

## Artocarpus heterophyllus

Lam.

Moraceae

### LOCAL NAMES

Bengali (kanthal); Burmese (khnaôr,peignai); English (jacquir,jackfruit,jack tree); Filipino (nancas,langka); French (jacquier); German (jackfruchtbaum); Hindi (halasu,kathar,alasa,kanthal,chakki,kathal,panos); Indonesian (nangka,nongko); Javanese (nangka,nongko); Khmer (khnaôr); Lao (Sino-Tibetan) (miiz hnang,miiz); Luganda (Yakobo,kifenensi); Malay (tajaka,nangka); Mandinka (jak); Sanskrit (panasa); Sinhala (kos); Spanish (pan de fruta,jacueiro,buen pan,rima,jaca); Swahili (mfenesi,mfenesi mfuu); Tamil (pilla,pilapalam,pilavu); Thai (makmi,khanun,nangka,banun); Vietnamese (mit)

### BOTANIC DESCRIPTION

*Artocarpus heterophyllus* reaches 8-25 m in height; straight stemmed, branching near the base at an angle of 32-88 deg; canopy dense, dome shaped or rarely pyramidal; diameter varies with age, in 5-year-old trees it ranges from 3.5 to 6.7 m; trunk rarely buttressed, with a girth of 30-80 cm and a circumference of 42-96 cm; bark greyish-brown, rough, uneven, somewhat scaly; inner bark thick, ochre; all parts smooth, having either no hairs or minute, white hairs up to 0.5 mm long with tips easily broken, giving twigs and leaves a slightly rough feel; trees produce a long taproot; when injured, all living parts of the tree exude a copious, white gummy latex.

Leaves 4-25 x 2-12 cm, coriaceous, glossy, usually glabrous; top dark green, underside pale green; may be flat, wrinkled or with upcurled sides; arranged alternately on horizontal branches, and spirally on ascending branches with 2/5 phyllotaxis; broadest at or above the mid-portion; pinnately nerved, with 5-12 pairs of veins; those on flower-bearing branches obovate or oblong, those on young shoots oblong, narrow; entire when mature, 2 or 3 lobed when young; apex blunt, short and pointed; base cuneate or pointed; midrib and main veins greenish-white to pale greenish-yellow; at the nodes, stipules fused around stem, leaving an encircling scar after they fall off.

Individual flowers borne on an elongated axis and forming a racemoid inflorescence; male spikes produced singly, elongated, whitish-green or dark green with smooth skin, becoming yellowish and rough when mature, oblong, cylindrical, clavate, ellipsoidal or barrel shaped, distal end with a 1.5-2.5 mm wide annular ring, 3-10 x 1-5 cm, slightly hairy. Hanging or drooping peduncle 1.5-3.5 cm long and 4-5 mm thick, many densely crowded sterile or fertile flowers; sterile flower has a solid perianth and the fertile one is tubular and bi-lobed. Female spikes either solitary or paired, oblong or cylindrical with rough, light to dark green skin, 5-15 cm, peduncle 8-9 mm thick; base with 3-4 mm wide and green annulus.

A multiple fruit consisting of several achenes (syncarp), each of which is indehiscent and 1-seeded, cauliflorous, 20-100 x 15-50 cm, the entire fruit weighing 4.5-50 kg; oval, oblong or ellipsoid, pale or dark green when young, greenish-yellow, yellow or brownish when mature; peduncle green, 2-10 cm long, 1-3.5 cm thick, covered by a rubbery rind and hard pyramidal, pointed or blunt spines. Inside are the fruitlets, which are the true fruits, 4-11 x 2-4 cm, 6-53g, composed of fleshy aril and the seed; aril waxy, firm or soft, yellow, golden yellow to yellow-orange, sweet, aromatic, 2-6.5 x 0.1-0.7 mm, 5-42 g. Fruits contain more than 500 firm or waxy seeds, oval-oblong or oblong-ellipsoid, thickened at the hilum, flattened in a plane parallel with the sagittal, 2-4.5 x 1-3.7 cm, 2.5-14 g.

The generic name comes from the Greek words 'artos' (bread) and 'karpos' (fruit); the fruits are eaten and are commonly called breadfruit. The specific name, 'heterophyllus', is Latin for various leaved, or with leaves of different sizes and shapes; it is from the Greek word 'heteros' (different).

### BIOLOGY

Trees start flowering and fruiting 2-8 years after planting. Flower and fruit



15kg fruit from trees in Sri Lanka (Pushpakumara)



Close-up of female inflorescence (Anthony Simons)



*Artocarpus heterophyllus* fruit (Heranth Gunasena)

loads are initially low and improve with increasing size and age; trees 2 years old produce about 25 flowers and 3 fruits; trees 5 years old bear as many as 840 flowers, and trees 6 years old 1500 flowers. However, only 15-18 fruits develop due to the low production of female spikes (about 0.6-5% of the total number of inflorescences). Young trees bear more male than female flowers at a ratio of 4:1; production of female flower increases with age. A male-to-female ratio of 2:1 produces 250 fruits per tree, and as the trees ages, fruit productivity declines.

In suitable environments trees bear fruits and flowers throughout the year, but in areas with distinct dry and wet seasons, flowering occurs in the wet season. In young trees, fruits are usually borne on branches and in older trees, on trunks and roots.

The tree is wind and insect pollinated. Insects normally visit the scented male flowers, which release pollen that is carried to female flowers by the wind. Wilting and drying stigmas are the best indicators of fruit set. Fruits mature in 80-160 days, and a sweet and strong aroma indicates that the fruit is ripe.

**ECOLOGY**

A. heterophyllus grows in tropical, near tropical and subtropical regions. The species extends into much drier and cooler climates than do other Artocarpus species. It can also withstand lower temperatures and frost; it bears fruit at latitudes up to 30 deg. north and south, with good crops at 25 deg. north and south. The tree will not tolerate drought or flooding, and for optimum production it requires a warm, humid climate and evenly distributed rainfall.

**BIOPHYSICAL LIMITS**

Altitude: 0-1600 m, Mean annual temperature: 16-22 deg. C, Mean annual rainfall: 1000-2400 mm

Soil type: A. heterophyllus thrives in deep, alluvial, sandy-loam or clay loam soils of medium fertility, good drainage and a pH of 5-7.5. It flourishes in rich soils of medium or open texture and grows even in the poorest soils, including gravelly or lateritic soils, shallow limestone, shallow light soils, and sandy or stony soils. It exhibits moderate tolerance to saline soils.

**DOCUMENTED SPECIES DISTRIBUTION**

Native: Bangladesh, India, Malaysia

Exotic: Algeria, Angola, Australia, Benin, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, China, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Indonesia, Kenya, Lesotho, Liberia, Libyan Arab Jamahiriya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Myanmar, Namibia, Niger, Nigeria, Philippines, Rwanda, Sao Tome et Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Surinam, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe



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:** The pulp of young fruit is cooked as a vegetable, pickled or canned in brine or curry. Pulp of ripe fruit is eaten fresh or made into various local delicacies (e.g., 'dodol' and 'kolak' in Java), chutney, jam, jelly and paste, or preserved as candy by drying or mixing with sugar, honey or syrup. The pulp is also used to flavour ice cream and beverages, or reduced to a concentrate or powder and used for preparing drinks. Addition of synthetic flavours such as esters of 4-hydroxybutyric acid greatly improves the flavour of the canned fruit and nectar. The seeds, rich in vitamin A, sulphur, calcium and phosphorus, are eaten after boiling or roasting, dried and salted as table nuts, or ground to make flour that is blended with wheat flour for baking. Male spikes left to rot on trees are used as a salad or pickle.

**Fodder:** Leaves are cropped in India for fodder, and overripe, immature or fallen fruits are fed to hogs and cattle. Elephants eat the bark, leaves and fruits.

**Fibre:** The inner part of the bark or bast is occasionally made into cordage or cloth.

**Timber:** Wood is yellow at first, becoming red, with a specific gravity of 0.6-0.7. It is classified as medium hardwood. It is resistant to termite attack and fungal and bacterial decay and is easy to season. It takes polish beautifully. Though not as strong as teak, *A. heterophyllus* wood is considered superior to teak (*Teclona grandis*) for furniture, construction, turnery and inlay work, masts, oars, implements and musical instruments. The wood is widely used in India and Sri Lanka and is even exported to Europe. Roots are highly prized for carvings and picture framing.

**Gum or resin:** The latex yields 71.8% resin, consisting of 63.3% fluavilles (yellow) and 8.5% albanes (white). These resins may be valuable in varnishes.

**Latex or rubber:** The latex is commonly used as adhesive for mending broken chinaware or earthenware, caulking boats, mending holes of buckets and trapping birds. In India and Brazil, the latex serves as a substitute for rubber.

**Tannin or dyestuff:** The bark gives a dark, water-soluble resinous gum that contains 3.3% tannin. When boiled with alum, the sawdust or chips of the heartwood produce a rich yellow dye used for silk and the cotton robes of Buddhist priests.

**Alcohol:** Arils can be fermented and distilled to produce an alcoholic beverage.

**Medicine:** Ashes of leaves, with or without oil, are used in Malaysia and Philippines to treat ulcers, diarrhoea, boils, stomach-ache and wounds. Pulp and seeds of the fruit are regarded as a cooling tonic. Seeds are said to be an aphrodisiac. The sap is an anti-syphilitic and a vermifuge. Wood is claimed to have sedative properties, and its pith is said to be able to induce abortion. A root decoction is used to alleviate fever, treat diarrhoea, skin diseases and asthma. The bacteriolytic activity of *A. heterophyllus* latex is equal to that of papaya latex. Dried latex yields artotenone, a compound with marked androgenic action; it can also be mixed with vinegar to promote healing of abscesses, snakebite and glandular swellings.

**SERVICES**

**Erosion control:** *A. heterophyllus* can be planted to control floods and soil erosion in farms.

**Shade or shelter:** Trees planted at a close spacing act as a windbreak and are sometimes used as shade for coffee.

**Boundary or barrier or support:** The trunk is occasionally used as living support for pepper.

**Intercropping:** In the Philippines, *A. heterophyllus* is planted with coconut groves. In Malaysia, trees have been used as an intercrop in durian orchards, and in India the trees are intercropped with mango and citrus. Young *A. heterophyllus* orchards may be intercropped with annual cash crops such as banana, sweet corn and groundnut.

**TREE MANAGEMENT**

Site preparation depends on the scale of production and the condition of the land; it should be cleared of all growth before digging holes (60-80 x 40-50 cm) for planting. Trees should eventually be thinned to a spacing of 7.5-12 m, and lack of thinning may lead to die-back. Hardly any pruning is required. Dead branches should be removed from the interior of the tree so that sufficient light is obtained for the developing fruit and to check the spread of pests. Both interrow and circle weeding are employed to keep down weeds; mulching may also be used to suppress weeds and conserve soil moisture. Fungicide is sprayed to protect trees from diseases. *A. heterophyllus* exhibits fairly rapid growth, attaining a height of 3 m and a canopy diameter of 2 m at 2 years of age. In 5 years, the tree height reaches 7 m and the canopy diameter 4 m; trees 20 years old are about 18 m, as tree growth slows down with age. It is good practice to water trees during the dry season, but the soil at the base of the plant should be raised, and drainage pathways need to be constructed to avoid waterlogging. It is recommended that fertilizer be applied twice yearly -- at the onset and the end of the rainy season.

**GERMPLASM MANAGEMENT**

Seed storage behaviour is recalcitrant. Viability is maintained for 2 years in moist storage at 15 deg. C, seeds kept in polythene bags filled with perlite at 6 deg. C. There are about 430 seeds/kg.

**PESTS AND DISEASES**

A large number of insects belonging to the Aphididae, Ateyrodidae, Cercophidae, Coccidae and Fulgoridae families feed on the sap. Insect pests affecting the tree include *Anomala* spp., *Batocera rubus*, *Dacus umbrosus*, *Daphania caesalis*, *Ferrisia virgata*, *Leucopholis irrorata*, *Melicodes* spp., *Melicodes tenebrosa*, *Nasutitermes luzonicus*, *Nipaecoccus filamentosus*, *Phytorus lineolatus*, *Planococcus lilacinus*, *Pulvinaria psidii* and *Thosea sinensis*.

Several fungi attack different parts of the tree. Organisms that cause disease include *Cercospora artocapi*, *Chanephora cucurbitarum*, *Fusarium* spp., *Nectria cinnabarina*, *Pellicularia salmonicolor*, *Phomopsis artocapina* and *Rhizophus nigricans*.

**FURTHER READING**

Abbas B, El-Tayeb AE, Sulleiman YR. 1992. Calotropis procera: feed potential for arid zones. Veterinary-Record. 131(6):132.

Acedo AL. 1992. Multipurpose Tree Species Network Series: Jackfruit biology, production, use, and Philippine research. Forestry/Fuelwood Research and Development Project.

Anon. 1986. The useful plants of India. Publications & Information Directorate, CSIR, New Delhi, India.

Clarke WC, Thaman RR. 1993. Agroforestry in the Pacific Islands: Systems for Sustainability. United Nations University Press.

Hong TD, Linington S, Ellis RH. 1996. Seed storage behaviour: a compendium. Handbooks for Genebanks: No. 4. IPGRI.

Katende AB et al. 1995. Useful trees and shrubs for Uganda. Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit (RSCU), Swedish International Development Authority (SIDA).

Lemmens RHMJ, Soerianegara I, Wong WC (eds.). 1995. Plant Resources of South-east Asia. No 5(2). Timber trees: minor commercial timbers. Backhuys Publishers, Leiden.

Luna RK. 1996. Plantation trees. International Book Distributors, Dehra Dun, India.

Mbuya LP et al. 1994. Useful trees and shrubs for Tanzania: Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit (RSCU), Swedish International Development Authority (SIDA).

Noad T, Birnie A. 1989. Trees of Kenya. General Printers, Nairobi.

Perry LM. 1980. Medicinal plants of East and South East Asia : attributed properties and uses. MIT Press. South East Asia.

Pushpakumara DKN, Harris SA. 2007. Identification of fruit types of Artocarpus heterophyllus Lam. jackfruit using RAPD markers: Journal of National Science Foundation. 35(3):175-179.

Pushpakumara DKN, Harris SA. 2007. Potential of RAPD markers for identification of fruit types of Artocarpus heterophyllus Lam. jackfruit: Journal of the National Science Foundation of Sri Lanka. 35(3):175-179.

Pushpakumara DKN, Harris SA. 2007. Occurrence of agamospermy in Artocarpus heterophyllus Lam. Jackfruit: Proceedings of the Peradeniya University Research Sessions PURSE, Sri Lanka, held on 30 November 2007. 12 (1):15-17.

Pushpakumara DKN, Silva GLLP, Harris SA, Jianlin H. 2005. DNA extraction, PCR optimization and southern hybridization laboratory protocols for woody perennial and farm animals: jackfruit Artocarpus heterophyllus Lam. and cattle Bos taurus, Bos indicus and sheep Ovis aries. Colombo, Sri Lanka: CARP-ICRAF Tree Domestication Project. 78p.

Rice RP, Rice LW, Tindall HD. 1987. Fruit and vegetable production in warm climates. Macmillan Press, London.

Roshetko JM and Evans DO. 1997. Domestication of Agroforestry trees in Southeast Asia. Yogyakarta, Indonesia.

Singh RV. 1982. Fodder trees of India. Oxford & IBH Co. New Delhi, India.

Taylor DH, Macdicken KG. 1990. Research on multipurpose tree species in Asia. Proceedings of an International Workshop held November 19-23, 1990 in Los Baños, Philippines. Winrock International Institute for Agricultural Development.

Verheij EWM, Coronel RE (eds.). 1991. Plant Resources of South East Asia No 2. Edible fruits and nuts. Backhuys Publishers, Leiden.

**SUGGESTED CITATION**

Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. 2009. Agroforestry Database: a tree reference and selection guide version 4.0 (<http://www.worldagroforestry.org/af/treedb/>)