Abiu

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*Pouteria caimito* Radlk.

Family: Sapotaceae

This small to medium sized evergreen tree can grow to over 30 feet in height under optimal conditions but usually is kept low to facilitate harvesting. The rough bark is grey to brown and exudes white latex when cut. The glossy leaves are pointed at both ends and tend to cluster at the end of the branch. Flowers occur along branches between the branch tip and trunk, always in leaf axils. Trees are relatively quick to produce fruit, sometimes in as few as two years or as much as 10 years. Environmental factors also play a part in the time it takes to fruit. Fruit development takes up to 3 months, depending on rainfall or irrigation.

When immature, all parts of the fruit contain a sticky white latex, and the cut surface browns rapidly. As the fruit matures, the latex disappears from the pulp and remains only in the peel. The smooth, bright yellow–skinned fruit can be oblong or round and differs in size from 2.5 inches in length to as large 7 inches. The translucent flesh becomes jelly-like, with a pleasant caramel-flavored pulp. The leathery skin can easily be bruised.

**Other common names**

yellow sapote, yellow star apple, abiu (originally a Tupi Indian word) (English); caimito, caimo, cauje, abiuana, abi, abierio, abio (Brazil); amarilla, madura verde (Colombia); luma, cauje (Ecuador); temare (Venezuela)

**Origin**

The fruit is said to originate along the headwaters of the Amazon River and found in the wild in Peru, Columbia, Ecuador, Venezuela, and elsewhere in Brazil. The fruit was well known in the pre-Columbian Amazon, where it was considered to be an essential component of Native American home gardens and fruit orchards, a popularity that continued during the colonial period. The USDA first received seeds in 1914. It is not known when the fruit first appeared in Hawai‘i. Abiu is well distributed throughout the tropics. Small commercial orchards are occasionally found in northern Peru, Ecuador, Brazil, Colombia, and Venezuela.

**Cultivars**

The genus *Pouteria* consists of dozens of edible fruits, most of which originated in Brazil. Other species found in Hawai‘i include *P. lucuma* (lucumo), *P. viridis* (green sapote), *P. sapote* (mamey), and *P. campechiana* (canistel).


**Environment**

The tropical abiu grows best in areas with a year-round
warm, moist climate. Soil should be moist, well mulched and well drained, with a pH from mildly acidic to neutral. The trees will fruit in Hawaii from 100 to 3000 feet elevation. In tropical South America, trees fruit to 6000 feet. Established trees will withstand short periods of drought, but in dry areas in Hawaii, or in times of drought, irrigation is required to produce fruit.

**Propagation**
The short-lived seeds should be planted as soon as possible after collection. Germination generally is within 50 days after planting with a 90 percent success rate. Grafting and other vegetative propagation techniques are often difficult due to copious amounts of latex. Most seeds will produce acceptable but, often, smaller fruit than the parent tree bears. Some Brazilian abiu are relatively true to type when grown from seed.

**Culture and management**
Younger plants should be protected from wind and require irrigation to become established. Trees can be spaced from 7 x 7 feet to 15 x 20 feet and pruned low to facilitate harvesting. In Brazil, fertilizer at planting time includes manure, lime, super-phosphate, and potassium chloride in the planting hole. On Kona test trees, quarterly applications of a ½ pound of 6.6.6 (NPK) and daily irrigation (1 gallon emitter for 10 minutes per day) are used for consistent yields. In Australia, 2 pounds of NPK of 12.12.17 plus trace elements is used on mature trees every 4 months. As the fruit are susceptible to fruit fly and bird damages, protective wrapping on individual fruit while they are growing is advised.

**Pests and diseases found in Hawaii**
Some leaf-eating larvae, twig borers, various scales, aphids, and mealy bugs attack various parts of the tree. The fruit is a host for fruit flies as it ripens.

*Aphis gossypii* Glover (aphids)
*Toxoptera aurantii* Boy (aphids)
*Bactrocera dorsalis* Hendel (fruit fly)
*Ceratitis capitata* Widemann (fruit fly)
*Ceroplastes rubens* Maskell (scale insect)
*Coccus viridis* Green (scale insect)
*Cephaleuros virescens* Kunze (algae leaf spot)
*Colletotrichum gloeosporioides* Penz. & Sacc. (fruit spot)
*Cylindrocladium pteridis* F.A.Wolf (fungus)
*Lasiodiplodia theobromae* Griff & Maubl. (dieback)

**Harvesting and yield**
Abiu trees in Hawaii will produce in 4–6 years. Mature trees 10–12 years old can yield as many as 500 fruits per tree, each weighing 7–10 ounces. Fruit is ready to harvest 3 months after fruit set. Fruit can be harvested half ripe and packed in protective boxes to ensure that the easily bruised skin is not damaged. The tree may fruit multiple times per year depending on rainfall and irrigation. A mature wild tree in Brazil was observed to bear in excess of 1000 fruits. Although vigorous pruning will ensure new growth and production, yield generally starts to decline after 20 years.

**Postharvest considerations**
Full ripening occurs 1–5 days after harvest, when the fruit pulp and skin loses the sticky latex. Fruit can be stored at 50°F with a shelf life of 7–14 days. At all times during the harvest and postharvest process, the fruit needs to be protected from bruising. There are USDA protocols that allow abiu to be treated with irradiation and sent to the U.S. mainland from Hawaii.

**Packaging, pricing, and marketing**
Abiu fruits should be protected from bruising at harvest by placing them directly into padded or protected sections of boxes. Individual fruit can be wrapped in a styrofoam netting for additional protection. Fruits baseball- to softball-size are sold to wholesalers at $2.50 to $3.50 per pound, depending on size. Growers may sell smaller and off-grade fruits at farmers’ markets at 50¢ to $2.00 each. Some resort hotel chefs who offer the fruit cut it just before serving rather than pre-cutting it, due to its rapid oxidation and color change.
Nutritive value
Composition of abiu per 100 g edible portion

Proximate (g)

<table>
<thead>
<tr>
<th>Component</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>water</td>
<td>61–81.5</td>
</tr>
<tr>
<td>calories</td>
<td>62–95</td>
</tr>
<tr>
<td>protein</td>
<td>0.8–2.1</td>
</tr>
<tr>
<td>lipid (fat)</td>
<td>0.4–1.6</td>
</tr>
<tr>
<td>carbohydrate</td>
<td>14.5–36.3</td>
</tr>
<tr>
<td>fibre</td>
<td>0.9–3</td>
</tr>
<tr>
<td>ash</td>
<td>0.7–0.9</td>
</tr>
</tbody>
</table>

Minerals (mg)

<table>
<thead>
<tr>
<th>Component</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium</td>
<td>21–96</td>
</tr>
<tr>
<td>iron</td>
<td>0.8–1.8</td>
</tr>
<tr>
<td>phosphorus</td>
<td>17–45</td>
</tr>
</tbody>
</table>

Vitamins (mg)

<table>
<thead>
<tr>
<th>Component</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>ascorbic acid</td>
<td>11–49</td>
</tr>
<tr>
<td>thiamine</td>
<td>0.02–0.04</td>
</tr>
<tr>
<td>riboflavin</td>
<td>0.02–0.03</td>
</tr>
<tr>
<td>niacin</td>
<td>3.4–1</td>
</tr>
</tbody>
</table>

Vitamin A

| Vitamin A | 78 IU |

Glycerides

| Glycerides | 22 g |

Vitamin B

| Vitamin B | 0.2 mg |

Vitamin B2

| Vitamin B2 | 0.2 mg |

Amino acids (mg per g of nitrogen (N 6.25))

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lysine</td>
<td>316</td>
</tr>
<tr>
<td>methionine</td>
<td>178</td>
</tr>
<tr>
<td>threonine</td>
<td>219</td>
</tr>
<tr>
<td>tryptophan</td>
<td>57</td>
</tr>
</tbody>
</table>

Uses and recipes
Abiu usually is used fresh, sometimes in salads with other fruit. The ripe pulp can be added to sherbets, jams, and yogurt, or dried.

Abiu and Date Sticky Toffee Pudding
Chef Matthew S. Zubrod

2¼ c pitted dates
1 large abiu’s pulp
2 c water
2 tsp vanilla extract
2 tsp baking soda
2 tsp baking powder
4 c all-purpose flour
pinch salt
¼ lb butter
1½ c sugar
2 eggs

Boil dates with water. Cool. Remove dates, peel and pit. SAVE water! In mixer, cream butter and sugar. Add eggs, vanilla, salt, and baking powder. Add baking soda to water. Add dates, abiu, and water to butter mixture alternating with flour. Cook in a bread/loaf or cake pan lined with parchment paper at 400 degrees for 16–20 minutes (toothpick test). Allow to cool, then cut into squares. Heat in toffee sauce and serve with vanilla ice cream.

Toffee Sauce

¼ lb butter
2 c brown sugar
2 c cream
1 oz Knob Creek bourbon

Heat until caramel, mix well.

Abiu and Onion Soup
Chef Matthew S. Zubrod

(serves eight)

2 oz unsalted butter
5 onions, julienned
2 peeled, diced parsnips
3 abiu fruits’ pulp
2 oz garlic, chopped
½ c cognac
1 qt duck or chicken stock
1 qt veal or beef stock
1 tsp thyme, chopped
Caramelize onions until dark brown in butter. Add garlic, deglaze with cognac, add parsnips, thyme, and abiu. Stir and add stocks, and simmer until tender (onions). Season to taste. Gratin with Gruyere cheese and crouton.

**Cost of production**

It is essential that growers determine their own cost of production for each crop in each growing location. Including all the variables in figuring your cost to produce a specific crop is key to farm sustainability. A few of the operating (or “variable”) costs include fertilizer, weed control, pest control, pruning, irrigation, harvesting, marketing, and operations overhead. Ownership (or “fixed”) costs also need to be taken into account. For detailed information on the various types of cost, see “The economics of cacao production in Kona” (www.ctahr.hawaii.edu/oc/freepubs/pdf/AB-17.pdf).

The cost-of-production spreadsheet on the following pages can be downloaded as a Microsoft Excel file from www.ctahr.hawaii.edu/oc/freepubs/spreads/6fruits.xls.

**Selected references**


**Internet resources**

Fruits of warm climates, by Julia F. Morton
www.hort.purdue.edu/newcrop/morton/index.html

Montoso Gardens
www.montosogardens.com

Plant Resources of Southeast Asia
www.prosea.lipi.go.id

International Tropical Fruit Network
www.itfnet.org

**Acknowledgments**

We thank Dr. Francis Zee and Dr. Bryan Brunner for review and comment on the manuscript, and Dale Evans for editing and layout services. The provision of cost-of-production tables by Dr. Kent Fleming is gratefully acknowledged.
### Assumptions:
(Data entries are annual amounts expressed on a per tree basis)

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of bearing trees</td>
<td>5</td>
<td>To calculate profitability, enter wage rate &amp; benefits actually paid (or the rates one would pay if labor were hired.) To calculate cash flow enter nothing.</td>
</tr>
<tr>
<td>Yield (expressed in number of fruit [F] or lbs)</td>
<td>F 125</td>
<td></td>
</tr>
<tr>
<td>Average wt. (ozs.) / fruit</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Total lbs. harvested/ tree =</td>
<td>46.9</td>
<td></td>
</tr>
<tr>
<td>Marketable yield /tree (%) =</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Fruit tree =&gt; ABIU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Gross Margin Budgets for Mixed Tropical Fruit Tree Production

1. **Average number of bearing trees (counted)**: 5 trees
2. **Yield (expressed in number of fruit [F] or lbs)**: F 125 fruit / tree
3. **Average wt. (ozs.) / fruit**: 6.0 ounces
4. **Total lbs. harvested/ tree**: 46.9 lbs. gross yield
5. **Marketable yield /tree (%)**: 85% of the gross yield

**Gross Revenue:**

<table>
<thead>
<tr>
<th>% of total</th>
<th>$/lb</th>
<th>Lbs./tree/yr.</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wholesale sales</td>
<td>25%</td>
<td>2.00</td>
<td>10.0</td>
<td>marketable lbs.</td>
<td>19.92</td>
</tr>
<tr>
<td>2 Retail sales</td>
<td>75%</td>
<td>3.00</td>
<td>29.9</td>
<td>marketable lbs.</td>
<td>89.65</td>
</tr>
</tbody>
</table>

**Total sales = Weighted ave. price/lb.** = 39.8 marketable lbs. 109.57 548 100%

#### Operating Costs:

**A. Growing costs:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lb of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilization</td>
<td>2.0</td>
<td>$2.00</td>
<td></td>
<td>0.20</td>
<td>8.00</td>
<td>7%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>15</td>
<td>$0.27</td>
<td></td>
<td>0.100</td>
<td>4.00</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Irrigation:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lbs of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (gallons)</td>
<td>3</td>
<td>$0.002</td>
<td></td>
<td>0.03</td>
<td>1.34</td>
<td>6%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>5</td>
<td>$0.27</td>
<td></td>
<td>0.033</td>
<td>1.33</td>
<td>6.7%</td>
</tr>
</tbody>
</table>

**Pest control:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lbs of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>1.0</td>
<td>$10.00</td>
<td></td>
<td>0.251</td>
<td>10.00</td>
<td>50%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>10</td>
<td>$0.27</td>
<td></td>
<td>0.067</td>
<td>2.67</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

**Weed control:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lbs of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals and/or machinery</td>
<td>0.0</td>
<td>$0.00</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>10</td>
<td>$0.27</td>
<td></td>
<td>0.067</td>
<td>2.67</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

**Pruning:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lbs of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery</td>
<td>0.0</td>
<td>$0.00</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>20</td>
<td>$0.27</td>
<td></td>
<td>0.134</td>
<td>5.33</td>
<td>26.67%</td>
</tr>
</tbody>
</table>

**Other:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>$/unit</th>
<th>$/lbs of fruit</th>
<th>$/tree /yr.</th>
<th>$/total crop /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials and/or machinery</td>
<td>0.0</td>
<td>$0.00</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0%</td>
</tr>
<tr>
<td>Labor (min.)</td>
<td>0</td>
<td>$0.27</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Total growing costs =** 0.753 30.01 150.03 27%

**B. Harvesting costs:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Average cents per pound</th>
<th>$/lb of fruit</th>
<th>$/tree /yr.</th>
<th>$/enterprise /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picking</td>
<td>25.6</td>
<td>$/lb</td>
<td>25.6</td>
<td>12.00</td>
<td>60.00</td>
</tr>
<tr>
<td>Packing: for wholesale</td>
<td>20.1</td>
<td>$/lb</td>
<td>5.0</td>
<td>0.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Packing: for retail sales</td>
<td>20.1</td>
<td>$/lb</td>
<td>15.1</td>
<td>6.01</td>
<td>30.03</td>
</tr>
</tbody>
</table>

**Delivery to market:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Average cents per pound</th>
<th>$/lb of fruit</th>
<th>$/tree /yr.</th>
<th>$/enterprise /yr.</th>
<th>% of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0</td>
<td></td>
<td>$/lb</td>
<td>10.0</td>
<td>3.98</td>
<td>19.92</td>
</tr>
</tbody>
</table>

**Total harvesting costs =** 50.7 21.99 109.95 20%

**TOTAL Operating Costs =** 51.4 52.00 259.99 47%

### Break-even analysis:

**Gross Margin =** 223.6 57.57 287.86 52.5%

- Given the weighted average price of $2.750 $/lb. fruit, the mkt. yield required to cover operating costs = 94.5
- Given the marketable yield of 39.8 lbs. fruit/ tree, the ave. price req. to cover operating costs = $1.305
Gross Margin Budgets for Mixed Tropical Fruit Tree Production

Dr. Kent Fleming, Agricultural Economist
Email: fleming@hawaii.edu

How to calculate your harvesting costs expressed as ¢ / lb:

**Picking:**

1. **Assume picking labor wage rate = $12.00 /hour**
2. Weigh all of the fruit picked in one harvest year & average it out for one tree. **Ave. gross yield / tree = 46.9 lbs./year**
   - **Important:** The picked fruit yield recorded here is the gross yield and not the marketable yield.
3. Record how many minutes on average it takes you to pick all of the fruit on one tree. **60 minutes**
   - **Note:** You will probably harvest the tree a number of times during the season. We need the time it takes for the whole crop year.
4. Divide the ave. gross yield /tree by the ave. time taken to pick. Your average picking rate in pounds per minute = 0.8
5. Divide the hourly wage rate for pickers by 60 minutes. This will give you the cents per minute wage rate = 20.0
6. Divide this wage rate, in ¢ / min. (result from step 4 above), by the ave. picking rate (in lbs./min.) (from step 3 above.)
   - The result is your **cost (in ¢ / lb.) to pick a tree’s annual gross yield of fruit = 25.6 ¢ / lb.**

**Example to illustrate the process:**

a. In one year you picked 1,600 fruit with a total weight of 800 pounds in 1 hour 20 min = 100 minutes. Your average picking rate is: 800 lbs. + 100 minutes = 8 lbs./min.
   - You would pay pickers $12.00 per hour = 20 ¢ per minute to pick fruit.
   - Your picking cost / tree is: 20 ¢/min + 8 lbs./min. = 2.5 ¢/lb. per pound of fruit picked

**Packing:**

1. WHOLESALE: Record the total annual cost for packaging to pack the marketable fruit sold wholesale. **$2.00**
2. Divide this cost by the pounds of fruit sold wholesale. **10.0 c / lb.**
   - Your materials cost in ¢ / lb. = 20.1 ¢ / lb.
3. If more labor (in addition to the picking labor) is required to pack, calculate its cost in ¢ / lb. as above.
   - Extra labor required (minutes): 0
   - Packing rate = lbs. / minute Labor cost =
4. Add these 2 costs together to obtain the **total packing cost per pound of fruit marketed wholesale = 20.1 c / lb.**
5. RETAIL: Follow the same procedure (steps 1 to 4 above) to calculate the cost to pack fruit sold retail.
   - Total cost of retail packaging = $6.00
   - Extra labor required (minutes): 0
   - Packing rate = lbs. / minute Labor cost =

   **Total packing cost per pound of fruit marketed retail = 20.1 c / lb.**

**Example:**

a. In one year you picked 1,600 pounds of fruit, of which 75% was marketable, that is, 1,200 pounds.
   - During the year you used 24 boxes (@ $2 each) to ship 1,200 pounds of fruit to the wholesale market.
   - Divide the packaging cost ($48) by the amount of marketable fruit. This will give you the materials cost / lb. of fruit: 48.00 + 1,200 = $0.04 = 4¢ / lb.
   - During the year 60 minutes of packing labor was required (beyond the picking labor.) Your average packing rate is: 1200 lbs. + 60 min. = 20 lbs. / min.
   - You would pay packers $12.00 per hour ( = 20 ¢ per minute) to pack fruit. Your annual packing labor cost /tree is: 20 ¢/min + 20 lbs./min. = 1.0 ¢/lb.
   - Add the annual material cost (step c) and labor cost (step e) to obtain your total packing cost / lb. of marketed fruit. 8 ¢/ lb. + 1 ¢ / lb = 9.0 ¢/ lb. for packing wholesale fruit.

**Delivery:**

1. Based on your annual records, calculate your average cost / mile for vehicle & driver to haul boxes: **$1.00**
2. Record the total delivery mileage for one year & estimate a portion to allocate to delivering this crop: **4**
3. Record the total weight of marketable fruit delivered during the year: **39.6**
4. Multiply estimated share of mileage times mileage rate & divide by total weight of deliveries: **10.0 ¢ / lb.**

**Example:**

a. You have 10 trees that yield an average of 1,200 lbs of marketable fruit = 12,000 lbs.
   - During the year you made 24 deliveries carrying 500 lbs of fruit averaging 20 miles round trip.
   - The cost for your vehicle and driver’s time averages about $1.00 per mile driven.

   **Note:** Obviously, the average delivery cost / lb. of all fruit marketed, unlike the picking and packing costs per pound of fruit, will vary widely for different growers, depending on their location relative to their markets.

   480 miles driven @ $1.00 / mile = **$480**
   - $480.00 transport cost + 12,000 lbs fruit = $0.04 = **4.0 ¢ / lb.** of fruit delivered