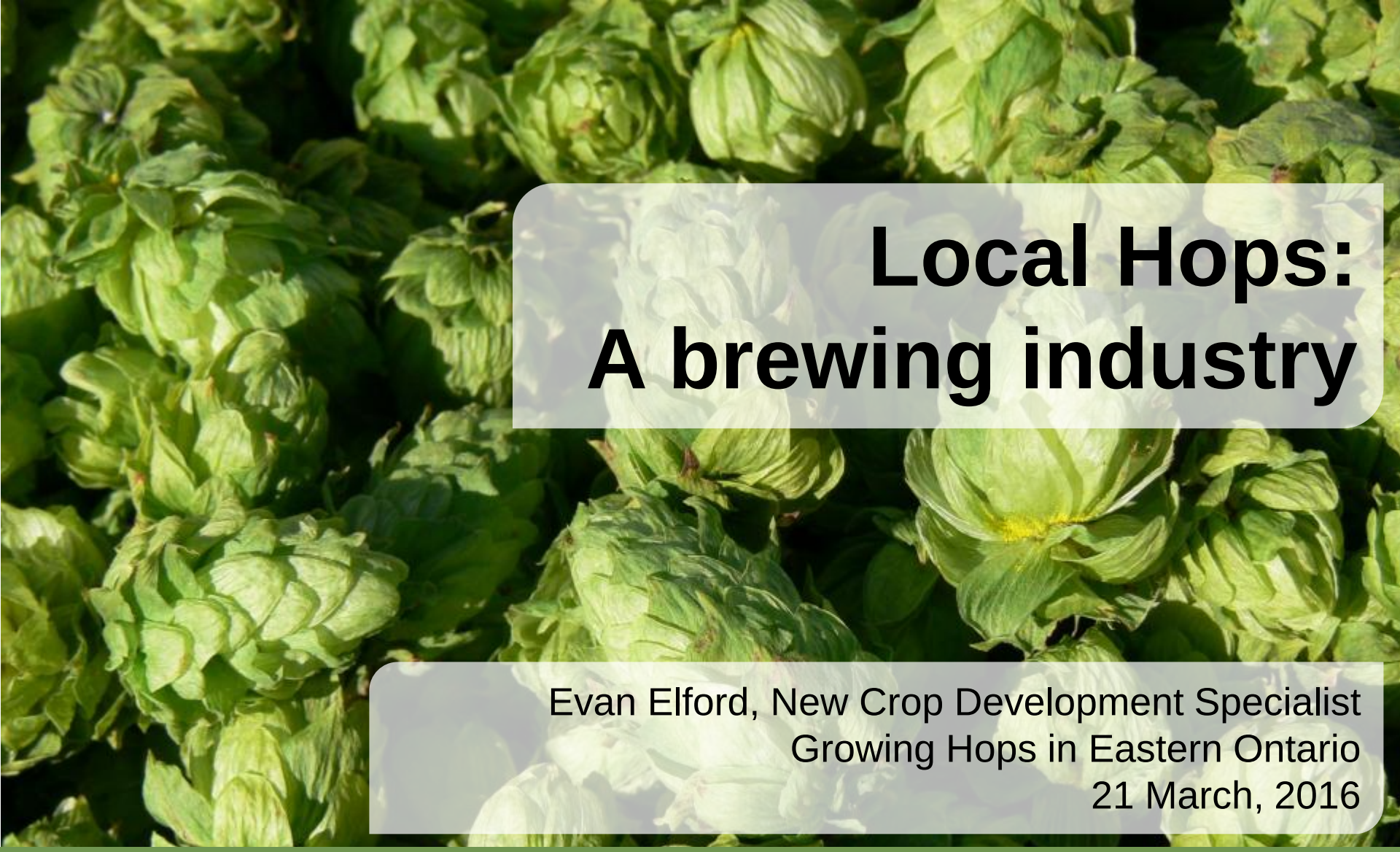


Local Hops: A brewing industry

Evan Elford, New Crop Development Specialist

Growing Hops in Eastern Ontario

21 March, 2016

Ministry of Agriculture, Food and Rural Affairs

Ministère de l'Agriculture, de l'Alimentation et des Affaires rurales

Ontario

OMAFRA Field Specialists

Evan Elford, New Crop Development

Edible non-traditional horticulture crops (fruit and vegetables); specialty grains and hops

Background: Horticulture, weed science, direct farm marketing

Melanie Filotas, IPM Specialist for Specialty Crops

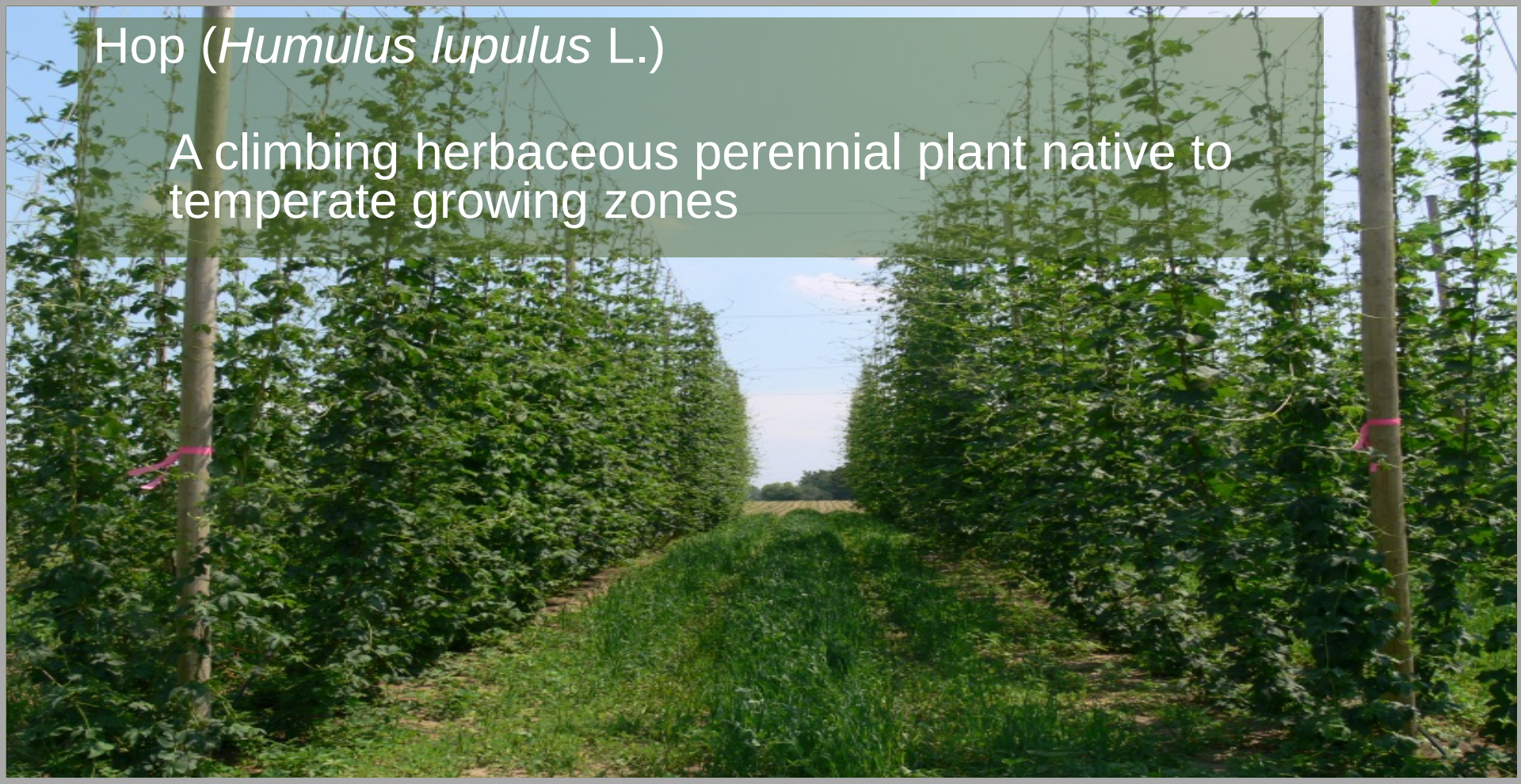
Pest management for specialty crops (incl. hops)

Background: Entomology, IPM, biopesticides

Overview

- Hops and their Uses
- Market Summary
- Ontario Hop Production
  - Field Infrastructure & Crop Agronomy
  - Harvesting & Processing
- Infrastructure Estimates
- Ontario Hop Resources

What are hops?



Hop (*Humulus lupulus* L.)

A climbing herbaceous perennial plant native to temperate growing zones

What are hops?

Hop (*Humulus lupulus* L.)

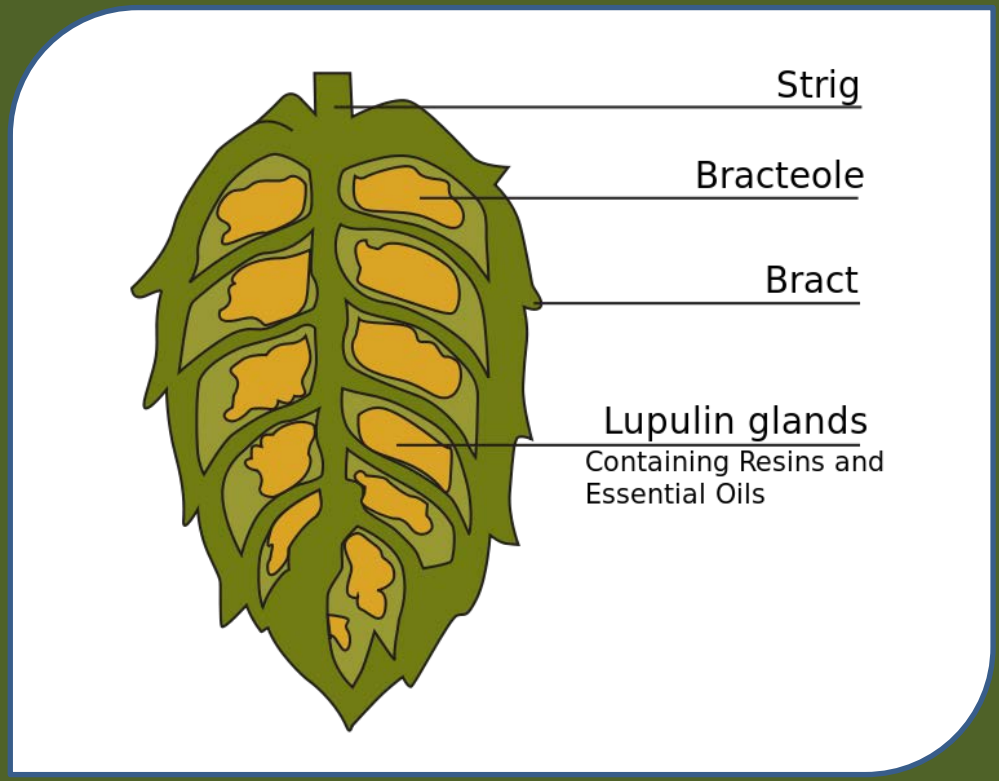
Dioecious (separate male and female plants)

Only the female plant is used for commercial production

- Hop ‘cone’ (unfertilized flower) produces a range of compounds that are useful for different products

What are hops used for?

The hop cone contains compounds in the lupulin glands such as acids and essential oils which differ in levels depending on hop cultivar.



http://en.wikipedia.org/wiki/File:Cross-section_of_hop_cone.svg

What are hops used for?

Beer

- Flavouring and preserving (alpha acids, beta acids, essential oils)
- Brewers will buy hops based on the cultivar for different beer styles (over 80 hop cultivars in use around the world today…)
- Typically classified as either ‘bittering’ or ‘aroma’ hops

What are hops used for?

Natural Health Products

https://img0.etsystatic.com/045/0/6414569/il_570xN.685579520_5kfl.jpg

www.agecomfort.com/product_images/f/306/J440409-Jamieson-RelaxandSleep-60capsules__46604_zoom.jpg

What are hops used for?

Culinary Products (e.g. ‘Hop Asparagus’)

What are hops used for?

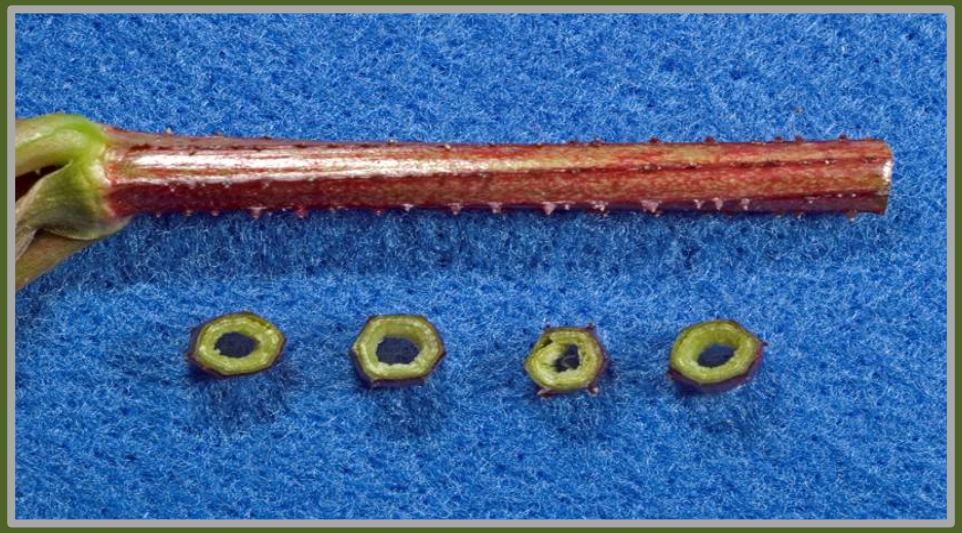
Ornamental items

www.essentiallyhops.co.uk/acatalog/Decorated_Hop_Garlands.html

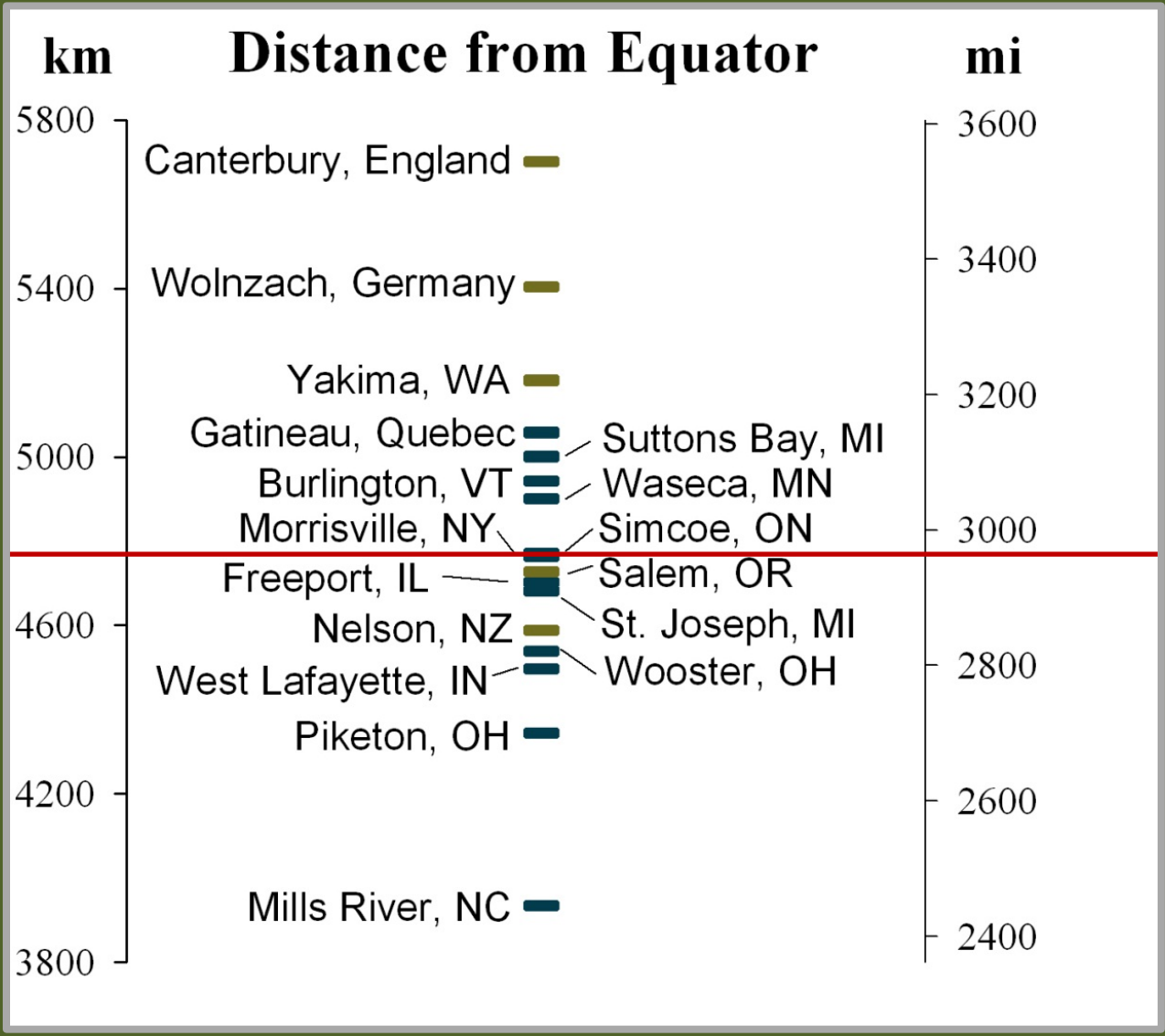
www.thetreefarm.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/h/o/hops-ornamental-vine.jpg

How do hops grow?

- Perennial plant which produces an annual ‘bine’ (not a vine)
- Climbs in a clockwise direction using trichomes
- Requires a trellis structure



Where can hops grow?



4759.25 km

Where can hops grow?

Photoperiod requirements

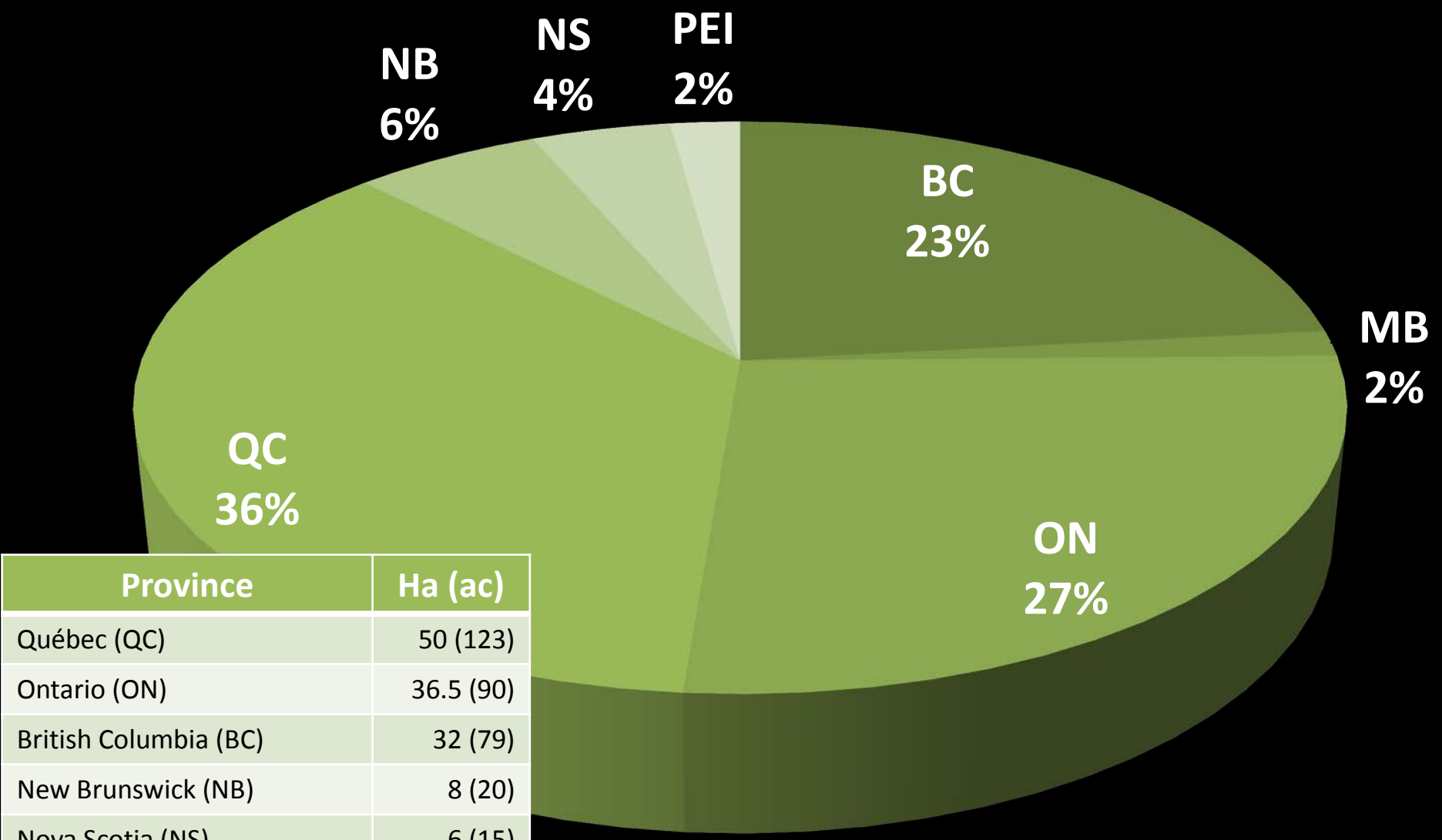
http://mapmaker.nationalgeographic.org/#/

Ontario Hops at a Glance

- Historically grown in Ontario and Eastern North America
  - Declined due to disease issues and market pressures
  - Re-emerged due to hop shortages and local food movement
- Currently ~ 35 commercial growers across Ontario
- ~ 36.5 ha (~ 90 acres) based on 2016 estimates
- Increasing acreage and number of growers since 2009
- Conventional & organic production (2015 estimates)
  - 70:30 acreage
  - 40:60 # of growers

http://www.agr.gc.ca/resources/prod/img/science/cmc/images/humulus.jpg

Canadian Hop Acreage (%) by Province 2016



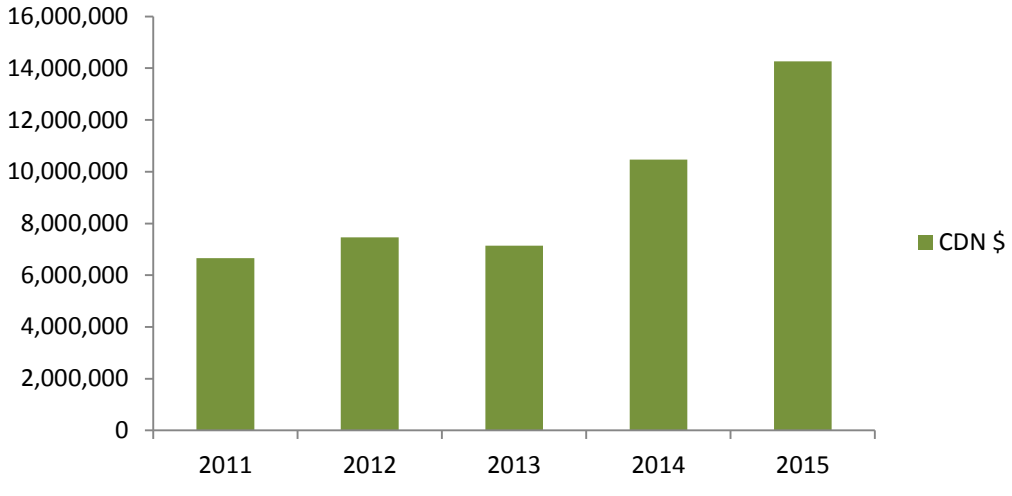
Province	Ha (ac)
Québec (QC)	50 (123)
Ontario (ON)	36.5 (90)
British Columbia (BC)	32 (79)
New Brunswick (NB)	8 (20)
Nova Scotia (NS)	6 (15)
Prince Edward Island (PE)	3 (7.5)
Manitoba (MB)	2 (5)

Market Opportunities

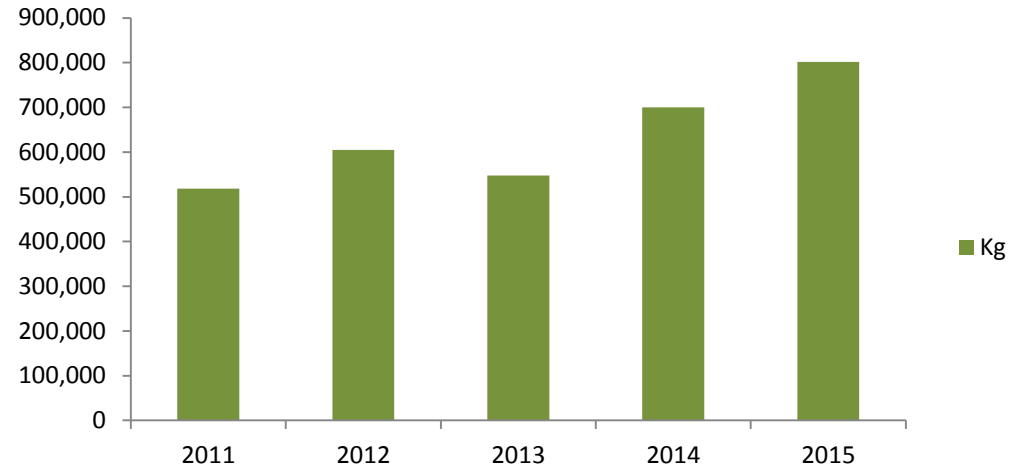
Hops for use in brewing

Form	Processing Required	Shelf Life
Fresh/Wet Whole Cone/Leaf	None	24 hours
Dried Whole Cone/Leaf	Drying, conditioning, packaging	6 months
Pelletized	Drying, conditioning, crushing (milled), pelletizing, packaging	2 years
Extracts	Drying, conditioning, milling, pelletizing, re-milling, solvent or CO_2 extraction	>5 years

Hop Imports for Ontario (by $) 2011-2015



Hop Imports for Ontario (by kg) 2011-2015



Source: Statistics Canada

Facts & Statistics

Hop Imports – Canada 2014-15

	2014		2015	
	$	kg	$	kg
Total hop imports †	18,889,314	1,248,538	25,266,714	1,469,714
$/kg (lb)	$15.13 (6.86)		$17.19 (7.79)	
Percent (%) of total in pellets	~ 84%		~ 80%	

† Includes all line items for hops such as hop cones (whole or partial), hop powders, hop pellets, etc. and resin products
Includes corrected figures for 2014.

Source: Statistics Canada

Some Sobering Thoughts…

Ontario

Import markets:

Complete import replacement* to Ontario requires **~1500** + acres at commercial densities/yields

Domestic markets:

Ontario Craft Brewers 2015 production estimate 289 508 HL

Hop production to meet OCB needs at current yields*:

<u>128-320 ac</u>†

*Total import replacement is unrealistic due to many factors

† Based on calculations on average current yields (below optimal) and the range of hops used per HL in many craft beer recipes. Acreage estimate based on 1000 lb/ac

Trends & Insights

- ⬆ domestic acreage and new growers (with larger initial acreage)
- ⬆ domestic mechanization and processing capability
- CDN/US exchange rate
- Food safety and traceability
- Changes in Ontario industry over the next 2-3 years…

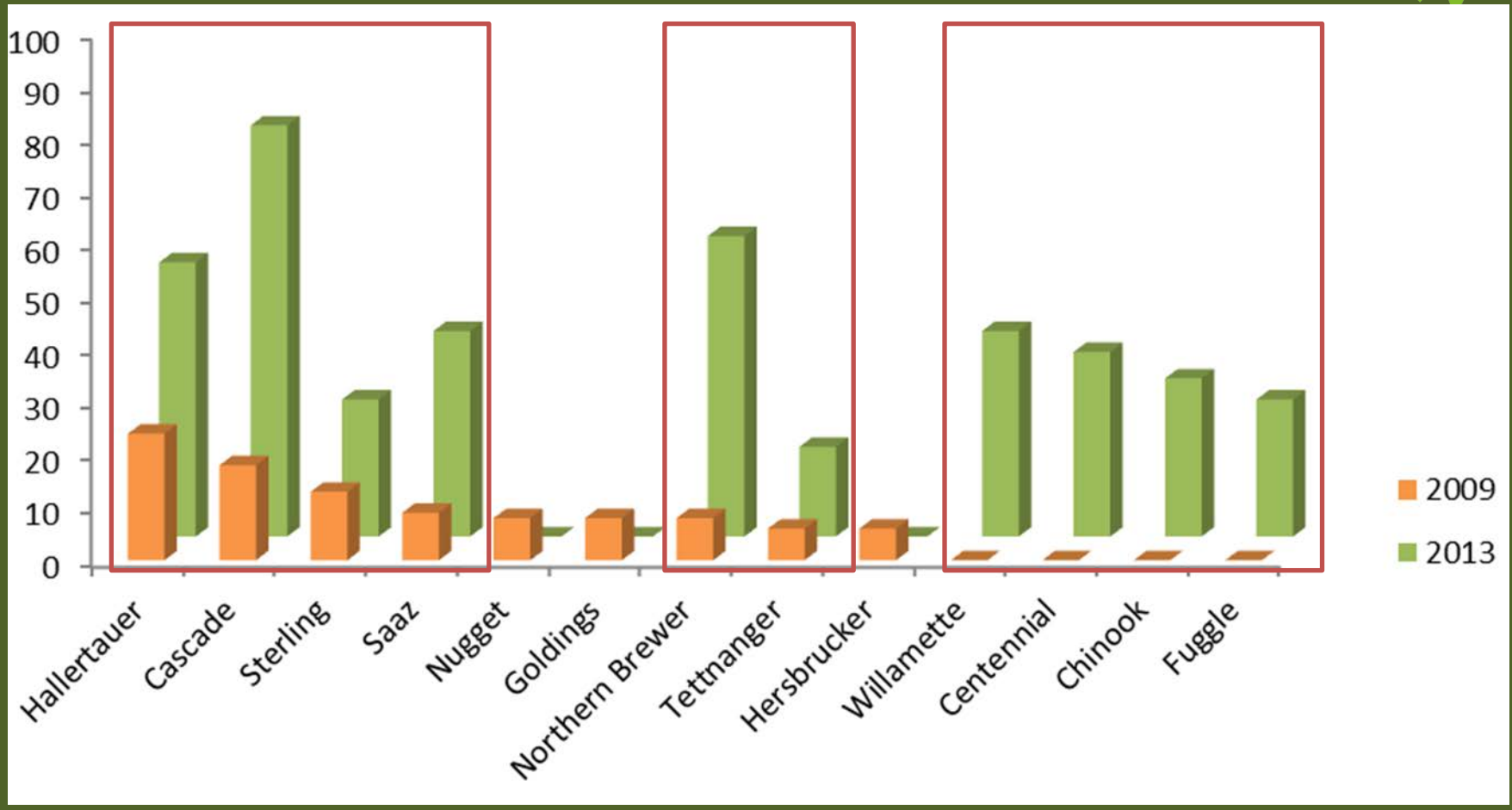
What Cultivars Should I Grow?

- Talk with your local brewers:
  - Communication and relationship building is key
  - Cultivars suited for your growing zone (climate, soil, pest management) – preliminary stages for Ontario
  - Few or many cultivars? Depends on your market.
  - Typical price range for local hops $30-35/kg ($14-16/lb) but can be higher or lower depending on quality, cultivar and supply.

USDA / OSU HOP CULTIVARS

Cultivar	Pedigree	Release Date	Alpha Acids	Beta Acids	Oil	Aroma
Cascade	Derived from a cross between Fuggles and the Russian hop Serebrianka.	1972 Haunold, OSU	6-9%	5.00%	1-2.5 ml	An American craft brewing workhorse.Resiny/piney, citrusy and floral. Character varies depending on growing region. First public cultivar since Prohibition. Adolph Coors first to brew with it in mid 1970s. Today most popular craft hop.
Centennial	Cross between Brewer's Gold and a selected USDA male.	1974 USDA	9.5-11.5%	3.5-4.5%	1.5-3.5 ml	Popular IPA hop for it's abundant aroma featuring pineapple citrus, resiny and floral character. Perhaps the first public hop saved from oblivion by the fledgling craft brewing industry.
Columbia	Tetraploid Fuggle (USDA 21003) x Fuggle seedling 2-4	1967 Haunold, OSU	8-10%	3-5%	.9-1.4 ml	Refreshing lemon citrus. Selected by Anheuser Busch taste panel in mid 1970s but overruled by Bud Master Brewer in favor of its sister Willamette, probably because slightly higher alpha. Columbia yet to be brewed commercially.
Crystal	Tetra. Hal. mittelfrueh, Cascade deriv.	1993 Haunold, OSU	3-6%	4-6%	.8-1.2	A contradictory marriage of "noble" European balance with renegade American brashness. Can make a fine pilsner style, then jump into an IPA and provide a resiny/grapefruit edge.
Fuggle	Old English heritage hop.	1961	4.0-5.5%	1.5-2.0%	0.7-1.2 ml	Balanced herbal, floral, and spicy. Classic English Ale hop, and a base hop for many popular American craft ales. AB once called the Willamette the closest analogue to UK Fuggle.
Horizon	Brewer's Gold, Early Green, Zattler	1998 Haunold, OSU	13-15%	6.30%	1.25-2.60 ml	Sultry, earthy, robust bittering hop adopted by curious craft brewers for unique flavor and aroma character in IPA's.. Chad loves to dry hop with Horizon because of strong oil profile
Liberty	Tetraploid Hallertauer m.f. x Zattler Seedling	1983 Haunold, OSU	4-6%	3.5%	1.3 ml	Subtle spicy finish but also has an added citrus note. One of Haunold's famed German Hallertauer Mittelfrueh "mimics" but with higher alpha, higher yields and better disease resistance.
Meridian	Unknown.	2011	6%-7%	6-10%	1.1-1.5 ml	Smooth, complex combination of sweet lemon, mixed berry, tropical fruit, and cool mint. Bright, alluring flavor and/or aroma addition to any beer style. Discovered by Indie Hops.
Mt. Hood	Tetra Hallertauer deriv.	1989 Haunold, OSU	5-7%	6-7.5%	1.4 ml	Herbal, cedar woodsy, and spicy, Mt. Hood was the first USDA release designed as a substitute for Hallertauer m.f. from Germany, with higher yields, oils and alpha. Widely used in craft for light and medium bodied beer styles.
Mt. Rainier	Hallertau, Galena, and Fuggle	2006 Henning, OSU	5.0-8.1%	5.0-7.0%	0.2-0.5 ml	A spicy, floral, noble aroma/flavor with licorice notes and hints of citrus. Designed as Hallertauer m.f. substitute with better disease resistance, higher yields and noble aroma. Not yet widely used.
Newport	18.8% Brewers Gold, 12.5% Hallertauer Mittelfrüh, 6.3% Late Grape, 4.6% Belgian 31, 3.1% Fuggle, and 54.7% unknown.	2002 Haunold, OSU	13-17%	7.2-9.1%	1.3-3.6 ml	Dual purpose hop. Haunold designed in response to Miller Brewer's request to breed back up to high alpha Galena. Excellent organic hop potential due to disease resistance.
Nugget	Brewer's Gold, Early Green, E.K.Golding, Bavarian	1983 Haunold, OSU Avail since 1978	12.5-14.5%	4.60%	1.5-2.0 ml	Clean, consistent bittering hop for layering flavors on top of. Exceptionally mild and clean aroma for a high alpha acids hop. Nugget can also be used for aroma character. In early 1970s, known as highest American made alpha hop.
Santiam	Tettnanger , Hal. Mittelfrueh deriv. Brewers Gold, Cascade	1998 Haunold, OSU	5.5-7.0%	7.0-8.5%	1.3-1.7 ml	Designed as US substitute for German Tettnanger, Santiam does carry the classy, noble heritage along with a dried apricot/peach finish. Excellent for unique flavor/aroma contribution in light/medium bodied beer styles. Note: "US Tettnanger" is really Fuggle.
Sterling	Saazer, Cascade, Brewer Gold, Early Green deriv.	1998 Haunold, OSU	6-9%	4-6%	1.3-1.9 ml	Designed as a US sub for Czech Saazer, Sterling is a bolder Saaz-type, with the classic Saaz spicy, floral character. Versatile enough for pilsner on through to IPA's. Named after Crown Sterling to remind brewers to avoid Euro-US Dollar fluctuations. Coors first to brew it.
Teamaker	Fuggle, Late Grape, and Late Cluster	2008 OSU	0.6-1.8%	5.4-13.2%	.98ml/100g	Living proof of the wonders of selective breeding. A hop with nearly zero alpha acid. Used in teas and touted for sedative qualities.
Ultra	Tetraploid Hallertauer mittelfrueh x diploid Saazer: OP4/6 Hallertauer mittel-frueh; 1/6 Saazer; 1/6 unknown	1983 Haunold, OSU	3-5%	4-5%	1.3-1.5 ml	Mildly Spicy. Another famed Haunold german noble flower "mimic," but with slightly better yields and disease resistance. Not widely used, yet.
Willamette	Fuggle Derivative	1976 Haunold, OSU	5-7%	3.80%	0.8-1.2 ml	Selected as A-8's replacement to Oregon Fuggle in Budweiser, Willamette has Fuggle's herbal/floral/spicy character and is equally adapted to a wide range of American craft beers. Most popular Oregon grown hop 1980s-2000s. One of top three most widely used hops in 2009. Oregon production drastically cut when Inbev bought AB.

Ontario Surveys & Cultivar Evaluations



Hop agronomics

Introduction to the basics requirements for small-scale, commercial hop production.

- Soil conditions
- Trellis structure
- Planting & Establishment
- Stringing, Training & Stripping
- Irrigation
- Fertility
- Pest Management
- Harvesting
- Post-harvest Processing

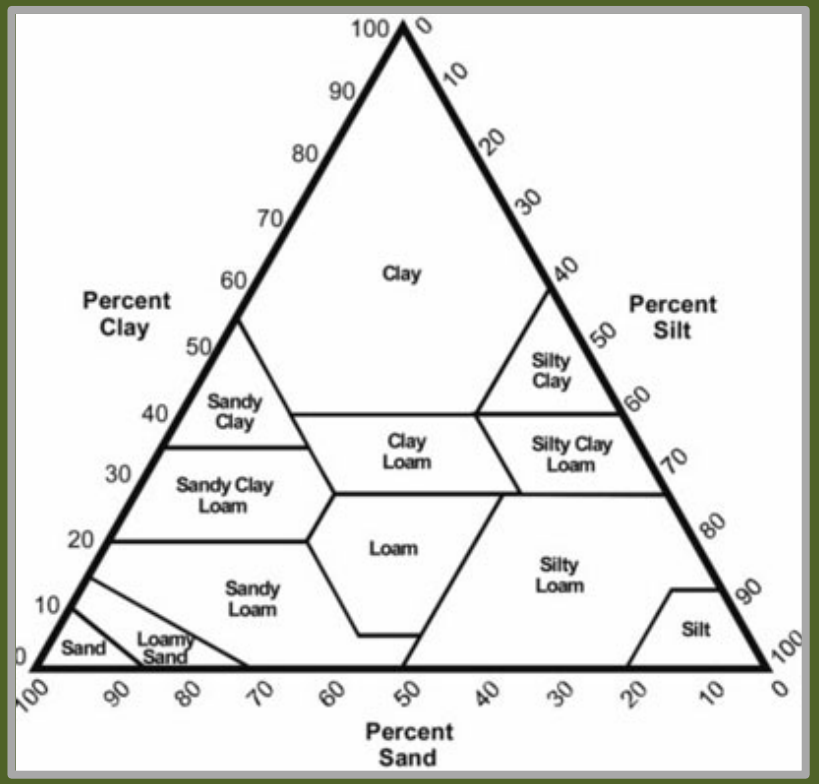
Soil Conditions

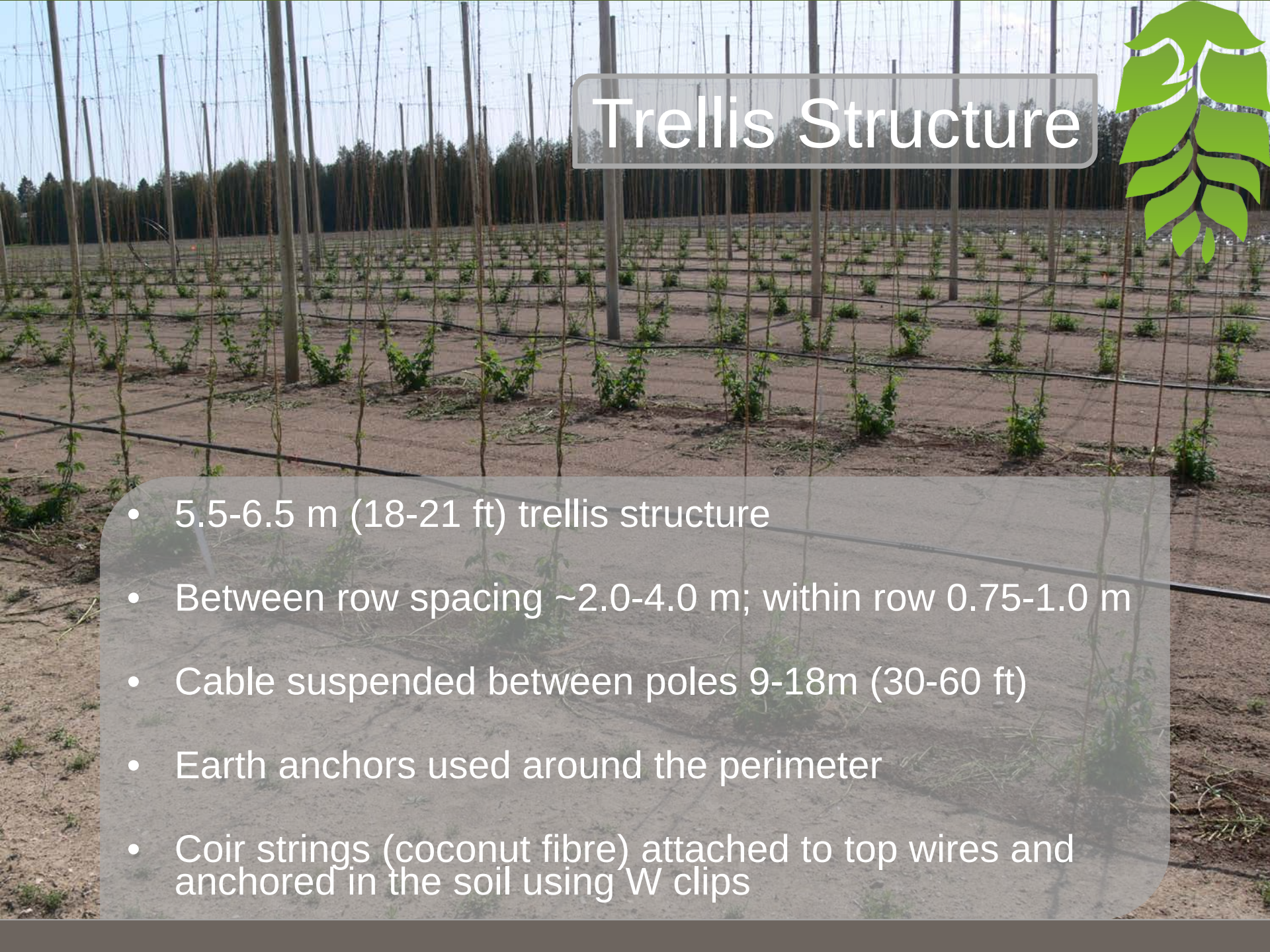
Hops can grow in a range of soil types (clay, loam, sand) and a range of pH values (typically found in 6.5-7.5), BUT…

- Hops require well drained soil

"Don't like wet feet"

If growing on clay, drainage is typically required and in some years may expect 50% yield of other soil types.

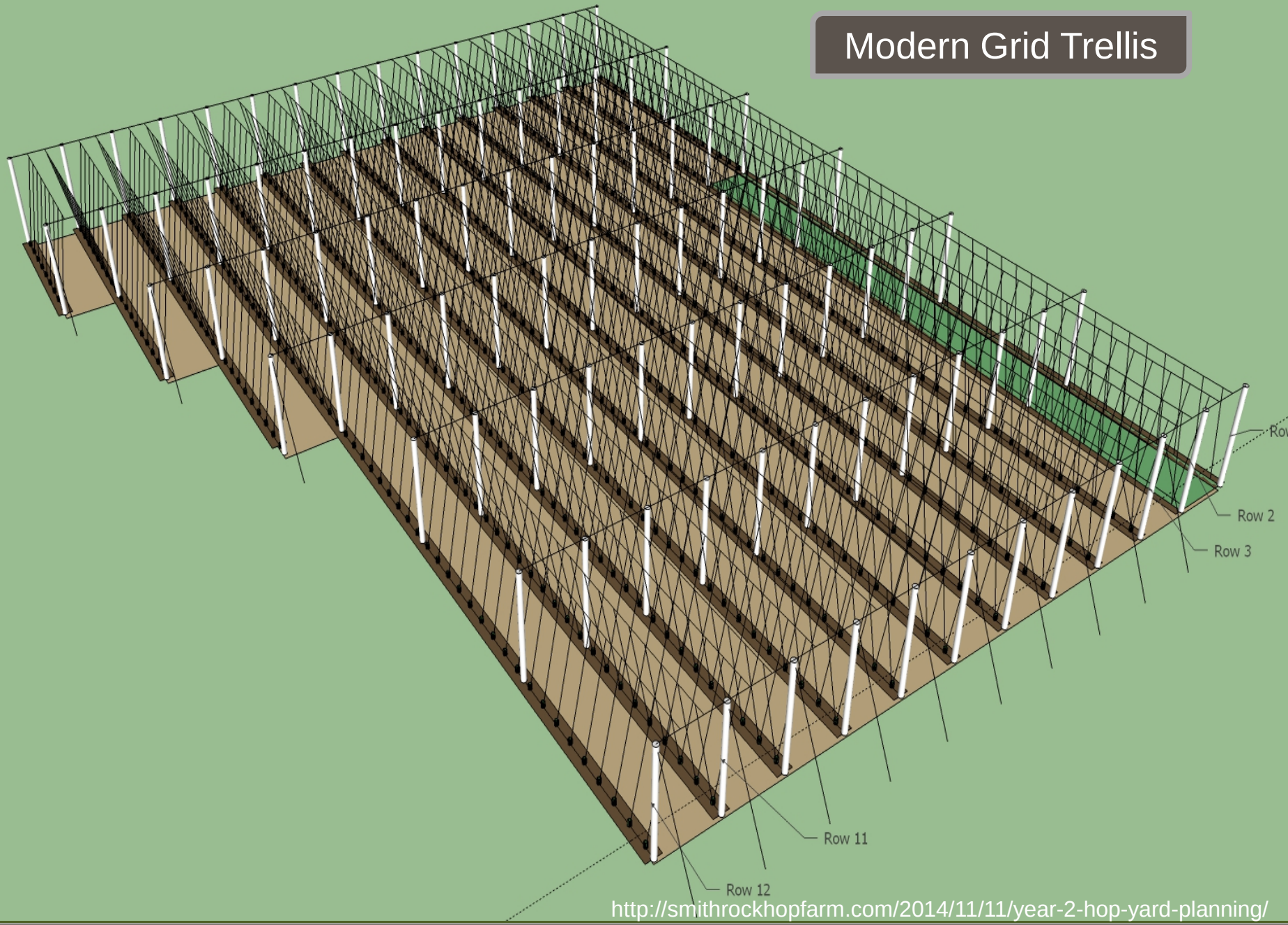




Trellis Structure

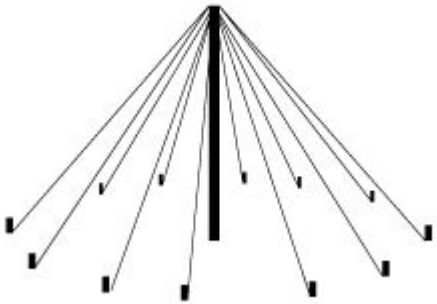
- 5.5-6.5 m (18-21 ft) trellis structure
- Between row spacing ~2.0-4.0 m; within row 0.75-1.0 m
- Cable suspended between poles 9-18m (30-60 ft)
- Earth anchors used around the perimeter
- Coir strings (coconut fibre) attached to top wires and anchored in the soil using W clips

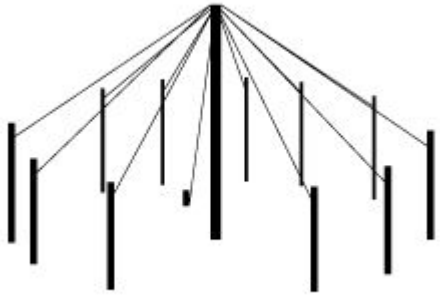
Modern Grid Trellis



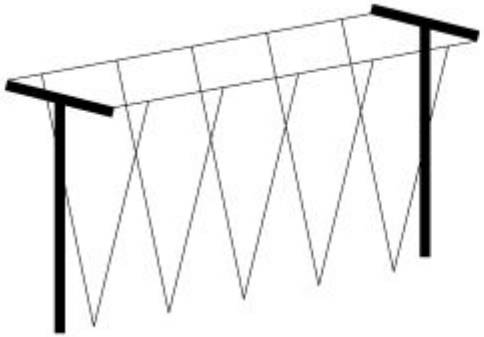
http://smithrockhopfarm.com/2014/11/11/year-2-hop-yard-planning/

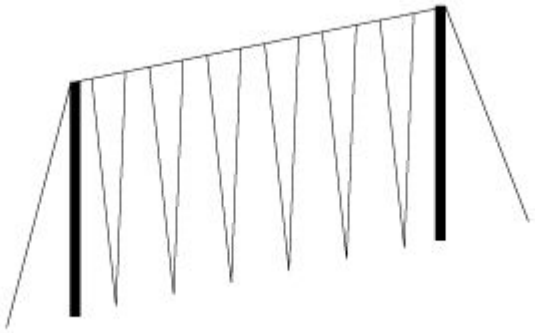
Single and Centre Pole Trellis

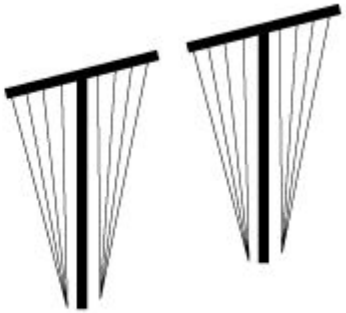




Other Simple Trellis Designs







http://www.aussiehomebrewer.com/articles/article91.html


Hallertau
Hallertau

Planting/Establishment

- Historically propagated from rhizomes; hop starts/field transplants becoming more common
- Obtain clean stock if possible (virus indexed)
- Order plant material early (Nov-Feb)
- Plant after trellis construction
- Plant mid-late spring, late summer/autumn planting is not advised

http://blog.uvm.edu/hoppenin/files/2012/12/DSC00083-e1355926438127.jpg
http://www.plantlabs.com/clean-stocks/hop-field-transplants/

A Season in the Hop Yard

9 Principle Growth Stages:

1. Sprouting: dormancy to shoot development

2. Leaf development

3 & 4. Formation of side shoots; Elongation of bines

Summer solstice

5 & 6. Inflorescence emergence; flower development

7 & 8. Development of cones; maturation of cones

9. Senescence, dormancy

Crowning, pruning and training

Crowning and scratching:

Typically on dormant, mature plants for disease management (varies depending on plant age, growing zone and disease severity)

- Crowning: Remove 2.5-5 cm of crown
- Scratching: Removing buds from crown within 2-5 cm of soil surface
- Hilling after crowning/scratching can help rejuvenate crowns/promote rhizome development

Pruning:

Removal of first shoots prior to training for disease management and to provide uniform shoots for training with higher yield potential

Training:

Selection of best bines and physical placement on strings

Pruning and Training

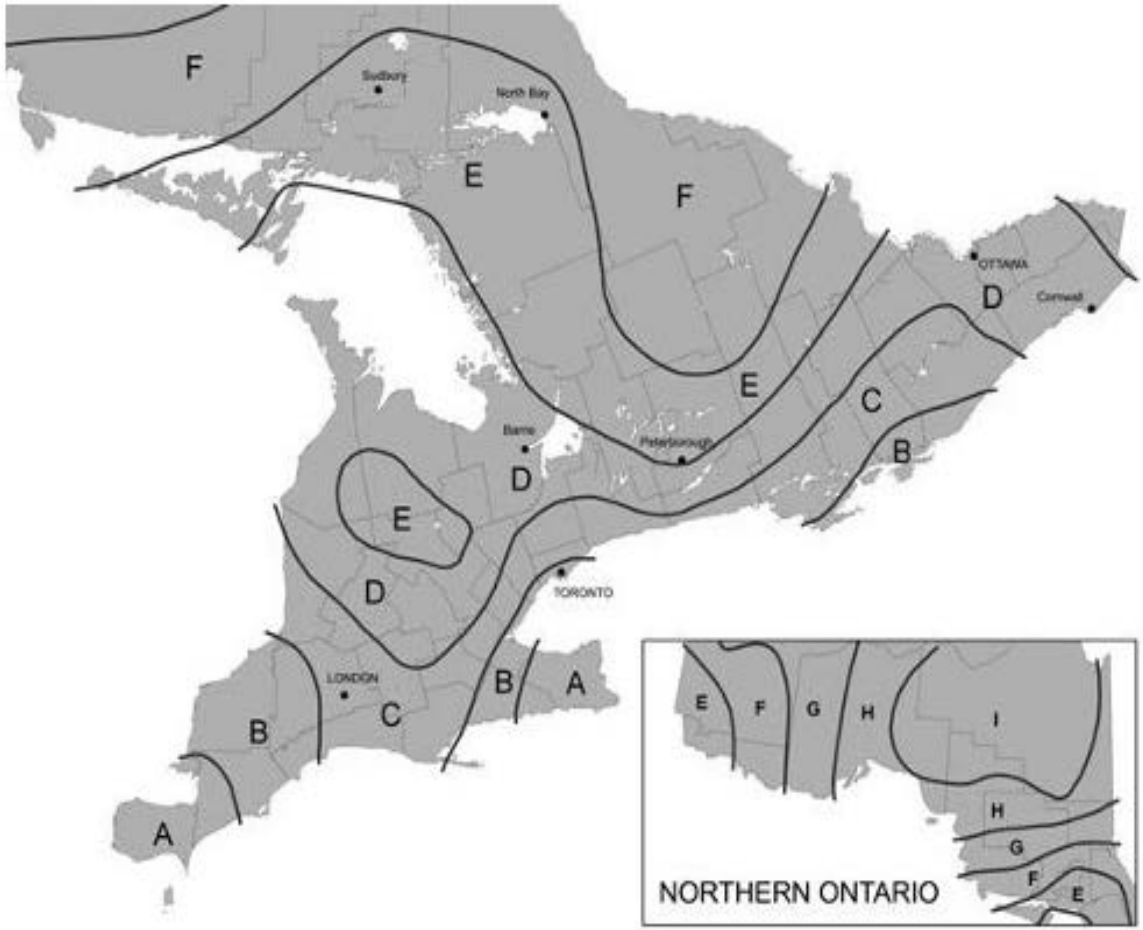


Figure 1. Climate Zone Map of Ontario (1976-2005). Source: Weather Innovations Incorporated

Target Dates for Pruning and Training in Ontario

Zone	Target Dates	
	Pruning	Training (earliest)
B	Last week of March/First week of April	April 30
C	First week of April	May 3
D	2nd week of April	May 11
E	Last week of April	May 17

*Issues with late spring frost in 2013 and 2015

Stringing and Training the Hop Yard

30-60 cm tall plants are trained clockwise on strings (2-4 bines)

Leaf Stripping

~2 m tall plants, remove lower 0.5-1 m of leaves, lateral branches and remaining shoots (increase airflow)

Irrigation

~55-60 L/plant/wk during the growing season

Fertility

No current Ontario fertility recommendations exist for hops.

N:

Establishment year (first year): 65-130 kg N/ha

Established yards: 130-150 kg N/ha

P & K:

Requirements are generally low for mineral soils found in Ontario and should be based on a soil test of your yard.

Phosphorus: 0-30 kg/ha

Potassium: 0-150 kg/ha

Apply fertilizer in split applications after plants emerge approximately every two weeks with no more than 25 kg N/ha in any one application. Cease applications in the last week of June or first week of July.

Harvesting

- Starts mid-August ends mid-September
- Early, mid and late season cultivars
- Harvest at ~75-80% moisture
- Online moisture calculators and sensory
- 5-7 day harvest window
- Hand vs. mechanical harvest
  - >0.2 ha (~0.5 acre) = mechanization


© Rod Kirkpatrick/F Stop Press


EXIT
HOP
TOP
CUTTER
$9,500.00
LRJ 3000


http://northwesthops.blogspot.ca/

Mechanical Harvesters

Mechanical Harvesting Options

Harvest Option	Initial Cost (USD)	Crew	Bines/Hr
Hand harvest	0	1	1
Crafty hop Plucker	5, 000	1	30-60
Steenl and Hop Harvester 1000	11, 800	1	120
Bine 3060	14, 250	1-3	20-40
HopsHarvester.com	22, 500	2-3	120
Wolverine	29, 990	2-3	120
UVM Mobile – Open Source	30, 000	4	60-120
Wolf WHE 140	30, 000	3	140
Wolf WHE 170	43, 500	3	170

Adapted from Steve Miller, Cornell University Extension

Expected Yields

Current limiting factors in Ontario production:

1. Optimising plant density and # of strings/acre

2. Optimising irrigation, fertility and pest management

- Ontario field trials have demonstrated ability to achieve ~1800 lb/ac for higher yielding cultivars
- Most production is significantly below that figure…

Post-Harvest Processing

- Processing:
  - Whole cone (leaf) - wet
  - Whole cone (leaf) - dry
  - Pelletized
- Drying:
  - Oast house or screens ~8% moisture
  - -Conditioning

Packaging:

- Vacuum packed
- Nitrogen purged bags (gas flush system)

- Ziploc bags are not acceptable for the market…

- Packaging must exclude oxygen and light to prevent degradation of the hops.

www.pleasanthillgrain.com

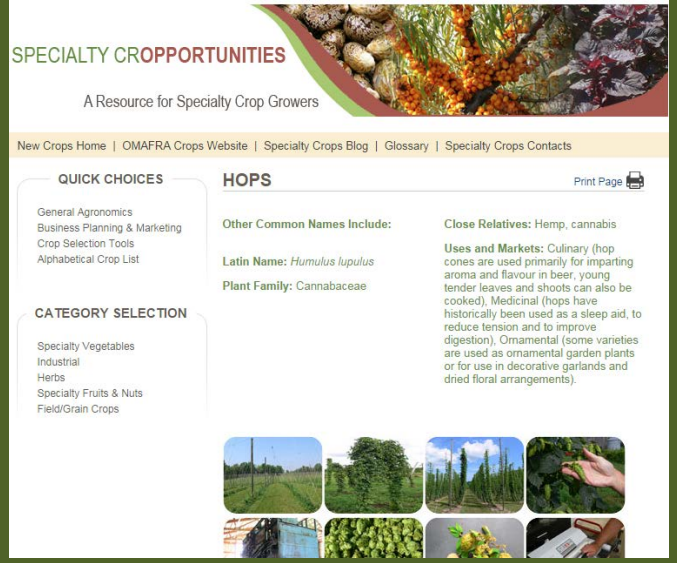
Costs

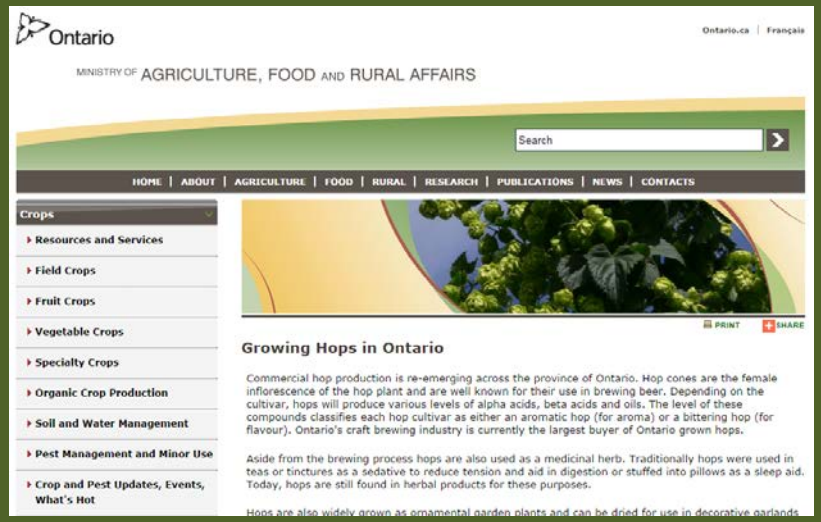
	Cost Estimate
Establishment (field): trellis, plants, irrigation, etc.	$7 000 - 20 000/acre (most estimates in the $15-20 000/ac range)
Harvesting/processing equipment (mechanised)	>$50 000
Ongoing labour	$5 800 - 9 500+/acre

Summary

- Market development required
- Perennial system
- Investment in infrastructure
- Labour intensive

Resources





- **Hop Production Profile**
- **Hop Resource Page**
- **ONSpecialtyCrops Blog**

Thank You!

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Pests and Pest Management – Melanie Filotas, Specialty Crops IPM Specialist
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