis program

Hand harvesting

- It takes about one hour to harvest a pound of wet hops.
- A small brewery wants between 25-30 lbs of hops within 24 hours of harvest to do a wet hop brew.
- That means some very long hours or extra help.

Photos from Rita Pelczar

How others harvest

Top left: from Blue Mountain Brewery, top right: Willamette Valley Hops; lower left: MOFGA; lower right, Chillindamos Brewing

Step 12. Dry

Photos from J. Davis program and Rob Austin

Step 12. Dry and Package

Photos from J. Davis program and Rob Austin

Drying at Blue Ridge Hops

- Get hops into the dryer ASAP.
- Low temperature and high air flow.

Photo from Ritz Pelczar

Step 12b. Pelletize?

- Many breweries only use dried, pelletized hops.
- Pelletizers are expensive but can be shared equipment.

Photo (top) from makepellets.com and (bottom) from breworganic.com

Step 13. Packaging

FoodSaver®
THE #1 VACUUM SEALING SYSTEM

Note: Hop varieties have different storage stabilities, they don't all keep the same!

Photos from J. Davis program and FoodSaver.com

Step 14. Sell the hops

- Craft breweries
- Home brewers
- Herbal product companies
- Make your own beers
- Make your own products
- Hop rhizomes and cuttings
- Pick your own
- Sell wet or dried

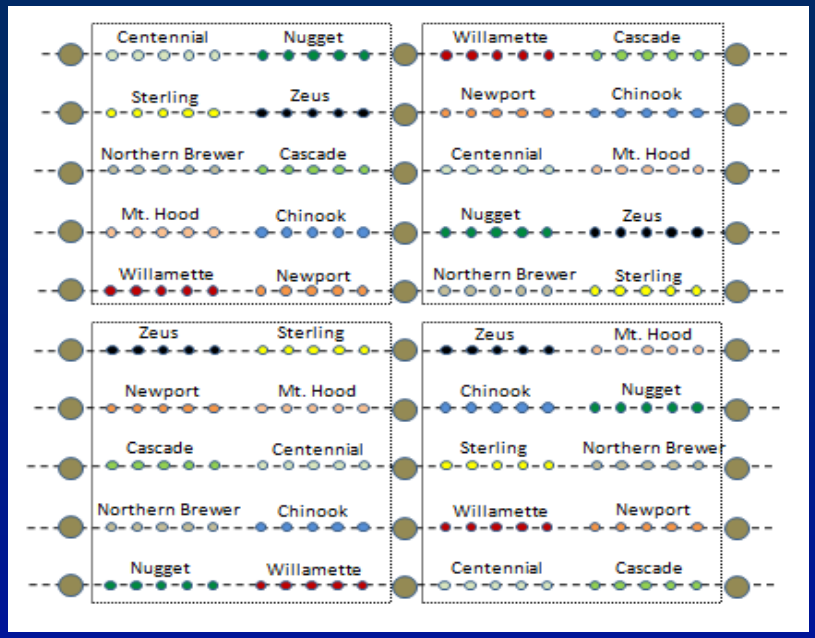
Step 15. Fall Clean-up

Photos from Rita Pelczar

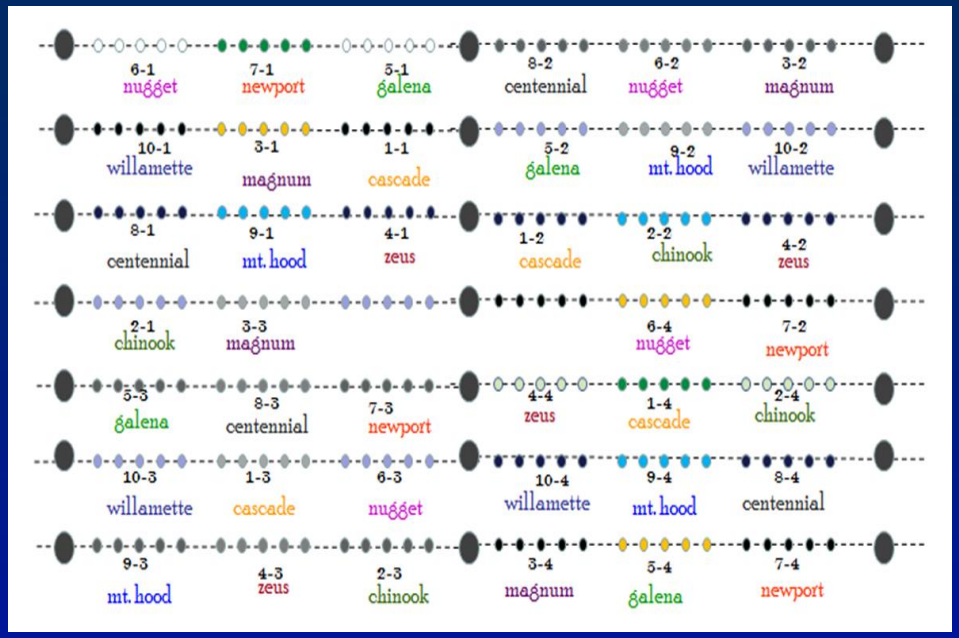
What have we learned from our research?

- Piedmont: Raleigh in July of first year of growth (also called Lake Wheeler in some of the slides)

- Mountains: Mills River in July of first year of growth



Raleigh

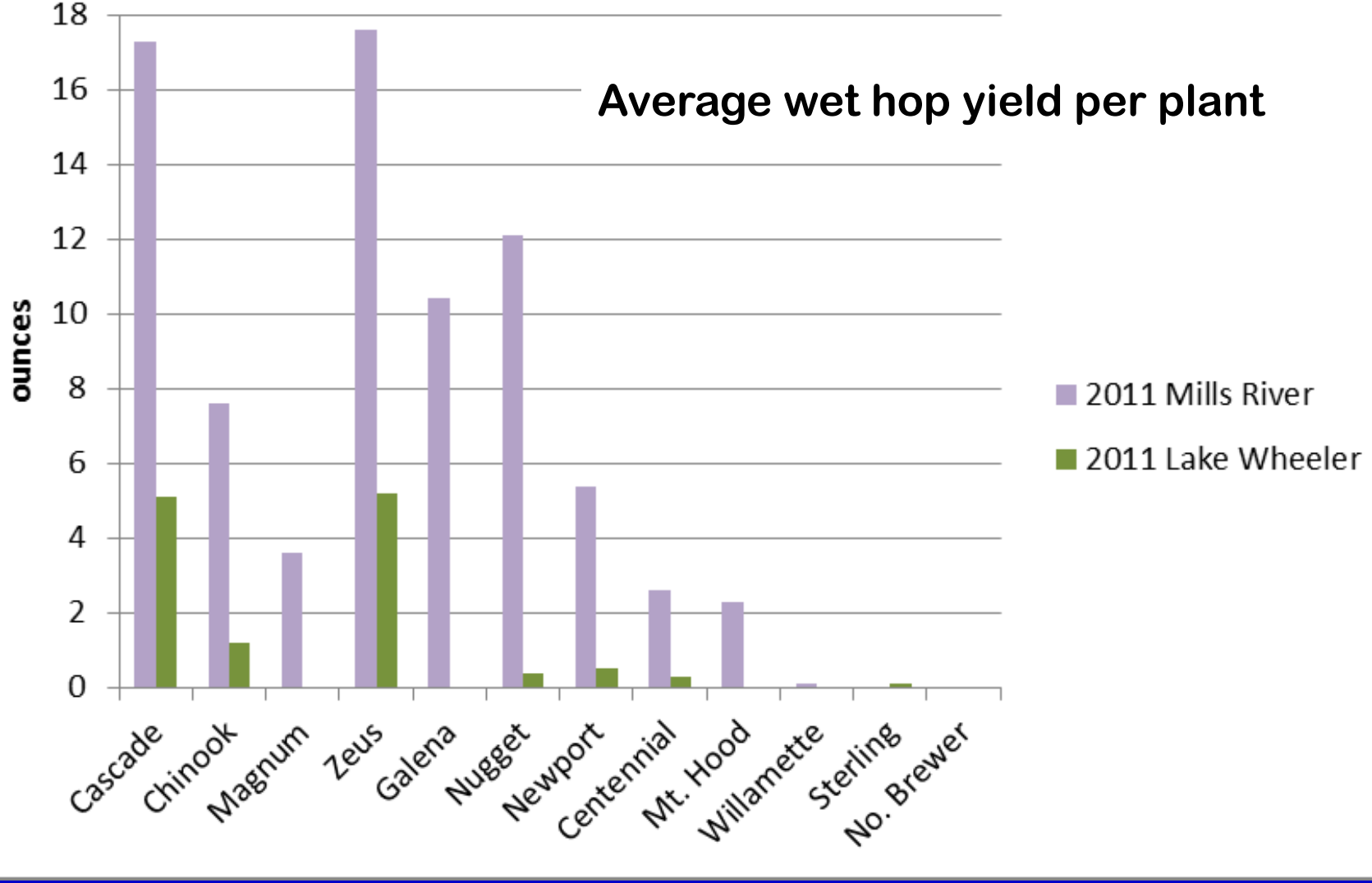


Mills River

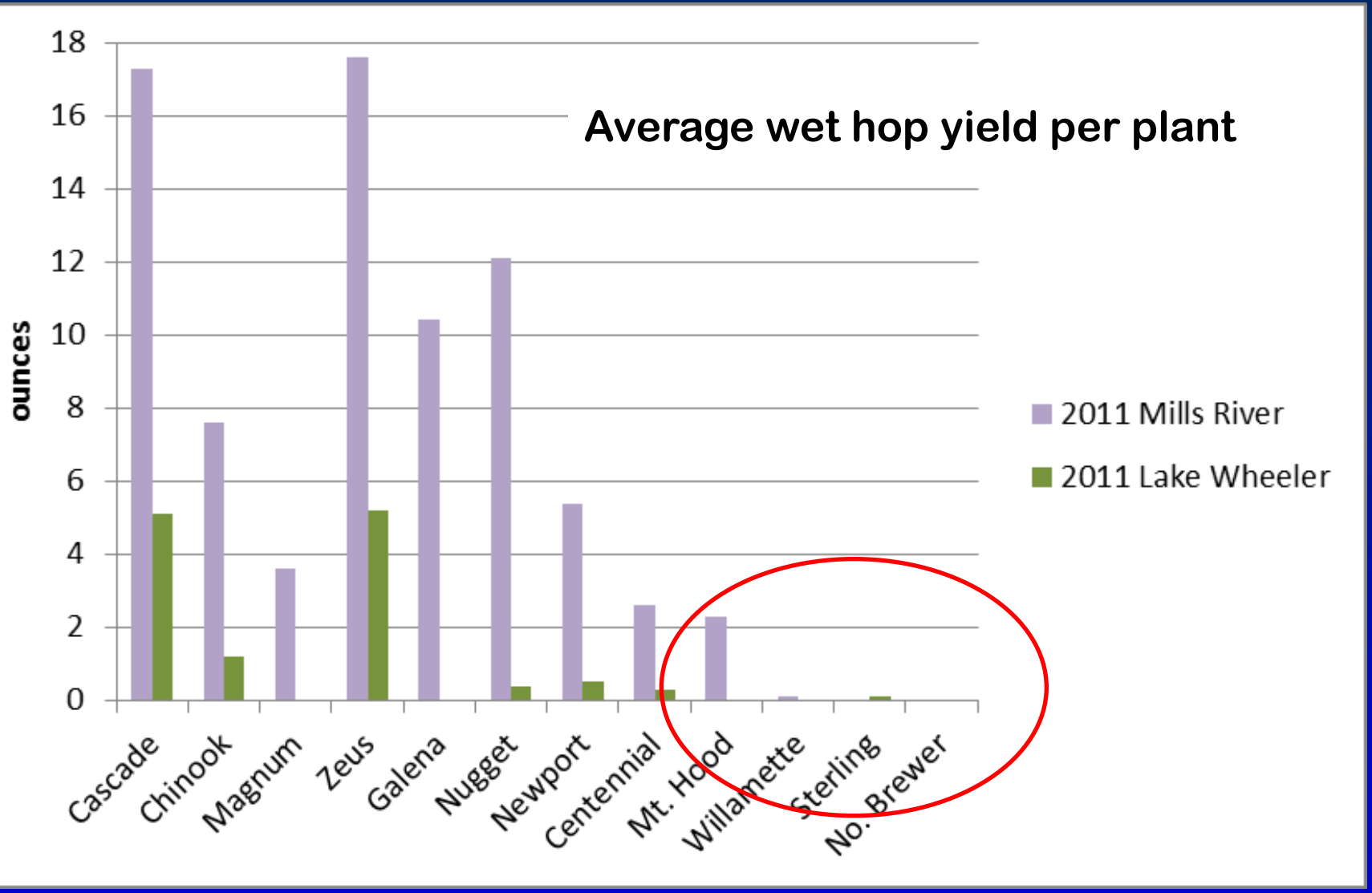
- Both sites contained Centennial, Nugget, Zeus, Cascade, Newport, Mt. Hood, Willamette, and Chinook.
- The Raleigh yard also had Sterling and Northern Brewer.
- The Mills River yard had Galena and Magnum.

We measured and recorded everything we could think of

- Plant height
- Plant vigor
- Susceptibility to insects and diseases
- Cone yield
- Plant tissue nutrients
- Dried cone analyses
- Soil analyses



2011: higher yields of all varieties in Mills River (year one) than Raleigh (Lake Wheeler) (year two).



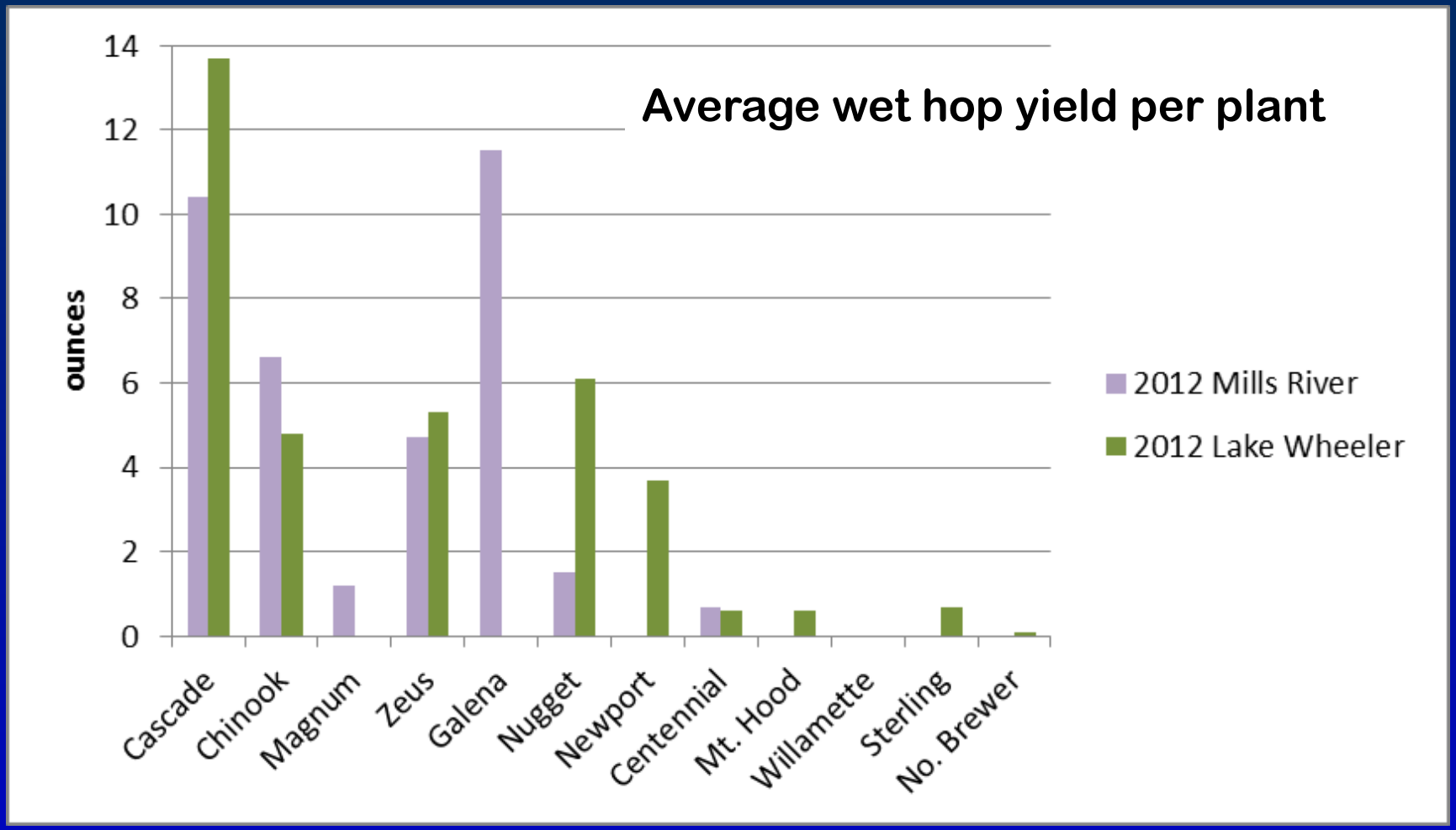
2011: higher yields of all varieties in Mills River (year one) than Raleigh (Lake Wheeler) (year two).

Downy Mildew in Mills River

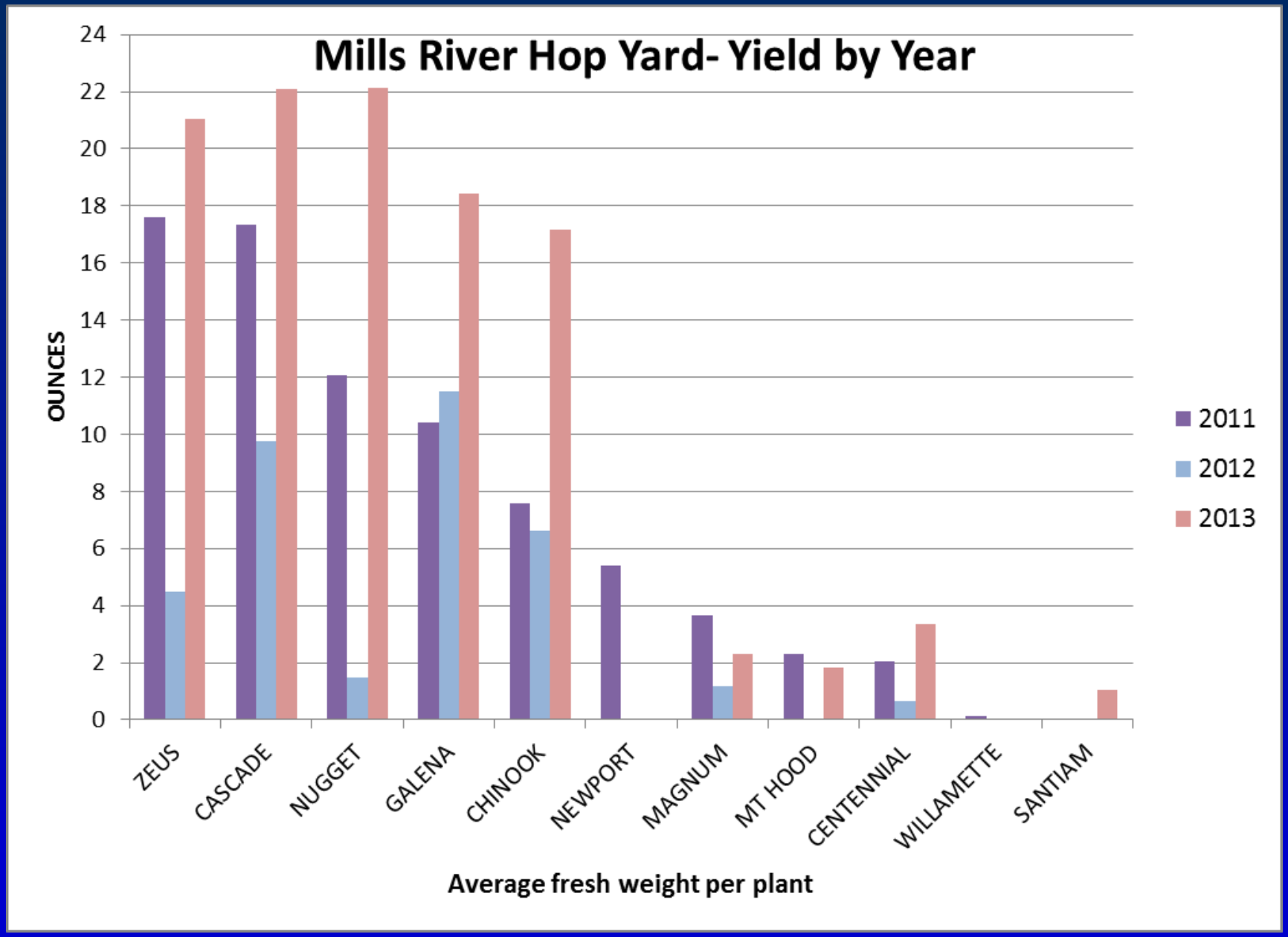
Year 1

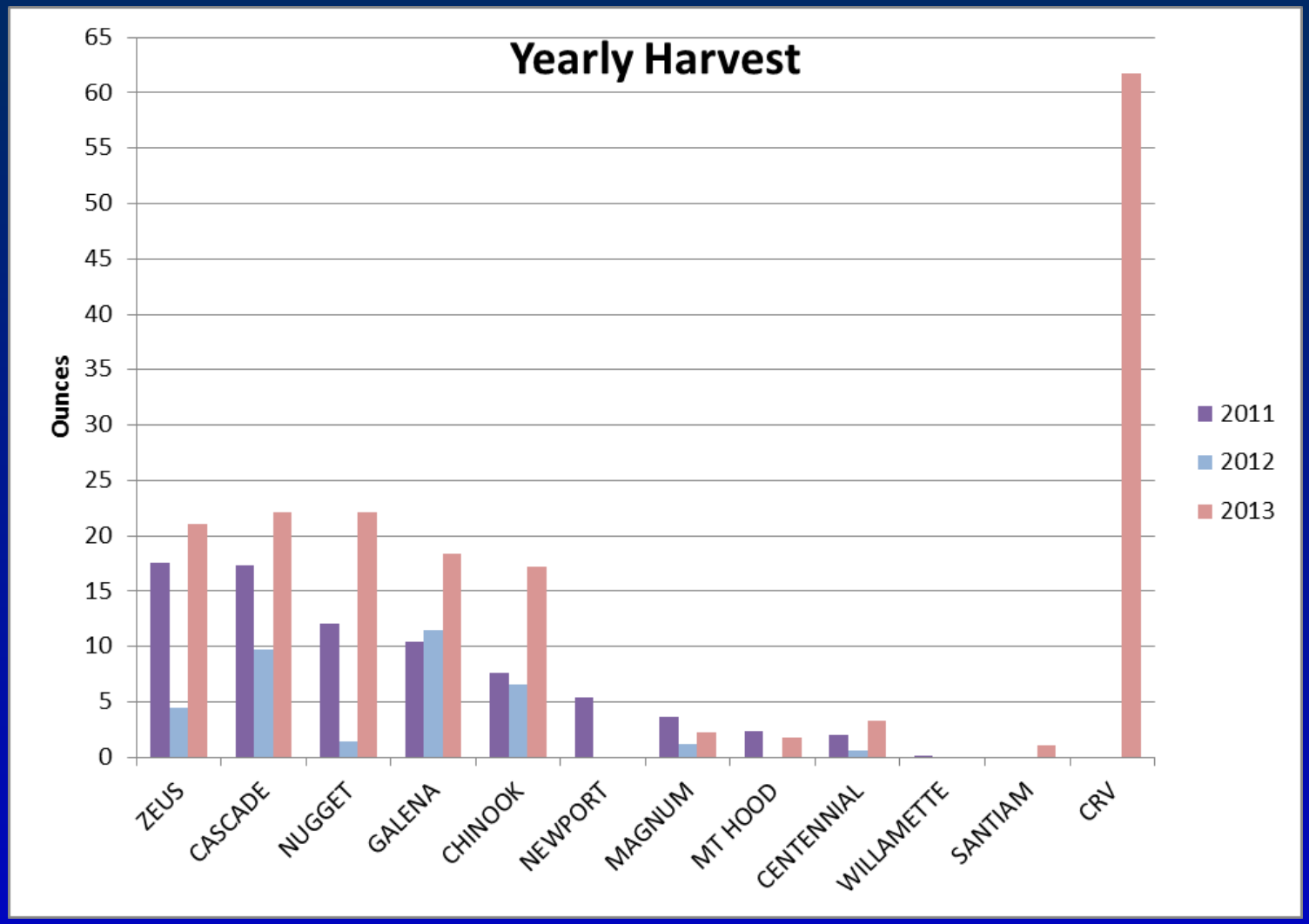
Year 2

Year 3



- 2012: four varieties in Raleigh out-yielded those in Mills River.
- Cascade was the most reliable producer.


Mills River Hop Yard- Yield by Year
OUNCES
24
22
20
18
16
14
12
10
8
6
4
2
0
ZEUS
CASCADE
NUGGET
GALENA
CHINOOK
NEWPORT
MAGNUM
MT HOOD
CENTENNIAL
WILLAMETTE
SANTIAM
2011
2012
2013
Average fresh weight per plant



- Harvest yields including CRV (Canadian Red Vine)
- CRV was planted as a crown (not rhizome) in 2013 and yielded 3.86 pounds per plant.

Canadian Red Vine-
a great first year

Cones were dried and analyzed.

Variety	White Labs 2011	Alpha Analytics 2013	Average Range %
Cascade Alpha Acid	4	5.2	4.5-7
Cascade Beta Acid	2.6	4.5	4.5-7
Nugget Alpha Acid	8.9	12.1	11-14.5
Nugget Beta Acid	2.8	4.7	4.5-5.5
Chinook Alpha Acid	6.7	8.1	10-14
Chinook Beta Acid	1.7	2.5	3-4
Centennial Alpha Acid	6	5.9	9.5-11.5
Centennial Beta Acid	2	2.6	3.5-4.5
Galena Alpha Acid	9.6	6.8	10-14
Galena Beta Acid	5.3	5.5	7-9
Magnum Alpha Acid	6.9	8	13-15
Magnum Beta Acid	2.6	3.5	4.5-5.5
Zeus Alpha Acid	5.5	6.1	13-17
Zeus Beta Acid	3.8	4.1	4.5-5.5
Mt. Hood Alpha Acid	3.9		3-7
Mt. Hood Beta Acid	4.1		5-7
CRV Alpha Acid		6	2-5.5
CRV Beta Acid		7	5-6

Do the hops make good beer?

- Reports from breweries, home brewers, taste tests, festivals, and hop yards are that Southeastern grown hops can be used, wet and dried, to make good beer.
- We need to work on producing a more consistent product.
- We need to deliver what we say we can deliver when we promise it.

Photos from Ivory Tower Brewery

- Variety selection appears to be the single most important factor in hop yard success or failure!
- Thus far, Cascade and Columbus (Zeus) are top performers with Galena, Chinook, and Nugget also proving to be acceptable.

Wet Hop Yields

- Common yield from young NC plants is one wet pound per plant.
- This should increase each year as the plants mature.
- Some growers in NC reporting yields of 4 to 6 wet pounds per plant.
- One pound wet dries to about 0.25 lb.

Hop yields-Cascade
assume 1,000 plants/acre and 8% moisture

Location	Plant age	Wet yields (lbs)	Dry yields (lbs)
Oregon	Mature		1,000-2,000
NY (Univ. est.)	Mature		800-1,200
Michigan	Mature	2,000-6,000	160-480
Vermont (Univ.)	3 years		200
NCSU-mtns	3 years	1,250	313
NC mtns-comm.	4 years	2,000	160
NC mtns-comm.	Mature	4,000	320
NC piedmont-comm.	4 years	2,000-3,000	160-240

Economics of Production

NCSU web resources

NC STATE UNIVERSITY

ncherb.org
dr. jeanine davis

Bypass Navigation | NC Herb Home | Enterprise & Crop Information | Organizations | J
Jeanine's Book List | NC Organic | NC Specialty Crops | Events Calendar | MHCRS

Welcome

My name is Jeanine Davis and I am an associate professor in the Department of Horticultural
Carolina State University. My research and extension programs are dedicated to the developm
organic production systems for herbs, vegetables, and a wide variety of specialty crops.

The purpose of this website is to provide access to up-to-date, practical information on the p
marketing of these crops and to keep you informed about the current projects in my program.
visit the other websites I maintain that are listed below. Also visit **NC Medicinal Herbs** which
with the University of NC-Chapel Hill.

Some of the current projects my staff and I are involved in include working on a regional Chin
production study in which we are overseeing the on-farm test sites. One of those test sites is
Mountain Horticultural Crops Research Station in Mills River. We are establishing a new organ
Mountain Research Station in Waynesville where we also recently planted a truffle orchard. We are involved in a hops project i
colleagues in Soil Science. Our responsibility is to work closely with four hop growers in the region. We are cooperating on a tw
funded project, led by Tuskegee University, to train extension agents and other agricultural professionals in organic agriculture
for the non-timber forest products component of a ARRA (federal stimulus funds) project to put unemployed and underemploye
to work. For that project, we are reviewing inventories of forest products buyers and sellers in western NC, providing technical
information, and assisting non-timber forest product producers. We are cooperators on a five year, multi-state project to devel
broccoli industry. And we continue to grow a large number of woodland botanicals and ramps under artificial shade and in the v
River location.

Links to Our Projects and Other Web Sites

- Farm Prosperity Project — Helpful decision making tools, production information, surveys, and presentations pertaining to
and farmland protection.
- NC Organic — An organic agriculture internet resource for North Carolina farmers.
- NC Specialty Crops — A resource for farmers, entrepreneurs and consumers within the specialty crops market.

NORTH CAROLINA HOPS PROJECT
NC STATE UNIVERSITY HOPS RESEARCH AND VARIETY TRIAL

Research Sponsored through:
Golden LEAF FOUNDATION

PROJECT
- INTRODUCTION
- METHODS
- VARIETIES
- OBSERVATIONS
- STATE OF INDUSTRY
- ABOUT US

ADDITIONAL
- CONTRIBUTING FARMS
- RESOURCES
- PHOTO GALLERY - 2010
- PHOTO GALLERY - 2011

PROJECT INTRODUCTION

Spurred on by the demands of a burgeoning craft brewing industry and a strong public interest in locally grown ingredients, farmers are experimenting with hops (*Humulus lupulus*) as an alternative income source. Over the past three years, a small community of growers across North Carolina have established hop yards and sold their product to local craft breweries and home brewers. The majority of information and figures regarding hops production in the U.S. is developed for the Pacific Northwest hops industry and is not intended for the unique agronomic, economic, and environmental conditions found in North Carolina. The objective of this project is to help identify the best performing hop cultivars, promising geographic areas for hops production, and the key issues related to nutrition, disease, and pest control. In addition, local market conditions and production costs will also be addressed.

This spring, with support from the Golden Leaf Foundation, an experimental hop yard was established at the Lake Wheeler Road Field Laboratory in Raleigh, North Carolina. The experimental hop yard includes 200 total hops plants on 1/4 of an acre. The hop yard contains 10 different U.S. hops varieties planted randomly throughout the experimental site. The varieties were selected based on their range of alpha acid content (bitterness), yield potential, disease and pest resistance, total U.S. production, and demand by local craft breweries. The site is designed to test which hop varieties are best suited for North Carolina's unique growing conditions and which varieties offer the greatest potential for commercial production. To date, the varieties planted show significant variation in their vigor, height, yield, maturity times, pest and disease resistance, and overall agronomic health. For example, while 7 of the 20 plants of the variety 'Zeus' are at the top of the 12 foot trellis and producing cones, the tallest 'Northern Brewer' is 6 feet, visually stressed, and without cones. Although variation was expected during the establishment year and additional research is needed, it is clear that variety selection will play a significant role in the economic viability of locally grown hops.

In addition to the experimental hop yard in Raleigh, we are actively working in the Mountains with a small community of growers with established hop yards. The hops yards are in various stages of establishment (1-3 years) and managed using a range of cultural practices (i.e. organic, conventional, and mixed). These growers are working with us to help monitor, test, and analyze various agronomic conditions and their significance throughout the growing season. These pioneering growers have provided an opportunity to analyze the agronomic requirements and disease and pest pressures of hop yards managed under different strategies, in different stages of establishment, and

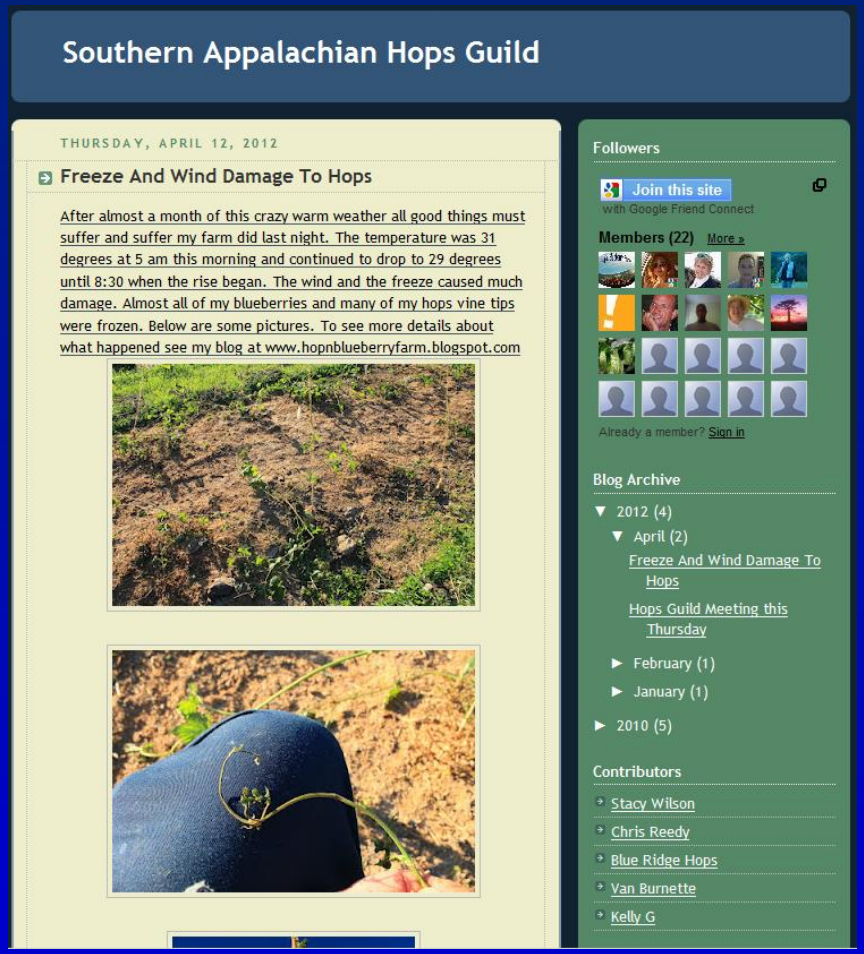
Other Resources

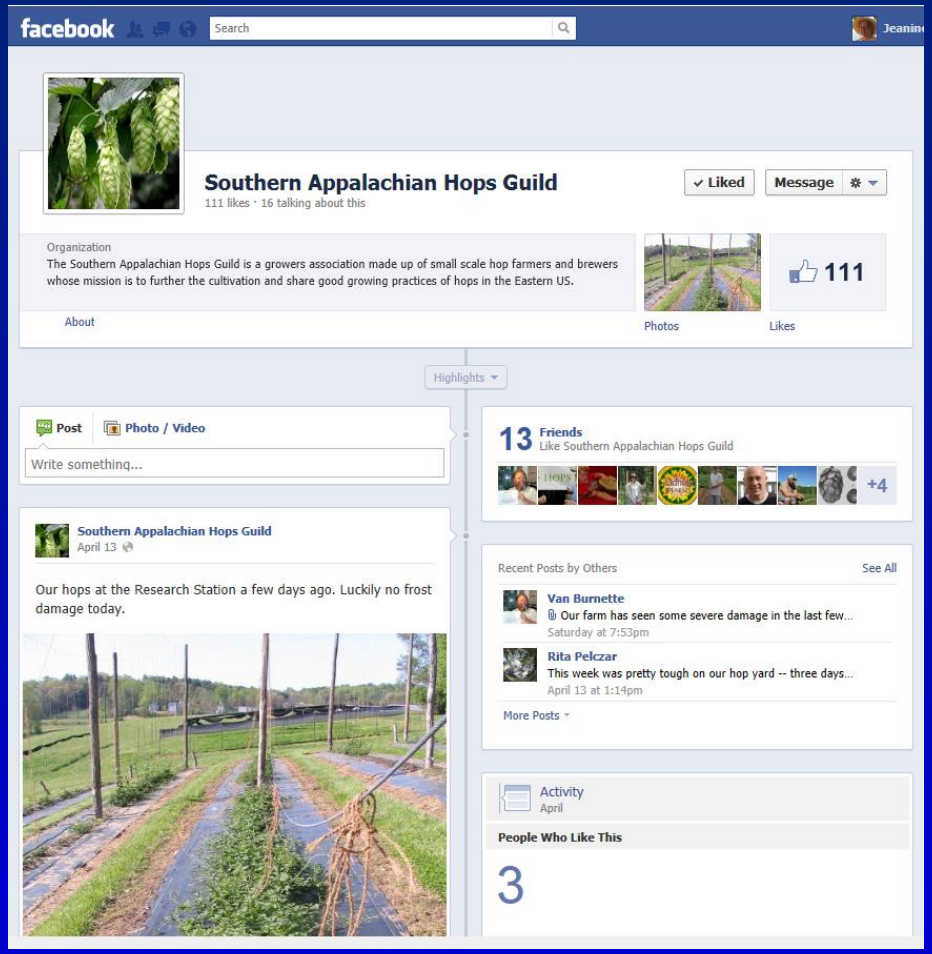
http://www.uvm.edu/extension/cropsoil/hops

http://nehopalliance.org/

http://www.greatlakeshops.com/

Southern Appalachian Hops Guild





Southernappalachianhopsguild.blogspot.com

Project funded by:

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