HOP BREEDING AND GROWING TRENDS

- The role of hop breeding
- Objectives
- Trend: Aroma versus Alpha acreage
- Future trends

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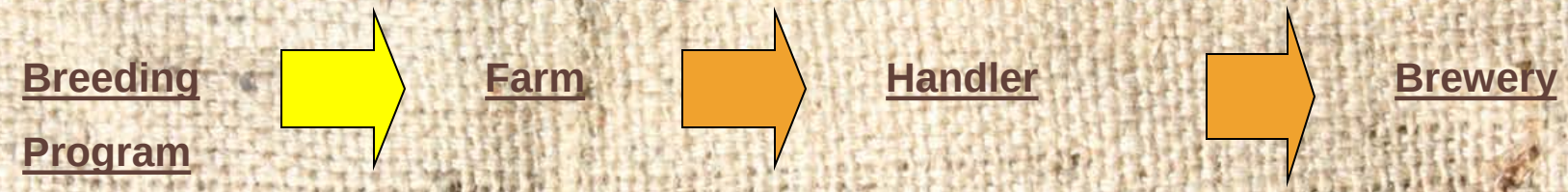
ROLE OF VARIETY DEVELOPMENT

- Hop Supply Chain: Each link on the supply chain affects subsequent links.



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CUSTOMER DEMAND…

- **Farming Customers:**
  - Pest resistance
  - Storage
  - Yield
  - General agronomics
  - Maturity

- **Brewing Customers:**
  - Brewing Quality
    - Alpha / Beta / CoH
    - Oils
  - Classic/Noble aroma
  - Special aroma

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VALUE TO OUR SUPPLY CHAIN

- Higher yield = less inputs (water, fertilizer), fewer acres
  - Pest resistance = fewer pesticides, higher quality
- Higher alpha = improved efficiency
- Varied maturity = better asset utilization, quality, etc.
  - Special aroma = flavor/ aroma options…

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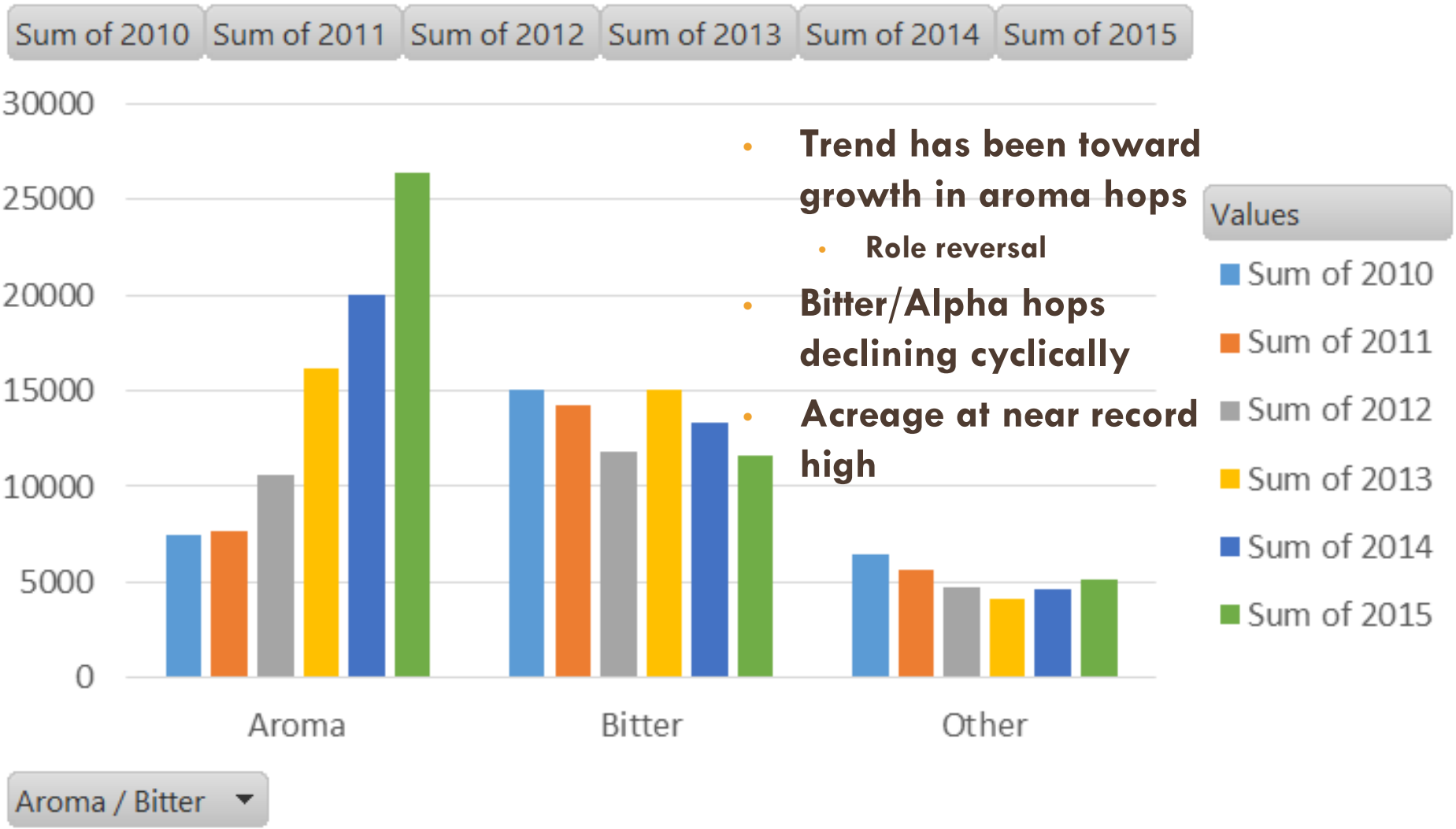
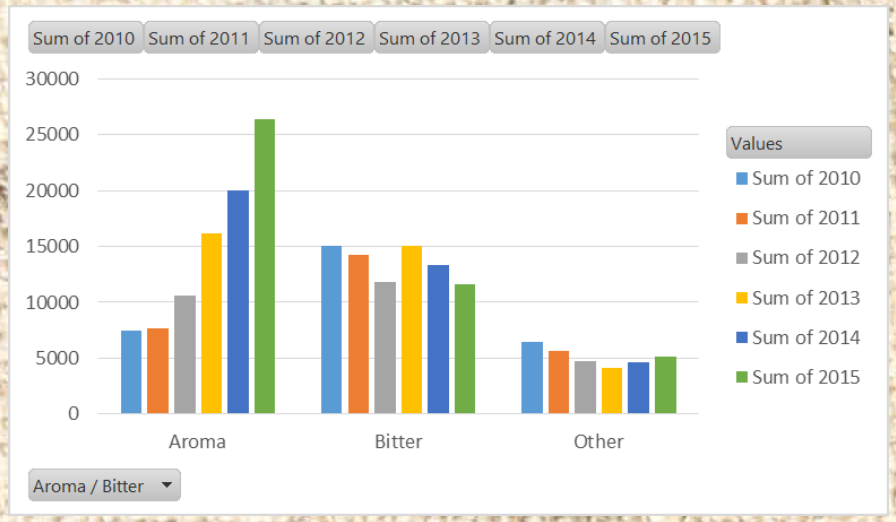
ACREAGE TREND: AROMA VERSUS ALPHA



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

ACREAGE TREND: AROMA VERSUS ALPHA



- Can we keep up?
  - Driven by economics
  - Aroma hops are driving this.
  - Grower investment and expansion at all time high
  - New generations.
- What happens to alpha?
  - Trend is cyclical
  - Demand vs inventories
- Breeding as a part of the equation.

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ACREAGE TREND: IMPACT OF BREEDING

- Hypothetical situation: improve CTZ alpha yield by 30%.
- 2014:
  - acres = 5775
  - yield = 2765
  - Alpha = 16.5%
  - Alpha Yield = 456 lb alpha/acre
  - Alpha production = 2,635,298 lb alpha
- 30% increase in yield = 3,425,887 lb alpha on same acres or same production on only 4446 acres (1330 acre decrease).
- What if we applied this same math across all acres?

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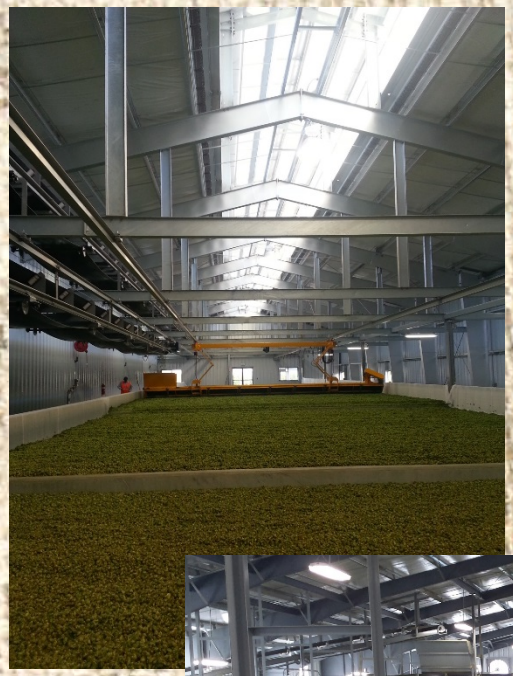
CAN WE (GROWERS) KEEP UP?



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IMPLICATIONS

- Breeders must select for efficiency first.
- Growers should demand efficiency and expect economically viable returns.
- Brewers should be selective when considering new varieties.
- Active role for all involved.

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A DECADE OF DEVELOPMENT

Year 1: Parental selection and crossing
- Based on breeding objectives

Year 2: Early selection
- Greenhouse screening
- High density field screening
- 10% selection rate

Years 3,4,5: Intermediate selection
- Remaining plants transplanted to 18' trellis
- 1% selection rate

Years 6,7,8: Advanced selection
- Expand selections to multi plant plots
- 2% selection rate

Years 9,10,11: Elite Trials
- Selections expanded to commercial trials
- Selection rate: ?

Year 11+: Commercialization

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FUTURE TRENDS IN HOP BREEDING

- Molecular research
  - Marker assisted selection (SNP), gene mapping and functionality
- Continuing conversion to new varieties
  - Driven by quality, disease, handling, economic pressures, continued growth in demand, and competition…
- **Result: Increased focus on quality and supply chain management**

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