

# Recommended Cacao Varieties Tested in Hawai'i

Four trees from the 2010-2017 Hawai'i State Cacao Trial are recommended to Hawai'i cacao farmers: Easton (UH3) and ICS95 (UH8) are recommended as grafted scions for pod production, and UH4 and UH5 primarily as rootstocks for grafting and for pod production.

Cacao Theobroma cacao is grown commercially on the islands of Hawai'i, Kaua'i, Maui, and O'ahu.



Virtually all cacao farms are planted from seedlings, and because cacao is generally cross-pollinated, every tree is unique. Uniqueness means that many of the seedling cacao trees have one or more poor characteristics, such as low yield, poor growth habit, and poor chocolate quality.

In 2005, the Department of Tropical Plants and Soil Sciences, College of Tropical Agriculture and Human Resources (CTAHR) at the University of Hawai'i at Mānoa, began a project to find trees-seedlings and/or named cacao varieties of *Theobroma cacao* L. to recommend for planting as grafted trees to the emerging cacao-to-chocolate industry in Hawai'i.

# Hawai'i-Grown Cacao

Ten unique Hawai'i-grown cacao trees from across the state were selected and cloned by grafting for evaluation in multi-location trials. Three trees were seedlings growing in the cacao orchard of the CTAHR Waimanalo Research Station, O'ahu. Two were seedlings from the UH Waimanalo orchard found on a farm in Waialua, O'ahu. Two were Criollo race seedlings, one from the CTAHR Poamoho Research Station on O'ahu, and one from a farm on Kaua'i. Three trees [two grafted varieties (ICS95 and Amelonado) and one unnamed grafted tree] were from and recommended by the USDA Agricultural Research Service's Pacific Basin Agricultural Research Center (PBARC), Germplasm Collection at Waiakea, Hawai'i Island.

Chupons (orthotropic or vertical branches) were taken from the ungrafted seedlings and grafted onto seedling rootstocks obtained from two trees growing in

Mānoa Valley, O'ahu. Fan (plagiotropic or lateral) branches were taken from the grafted varieties (fan branch scion on seedling rootstock) and grafted on the rootstock seedlings).

Initially, 40 grafted trees (10 selected trees were copied four times) were planted in 2010 at multiple locations across the state, from Hawai'i Island to Kaua'i. Each location was planted with a tree spacing of 10x10 ft. in eight rows. Rows were staggered every five feet so that no tree was directly across the row from another tree.

> April 2021 Subject Category: FN-59

H. C. Bittenbender Department of Tropical Plant and Soil Sciences

## Daniel C. O'Doherty

THIS INFORMATION HAS BEEN REVIEWED BY CTAHR FACULTY

In most locations, a 48"tallx10" diameter cage made of 2"x4" wire mesh was covered on the long side by clear 4-mil plastic film, which was open on the ends to shade the graftlings and protect them from wind, Chinese rose beetle, herbicide sprays, and string trimmers. However, problems were encountered and forced the abandonment of all non-O'ahu locations.

Four O'ahu locations: Waialua Chocolate (irrigated, Waialua), CTAHR Urban Garden Center (irrigated, Pearl City), Kualoa Ranch (unirrigated, Kualoa, windward O'ahu), and Waimanalo Research Station (irrigated, Waimanalo, windward Oahu). Later, two additional unirrigated O'ahu locations were planted: Hawai'i Agricultural Research Center farm (in 2012 at Mauanwili, Windward O'ahu) and the University of Hawai'i's Lyon Arboretum (in 2016 in upper Mānoa Valley).

Pods were harvested in three-week intervals when pods were ripening. Seeds from harvested pods were fermented for six days using the CTAHR bag system, dried, stored for two months, then roasted, cracked, cocoa liqueur prepared, and taste evaluated.

## Description of UH3 (Easton)

Easton (UH3) was a seedling growing on the Waimanalo Research Station. It came from seeds purchased by the Hawai'i Vintage Chocolate from the Tagnanan plantation in Mindanao, Philippines, then grown in its nursery at Kea'au, Hawai'i island.

In 1988, Joe DeFrank of CTAHR's Dept. of Tropical Plant and Soil Sciences purchased 300 seeds from the Kea'au trees and planted them at the Waimanalo Experiment Station for a herbicide registration experiment. After DeFrank's experiment was concluded, the planting was used as source for seeds to establish cacao orchards. For example, Dole Foods' cacao farm in Waialua was planted with seedlings from this orchard.

It is a compact tree, with upright fan branches, a large seed, good yield, and some resistance to Black Pod Disease. It should be grafted onto a seedling or clonal rootstock of UH 4 or UH5. It is not compatible with its pollen and must be pollinated by another variety or seedling. Tasting notes for the cocoa liqueur – using liquified, fermented, roasted dry bean – are a moderate level of cocoa, woody, nutty, low acidity, some sweetness, fresh, and brown fruit flavor.

Genetic background is 60% Amelonado and 40 % Criollo. This based on DNA analysis reveals the percentage of each of the six major cacao types: Nacional, IMC/Nanay, Parinari, Criollo, Amelonado, and SCA/Ucayali.



Figure 1. (Above) Tree and (Below) fruit of Easton (UH3).



# **Description of UH4**

UH4 was a seedling from a tree at the Waimanalo Research Station that was found as a tree on the Dole Foods' Waialua farm on O'ahu. It was identified by Chifumi Nagai as W1020117 in a genetic study of a portion of the orchard. It is a tall tree with upright branches, which produces good-quality seedlings for rootstocks. As a grafted tree, it has good yield, but it is not compatible

# EXTENSION PUBLICATIONS



COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES UNIVERSITY OF HAWAI'I AT MANOA



**Figure 2.** (Above) Tree, author, and (Below) ripe fruit of UH4.



with its pollen and must be pollinated by another variety or seedling. Tasting notes for the cocoa liqueur are moderate level of cocoa, woody, and nutty, low acidity, less sweetness, fresh, and brown fruit flavor. Its genetic background is 33% Parinari, 33% Amelonado, 25% SCA/ Ucayali, 9% IMC/Nanay, and a slight amount of Criollo.

#### **Description of UH5**

Like UH4, UH5 was another seedling from the tree at Waimanalo and grown on the Dole farm, and identified by Nagai as W1010709. The tree shape is poor with long, horizontal branches, with large pods often found on the middle to ends of the branches, which can lead to searching for pods among the leaves and broken branches. It produces good-quality seedlings for rootstocks. When



Figure 3. (Above) UH5 tree and (Below) fruit.



grown as a grafted tree, the yield is good, though the seed is small. It is not compatible with its own pollen and must be pollinated by another variety or seedling.

Tasting notes for the cocoa liquor are more cocoa, moderate woody and nutty flavors, low acidity, slightly more sweetness, fresh, and brown fruit. Its genetic background is 40% IMC/Nanay, 35% SCA/Ucayali, and 25% Amelonado.

# **Description of UH8 (ICS95)**

ICS95 (UH8) is a named variety from the Caribbean, obtained from the PBARC germplasm collection in Waiakea, near Hilo on Hawai'i Island. It was grafted from



Figure 4. (Above) ICS95 tree and (Below) fruit (UH8).



budwood taken from fan branches (plagiotropic). The tree shape is good, when grafted from fan branch buds onto a rootstock. This grafted tree is compatible with its own pollen and therefore, does not require other varieties or seedlings as pollinators. It may have some Black Pod Disease resistance.

Tasting notes for the cocoa liquor are more cocoa, moderate woody and nutty flavors, low acidity, less sweet, fresh, and brown fruit. Its genetic background is 60% Criollo and 40% Amelonado, a Trinitario type.

## Availability

Please contact the CTAHR Extension office on your island or visit CTAHR Extension.

#### References

- Bittenbender, H.C., L. Gautz, Ed Seguine, and J.L. Myers. 2017. Microfermentation of Cacao: The CTAHR Bag System. *HortTechnology* 27: 690-694. doi: 10.21273/ HORTTECH03769-17.
- Nagai. C., R. Heinig, J. Buenafe, A. Lewis, N. Rosete and R.J. Schnell. 2009a. Selection of High Yielding Cacao Trees for Hawaii. *Hawaii Agriculture Research Center Annual Report.* 2007-08. P 25-26. Honolulu, HI.
- Nagai, C., R. Heing, C.T. Olano, J.C. Motamayor and R.J. Schnell. 2009b. Fingerprinting of cacao germplasm in Hawaii. *Hawaii Agriculture Research Center, Cacao Report No.* 1. Honolulu, HI.
- Schnell, R. J., C.T. Olano, J.S. brown, A.W. Meerow, C. Cervantes-Martinez, C. Nagai, and J.C. Motamayor.
  2005. Retrospective determination of parental population of superior cacao (Theobroma cacao L.) seedlings and association of microsatellite alleles with productivity. J. Amer. Soc. Hort. Sci. 130(2):181-190.

## Acknowledgements

We gratefully acknowledge the assistance and cooperation of Michael Conway and staff, Dole Foods, Waialua; John Morgan and staff, Kualoa Ranch, Kualoa; Roger Corrales and staff, CTAHR Waimanalo Research Farm; Steve Nagano and staff, CTAHR Urban Garden Center, Pearl City; Nick Dudley, Hawai'i Agricultural Research Center, Maunawili Research Station; Dr. Francis Zee, USDA/ARS Pacific Basin Agricultural Research Center (PBARC), Plant Genetic Resource and Disease Research, Hilo; Erik Kling, Jason Myers, Nick Dudley, Jr., and Yui Fujita.



| Table 1. Average dry bean yield, fruit and tree characteristics |   |  |  |                   |                       |                              |                   |                            |                           |                                      |
|---|---|--|--|-------------------|-----------------------|------------------------------|-------------------|----------------------------|---------------------------|--------------------------------------|
|   | Dry bean<br>Ibs at 6<br>years old<br>at 4 sites | Dry bean<br>at 5 yrs<br>old at wet<br>site | Dry bean<br>at 3 yrs<br>old at<br>very wet<br>site | Pod size          | Dry bean<br>size      | Pod<br>index                 | Ripe pod<br>color | Tree<br>height at<br>6 yrs | Tree<br>width<br>at 6 yrs | Pod on<br>tree                       |
|   | Per tree<br>(per<br>acre) <sup>1</sup>          | Pound<br>per tree<br>(per acre)            | Pound<br>per tree<br>(per acre)                    | Pods per<br>pound | Beans<br>per<br>pound | Pods per<br>pound of<br>bean |                   | feet                       | feet                      | 1 is close<br>to trunk;<br>5 are far |
| UH3<br>Easton   | 3.6<br>(1,600)                                  | 4.1<br>(1,800)                             | 0.3<br>(130)                                       | 0.89              | 320                   | 11.3                         | Y                 | 10.1                       | 10.4                      | 2.6                                  |
| UH4   | 4.1<br>(1,800)                                  | 2.2<br>(960)                               | 0.2<br>(87)  | 0.97              | 450                   | 14.4                         | Y                 | 11.7                       | 10.7                      | 3.2                                  |
| UH5   | 4.5<br>(1,960)                                  | 2.4<br>(1,000)                             | 0 (0)  | 0.92              | 480                   | 11.6                         | Y                 | 10.1                       | 9.7                       | 3.9                                  |
| UH8<br>ICS95  | 2.0<br>(870)                                    | 3.4<br>(1,500)                             | 0.5<br>(220)                                       | 1.2               | 440                   | 14.8                         | OR                | 8.6                        | 10.6                      | 2.8                                  |

<sup>1</sup> Trees spaced 10x 10 feet or 435 trees per acre

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, under the Director/Dean, Cooperative Extension Service/CTAHR, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Copyright 2020, University of Hawai'i. For reproduction and use permission, contact the CTAHR Office of Communication Services, <u>ocs@ctahr.hawaii.edu</u>, (808) 956-7036. The university is an equal opportunity/affirmative action institution providing programs and services to the people of Hawai'i without regard to race, sex, gender identity and expression, age, religion, color, national origin, ancestry, disability, marital status, arrest and court record, sexual orientation, or status as a covered veteran. Find CTAHR publications at <u>www.ctahr.hawaii.edu/freepubs</u>.