



## *Pterocarpus indicus* (narra)

Fabaceae (legume family)

*bluwota* (Vanuatu); *liki* (Solomon Islands); narra, amboyna, rosewood, Burmese rosewood (trade names); narra, rosewood (English); New Guinea rosewood (Papua New Guinea); *pinati* (Samoa); *santal rouge amboine* (French)

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### IN BRIEF

**Distribution** Native to Southeast and East Asia and to the northern and southwest Pacific region; now distributed widely throughout the tropics.

**Size** Typically reaches 25–35 m (82–115 ft) in height with a broad canopy when grown in the open.

**Habitat** Grows at elevations of 1–1300 m (3.3–4300 ft) with annual rainfall of 1300–4000 mm (50–160 in).

**Vegetation** Thrives best in riverine, closed, and secondary forests.

**Soils** Adapted to a range of soils, growing best on deep, fertile, loamy, alluvial soils.

**Growth rate** In optimal conditions, height growth may be 2 m/yr (6.6 ft/yr) for the first 3–4 years, slowing to about 1 m/yr (3.3 ft/yr) thereafter.

**Main agroforestry uses** Soil stabilization, windbreaks, ornamental.

**Main products** Timber.

**Yields** Estimated at 5–10 m<sup>3</sup>/ha/yr (72–144 ft<sup>3</sup>/ac/yr) over a 30–40 year rotation, on optimal sites.

**Intercropping** Planted as boundary and windbreak around food crops or as a living fence around pastures.

**Invasive potential** Has limited potential to invade undisturbed native plant communities.



PHOTO: L. THOMSON

Large tree,  
Thurston Gardens,  
Fiji.

## INTRODUCTION

Narra (*Pterocarpus indicus*) is a briefly deciduous, majestic tree typically growing to 25–35 m (82–115 ft) in height. Grown under open conditions, the canopy diameter is similar to the tree height. It has a very wide natural distribution in Southeast and East Asia extending eastward to the northern and southwest Pacific region. It may be found in various plant communities but attains its best development in riverine, tropical, closed and secondary forests, including those near to the coast and fringing tidal waterways. Narra is widely planted for amenity and ornamental purposes throughout the humid tropics.

Narra is adapted to subtropical and tropical (mean annual temperature 22–32°C [72–90°F]), subhumid/humid lowlands. In tropical regions it can grow well at higher elevations. A few populations are able to cope with a prolonged dry season of six or more months. Narra is also well adapted to strong winds, and established trees usually stand up well in cyclones, suffering only branch breakage.

The species occurs on a very wide range of soils, attaining its best development in deep, fertile, loamy alluvial soils. It is normally found growing in well drained, sandy to clay loams of mildly acidic to mildly alkaline pH.

It is one of the most promising multipurpose tree species in the Pacific islands for reforestation, village-level woodlots, living fencing, and large amenity trees. It is traditionally one of the most important multipurpose trees for timber and medicine. It fixes nitrogen and reproduces readily, both by seed and from cuttings. On good sites and when open grown it is moderately fast growing, but closely spaced plantings on less fertile sites are likely to grow slowly and not be economically viable for timber production. It is considered very unlikely to become an invasive weedy species. It is in decline in most parts of its natural range due to excessive and often illegal exploitation for timber, and it has been considered for exclusion from international trade (CITES nomination).

It has limited potential for interplanting with crops due to its large size and heavy shade. However, due to its ease of establishment through branch cuttings, it could be managed in an alley farming configuration. It is generally regarded as a useful tree for bordering food gardens due to its inputs of nitrogen-rich leaf fall and its valuable wind-break function.

## DISTRIBUTION

### Native range

Narra has a wide distribution in Southeast and East Asia,

including southern Myanmar, Cambodia, southern China, Vietnam, Philippines, Brunei, Malaysia, and Indonesia. It extends east to the northern Pacific (Ryukyu Islands/Japan, Yap and Pohnpei [Federated States of Micronesia], and Palau) and southeast to New Guinea, New Britain, New Ireland and Manus, the Solomon Islands, and Vanuatu.

### Current distribution

The species has been introduced to other tropical regions and countries including the Caribbean and the tropical Americas (Cuba, southern Florida/USA, Granada, Guyana, Honduras, Jamaica, Panama, Puerto Rico, Trinidad), Africa (Congo, Sierra Leone, Tanzania), Asia (India, Sri Lanka, Taiwan), and some Pacific islands (Guam, Hawai'i, Fiji, and Samoa).

## BOTANICAL DESCRIPTION

### Preferred scientific name

*Pterocarpus indicus* Willd.

The genus name is derived from the Greek *pteron*, which means wing, and *karpos*, which means fruit, referring to the flat, winged pods characteristic of the genus.

### Family

Fabaceae (legume family)

### Subfamily

Faboideae

### Non-preferred scientific names

*Pterocarpus carolinensis* Kaneh.

*Pterocarpus draco* sensu auct.

*Pterocarpus indica* Willd.

### Common names

#### Pacific islands

*bluwota* (Vanuatu)

*liki* (Solomon Islands)

narra, amboyna, rosewood, Burmese rosewood (trade names)

narra, rosewood (English)

New Guinea rosewood (Papua New Guinea)

*pinati* (Samoa)

*santal rouge amboine* (French)

## Solomon Islands

Kwara'ae, To'obaita	<i>liki</i>
Ngini, Kwaio, Bugotu	<i>ligi</i>
Ayiwo	<i>nyia neli</i>
Vaiakau	<i>na</i>
Graciosa Bay	<i>noi'eni</i>
Roviana	<i>ringi</i>
Morovo	<i>rigi</i>
Kusage	<i>dandara</i>
Varisi	<i>nakumu</i>
Maringa	<i>grigi</i>
Santa Ana	<i>riki</i>

## Vanuatu

Bislama language	<i>bluwota</i>
Torres Island: Loh/Lungharagi	<i>neniera</i>
Banks Group: Vanua Lava/Mosina	<i>narara</i>
Banks Group: Gaua/Lambot	<i>nar</i>
Maewo: Naone	<i>nanara</i>
Santo: Petawata	<i>navilae</i>
Santo: Penour	<i>navulae</i>
Santo: Valpei	<i>vulae</i>
Santo: Narango	<i>philai</i>
Santo: Sarete	<i>philae</i>
Santo: Hog Harbour	<i>nula</i>
Malo: Naviaru	<i>vuvilae</i>
Malekula: Larevat	<i>nakambis</i>
Malekula: Potindir	<i>weiwuli</i>
Malekula: Bubar	<i>nusmar</i>
Epi: Moriu	<i>burmeia, purmeia</i>
Erromango: Ipota	<i>vohovati</i>
Tanna: Ikutingting	<i>nakautufe</i>
Tanna: Greenhill	<i>kautufa</i>
Aniwa: Kaokao	<i>kautora</i>
Aneityum: Port Patrick	<i>kautofa</i>
Aneityum: Anelghowat	<i>nakautefa</i>

## Size and form

A briefly deciduous, majestic, large tree typically growing to 25–35 (–48) m (82–115 [–160] ft) tall and about the same canopy width in open situations. Trees have a large, rather dense canopy. The semi-pendulous lower branches may extend to near ground level in open sites.

## Flowers

Flowering is often initiated before the new leaf flush but continues after leaf flushing. Flowering takes place in several short bursts of about 1–2 days duration. The pea-shaped flowers are bright yellow to orange-yellow, about 1.5 cm (0.6 in) long, fragrant, and arranged in branched axillary racemes. The flowers are borne in pro-

fusion, adding to the ornamental appeal of trees when in full flower. Seasonality of flowering varies geographically.

## Flowering seasons:

Country/Area	Flowering period
Papua New Guinea	May–October
Solomon Islands	
Western Province	(March–) June–July (–August)
Malaita Province	(May–) Oct.–Nov. (–Dec.)
Makira Province	(July–) Oct.–Dec. (–Jan.)
Choiseul/Santa Isobel	June–July
Santa Cruz Group	September–December
Vanuatu	
Torres and Banks Is.	(June–) October–December (–Mar.)
Santo, Malo, Maewo	(July–) August–October (–Nov.)
Malekula, Ambrym, and Epi	October–December (–April)
Tanna and Aneityum	December–January (–April)
Philippines	(January–) April–May (–July)

## Leaves

The bright green, imparipinnate leaves are arranged alternately on the branchlets. Trees are either briefly fully deciduous or may be evergreen in uniformly humid zones. The new flush of leaves is light green, turning dark mid-green. Each leaf has (5–) 7–9 (–11) alternately arranged, ovate leaflets; each leaflet is about 6–12 cm (2.4–4.8 in) long by 3–7 cm (1.2–2.8 in) wide, with an entire margin. The terminal leaflet is larger, with the smallest leaflets in the lowest pair on the rachis.

## Fruit

The pods are thin, papery winged, disc-shaped, about 5–6 cm (2–2.4 in) across, and borne in clusters. They are light green, turning dull brown when fully mature.



The short bursts of flowers are very showy. PHOTO: C. ELEVITCH



Pods are indehiscent: internally the pod is divided by cross-walls into four or five seed chambers, of which one or two (rarely three) may contain developed seeds.

The seeds mature about 3–4 (–5) months after flowering. The fruiting period varies geographically. In Papua New Guinea (PNG) the pods ripen from early December to March. Some pods fall while others remain on the tree up to the end of May. In the Solomon Islands seeds mature sometime during the period from July to January. The main fruiting period in northern Vanuatu is November to January, while in central and southern Vanuatu it is from January to March. In Fiji, seeds mature around March–April.

The time to bearing fruit depends on the planting material. Plants established from large branch cuttings taken from mature trees typically flower and fruit within 2–3 years. Trees established from seedlings may take many years (e.g., probably more than 5–7 years) before producing useful quantities of seed.

### Seeds

The seeds are flattened, bean-shaped, 6–8 mm (0.2–0.3 in) long with a leathery, although rather brittle, seed coat. Pod/seed dispersal is mainly by wind. Pods can float, and water dispersal is likely to also be significant for riverine populations.

### Rooting habit

Trees have a well developed near-surface lateral rooting structure. Young plants compete poorly with *Imperata* and other tall, vigorous grasses and need to be regularly weeded on grassy sites. For establishment on grassy sites, good pre-planting control of grasses is essential, and a once-only treatment with glyphosate herbicide is recommended for this purpose. Because roots can grow large near the surface, it is best to grow the tree well away from sidewalks and pavement.

### Similar species

Narra is a very distinctive tree in terms of its general appearance, leaves, flowers, and fruits, and there are no similar species, either naturally occurring or planted, in the Pacific islands (aside from recent small trials of *Pterocarpus macrocarpus* and *P. dalbergioides* on Kolombagara in the Solomon Islands).



Mature pods can often be found on trees. PHOTO: C. ELEVITCH

## GENETICS

### Variability of species

Morphological variation was well documented by Rojo (1972). There is considerable intraspecific variation in morphological characteristics, such as leaflet, flower, and fruit size, shape, and hairiness, as expected for a species with a wide geographic and ecological range. Larger-fruited forms are found in Melanesia (PNG, Solomon Islands, and Vanuatu). There is also considerable variation in wood properties. In different parts of Vanuatu, two folk varieties are often distinguished on the basis of wood characters (such as width of sapwood, color of heartwood).

### Known varieties

The only formally named variety is forma *echniatus* (Pers.) Rojo from Southeast Asia (including Philippines and Lesser Sunda Islands, Indonesia). This form is distinguished from the type form by its spiny or prickly fruits.

### Culturally important related species in the genus

*Pterocarpus macrocarpus* (in Southeast Asia, Indochina) and *P. dalbergioides* (Andaman Islands, India, and Burma) are highly valued local timber trees, with the former being very important for furniture and wooden articles for Buddhist temples in Thailand and Vietnam.



## ASSOCIATED PLANT SPECIES

Its best development is in riverine, tropical, closed, and secondary forests. In these situations it may occur in small patches of nearly monospecific stands. It also occurs in seasonally dry, semi-deciduous hill forests and fringing mangrove swamps.

### Associated native species commonly found

On Santo, Vanuatu, it occurs naturally with *Antiaris toxicaria*, *Barringtonia* spp., canarium nut (*Canarium indicum*), *Castanospermum australe*, *Dendrocnide* spp., *Dracontomelon vitiense*, whitewood (*Endospermum medullosum*), and *Pangium edule*. In PNG it commonly occurs with *Kingiodendron alternifolium*. In the Philippines it occurs with *Calophyllum blancoi*, *Intsia bijuga*, *Syzygium simile*, and *Vitex parviflora*.

### Species commonly associated as aboriginal introductions in Pacific islands

The tree appears to have been introduced to Pacific islands after European contact.

### Species commonly associated in modern times or as recent Pacific island introduction

Narra is a large amenity tree grown in association with other commonly planted trees such as *Adenanthera pavonina*, candlenut (*Aleurites moluccana*), breadfruit (*Artocarpus altilis*), ylang-ylang (*Cananga odorata*), *Citrus* spp., coconut (*Cocos nucifera*), *Delonix regia*, *Dracontomelon vitiense*, *Ficus* spp., Tahitian chestnut (*Inocarpus fagifer*), mango (*Mangifera indica*), tava (*Pometia pinnata*), *Spathodea campanulata*, *Spondias dulcis*, mahogany (*Swietenia macrophylla*), and Malay apple (*Syzygium malaccense*).



Left: Extensive shallow root system presumably exposed by erosion. PHOTO: C. ELEVITCH Right: Lower trunk of large tree. PHOTO: L. THOMSON

## ENVIRONMENTAL PREFERENCES AND TOLERANCES

Narra is adapted to the subtropical and tropical, subhumid/humid lowlands (up to 600 m [1970 ft]). In tropical regions it can grow well at higher elevations (up to about 1300 m [4300 ft]). Some populations, e.g., in East Nusa Tenggara, Indonesia are well adapted to prolonged dry seasons of six or more months.

### Climate

#### Elevation range

1–1300 m (3.3–4300 ft)

#### Mean annual rainfall

1300–4000 mm (50–160 in)

#### Rainfall pattern

It favors environments with summer, bimodal, and uniform rainfall patterns.

#### Dry season duration (consecutive months with <40 mm rainfall)

0–6 months

#### Mean annual temperature

22–32°C (72–90°F)

#### Mean maximum temperature of hottest month

29–34°C (84–93°F)

#### Mean minimum temperature of coldest month

18–24°C (64–75°F)

#### Minimum temperature tolerated

5–8°C (41–46°F)

### Soils

Narra is adapted to a very wide range of soils, attaining its best development on deep, fertile, loamy, alluvial soils. It is most commonly found growing in well drained, sandy to clay loams of slightly acid to slightly alkaline pH. However, particular populations may be adapted to different soil types, e.g., infertile, alkaline, stony soils on Sumba and East Nusa Tenggara (Indonesia). In the Philippines it is mainly found on alkaline soils.

### Soil texture

It can grow in light and medium-textured soils (sands, sandy loams, loams, and sandy clay loams).

### Soil drainage

It requires free drainage for best growth.

### Soil acidity

The tree tolerates acid to neutral soils (pH 4.0–7.4).

### Special soil tolerances

Narra tolerates shallow, sodic, and infertile soils.

### Tolerances

#### Drought

The ability to tolerate drought is expected to vary considerably between provenances, with the most drought-resistant sources originating from eastern Indonesia (Sumba, East Nusa Tenggara). Established trees from Melanesian sources are likely to tolerate a dry season of many months (e.g., 4–6 months), especially on deeper soils.

#### Full sun

The species grows best in full sun, and mature specimens will be present in the upper canopy or as canopy emergents.

#### Shade

It can tolerate up to 25% shade.

#### Fire

The tree is likely to have limited fire tolerance due to thin bark, except possibly for sources from regularly-fired grassy woodland communities in eastern Indonesia.

#### Frost

It is expected to be severely damaged or killed by low temperatures (i.e., less than 5–8°C [41–46°F]).

#### Waterlogging

It grows best on freely draining soil types, but its riverine distribution suggests it must be able to at least tolerate short periods (several weeks duration or more) of shallow inundation very well.

#### Salt spray

Narra is expected to be damaged (including some leaf scald and drop) by salt-laden winds, and it is not recommended for planting in the most exposed seaside locations. However, it often occurs near to the sea and presumably has a moderate level of tolerance of foliar salt spray.

#### Wind

Trees have overall good tolerance of both steady and storm winds; e.g., mature trees planted in Fiji suffered minor



damage during a particularly severe cyclone (Kina, January 1993).

## Abilities

### Fix nitrogen

Narra is a nitrogen-fixing tree that nodulates readily.

### Self-prune

The species generally has a poor self-pruning habit, at least in open areas.

### Coppice

The coppicing ability is not well known, but cut and fallen trees are reported to coppice well in Vanuatu and PNG.

### Pollard

The species regrows fairly well after moderately heavy pruning, but the longer-term responses to occasional or regular pollarding are unknown.



**Narra nodulates readily with nitrogen-fixing bacteria.** PHOTO: J. B. FRIDAY

## GROWTH AND DEVELOPMENT

Plants have an intermediate but highly variable growth rate: initially growth is directed toward shoot elongation, especially in more shaded situations, and then later into stem diameter growth. Rapid diameter growth is dependent on plants having sufficient space and light for development of an extensive crown. Plants established from large branch cuttings have the fastest growth, e.g., averaging 2.5 cm (1 in) diameter at breast height (dbh) growth per annum (up to a 4 cm [1.6 in] dbh annual increment). In Cebu (Philippines) the mean annual diameter increment increased with age, such that for the first 11–12 years the diameter incre-

ment averaged less than 0.5 cm (0.2 in) per year, but by 26 years it was averaging 1.1 cm/yr (0.4 in/yr). Initiation of heartwood may not begin to occur until many years after planting; e.g., about 18–19 years in the Philippines.

## Growth rate

Height growth is highly dependent on site. On deep, well watered, fertile, lightly shaded sites, height growth may reach 2 m/yr (6.6 ft/yr) in the first 3–4 years, before slowing to about 1 m/yr (3.3 ft/yr). In open areas plants have a plagiotrophic growth habit with poor apical dominance. The shoot leader grows 1.5–3 m (5–10 ft) before bending over, growing almost laterally before another more upright leader emerges and takes over. Through this process the bole self-straightens to a large extent. In the open, however, plants may develop a multi-stemmed, branchy habit, and height growth may only be 0.5–0.75 m (1.6–2.5 ft) per year. The only growth data for the f. *ebniatus* indicated an average height growth increment of 0.6–1.2 m (2–4 ft) per year.

## Reaction to competition

Weed control is important for at least the first 2–4 years to reduce competition until the trees grow large enough to cast enough shade to suppress undergrowth.

## PROPAGATION

Narra can be propagated from seeds, cuttings, grafting, and tissue culture. Seedlings and large branch cuttings are the most common methods of propagation.

### Seedlings

#### Seed collection

The time for collection of ripe fruits varies by region. Pod maturity is indicated by a color change from light green to brown. Some pods fall or disperse soon after maturing, but most remain on the tree for several months. It is preferable to collect mature fruits by climbing into the canopy and lopping fruit-laden branches or else shaking and/or beating with long poles to dislodge fruits onto tarpaulins on the ground.

#### Seed processing

Fruits may be de-winged in order to reduce bulk and improve storability. Dewinging is done using a hammer mill or brushing machine fitted with hard brushes. There are about 1500–3000 ( $Av=2300$ ) air-dried pods per kg (3300–6600 [ $Av=5000$ ] pods/lb). Typically about 50% of fruits contain one healthy seed, but the percentage of viable

seed may be as low as 10–20%. With about 50% of fruits containing one healthy seed, there are 1200–1300 seeds/kg (2640–2860 seeds/lb) of air-dried pods. There are about 13,000 extracted seeds/kg (28,600 seeds/lb).

### Seed storage

Storage behavior is orthodox, with seed being able to be safely dried down to 4% moisture content. The initial moisture content of seeds was found to be around 16–17% on a fresh weight basis. The most suitable method for longer-term storage, i.e., several years, is to store de-winged fruits at low temperature and moisture content.

### Seed pretreatment

Seeds are typically sown still encased in their indehiscent pod into either open nursery beds, seed trays, or directly into individual containers (especially if extracted seed is used). The germination rate is improved if seeds are extracted from the pod before sowing; however, no pretreatment is required for germination. Seed extraction is not recommended for routine sowing, as it is a slow, manual process, often resulting in some damage to extracted seeds (and reducing their viability and/or storage life).

### Growing area

It is preferable to germinate seeds in a sheltered area, such as a shade house. Seedlings should also be kept in sheltered areas with light shade (25–50%) for 2–4 weeks after transplanting. They may then be moved into an open nursery situation and should be grown and hardened in full sunlight for at least 6–8 weeks prior to field planting. Seedlings derived from direct-sown fruits may be grown in the open if nursery infrastructure is unavailable.

### Germination

The fruits are pushed, on the flattened side, into soil to a depth of about 10 mm (0.4 in), and then covered with a thin layer of soil. If extracted seeds are used, they should be laid flat and shallowly covered with 2–3 mm (0.08–0.12 in) of media/soil. Light shade should be provided, and the seedbed mulched. Seeds begin to germinate 3–4 days after sowing. The germination rate is about 24–40% at 4–15 days after sowing. Transplant germinants into individual pots at the cotyledon or four-leaf stage.

### Media

A freely-draining, standard nursery potting medium is recommended.

### Approximate size at outplanting

Seedlings take about 4 months to reach a suitable size for field planting; i.e., about 25 cm (10 in) tall.

### Guidelines for outplanting

Seedlings need to be planted into well weeded and maintained areas, preferably with light to moderate shade to encourage apical dominance and better stem form.

### Direct-seeding

Direct-seeding is often the best method for outplanting. It eliminates any transplant trauma. It also allows planting multiple seeds, so that the best-formed, most vigorous seedling can be selected at each planting site. The drawbacks of direct-seeding include risk of predator damage (e.g., rats, pigs, cattle), lack of rains to sustain the newly germinated seeds, and the mandatory frequent maintenance that must be done to ensure weeds do not smother the small seedlings.

In direct-seeding, an area is prepared for each planting spot, cleared of weeds, and cultivated to a depth of 50 cm (20 in) if the soil is compacted. It is recommended that 5–10 pods be sown in the final planting location, in order to ensure at least one healthy, vigorous germinant per position. Ideally, direct-sown fruits should be sown early in the wet season and fairly soon after the first good rains have been received. Fruits are planted at a depth of 2 cm (0.8 in).

### Other propagation methods

Stem cuttings can be taken from trees of any age and size, but cuttings of diameter 6 cm (2.2 in) or larger will root better than cuttings of smaller diameter. In the Philippines, 30-cm-long (10 in) cuttings taken from trees approximately 20 years old were planted in plastic bags and placed under shade. They developed shoots and roots and became established. Trees established from large branch cuttings have a greater tendency to be affected by heart rot, and this propagation method should be avoided if timber production is a major objective of planting.

Grafting is also possible. Buds on scions were observed to develop 5 days after grafting, at which time callus formation at the point of stock-scion union was also obvious.

The species can be successfully propagated through tissue culture, but there is minimum need for this method given ease of propagation by seed and conventional vegetative cuttings.

## DISADVANTAGES

The species' main drawbacks are

- poor adaptability to less fertile and drier sites, including slow growth
- late onset of heartwood formation



- lack of knowledge concerning best seed sources
- its large, spreading, and dense canopy and poor stem form in open situations limit its potential for inclusion in most agroforestry systems.

### Potential for invasiveness

The species has low potential to invade undisturbed native plant communities and has not been reported to become widely naturalized when planted outside of its native habitats. The exceptionally high value and demand for its timber further mitigate against its spread, as larger trees capable of producing sizable fruit crops would likely be cut and utilized for timber.

### Pests and diseases

The species is variously affected by pests and diseases in its native habitats. The most serious insect pests include an unidentified leaf miner in Solomon Islands and Vanuatu (possibly *Hyloconis*, which is recorded from Malaysia) and a caterpillar (*Melipotis diversipennis*) in Sumatra, Indonesia. Plants may also be damaged by sap-sucking psyllids. Seeds may be infected by the fungus *Phomopsis*. Fungal damage has been reported on seedlings, including anthracnose (*Glomerella cingulata/Colletotrichum gloeosporioides*) and leaf spots (*Cyllindrocladium quinoseptatum*, *Phyllocora pterocarpii*, *Pestalotia* sp., *Guignardia* sp., *Phyllosticta* sp., and *Aldora stella-nigra*). A soft scale (*Coccus longulus*) has been noted in Fiji. An insect pest (*Agrilus* sp.) has been recorded in the Solomon Islands.

Root fungal diseases can be reduced in the nursery through use of sterilized and freely draining media, avoiding dense sowing of seeds, and early sanitary disposal of diseased seedlings.

Larger trees may be affected by potentially serious root and stem rots including *Fomes lamaoensis*, *Ganoderma lucidum*, and *Phellinus noxius*. An unknown disease caused extensive dieback and death in street trees in Malaysia in the late 1800s to the early 1900s.

### Host to crop pests/pathogens

No data available.

## AGROFORESTRY/ENVIRONMENTAL PRACTICES

### Mulch/organic matter

It has excellent potential to provide surface mulch and build soil organic matter due to its nitrogen-fixing capacity and its annual leaf fall (deciduous) habit.

### Soil stabilization

The tree has excellent potential for soil stabilization, especially along drainage lines and flood plains, due to its adaptation to such sites, large buttresses, and extensive, spreading, near-surface root system.

### Crop shade/overstory

The large canopy and heavy shade make the species unsuitable as a crop shade for all but the most shade-tolerant species. It has been used as shade tree for coffee.

### Alley cropping

Narra might have potential for alley cropping given its nitrogen-fixing potential and ease of propagation by branch cuttings. However, there are generally other better-proven leguminous tree species available for this role, such as *Calliandra calothyrsus*, *Gliricidia sepium*, and *Leucaena* spp.

### Homegardens

It is unsuitable for homegardens due to its large size and spread.

### Improved fallows

The tree has some potential for planting as improved fallow, including for short rotations by using branch cuttings to quickly establish plantation. In a short-rotation improved fallow, branch cuttings enable a rapid and cheap establishment and a shorter weeding period.

### Living fences

It is widely used as a living fence due to ease of establishment by large branch cuttings.

### Boundary markers

Has some potential as a boundary marker due to its longevity and cyclone resistance and is sometimes planted for this purpose, e.g., in the Reef Islands (Solomon Islands), where it is believed to benefit gardens through fall of N-rich leaf litter and cycling of mineral nutrients from deep soil layers. Neighboring farmers may not always appreciate narra being used as a boundary marker due to its canopy spread and possible excessive shading of crops and/or pastures.

### Windbreaks

The species is wind-firm, often with branches drooping to near ground level, and is well suited for windbreak planting where space permits.

### Silvopasture

A few trees might be included in each paddock in silvopastoral systems to provide shade for livestock.



**Left: The broad canopy is too dense for most understory crops. Right: The drooping branches are advantageous for shade in many public situations.** PHOTOS: C. ELEVITCH

**Animal fodder**

No data available.

**Woodlot**

Has potential for woodlot planting, especially due to the high value of its timber, although it is not suitable for short-term rotations.

**Native animal/bird food**

No data available.

**Wildlife habitat**

Considered to be an important wildlife habitat tree in the Philippines.

**Bee forage**

The scented flowers are regularly visited by a large number of bee species, including honeybees, and the tree is considered to be important source of nectar and/or pollen.

**Fish/marine food chain**

It grows in the lower reaches of major rivers, including tidal creeks, and is likely to be important for stabilizing soils

and maintaining water quality in these sensitive habitats that are vital to the marine food chain.

**Coastal protection**

It often grows near to the sea and is useful for coastal protection, but is not recommended for planting in the most exposed sites.

**Ornamental**

Narra is an outstanding ornamental tree for large public parks and avenue plantings.

**USES AND PRODUCTS**

Narra produces a beautifully figured and richly colored timber with excellent working and technical properties. It has been traditionally used throughout South and South-east Asia and western Pacific islands for a wide range of products, including light construction purposes, furniture, and tools. In some parts of its range, such as Vietnam, the species has been extinct for several centuries as a result of over-exploitation. Some trees produce strongly figured wood known as Ambonese gnarl wood, or amboyna, that



is highly sought after for craftwood and face veneers for high-value end uses. Narra wood is durable in salt water, particularly the wood obtained from trees growing near the sea, and is a preferred species for canoes and boats and their accessories. Narra is one of the Asia-Pacific region's finest timbers, and it is highly favored for use in interior joinery, paneling, decorative flooring, musical instruments, precision tools, and handicrafts.

Throughout its native range it is an important trees for use in preparation of traditional herbal medicines. Different parts of the tree, notably bark extracts, are used in the treatment of a wide range of ailments and illnesses, particularly those pertaining to the digestive system and skin. In recent times it has been claimed in the Philippines (Research Centre for Tropical Medicine) to have amazing healing properties for diverse and major illnesses, but further trials are needed to verify such claims.

The species is widely planted for amenity purposes due to its

- ornamental appeal (large spreading habit, excellent shade tree, and masses of fragrant yellow flowers)
- stability and wind-firmness
- ease of establishment and quick landscape impact through use of large branch cuttings
- longevity.

It is widely planted as a street tree in the Philippines, Malaysia, and Singapore and is used for living fences in the Solomon Islands and Vanuatu.

### Leaf vegetable

The young leaves and flowers are eaten, but only rarely.



### Medicinal

Narra has a vast number of traditional medicinal uses reported, especially from bark extracts. In several regions the shredded bark is boiled and the fluid taken orally for treatment of dysentery and diarrhea. In PNG it is used to treat tuberculosis, headaches, and sores, and as a purgative. In the Solomon Islands it is used to treat dysentery, heavy menstruation, and gonorrhoea. In Vanuatu it is used to treat cuts and wounds, and stomachache and diarrhea in infants. In Malaysia juice extracted from the roots has been used to treat syphilitic sores and mouth ulcers. In Indonesia the young leaves have been used in the treatment of boils, ulcers, and prickly heat rashes.

In recent years, herbal teas and pills made from narra extracts have been popularized in the Philippines for treating a wide range of diseases and ailments including leprosy, menstrual pain, flu, rheumatoid arthritis, and diabetes.

### Beautiful/fragrant flowers

The bright yellow flowers are both ornamental and sweetly fragrant.

### Timber

Narra produces one of the world's most highly prized cabinet timbers—decorative with excellent working and technical properties. The wood is moderately hard and heavy (550–900 kg/m<sup>3</sup> [34–56 lb/ft<sup>3</sup>] at 15% moisture content), and easily cut and worked by saws, planes, and other tools. The heartwood is streaked, light yellowish-brown to reddish-brown, and readily distinguished from the pale, yellowish sapwood.

The wood is highly durable in low-decay situations, such as interior uses. The sapwood is susceptible to lyctid (powder-



**Left: Bees and other pollinators frequent narra when it is in blossom. Right: When pruned, the tree can even be used in tight landscaping areas.** PHOTOS: C. ELEVITCH



post beetles), while the heartwood is only infrequently attacked by termites. Durability in ground contact is reportedly extremely variable, lasting from 2–3 up to 20–25 years. It is an important commercial timber species wherever it occurs, and it has been overexploited and has become rare or extinct in parts of Southeast Asia.

### Fuelwood

The wood is an excellent, hot fuel but is only rarely used for this purpose.

### Craft wood/tools

The wood is valued for making craft items, being highly decorative and easily turned and worked by hand tools. Some trees, especially from the island of Seram (Indonesia), produce strongly figured wood known as Ambonese gnarl wood, or amboyna, that is highly sought after for craftwood. In the Solomon Islands and Vanuatu the large plank buttresses are cut into doors and seats, while burls are favored for making ornate bowls and for slicing into decorative face veneers for high-value end uses.

### Canoe/boat/raft making

In Melanesia it is important for canoes, paddles, and outrigger beds. It is considered a very good boat-building timber due to its durability in seawater, including good resistance to marine borers.

### Tannin/dye

The heartwood contains various red compounds, and in the Philippines the heartwood is used to make a red dye. The bark extract can be used for tanning.

In contact with water the wood/bark imparts a blue fluorescence, which gives rise to the common name in Vanuatu Bislama, bluwota.

### Cosmetic/soap/perfume

An infusion from the leaves is sometimes used as shampoo in the Philippines.

## COMMERCIAL CULTIVATION

The principal commercial product is timber, both for local uses and for export. The timber is used for high-class furniture and cabinets, decorative sliced veneer, interior wall paneling, feature flooring (including strip and parquet), musical instruments, gun stocks and rifle butts, turned articles, knife handles, boat building, and specialized joinery. It is also used for light building construction purposes including posts.

In Papua New Guinea, narra is an important commer-



**Top: Trunk with burl. Bottom: High-end products made from narra burl.** PHOTOS: J. NAUPA

cial timber that fetches high prices. The export of logs is banned, and only processed wood is exported.

In the Philippines, export of narra wood was 3 million kg (6.6 million lb) in 1985, declining to 2.3 million kg (5 million lb) in 1986 (57% processed) and 430,000 kg (950,000 lb) in 1987 (all processed). From that time, export has been

negligible, and at present there is a total cutting ban on the species.

Due to supply shortages there is relatively limited international trade in narra at present. The price (in 2004) for sawn boards from Papua New Guinea, the Solomon Islands and Vanuatu was US\$600–800/m<sup>3</sup> (US\$17–23/ft<sup>3</sup>) FOB.

### Spacing

The recommended initial plantation density is about 400 trees/ha (162 trees/ac), or a spacing of 8 x 3 m (26 x 10 ft). One or more selective thinnings reduces the density down to a final crop density of 100–150 trees per ha (40–60 trees/ac). Closer initial spacings, e.g., 2.5–3 x 2.5–3 m (8–10 x 8–10 ft), may be employed in order to gain more rapid site control and provide greater choice for selecting well formed trees for retention as final crop trees.

The area required for commercial production of narra timber depends on factors such as distance to processing facilities, markets, and the number of other growers. For a smallholder an area of as little as 1 ha (2.5 ac), or 100 trees, may provide worthwhile financial returns. The plantation area of commercial timber species required to supply a viable larger sawmill is considered to be around 10,000–12,000 ha (25,000–30,000 ac).

### Management objectives and design considerations

The key management objective is to obtain an adequate or high stocking of well formed trees. Management approaches include

- use of seed sources with good stem form (but these are yet to be established)
- manipulating remnant and planted vegetation on site to provide appropriate light regimes (including intermediate levels of shade)
- close initial spacing to enable thinning of poorer phenotypes
- regular weeding and vine cutting.

### Advantages of polycultures

Narra may naturally occur in near-monospecific stands and is expected to be amenable to growing in a monoculture. Its nitrogen-fixing ability would enable it to be advantageously grown with other moderately fast-growing tree species that have a high nitrogen requirement.

### Yields

There is very limited yield data. On the most fertile Pacific islands sites with optimum silviculture the yield is likely to

Narra is the national tree of Philippines and more than 100,000 ha (247,000 ac) of narra plantations were established there from 1960 to 1990.

be 5–10 m<sup>3</sup>/ha/yr (72–144 ft<sup>3</sup>/ac/yr) on a 30–40 year rotation. On poorer sites and with longer rotations the yield is likely to be less than 3–4 m<sup>3</sup>/ha/yr (43–57 ft<sup>3</sup>/ac/yr). In the Philippines a growth rate of 12 m<sup>3</sup>/ha/yr (172 ft<sup>3</sup>/ac/yr) over a 50-year rotation has been used for plantation planning purposes, which appears optimistic.

### Markets

Narra timber is well known in the international timber trade, and there are established markets in Asia, Europe, the USA, and Australia/NZ. These markets would accept large volumes of sawn timber at high prices (e.g., >US\$600/m<sup>3</sup> [US\$17/ft<sup>3</sup>]) if it were available. Narra is a preferred and highly sought-after timber wherever it occurs, and local markets are also very good.

## INTERPLANTING/FARM APPLICATIONS

### Example system 1

#### Location

Reef Islands, Solomon Islands.

#### Description

The traditional method in which narra is planted as a boundary marker on the edge of food gardens.

#### Crop/tree interactions

Narra trees provide windbreak and shelter for crops.

#### Yields

Unknown yield, although more open-grown trees have much faster diameter increment than in close-spaced plantations. Leaf fall from overhanging branches improves the soil fertility and organic matter.

#### Spacing/density of species

The tree density is estimated at 10–12 trees/ha (4–5 trees/ac).

### Example system 2

#### Location

Santo, Vanuatu.

## Description

This system is newly developed over the past 20–30 years. Narra is planted as live fences around pasture paddocks.

## Yields

Trees grow moderately fast but have poor bole form and limited value for timber due to high incidence of heart rot and degrade (due to being open-grown plants established by means of large branch cuttings). The main benefits are low-cost, long-lasting fencing and possibly some benefits to pasture in terms of nitrogen inputs through leaf-fall.

## Crop/tree interactions

The trees provide useful shade for livestock in situations where the existing forest has been fully removed.

## Spacing/density of species

The spacing varies considerably, e.g., 5–10 m (16–32 ft) between larger specimens, and fence lines are often interplanted with other living-fence species such as *Hibiscus tiliaceus*.

## PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

Extension offices for agroforestry and forestry in the Pacific: <<http://www.traditionaltree.org/extension.html>>.

## INTERNET

Agroforestry database, World Agroforestry Centre (ICRAF): <http://www.worldagroforestrycentre.org/Sites/TreeDBS/AFT/AFT.htm>

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Species Profiles for Pacific Island Agroforestry ([www.traditionaltree.org](http://www.traditionaltree.org))

## *Pterocarpus indicus* (narra)

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