

LOCAL NAMES

Bislama (beta); Creole (vèritab, laba pen); English (breadfruit, breadnut); Fijian (uto, kulu); Filipino (kamansi, rimas); French (arbre à pain, âme véritable, veritable); German (brotfruchtbaum); Hawaiian (ulu); Indonesian (sukun, kelur, timbul); Khmer (saké, khnaôr sâmlou); Malay (sukun, kuror, kulur); Mandinka (tubab tio); Pidgin English (kapiak); Portuguese (rimas); Samoan (ulu); Spanish (castaña, albopán, arbol del pan, pana de pepitas, panapén); Swahili (mshelisheli); Tamil (seema pila); Thai (khanun-sampalor, sa-ke); Tongan (mei, mai); Vietnamese (saké)

BOTANIC DESCRIPTION

Artocarpus altilis is a large, attractive, evergreen tree, reaching heights of 15-20 m; bark smooth, light coloured; trunk up to 1.2 m in diameter, may reach a height of 4 m before branching; 2 large stipules enclosing the terminal bud, up to 30 cm long at maturity, yellowing and falling when leaves fold or inflorescence emerges.

Leaves thick, leathery; top dark green, often glossy; underside dull with an elevated midrib and main veins; striking variation in leaf outline and dissection; leaves broadly obovate to broadly ovate, varying in size and shape; juvenile leaves on young trees and new shoots of mature trees usually larger, more dissected and more hirsute; leaves sometimes smooth but often with few to many pale to reddish hairs, especially on the midrib and veins.

Fruit a highly specialized structure, a syncarp, composed of 1500-2000 flowers attached to the fruit axis or core; bulk of fruit formed from the persistent perianth of each flower; perianths are fused together except at base. As the fruit develops, this area grows vigorously and becomes fleshy at maturity, forming the edible portion of the fruit; tough rind composed of 5- to 7-sided disks, each the surface of an individual flower; 2-3 strap-shaped, reflexed stigmas protrude from the centre of the disk and often leave a small distinctive scar when they blacken and wither; rind at maturity usually stained with latex exudations.

Fruit globose to oblong, 12-20 x 12 cm; rind light green, yellowish-green or yellow when mature, flesh creamy white or pale yellow; surface varies from smooth to slightly bumpy or spiny, with individual disks ranging from areolate to slightly raised and flattened, to widely conical, up to 3 mm high and 5 mm across at the base, to narrowly conical up to 5 mm long; seedless, some forms seeded. Seeds have a thin, dark-brown outer skin about 0.5 mm thick and an inner, fragile, paperlike membrane that surrounds the fleshy, white edible portion of the seed.

The generic name comes from the Greek words 'artos' (bread) and 'karpos' (fruit). The fruit is eaten and is commonly called breadfruit.

BIOLOGY

A. altilis trees are monoecious -- male and female flowers occur separately on the same tree. Male inflorescence emerges before the female. Pollen is shed 10-15 days after the emergence of the male inflorescence, for a period of about 4 days. Female flowers are receptive 3 days after the emergence of the female inflorescence from the bracts and open in successive stages, with basal flowers opening 1st. As with other members of its genus, *A. altilis* is cross-pollinated.

Honeybees have been observed actively working the male inflorescence and collecting pollen, especially from fertile, seeded accessions. Other insects such as earwigs have also been observed on the male inflorescence. Only a few flowers in the male inflorescence of seedless *A. altilis* produce and release pollen. Pollen grains from fertile cultivars are uniformly shaped and stain well, while triploid cultivars have the lowest pollen sustainability, averaging 6-16%. Pollen grains are typically malformed, clumped and poorly stained. *A. altilis* is diploid ($2n = 56$) and triploid ($2n = 84$).



Habitat at Keanae Arboretum, Maui, Hawaii (Forest and Kim Starr)



Leaves and fruit at Puehuhueiki cemetery Lahaina Maui, Hawaii (Forest and Kim Starr)



Betel nut palms are planted along the property boundary. (Craig Elevitch)

Asexually propagated trees start fruiting in 3-6 years.

ECOLOGY

A. altilis is a crop for the hot, humid, tropical lowlands. Rain stimulates extension growth, flowering and rate of growth of the fruit. It prefers rainfall of fairly equal distribution but is quite tolerant of short dry periods. *A. altilis* grows best in equatorial lowlands; it is occasionally found in the highlands, but yield and fruit quality suffer in cooler conditions. Good drainage is essential, and trees may shed their fruit when the soil is excessively wet.

BIOPHYSICAL LIMITS

Altitude: (0) 600-650 (1 550) m, Mean annual temperature: (12) 21-32 (40) deg. C, Mean annual rainfall: 1 500 (2 000)-2 500 (3 000) mm

Soil type: Can be grown on a variety of soils and thrives on alluvial and coastal soils. They do best in deep, fertile, well-drained sandy loam or clay loam soils. Some cultivars, especially interspecific hybrids, have adapted to shallow, calcareous soils and appear to tolerate high saline conditions.

DOCUMENTED SPECIES DISTRIBUTION

Native: Malaysia, Papua New Guinea, Philippines

Exotic: Antigua and Barbuda, Australia, Bahamas, Barbados, Brazil, Byelarus, Colombia, Cook Islands, Costa Rica, Cuba, Dominica, Dominican Republic, Fiji, French Guiana, French Polynesia, Gambia, Grenada, Guadeloupe, Guatemala, Guinea, Guyana, Haiti, India, Indonesia, Jamaica, Kiribati, Madagascar, Maldives, Marshall Islands, Martinique, Mauritius, Mexico, Montserrat, Netherlands Antilles, New Caledonia, New Zealand, Norfolk Island, Puerto Rico, Samoa, Seychelles, Solomon Islands, Sri Lanka, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Taiwan, Province of China, Tonga, Trinidad and Tobago, US, Vanuatu, Virgin Islands (US)



The map above shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species can not be planted in other countries than those depicted. Since some tree species are invasive, you need to follow biosafety procedures that apply to your planting site.

PRODUCTS

Food: Breadfruit is versatile and can be cooked and eaten at all stages of its development. It can be eaten raw, boiled, steamed or roasted. Very small fruits, 2-6 cm or larger in diameter, can be boiled and have a flavour similar to that of artichoke hearts. They can also be pickled and marinated. As breadfruit is a seasonal crop that produces much more than can be consumed fresh, Pacific Islanders have developed many techniques to use large harvests and extend availability of the fruit. The most common method of preservation is by preparing the fermented, pit-preserved breadfruit called ma, masi, mahr, furo or bwiru. In many areas, the male inflorescence is pickled or candied.

Compared with other staple starch crops, breadfruit is a better source of protein than is cassava; it is comparable to sweet potato and banana. It is a relatively good source of iron, calcium, potassium and riboflavin. Fermented breadfruit and breadfruit paste are both traditional products. Processing breadfruit into a snack such as chips, flour, pulverized starch or even freeze-drying it are all common methods of consuming or preserving it.

The seeds are cooked with the raw breadfruit or removed and roasted or boiled. They are firm, close-textured and have a sweet, pleasant taste that is most often compared with chestnuts. Both fresh and cooked seeds are about 8% protein. The seeds are a good source of protein and are low in fat, compared with tree nuts such as almond, brazil nut and macadamia nut, which contain 50-70% fat. The seeds are a good source of minerals and contain more niacin than cashews, almonds, macadamia nuts, brazil nuts, pecans, black walnuts or chestnuts.

Fodder: Since only the pulp of mature breadfruit is consumed as human food, at least 25% of the fruit is wasted. The non-edible portions are high in carbohydrates, contain more protein than the pulp and are excellent sources of nutrients. Leaves are eaten by livestock and can be fed to cattle, goats, pigs and horses. They have even been reported to be good food for elephants. Horses will eat the bark, young branches and shoots and must therefore be kept away from new plantings. Excess ripe breadfruit, seeds, cores and other breadfruit waste are fed to pigs and other animals.

Fuel: The trees are an important source of firewood on the atolls of the Pacific.

Fibre: The male flower spikes are blended with fibre of paper mulberry (*Broussonetia papyrifera*) to make elegant loincloths. The inner layer of bark, or bast, was used to make bark cloth (tapa). Traditionally it had ceremonial and ritual uses, was also used for beddings and items of clothing such as cloaks, loincloths and robes. Breadfruit bast makes good cordage with a diverse range of uses such as harnesses for water buffalo and nets for catching sharks.

Timber: The wood is differentiated into yellow or brownish-yellow sapwood and heartwood, golden speckled with orange. The golden yellow colour darkens with age. The wood is very light (density 505-645 kg/cubic m at 15% mc), durable, soft, but quite resistant in spite of its low specific gravity. Traditionally it was widely used for construction of houses and canoes because of its resistance to termites and marine worms. The wood is used in Haiti to make bowls, carvings, furniture and even surfboards.

Gum or resin: *A. altilis* gum is used to caulk canoes to make them watertight and can be used as an adhesive to seal and prepare wooden surfaces for painting.

Latex or rubber: A sticky latex is present in all parts of the tree and has many uses. It is used as a chewing gum in the Caribbean and elsewhere. The sap is widely used throughout the Pacific and other areas as birdlime to catch birds for food and their feathers. In Kosrae, the latex is mixed with coconut oil for trapping houseflies.

Tannin or dyestuff: The inflorescence was used in Hawaii to make a yellow tan to brown dye.

Lipids: The fat extracted from the seed is a light yellow liquid, viscous at room temperature, with a characteristic odour similar to that of peanuts. It has a chemical number and physical properties similar to those of olive oil.

Poison: In Vanuatu and Hawaii the dried, hard flowers are burned as mosquito repellent.

Medicine: Toasted flowers are rubbed on the gums around aching teeth to ease pain. Latex is massaged into the skin to treat broken bones and sprains and is bandaged on the spine to relieve sciatica. It is commonly used to treat skin ailments and fungal diseases such as thrush. The latter is also treated with crushed leaves. Diluted latex is taken internally to treat diarrhoea, stomach-ache and dysentery. Latex and juice from the crushed leaves are both traditionally used in the Pacific Islands to treat ear infections. The root is an astringent and is used as a purgative; when macerated it was used as a poultice for skin ailments. The bark is used in several Pacific Islands to treat headache.

In the West Indies, the yellowing leaf is brewed into a tea and taken to reduce high blood pressure. The tea is also thought to control diabetes. Leaves are used in Taiwan to treat liver diseases and fevers, and an extract from the flowers was effective in treating ear oedema. Bark extracts exhibited strong cytotoxic activities against leukaemia cells in tissue culture, and extracts from roots and stem barks showed some antimicrobial activity against Gram-positive bacteria and may have potential in treating tumours.

Other products: The leaves are widely used to wrap food for cooking and serving. The dried stipules or senescent leaves are slightly rough, and in Hawaii they were used to polish and smooth bowls and nuts strung for decorative purposes. In the atolls of Yap, the leaves are used to make fishing kites to catch reef fish.

SERVICES

Shade or shelter: *A. altilis* is a long-lived, perennial tree crop that provides beneficial shade and cooler microclimate for humans, plants and animals beneath its canopy.

Soil improver: The tree can be used to provide mulch.

Intercropping: It is an important component of traditional agroforestry systems in the Pacific Islands, particularly the eastern Solomon Islands, Pohnpei and Kosrae. The trees are integrated into mixed cropping systems with yams and other root crops, *Piper methysticum*, bananas and some cash crops, especially black pepper and coffee.

Boundary or barrier or support: In the Pacific, yam vines are often grown with the tree, using its branches and canopy for support.

Ornamental: Occasionally grown as an ornamental in the humid areas of Gambia.

TREE MANAGEMENT

Plants should be set out at the onset of the rainy season, and supplementary irrigation may be required to help the trees establish. Once established, they require little attention or input of labour or materials. Trees generally do not require any training or pruning except to remove dead branches and to trim them to a height convenient for cultivation. They are known to grow and fruit well without irrigation, even in areas with a distinct dry season.

Regardless of the method used for propagation, young plants do best under shade, but trees require full sun once established.

An orchard would require thorough land preparation consisting of deep ploughing followed by harrowing. Approximately 100 trees/ha can be planted if spaced 12 x 8 m or 10 x 10 m apart.

GERMPLASM MANAGEMENT

Seeds display recalcitrant storage behaviour. The short-lived seeds should not be allowed to dry out and should be kept moist at 20 deg. C.

Seeds germinate immediately and are unable to withstand desiccation, hence loose viability within a few weeks and cannot be stored. Wherever seeds occur they are distributed by flying foxes.

PESTS AND DISEASES

Breadfruit is a hardy tree and is relatively free of diseases and pests, although scale insects, mealy bugs and *Cercospora* leafspot may be seen on many trees. Pest problems seem to be regional. For example the 2-spotted leaf hopper has been observed damaging trees in Hawaii; *Rastrococcus invadens* is becoming a pest in certain parts of West Africa, and *Rosellinia* spp. has been reported as a potential threat in Trinidad and Grenada.

Several causal organisms are responsible for fruit rot on breadfruit. Fruits may be affected by *Phytophthora*, *Colletotrichum* (anthracnose) and *Rhizopus* (soft rot), but these can be controlled by prompt harvest of mature fruits and removal of diseased fruits.

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SUGGESTED CITATION

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