Species Profiles for Pacific Island Agroforestry
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Terminalia richii (malili)

Combretaceae (combretum family)

malili **(Samoa)**

Lex A. J. Thomson

IN BRIEF

Distribution Samoa, American Samoa, and Niue.

Size Large tree 25–35 m (80–115 ft) tall at maturity.

Habitat Lowlands and lower montane rainforest, in maritime, humid tropical, seasonally wet climates; annual rainfall of 2050–3250 mm (80–130 in) and elevations up to 830 m (2700 ft).

Vegetation Associated with remnants of tall native canopy forest and secondary forest.

Soils Fertile, neutral, well drained, heavy textured, and of basaltic origin.

Growth rate Moderate to moderately fast height growth: 2–2.5 m/yr (6.6–9 ft/yr) in early years; 1.3–1.5 m/yr (4.3–5 ft/yr) after 14–22 years; diameter increment: 1.8–2.1 cm/yr (0.7–0.8 in/yr) after 14–22 years.

Main agroforestry uses Soil stabilization, windbreak, improved fallow.

Main products Timber, fuelwood.

Yields 10–13 m^3/ha/yr (143–186 ft^3/ac/yr) (estimate).

Intercropping Root crops during establishment.

Invasive potential Little potential for invasiveness.

PHOTO: L. THOMSON

Remnant tree, south ʻUpolu, Samoa.

INTRODUCTION

Malili (*Terminalia richii*) is typically a straight, long-boled forest tree to 25–35 m (80–115 ft) tall native to the Samoan archipelago (Samoa and American Samoa) and Niue in the central South Pacific. It is found in lowland and lower montane rainforest, sometimes emergent above the forest canopy. The climate in its native habitats is maritime, humid tropical, with a distinctive wet season (November–April) and a dry season (May–October). It occurs up to an elevation of 830 m (2700 ft). The soils are mainly of basaltic origin (or, rarely, derived from limestone) and typically fertile, neutral, well drained, and heavy textured.

The wood has excellent working and machining properties and is suitable for a wide range of interior uses as well as general construction. In Samoa, malili is a very well regarded timber species and it has been extensively logged in most parts of its natural range. The species is now uncommon throughout its range, and steps need to be taken to ensure that remaining genetic resources are conserved.

The species has potential for timber plantation development in the lowland humid tropics, as a moderately fast-growing, general-utility timber species with a demonstrated resistance to tropical cyclones and short periods of drought. It also has good potential in various agroforestry systems, including wide-spaced alleys (e.g., interplanted with *Flueggea flexuosa*), boundary plantings, woodlots, and long-rotation, improved fallows.

While malili trees stand up well to cyclones, it takes at least 3 years to set a heavy fruit crop after two major cyclones in successive years. Until recently its wider planting was hampered by the difficulty in obtaining seed, in part because of the lengthy period for trees to bear fruit following major cyclones. Its biological characteristics ensure that it will not become an environmental weed. More research is required to ascertain the extent of genetic variation and to optimize propagation techniques, both from seed and cuttings.

DISTRIBUTION

Native range

The tree is indigenous to the Samoan archipelago, and it was formerly found on Niue (where it is now extinct in the wild). In Samoa, malili occurs mainly as individual trees in scattered locations over a wide elevation range from lowland to montane forests.

Current distribution

Malili was never abundant in Samoa, and it has become less frequent as a result of agricultural activities, especially on ʻUpolu. The formerly good stands of malili in central ʻUpolu (about 730 m [2400 ft] elevation) and southwestern ʻUpolu (50 m [164 ft]) have been largely cleared, and most remaining stands are highly disturbed. It was introduced at Colo-I-Suva, Fiji for trials and recently re-introduced to Niue.

BOTANICAL DESCRIPTION

Preferred scientific name

Terminalia richii A. Gray

Family

Combretaceae (combretum family)

Common names

malili (Samoa)

Size

Malili develops into a large tree up to 25–35 m (80–115 ft) tall and 15–20 m (50–66 ft) in crown diameter, sometimes emergent above the forest canopy.

Typical form

The canopy is tiered with branches in horizontal false whorls becoming irregular with age. The bole is usually long and straight, with small steep buttresses in old trees.

Flowers

The flowers are arranged in axillary spikes at the ends of branchlets. Individual flowers are small, yellowish-white, the calyx five-lobed and star-shaped, with 10 long anthers. In open situations malili trees first flower at around 6–8 years of age. Flowering occurs after the flush of new leaf growth from September to January. In Samoa, flowers and fruits develop about 1–2 months later on Savaiʻi compared with ʻUpolu, with the main flowering period on Savaiʻi taking place from November to January.

Leaves

The adult leaves are simple/entire, lanceolate, (5–) 6–13 cm ([2–] 2.4–5.1 in) long by (2–) 2.5-5 cm ([0.8–] 1–2 in) wide, discolorous, dark shiny green above and light green below. Young leaves are larger, up to 27 cm x 7.5 cm (11 x 3 in). The new shoots and young leaves are covered in silvery to light-rusty, short, silky hairs. The tree is briefly deciduous and may be completely leafless from late June to early July.

Fruit description and time to bearing

The time from flowering to fruit maturity is about 4–5 months. In Samoa the fruiting season is from December to March (usually December–early February on 'Upolu and February–March on Savai'i). The fruits are ovoid, flattened on one side, with a thin flesh covering a single stone, ca. 3 x 2 cm (1.2 x 0.8 in), green, ripening to reddish-purple.

Seeds

Surveys of traditional knowledge indicated that several species of pigeons, doves, and bats were both pollinators and seed dispersers for the species.

Bark description

The bark is grey, shallowly and longitudinally furrowed to tessellated and persistent. With age, the bark of specimens in forest situations becomes covered in an attractive patchwork of different colored lichens and mosses (including dark green, light bluish grey, pink, and whitish).

Rooting habit

Trees appear to have a spreading, near-surface lateral root system, presumably complemented by deep sinker roots.

Similar or look-a-like species

The genus *Terminalia* comprises about 150–250 tropical tree species. *T. complanata* from Papua New Guinea and the Solomon Islands is most closely related to malili (Smith 1971) and is also considered a useful timber species. The *T. complanata* group includes two other PNG species, *T. sogerensis* and *T. longespicata* (Coode 1969).

How to distinguish from similar species/look-a-likes

T. complanata differs from *T. richii* in its thicker leaf blades

Top left: Leaves (note: slightly broader-leaved form than typical). PHOTO: L. THOMSON **Top right: Flowers and immature fruit.** PHOTO: J. LARMOUR **Bottom right: Bark.** PHOTO: L. THOMSON **Bottom left: Ripe fruit on tree.** PHOTO: J. LARMOUR

which are conspicuously glandular/pustulate above, less persistent hairs on foliage and inflorescences, shorter petioles (7–15 mm compared with 10–30 mm [0.27–0.59 in compared with 0.4–1.2 in]) and shorter inflorescences (7-14 cm compared with 10-20 cm long [0.27–0.55 compared with 0.4–0.8 in]). *T. richii* is easily distinguished from the other three native *Terminalia* species in Samoa (i.e., *T. catappa*, *T. glabrata*, and *T. littoralis*), by its smaller, narrower, lanceolate leaves.

GENETICS

Variability of species

There is no published information and little is known about variation in malili. One survey indicated variation in leaf size among trees, but the extent to which this character is under genetic control is unknown (François Martel and Associates 1998). Some trees have broader leaves.

Known varieties

There are no recognized varieties.

ASSOCIATED PLANT SPECIES

The main native habitats include lowland and lower montane rainforest. Due to the effects of logging, agricultural clearing, and cyclones, it is increasingly found in more open secondary forest associations. The principal associated tree species are in the genera *Calophyllum, Canarium*, *Dysoxylum*, *Planchonella*, *Pometia*, and *Syzygium*.

Associated species commonly found in native habitats

Associated species in Samoa include *Adenanthera pavonina*, *Calophyllum neo-ebudicum*, *Cananga odorata*, *Canarium vitiense*, *Dysoxylum* spp. (including *Dysoxylum samoense*), *Garuga floribunda*, *Hibiscus tiliaceus*, *Inocarpus fagifer*, *Intsia bijuga*, *Manilkara samoense*, *Myristica fatua*, *Neonauclea forsteri*, *Pouteria samoensis*, *Pometia pinnata*, and *Syzygium* spp. (including *S. inophylloides*).

Species commonly associated in modern times or as recent introduction

In more recent community forestry plantings in Samoa it is most commonly being planted with *Swietenia macrophylla* and/or *Flueggea flexuosa*.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

The climate in its native habitats is maritime, humid tropical with a distinctive wet season (November–April) and a dry season (May–October).

Elevation range

5–830 m (16–2700 ft).

Mean annual rainfall

2050–3250 mm (80–130 in).

Rainfall pattern

The tree prefers climates with summer rainfall.

Dry season duration (consecutive months with <40 mm [1.6 in] rainfall)

None.

Mean annual temperature

24–27°C (75–81°F).

Mean maximum temperature of hottest month

26–31°C (79–88°F).

Mean minimum temperature of coldest month

21–24°C (70–75°F).

Minimum temperature tolerated

In its natural habitats the lowest temperatures are only 14–17°C (57–63°F), but *T. richii* is likely to be able to tolerate temperatures down to about 7°C (45°F).

Soils

Malili prefers fertile, well drained, neutral clay loams but is adapted to most soil types of volcanic origin. It also occurs on slightly alkaline skeletal soils overlying coralline limestone.

Soil texture

It prefers medium to heavy soils (loams, sandy clay loams, clays, clay loams, and sandy clays).

Soil drainage

Best growth is on freely draining soils, but it can grow on wet/periodically waterlogged sites.

Soil acidity

The tree grows in neutral soils (pH 6.1–7.4).

Special soil tolerances

It grows in apparently skeletal, rocky soils, but these are of basaltic origin and may overly deeper soils that are accessible to the root system.

Tolerances

Drought

Unknown.

Full sun

It grows fastest in full sun.

Shade

The tree tolerates 0–25% shade. Seedlings tolerate moderate shade levels but require high light levels to grow rapidly, and sapling and mature trees prefer full or nearly full sunlight.

Fire

Unknown.

Frost

It is likely to be damaged by low temperatures, i.e., less than 7°C (45°F).

Waterlogging

Some populations may have moderate waterlogging tolerance, as it is found on moist sites with poor drainage on ʻUpolu.

Salt spray

It is reported to be sensitive to salt spray.

Wind

Malili is highly tolerant of both steady winds and cyclone damage. It was found to be the most cyclone resistant plantation species in Samoa following the major cyclones Val and Ofa in the early 1990s. Its high cyclone resistance was again proven during cyclone Heta in early 2004: on Savaiʻi, malili plantings of various ages suffered only minor damage besides that from falling trees of residual overstory of other tree species. Malili plants suffered very few broken tops, but in rocky, rather open sites at Falelima a small percentage (<10–20%) of saplings were blown over.

Abilities

Regenerate rapidly

Field observations suggest that malili regenerates fairly well under natural conditions, with numerous seedlings being recorded near mature trees.

Self-prune

Good self-pruning habit in forest-grown trees, but open-grown trees may retain some lower branches.

Coppice

Seedlings and younger specimens coppice strongly. Coppice ability is unknown in mature trees.

GROWTH AND DEVELOPMENT

Growth rate

Malili is fast growing in its early years, e.g., 2–2.5 m/yr (6.6–8 ft/yr) in annual height increment, thereafter growing at a steady and moderately fast rate. Plots of 14- and 22-year-old trees had mean annual increments of 2.1 and 1.8 cm (0.8 and 0.7 in) dbh and 1.5 and 1.3 m (4.9 and 4.3 ft) height, respectively (Neuteboom 1977, Pouli et al. 1995).

Flowering and fruiting

Open-grown malili trees are expected to yield light to moderate seed crops commencing at about 8–10 years of age.

Reaction to competition

No data available.

PROPAGATION

The species is readily propagated from seed. Mass vegetative propagation by rooted cuttings is also feasible. Clones can be developed either from seedlings or from basal coppice resulting from felling or girdling selection-aged trees. Seed production may be non-existent or greatly reduced in the 2–3 years following major successive cyclones, so ongoing planting programs for this species need to be based on a combination of seedlings and rooted cuttings.

Propagation by seed

Seed collection

In Samoa, the timing of fruit maturation varies between locations. Fruits ripen first in low-altitude locations on northern ʻUpolu and much later at higher altitudes on Savaiʻi. Mature fruits, indicated by their turning reddish-purple, should preferably be collected directly from the tree, as fallen fruits are prone to be heavily attacked by insects. Fruits may be removed from the trees by either the use of a catapult to secure a line over seed-bearing branches and pulling the branch down or by climbing the tree (using appropriate safety equipment). The catapult is most effective

in trees occurring in open situations and may be used to remove fruit-bearing branches up to a maximum of about 30 m height.

Seed processing

The fleshy outer covering should be removed from the seed/nut shortly after collection. There are about 2600 seeds per kg (5700 seeds/lb). The germination rate for fresh seed is typically 35–40%.

Seed storage

Unknown. The seed storage behavior is likely to be orthodox, but seeds appear to lose viability fairly rapidly in storage.

Pre-planting treatments

Germination has not been improved to any extent by pretreatments such as nicking seeds or soaking them in water overnight.

Growing area

Seeds are germinated in a freely draining potting mix in germination trays in a protected area under cover, such as a shade house. Seedlings are progressively moved to higher light levels, e.g., 33% shade after transplanting, then 25% shade for 1–2 months, and then full sun for 1–2 months prior to outplanting.

Seedlings in nursery, 'Upolu, Samoa. PHOTO: L. THOMSON

Germination

Germination is rather slow and typically occurs sporadically over a long period of several months. Shortly after seeds germinate, and before their roots are about 2 cm (0.8 in) long, they are transplanted into final pots.

Media

Seedlings should be grown in a standard potting mixture or fertile, freely draining loam to clay loam, preferably with good levels of organic matter. It is recommended that a controlled-release, complete fertilizer be added at a rate of 12 g/l (1.6 oz/gal) into the potting mixture. This will ensure rapid, healthy seedling growth, including post-planting.

Time to outplanting

The time from germination to outplanting is about 4 months.

Approximate size

Plants should be about 25 cm (10 in) tall at outplanting; smaller seedlings about 20 cm (8 in) high may also be used.

Guidelines for outplanting

Seedlings should be outplanted at the onset of the wet season, typically early December in the South Pacific. The typical sequence for seedling production is January–March, seed collection; April–June, germination; July–November, nursery phase; November–January, field planting.

Vegetative propagation from cuttings

Seedling hedges of better phenotypes should be developed by regular cutting back to a height of about 20–30 cm (8–12 in) or by laying seedlings flat, pinning, and cuttings back new shoots. Multi-node, semi-hardwood cuttings should be treated with rooting hormone (0.8% IBA powder), set in washed river sand, and rooted under mist. Tip and hardwood cuttings may be also be used. The success rate for ju-

venile cutting material averages 30–60%, but rooting percentage is highly variable among individual clones, ranging from less than 10% to greater than 60%.

DISADVANTAGES

The main limitation to the wider use of malili in Samoa in experimental or operational plantings is its poor flowering and fruiting, especially for 2–3 years following severe cyclones, and low germination of typically less than 50% in the nursery.

The current planting rate is low (less than 10 ha [25 ac] per year) owing to the lack of viable seed of the species. The scale of future planting of malili is hard to predict, but together with poumuli (*Flueggea flexuosa*) and mahogany (*Swietenia macrophylla*) it is expected to become a major timber plantation species in Samoa.

Potential for invasiveness

Several biological characteristics of malili, including late onset of reproductive maturity and inability to regenerate in closed forests, will ensure that it will not become an invasive or environmentally weedy species when planted outside of its natural range.

Diseases and pests

The tree may succumb to butt rot, possibly caused by the fungus *Phellinus noxius,* and the leaves are highly susceptible to rose beetle (*Adoretus versutus*).

Host to crop pests/pathogens

Unknown. Other *Terminalia* species may be host to citrus fruit-piercing moth.

AGROFORESTRY/ENVIRONMENTAL PRACTICES

Mulch/organic matter

Annual leaf drop produces a good organic matter build-up under trees.

Soil stabilization

The excellent cyclone resistance, surface rooting habit, lower stem buttressing, and small-medium leaves which break down at an intermediate rate combine to make this a species of choice for soil erosion control.

Crop shade/overstory

Malili is only suitable as an overstory tree for more shade-tolerant crops.

Alley cropping

It is suitable for wide-alley cropping in farming systems using rotational gardening or shifting cultivation.

Homegardens

Good cyclone stability makes this a reasonable choice for planting near homes, but overall it is not well suited to homegardens due to large size, moderately heavy shade levels, and lack of non-wood products for home use.

Improved fallows

Malili is an excellent species for inclusion in mixed-species improved fallow plantings with a duration of at least 30 years (to allow for production of timber).

Boundary markers

It is an excellent species for boundary marker plantings due to longevity and stability.

Windbreaks

Where space permits, malili is an ideal species for inclusion as a middle to upper layer in windbreaks.

Native animal/bird food

It is a good source of food for native pigeons and doves, many of which are highly regarded wild foods in Samoa and Niue. It also provides food for the endangered and protected manumea, the national bird of Samoa.

Ornamental

Malili is an attractive tree for amenity and ornamental plantings in larger, public spaces.

USES AND PRODUCTS

The main traditional uses for malili were for production of canoes and as timber in local building construction (non-ground contact situations). It was also favored as a tree for staking out during pigeon hunting season, as the fruits are attractive to these birds.

Timber

Malili is one of the lighter colored, lighter weight Samoan hardwoods having low shrinkage and excellent working and machining properties. The wood is a light- to medium-density hardwood (550 kg/m^3 [34 lb/ft^3] at 12% moisture content). It is suitable for a wide range of interior uses including paneling, cabinetwork, and furniture, as well as

Reintroduced trees on Niue. PHOTO: L. THOMSON

general construction. It was traditionally used in house construction. However, its present day use in the timber and building industries in Samoa is very limited due to its rarity.

Malili is an indigenous tree species with major plantation potential. Key attributes include production of a good utility timber, moderately fast growth, excellent stem form, and adaptation to local South Pacific conditions, including periodic severe cyclones. Its wider planting is being encouraged and promoted by the forestry departments in the countries of its native origin.

Fuelwood

The wood is suitable for use as fuelwood.

Canoe/boat/raft making

It was traditionally used for canoe building in Samoa.

COMMERCIAL PRODUCTS

The main commercial product of malili is sawn timber for local use, especially in house and building construction.

Spacing

An appropriate initial spacing for commercial production in monocultural plantings of malili for timber production is 3 x 3 m (1111 stems per ha [450 stems/ac]). Wider interrow spacings and/or intercropping systems could be used to reduce weeding costs, e.g., 2.5 x 8 m (8 x 26 ft) (500 stems per ha [200 stems/ac]). The final stocking for sawlog production will be about 150–200 stems per ha (60–80 stems/ac). A suitable area for commercial production is ten or more hectares, but even small woodlot areas of about 1 ha (2.5 ac) could be grown on a commercial basis by groups of smallholders for supply to local sawmills.

Management objectives

The aim of management is to produce high-quality sawlogs within an economically feasible, attractive time frame, e.g., a rotation period of about 30 years. This will include use of selected genetic material, regular maintenance in early years including frequent weeding and removal of vines, and one or more thinnings to maintain balance of site control and concentrate wood increment on better formed stems. Pruning of lower whorls of branches, up to a height of 6–12 m (20–40 ft), may be required to produce better quality, less knotty sawlogs.

Advantages and disadvantages of growing in polycultures

Malili is expected to be highly compatible with production of durable poles of the smaller *Flueggea flexuosa*, which could be interplanted and cut at about 7–10 years. The commercial rotation length of malili is likely to be either more than some prospective timber species (e.g., *Endospermum medullosum*) or less than others (e.g., *Swietenia macrophylla*, *Syzygium inophylloides*, and *Pometia pinnata*). Accordingly, malili may not be especially compatible for growing with these species for commercial timber production.

Yields

There is no data available on growth rate over a projected rotation length of about 30 years. It is likely that good


Left: Eight-year-old plus trees at Masamasa, Savai'i, Samoa. Right: 27-year-old planted stand at Falelima, Savai'i, Samoa. PHOTOS: L. THOMSON

quality plantations grow at about 10–13 m^3/ha/yr (143–186 ft^3/ac/yr).

Market

Markets for planted malili timber are the local markets for general-purpose timbers, and vary considerably in volume. For example, in Samoa, malili plantings have the potential to replace imports of *Pinus* and declining local production from native forests of *Pometia* and other species.

INTERPLANTING/FARM APPLICATIONS

Malili is being planted in community agroforestry plantings in northern 'Upolu and western Savai'i in Samoa. The planting spacing is 8 m (26 ft) between rows and 4 m (13 ft) within rows. This allows intercropping for 3–4 years with traditional root crops including taro (*Colocasia esculenta*) and tamu (*Alocasia macrorrhiza*).

PUBLIC ASSISTANCE

See general extension links at:
http://www.traditionaltree.org/extension.html

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