College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa

CTAHR and Coffee in Hawai'i 1986 to 2017

Introduction

The University of Hawai'i, College of Tropical Agriculture and Human Resources (UH-CTAHR), has a long history of coffee research and Extension. In 1928, a field office was started in Kona and in 1930, the UH Agricultural Experiment Station was established in Kainaliu to help growers. Hawai'i gained a reputation as a world leader in coffee production. Early names from UH publications include Beaumont, Dean, Fukunaga, Goto, and Ripperton, and in late 1985, HC "Skip" Bittenbender was hired. This paper is a chronology of Hawai'i coffee industry highlights during Bittenbender's career as the CTAHR Extension specialist for coffee. Some notable events are also included to place this period into historical perspective.

Kona Typica coffee from CTAHR's Kona Research Station showing the various stages of coffee: (Top, going counterclockwise) green berries, ripe fruit or "cherries," parchment, green beans (the form typically traded), and roasted coffee.

Coffee growing in Hawai'i has been traced back to an unsuccessful attempt in 1813 by Don Paulo Marin. In 1825, John Wilkinson and High Chief Boki planted coffee seedlings from Brazil in Mānoa. Reported to be 'Bourbon' Arabica from Ethiopia, these are a likely source of "kanaka kope." A few years later, Reverend Samuel Ruggles brought plants to Kona. In 1892, a Guatemalan 'Typica' coffee variety was planted near Honoka'a by Hermann Widemann and was rapidly embraced in Kona. This variety was called 'Guatemalan' or "*melikan* (American) *kope*," and its descendants (or perhaps natural crosses with "*kanaka kope*") are known today as 'Kona Typica.'

Large coffee plantations were established on Kaua'i in 1836 and in the Kona District in 1841. However, by the 1920s, apart from some scattered plantings in other areas, only Kona remained as a coffee-producing region. There, the large coffee plantations were divided, so by 1920, 80% of Kona's coffee farms were small and family run. In 1959, statehood led to an increase in employment opportunities created by government jobs, construction booms, and the rise of the visitor industry. For this reason, many farms became part-time operations, run by what Bittenbender later described as "Multiple Income Farm Families," or MIFFs. These conditions in the coffee industry continued until the late 1980s, when mechanized operations were established on other islands. Thus, until the last 30 years, the history of coffee in Hawai'i has mostly been the history of Kona Coffee. In 2018, about half of the coffee acreage was on Hawai'i and half on Kaua'i, Maui, Lana'i, Moloka'i, and O'ahu.

One of the functions of the Hawai'i Cooperative Extension Service was to collect and publish agricultural statistics; the annual *Statistics of Hawaiian Agriculture* was published from 1936 to 1960, when the Hawai'i Crop and Livestock Reporting Service was transferred to the Hawai'i State Department of Agriculture and the USDA. Based on

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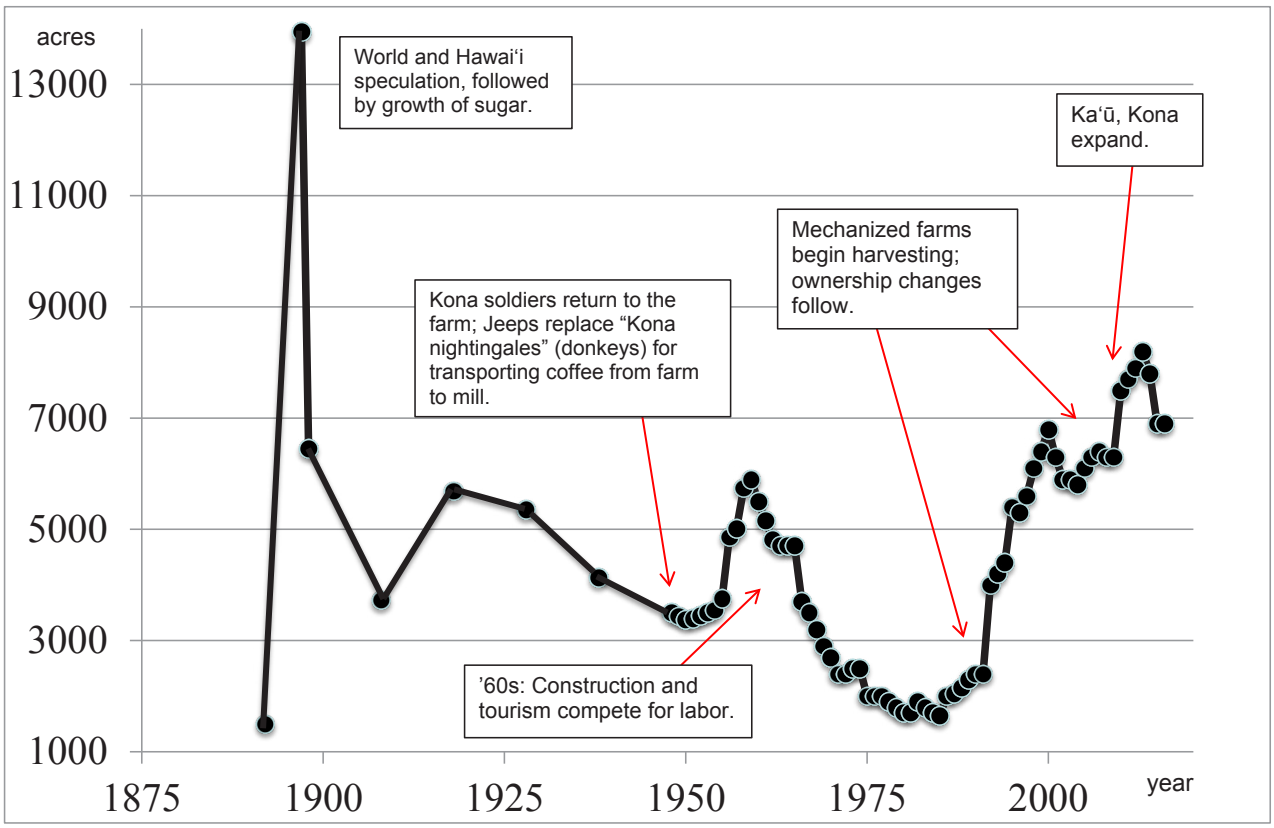
these statistics, the following figures trace the acreage, production, yield, price, and value of coffee, together with some historical highlights.

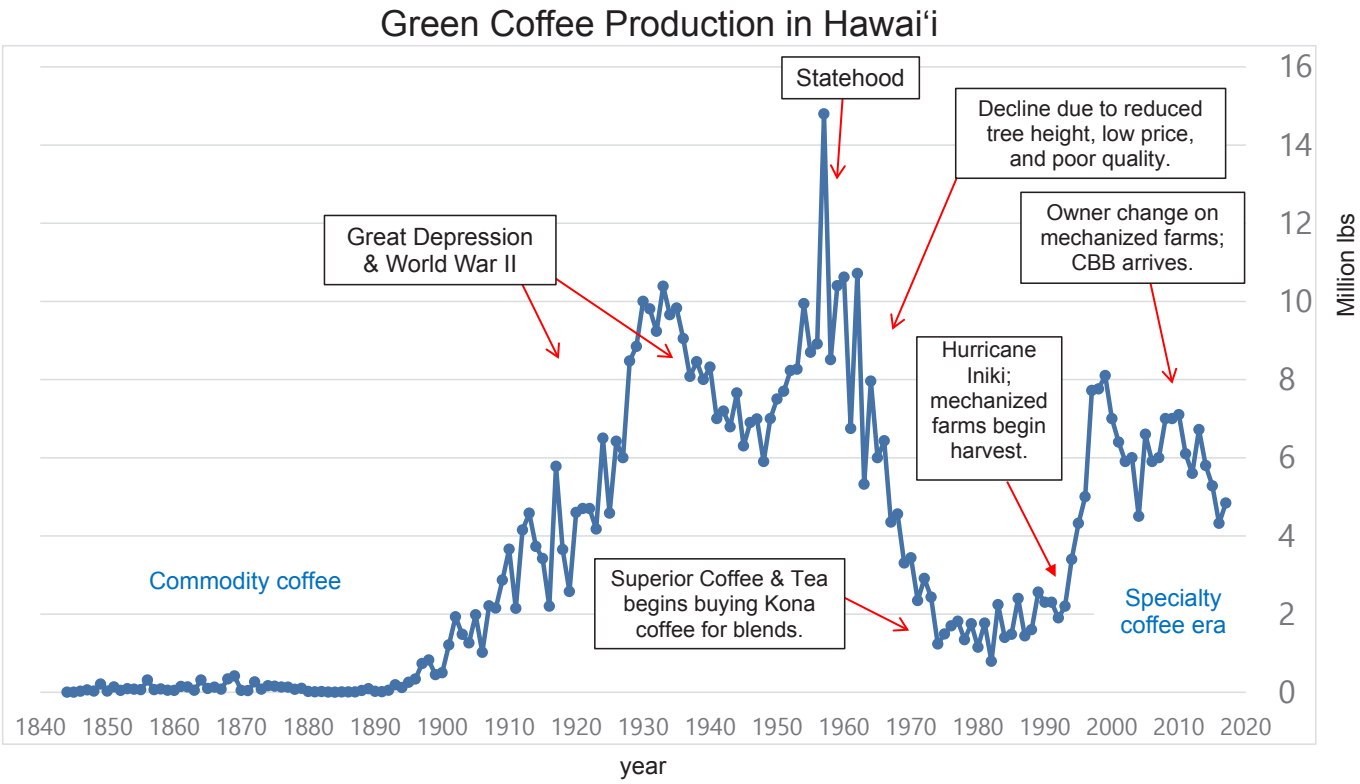
According to Hawai'i Agricultural Statistics Service (HASS) annual reports, the largest harvest of Kona Coffee was in 1957, comprising 18,496,000 lbs. of parchment coffee valued at $6,548,000. The harvest was 13,392,000 lbs. in 1962 ($3.2 million), but it never topped 10 million lbs. again. Although acreage in coffee has been increasing since the 1980s, coffee yields/acre show a long decline since the mid-1950s. The first decreases have been attributed to a switch to a new pruning method, the Kona style, which resulted in a shorter tree that was harvested without ladders. Together with the change in fertilization practices that occurred at the same time, this reduced much of the trees' alternate bearing.

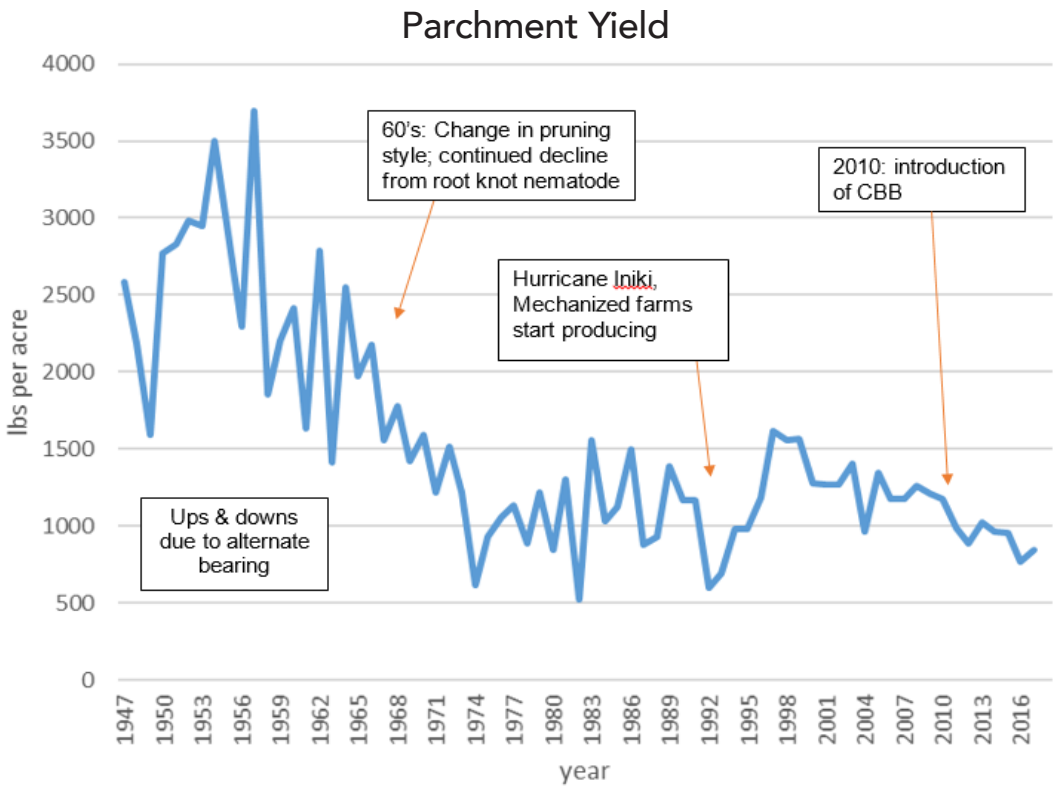
The trend in yields was more stable in the 1970s through the '90s, perhaps due to new varieties and to the interplanting of macadamia nuts with coffee. There was an upswing in the 1990s with the influx of large, mechanically harvested farms, but then the decline continued. An insidious reason might be the Kona coffee root-knot nematode, whose symptoms were first described in the early 1900s without knowing the cause.

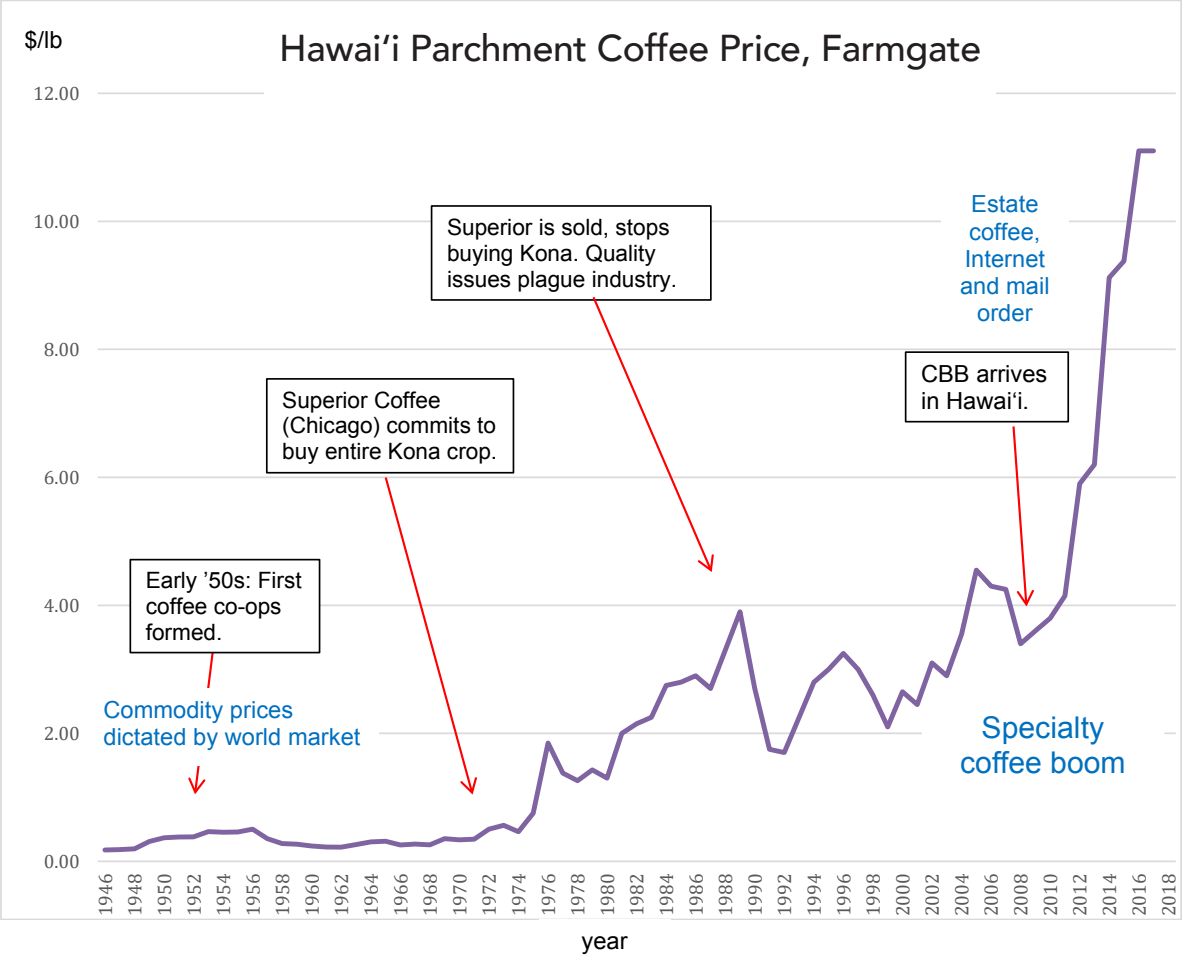
Although the quality of Kona Coffee has long been recognized, prices were basically dictated by the global market until 1972, when Superior Coffee agreed to purchase the entire Kona crop. Their marketing a Kona blend coffee also helped establish the name of Kona Coffee, which in turn, eventually benefitted other Hawai'i coffees, so farm prices started improving. With the coming of the era of specialty coffee, consumers began to be more willing to pay for quality, but prices really took off with the advent of mail order and the Internet, in turn increasing the crop's value to historical highs.

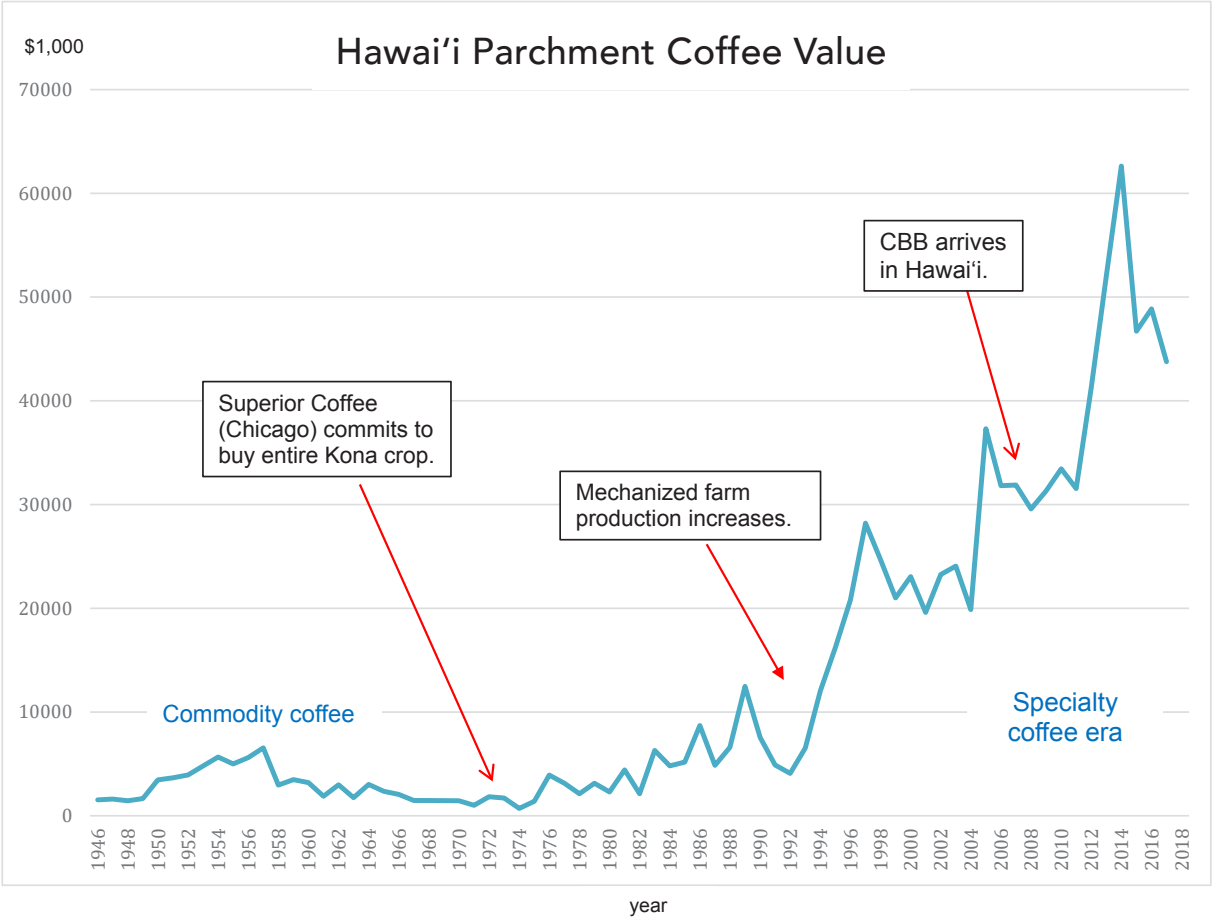
In 1985, HASS reported 620 coffee farms with 2,100 acres in crop, all on Hawai'i Island. Production in the 1985-86 crop year was 1.85 million lbs of parchment (1.535 million lbs of green) valued at $5.18 million. Based on farmgate value, coffee was ranked as the seventh most valuable crop statewide, just ahead of seed corn at $5.17 million. Sugar and pineapple were dominant, with production valued at $222.4 and $90.53 million. The other crops with higher values than coffee were macadamia nuts, potted foliage plants, papayas, and anthuriums. The rankings changed dramatically over the following years as sugar and pineapple operations waned, as coffee plantings were established on other islands, and as Hawai'i coffees gained worldwide recognition.


Bearing Coffee Acreage in Hawai‘i
acres
13000
11000
9000
7000
5000
3000
1000
1875
1900
1925
1950
1975
2000
year
World and Hawai‘i speculation, followed by growth of sugar.
Kona soldiers return to the farm; Jeeps replace “Kona nightingales” (donkeys) for transporting coffee from farm to mill.
’60s: Construction and tourism compete for labor.
Mechanized farms begin harvesting; ownership changes follow.
Ka‘ū, Kona expand.


Green Coffee Production in Hawai‘i
Million lbs
16
14
12
10
8
6
4
2
0
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
year
Statehood
Decline due to reduced tree height, low price, and poor quality.
Great Depression & World War II
Owner change on mechanized farms; CBB arrives.
Hurricane Iniki; mechanized farms begin harvest.
Superior Coffee & Tea begins buying Kona coffee for blends.
Commodity coffee
Specialty coffee era


Parchment Yield
lbs per acre
year
60's: Change in pruning style; continued decline from root knot nematode
2010: introduction of CBB
Hurricane Iniki, Mechanized farms start producing
Ups & downs due to alternate bearing


$/lb
Hawai'i Parchment Coffee Price, Farmgate
year
Superior is sold, stops buying Kona. Quality issues plague industry.
Estate coffee, Internet and mail order
CBB arrives in Hawai'i.
Superior Coffee (Chicago) commits to buy entire Kona crop.
Early '50s: First coffee co-ops formed.
Commodity prices dictated by world market
Specialty coffee boom



Annotated Timeline

Late 1950s–early '60s Kona coffee growers begin to establish their own mills to process parchment to green coffee; Pacific Coffee and Sunset Coffee Cooperatives are formed. By 1959, there are twelve mills.

1961 Black twig borer first found in Hawai'i.

1963 First grades and standards for Kona Coffee.

1970 First Annual Kona Coffee Cultural Festival held.

1979 Douglas Bong ships the first coffee outside of co-op control, thus breaking the co-op monopoly. Other U.S. mainland West Coast transplant farmers quickly follow suit. Kona Coffee establishes a firm foothold for itself among the very finest gourmet coffees. Increasingly educated consumers demand Kona Coffee and are willing to pay its premium price.

1981 Only 1,600 acres of coffee remain, mostly grown by small independent farms run by aging immigrant farmers and their families.

1984 Kona Coffee Council (KCC) founded; it includes Kona Farmers Cooperative, the Pacific Coffee Cooperative, independent growers and processors. Tom Kerr elected as first president.

1985 John Hays (founder of Coffees of Hawai'i, Moloka'i) imports 'Red Catuai' seeds from Brazil and grows them in the HDOA Honolulu Plant Quarantine greenhouse. A year later, disappointed by their growth in 3" flats, he is about to throw them in the trash when they are rescued by CTAHR's Roy Nishimoto, chair of the Horticulture Department. He gives them to newly arrived H.C. "Skip" Bittenbender.

1986 CTAHR's Ronald Mau realizes the industry is defenseless against a return of the scale/ant problem or a new pest, and he starts field trials in Kona to provide residue data on Mavrik Aquaflow®, a new broad-spectrum insecticide.

CTAHR's Mike Nagao publishes *Mineral Deficiency Symptoms of Coffee*, a full-color bulletin that is well-received worldwide.


Mike Nagao

KCC Annual education meeting is held. Steve Hicks is acting chair of KCC. President Bill Koepke is manager of Kona Farmers Coop.

Norm Bezona

Norm Bezona is Extension agent in Kona. CTAHR's Cathy Cavaletto tells growers, "You need to know your coffee as well as the roasters."

The second Coffee Industry Analysis is conducted. the issues identified are increasing cherry price, reduced availability of harvest labor, and expanding coffee production using mechanical harvesting.

Norm Greenwell works with engineers in Oregon on a mechanical coffee harvester. It is ultimately judged to be a failure but is a predecessor to later models.

Norm Greenwell

10% Kona Coffee Blend bill passed in legislature; KCC undecided about opposing or supporting a veto by governor. This remains an issue today, over three decades later.

CTAHR coffee variety trial planned by Phil Ito, Mike Nagao, and Bittenbender.

H.C. Bittenbender

CTAHR mechanical pruning for mechanical harvesting project planning by Bittenbender and Loren Gautz, to use Nishimoto's former herbicide plot in Waimanalo.

CTAHR's Ed Trujillo begins planning to develop a quarantine protocol for importing green coffee for roasting.

Ed Trujillo

1987 A major outbreak of green scale nursed by the long-legged ant, *Anoplolepis longipes* (also known as the crazy ant), and big-headed ant, *Pheidole megacephala*. occurs during the drought of 1987–1988.

Bittenbender organizes CTAHR Hawaii State Coffee Trial (HSCT) using 21 varieties, mostly from the CTAHR coffee collection

CTAHR's Ito, Roy Yamakawa and Mike Nagao (l to r) and Peter Tausend at Kauai HSCT nursery

at the Kainaliu Kona station. Sites include 4 in Kona, 4 in East Hawai'i, 3 on Kaua'i, 2 on Maui, 1 on Moloka'i, and 3 on O'ahu.

Coffee transplanter

Kaua'i Coffee (A&B), with Dr. Peter Tausend, begins planting with 'Yellow Catuai' and expands with varieties from the HSCT, through 1990.

1988 Crab spider discovered in Hilo. Webs are a nuisance in Kona coffee orchards and bites are slightly painful. Soap sprays are used. HDOA introduces a parasitic wasp.

Kimo Falconer

Kimo Falconer overseas the development of Ka'anapali Coffee, now MauiGrown. David Roche begins with combining an Amfac and the HSCT variety trial. From the trial

he selects varieties 'Maui Mokka', 'Red Catuai', 'Guatemalan', aka 'Kona Typica', and 'Yellow Caturra'.

John Hays, owner of Coffee of Hawai'i (Moloka'i), selects 'Red Catuai' from the HSCT for 500 acres.

Ueshima Coffee Co. expands production in Kona.

1989 Bittenbender facilitates the first state-wide coffee organization, Hawai'i Coffee Growers Association (HCGA), formed from KCC and growers on Kaua'i, Maui, Moloka'i, and O'ahu. Its first board includes growers from all the successful HSCT sites. Participants pictured include Dan Kuhn (Coffees of Hawai'i), Lyle Wilkinson (Kaua'i Coffee), Bob Osgood (HSPA/HARC), Derrick Nishimura (Kaua'i Coffee), Kimo Falconer (MauiGrown), Tom Greenwell (Greenwell Farms, Kona), CTAHR alum Mike McLean (Waialua Estate), and Bittenbender. First president Skip Cowell (Kona Mountain Coffee) is not shown.

First HCGA Board

Due to lack of harvest labor, a processor and farm management company in Kona hires over 20 Mexican migrant farm labors from California in the 1989–90 season. The labor agreement covers transport and lodging, plus an hourly wage of $7.70/hr.

CTAHR's Phil Ito plants nematode–resistant rootstock trial with 'Kona Typica' and 'Progeny 502' scions on *Coffea liberica* seedlings, 'purpurascens' (an Arabica mutant), 'SL12 or 'Kaffe', and *C. congensis* seedlings at the CTAHR Kona Station.

CTAHR's Stuart T. Nakamoto and John Halloran publish *Markets and Marketing Issues of the Kona Coffee Industry*. They find that product quality, reputation, and image are important, and that Kona-style and counterfeit Kona Coffees are major concerns. No quantifiable evidence is found that Kona blends help or hurt growers. They push for use of "Kona Coffee" with a capital C to differentiate the product.

Stuart T. Nakamoto

1990 Mavrik approved to control green scale on coffee. Labor cost to harvest is $0.66/lb of cherry.

CTAHR alum Les Fuchigami (Oregon State) and his students working at Kunia, O'ahu, publish the use of gibberellic acid (GA) to synchronize coffee flowering. *Note:* in 1975 CTAHR's Bullock and H. Nakasone tried ethylene for coffee mechanization and gibberellic acid for flowering control without success. In 2010 CTAHR alum Tracie Matsumoto resumes GA research as her USDA/ARS project.

Early mechanical planting at Kaua'i Coffee.

Bittenbender gets the idea for genetically engineered decaf coffee at a conference after seeing a poster on caffeine biosynthesis in tea.

1991 CTAHR's Don Schmitt and his student Mario Serracin identify a new nematode species, *Meloidogyne konaensis*, the Kona coffee root-knot nematode. Eventually nearly all of Kona is infested.

Serracin and Schmitt

Four different mechanical coffee harvester designs are being evaluated on Kaua'i and in Kona.

Korvan harvesters

(L) Littau harvester. (R) Kaua'i Coffee's 'Big Bertha.'

1992 CTAHR's Cathy Cavaletto organizes first coffee cupping training for coffee growers. The two-day program draws 31 participants. Her trained cupping panel finds coffee grafted onto two rootstocks, *C. liberica* and *C. arabica* '*purpurascens*', have no flavor difference from 'Guatemala'—now called 'Kona Typica'—on its own roots.

Cathy Cavaletto

Virginia Easton Smith

CTAHR alum Virginia Easton Smith, formerly an MS student of Joe DeFrank replaces Norm Bezona as Extension agent in Kona.

Work on genetically engineered decaf coffee by CTAHR's John Stiles is funded by the Governor's Ag Coordinating Committee and supported by the HCGA and the KCC.

1993 Stiles begins work to genetically engineer coffee that can be controlled to ripen using ethylene.

CTAHR's Vince Jones begins survey and control methods for black twig borer, *Xylosandrus compactus*, on coffee. He concludes that the best control is to prune infested laterals, then remove prunings from orchard the same day and shred. While working on tropical nut borer (TNB, *H. obscurus*) biology on macadamia he discovers that the square-necked grain beetle, *Cathartus quadricollis*, eats the TNB.

Twenty years later, the beetle is used to help control a related species: the coffee berry borer.

V. Jones

Black Twig Borer symptoms

1994 Bittenbender and CTAHR's Donna Ching facilitate coffee industry analysis no. 4, which leads to forming the Hawaii Coffee Association (HCA), comprised of growers, processors, and roasters representing the Hawai'i coffee industry on all islands.

Donna Ching

Kent Fleming

CTAHR's Kent Fleming produces the first interactive 'coffee cost of production' spreadsheet and bulletin.

1996 First HCA annual conference.

Robert Regli and Michael Norton of Kona Kai, a grower and buyer of Kona Coffee, are arrested and later convicted for counterfeiting Kona Coffee, using coffee from Panama and Costa Rica, from 1988 to 1996.

CTAHR's Bittenbender and Loren Gautz begin on-farm experiments in mechanical pruning for mechanical harvesting at three successful HSCT cooperating farms: Kaua'i Coffee Co., MauiGrown Coffee Co., and Coffees of Hawai'i

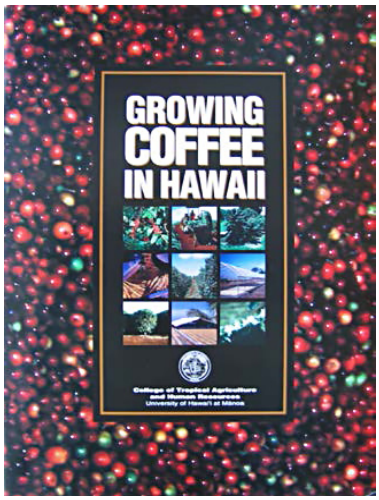
Three Mechanical pruners

(Moloka'i). Treatments include spacing (tree removal), pruning strategy (stumping and hedging), and date of annual pruning. They attempt to account for every cherry before and after harvesting. Pruning and harvesting equipment are either purchased or developed by farmers.

1997 At the second HCA conference, Ganzalo Roa of Cenicafe (Colombia), on sabbatical, and CTAHR's Loren Gautz introduce the BeColSub, a new low-water pulping and demucilage machine. Kaua'i Coffee purchases the portable model. This technology is widely used throughout the state today.

BeColSub

1999 CTAHR's Bittenbender and Virginia Easton-Smith publish *Growing Coffee in Hawai'i*.



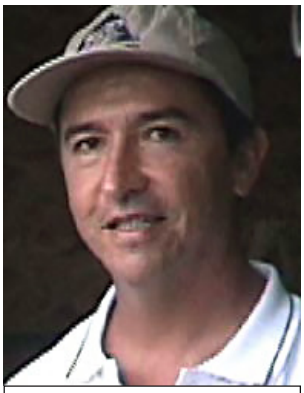
CTAHR alumna Dr. Chifumi Nagai at Hawai'i Agricultural Research Center (HARC) begins making crosses with trees grown from the HSCT to create varieties of Hawai'i origin.

'Mamo' is showcased at the 2018 Specialty Coffee Association Conference in Seattle.

2000 Six geographic certification marks are approved for Hawai'i origin coffee: Kona, Hawai'i, Kaua'i, O'ahu, Maui, and Moloka'i.

2001 Based on Ito's 1998 trial, CTAHR recommends 'Fukunaga' (selection of *C. liberica* var. *dewevrei*) as a nematode-tolerant rootstock for Kona Coffee. Edward Fukunaga, who was the superintendent of CTAHR's Kona Experiment station in the 1950s through the 1970s, had developed a stump pruning system with John Beaumont, the chair of Horticulture, as well as an early demucilager. CTAHR Kona Station Farm Manager Marc Meisner is an active assistant.

(L) Hypocotyl grafting for coffee rootstocks
(R) E. Fukunaga and M. Meisner



A. Correa

Loren Gautz's student Arturo Correa (CeniCafe, Colombia) develops the 3-layer coffee dryer.

Gautz reduces dropped cherry losses in mechanical harvesting by raising the stumping height to 3 ft for the CTAHR "mechanized Beaumont-Fukunaga" pruning system and removing lower laterals on all pruning styles.

Before and after: taller stumps and higher laterals

2002 HCA, KCC, and Kona Farmers Alliance—later known as Kona Coffee Farmers Association—withdraw their support for coffee genetic engineering, which began in 1992.

2003 USDA's Jack Armstrong demonstrates that ozone fumigation (10,000 ppm ozone at -30.5 cm vacuum for 6 h) works as well as methyl bromide to disinfest imported coffee of rust and CBB, except for CBB eggs. Cavaletto shows ozone does not change cup profile compared to unfumigated coffee. This organic method was not approved by APHIS/USDA. It's not clear why, and methyl bromide should still be replaced. Armstrong retires in 2011.

J. Armstrong

S. Mauri

Research by Bittenbender and Gautz on three farms, supported by economic analysis by Bittenbender's MS student Silvia Mauri, shows that mechanized topping and hedging of mechanically harvested coffee can cost as little as $70/acre compared to over $1,000/acre for hand pruning. They also show that 5- to 6-ft vs. 3-ft tree spacing in the row makes for higher yields per acre.

(L) Mechanical hedging. (R) Bittenbender

2005 CTAHR's Scot Nelson writes an Extension bulletin on banana moth, *Opogona sacchari*, a problem on regrowth of stumped coffee. He establishes a trial at the Kainaliu station to evaluate nine potential rootstocks for nematode resistance. Only one year of yields is recorded, but it confirms performance of the 'Fukunaga' rootstock.

S. Nelson

Banana moth damage

(L) M. Wright. (R) E. Burbano Greco

Mark Wright resumes work on Black Twig Borer with his student Elsie Burbano Greco (Colombia).

Shawn Steiman, Bittenbender's MS and PhD student, begins research on shade vs. sun-grown coffee yield and quality. He finds spray-on shade improved yield.

Conventional and spray-on shade

2006 CTAHR Ph.D. student Roxana (Cabos) Myers, working with Brent Sipes, Don Schmitt, and HARC's Chifumi Nagai, creates and demonstrates a GMO 'Kona Typica' that is nematode-resistant by inserting genes from rice. It works, but no field testing is done, and it is never released.

R. Myers

L. Gautz and dryer

Loren Gautz demonstrates on-farm that a heat pump-dehumidifier dryer is more cost effective that propane dryers, paying for itself in 2 years; this is before PV panels become popular and are incorporated into a 3-layer drying system.

Insecticide containing imidacloprid is registered for coffee to control scale and chewing insects based on work begun by CTAHR's Mike Kawate ten years earlier.

Crop insurance with federal subsidized premiums is offered for coffee cherry. The first efforts in 1989 were not successful. Crop insurance for coffee trees is also offered, but does not apply to nematode-infested areas.

Maui Coffee Association formed.

2007 Black twig borer outbreak.

CTAHR's Nakamoto and Sabina Swift start risk-management training funded by the USDA Risk Management Agency for the newly formed Ka'u Coffee Growers Co-op. This sets the stage for improvement of grower profitability and coffee quality plus more involvement by O'ahu-based faculty in this new coffee area. Swift retires in 2010; other faculty and government partners are recruited by Nakamoto and program is expanded statewide and for all crops.

S. Swift

2008 Shawn Steiman, Bittenbender's MS and PhD student, publishes *The Hawaii Coffee Book*.

Bittenbender & Steiman

HDOA's Jeri Kahana presents new green coffee standards; to use regional origin marks, the green coffee must be certified for quality at Prime grade or better.

2009 Kawate's work results in coffee label for Buprofezin (Applaud) to control green scale and Pyrifoxyfen (Esteem) for ant control.

M. Kawate

First state-wide coffee cupping competition at HCA conference organized by David Gridley of Maui Oma coffee. Kona farms wins top three places, Ka'u farms 4th and 5th place. Ka'u Coffee takes 7th-place cupping awards at the Specialty Coffee Association of America (SCAA) Coffee of the Year Competition.

CTAHR's Travis Idol and Shawn Steiman, with Craig Elevitch, demonstrate that 50% tree shade in Kona does not reduce yield.

Tree shade

2010 Little Fire Ant found in Kona.

Ka'u (Lorie Obra & Rusty's Hawaiian) wins first place in HCA cupping contest and again in 2011. Will Tabios & Rising Sun (Ka'u) takes 4th place at SCAA World Competition.

Coffee cherry tea (tisane) a by-product of pulp, sold by Coffees of Hawaii.

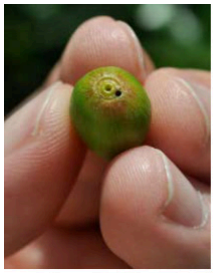
T. Matsumoto

CTAHR alumna Tracie Matsumoto (USDA in Hilo) resumes coffee-flowering control research with gibberellic acid and other products.

CTAHR Kona Extension agent Virginia Easton-Smith resigns.

Burbano demonstrates that soil-drenched Admire Pro (imidacloprid) is nearly as effective as pruning on Black Twig Borer, and annual treatment costs 80% less.

Coffee Berry Borer arrives. The most serious insect pest of coffee in the world breaks through Hawai'i's over-100-year quarantine and the methyl bromide fumigation that all imported green coffee undergoes. *Hypothenemus hampei* is the third species in this genus in Hawai'i.



South Kona coffee grower sends cherries to Bittenbender in August. Elsie Burbano identifies the tiny beetle as Coffee Berry Borer (CBB). Possible source: a Kona farmer who visited

an infested coffee farm in Central America. This invasive species becomes a federal issue.

Sept 10, 2010: first public meeting in Kona.

2011 Burbano reports on CBB control strategies—making traps and spraying Provado and Surround (kaolin clay)—and begins working in Kona. She notes that the fungus *Beauveria bassiana* is used in South America with success.

E. Burbano Greco

Gautz demonstrates best coffee origin separation results yet using non-radioactive isotope ratios. Project began 20 years earlier using Near Infrared spectrophotometry. Interest motivated by concern for counterfeiting of Kona Coffee.

A. Kawabata

Andrea Kawabata, Nagao's MS student, is hired as CTAHR coffee (statewide) and orchard crops Extension agent in Kona.

2012 CTAHR scientists are fully engaged in CBB-management activities:

Kawate continues pesticide registration program and adds laboratory bioassays of many pesticides, including direct and indirect contact on-tree sleeve tests, with CBB.

Bittenbender begins a CBB grower survey to monitor damage and determine growers' observations and whether recommendations are accepted.

Wright adds to his CBB team. Burbano shows that Surround kaolin clay, sprayed regularly, reduces CBB damage.

CTAHR's Russell Messing investigates improved trap monitoring and demonstrates that koa haole is not a CBB host but feral/abandoned/unmanaged coffee is.

Nakamoto, PingSun Leung, Kawabata, and graduate student A. John Woodill start economic analyses of CBB-management strategies.

Gautz builds heat treatment unit for 100 lb bags and demonstrates that 50°C hot air for 30 minutes kills CBB in green coffee. He finds that parchment storage at 11% moisture at 60°F prevents CBB feeding.

USDA PBARC scientists (Drs. Rob Hollingsworth, Lisa Keith, Tracie Matsumoto, Eric Jang, and many others) are also fully engaged in research that includes improving traps and lures, investigating Beauveria genetics, persistence in the field, spray composition, freezing green coffee to kill CBB, control of flowering, and nematodes to control CBB and banana moth. HDOA approves the import of commercial Beauveria to control CBB.

Synergistic Hawaii Agriculture Council (SHAC), led by Rod Yonemura, works with the CBB Task Force to develop a program with the USDA Foreign Agricultural Services, Technical Assistance for Specialty Crop (TASC) grant for CBB management. Cooperating farms receive subsidized *Beauveria*.

HARC scientists (Dr. Chifumi Nagai, Mel Jackson, and team) continue Hawai'i variety breeding field testing, tissue culture propagation, testing for better nematode resistance in Ethiopia coffees, and analysis of quality components.

Kauai Coffee reports promising results of new HARC-developed coffee varieties.

2013 HDOA begins a program funded by HB 353 for farmers who participate in a CBB IPM program with subsidized commercial Beauveria products. Neither companies nor farmers are permitted by law to produce their own *Beauveria bassiana* concentrates and apply to their trees.

Kawabata and Nakamoto organize annual CBB meeting

to update recommendations for growers to manage CBB based on research results. Together with Rob T. Curtiss of HDOA, they lead the effort to combine research results into an IPM program for CBB in Hawai'i.

% infestation	% A/B Alive																			
	0	1%	2%	3%	4%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
1%	0.01	0.02	0.03	0.04	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	
2%	0.02	0.04	0.06	0.08	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5	
3%	0.03	0.06	0.09	0.12	0.15	0.3	0.45	0.6	0.75	0.9	1.05	1.2	1.35	1.5	1.65	1.8	1.95	2.1	2.25	
4%	0.04	0.08	0.12	0.16	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	
5%	0.05	0.1	0.15	0.2	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	
10%	0.1	0.2	0.3	0.4	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	
15%	0.15	0.3	0.45	0.6	0.75	1.5	2.25	3	3.75	4.5	5.25	6	6.75	7.5	8.25	9	9.75	10.5	11.25	
20%	0.2	0.4	0.6	0.8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
25%	0.25	0.5	0.75	1	1.25	2.5	3.75	5	6.25	7.5	8.75	10	11.25	12.5	13.75	15	16.25	17.5	18.75	
30%	0.3	0.6	0.9	1.2	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5	18	19.5	21	22.5	
35%	0.35	0.7	1.05	1.4	1.75	3.5	5.25	7	8.75	10.5	12.25	14	15.75	17.5	19.25	21	22.75	24.5	26.25	
40%	0.4	0.8	1.2	1.6	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	
45%	0.45	0.9	1.35	1.8	2.25	4.5	6.75	9	11.25	13.5	15.75	18	20.25	22.5	24.75	27	29.25	31.5	33.75	
50%	0.5	1	1.5	2	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	

=0-0.99 – Spraying not recommended; will cost more than the expected value of coffee saved from CBB

=1-1.99-Consider spraying, especially early in the season

=2-4.99 – Especially early in the season, this is a critical level to start spraying to avoid economic loss.

=5-9.99 – You are starting to lose money due to CBB damage. Losses will be greater if you don't spray.

=10-19.99 – You are losing money due to CBB damage, but you may still want to spray.

=>20 – Processors may reject your harvest. The value of your harvest may not cover picking cost, so consider focusing on your next crop (i.e. strip pick, stump prune)

IPM spray decision table

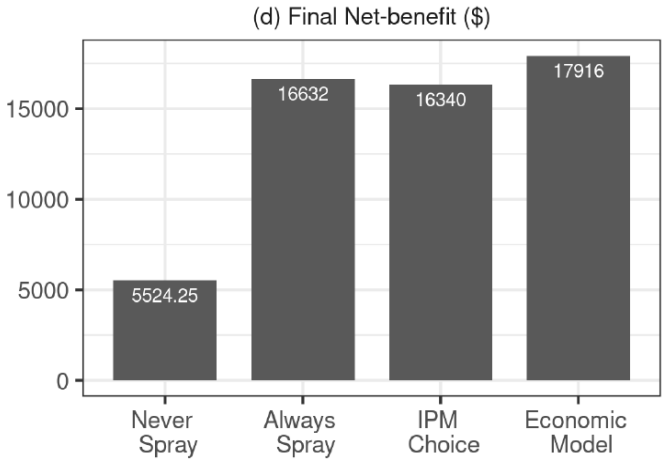
Kawabata conducts 24 workshops related to CBB during the 2013–2014 season. Subsequent years are even higher:
2014–2015: 33 CBB events
2015–2016: 26 CBB events
2016–2017: 28 CBB events
2017–2018: 38 CBB events

Possible Hawai'i coffee bicentennial. At HCA, Bittenbender and Steiman present research of early literature on when first coffee was planted in Hawai'i. They determine 1825 is more likely than 1813. Citations for 1813 only go back to statement in Hawaii's Crops Parade (1937), attributed to CTAHR's Y. Baron Goto. Nonetheless, Hawai'i's coffee bicentennial is celebrated at the 2013 HCA conference.

2014 CBB found at Waialua Estate Coffee, O'ahu.

Wright adds Ishakh Pulakkatu-thodi as postdoc and Sayaka Aoki as PhD student on CBB.

CTAHR's PingSun Leung, his student John Woodill, Kawabata, and Nakamoto develop model and estimate CBB impact on Hawai'i coffee industry.



2015 Kawabata with Greenwell Farms finds in cupping tests that 10–15% CBB damage is detectable.

HCGA members, Kawabata and Nakamoto (CTAHR), and Matsumoto (PBARC) visit Brazil to observe CBB manage-

(L) Sweeper-vacuum harvesting system and (R) Hand harvesting aid

ment on mechanically harvested farms. One big advantage is their use of chemicals (in the process of being banned) that are not available to Hawai'i growers.

(L) CRKN non-tolerant and (R) tolerant rootstocks

Kawabata, Alyssa Cho, Roxana (Cabos) Myers of USDA, and Nakamoto revisit the 2005–2006 Coffee Root Knot Nematode (CRKN) rootstock trial for nematode resistance to evaluate performance 10+ years later. The full cycle of harvests will be completed with the 2018–19 season.

2016 Based on Hawai'i mechanical harvesting costs, Gautz shows that even a 10-acre farm can save money using a mechanical harvester. The opportunity for mechanical harvesting to replace hand harvesting has arrived.

CBB detected on Maui.

2017 Based on the CBB Survey:
- Kona growers reduce CBB damage.
- CBB control is expensive.

Based on CTAHR and USDA research:
- Growers stopped using CBB traps.
- Growers increased frequency of sprays containing spores of Beauveria bassiana.
- Growers increased sanitation practices such as removing all ripe and overripe cherry from each tree when harvesting and stripping cherries at all stages after last harvest of the season before pruning.

Bittenbender presents to HCA equations for farms that sell cherry and farms that sell green bean to calculate annual % CBB damage.

2018 Bittenbender retires, and CTAHR and its alumni continue to support Hawai'i's coffee industry.

Epilogue

In 2018, the USDA National Agricultural Statistics Service reported 7,100 acres in coffee compared to 2,100 acres in 1985, but had no number of farms or breakdown by island. (The 2017 Agricultural Census in 2017 found 1,477 coffee farms in Hawai'i with 9,300 acres.) Production in the 2018-2019 crop year was 6.85 million lbs of parchment which was equivalent to 5.48 million lbs of green or 27.3 million lbs of cherry coffee. 900 thousand lbs of cherry were harvested but not sold.

As parchment, the crop was valued at $91.8 million. Although production had increased 3.7-fold since 1985, the crop was nearly 18 times more valuable. Farm gate value was changed since 1985 from parchment to utilized cherry production and was reported at $50.16 million. As either cherry or parchment, coffee is ranked second among the top agricultural commodities of the State of Hawai'i. Seed crops was first at $105.7 million. Especially with sugar and pineapple gone, coffee is a major component of agriculture's contribution to Hawai'i's economy.

In October 2020, Coffee Leaf Rust *Hemileia vastatrix*, the world's worst coffee disease, was identified in Hawai'i. Within a few months, CLR's presence is confirmed on four islands.

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