Coffee

“wonderful world of caffeine”

Botany

Family Rubiaceae

Genus Coffea- a pantropical genus with up to 60 species. Not frost tolerant, growth stops below 15 C.

Three main species are *C. Arabica*, *C. canephora*, *C. Liberica*. *They do not cross pollinate*.

Leaves are opposite, and evergreen meaning all leaves do not drop at end of season. Two types of branches, vertical, horizontal or lateral.

Shrub to tree generally up to 4-5 m, but some species like *C. liberica* up to 10 m.

Coffea liberica

Little commercial production, but a selection called ‘Fukunaga’ formerly known as ‘Dewevrei’ is used as a rootstock in Kona for protection from nematodes.

Coffea canephora

This commonly known by an old variety name ‘Robusta’, higher in caffeine but lower taste quality than Arabica.

It is more adapted to warmer areas, and generally considered more pest and disease resistant.

Flowers are open pollinated, so propagation is by cuttings.

Seed rounder and less green.

Coffea Arabica

This is what we grow in Hawaii, highest taste (cup) quality and the dominant coffee species in production world-wide.

Tree is more single stem that robusta, leaves not as ridged, seed is longer and more green.

2009 World Coffee Production

8.3 M Mt from 83 countries

Brazil 2.4 M Mt

Vietnam 1.2 M Mt

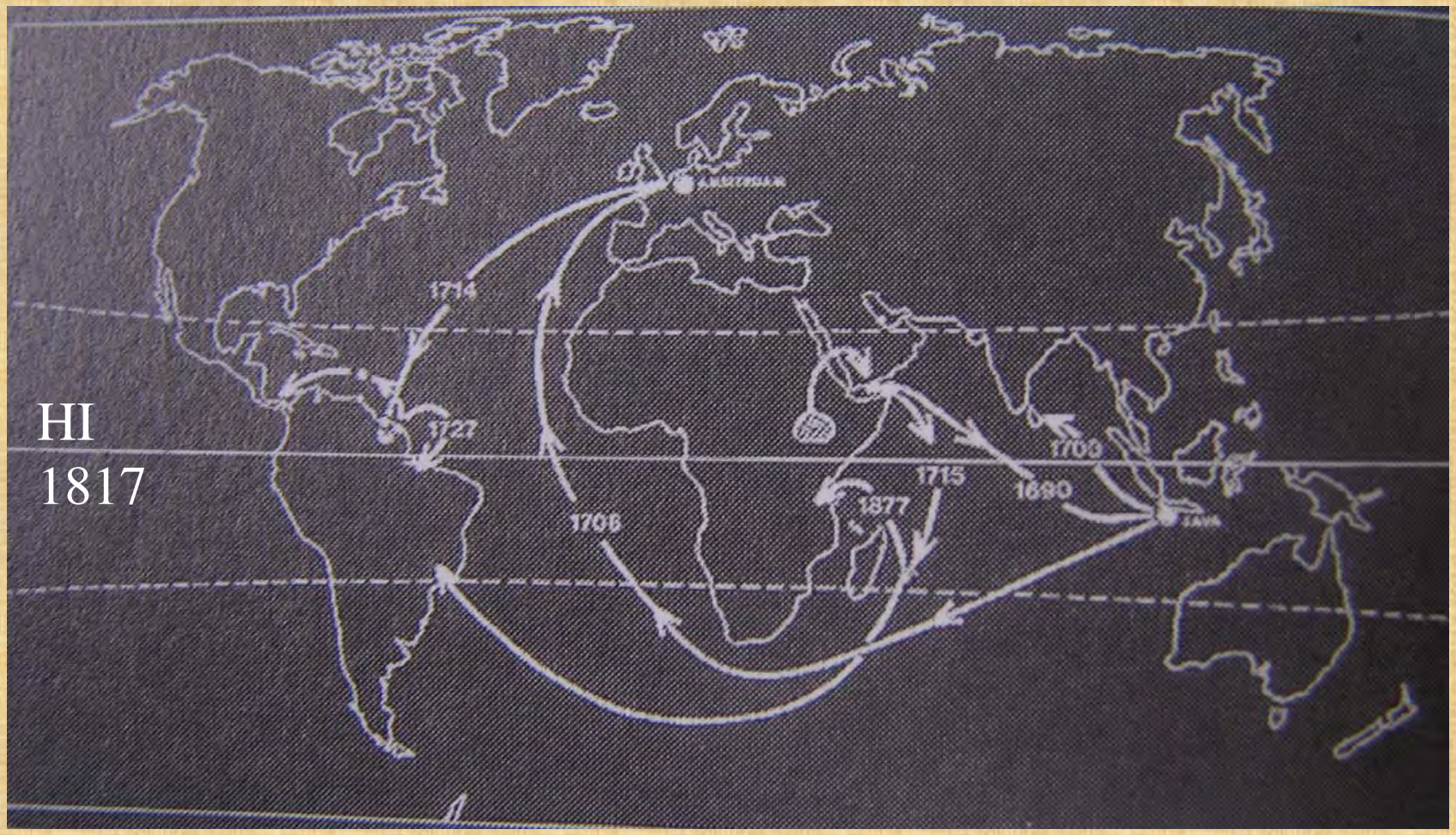
Colombia 0.9 M Mt

Indonesia 0.7 M Mt

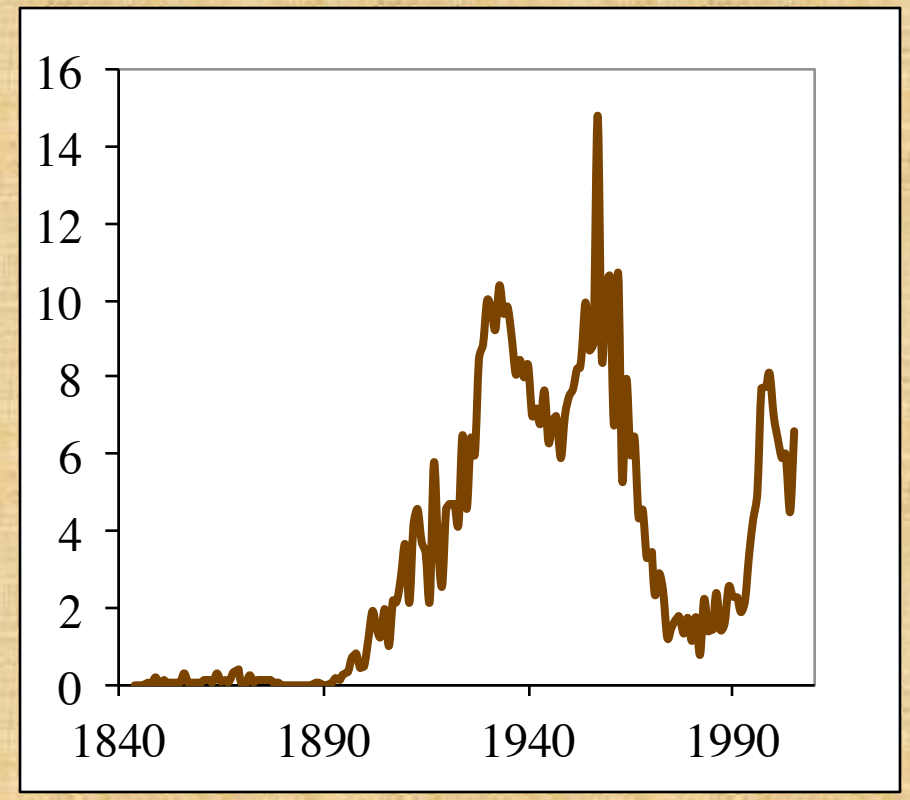
HI 0.004 M Mt

Puerto Rico 0.008 M Mt

Movement of Arabica coffee



Hawaii's past production

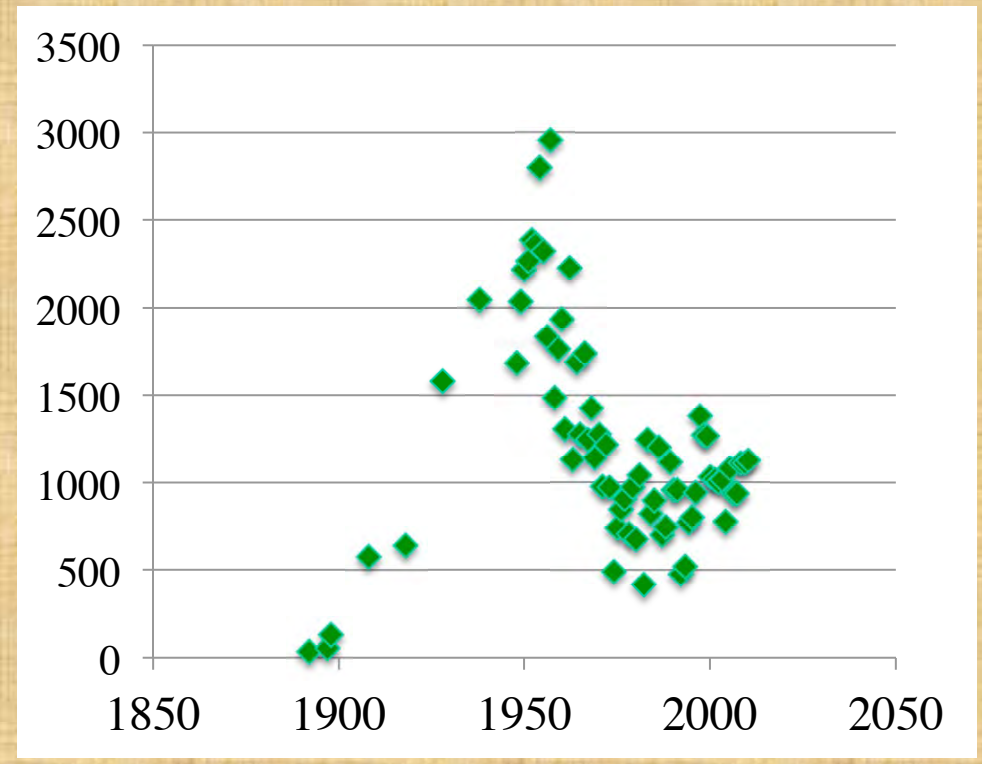


Million pounds of green coffee

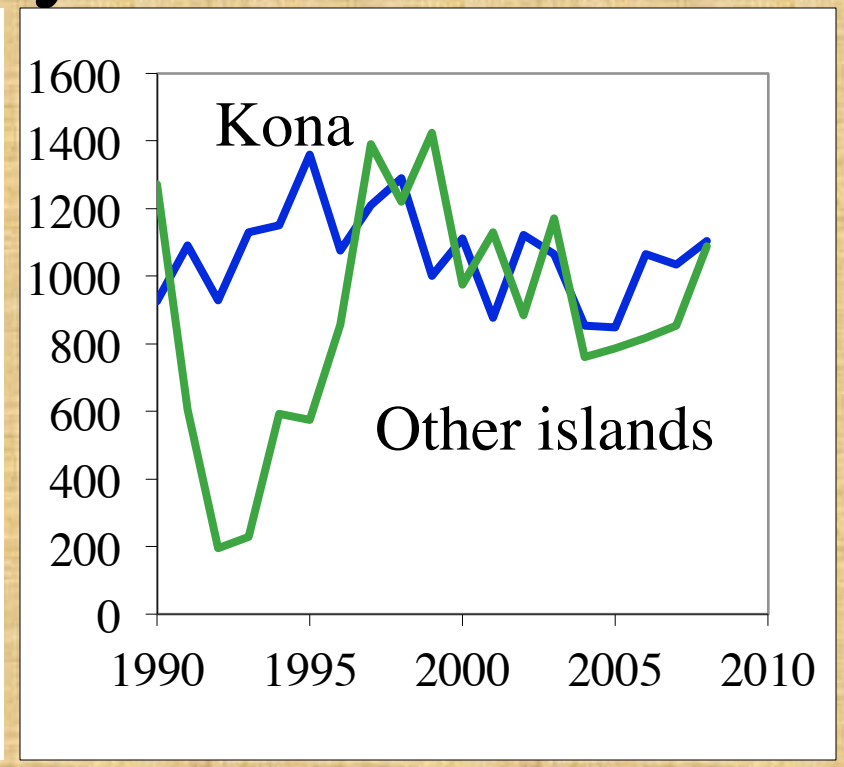
“Old style” harvest

Note taller trees and school kids picking during Kona ‘summer’ vacation.

Hawaii yields



Green bean lbs/acre



Green bean lbs/acre

Hawaii's Coffee Appellations

Factors affecting quality

Site

Variety

Nutrition

Pest

Pruning

Disease

Harvest

Processing

Handling

Site

- Not too hot - windward sea level OK but leeward at sea level is too hot, use shade
  - Objective is slow down the growth rate for larger and denser beans.
- Not too cold -windward under 2000’ OK leeward under 2800’ OK
  - Objective is no frost, plants grow well, no year-round flowering.

Variety

- ‘Guatemala’ or ‘Kona typica’ is still your best quality in Hawaii.
- ‘Mokka’ has a good cup but very small bean size and very low yield potential.
- Breeding programs around the world are now focusing on improving quality.
  - HARC & CTAHR are evaluating crosses to improve the quality of the Catuai varieties with Mokka.

Kona Environment

Temperature

Temperature not elevation is factor of importance, best averages are 59 (15C) low to 77F (25C) high

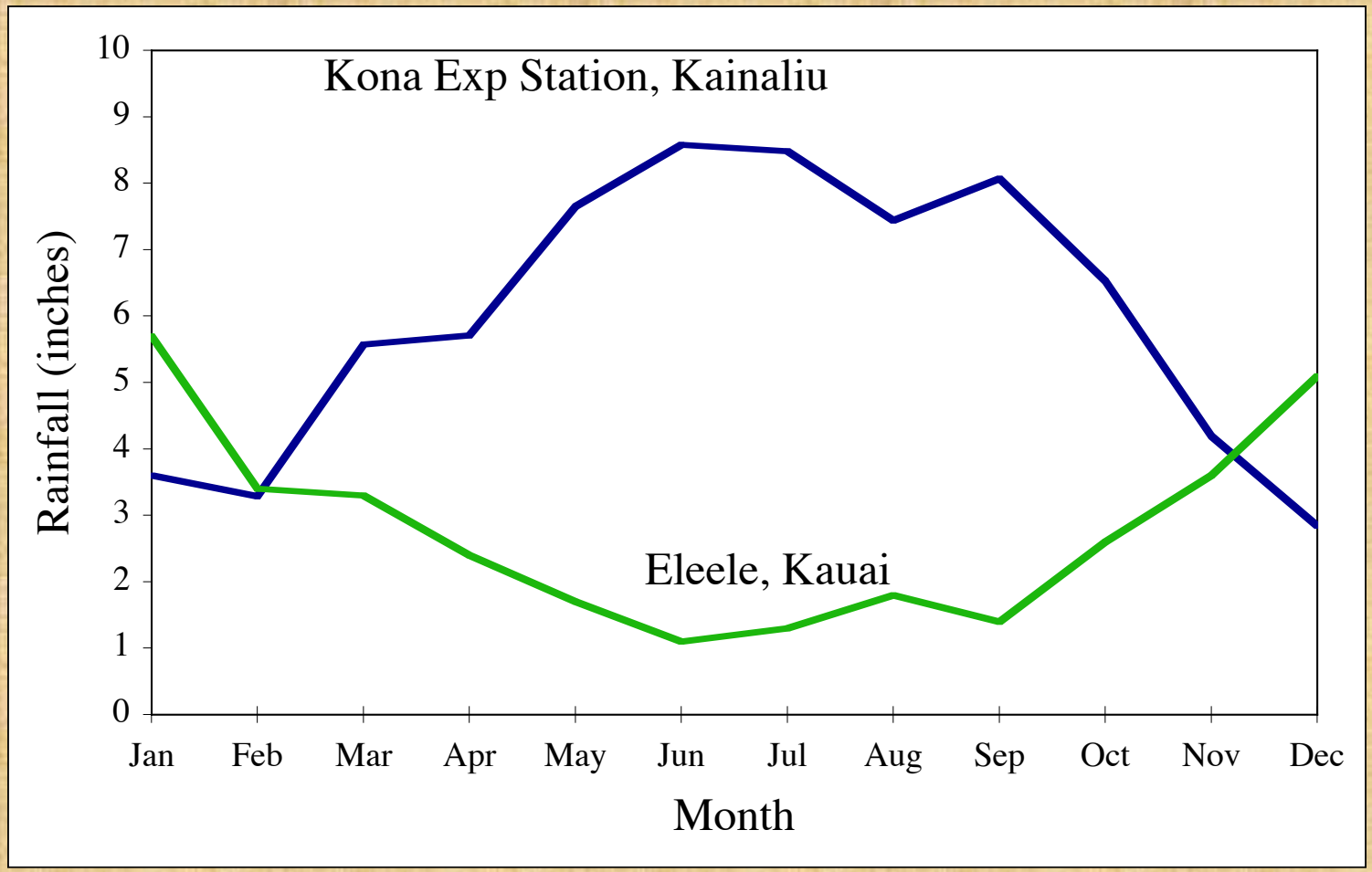
1500 ft (457 m) in Kona is equivalent to 3900 ft (1190 m) in Colombia

At Kona Experiment Station 1500 ft, temperatures averages 69F (20C) year round, average low is 60F, average high is 78F.

Kona Coffee belt lies between 700 and 2000 ft (213 and 610 m).

Kona Environment

Rainfall-target 60 inches/ yr



Kona Environment

Soil

Coffee grows best in well drained, volcanic soils

Kona soils are very young, of recent volcanic activity with a high organic matter between the crumbled lava rock known as a'a

Kona Environment

Light intensity- Shade

- Coffee evolved in the mountain dry forests of Ethiopia
- Sun grown coffee in sunny locations requires fertilizer to prevent over-production that can kill trees. Yield reduction with adequate fertilizer and water begins around 50% shade.
- Typical weather in Kona:
  sunny mornings and cloudy afternoons

Planting

Nursery grown vs pulapula (volunteer)

- Nursery grown strongly recommended
- Plant in field at 12-14 months old
- Uninfected root system prevent the spread of nematodes

Planting

Variety

- ‘Guatemalan’ or ‘Kona typica’ known for high quality
- Other varieties like Yellow Catuai grown on Kauai are not common in Kona

Planting

Spacing

Various configurations dependent on management choices and elevation

8’ x 8’ spacing, 680 trees/A

5’ x 9’ spacing, 968 trees/A

6’ x 12’ spacing, 605 trees/A

Mechanical harvest 2.5’ x 12, 1450 trees/A 5’ x 12’ is better.

Pruning

‘Kona style’ vs. Beaumont -Fukunaga

Moderate pruning every year.

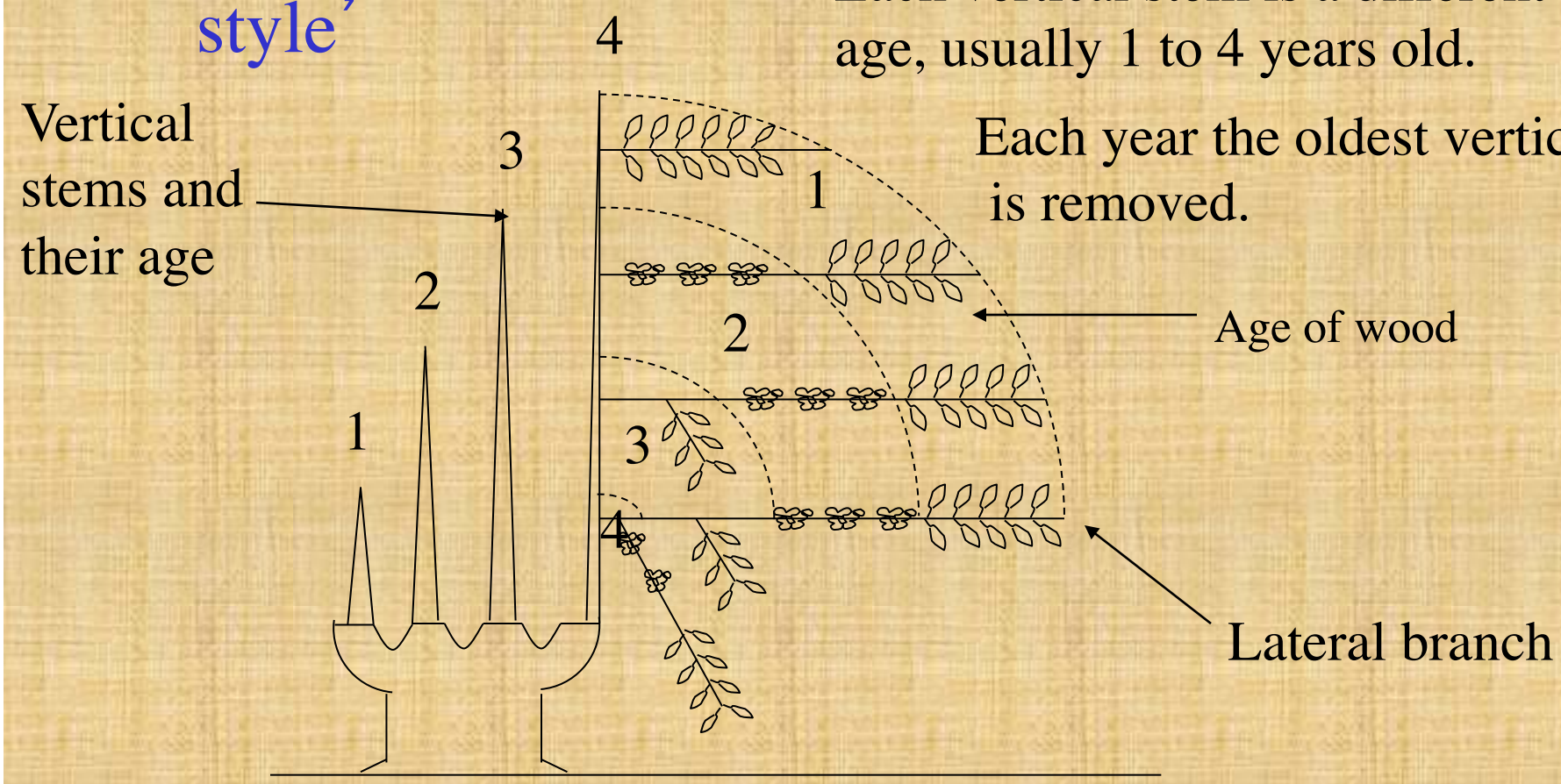
Severe pruning after 4 years.

Pruning

'Kona style'

Each vertical stem is a different age, usually 1 to 4 years old.

Each year the oldest vertical is removed.

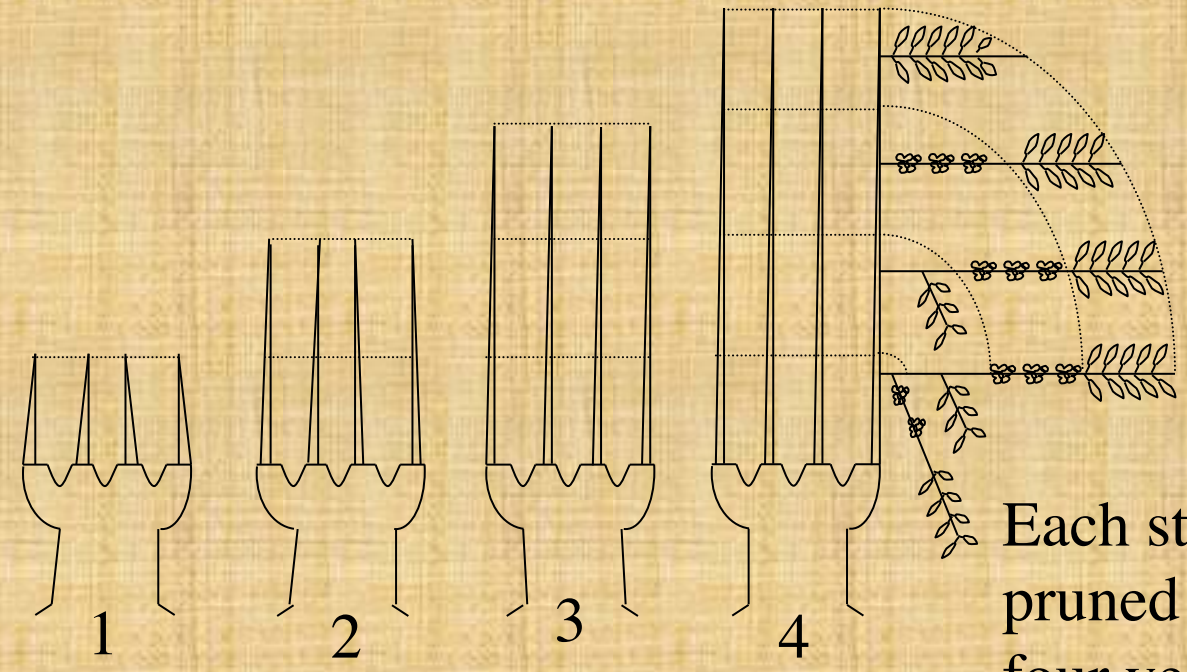


Tree stump is many years old.

Pruning

Beaumont -Fukunaga

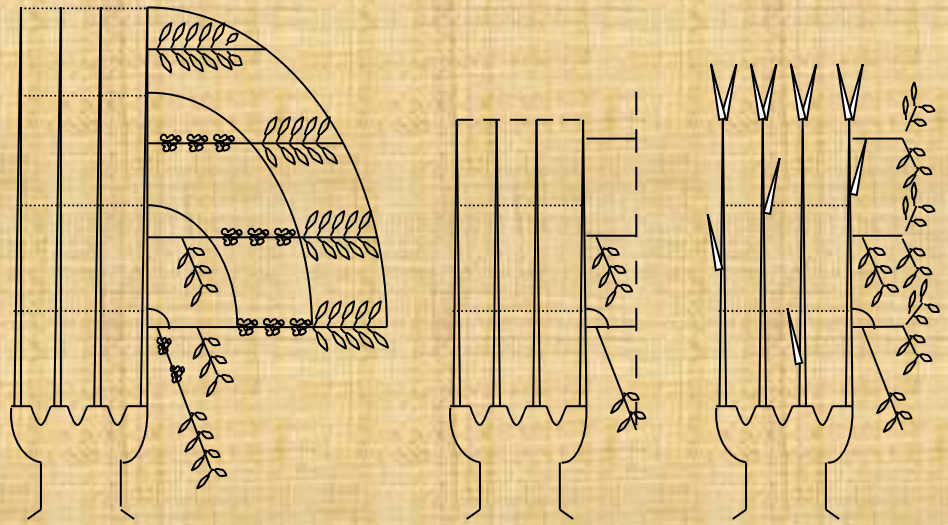
All verticals on stump are same age,
but each stump has different age verticals



Age of vertical stems on each stump

Each stump is pruned every four years.

Pruning



CTAHR hedge

- Top cut 1.5 m (5 ft)
- Sides cuts so 1.5 m wide
- Yearly top to allow 0.5 m (18 inch) new top growth

A tractor-mounted ‘sickle bar’ pruner 10ft long with 3” teeth

Coffee Tree Nutrition

In general a well growing tree that does not drop its old leaves before harvest is your goal.

If both the old leaves and new leaves are gone at harvest or worst -before harvest, then you've lost quality- beans maybe smaller (lower grade), less dense - poorer cup, or ripened too early or died.

Mature coffee has high demand for potassium and nitrogen.

Overbearing dieback

Competition between vegetative and reproductive growth. Coffee does not drop excess fruit after setting the cherry.

Excess vegetative growth in 2011 leads to excessive flowering and fruit set in 2012 (big crop but little vegetative growth. In 2013 there will a small crop but excess vegetative growth.

Both old and new leaves dropped.

Lateral begins dying from tip to vertical.

Coffee ripens too early or dies.

Causes of overbearing dieback

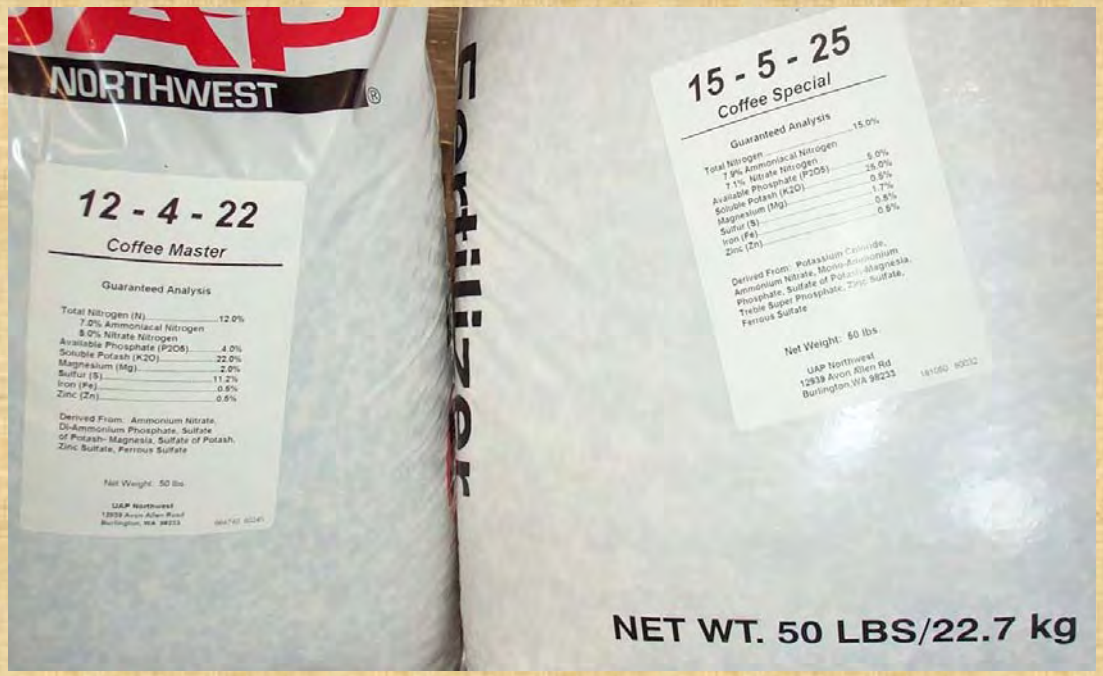
- Insufficient sugars produced by leaves to ‘grow’ the cherry, so the cherry ‘eats’ the leaves !
- Drought between flowering and full size fruit reduces leaf production.
- Nutrient deficiency especially N reduces the sugar production of the leaves even as late as cherry ripening.
- Root damage from low pH, j root, or nematode reduces nutrients and/or water in leaves.
- Scale and black twig borer damage leaves.

Fertilization

Conventional

1600-2000 lb/A/yr.

High potassium needed

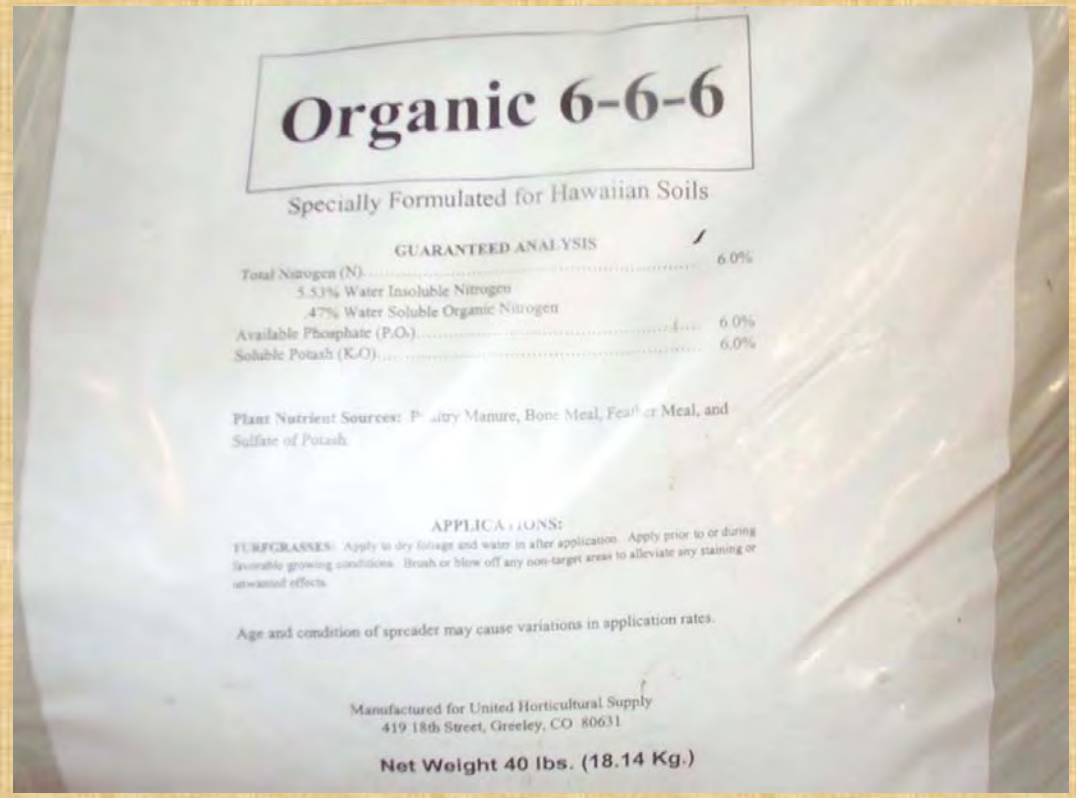


Fertilization

Organic

Higher lb/A needed as less nutrient dense

Additional materials such as manure, compost



Fertilization

Monitoring

- Leaf and Soil nutrient analysis
- Annual sampling
- Fertilizer recommendation based on test results

Irrigation

If rainfall during fruit development to ripening is less than 6 inches a month irrigation will benefit yields.

Drip irrigation is best for our trade wind conditions.

Fertigation is recommended to reduce cost.

Pests

- Weeds
- Insects
  - Green scale
  - Coffee berry borer
  - Black twig borer
- Nematodes and Disease
  - Kona Coffee Root knot Nematode
  - Anthracnose

Pests

Weeds

Weed control is essential the first year

Control by cutting, herbicides -RoundUp, even geese

In mature fields tall grass, trees, vines, and volunteer coffee seedlings can be serious

Pests

Insects Green scale

Most serious insect especially first 2 years, sucks sap from leaves arrived in late 1890s.

White halo fungus introduced 1910, kills scale in rainy season in Kona.

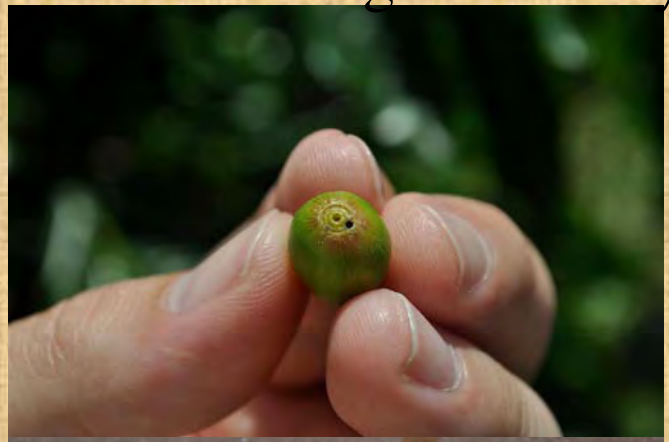
Control soaps & oils.
Ant bait stations.

Pests

Coffee Berry Borer (CBB) arrives in Kona, 2010

CCB female in entrance hole

CCB hole in green cherry



CCB already destroyed beans in green cherry

Strategies for CBB are being readied for 2011

1 Sanitation. Tactics for use on farm and mill employing the 'contain & kill', quarantine to slow CBB movement out of Kona. The issue of unharvested coffee farms and feral coffee in Kona requires a community & landlord response.

2 Trapping. As a monitor of CBB activity and to reduce population.

3 Spray solutions of the fungus Beauveria bassiana. Evaluate systemic and contact insecticides. Effectiveness is based on timing of application when females are seeking fruit and chemistry of the product.

January thru March: Pruning season

Sanitation Strip Pick before Pruning

Remove all cherries from the tree including out-of-season, immature, ripe, over-ripe, and raisins. Pulp or destroy to prevent CBB waiting in these until after flowering.

Collect all remaining cherry on the ground

Aggressive strip picking leaves many dropped cherry.

Raking dropped cherry

Gas and electric leaf blower /vacuums

Trapping: Monitor traps weekly (catching anything?, fallen, broken, refill lure, clean out dead beetles, refill bait solution- mix of methanol and ethanol and killing solution- soapy water or antifreeze.

Spray using a commercial spore solution of the fungus Beauveria bassiana, a generalist insect pathogen.

CBB with the fungus growing out of its body.

Pests: Insects Black Twig Borer

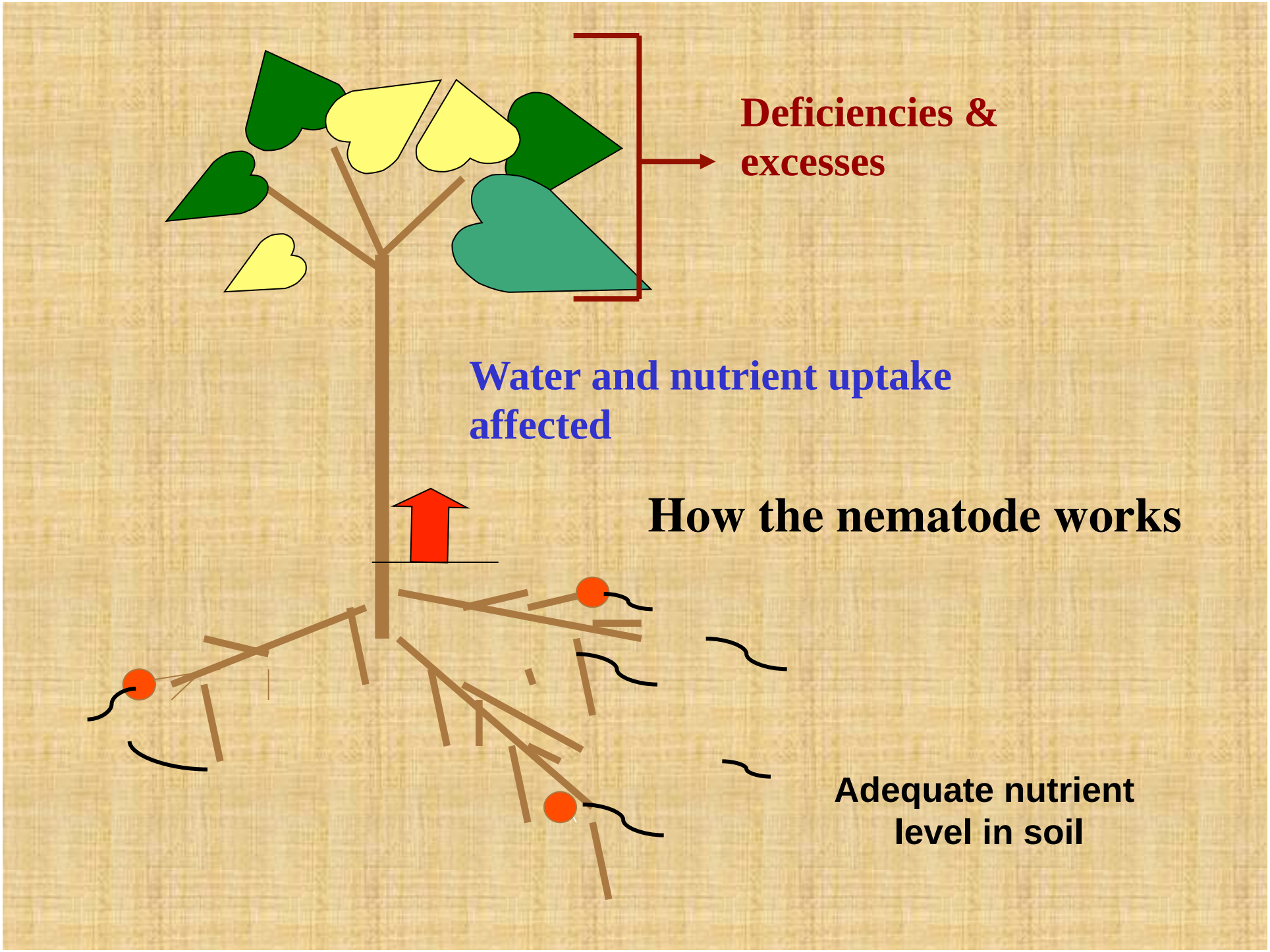
Less serious, arrive 1960's, beetle kills branch

Prune flagging laterals below the hole, burn, shred, or compost the laterals. Fruit beyond the hole ripen prematurely.

Nematodes and Disease

Kona Coffee Rootknot Nematode damage to roots

Kona typica is scion,
Fukunaga is rootstock


Deficiencies & excesses
Water and nutrient uptake affected
How the nematode works
Adequate nutrient level in soil

Harvest

Years to maturity

Yields

Labor

Converting cherry

to green coffee to roasted

Harvest

Years to maturity

- Very small crops in the 1st and 2nd years after planting
- Economic harvest in the 3rd year
- Fully mature in 6th year after planting

Yields

Harvest

Mature trees yield 3-4.5 kg cherry/tree(12-15 lb)

8,200 – 10,000 lb/A cherry with 680 trees/A.
Potential is 40,000 lb/A with YellowCatuai at
1210 trees/A

Harvest

Generally all the fruit (cherry) does not ripen at once. Rather it require several harvests.

Harvest only ripe cherry, if you can't squeeze the parchment bean don't pick it.

Beans from immature cherry weigh less and have inferior flavor.

Separate unripe, ripe, and over ripe (raisins).

Harvesting

If harvesting by hand as on Hawaii island expect 4-8 harvests/ harvest season.

Pickers can harvest

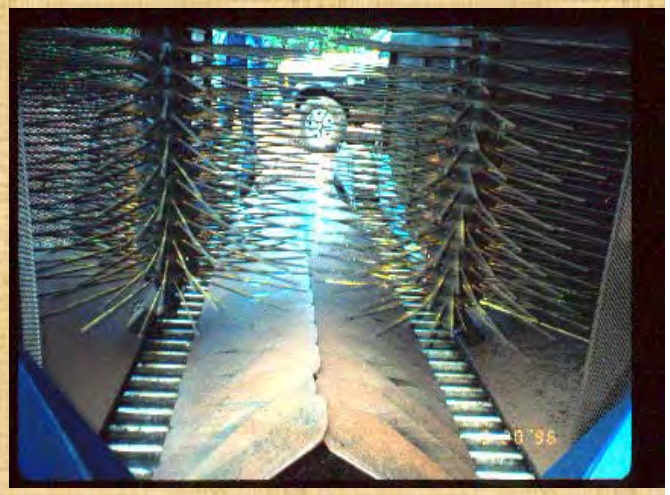
200-400 lb cherry/day

Labor is 50% cost of production.

If 10,000 lb cherry/A in 4 harvests and 300 lb /picker/day then 33 d/A/yr or 8 d/A per harvest, assume need 2 pickers per acre to finish a harvest in less than a week.

Harvest

- Mechanical harvester eg. Korvan is
- $130K new.
- One machne can harvest 180 to 400 A per season
- Cost over long term is 10% of hand harvest/A.



Processing

Converting cherry to roasted coffee

500 lbs of cherry, which when pulped will be…

125 lbs of parchment, which when hulled will be…

100 lbs of green bean, which when roasted will be...

80 lbs of roasted coffee

Processing

Wet, Dry, and in between

Wet processing involves pulping (removing the skin of the cherry), soaking the mucilage covered seed in water, rinsing the seed after 12-16 hours to remove the mucilage, drying the parchment covered seed (parchment coffee), hulling (milling the parchment coffee) to get green coffee.

Dry processing is drying the cherry, and hulling the dried cherry to green coffee in one operation.

In between is pulping and immediate demucilaging, drying and hulling.

Initial processing- 3 ways

Wet processing

Low water pulping, no fermentation

Dry processing, dry fruit

Roasting

Essential to realize coffee flavor
Coffee at 10-12% moisture
Roaster at 218 to 230 C (425-450F)
Time 10 to 20 minutes
Initially the beans absorbs heat,
but once fully heated releases heat as it burns.

Once it reaches the color you want, immediately cool, other it will continue to burn.

Bag when cool use one-way valved bag, to allow gases to leave but prevents air and moisture entering.

Roasts are classified by color,
Cupping roast is very light brown.
French is quite dark

Cupping- organoleptic evaluation

Weigh grounds (0.055g/mL or 5.5 g/ 4 oz. cup),
smell, add boiling water,
remove floating grounds at 2 mins,
Taste at 5 mins.

Coffee Brewing

- Automatic Drip
- Manual Drip
- Press pot
- Vacuum pot
- Moka pot
- Neapolitan flip
- Percolator
- Cold brew
- Espresso
- Aeropress
- Clover
- Mediterranean style
- “Cowboy” coffee

Neapolitan Flip

Moka Pot

Clover

Ibrik

Aeropress

Vacuum Pot

Brewing

Percolator- coffee is boiled and repeatedly dripped through grounds.

Drip- hot water dripped through grounds and paper or metal screen once.

Press pot- hot water poured over coffee, stirred, then metal screen pushed to bottom, forcing brew through the grounds.

Espresso- boiling water under 9 atmospheres pressure is forced through grounds and metal screen.

Aeropress- hot water poured onto grounds, pressed through grounds and paper filter.

Need more information?

Read ‘Growing Coffee in Hawaii’ from www2.ctahr.hawaii.edu/ctahr2001/ click on ‘Publications’. Also read ‘Hawaii Coffee Book’ by Dr. Shawn Steiman order from www.booksHawaii.net