



Jackfruit

Ken Love¹ and Robert E. Paull²

¹Hawaii Tropical Fruit Growers, ²CTAHR Department of Tropical Plant and Soil Sciences

Artocarpus heterophyllus Lam.
Synonyms: *A. philippensis* Lamk.,
A. maxima Blanco
Family: Moraceae

The evergreen, latex-producing jackfruit tree can reach up to 80 feet in height, with a straight stem that branches near the base. The tree produces a long taproot. All parts have milky white, very sticky latex. The jackfruit flowers are borne on short shoots on the trunk and older branches. The thick, rubbery rind has short, blunt spines, and the fruit can have up to 500 seeds. Average fruit size is about 35 pounds, but they are often much larger. In 2010, at a jackfruit festival in Kerala, India, a 144-pound fruit was featured. The largest Hawaiian fruit was 79 pounds and held the Guinness book of records for a number of years. In locations where the fruit is relished, only the rind and core are inedible. The fruit odor can be described as blend of grapefruit, banana, and cheese, or something between spoiled onions and sweaty gym socks, and cloyingly sweet.

Other common names

jakfruit, bo luop mi (China), jacquier (French), nanka, (Indonesia), jaca, yaca (Spanish, Portuguese), lanka, (Philippines), kapiak (New Guinea), uto ni India (Fiji), ulu initia (Samoa), chakka, chakki, kanthal, kathar, panos (India), jaca, jaca mole, jaca dura (Brazil), mit (Vietnam), khanun, makami, banum (Thailand)



Origin

Jackfruit is thought to have originated in southwest India and been spread in ancient times throughout Southeast Asia, then to tropical Africa. It was probably introduced to the Philippines in the 12th century and domesticated soon thereafter. The writings of Pliny the Elder, as early as AD 100, mention jackfruit's origin as "where of the Indian sages and philosophers do ordinarily live." The tree is still highly regarded by subsistence farmers from India to Southeast Asia for its fruit, timber, and medicinal uses. It was one of the earliest cultivated

fruits. Jackfruit was reported in Hawai'i prior to 1888.

Cultivars

Numerous varieties are found around the world, and the fruit is usually divided into two categories, soft or firm. The fruit carpel, or section, can be colored from off-white to yellow to dark orange. There are also reports of red-fleshed jackfruit.

Australian cultivars are 'Black Gold', 'Gold Nugget', 'Honey Gold', 'Lemon Gold', 'Cochin', 'Kun Wi Chan', 'Leung Bang', 'Bosworth', 'Galaxy', 'Fitzroy', and 'Nahen'. In Thailand are found 'Dang Rasimi', 'Golden Pillow', 'Chompa Grob', 'Malaysia', 'Mastura', 'NS1', 'J33', 'J31', 'J30', and 'J29'. Indonesia has 'Tabouey', 'Bali Beauty', and many others from India including 'Mut-tam' and 'Varikka'. Elsewhere, 'Bhadaiyan' and 'Busila'

are found in Sri Lanka and ‘Chompa Gob’, ‘Handia’, ‘Khaja’, and ‘Safeda’ are found in Singapore. ‘Cheena’, a Malaysian hybrid with champedak (*Artocarpus integer* (Thunb.) Merr.) is growing in popularity in regions where jackfruit is common.

The genus *Artocarpus* contains about 50 species; most are native to Asia and 15 produce edible starchy fruit that frequently are staples. The four most important species are the more tropical breadfruit *Artocarpus altilis* (Parkins) Fosb. and the jackfruit *A. heterophyllus* Lam.; chempedak, *A. integer* (Thunb.) Merr.; and marang, *Artocarpus odoratissimus* Blanco.

A few other edible species followed by a common vernacular name include *Artocarpus ansiophyllus* (ent-awak), *A. hypargyrea* (kwai muk), *A. kemando* (pudau), *A. lakoocha* (lakoocha), *A. nitidus* (butong), *A. rigidus* (monkey jackfruit), *A. sarawakensis* (pingan), and *A. sericicarpus* (pedalai). These exist in Hawai‘i but are rare.

Environment

Jackfruit thrives in tropical warm and humid frost-free climates at elevations below 5000 feet. The trees have some salinity tolerance but poor drought and flooding tolerance. It will grow in a variety of well-drained soils with a pH between 5 and 7.5. The tree does not do well in exposed locations with strong, drying winds. It needs irrigation in times of drought in order to produce fruit. Growth habits vary from tall and straight with a thin trunk to short with a thick trunk, varying with soil type, environment, and cultivar.

Propagation

Seeds from selected trees are the major means of propagation. After overnight soaking in water, they should be planted as soon as possible after harvest, as they lose viability within 1–3 months. Seeds germinate in 3–8 weeks. Seedlings are best grown under shade. To propagate a desirable tree, root cuttings can also be used, with stem cuttings and air layers also being successful. Grafting and budding are now widely used in India and Southeast Asia. Budding, grafting, and inarching are done onto 12-month-old rootstocks of *A. integer*, *A. heterophyllus*, other *Artocarpus* species, as well as the same species being propagated. However, the suitability of these rootstocks has not been evaluated in a range of environments. Modified veneer grafts and cleft grafts are among the most common. Sometimes seedlings, such as



The author (K.L.) with a record-breaking Hawai‘i-grown jackfruit weighing just over 76 pounds.

those of the Singapore variety, are true to type. In major producing areas, seeds are usually planted in the field and later top-worked with selected varieties. Seedlings need to be transplanted before they are 1 year old to avoid damage to the sensitive taproot.

Culture and management

The tree will thrive from 100 feet to 5000 feet in Hawai‘i and is tolerant of salt spray. It will not survive in standing water for more than a day or two. India has roughly 30,000 acres producing jackfruit, with trees in orchards planted at 25 x 25 ft to 30 x 40 ft and often intercropped with coffee, pepper, vanilla, and betel palm.

In Hawai‘i, one or two trees are often found near rural farm homes. There are very few cases of more than two trees per farm. The trees generally produce within 3–4 years and can live to 100 years old, but productivity declines with age.

The Malaysian fertilizer recommendation is that nitrogen, phosphorus, potassium, and magnesium (N, P, K, Mg) are applied in the ratio of 8:4:2:1 at 30 grams/tree at 6 months, doubling every 6 months up to 2 years. Older trees receive 1 kg/tree of a 4:2:4:1 ratio every 6 months. Higher rates of 2–3 kg are recommended in the Philippines. Application occurs before and at the end of the wet season and is done around the outer canopy drip line. In Hawai‘i, trees are usually give a quarterly application of 8:8:8, but it is recommended that growers contact their UH-CTAHR Cooperative Extension Service to obtain a soil analysis. This will help determine what type of fertilizer would best serve the tree’s nutritional needs.

Deadwood should be removed and branches can be thinned. Production trees are kept at about 15 ft high to facilitate harvesting. Trees at lower elevations (300–600 ft) in South Kona were given 15 minutes of water daily from a 1/2-gallon water bubbler. Other jackfruit is given 10 minutes of water three times per week from a 1-gallon-per-hour drip emitter.

Pests and diseases

Seed and blossom rots, leafspots, pink disease, and fruit rot occur on jackfruit. The blossom and fruit rot are caused by *Rhizopus artocarpi* on both developing and mature fruit. Bacterial dieback (caused by *Erwinia canetorora*) can be a problem with most *Artocarpus* species. *Corticium salmonicolor* causes pink disease. Root rots due to *Fusarium* and *Phytophthora* are major problems, especially if the root system is flooded for a few days. Leafspot, caused by *Phomopsis artocarpina*, *Colletotrichum lagenarium*, and *Septoria artocarpi*, is a problem in many areas.

Jackfruit is reported to be attacked by shoot borers, bark borers, bud weevils, spittle bugs, mealybugs, scale insects, and aphids. Larva from oriental jackfruit fly (*Dacus umbrosus* Fabricius and *Dacus dorsalis*) has been found in marang and jackfruit but can be controlled with modern baits and protective bags covering the fruit as it develops. Borers can also be a problem. Once the tree is established, weeds are not a problem due to dense shade.

Harvesting and yield

Fruit matures 6–8 months after flowering. Depending on rainfall, irrigation, and tree age, jackfruit can produce from 20 to 250 fruits per year, sometimes up to 500 fruits on old-growth trees. Harvest indicators include a hollow sound when tapped, change of skin color, increased odor, and a flattening of its spines. In some Caribbean locations, a week or two before harvest the fruit stem (peduncle) is sliced to drain latex, which is said to speed ripening and improve flavor. This technique is becoming increasingly popular in India and other areas. Commercial yields average 250 pounds per year per tree. Orchards in Malaysia report a yearly average of 37,500 pounds per hectare. For the year 2000, the Philippines reported 29,000 acres of jackfruit in production, while India reported more than 252,000 acres in jackfruit production.

Postharvest considerations

Fruit quality and shelf life is dependent on maturity at



Edible portion (arils, containing seeds)

harvest. Fruit is sometimes allowed to fall and must be collected daily, for it has a shelf life of only 2–3 days. Whole fruit is moved rapidly to market. Half-ripe fruit cut in sections has a longer shelf life and is often sold in Indian grocery stores, where a wide variety of whole fruit sizes are also available. Mature, undamaged fruit can be stored at 50°F for 2–3 weeks. Fruit ripens in 3–7 days at 71–80°F, depending upon the stage of maturity at harvest. Fruit can be dried or preserved in simple syrup for future use. It is also canned and sold commercially.

Uses, packaging, pricing, and marketing

Thousands of value-added products can be made from jackfruit seeds as well as ripe and half-ripe pulp. In India and other parts of Asia and the South Pacific, the half-ripe fruit is commonly cooked into curries, soups, and stews. It can be pickled, dried, and canned. Vacuum-dried jackfruit chips are sold widely in Southeast Asia in sealed bags as a snack. It is also used as flavoring for ice cream or made into pudding, gum, and beverages. The seeds are usually boiled and eaten as a snack, although in South India they are often dried and milled into flour used for dosa or confections. This gluten-free seed flour can serve as a substitute for wheat for those with specific food allergies. Leaves are used for cooking and wrapping foods, and the wood is used for utensils, fencing, fodder, and fuel.

Jackfruit in Hawai'i is usually sold by size, as indicated above. At some markets it might be sliced into sections

and sold in bags; state health officials frown upon this practice unless the fruit was cut in a certified kitchen and kept chilled at the market. Some Hawai'i wholesalers will pay from \$1.50 to \$2.00 a pound for the fruit, but sales are infrequent and dependant on chefs' needs. At some farmers markets, dried jackfruit retails for an average of \$3.50 for a 2 oz bag. Seeds are seldom sold in Hawai'i but are sometimes given out as samples at farmers markets. Chefs in Hawai'i are just beginning to work with jackfruit, and demand for the fruit is expected to increase.

Nutritive value

Per 100-g edible portion; edible portion averages 28% of fruit weight.

	Ripe fruit	Seeds
<i>Edible portion (g)</i>		
moisture	72–77.2	51.6–57.77
calories	98	
protein	1.3–1.9	6.6
fat	0.2	0.4
carbohydrate	15.1–25.4	38.4
fibre	1.0–5	1.5
ash	0.8–2.2	1.25–1.50
<i>Minerals (mg)</i>		
calcium	22–37	0.05–0.55
iron	0.5–1.7	0.002–1.2
phosphorus	38	0.13–1.23
potassium	292–407	
sodium	2–48	
<i>Vitamins (mg)</i>		
vitamin C	8–10	
thiamine	0.03	
riboflavin	0.06	
niacin	0.4–4	
vitamin A	540 IU	

Recipe

In addition to Indian jackfruit curries, there are a number of other jackfruit curry-like dishes from Malaysia, Indonesian, and Thailand. Jackfruit is often added to rice dishes and salads, mixed with shrimp, or used in drinks like lassi or even martinis. Jackfruit lumpia and halo halo is popular in the Philippines.

Jackfruit, Coconut, and Macadamia Nut Ice Cream

Chef Matt Zubrod

1 c	canned coconut milk
1 c	whole milk
2 c	sugar
1 tsp	salt
2 c	heavy cream
½ tsp	Hawaiian vanilla extract
½ c	jackfruit arils (edible flesh), pureed
2 oz	toasted coconut
4 oz	macadamia nut pieces

In a small saucepan, place milk and creamy portion of coconut milk and warm over medium heat. Do not boil. Remove from heat, stir in sugar, salt, remaining coconut milk, heavy cream, and vanilla extract. Pour milk mixture, jackfruit, coconut pieces, and mac nut pieces into an ice cream maker and let it rip according to manufacturer's instructions. Serve with shortbread cookies and some good rum.

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.

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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

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Assumptions: (Data entries are annual amounts expressed on a per tree basis)			Fruit tree =>	JACKFRUIT	
1. Average number of bearing trees (counted)	2	trees	To calculate <u>profitability</u> : Enter wage rate & benefits actually paid (or the rates one would pay if labor were hired.) To calculate <u>cash flow</u> enter nothing. The cash flow result is (except for depreciation considerations) one's taxable income.		
2. Yield (expressed in number of fruit [F] or lbs)	F 25	fruit / tree			
3. Average wt. (ozs.) / fruit =	560.0	ounces			
4. Total lbs. harvested/ tree =	875.0	lbs. gross yield			
5. Marketable yield /tree (%) =	75%	of the gross yield			
6. Wage rate (\$/hr.) =					\$12.00
7. Benefits (FICA, etc.) (%) =					33%

Gross Revenue:	% of total	\$/lb:	Lbs./tree/yr.	\$/tree /yr.:	\$/total crop /yr.	% of gross
1 Wholesale sales	70%	0.29	459.4 marketable lbs.	131.38	263	54%
2 Retail sales	30%	0.57	196.9 marketable lbs.	112.42	225	46%
Total sales =	Weighted ave. price/lb. = \$0.372		656.3 marketable lbs.	243.80	488	100%

Operating Costs: Enter unit quantities as total per year per tree:							
A. Growing costs:	Units:	\$/unit:	¢/lb. of fruit	\$/tree /yr.:	\$/total crop /yr.	% of gross	
1 Fertilization	Sub-totals =>			0.01	6.39	12.78	3%
Fertilizer (lbs.)	3.0	\$0.80	0.004	2.40	4.80		
Labor (min.)	15	\$0.27	0.006	3.99	7.98		
2 Irrigation: Assuming ag water rate =	\$2.00	/1,000 gals.	Sub-total=>	0.00	1.33	2.66	1%
Water (gallons)	1	\$0.002 / 1,000 gals.	0.000	0.00	0.00		
Labor (min.)	5	\$0.27	0.002	1.33	2.66		
3 Pest control:	Sub-totals =>			0.00	1.33	2.66	1%
Materials	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	5	\$0.27	0.002	1.33	2.66		
4 Weed control:	Sub-totals =>			0.00	1.33	2.66	1%
Chemicals and/or machinery	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	5	\$0.27	0.002	1.33	2.66		
5 Pruning:	Sub-totals =>			0.01	5.32	10.64	2%
Machinery	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	20	\$0.27	0.008	5.32	10.64		
6 Other:	Sub-totals =>			0.00	0.00	0.00	0%
Materials and/or machinery	0.0	0.00	0.000	0.00	0.00		
Labor (min.)	0	\$0.27	0.000	0.00	0.00		
Total growing costs =				0.024	15.70	31.40	6%

Enter picking costs based on gross yield and packing and delivery costs based on marketable yield.

B. Harvesting costs:	Average cents per pound	¢/lb. of fruit	\$/tree /yr.:	\$/enterprise /yr.	% of gross	
1 Picking	5.7	¢/lb.	5.7	49.88	99.75	20%
2a Packing: for wholesale	1.5	¢/lb.	1.1	4.82	9.65	2%
2b Packing: for retail sales	-	¢/lb.	0.0	0.00	0.00	0%
3 Delivery to market	6.1	¢/lb.	6.1	40.03	80.06	16%
Total harvesting costs =			11.8	89.91	179.81	37%
TOTAL Operating Costs =			11.8	105.61	211.22	43%

Break-even analysis:					
Gross Margin =		25.3	138.19	276.38	56.7%
Given the weighted average price of	\$0.372	\$/lb. fruit,	the mkt. yield required to cover operating costs =	568.6	
Given the marketable yield of	656.3	lbs. fruit/ tree,	the ave. price req. to cover operating costs =	\$0.161	

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

Picking:

Assume picking labor wage rate = \$12.00 /hour

- 1 Weigh *all* of the fruit picked in one harvest year & average it out for one tree. Ave. gross yield / tree = 875.0 lbs./year
(Important: The picked fruit yield recorded here is the gross yield and not the marketable yield.)
- 2 Record how many minutes on average it takes you to pick *all* of the fruit on one tree. 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.)
- 3 Divide the ave. gross yield /tree by the ave. time taken to pick. Your average picking rate in pounds per minute = 14.6
- 4 Divide the hourly wage rate for pickers by 60 minutes.. This will give you the cents per minute wage rate = 20.0
- 5 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** =

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:
 $800 \text{ lbs.} \div 100 \text{ minutes} = 8 \text{ lbs./ min.}$
- b You would pay pickers \$12.00 per hour = 20 ¢ per minute to pick fruit. $12 \div 60 = \$0.20$ or **20¢ per minute**
- c Your picking cost / tree is: $20 \text{ ¢/min} \div 8 \text{ lbs./ min.} = 2.5 \text{ ¢/ lb.}$ per pound of fruit picked

Packing:

- 1 WHOLESALE: Record the total annual cost for packaging to pack the marketable fruit sold wholesale.
- 2 Divide this cost by pounds of fruit sold wholesale. (This has been calculated in "Gross Revenue" above) 459.4
Your materials cost in ¢ / lb. = ¢ / 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): Packing rate = _____ lbs. / minute Labor cost = _____
- 4 Add these 2 costs together to obtain the **total packing cost per pound of fruit marketed wholesale** =
- 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 = Retail sales = 196.9 pounds Materials cost = 3.5 ¢ / lb.
Extra labor required (minutes): Packing rate = _____ lbs. / minute Labor cost = _____
Total packing cost per pound of fruit marketed retail =

Example:

- a In one year you picked 1,600 pounds of fruit, of which 75% was marketable, that is, 1,200 pounds.
- b During the year you used 24 boxes (@ \$2 each) to ship 1,200 pounds of fruit to the wholesale market.
- c Divide the packaging cost (\$48) by the amount of marketable fruit. This will give you the materials cost / lb. of fruit:
 $\$48.00 \div 1,200 = \$0.08 = 4 \text{ ¢ / lb.}$
- d During the year 60 minutes of packing labor was required (beyond the picking labor.) Your average packing rate is:
 $1200 \text{ lbs.} \div 60 \text{ min.} = 20 \text{ lbs. / min.}$
- e You would pay packers \$12.00 per hour (= 20 ¢ per minute) to pack fruit. Your annual packing labor cost /tree is:
 $20 \text{ ¢/min} \div 20 \text{ lbs./ min.} = 1.0 \text{ ¢/ lb.}$
- f Add the annual material cost (step c) and labor cost (step e) to obtain your total packing cost / lb. of marketed fruit.
 $8 \text{ ¢/ lb.} + 1 \text{ ¢ / lb} = 9.0 \text{ ¢/ lb.}$ for packing wholesale fruit.

Delivery:

- 1 Based on your annual records, calculate your average cost / mile for vehicle & driver to haul boxes:
- 2 Record the total delivery mileage for one year & estimate a portion to allocate to delivering this crop:
- 3 Record the total weight of marketable fruit delivered during the year: 656.3
- 4 Multiply estimated share of mileage times mileage rate & divide by total weight of deliveries:

Example:

- a You have 10 trees that yield an average of 1,200 lbs of marketable fruit = 12,000 lbs.
- b During the year you made 24 deliveries carrying 500 lbs of fruit averaging 20 miles round trip.
- c 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