Hop Botany and Production

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Hop Botany and Production

- Importance of hops.
- Basic botanical information.
- Crop development and cultivation.
- Impact of hop varieties.

Regional Economic Importance

- U.S. Production centered in the PNW.
  - 46,633 WA, OR, ID
  - 1249 rest of NA
- 2015 value (US) = $345 million

Humulus spp. Overview

- Family: *Cannabaceae*
  - *Cannabis*
    - *C. sativa*
  - *Humulus*
    - *H. japonicus*
    - *H. yunnanensis*
    - *H. lupulus*

(Neve 1991)

Humulus lupulus

- “Hops”
- Dioecious, perennial, climbing vine
- Indigenous to the Northern Hemisphere
  - Origins in Europe:
    - *H. lupulus* var. *lupulus*
  - Origins in Asia (mainly Japan):
    - *H. lupulus* var. *cordifolius*
  - Origins in North America:
    - *H. lupulus* var. *pubescens*
    - *H. lupulus* var. *neomexicanus*
    - *H. lupulus* var. *lupuloides*

Hop Basics

- Dioecious (male and female plants).
  - Genetically complex.
  - Male-no commercial value
  - Female-Produces the valued strobiles, “cones”
- Annual above ground.
- Perennial below.
  - Allows for clonal propagation.
- Climbing bine requiring a support system.
- Photoperiod sensitive

Dioecious Plants

- Separate male and female plants
- Commercial value derived from the strobiles or “cones” of the female plant
- Male plants utilized only for hybridization
- Pollination results in:
  - Unwanted seeds
  - Increased cone size

The “Cones”

- These are the manufacturing unit of the commercial hop plant.
  - The cones contain lupulin glands (actually modified vine hairs).
  - These glands contain the chemistry we are after:
    - Essential oils: over 300 compounds, contribution to aroma.
    - Soft resins: beta acids, and the all important alpha acids.
  - Lupulin accounts for 20 – 30 % of cone weight.

Mature Female “Cones”

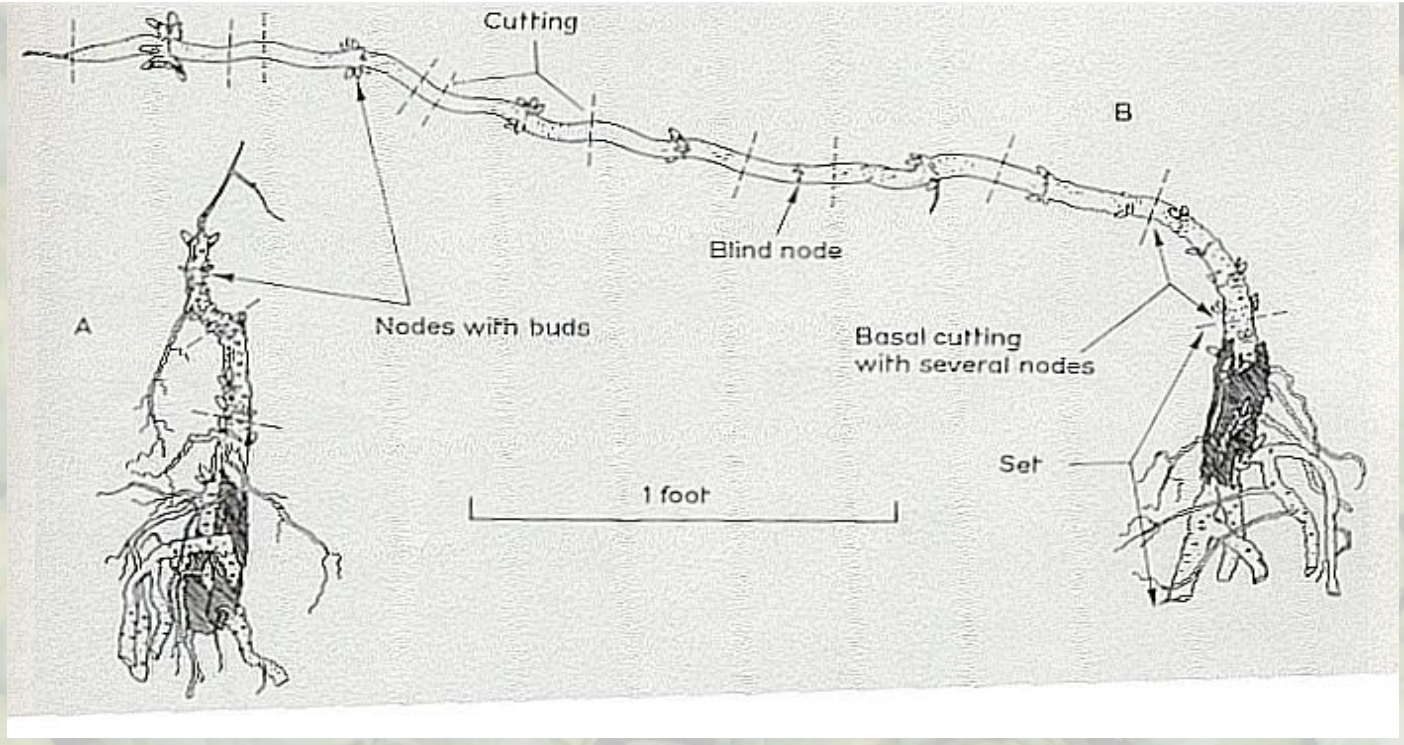
Male flowers at anthesis

Annual vs. Perennial Growth

- The above ground portion of the stem is annual.
  - Dies off at dormancy.
- The root is perennial, can survive low winter temps.
  - Requires a dormant period.
- The plant also produces rhizomes (below ground stems).
  - Buds become new spring growth.
  - Easily propagated from cuttings.

Clonal Propagation

- Propagation of hops purely vegetative
  - Root cuttings
  - Layering
  - Softwood cuttings
- Resulting plants genetically identical to parent material


Cutting
B
Blind node
A
Nodes with buds
Basal cutting
with several nodes
Set
1 foot

Climbing Bines

- In the wild-usually found climbing on companion species.
  - In cultivation, trellis is used.
  - Typical Field Setup:
    - Trellis 18’ high
    - Plant spacing at 3.5’ x 14’ or 7’ x 7’.
      - Result is 889 plants per acre
    - Anchored twine is used to support plant growth.
- The vine wraps clockwise around string.
  - Function of phototropism and thigmotropism (Light and Touch).
- Rapid growth: The hop plant will grow a foot or more a day under ideal conditions. 18-25’ in a season.

Photoperiod Sensitive

- Hops are a short day plant.
  - Under a critical number of light hours - floral initiation.
    - Also node dependant.
  - Over the critical amount, vegetative growth.
  - In shorter day areas, flowering occurs as soon as the node requirement in met-yield not maximized.
  - In longer day areas-vegetative growth is maximized prior to shortening days of mid to late summer.
- Results in defined “Production Stages”

Developmental Physiology of the Hop Plant (or Production Stages)

- The hop plant goes through numerous stages of growth throughout the year.
  - Each stage has its own unique characteristics.
  - Therefore each stage of growth requires its own unique management scheme.
- Main Stages of Growth
  - Dormancy
  - Spring regrowth
  - Vegetative Growth
  - Reproductive Growth
  - Preparation for Dormancy

Comments on Development

- The stages of hop plant growth need to be understood to properly manage the crop.
  - Each stage is unique, thus unique management requirements.
- Yield is already being determined as early as April and May.
- To complicate things further: *Much of this is variety dependant.*

Varietal Impact

- Physiology and development are impacted by variety.
- Crop management is varietal dependant.
- There is a strong genetic x environmental interaction.
- The goal: Realize the maximum genetic potential.
- The problem: Maximum genetic potential cannot be reached in all environments.

The solution: Breeding varieties to match the environment and meet the industry needs.

- Breeding objectives based on the needs of all stakeholders.
  - Objectives meant to provide brewers with hops/hop products which enhance their brews, while being agronomically efficient.
  - Performance of a variety at every level, from the farm to the brewery, adds to the overall health of the industry.

How important is this?

- Hop Supply Chain: Each link on the supply chain affects subsequent links.
  - The efficiency of a hop has a corresponding impact on the chain.

Breeding Program

New Variety:

-Good yield

-Disease resistant

-Good quality

-Stores well

Farm

Cost/Acre

Yield

COST/UNIT

Handler

Cost

Storage

Pellet Recoveries

Extract Recoveries

Shipping

Brewery

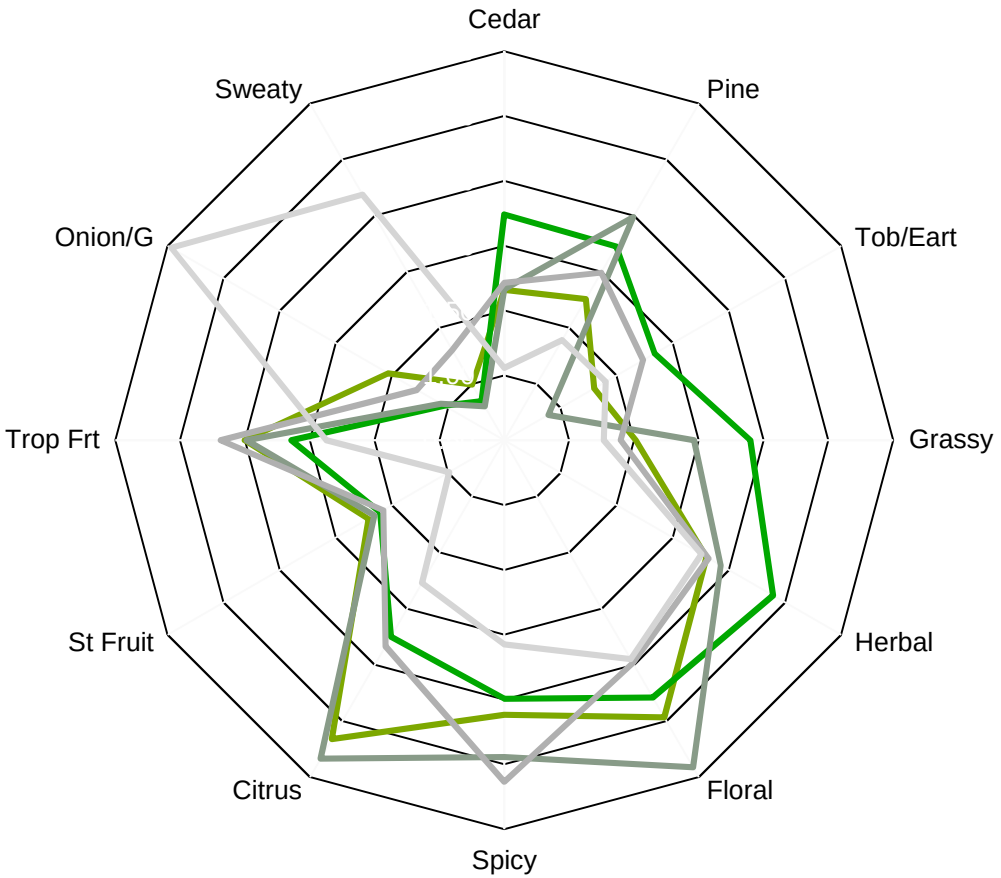
Efficiency

Quality

Flavor

Cost

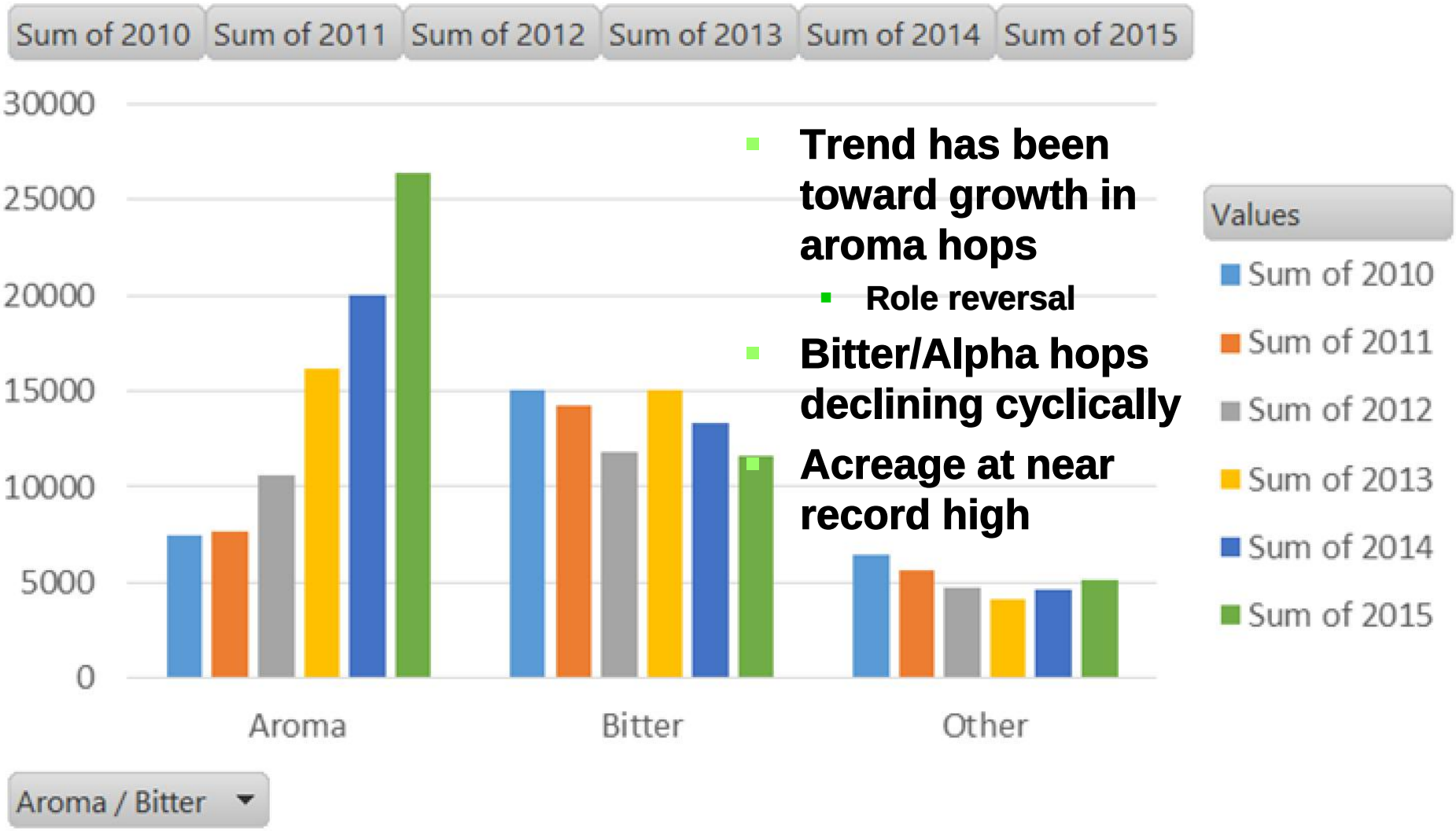
Aromatic Variablity



Future Trends in Hop Breeding

- Molecular research
  - Marker assisted selection
  - Gene mapping
  - Gene functionality
- Non-brewery usage
- Continuing conversion to new varieties
  - Driven by disease pressure, storage issues, basic economic pressures, and continued growth in craft brewing.
  - Increases focus on AROMA

Acreage Trend: aroma versus alpha



- **Trend has been toward growth in aroma hops**
  - **Role reversal**
- **Bitter/Alpha hops declining cyclically**
- **Acreage at near record high**


Thank you for your time.
Questions?