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Endospermum medullosum (whitewood)

Euphorbiaceae (spurge family)

***a'asa*, *kakadikana* (Solomon Islands); *kumaro*, *napasa* (Vanuatu); PNG basswood (PNG); whitewood, whitewud (Vanuatu)**

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IN BRIEF

Distribution The natural range extends from Indonesia (West Papua or Irian Jaya) through Papua New Guinea, the Solomon and Santa Cruz Islands, to Vanuatu.

Size Typically 20–40 m (66–132 ft) tall at maturity.

Habitat Lowland, humid tropics, 0–350 m (0–1150 ft), mean annual temperatures of 22–28°C (72–82°F), annual rainfall of 1500–5600 mm (60–220 in), uniformly distributed.

Vegetation Plays an important environmental role in revegetation of various types of disturbed sites.

Soils Wide range of soils, especially alluvials and seasonally inundated soils.

Growth rate Grows very rapidly in height, 2.5–3 m (8–10 ft) annually until an age of about 10 years, after which growth slows.

Main agroforestry uses Mixed-species woodlot, silvopasture.

Main products Timber.

Yields Wood yields of 20–30 m^3/ha/yr (286–429 ft^3/ac/yr) are expected to be obtainable on fertile sites.

Intercropping Short-term agricultural or timber crops can be grown.

Invasive potential Whitewood is potentially invasive outside its native range.

PHOTO: L. THOMSON

Tree at Khole, Santo, Vanuatu.

INTRODUCTION

Whitewood (*Endospermum medullosum*) is a useful timber species with excellent forestry plantation and agroforestry potential in the South Pacific region. It occurs naturally on the island of New Guinea, extending through the Solomon Islands to Vanuatu as far south as the island of Erromango. The species predominately occurs in lowland, humid tropical climates where rainfall is high, typically 2500–4500 mm (100–180 in) per annum, with no pronounced dry season. The tree has been reported growing on a wide range of soil types, especially alluvials.

Whitewood grows into a large, spreading tree 20–40 m (66–132 ft) tall. It is dioecious, i.e., there are separate male and female plants. It may be classified as an early secondary species with some pioneer characteristics. It is shade intolerant and can only regenerate and persist when sizeable gaps in the canopy are created and maintained. Natural regeneration after logging or extensive storm damage is often prolific, especially where this is accompanied by soil disturbance. Young trees may be shaded out by other faster-growing pioneers or smothered by climbers. Trees of all ages have good cyclone resistance, mainly losing leaves and lateral branches during strong winds.

Whitewood is the major commercial timber species in Vanuatu, and it is also milled and marketed extensively in Papua New Guinea (PNG) along with two related *Endospermum* species under the trade name PNG basswood. Traditionally the tree was used to a fairly limited extent for canoes, firewood, and medicines.

Whitewood has a rather soft, low-medium density timber in which both heartwood and sapwood have a light, whitish color. The texture is intermediate and even, and the grain is usually straight. It is readily kiln dried and not prone to surface checking. It is non-durable in ground contact but readily treatable with preservatives, including in the green condition. The timber is easy to saw and machine and produces an excellent finish that is readily stained. It is mainly used for light construction, furniture, and interior joinery.

In Vanuatu the species grows rapidly and its timber is in high demand, both locally and for export. The Department of Forests has encouraged planting of the species by smallholder farmers by providing seedlings and silvicultural information. These plantings may take the form of either agroforestry plantings or woodlots (Sam 1997). Whitewood is potentially invasive outside its native range.

DISTRIBUTION

Native range

Whitewood is distributed from Indonesia (West Papua or Irian Jaya) through Papua New Guinea, the Solomon and Santa Cruz Islands, to Vanuatu. In Indonesia it is recorded from several islands on the northern and western sides of Irian Jaya, namely Salawati, Biak, and Yapen Islands (Airy Shaw 1980a). The species is widespread in PNG, including New Guinea (West and East Sepik, Madang, and Morobe Provinces), Papua (Gulf, Northern, and Milne Bay Provinces), Bismark Archipelago (Manus and New Britain), and Bougainville (Smith 1947, Airy Shaw 1980a). The species is reported to be widespread in the Solomon and Santa Cruz Islands (Whitemore 1966). In Vanuatu whitewood is found on most islands north of Erromango, including Vanua Lava and Gaua (in the Banks group), Espiritu Santo, Malo, Maewo, Ambae, Pentecost, Malekula, Paama, Epi, the Shepherd Islands, Efate, and Erromango (Sam 1997, Wheatley 1992). The species is not presently being cultivated outside of its natural range.

BOTANICAL DESCRIPTION

Preferred scientific name

Endospermum medullosum L. S. Smith

Family

Euphorbiaceae (spurge family)

Common names

PNG Basswood (PNG)
Whitewood or whitewud (Vanuatu)

Local names

a'asa (Solomon Islands: Kwara'ae)
kakadikana (Solomon Islands: Roviana)
kumaro (South Maewo, Vanuatu: Baetora)
napasa (Espiritu Santo, Vanuatu: Matantas)

Size

The tree is typically 20–40 m (66–132 ft) tall, reaching a maximum height of 54 m (177 ft). The bole is typically long and fairly straight, although twisted and kinked, uneven, and/or leaning trees occur. The length of clear bole is generally 10–24 m (33–79 ft) (exceptionally to 36 m [118 ft]). The diameter above buttresses may reach more than 1 m (3.3 ft), but more usually the diameter of mature specimens is in the range 50–80 cm (20–31 in).

Typical form

Mature specimens have a distinctive appearance characterized by shallow, flat-topped, and umbrella-like crowns and massive horizontal branches in distinctive tiers. Young and pole-stage specimens exhibit a rather cylindrical bole: the crown is monopodial, with a single, straight leader and branches in whorls.

Flowers

The species is dioecious, i.e., male and female flowers are borne on different trees. The inflorescence consists of axillary panicles, 10–19 cm (4–7.5 in) long, with racemose branches to 4 cm (1.6 in) long, and a covering of stellate hairs. Bracts and bracteoles are 1.5–2 mm (0.06–0.08 in) long, triangular. Flowers are small, greenish white, and arranged in axillary spikes; bisexual flowers are rarely present; the calyx is indistinctly 4-lobed; petals are absent. Male flowers have a calyx ca. 1.5 mm (0.06 in) long; 5–7 stamens, spirally arranged, 4–valved anthers, and are fragrant. Female flowers have pedicels 3–4 mm (0.12–0.16 in) long, a calyx ca. 1 mm (0.04 in) long, and have a tomentose ovary, 1-locular, stigma sessile, discoid, lobed, ca. 1 mm (0.04 in) wide.

Branchlet showing growing tip. PHOTO: L. THOMSON

Leaves

Leaves are simple/entire, large 8–25 (–33) cm long by 5.5–20 (–25) cm across (3.1–7.9 [–13] in. long by 2.2–3.1 [–10] in. across) cordate or peltate, mid-dark green/sub-shiny and finely softly hairy above and light silvery-green and densely hairy below. The leaves are spirally arranged and bunched in clusters at branch ends (Whitmore 1966). The underside of the leaf and petiole has a distinct indumentum (hairs). Venation is reticulated, conspicuous raised. Small glands occur at major nerve junctions. Juvenile foliage is much larger, often several times the size of mature leaves, and with both surfaces covered in dense, soft hairs.

Fruit

Fruits are borne in panicles. At maturity each fruit consists of a small, firm/fleshy, ovoid capsule, 8–9 mm (0.31–0.35 in) long and 5–6 (–7) mm (0.2–0.24 [–0.28] in) diameter; light grayish green, ripening to light yellowish green.

Seeds

Fruits do not split, and they encase a single brown to black seed about 6 mm long by 4 mm across (0.24 x 0.16 in).

Similar or look-a-like species

Whitewood is most closely related to *E. myrmecophilum* L.S. Smith and *E. domatiophorum* Schaeffer (Schaeffer 1971, Airy Shaw 1980a).

E. myrmecophilum from Australia and Papua New Guinea is only reliably distinguishable from whitewood by the weaker indumentum (hairs) and less prominent venation on the leaf undersurfaces. As the name suggests, *E. myrmecophilum* has a close relationship with an ant, *Camponotus quadriceps*, and where this ant species occurs its branchlets are swollen, hollowed, and colonized by these ants. The leaves of young plants of *E. myrmecophilum* differ in having two large, swollen/flattened, sub-globose petiolar glands about 6 mm (0.24 in) across, whereas *E. medullosum* has two small petiolar glands, globose/rounded, about 1–1.5 mm (0.04–0.06) across and four to eight pairs of small glands, about 1 mm (0.04 in) across at major leaf junctions on the undersurface of the leaf blade. The upper stems of *E. myrmecophilum* are hairier (finely puberolous/tomentose) and the stipules, located at base of petiole, are shorter, 2–3 mm (0.08–0.12 in) long compared with 6–8 mm (0.24–0.3 in) long in *E. medullosum*.

E. domatiophorum from PNG has two domatia (pitted glands) instead of solid glands in the main nerve-axils and in the usually non-hairy leaf undersurface (Airy Shaw 1980a).

Top: Smaller petiolar gland on underside of whitewood leaf (top left) aids in distinguishing it from *E. myrmecophilum* (top right). Bottom: *E. myrmecophilum* (taller plants on left) and *E. medullosum* at 6 months of age, Santo, Vanuatu. PHOTOS: L. THOMSON

ASSOCIATED PLANT SPECIES

In PNG it grows with *Homalium*, *Pterocymbium*, *Pometia*, and *Pterocarpus*. In Vanuatu it is the co-dominant or dominant species with *Antiaris toxicara, Elaeocarpus, Terminalia*, and others. It grows in two associations: at mid-elevation with *Calophyllum neo-ebudicum, Elaeocarpus* sp., *Syzygium* sp., and *Antiaris toxicaria*, and at low elevations with *Macaranga* spp., *Pangium edule*, *Antiaris toxicaria*, *Pterocarpus indicus*, and *Dysoxylum* spp. (Sam 1997). In the Solomon Islands, whitewood commonly occurs with *Campnosperma brevipetiolata* in previously disturbed areas (Marten 1980).

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

Whitewood predominately occurs in the lowland humid tropics.

Elevation range

0–350 (–1000) m (0–1150 [–3280] ft)

Mean annual rainfall

1500–5600 mm (60–220 in). Typical rainfall is 2500–4500 mm (100–180 in).

Rainfall pattern

Whitewood prefers climates with summer or uniform rainfall patterns.

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

0 months

Mean annual temperature

22–28°C (72–82°F)

Mean maximum temperature of hottest month

29–32°C (84–90°F)

Mean minimum temperature of coldest month

15–24°C (59–75°F)

Minimum temperature tolerated

6–10°C (43–50°F)

GENETICS

Variability of species

A high level of variation in growth and morphology is observed in Vanuatu populations. In SPRIG/Department of Forestry field trials at Shark Bay, Santo, the fastest growing sources in Vanuatu at age 4 years were from lowland parts of east and southeast Santo (Smith et al. 2003).

Known varieties

None.

Soils

In New Guinea the species has been reported growing on a very wide range of soil types, especially alluvials, including clays, gravelly alluvials, sandy clays, grey sandy loams of considerable depth, and seasonally inundated soils. In the Solomon Islands *E. medullosum* prefers drier inland lowland sites but is also found on damp alluvial soils. On Santo, Vanuatu, the species grows on ferralitic Cambisols, soils of good fertility formed over raised limestone.

Soil texture

The tree grows in light to heavy soils (sands, sandy loams, loams, and sandy clay loams, sandy clays, clay loams, and clays).

Soil drainage

Freely draining soils are preferred, but it tolerates soils that are seasonally waterlogged or shallowly inundated for short periods

Soil acidity

Neutral to acid soils (pH 7.4–4.0).

Tolerances

Drought

Because the tree grows in high-rainfall areas with no dry season, drought tolerance is expected to be limited.

Full sun

The tree prefers full sun but will tolerate 0–15% shade.

Fire

The tree's tolerance of fire is expected to be limited, as it has not evolved in fire-prone environments.

Frost

It does not grow in frost-prone regions, so it is unlikely to tolerate frost.

Waterlogging

Mature trees can tolerate up to a few weeks of shallow inundation less than 1 m (3.3 ft) in depth.

Salt spray

Expected to be limited, as it does not naturally occur in near-seaside situations.

Wind

With increasing wind speed the damage is usually leaf loss and then breakage of lateral branches. During cyclones some breakage of tops of smaller trees may occur.

Sapling after Cyclone Zuman, Santo, Vanuatu. PHOTO: L. THOMSON

Early findings on species susceptibility to cyclones showed whitewood as resistant to cyclones in Vanuatu (Neil 1987), although Marten (1980) has observed damage from strong winds in the Solomon Islands.

ABILITIES

Regenerate rapidly

It has good regeneration ability in gaps following logging and in garden areas. In open sites and large gaps it can be overtopped and shaded out by faster-growing pioneers, such as *Macaranga* or *Merremia* vines.

Self-prune

The tree has a very good self-pruning habit.

Coppice

Coppices well up to 3–4 years of age; thereafter coppicing ability is low and variable.

The author inspects coppice shoots. PHOTO: K. AKEN

Pollard

Pollarding ability is expected to be good even in older specimens.

GROWTH AND DEVELOPMENT

In fertile, sunny locations young plants grow very rapidly. In order to keep whitewood trees growing vigorously beyond the first 5–10 years, it is essential that they are provided with increased space to grow. This can readily be achieved in managed systems through timely, selective thinnings.

Growth rate

The tree is fast growing, with height growth in early years of 2.5–3 m (8–10 ft) per year. Height growth falls off considerably after about 7–10 years. Diameter increment also slows with age, e.g., 3–4-year-old trees have a diameter of about half that of trees 20–25 years old.

Flowering and fruiting

In plants grown under optimum conditions, flowering and fruiting first occur at about 3–4 years of age. However, plants need to attain 4–6 years of age before flowering is widespread and large quantities of fruit are produced.

Rooting habit

The major part of the root system consists of widely spreading, shallow lateral roots.

Reaction to competition

It dislikes overhead shading from neighboring plants.

PROPAGATION

Whitewood may be raised either from seedlings, small wildings (Marten 1980), or vegetative cuttings (Walker et al. 1996).

Propagation by seed

Seed collection

Collection times vary geographically: In PNG fruiting has been reported throughout the year, but the peak periods appear to be May–June and September–October. In the Solomon Islands fruits are mostly collected in January–March. In Vanuatu, fruiting occurs from February to May and August to October, with March–April being the best and most reliable months for collection.

Fruits are mature and ready for collection once some fruits in a bunch change from darker green to lighter green and turn soft. At this stage some fruits may fall and/or be consumed by birds.

The preferred collection method is to lob a rope over a large, fruit-bearing branch (e.g., by throwing or using a big-shot catapult with a weighted end), breaking off the branch, and hand picking the fruit bunches from the branch on the ground.

There are 9000–9600 fruits/kg (4090–4360 fruits/lb). A kilogram of fruit yields 30,000–35,000 freshly depulped seeds/kg (13,600–15,900 seeds/lb) (Ngoro 1988, Leslie 1994). Initial seed viability is highly variable and often very low due to damage by wasp larvae. Seeds appear to be intermediate or recalcitrant and should be collected when mature and sown as soon as possible after collection.

Propagule processing

Non-viable, wasp-infested fruits float in water, and these should be discarded at the time of collection. This flotation test should be done at the time of collection, as good fruits may float after a short period (e.g., less than 6–12 hours) of drying.

Ideally, seeds should be sown within a few days of collec-

Top: Fruit collection on Santo, Vanuatu. Bottom: Seedling/nursery, Shark Bay, Santo, Vanuatu. PHOTOS: L. THOMSON

tion, and they may be sown without removal of the outer pulpy fruit layer. If seeds are to be stored then it is recommended that the pulpy fruit layer be rubbed off on a wire mesh, washed, and the seeds air-dried under shade. The cleaned seed should be spread out in a thin layer to facilitate drying preferably on a well ventilated rack or absorbent surface. The period of air-drying varies depending on local conditions, but it is likely to take about 1 day under well ventilated conditions.

Seed storage

The most appropriate conditions for storage of seed are yet to be established. It is suggested that seed be stored moist in a well aerated medium, such as slightly moistened peat moss or sawdust in a plain cotton or open plastic bag, at a uniformly low–intermediate temperature of 10–15°C (50–59°F). Rigid, sealed storage containers should be used where there is the risk of seed loss from insect pests and vermin, such as rodents.

Pre-planting treatments

No scarification of seeds (or depulping of fruits) is required prior to sowing.

Growing area

Full sun is preferable, but seed may be germinated in partly shaded conditions (up to 25% shade).

Germination

Germination generally takes 2–5 weeks.

Media

A freely draining loam is preferred.

Time to outplanting

With good nursery practices, seedlings are ready to plant out in 14–16 weeks.

Approximate size

The optimal height for outplanting is considered to be about 25 cm (10 in).

Other comments on propagation

Given the often very low seed viability, it is advisable to sow the seed into open beds and prick out into containers as germinants emerge. Seedlings may be raised in rigid tapering plastic pots (12 cm deep, 250 cm^3 [5 in deep, 15 in^3]) and need to be given ample space, e.g., 50 seedlings per m^2 (4.5 seedlings/ft^2) to avoid crowding/shading and development of spindly seedlings (Walker et al. 1996). Root pruning and hardening off the seedlings in full sun prior to planting are important (Marten 1980).

Guidelines for outplanting

Good pre-planting weed control, especially elimination of the vine *Merremia peltata*, is essential: this can be achieved by a combination of cattle-grazing followed by glyphosate herbicide. Seedlings are best field-planted at the onset of the wet season, and growth is rapid in well hardened seedlings. Regular weed control must be done during the first 3 years on an as-needed basis. This may be as often as every 6 weeks during the wet season. However, young trees grow rapidly on favorable sites and cast heavy shade, so that minimal tending is required beyond 3 years.

Propagation by cutting

The species is readily propagated from cuttings taken from young hedges when set under mist. It is possible to grow plants suitable for field planting by directly setting 20–25 cm (8–10 in) long terminal cuttings directly into containers (Walker et al. 1996).

The potential benefits of using cuttings are:

- overcoming lack of availability of viable seed
- the capability to rapidly propagate superior populations, families, or individuals that have been identified in trials (Walker et al. 1996).

DISADVANTAGES

Potential for invasiveness

The species has several colonizing traits, including rapid early growth and production of heavy fruit crops that may be consumed and widely dispersed by certain bird species. In favorable environments it may constitute a minor environmental weed hazard. Whitewood is potentially invasive outside its native range (needs further evaluation).

Diseases and pests

In Vanuatu, relatively minor pests and diseases recorded in young plantations of whitewood include a defoliating black weevil, skeletonizing moth larvae (*Cyfura bifusciata* or *Urapteroides astueniata*), and a leaf fungus (*Phaeoseptoria* sp.) (Leslie 1994). Rat damage (eating tips of branches) and cattle damage (stripping of bark) have also been observed in commercial plantations in Santo. In the Solomon Islands the leaves of young trees are often skeletonized but the damage is not serious (Marten 1980). A wasp larva (*Syceurytoma* sp., family Eurytomidae) may cause considerable damage to developing seed crops, with over half of fruits being damaged (Leslie 1994). A study of brown root rot (caused by *Phellinus noxius*) established that whitewood was highly resistant to the disease (Ivory and Darubi 1993). In PNG, severe defoliation of juvenile leaves was recorded on a trial in Lae in September caused by an unidentified caterpillar.

Host to crop pests/pathogens

The tree is not reported to be a host for crop pests and pathogens.

Other disadvantages or design considerations

Cattle must be excluded from young plantings (at least for the first 4–5 years), as they may cause extensive damage and kill young trees by chewing the bark.

Hedge for production of cuttings for propagation. PHOTO: L. THOMSON

Obtaining sufficient seed for propagation is a potential limitation, as it is difficult to collect large quantities of viable seed from native stands due to damage from seed wasp larvae. Cleaned seed appears to lose viability in transit, as seed exchanged between different countries often has low viability.

AGROFORESTRY/ENVIRONMENTAL PRACTICES

Mulch/organic matter

The leaves break down moderately fast, and therefore the tree is expected to be useful for soil improvement and raising organic matter levels.

Soil stabilization

Whitewood is a very good soil stabilizer, having extensive lateral surface roots.

Crop shade/overstory

The tree provides moderately heavy shade that is only suitable for plants requiring moderate to high shade levels, such as cardamom, cocoa, and *Xanthosoma* taro (*X. sagittifolium*).

Alley cropping

The tree is good for alley cropping for about 3 years if planted at wide spacing, e.g., in rows 10–12 m (33–39 ft) apart, before shade levels become too great for most agricultural crops

Homegardens

It is suitable as an upper canopy component in mixed homegardens.

Improved fallows

The tree is ideal for improved fallows at lengths of 10–15 years.

Windbreaks

It can be a useful upper story component of windbreak plantings.

Silvopasture

The tree is highly suitable for older specimens in an open woodland/woodland with pasture configuration. Bark of young trees is readily chewed by cattle, causing severe damage and ring-barking.

Animal fodder

Leaves have been fed to pigs and cattle in Vanuatu (Siwatibau 1998).

Woodlot

Whitewood has excellent potential to grow in woodlots for timber production, especially if near to a sawmill and preservative treatment facilities (if wood is for local use).

Native animal/bird food

Fruits are a food source for pigeons.

Wildlife habitat

Older specimens provide useful wildlife habitat, often being emergent above other forest tree species.

Ornamental

Little-used as an ornamental, although the tree develops into an attractive, large, long-lived tree.

USES AND PRODUCTS

In Vanuatu, the wood of whitewood has been traditionally used for making canoes and for firewood. Other traditional uses include a leaf vegetable and medicinal. It is currently the major timber species cut in Vanuatu, together with *Antiaris toxicara* (with whitewood being preferred). The timber is used locally in Vanuatu, especially in preservative-treated form. It has an established export market in East Asia (principally Japan and Taiwan, with some export to other countries such as Australia). It is particularly useful for moldings, and the pale color of the wood lends itself to a variety of wood stains. Material from young, 3–4-year-old plantations has been successfully trial-milled and made into glue-laminated finger-jointed boards.

Leaf vegetable

In PNG the young leaves are sometimes used as a vegetable (Airy Shaw 1980a).

Medicinal

The bark is widely used in Vanuatu for custom medicine (Siwatibau et al. 1998), including treatment of rheumatism (Sam 1997). The bark or sap is used for treatment of stomachache on Santo (Curry 1995).

Timber

Whitewood has a rather soft, low–medium density timber in which both heartwood and sapwood have a straw color that lightens on exposure. The texture is intermediate and even. The grain is usually straight but sometimes slightly interlocked or wavy. Tension wood is sometimes present. It is very easy to kiln dry from the green condition and not prone to surface checking: the drying time from the green condition to a final moisture content of 12% is 2–3 days (Eddowes 1977). Mean air-dry density (12% moisture content) is about 440 kg/m^3 (27.5 lb/ft^3), and the timber has low strength properties (Forestry Division 1976). It is non-durable in ground contact but readily treatable with preservatives to prevent blue stain and attack from pinhole (ambrosia) borers. Its sapwood is susceptible to *Lyctus* and should be given an appropriate anti-*Lyctus* treatment before being sold. The timber is easy to saw and machine and produces an excellent finish (Pleydel 1970, Forestry Division 1976) using either machines or hand tools. It is used in Vanuatu for light construction, furniture, and interior joinery and has potential for veneer and plywood production. In PNG it is considered suitable for many purposes including molding, veneer, wide boards, lining, joinery, interior finish, match splints, match boxes, shuttering, turnery, dowels, pattern making, packing cases, furniture, cabinet work, weatherboards, shingles, and drawing-boards. In the Solomon Islands the species is used for light construction, weather boards, and boom-logs (Marten 1980).

Fuelwood

The wood is used locally for firewood, but whitewood is not a major fuelwood source.

Canoe/boat/raft making

The wood is used locally for canoes in Vanuatu.

Other

The wood is sometimes used as a food source and habitat for an edible worm in Vanuatu.

Lorum Plantation planted by Melcoffee Sawmills Ltd., Santo, Vanuatu. PHOTO: L. THOMSON

COMMERCIAL PRODUCTS

The primary commercial product from whitewood is timber.

Spacing in forestry

In monocultural plantings the spacing is rows 5–6 m (16–20 ft) apart with spacing within rows of 2.5 m (8 ft). However, the preferred silvicultural option is to plant in mixtures with a tree species that can be commercially thinned at about half the rotation age for whitewood. *Flueggea flexuosa* is ideal for this purpose, providing durable posts or small poles at 6–7 years of age. In the above system every alternate position is planted with *Flueggea*. The initial spacing of whitewood trees is 333–400 trees per ha (135–162 trees/ac). Thinning reduces the final density to 150–250 trees per ha (60–100 trees/ac), depending on the age of harvest and other factors.

On Santo, Vanuatu a final spacing of around 280–310 stems/ha (115–125 stems/ac) is considered to be optimal (Ken Robson, pers. comm.). To obtain this final stocking rate, an initial planting spacing of 6 x 3 m or 8 x 2 m (20 x 10 ft or 26 x 7 ft) is suitable, allowing the for thinning of poorer stems. The choice of 6 m or 8 m (20 ft or 26 ft) between rows depends on harvesting equipment to be used: 6-m spacing will accommodate portable sawmill operations while 8-m spacing is more adapted to the heavy machinery utilized by large logging companies.

Spacing in agroforestry

In mixed agroforestry systems, rows are planted 10–12 m (33–39 ft) apart with spacing within rows of 2.5 m (8 ft). It is preferable for every other planting spot to be planted with *Flueggea flexuosa*, which can be commercially thinned for durable posts and small poles at 6–7 years age. Initial spacing of whitewood trees is 166–200 trees/ha, and this would be the final spacing less any mortality and culling of poor stems.

Management objectives

The object is to produce tall, large-diameter, straight stems with knot-free wood. Some pruning to encourage clear wood is recommended, where the pruning regime aims to ensure a knotty core not exceeding 8–10 cm (3–4 in) in diameter and clear wood bole lengths of 4.5–6.0 m (15–20 ft). If breeding for improved wood quality, an additional objective is higher wood density. On less fertile sites it is recommended that trees be given 100–200 g (3.5–7 oz) of complete fertilizer during the first 2 years and/or intercropped with shrub legumes such as *Flemingia*.

Design considerations

Adequate initial spacing followed by timely thinning is needed to provide developing saplings with adequate sunlight, water, and nutrients for rapid growth. Growth in dense, even-spaced plantings can slow down and stall as trees begin competing for light, water, and nutrients (stagnate).

Yields

On fertile sites with optimum germplasm and silviculture, expected yields are high, about 20–30 m^3/ha/yr (286–429 ft^3/ac/yr). Yields in agroforestry systems at wider spacing will be lower, especially in early years, e.g., 15 m^3/ha/yr (215 ft^3/ac/yr).

Processing required

Wood needs to be preservative-treated for use in situations of moderate to high decay hazard. Finger-jointing or glue-lamination can be done to allow use of smaller dimension material.

Market

The wood is a good general-purpose timber for local markets, especially if treated with preservatives. It is a preferred timber in Japan, where it fetches high prices.

INTERPLANTING/FARM APPLICATIONS

Whitewood provides a useful low windbreak for crops in alley cropping systems. Intercropping is limited to the first 3–4 years depending on spacing, due to declining light levels in the area between tree rows. It can also be successfully

used in silvopasture once the trees are older than about 10 years and resistant to bark-stripping by cattle.

The benefits of interplanting with crops include:

- substantial additional financial returns from timber in addition to the return from the agricultural crop
- trees act as planted fallow, restoring soil fertility more quickly after cropping, especially if the nitrogen-fixing shrub *Flemingia* is planted in alleys after the main cropping phase
- trees provide windbreak for crops in years 1–3
- the maintenance of crops between rows also serves as good weed control for trees.

Potential drawbacks of interplanting include:

- alley cropping phase ceases to be viable for most light-demanding crops after about 3 years
- wider spacing means lower growth rates on a per-unit area basis.

Example system

Location

Shark Bay, Santo, Vanuatu.

Description

This system has been developed in recent years by the Department of Forests and implemented by local villagers. It appears to have exceptional potential on Santo, as agricultural yields are maintained and farmers get substantial additional income from trees at two stages, after 6–7 years (from *Flueggea flexuosa* poles), and again at 15–20 years (from *Endospermum* timber).

Yields/benefits

Average growth increment of whitewood at age 5–8.5 years was about 17 m^3/ha/yr (243 ft^3/ac/yr), which is equivalent to a return of about US$240–600 per hectare per year

Whitewood-*Flueggea* agroforestry system at Santo, Vanuatu, at 4 years of age (left) and at 9 years after *Flueggea* was harvested (right). PHOTOS: L. THOMSON AND R. THAMAN

(US$100–240/ac/yr) to the grower. The amount received depends on stumpage: the low value is what is currently paid, whereas the higher value is reasonable for plantation-grown material where harvesting costs are much lower. Returns from poles from interplanted *Flueggea* trees are equivalent to about US$1500 per hectare (US$600/ac) after 6–7 years. Agricultural crop yields (from various root crops, vegetables, kava, etc.) during the first 3 years about the same as for non-intercropped systems.

Spacing

The spacing is 10 m between rows and 2.5 m within rows (33 x 8 ft). Within rows, every other tree is whitewood alternating with *Flueggea*.

PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

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

BIBLIOGRAPHY

(☛ indicates recommended reading)

Airy Shaw, H.K. 1980a. The Euphorbiaceae of New Guinea. Royal Botanic Gardens, Kew. Kew Bulletin Additional Series VIII. Her Majesty's Stationery Office, London.

Airy Shaw, H.K. 1980b. A partial synopsis of the Euphorbiaceae-Platylobeae of Australia (excluding *Phyllanthus*, *Euphorbia* and *Calycopeplus*). Kew Bulletin 35(3): 577–700.

Anon. 1996. Improved Regeneration and Management of Natural Forest in Vanuatu. Report of Vanuatu Sustainable Forest Utilization Project (Milestone 40) prepared for AusAID by Hassall & Associates Pty Ltd/Margules Groome Poyry Pty Ltd and Anutech Pty Ltd.

Anon, 1997. Improved Regeneration and Management of Natural Forest in Vanuatu—Silvicultural Forest Harvesting Prescriptions for Vanuatu (Component 4.1.3). Report of Vanuatu Sustainable Forest Utilization Project prepared for AusAID by Hassall & Associates Pty Ltd/Margules Groome Poyry Pty Ltd and Anutech Pty Ltd.

Applegate, G.B. 1992. Rainforest Regeneration Study in Vanuatu. Report prepared for the Vanuatu National Forest Resource Inventory Survey Project for AIDAB. Margules Poyry Ltd, Canberra, Australia.

Burslem, D.F.R.P., and T.C. Whitmore. 1996. Silvics and Wood Properties of the Common Timber Tree Species on Kolombangara. Tropical Forestry Papers 34/Solomon Islands Forest Record 7. Oxford Forestry Institute, Oxford, UK.

Curry, P. 1995. The Department of Forests Botanic Database. Department of Forests, Port Vila, Vanuatu.

Eddowes, P.J. 1977. Commercial timbers of Papua New Guinea: Their properties and Uses. Forest Products Research Centre, Office of Forests, Papua New Guinea.

Forestry Division. 1976. Solomon Islands Timbers, Timber Booklet 1. Major Species. Ministry of Natural Resources, Honiara. Government Printing Office, Honiara, Solomon Islands.

Ivory, M.H., and G. Darubi. 1993. Outbreaks and new records. Vanuatu. New host records for *Phellinus noxius* in Vanuatu. FAO Plant Protection Bulletin 41(1): 37–38.

Keating, W.G., and E. Bolza. 1982. Characteristics, Properties and Uses of Timbers. Volume 1. South-east Asia, Northern Australia and the Pacific. Inkata Press, Melbourne.

Leslie, A.D. 1994. A Compilation of Results from Forestry Trials Established on Espiritu Santo, Vanuatu. Technical Booklet 3. Santo Industrial Forest Plantation Project, Department of Forests, Vanuatu.

Marten, K.D. 1980. Research Report S/6/80. Solomon Islands Forestry Division, Honiara, Solomon Islands.

Neil, P.E. 1987. Cyclone Uma and Damage to Southern Forests. Forest Research Report Vanuatu 1–87. Department of Forests, Port Vila, Vanuatu.

Ngoro, M.L. 1988. The status of *Endospermum medullosum* in Solomon Islands. Forest Research Note 47. Forestry Division, Solomon Islands, Honiara.

Pleydel, G.J. 1970. Timbers of the British Solomon Islands. Levers Pacific Timbers Ltd & United Africa Co. (Timber) Limited, London.

Sam, C. 1997. Information for Developing a Conservation Strategy for *Endospermum medullosum*. Forest Conservation Unit, Department of Forests, Vanuatu.

Schaeffer, J. 1971. Revision of the genus *Endospermum* Bth. (Euphorbiaceae). Blumea 19: 171–192.

Siwatibau, S., C. Bani, and J. Kalotap. 1998. A Report of RRA and Review of Earlier Surveys on Community Preferences for Tree Species. South Pacific Regional Initiative on Forest Genetic Resources, CSIRO Forestry and Forest Products, Canberra, Australia.

Smith, L.S. 1947. The ligneous genus *Endospermum* Benth. (Euphorbiaceae) in New Guinea. Proceedings of the Royal Society of Queensland 58: 51–62.

Smith, A., M. Sethy, I. Viji, J. Larmour, and L.A.J. Thomson. 2003. Compilation Report of SPRIG field activities for Vanuatu. Milestone Report 37 to AusAID for SPRIG 2 Project. CSIRO Forestry and Forest Products, Canberra, Australia.

☛ Thomson, L.A.J., and A. Uwamariya. 2003. *Endospermum medullosum.* In: CAB International, Global Forestry Compendium. CAB International, Oxford, UK.

Walker, S., R. Haines, and R. Aru. 1996. Melcoffee hardwood plantation project in Vanuatu: current status and future directions. Pacific Islands Forests and Trees newsletter 4/96, South Pacific Forestry Development Program, Suva, Fiji.

Wheatley, J.I. 1992. A Guide to the Common Trees of Vanuatu. Department of Forestry, Vanuatu.

Whitmore, T.C. 1966. Guide to the Forests of the British Solomon Islands. Oxford University Press, London.

Whitmore, T.C. 1974. Change with Time and the Role of Cyclones in Tropical Rain Forest on Kolombangara, Solomon Islands. Commonwealth Forestry Institute Paper No 46. University of Oxford, UK.

Traditional Tree Initiative—Species Profiles for Pacific Island Agroforestry (www.traditionaltree.org)

Endospermum medullosum (whitewood)

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