FOREST MANAGEMENT AND CONSERVATION PROGRAMME
LAO P.D.R.-FINLAND-WORLD BANK

35 POTENTIAL TREE SPECIES FOR PLANTING IN LAOS

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The information for this guide for species selection for planting in Laos has been chosen from the following publications :

1. Forestry / Fuelwood Research and Development Project. 1994. **Growing Multipurpose Trees on Small Farms,** (2nd ed.). Module 9, Species Fact Sheets. Bangkok, Thailand : Winrock International.
2. Tropical forestry papers n:o 15. (2nd edition, revised). **A Guide to Species Selection for Tropical and Sub-Tropical Plantations**. by Derek B. Webb, Peter J. Wood, Julie P. Smith, G. Sian Henman Unit of Tropical Silviculture, Commonwealth Forestry Institute, University of Oxford, 1984
3. National Research Institute, Department of Agriculture and Biology, Section of Coordinating Research and Forest Resource and Multipurpose Trees. **Native MPTS (Multi Purpose Tree Species) in Thailand.** 1995. Bangkok, Thailand. in Thai language.

We want to express our gratitude for the availability of the excellent material to the publishers. Best thanks are expressed to Mr. Jay Seidler for translating and compiling the fact sheets from Thai language.

The main criteria in selecting the species to this guide has been that the tree species should be adaptable to the weather and soil conditions mainly in low altitude areas (below 500 m a.s.1.) in Laos, i.e. annual rainfall in range of about 1000 to 1500 mm, dry season of 4 to 6 months, and shallow soils of quite low fertility.

The list includes indigenous, regional and exotic species which grow naturally or have been planted successfully in Laos or neighbouring countries in similar conditions. Many of the local species are common in natural forest and are important for wood processing industry but their silvicultural properties are seldom documented. The list includes several multipurpose species, fast growing species and species producing valuable timber. Fact sheets from two different sources are introduced for several common plantation species.

This list of species and their characteristics is a modest attempt to help foresters, nursery staff and farmers in species selection, seed collection and treatment, nursery requirements and plantation management. This list is still far from comprehensive and it should be further developed. Comments and suggestions for improving the coming editions are warmly welcomed.

The target is to have this guide to be translated into Lao language soon

35 POTENTIAL TREE SPECIES FOR PLANTING IN LAOS

General requirement: tolerant to dry season of at least 4 months, adaptable to poor and shallow soils

No	Name; latin, English, Lao or Thai	Main use	Secondary use	Notes
1	Acacia auriculiformis Wattle, Ka thin narong	Greening	Timber	
2	Acacia mangium Mangium, Ka thin tepa	timber	greening	
3	Albizia lebbek East Indian walnut, Phruek	fodder	timber	
4	Albizia procera White siris, Thing thon	timber	fodder	
5	Afzelia xylocarpa Mai to khaa	timber		Beautiful rosewood
6	Anacardium occidentale Cashew, Mak muang, himma phan	Nuts	timber	
7	Aquilaria crassna Eagle wood, Mai ked sanaa	Fragrant wood		
8	Artocarpus heterophyllus Jackfruit, Kok mak mi	fruit	timber	
9	Azadirachta indica Neem, Kadau	timber	timber	
10	Bombax ceila Kapok, Mai ngiu	Kapok	timber	not yet fact sheet easy to grow from cuttings
11	Cassia siamea Thailand shower, Khi lek	greening	timber	
12	Casuarina equisetifolia Sea oak, Ton sonh	fuel	Timber	best fuel
13	Dalbergia cochinchinensis Mai khanjung	timber		most valuable rosewood
14	Dalbergia sissoo Rose wood, Praduu khaek	timber		
15	Dipterocarpus alatus Mai njaang	resin	timber	
16	Eucalyptus camaldulensis River red gum, Mai vic	timber	fuel	
17	Eucalyptus tereticornis Forest red gum, Mai vic	timber	fuel	

No	Name; latin, English, Lao or Thai	Main use	Secondary use	Notes
18	Hopea odorata Iron wood, Mai khen	timber		
19	Gliricidia sepium Gliricidia, Khae farang	greening	fuel	
20	Leucaena leucocephala, Leucaena, Ka thin yak	timber	fodder	Not good for acid soils, pH should be 6.8 up
21	Mangifera indica, mango, Kok Mango, Mak muang	fruit	timber	
22	Melia azedarach China berry, Kadau sang	fuel	Timber greening	
23	Moringa oleifera Horseradish tree, Marum	Food, fodder	fuel	
24	Morus alba Mulberry, Tonh mon	silkworm food	berries	
25	Peltophorum pterocarpum Mai sa kham	greening	fuel	
26	Pinus merkusii (continental provenances) Pine, Mai pek	timber		
27	Psidium guajava Guava, Kok mak sida	fruit	timber	
28	Pterocarpus indicus Red sandalwood, Pradoo baan	timber		
29	Pterocarpus macrocarpus Mai dou	timber		beautiful rosewood
30	Shorea robusta Sal, Saa la	timber		
31	Tamarindus indica Tamarind, Kok mak kham	fruit	timber	
32	Tectona grandis Teak, Mai sak	timber		
33	Terminalia catappa Terminalia, Huu kwaang	greening	timber	
34	Xylia kerrii Mai deng	timber		durable timber
35	Ziziphus mauritiana Indian jujube, Phut saa	fruit	Fodder, fuel	

and many other local and exotic species can be successfully planted

Acacia auriculiformis (wattle)

Origin

Australia and Oceania, including Papua New Guinea.

Ecology

Annual rainfall: 1000-3000 mm.

Normal temperature range: 22-32 ^{o}C.

Altitude range: 0-700 m.

Seasonal adaptability: 4-6 months dray season.

Soils: Can grow on soils ranging from highly acid to alkaline; form shallow clay soils to deep sandy loams.

Light requirement: Strong.

Other site limitations: Low wind tolerance.

Description

Height at maturity: 15-25 m.

Diameter at breast height (1.3 m) at maturity: 50-60 cm.

Form: Poor; crooked stem, heavy branching.

Coppicing ability: Poor-Fair.

Growth: 15-18 m. in height, 15-20 cm in diameter in 10-12 year rotation.

Other: Fixes nitrogen, produces high levels of nitrogen even on poor soils.

Primary advantages

Good pulp production on highly infertile sites with pH as low as 3.0 or on soils as shallow as 20 cm; also can shade out imperata grass (Imperata cylindrical).

Primary disadvantages

Has strong allelopathic effects that limit tree-crop interactions.

Products and Yields

Wood products: Poles, pulp, timber; 12-15 m^3/ha/year on 10-12 year rotation, higher or lower yields depending on rainfall and soil type. Tons/ha/year; branches and leaves are a good source of small diameter fuelwood, yielding 4-6 tons/ha/year.

Fuelwood: 4600-4800 kcal/kg, yields of 16 tons/ha/year; branches and leaves are a good source of small diameter fuelwood, yielding 4-6 tons/ha/year.

Fodder: Unpalatable for livestock after first year.

Other: Shade tree, tannin and gums.

Propagation

Planting seedlings is the best method but it is possible to direct seed.

Seed treatment

Some scarification of the seed is needed, hot water scarification is best.

Management

Pruning, coppicing, pollarding. For fuelwood and pulp, usually planted at 2x2 m up to 4x4 m. For better coppicing, cut stumps at 1m. above ground. Removing lower branches of young plants may improve stem form.

Agroforestry Uses.

Limited by the allelopathic effects of prolific leaf litter. Lands. Used as firebreak species in orchards, shades out imperata grass, thus reducing fire danger. Not recommended for growing close to food crops.

SPECIES: acacia auriculiformis A. Cunn. Ex Benth.

TAXONOMY:

1 FAMILY.....Mimosaceae

2 SYNONYMS ……A. auriculaeformis A. Cunn.

3 LOCAL OR TRADE NMES, Tan Wattle

NATURAL OCCURRENCE :

4 LATITUDES ……..20-7°S

5 AREAS ……..Coastal Queensland, Papau New Guinea and islands

CLIMATE :

6 ALTITUDINAL RANGE . . . 0-500 m

7 MEAN ANNUAL RAINFALL. . 1,300-1,700 mm

8 RAINFALL REGIME . . . . . .Summer

9 DRY SEASON . . . . . 4-6 months

10 MEAN MAX. TEMP HOTTEST MONTH . . . . . 28-34°C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . 20-24°C

12 MEAN ANNUAL TEMP. . . . .24-29°C

SOILS :

13 TEXTURE . . . . . .Light/medium/heavy

14 REACTION . . . . . .Alkaline/neutral/acid

15 DRAINAGE . . . . . .Seasonally waterlogged

16 OTHER CHARACTERISTICS Tolerates shallow soils and is adaptable to most soil conditions

SILVICUL TURE :

17 SIZE . . . . . h = 15-25 m ; d = 35-60 cm

18 DESCRIPTION . . . . . .Evergreen

19 FORM . . . . . Poor

20 LIGHT REQUIREMENTS . . . Strongly demanding

21 OTHER CHARACTERISTICS Coppices poorly but regenerates rapidly ; fixes nitrogen

PRODUCTION:

22 VOLUME $\left(M^3/HA.AN\right)$... 10-20

ROLE IN LAND USE:

23 …… Shade and shelter; dune fixation; antierosion; soil impr4ovement; ornamental.

TIMBER:

24 DENSITY …… S. G. 0.60-0.75

25 NATURAL DURABILITY ... Moderately durable

26 PRESERVATION …… Fair

27 SAWINE …… Easy

28 SEASONING …… Easy

29 OTHER FEATURES …… Small size and from limit use as sawtimber.

UTILIZATION:

30 SAW TIMBER . . . . . Limited use for furniture

31 ROUNDWOOD. . . Building poles: fence posts; fuel (c. v. =20,10020, 450 KJ/Kg) and charcoal; shortfibre pulp.

32 OTHER PRODUCTS . . . Tannins

NURSERY:

33 SEED SOURCES . . . . Malaysia, Indonesia and Papua New Guinea.

34 SEEDS PER KILOGRAMME. . . .39.000-42.000

35 STORAGE . . . . . Dry and airtight for one-tw0 years.

36 PRE-TREATMENT -

37 PLANTING STOCK . . . . . Bare-rooted plants.

38 SPECIAL REQUIREMENTS -

39 GERMINATION AND GROWTH -

PRINCIPAL PESTA AND DISEASES:

40 …… Roots attacked by Ganoderma lucidum, but generally none of importance reported.

PRAINCIPAL REFERENCES: 59 120 121 128 149 152 172

Acacia mangium (mangium)

Origin

Australia and Oceania, including Papua New Guinea.

Ecology

Annual rainfall: 1000-4000 mm.

Normal temperature range: 17.5-31 ^{o}C.

Altitude range: 0 to 720 m.

Seasonal adaptability: Poor drought tolerance Soils: pH from 4.5-8.0, grows well on red-yellow podsols, even if heavily eroded. Can tolerate some waterlogging.

Light requirement: Strong, as it is a pioneer species.

Other site limitations: Performs poorly with less than 1200 mm annual rainfall; does not tolerate strong wind.

Description

Height at maturity: 25-30 m.

Diameter at breast height (1.3 m) at maturity: 40-60 cm. Form: Good, self pruning, straight bole without knots, especially when grown in plantation.

Coppicing ability: Only in young stems, poor in old trees.

Growth: In a 13-year plantation, can reach 23-25 m height, 27-30 cm diameter at breast height (1.3 m).

Other: Fixes nitrogen.

Primary advantages

Provides timber and other wood products; can quickly suppress imperata grass (Imperata cylindrical) on degraded acid soild.

Primary disadvantages

Some damage has been reported in young stands due to pinhole borers; some damage in nursery due to mildew and molds; wood has a high degree of 'spring' in milling test, a potential defect; heart rot can be a problem in older stands.

Products and Yields

Wood products: Timber, pulp, plywood, particle board. Yields range from 14 m^3 /ha/year at 4 years to 44 m^3 /ha/year at 10 years. Its timber has nice, close grain.

Fuelwood: 48000-49000 kcal/kg, produces high quality charcoal.

Fodder: Generally considered a poor fodder tree.

Other: Shade and ornamental planting.

Propagation

By seed.

Seed Treatment

Pour boiling water over the seed, 1 part seed to 10 pars water. After 30 seconds to 1 minute remove seeds and place in cold water, then soak overnight, remove, and dray.

Management

Commonly planted at 3x3 m spacing. For timber, prune every six months, up to age 2 years, and thin stands at ages 2,6, and 10 years. To avoid heart rot, harvest at 5-7 years.

Agroforestry Uses

Used in taungya systems. Closes canopy quickly, however, and must be planted at wide spacing (greater than 3x3 m) to allow more than one year of annual inter crop.

SPECIES: Acacia mangium Willd.

TAXONOMY:

1 FAMILY . . . . . .Mimosaceae

2 SYNONYMS . . . . . -

3 LOCAL OR TRADE . . . . . -

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 18 -1°S

5 AREAS . . . . . Australia: N. Queensland, Papau New Guinea and Moluccas Islands.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . 0-100 (-720) m

7 MEAN ANNUAL RAINFAL . . . . . 1,000-2,100 mm

8 RAINFALL REGIME . . . . winter

9 DRY SEASON . . . . . 3-4 months

10 MEAN MAX, TEMP HOTTEST MONTH. .. . 30 -26°C

11MEAN MIN. TEMP. COLDEST MONTH. . . . . 13 -22°C

12 MEAN ANNUAL TEMP . . . . . 18 -28°C

SOILS

13 TEXTURE . . . . . Medium

14 REACTION . . . . . .Acid/neutral

15 DRAINAGE . . . . . .Moist; tolerates seasonal waterlogging.

16 OTHER CHARACTERISTICS Tolerates very poor sites and slight salinity; often growns on creek and swamp margins.

SILVICULTURE:

17 SIZE . . . . . h = 25-30 m

18 DESCRIPTION . . . . .Fluted bole.

19 FORM . . . . . Acceptable

20 LIGHT REQUIREMENTS . . . . Fairly light demanding.

21 OTHER CHARACTERISTICS Coppices; fixes nitrogen; competes well with Imperata grass; regenerates freely on disturbed sites.

PRODUCTION

22 VOLUME (M^3 / HA/AN) 20-46

ROLE IN LAND USE:

23 . . . . . Plantation of water catchments; firebreaks; reforestation after shifting cultivation.

TIMBER:

24 DENSITY . . . . . S.G. =0.63-0.69

25 NATURAL DURABILITY. .. . -

26 PRESERVATION. . . . . Easy

27 SAWING . . . . . Easy

28 SEASONING . . . . . .Fair

29 OTHER FEATURES . . . . . -

UTILIZATION:

30 SAW TIMBER . . . . . General construction; furniture, boxes.

31 ROUNDWOOD. . . Veneer/plywood; shortfibre pulp; particle board.

32 OTHER PRODUCTS . . . Fodder; medicines.

NURSERY:

33 SEED SOURCES . . . . Papua New Guinea; Queensland, Australia.

34 SEEDS PER KILOGRAMME. . . .40,000-70,000

35 STORAGE . . . . . Cold, sealed.

36 PRE-TREATMENT -

37 PLANTING STOCK . . . . . Bare-rooted plants.

38 SPECIAL REQUIREMENTS -

39 GERMINATION AND GROWTH -

PRINCIPAL PESTS AND DISEASES:

40 .. . . . . Seedlings attacked by insects in nursery.

PRINCIPAL REFERENCE: 1 156 157

Acacia mangium
Ka thin tepa

Albizia lebbek (East Indian walnut)

Origin

South Asia.

Ecology

Annual rainfall: 355-2500 mm.

Normal temperature range: 10-37 ^{o}C.

Altitude range: 0 to 1600 m.

Seasonal adaptability: Tolerates 2 to 6 months dry season

Soils Grows well on a variety of soils but best where pH is 5.5-7.5. Prefers deep, well-drained soils. Light requirement: Moderate.

Other site factors: Some problems with wind but strong resistance to frost damage.

Description

Height at maturity: Up to 30 m.

Diameter at breast height (1.3 m) at maturity: 100 cm maximum.

Form: Fair (in rain forest) to poor (in open pasture).

Coppicing ability: Fair to good.

Growth: 1-1.5 m/year in height and 4-6 cm/year in basal diameter.

Other: Fixes nitrogen well.

Primary advantages

Excellent fodder tree, open canopy allows light through for good grass yields; high yields even in low rainfall areas.

Primary disadvantages

In open areas the stem is too crooked for high timber yields. Animals brows seedlings.

Products and Yields

Wood products: Timber is valued for ornamental work; pulp is suitable for writing and printing papers; fuelwood. In rotations of 10-15 years yields 53^{3}/ha/year. Wood density 0.55-0.60.

Fuelwood: Good quality, 5200 kcal/Kg.

Fodder: In best usage, yields 1700 kg/ha/yr from pruning on a tree-year rotation. Grass yields can increase by up to 100% under this trees in open spacing.

Other: Good flowers for honey production; hosts lac insects, which secrete a resin used in making shellac.

Propagation

By seedlings, stem cuttings, or direct seeding.

Seed Treatment

Does not require scarification. For greater germination, boil for 3 seconds and then allow the waster to cool and soak for 24 hours. Remove and dry seeds. Viability of four years is possible at room temperature storage.

Management

Open spacing favors greater grass production, tighter spacing will yield greater digestible foliage. Tolerates both pollarding and lopping.

Agroforestry Uses

Used in intercropping, hedgerows for forage and fuel production, and often in systems combining trees and pasture also used as shade tree in tea, coffee, and cardamom plantations.

SPECIES: Albizia lebbek (L.) Benth.

TAXONOMY:

1 FAMILY . . . . . .Mimosaceae

2 SYNONYMS . . . . . .

3 LOCAL OR TRADE . . . . . .

NATURAL OCCCURRENCE:

4 LATITUDES . . . . 11-27^{o}C

5 AREAS . . . .. . .Burma, India and Andaman Islands.

CLIMATE:

6 ALTITUDINAL RANGE . . . 0-1,400 m

7 MEAN ANNUAL RAINFALL . . . 500-2,500 mm

8 RAINFALL REGIME . . . . . Summer

9 DRY SEASON . . . .2-6 months

10 MEAN MAX, TEMP, HOTTEST MONTH. . . 26 -36^{o}C

11 MEAN, MIN, TEMP, COLDEST MONTH . . . 10 -36^{o}C

12 MEAN ANNUAL TEMP. . . . 20 -28^{o}C

SOILS:

13 TEXTURE . . . . . Light/medium/heavy

14 REACTION . . . . .Alkaline/neutral/acid

15 REACTION . . . . .Free draining'

16 OTHER CHARACTERISTICS . . . Adaptable

SILVICUL TURE:

17 SIZE . . h = 15-30 m; d = 60-90 cm

18 DESCRIPTION . . . . . Deciduous; open-crowned.

19 FORM . . . . Poor

20 LIGHT REQUIREMENTS. . . . .Moderately demanding

21 OTHER CHARACTERISTICS . . . . . Coppices; termite resistant; tolerates salt winds; fixes nitrogen; moderately frost resistant when established; root suckers vigorously; drought hardy; not wind firm; rotation of 10-15 years

PRODUCTION:

22 VOLUME (M3 /HA/AN) 5

ROLE IN LAND USE:

23. . . . . .Shade and shelter; windbreaks; ornamental; anti-erosion; green manure; dune stabilization.

TIMBER:

24 DENSITY . . . . . S.G. 0.55-0.90

25 NATURAL DURABILITY. . . . . Moderately durable

26 PRESERVATION . . . . .Fair

27 SAWING . . . . . .Fair

28 SEASONING . . . . . Difficult

29 OTHER FEATURES . . . . Interlocked grain; decorative.

UTILIZATION:

30 SAW TIMBER. . . . Light construction; furniture; flooring.

31 ROUNDWOOD . . . . . Fuel (c.v. =21,340-21,350 kJ/kg) and charcoal; veneer/plywood; posts.

32 OTHER PRODUCTS. . . . . Fodder (leaves); gums; tannin; medicinal products.

NURSERY:

33 SEED SOURCES . . . . . India

34 SEEDS PER KILOGRAMME . . . 8,000-11,000

35STORAGE . . . . Ambient temperature for several years.

36 PRE-TREATMENT . . . Boiling water till cool.

37 PLANTING STOCK . . . . .Stumps; direct sown

38 SPECIAL REQUIREMENTS -

39 GERMINATION AND GROWTH: . . . 60-90% germination in 1-2 months. Plantable size in 4-7 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . . .None of importance reported but liable to browsing damage.

PRINCIPAL REFERENCES: 16 57 61 69 71 95 100 109 120 121 128 152

Albizia procera (White siris)

Origin

Australia and Oceania, including Papua New Guinea, Southeast Asia, South Asia.

Ecology

Annual rainfall: 500-300 mm

Normal temperature range: 21-32 ^{o}C

Altitude range: 0 to 1300 m.

Seasonal adaptability: Tolerates 6-8 months dry season

Sols: Moderately acid-tolerant to alkaline solids, pH 5.5-7.5; grows well on shallow soils but prefers alluvial soils.

Light requirement: Moderately demanding

Other site limitations: Easily damaged by frost; branches of mature trees break readily in high wind.

Description

Height at maturity: 25 m

Diameter at breast height (1.3) at maturity: 35 cm

Form: Good; clear stem but often curved; open canopy.

Coppicing ability: Fair to good.

Growth: On good sites, 12-year-old trees reach 0.9-1.1 m in diameter and 15 m tall.

Other: Fixes nitrogen.

Primary advantages

Good-quality timber; grows well in shallow stony soils and areas with a long dry season

Primary disadvantage

Its frost susceptibility limits planting at higher elevations.

Products and Yields

Wood products: Timber. Yields of 10 m3 /ha/year are reported on good sites. Wood quality is good; used for cabinets and veneer.

Fuelwood : Fair quality; 49000-5000 kcal/kg.

Fodder: Leaves provide good forage.

Other: Wood is used as a substitute for walnut and general construction. In Nepal, leaves used as insecticide.

Propagation

Easily by seedings, cuttings, stumps, root suckers or direct sowing.

Seed Treatment

Place seeds in boiling water, remove water from heat, let cool over night, then dry and store.

Management

Can be heavily lopped or pollarded to provide forage. In open stands, prune to improve stem quality.

Agroforestry Uses

Used in hedgerows, pastures, fuelwood plantings.

Afzelia xylocarpa

Mai te khaa

Origin

Along streams in mixed wet deciduous forests and dry evergreen forests

Ecology

Annual rainfall: 1,000-1,500 mm

Normal temperature range: (average) 19-24^{o} C

Altitude range: 100-600 m

Seasonal adaptability:

Soils: Good drainage, rich soils

Description

Height at maturity: -

Diameter: -

Form:-

Growth: -

Other: Not fire resistant

Products and yields

Wood products: Density 0.85. Natural durability 6-19 years. Difficult to air dry, must use extensive period of time. Medium difficult to kiln dry. Can be used for poles, railroad sleepers, building, floors, carvings, tools, furniture, boats, ceilings, and drums.

Other: Fruit used as medicine, Seeds can be eaten, Barkproduces Psyrogallol and catechol.

Propagation

Most common propagation method is by seed. Can be propagated by stump which is 9-12 months old or bare root. The ripe seed pods are dark brown and break off of tree. In January to March the seed pods will ripen and should be gathered from the tree and sun dried.

Seed Treatment

The hard shell should be broken by the head of the seed so that the inside is partially visible, soak in water one night and plant in sandy seed bed or poly-bags at 2-3 cm spacing. Cover with 0.5 – 1 cm of sand. 95-100% germination in 7-10 days.

Management

Water twice a day. Mix anti-fungus chemical with water, Seeding should have 50% light for 3-4 months. Harden 2-3 weeks before out-planting. Out-plant in level or slightly hilly area at 4x4 m spacing. Loosen soil around tree after 1 month, and antoerh 2-3 times in the first year. Trim branches so to maintain good form. In one year in 40% light the seedlings should have an average height of 2.50 m.

Anacardium occidentalis (cashew)

Origin

South and Central America

Ecology

Annual rainfall: 500-3500 mm.

Normal temperature range: 22-35^{o}C

Altitude range: 0 to 1200 m.

Seasonal adaptability: Good drought tolerance. Sensitive to frost.

Soils: Sandy soils with good drainage, pH of 4.5-6.5.

Light requirement: Strong light demander.

Description

Height at maturity: 12m

Form: Short bole, spreading crown, evergreen.

Primary advantages

Produces edible nut marketable as cash crop; can grow in drought-prone locations; suitable for deep sandy soil

Primary disadvantage

Some diseases, such as Anthracnose, can infest cashew and reduce nut yields considerably . Requires good tap tap toot and deep soil for good growth.

Product and Yields

Nut and peduncles: About 45kg/tree/year; 450-850 kg/ha in plantations.

Wood products: Small timber, fuelwood.

Other: Young shoots may be eaten as a vegetable. Cashew nut shell liquid has many industrial uses from high-temperature paints to clutch pads. Fruits (peduncles) used to make jam, vinegar etc.

Propagation

Usually by seedling. Plant multiple seeds per bag. For better yields, use grafting of improved variety. Pots must be tall enough to allow good tap root development.

Seed Treatment

Select seeds that sink in water or in a sugar-water solution. Seeds of high density produce much better seedlings. Seeds should be scarified.

Management

Plant at 8x8 m spacing; may be thinned later if needed. Weeding is necessary for about 3 years. Remove branches to about 1 m height of trunk for easier management.

Agroforestry Uses.

Sometimes used in intercropping systems during establishment phase, for example, with pineapple.

Anacardium occidentale
Chashew, Mak muang himma

SPECIES: Anacardium occidentale L.

TAXONOMY:

1 FAMILY . . . . . Anacardiaceae

2 SYNONYMS . . . . .-

3 LOCAL OR TRADE NAMES. Cashew; Mkorosho; Mkanju; Acaju

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 30° C-25°C

5 AREAS . . . . . .Tropical Americas, Mexico to Peru and Brazil, West Indies; naturalised in Africa and Mozambique.

CLIMATE:

6 ALTITUDINAL RANGE. . . . . 0-1,000 m

7 MEAN ANNUAL RAINFALL . . . . 500-1,600 (-3,000) mm

8 RAINFALL REGIME . . . . . .Summer/uniform

9 DRY SEASON . . . . 4-6 months

10 MEAN MAX. TEMP

HOTTEST MONTH. . .28° C-35°C

11 MEAN MIN.

TEMP COLDEST MONTH . . .9° C-35°C

12 MEAN ANNUAL TEMP . . . 27° C-33°C

SOILS:

13 TEXTURE . . . . . Light

14 REACTION . . . . . .Neutral/acid

15DRAINAGE . . . . . Good

16 OTHER CHARACTERISTICS. . .Tolerates poor soils; thrives on coastal soils if fresh ground water

SILVICUL TURE:

17 SIZE . . . .h = 5-15 m

18 DESCRIPTIONS. . . .Evergreen

19 FORM . . . . . Poor

20 LIGHT REQUIREMENTS . . . . .Light demanding

21 OTHER CHARACTERISTICS . . . . .Termite resistant; drought hardy; substantial provenance variation; requires wide spacing; frost sensitive; benefits from intercropping with legumes.

PRODUCTION:

22 VOLUME (M^3/HA/AN) ....

ROLE IN LAND USE:

23 . . . . . .Erosion control; dune stabilization; windbreaks.

TIMBER:

24 DENSITY . . . . . -

25 NATURAL DURABILITY . . . Durable

26 PRESERVATION . . . . . -

27 SAWING . . . . . -

28 SEASONING . . . . . -

29 OTHER FEATURES . . . . . Termite resistant.

UTILIZATION:

30 SAW TIMBER . . . . . -

31 ROUNDWOOD . . . . . .Fence posts; fuel.

32 OTHER PRODUCTS. . . . ..Nut (shell poisonous until roasted) 800-3000 kg nuts /ha/an; edible fruit stalk; oil (“cardol”) with many industrial uses; gum; medicine; ink; fodder.

NURSERY:

33 SEED SOURCES . . . . . Thailand; tropical America; Burma; France, India, Sri Lanka.

34 SEEDS PER KILOGRAMME 138-300

35STORAGE . . . . . Up to one year, dried and sealed.

36 PRE-TREATMENT . . . . .Soak 24 hours in water.

37 PLANTING STOCK . . . . .Potted; stumps; direct sown; air layering.

38 SPECIAL REQUIREMENTS . . . . . .Care of long tap root; water daily for I month.

39GERMINATION AND GROWTH . . . .60-70% germination in 4-7 weeks; transplant at one year old.

PRINCIPAL PESTS AND

40 . . . . Helopeltis spp. Main pest. Plocaederus ferrugineus – a cerambycid root/ shoot-boring beetle; Crimsissa crualis Brazil, chrysomelid bug.

PRINCIPAL REFERENCES: 67 107 117 124 134 135 152

Anacardium occidentale

Chashew, Mak muang himma

Aquilaria crassna

Mai ked sanaa, Eagle Wood. Lignum Aloes, Agarwood, Aloewood, Calambac

Origin

Laos, Philippines, India, Pakistan, China, Indonesia,

Thailand: North (Chiangrai, Prae, Nan), Central (Kamphang Phet, Phetchabunn), East (Korat, Buriram, Sisaket, Nakhonayok, Branburi, Kabinburi, Khao Yai National Forest).

Ecology

Altitude range: up to 1100 m or even higher

Forest description: Evergreen

Soils: loamy/heavy. Soils formed from limestone. Moist.

Light requirement: Partial shade in early growth and high light later

Description

Height at maturity: 18-21 m

Circumference 1.5-1.8 m

Products and yields

Wood, product: 14 years circum. 130 cm (diam. 41 cm)? wood density 0.3? Produces normal and fragrant wood. Normal wood is creamy white when fresly sawn and later durable. Fragrant wood is black, sinks in water. The quality of the wood depends upon the amount of resin which contains Sesquiterpene alcohol, Dihydroagarofuran, Beta-Agarofuran, Alpha-Agarofuran, Agarospirol and Agarol.

In Thailand the fragrant wood falls into 4 marketable grades. Grade A 15,000-20,000, grade B 8,000-10,000 Grade C 1,000-2,000, and Grade D 400-600 bath/kg. Fragrant wood in an 80 year old tree with a circumference of 1.5 m may be a high as 6.8-9 kg?. The production of fragrant wood is not caused by fungus as formerly believed but is produced as the tree reacts to wounds. Fragrant wood Fragrant wood traditionally used in religious rituals and medicine.

Propagation

Seed, cuttings. Most common by seed. In August the fruit breaks open releasing 1 or 2 ovoid seeds 5-6 mm long. Seeds must be gathered quickly before damaged by insect and fungus.

Seed treatment

No treatment is needed. 70% germination.

Management

Slow seedling growth. Seedlings are susceptible to Peronophythora sp. (fungus), therefore heat-sterilizing the soil of nursery pots is advised. Out plant on one year age at 5 x 5 m spacing.

Artocarpus heterophyllus (jackfruit)

Origin

South Asia

Ecology

Annual rainfall: 1100-2400 mm.

Normal temperature: 16-35^{o}C

Altitude range: 0 to 1000 m

Seasonal adaptability: Can tolerate 3-4 months dry season.

Soil: pH 5.0-7.5, deep well drained soils, clay-loams, sandy-loams.

Light requirement: Medium.

Other site limitation: Does not withstand flooding.

Description

Height at maturity: 30-60 cm.

Form: Good, straight bole, but branching begins quickly; fruits borne from trunk and braches.

Coppicing ability: Poor

Growth: Can reach 5 m height in 5 years.

Primary advantages

Fast-growing fruit tree able to grow in a range of climates. Straight-stemmed variety provides good

Timber and does not shade nearby crops. Generally not prone to disease or pest infestation.

Primary disadvantages

Fruit production decreases after 35-40 years. After 40 years, some holes may develop in the trunk, affecting wood quality.

Products and Yields

Fruit: Fruiting starts after about 5 years; earlier for grafted trees. Fruits require several months to mature, yields vary but 8-12 fruits/tree/year is normal for 5-year-old trees. Immature fruits used as vegetable in cooked dishes such as curries.

Wood products: Fuelwood and small timber; 3-5 m^3 /ha/yr when grown at a density of 80 stem/ha.

Also used to manufacture guitars.

Fuelwood; Good, with wood density of 0.5-0.7 and calorific value of 46000 kcal/kg.

Fodder: Not good, but leaves and fruit rind usable.

Other: Latex and dye. Dye is produced by boiling the sawdust. In Nepal, the root is used to relieve diarrhea and unripe fruit as a laxative.

Propagation

Form seed. Spacing in plantation is usually 8x8 m or greater.

Seed Treatment

Seeds are recalcitrant and cannot be stored long; should be planted when fresh. Store for short periods in airtight plastic bags or in dry sand, Seeds lose viability after 1 month.

Mangement

Pruning Rotations are normally 20-30 years, after which fruit production decreases dramatically.

Agroforestry Uses

Intercropping in homegarden systems.

Azadirachta indica (neem)

Orgin

South and Southeast Asia.

Ecology

Annual rainfall: 450-1500 mm.

Normal temperature range: 9.5-37°C

Altitude range: 0 to 1500 m.

Seasonal adaptability: Excellent; withstands 7-8 dry months dry season.

Soils: pH 5-7, grows well on most soils but does not tolerate seasonally waterlogged soils or deep sands with a deep water table. Does not grow on saline soils.

Light requirement: Medium to high, although prefers partial shade in first growing season.

Other site factors: Can grow with as little as 150 mm. annual rainfall on sites with an accessible water table.

Description

Height at maturity: 15-20 m.

Diameter at breast height (1.3 m) at maturity: Up to 100 cm.

Form: Bole of 2.5 m, canopy rounded or erect.

Coppicing ability: Good.

Growth: Height of 5-11 m in 8 years.

Primary advantages

Durable wood and good fuelwood; uses for all parts of the tree, including organic pesticide; grows on a wide variety of poor sites and arid conditions with significant wood yields.

Primary disadvantages

Seedlings can be damaged by fire; seeds lose viability quickly

Products and Yields

Wood products: Fuelwood and timber. Eight-year-old trees yield 108-137 m3 /ha, althought yields on drier sites may be much lower. Very durable wood. Fuel wood: Leaves used in medicine. Seeds produce insecticide and industrial, non-edible oils. Bark has high tannin content (12-14%). Young shoots of var. siamensis eaten as a vegetable.

Propagation

From seedlings, outplant to field at 3-4 months, or 30-50 cm in height. Weed during the first growing season.

Seed Treatment

Remove leathery endocarp, especially for seeds that have been stored. Sow seeds into nursery pots.

Management

Can be planted at 2.5x2.5 m in fuelwood plantations, on a 5-year cutting cycle. Rotations for fuelwood are 8-10 years; for saw timber, 15-30 years.

Agroforestry Uses

Commonly used in windbreaks (4x2 m spacing) and hedgerows, or left as single trees in cropland. Often grown for shade.

SPECIES: Azadirachta indica A. Juss.

TAXONOMY:

1 FAMILY . . . . . .Meliaceae

2 SYNONYMS. . ..Melia azadirachta L.; Melia indica Brand.

3 LOCAL OR TRADE NAMES . . . . Neem; Nim; Margosa; Marrango.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 10^{o} C-25^{o}C N

5 AREAS . . . . .Drier parts of India, Burma, Thailand and Cambodia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0-1,000 m

7 MEAN ANNUAL RAINFALL . . . . 450-1,200 mm

8 RAINFALL REGIME . . . .Uniform

9 DRY SEASON . . . .5-7 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . 26^{o} C-38^{o}C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .14^{o} C-24^{o}C

12 MEAN ANNUAL TEMP. . . . . .21^{o} C-32^{o}C

SOILS:

13 EXTURE . . . . .Light / medium/ heavy

14 REACTION . . . . . .Neutral

15 RAINAGE . . . . . Free draining

16 OTHER CHARACTERISTICS . . . . . Better growth on deep soils.

SILVICULTURE:

17 SIZES . . . . . h = 20-25 m; d = 100-150 cm

18 DESCRIPTIONS . . . . . Evergreen

19 FROM . . . . . Acceptable

20 LIGHT REQUIREMENTS . . .. .Moderately demanding; shade tolerant in youth.

21 OTHER CHARACTERISTICS . . . . .Aggressive colonizer; vigorous coppice; drought hardy; long tap root; frost and fire tender; fuelwood rotation of 8 years.

PRODUCTION:

22 VOLUME (M3/HA/AN) 5-18

ROLE IN LAND USE:

23. . . . . Shade and shelter; windbreaks; soil improvement; waste-land reclamation.

TIMBE:

24 DENSITIES . . . . . S.G. 0.60-0.70

25 NATURAL DURABILITY . . . . . Moderately durable

26PRESERVATION . . . . . Difficult

27 SAWING . . . . Easy

28 SEASONING . . . . Easy

29 OTHER FEATURES . . . . Resistant to termite and insect attack; interlocked grain.

UTILIZATION:

30 SAW TIMBER . . . Light construction; furniture; boxes.

31 ROUNDWOOD . . . . . Building poles; fence posts; fuel (c.v. = 20,895 kJ/kg) and charcoal; transmission poles.

32 OTHER PRODUCTS . . . . Fodder; leaves and seeds contain ‘azadirachtin’, a promising new insect repellant; medicine; green manure; oil from seeds; tannin.

NURSERY:

33 SEED SOURCES . . . . India; Nigeria; Sudan.

34 SEEDS PER KILOGRAMME 4,000-4,500

35 STORAAGE . . . . .Short viability (2-3 weeks).

36 PRE-TREATMENT . . . . . .Soak in cold water for one-two days.

37 PLANTING STOCK . . . . . Potted; stumps; direct sown.

38 SPECIAL REQUIREMENTS . . . . . .Light shade recommended; careful weeding.

39 GERMINATION AND GROWTH . . . .55% germination of fresh seed in 10-12 days. Plantable size in 11-14 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . Termites attack trees of all ages.

PRINCIPAL REFERENCES; 16 69 71 93 95 107 109 121 128 152

Bombax ceila

Mai ngiu, Kapok

Fact sheet not yet available.

Propagation

Plant cuttings taken from good mother trees of desirable form in the beginning of rainy season

Cassia siamea (Thailand shower)

Origin

South Asia.

Ecology

Annual rainfall: 500-2800 m.

Normal temperature range: 14-36^{o} C

Altitude range: 0 to 1300 m

Seasonal adaptability: 4-8 months dry season.

Soils: pH of 5.5-7.5, likes a deep well drained soil, can grow in laterites if drainage is good.

Light requirement: High

Other site limitations: Cannot withstand frost. If grown in dry climates roots need access to ground water.

Description

Height at maturity: 20m; 5m in arid conditions.

Diameter at breast height (1.3 m) at maturity: 50 cm.

Form: Spreading crown, bole of 2-3 m.

Coppicing ability: Good

Growth: 15 m in height and 15 cm diameter at breast height for 10-year-old trees.

Other: Does not fix nitrogen.

Primary advantages

Growth fast and is widely used; good roadside tree and in alley cropping.

Primary disadvantages

Needs weeding for the first one or two growing seasons. Pods, seeds, and leaves toxic to pigs. Does not tolerate forst.

Products and Yields

Wood products: Poles, small timber, fuelwood; wood yields of 10-15 m^3/ha/year.

Fuelwood: Good (wood density of 0.6-0.8), but wood produces much smoke when burning.

Fodder: Leaves and seeds used, but toxic for pigs.

Food: Young leaves and flowers are used in curry.

Other: Honey, tannins.

Propagation

By direct seeding, seedlings, and suckers. Transplant seedlings at 10-12 months.

Seed Treatment

None needed for fresh seeds. Otherwise, place in boiling water, leave in water to cool, then dry seeds.

Management

Coppicing, lopping, or pollarding. For shelterbelts, plant at 3x3 m. Fuelwood can be harvested in 6-8 years. Thin multistem coppice growth to one or two shoots for better pole production.

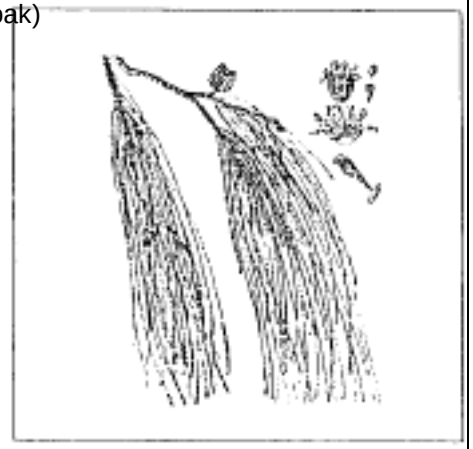
Agroforestry Uses

Intercropping, hedgerows, windbreaks, and shelterbelts. Used to shade cozoa, coffee and tea.

SPECIES: Cassia siamea Lam.	
TAXONOMY:	
1 FAMILY ……	Caesalpiniaceae
2 SYNONYMS ……	C. florida Vahl
3 LOCAL OR TRADE NAMES,	Cassia; Waa.
NATURAL OCCURRENCE:	
4 LATITUDES ……	1-5˚N
5 AREAS ……	S.E. Asia, including India, Sri Lanka and Malaya; but widely established as an exotic.
CLIMATE:	
6 ALTITUDINAL RANGE …..	0-1,000 m
7 MEAN ANNUAL RAINFALL..	650-1,500 mm
8 RAINFALL REGIME ……..	Summer
9 DRY SEASON ……	4-6 months
10 MEAN MAX, TEMP, HOTTEST MONTH ……	23-35˚c
11 MEAN MIN, TEMP, COLDEST MONTH ……	13-24˚c
12 MEAN ANNUAL TEMP …..	21-28˚c
SOILS:	
13 TEXTURE ……	Light/medium
14 REACTION……	Neutral/acid
15 DRAINAGE ……	Free draining
16 OTHER CHARACTERISTICS	Better growth on deep soils.
SILVICULTURE:	
17 SIZE ……	h = 8-10 (up to 20) m
18 DESCRIPTION……..	Evergreen
19 FORM ……	Poor/acceptable
20 LIGHT REQUIREMENTS…	Strongly demanding
21 OTHER CHARACTERISTICS	Coppices; termite resistant; tolerates salt winds; root suckers vigorously; drought hardy; moderately frost resistant; rotation of 10 years for firewood.

PRODUCTION:	
22 VOLUME (M^3/HA/AN)…..	8-12
ROLE IN LAND USE:	
23 ……..	Windbreaks; ornamental; agroforestry.
TIMBER:	
24 DENSITY ……..	S.G. 0.60-0.80
25 NATURAL DURABILITY ..	Durable
26 PRESERVATION ……..	-
27 SAWING……	Moderate
29 OTHER FEATURES…..	-
UTILIZATION:	
30 SAW TIMBER……..	Fine furniture in larger sizes.
31 ROUNDWOOD…….	Building poles; fuel (c.v. = 19,380 kJ/kg) and charcoal; veneer/plywood.
32 OTHER PRODUCTS……	Fodder (not for pigs).
NURSERY:	
33 SEED SOURCES…….	Most tropical countries.
34 SEEDS PER KILOGRAMME……..	34,000-40,000
35 STORAGE……..	Dry, ambient temperature for several years.
36 PRE-TREATMENT…….	Boiling water till cool.
37 PLANTING STOCK…….	Potted; stumps; direct sown.
38 SPECIAL REQUIREMENTS……..	-
39 GERMINATION AND GROWTH	Good (90%) and uniform after 7 days. Plantable size in 12-24 months.
PRINCIPAL PESTS AND DISEASES:	
40 ……	A serious disease is Phaeolus manihotis which kills roots causing dieback. Also susceptible browsing damage.
PRINCIPAL REFERENCES:	69 71 95 107 109 120 121 128 134 152

Casuarina equisetifolia (sea oak)



Origin

Australia, Pacific islands and Southeast Asia.

Ecology

Annual rainfall: 200-5000 mm.

Normal temperature range: 7-35^{o}C

Altitude range: 0 to 1500 m

Seasonal adaptability: Tolerates 6-8 months dry season.

Soils: pH 5.0-8.0, does not like clayey soils. Grows on moderately poor soils.

Light requirement: Strong.

Other site limitations; Cannot withstand waterlogging for long periods of time. Grows best in coastal areas.

Description

Height at maturity: 25-35 m.

Diameter at breast height (1.3 m) at maturity: 0.5-1 m.

Form: Poor to fair. Tall trees with variable stem qualities. Good potential to improve form.

Coppicing ability: Poor to fair.

Growth: At 10 years, 20 m in height and 20 cm in dbh.

Other: Fixes nitrogen; inoculation with Frankia improves N fixation greatly where no casuarinas have grown before.

Primary advantages

Among the best fuelwood species; wood burns when green; resistant to wind, salt and drought.

Primary disadvantages

Fire-sensitive, not compatible with some crops due to highly competitive nature.

Products and Yields

Wood products: Poles, fuelwood, posts and tools, heavy construction, pulp for writing and printing paper. 6-18 m^3/ha/year until age 20, declining after that. On a 7-10 year rotation yields 75-200 tons/ha.

Fuelwood: Excellent (wood density of 0.8-1.2); calorific Fodder: poor, but browsed by cattle. Yong tress can be damaged by heavy browsing.

Propagation

By seedling; raise seedlings until 5-10 cm in height, then transplant to containers for growing to a height of 30-50 cm before field planting.

Seed Treatment

None needed. Store seed in dry conditions; viability is low.

Management

Rotation periods for fuelwood is 7-15 years. Plant plantations at 2x2 m or 3x3 m. As with most other tree species, plant after rains have started; young seedlings need soil moisture.

Agroforestry Uses

Living fences, shelterbelts in windy zones. Will suppress most undergrowth, so it should not be used with annual crops in agroforestry systems. Used as a shade tree for coffee and cardamom in Papua New Guinea.

SPECIES: Casuarina equisetifolia L.

TAXONOMY:

1 FAMILY . . . . . .Casuarinaceae

2 SYNONYMS . . . . C. littoralis Salisb.

3 LOCAL OR TRADE NAMES . . . . Coast or Beach She-oak

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 31,5-12o S and 18-22o N

5 AREAS . . . . Coastal dunes of S.E. Asia and Australia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0,1-14,00 m

7 MEAN ANNUAL RAINFALL . . . . .. 750-2500 mm

8 RAINFALL REGIME . . . . . Winter/summer

9 DRY SEASON . . . .3-4 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . 20-30^{o}C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .10-20^{o}C

12 MEAN ANNUAL TEMP. . . . . .18-28 ^{o}C

SOILS:

13 EXTURE . . . . .Light

14 REACTIONS . . . . . Alkaline/neutral

15 RAINAGE . . . . . Seasonally waterlogged

16 OTHER CHARACTERISTICS . . . . ..Tolerates slightly saline soils and poor, dry soils.

SILVICULTURE:

17 SIZES . . . . . h = 10-40 m; d =40-45 cm.

18 DESCRIPTIONS . . . . . Evergreen, light crowned; dioecious.

19 FROM . . . . . .Exceptional/ Acceptable

20 LIGHT REQUIREMENTS . . .. .Strongly demanding

21 OTHER CHARACTERISTICS . . . . Weak coppice; termite resistant; tolerates salt winds; fixes nitrogen; requires wide spacing; frost tender; fire sensitive; short-lived (20-40 years); rotatons of 8-15 years for fuelwood

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . . 5-18

ROLE IN LAND USE:

23 . . . . Windbreaks; soil improvement; ornamental; anti-erosion; dune stabilization..

TIMBER:

24 DENSITY . . . . . .S.G. 0.80-1.20

25 NATURAL DURABILITY . . . . . Moderately durable.

26 PRESERVATION . . . . . Fair

27 SAWING . . . . . Difficult

28 SEASONING . . . . .Difficult

29 OTHER FEATURE . . . . . Very hard; attractive figure when quarter sawn.

TILIZATION:

30 SAW TIMBER . . . . . Heavy construction; boat building.

31 ROUNDWOOD . . . . . .Building poles; transmission poles; fence posts; fuel (c.v. 19,580-20,560 kJ/kg) and charcoal; shortfibre pulp.

32 OTHER PRODUCTS . . . .Tannins; dyes; medicine; ‘Cones’ (1.8 t/ha/an) for fuel.

NURSERY:

33 SEED SOURCES . . . . Nearly all tropical and sub-tropical coastal areas.

34 SEEDS PER DILOGRAMME 700,000-800,000

35 STORAGE . . . . Sealed at 4o C for up to 8 months.

36 PRE-TREATMENT . . . . none

37 PLANTING STOCK . . . .. Potted; bare-rooted plants; cuttings.

38 SPECIAL REQUIREMENTS. . . Shade in nursery. Inoculate soil of new plantation sites with crushed root nodules.

39GERMINATION AND GROWTH. . . .Germinates in 20-40 days (60-70% of fresh seed). 5-25% germination after 12 months storage. Plantable size in 4-8 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . . .Usually free from pests and diseases.

PRINCIPAL REFERENCES: 40 52 60 71 95 109 121 128 152

Dalbergia cochinchinensis

Mai khanjung, Black Wood, Rose Wood, Siamese Rose Wood,

Origin

Laos, Burma, Cambodia, Vietnam, Thailand in mixed wet deciduous and dry evergreen forest, in east, north east.

Ecology

Altitude range: 100-300 m

Seasonal adaptability:-

Soils: -

Light requirement:-

Other site factors:-

Description

Height at maturity: 25m

Diameter:-

Form: straight

Coppicing ability:-

Growth: in one test plot in which the trees were at 2x3 m spacing, at one year the trees measured h = 1.1 m, two years h = 2.1 m, 4 years h =4.2 m. At 2 x2 m spacing at 4 year h = 4.4 m. In another test in Saraburi; elevation = 40 m. temperature min/max 22.7 – 34.7^{o}C, rainfall 1488 mm: after 5 years 8 months in test plot using no fertilizer h =4.2 m d = 4.65 cm survival rate 85.3%, in plot using fertilizer h = 4.6 m, d = 5.8 cm survival rate 78.6%.

Products and yields

Wood products: Sawn timber has a fine grain with narrow darker coloured streaks. Reddish to purplish brown in colour. Oily appearance. Durable. Easy so saw. Usable Other: Sap can be used for coating (impregnating) wood. One tree may contain up to up to 50 kg of sap. Roots bark are used as medicine. Sap is used as external foot skin ointment.

Propagation

By seed, stumps. Most common by seed. Seed pods ripen from July to September. The pods do not break open before falling. Each pod contains about 4 seeds.

Seed Treatment

Soak in water for 24 hours and plant in sand, covering seed lightly. Water regularly but not to point of saturation. Germination in 7 days. Move to poly bag 10-14 days after germination. Transplant in 4x6 inch grid. Growing material should consist of alluvial soil, sand, rice husk ash, compost at a ratio of 5:2:2:1. After 3-5 months seedling should be about 30 cm high and can be out-planted.

Management

Best to out-plant during rainy season between May and August at 3x3 m or 2x3 m spacing.

Dalbergia sissoo (rose wood)

Origin

Himlayan foothills of South Asia.

Ecology

Annual rainfall: 500-2000 mm.

Normal temperature range: 9-36°C

Altitude range: 0 to 1500 m.

Seasonal adaptability: 4 months.

Soils: pH 5.5-7.5; pure sands to rich alluvial bottomlands. Likes well-drained soils, but can withstand some water-logging. Performs poorly on poorly drained clay soils.

Light requirement: High.

Other site limitations: Fire sensitive.

Description

Height at maturity: 15-30 m.

Diameter at breast height (1.3) at maturity: 80-100 cm

Form: Fair

Coppicing ability: Very good

Growth: in 5 years, can attain 9 m height on good sites, 13 cm diameter at breast height.

Other: Fixes nitrogen.

Primary advantages

Quality timber for carving, furniture; can tolerate a wide range of temperatures.

Primary disadvantages

Trees are browsed heavily by animals. Fire sensitive and can lose vigor after three cuttings. Root suckers can be weedy. Heartwood susceptible to root rot.

Products and Yields

Wood product:

Wood products: Carved items, farm tools, poles, timber, furniture, fuelwood; wood yields of 61-99 m^3/ha in a 10-year rotation.

Fuelwood: Excellent (wood density of 0.64-.07); 49000-52000 kcal/kg. Charcoal is also of good quality.

Fodder: Good quality leaves, pods, and branches; 12-24% protein and 12-26% crude fiber.

Other: Honey and tannins.

Propagation

By cuttings, direct seeding, seedlings, and natural regeneration. Shade is needed in the nursery. Grow stumps 6-12 months in bed; pull up carefully; prune shoot to 5-10 cm and roots to 20 cm length. Plant in container; outplant at site when stem diameter reaches 1-2.5 cm.

Seed Treatment

Break the seed pod into several pieces, each containing 1-2 seeds. Soak pods in room temperature water for at least 24 hours before sowing. Seeds can be stored for 2-4 years in a cold (5o) room.

Management

Coppice for fuelwood, lop or pollard for forage. Planting at close spacing yields more fuelwood and better stem quality. Weeding should be done for the first 3 years. Thin regularly for timber production

Agroforestry Uses

Tuangya systems, along canals, and irrigated plantations.

SPECIES: dalbergia sissoo Roxb.

TAXONOMY:

1 FAMILY . . . . . .Papiloonaceae

2 SYNONYMS . . . . . -

3 LOCAL OR TRADE NAMES . . . . Shisham; Sissoo.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 23-30° N

5 AREAS . . . . Indus to Assam; Himalayas.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0-1,500 m

7 MEAN ANNUAL RAINFALL . . . . 500-4,000 mm

8 RAINFALL REGIME . . . . . Summer monsoon.

9 DRY SEASON . . . .Up to 6 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . 35-45° C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .-2-+5° C

12 MEAN ANNUAL TEMP. . . . . .18-28° C

SOILS:

13 EXTURE . . . . .Light /medium

14 REACTIONS . . . . . Neutral/acidic

15 RAINAGE . . . . . Good; seasonally inundated.

16 OTHER CHARACTERISTICS . . . . . River beds and river flats.

SILVICULTURE:

17 SIZES . . . . . h = 30 m

18 DESCRIPTIONS . . . . . Deciduous

19 FROM . . . . . .Acceptable

20 LIGHT REQUIREMENTS . . .. .Strongly demanding

21 OTHER CHARACTERISTICS . . . . Coppices; frost resistant; drought hardy.

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . . 5-8

ROLE IN LAND USE:

23 . . . . Agroforestry (gives minimal root and shade competition); erosion control in gullies and dunes.

TIMBER:

24 DENSITY . . . . . .S.G. 0.78-0.83

25 NATURAL DURABILITY . . . . . Druable

26 PRESERVATION . . . . . Sapwood easily treated.

27 SAWING . . . . . Easy

28 SEASONING . . . . Easy

29 OTHER FEATURE . . . . . Black heartwood figured; good bending properties.

UTILIZATION:

30 SAW TIMBER . . . . . Carpentry; furniture; carriages.

31 ROUNDWOOD . . . . . Veneer; wheels; fuelwood (c.v. – 20,450kJ/kg); transmission poles; fence posts.

32 OTHER PRODUCTS . . . . Fodder (leaves for silage); honey flora.

NURSERY:

33 SEED SOURCES . . . . India; Pakistan; Sudan; Kenya; Cyprus.

34 SEEDS PER DILOGRAMME 45,000-55,000

35 STORAGE . . . . . Dry, cold, sealed for 1-2 years. Protect from rodents.

36 PRE-TREATMENT . . . Soak in water, 48 hours.

37 PLANTING STOCK . . . . Potted; stumps; root suckers; branch cuttings.

38 SPECIAL REQUIREMENTS. . . . . -

39GERMINATION AND GROWTH. . . . 85-95% germination in 7-15 days. Plantable size in 12-15 months.

40 . . . . . Mixed species plantations recommended to combat weeds and pests. Browsing damage by porcupines. Termites attack young plants. Tapinanthus dodoneifolius, mistletoe.

PRINCIPAL REFERENCES: 16 61 65 71 82 84 134 141 152

Dalbergia sissoo

Rose wood, Praduu khaek

Dipterocarpus alatus

Mai Njaang. Yang, Gurjan or Gargan

Origin

Laos, India, Bangladesh, Sri Lanka, Burma, Thailand, Vietnam, Cambodia, Malaysia and Philippines. In all of Thailand.

Ecology

Annual rainfall: at least 1 500 mm

Normal temperature range: Hottest month 45^{o}C. Cannot tolerate frost

Altitude range: 200-600 m

Soils: Rich deep soils, sandy loam, alluvial soils. pH 6-7. Good drainage. Grows poorly in heavy or water logged soils, shallow or rocky soils, or extremely sandy.

Light requirement: Partial shade in first two years, afterward high requirement.

Description

Height at maturity: 30-40 m. 20 m to first branches

Form: straight

Dry evergreen forest, in flat areas near rivers or streams. In areas near rivers or streams. In areas where seasonal flooding leaves alluvial soil.

Products and yields

Wood products: Density 0.70 Easy to treat. Easy sawing and planing, polishes well. Cut timber is reddish brown, straight grain, rough, medium heard. Can be used for building, plywood, treated wood can be used for eternal use e.g. railroad sleepers.

Other: sap can be use to coat (impregnate) wood, impregnate exterior of boats, used to make tools, make torches, medicine.

Propagation

The fruit has two wings at the end of the fruit which will become the roots. Inside the fruit is one seed which is similar to white flour with brown lines throughout. A viable seed must be completely enclosed with a swelled look. If cut open, the inside must be soft and sticky as it contains rubber. If the fruit is dry and can be peeled easily it is not viable. The seed ripens from March to May. The seeds which fall to the ground will only have a 30% germination rate, therefore it is best to collect the seeds from the tree. When the seed ripens the wings will change colour from green to light brown and finally dark brown. It is not necessary to let the colour change to dark brown as the seed will loose its viability quickly. If the moisture content of the seed drops below 30% the seed loses its viability. If the tree is too high the seeds must be collected from ground but only 57% will be viable. 37% have insect damage and 9 percent are rotten.

Seed Treatment

Better if not stored. Cut off the seed wings. Plant in rice husk ash. Push partly into the soil with the part which will become the roots appearing at the surface. Water. The seed will germinate in 5 – 6 days. An alternative way is to place many seeds in a rice sack, coconut husk, or rice straw, so the seeds are covered, water twice a day, morning and evening for about 5 – 7 days. The seeds which sprout can be moved to poly-bags. The seeds will continue to sprout for about 1 month. The material for the poly-bag may be the top soil from the areas of the mature trees mixed with other top soil, but the best results have come from mixing the top soil from the area of natural occurring of the trees, which has mycoriza, with coconut husks at a 1:1 ratio. Use osmodot fertilizer 0.5 grams/seedling. Out-planting can be done when the trees are 4 months, 25 -30 cm tall. The mycoriza fungus is of the kind ektomycoriza, if present will promote growth and increase the seedlings survival rate as it will help the plants ability to absorb minerals and water, along with preventing root disease and make the seedling more tolerable toward drought.

Management

Out-plant at 4 x 4 m spacing. When branches touch each other they must be trimmed. Later trees can be thinned out to 8 x 8 spacing. Prevent extensive insect damage. It may be advisable to plant together with other tree species to reduce insect infestation.

Agroforestry Uses

As this tree needs partial shade in first two years it is suggested to plant bananas for shade which also helps maintain good moisture level and is a source of income. The banana can continue to be grown for 10 years with proper spacing.

Ecucalyptus cammaldulensis (river red gum)

Origin

Australia

Ecology

Annual rainfall: 250—2500 mm.

Normal temperature range: 13-28 °C

Altitude range: 0 to 20000 m.

Seasonal adaptability: 2 to 8 months.

Soils: Acidic to neutral (pH 4.5-7.0); can withstand some watherlogging, slightly saline, slightly saline soils and infertile sites.

Light requirement: Strong.

Other site limitations: Poor growth on alkaline soils, dry sands, shallow soils. Important to match seed source with site.

Description

Height at maturity: 25-40 m.

Diameter at breast height (1.3 m) at maturity: 60-100 cm.

Form: Straight bole in plantation, narrow crown.

Coppicing ability: Good to excellent.

Growth: 18 m height and 17 cm in diameter at 10 years.

Primary advantages

Fast growth on poor sites with low rainfall if free from initial weed competition; good for fuelwood and poles; resistant to most diseases.

Primary disadvantages

Leaves are not palatable to livestock; grows so fast it is difficult to intercrop with this species; may be attacked by termites in seedling stage; Northern Australian provenances (seed sources) are rather frost-sensitive.

Products and Yields

Wood products: Poles, posts, charcoal, fuelwood, timber, and pulp. Yields of 17-30 m^3//ha/yaer on fair-good sites.

Fuelwood: Very good; wood density of 0.6-0.7; 4800 kcal/kg.

Fodder: Not palatable.

Other: Honey.

Propagation

By seed or cuttings; seedlings most common. Plant seedlings in the field when they are 3-4 months old.

Seed Treatment

No pretreatment needed. Seeds can be stored for over three years if storage space is cold and dry, and containers are sealed.

Management

Coppicing and pollarding. Plantations are usually planted at 3x3 m or 4x4 m spacing or wider between rows for intercropping. Weed for first two growing season.

Agroforestry Uses.

Used in taungya systems, shelterbelts, and windbreaks. Competes with crops very effectively for water, so planting location must be considered.

SPECIES: Eucalyptus camaldulensis Dehnh. (Northern Provenances)

TAXONOMY:

1 FAMILY . . . . .Myrtaceae

2 synonyms . . . . .E. rostrata Schlecht.

3 LOCAL OR TRADE NAMES. River Red gum.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 32-15^{O} C

5 AREAS . . . . . Australia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . 0-1,500 m

7 MEAN ANNUAL RAINFALL . . . . . 250-1,250 mm

8 RAINFALL REGIME . . . . . summer

9 DRY SEASON . . . . . 4-8 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . .28-36^{o}C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . 10-22^{o}C

12 MEAN ANNUAL TEMP. . . . . .19-26^{o}C

SOILS:

13 TEXTURE . . . . . Light/medium/heavy

14 REACTION . . . . . Alkaline/neutral

15 DRAINAGE . . . . . Seasonally waterlogged.

16 OTHER CHACTERISTICS . . Tolerates moderately saline soils.

SILVICULTURE:

17 SIZE . . . .h = 20-40 m; d =80-200 cm

18 DESCRIPTION . . . .evergreen

19 FORM . . . . . .Acceptable

20 LIGHT REQUIREMENTS . . . . .Strongly demanding

21 OTHER CHARACTERISTICS.Coppices; drought hardy; substantial provenance variation (Petford-QL, and Katherine-NT are enerally outstanding provenances for tropical climates, Wiluna-WA for alkaline soils); frost tender: 6-10 year coppice rotation

22 VOLUME (M^3/HA/AN) 15-25

ROLE IN LAND USE:

23 . . . . . Swamp reclamation; shade and shelter.

TIMBER:

24 DENSITY . . . . . .S.G. 0.75-1.0

25 NATURAL DURABILITY . . . . . Durable

26 PRESERVATION . . . . . Fair

27 SAWING . . . . . .Easy

28 SEASONING . . . . . Difficult

29 OTHER FEATURES . . . . . .Tough; interlocked grain; termite resistant.

UTILIZATION:

30 SAW TIMBER . . . . . Heavy construction; railway sleepers.

31 ROUNDWOOD . . . . .Building poles; transmission poles; fence posts; fuel (c.v. = 19,737 kJ/kg) and charcoal; shortfibre pulp.

32 OTHER PRODUCTS . . . . . Honeyflora.

NURSERY:

34 SEEDS PER KILOGRAMME . . . . . Australia specifying provenance.

35 STORAGE . . . . . 700,000-800,000 (plus chaff); or 190,000 plants/kg of seed

36 PRE-TREATMENT . . . . .None

37 PLANTING STOCK . . . . Potted

38 SPECIAL REQUIREMENTS. -

39 GERMINATION AND GROWTH . . . . Germinates in 4-15 days. Plantable size in 4 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . . Young plants liable to termite attack. Susceptible to attack by Gonipterus beetle.

PRINCIPAL REFERENCES: 4 16 46 71 82 83 84 91 95 96 107 109 121 128 130 152

Eucalyptus camaldulensis

River red gum, Mai vic

SPECIES: Eucalyptus tereticornis Sm.

SILVICULTURE:

17 SIZE . . . .h = 35-45 m; d =100-200 cm

18 DESCRIPTION . . . .evergreen

19 FORM . . . . . Acceptable to Exceptional.

20 LIGHT REQUIREMENTS . . . Strongly demanding

21 OTHER CHARACTERISTICS . . .Coppices; windfirm; frost resistant; substantial provenance variation; drought hardy; 6-10 year coppice rotation.

TAXONOMY:

1 FAMILY . . . . .Myrtaceae

2 synonyms . . . . .E. umbellate (Gaertn.) Domin

3 LOCAL OR TRADE NAMES. . . Forest red gum; Mysore 'hybrid" (India); "12ABL" (Madagascar); Eucalyptus "C" (Zanzibar).

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 38-5^{O} S

5 AREAS . . . . . Australia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . 0-1,800 m

7 MEAN ANNUAL RAINFALL . . . . . 500-1,500 mm

8 RAINFALL REGIMES . . . . . summer

9 DRY SEASON . . . . . 4-7 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . .22-32^{o}C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . 2-12^{o}C

12 MEAN ANNUAL TEMP. . . . . .17-27^{o}C

SOILS:

13 TEXTURE . . . . . Light/medium/heavy

14 REACTION . . . . . Natural

15DRAINAGE . . . . . Free draining

16 OTHER CHACTERISTICS. . Tolerates moderately saline soils.

PRODUCTION:

22 VOLUME (M^3/HA/AN) 15-25

ROLE IN LAND USE:

23 . . . . . .

TIMBER:

24 DENSITY . . . . . .S.G. 0.70-85

25 NATURAL DURABILITY . . . . . Durable

26 PRESERVATION . . . . . Easy

27 SAWING . . . . . .Easy

28 SEASONING . . . . . Fair

29 OTHER FEATURES . . . . . Interlocked grain; Lyctus susceptible.

UTILIZATION:

30 SAW TIMBER . . . . . Heavy construction; light construction; boxes; boat building.

31 ROUNDWOOD . . . . . Building poles; transmission poles; fence posts; fuel (c.v. = 22,120 kJ/kg) and charcoal; shortfibre pulp.

32 OTHER PRODUCTS . . . . . Honeflora; oils.

NURSERY:

34 SEEDS PER KILOGRAMME . . . . . Australia; Brazil; Sudan; India; Madagasca and many other tropical countries.

35 STORAGE . . . . . 300,000-800,000 (viable).

36 PRE-TREATMENT . . . . .None

37 PLANTING STOCK . . . . Potted

38 SPECIAL REQUIREMENTS. -

39 GERMINATION AND GROWTH . . . . Germinates in 5-15 days. Plantable size in 4-5 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . . Susceptible to termite attack when young. Liable to attack by Gonipterus beetle.

PRINCIPAL REFERENCES: 4 71 82 83 85 88 91 95 101 130 152

Eucalyptus tereticornis

Forest red gum, Mai vic

Hopea odorata

Mai Ken, Iron wood, Thingan, Sace, Takian

Origin

Southeast Asia: Thailand, Burma, Lao, Vietnam, Cambodia, and Malasia.

Ecology

Annual rainfall: 1,500 mm

Forest Description: evergreen, located on flat or nearly flat areas in evergreen forests or along river sides.

Soils: Light. Good drainage

Light requirement:

Other site factors:

Description

Height at maturity: 20-40 m

Primary advantages

Wood is resistant to termites.

Primary disadvantages

A giraffe beatle likes to eat the young leaves for breakfast.

Products and yields

Wood is brown to yellow in color with white or gray lines, hard, flexible. Density 0.82. Natural durability 3 – 10.5 years. Easily treated. Useful in construction of houses, bridges, railroad sleepers, boats, furniture.

Bark, core, flowers, pitch used as traditional medicines.

Propagation

Propagation by seed. Flowers from February to April. Does not produce seeds every year and the number of seed is usually low. The seeds loose viability quickly because of there moist nature. Seeds should be gathered while on the tree. The age of the seed can be determined from the seed wings. The wings of a ripe seed are green with red tips. An old seed has red wings with brown tips. The seeds should be collected when the seed wing tips are red. Ripe seed have a 60-90% moisture content and a high germination rate. If the moisture content falls below 35% the germination rate is endangered. If the seeds are not immediately planted, they should be kept at 20 degrees and 90% humidity or higher. The seeds germinate best at 20 – 35 degrees.

Management

Seedlings to be outplanted should be at lest one year old. The seed should be hardened a couple of weeks before outplanting. Plant after rainfall. Soak seedling roots in water before planting. Plant at 4x4 m spacing. Can be planted together with fast growing tree species.

Gliricidia sepium

Gliricidia sepium (gliricidia)

Origin

Central America.

Ecology

Annual rainfall: 650-3500 mm

Normal temperature range: 19-36 °C

Altitude range: 0 to 1500 m

Seasonal adaptability: Tolerates 6-7 months dry season.

Soils: pH 4.5-8.0. Pure sand to heavy clay; shallow, rock, and eroded soils; slightly saline soils

Light requirement: Medium to high.

Other site limitations: Light frosts cause dieback, but can resprout. Does not tolerate heavy frost or waterlogging.

Description

Height at maturity: 10-12 m.

Diameter at breast height (1.3m) at maturity: 30-50 cm.

Form: Poor to fair; trunk twists, multistem.

Coppicing ability: Very good.

Growth: Fast.

Other: Fixes nitrogen.

Primary advantages

Can be planted as large cuttings and pruned to maintain living fences; nitrogen fixer and good shade tree.

Primary disadvantages

Leaves, roots, and seeds are toxic to horses; fast decomposition reduces its effectiveness and a mulch for weed control.

Products and Yields

Wood products: Posts, charcoal; yields 10-15 m^3/ha/year.

Fuelwood: Very good (wood density of 0.5-0.6); 4700-4900 kcal/kg for fuelwood.

Fodder: High protein content (18-30%) and highly digestible (48-77%). Mixed feed of 10-30 fresh weight basis in mix of grass, straw or others.

Green manure: High nitrogen content, decomposes quickly. Yields very from 500-3000 kg/ha (dry weight) per cutting.

Other: Edible flowers, good-quality honey.

Propagation

By cuttings, seedlings, or direct seeding. For cuttings, take a mature, branch, 2-6 cm in diameter, 30-200 cm long. Plant to a depth of 20-50 cm.

Seed Treatment

None for fresh seed. Otherwise soak in tepid water overnight. Inoculate with rhizobium to ensure nodulation.

Management

For living fence, plant in rows at 1-2 m spacing, or 20 cm for a thick hedge. Woodlot rotations are about 5 years, coppicing every 2-4 years.

Agroforestry Uses

Living fences, hedgerows, alleycropping, shelterbelts, and fuelwood plantings. Used to shade coffee and cocoa, and as a support for pepper, yams, and vanilla.

SPECIES: Gliricidia sepium (Jacq.) Walp.

TAXONOMY:

1 FAMILY . . . . .Papilionaceae

2 synonyms . . . . G. maculate Kunth

3 LOCAL OR TRADE NAMES. . .. Madre de cacao (S. Am.); Kakawate (Philippines).

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 6-19 °N

5 AREAS . . . . . Tropical Americas. Naturalised in Philippines and W. Nigeria.

CLIMATE:

6 ALTITUDINAL RANGE . . . . 0-900 m

7 MEAN ANNUAL RAINFALL . . . . 800-2,300 mm

8 RAINFALL REGIME . . . . . summer/uniform

9 DRY SEASON . . . . . 4-6 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . .34-41 °C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . 14-20 °C

12 MEAN ANNUAL TEMP. . . . . .22-28°C

SOILS:

13 TEXTURE . . . . . Medium

14 REACTION . . . . . Alkaline/neutral/acid

15 DRAINAGE . . . . . Free draining; moist.

16 OTHER CHACTERISTICS . . Tolerates moderately saline soils.

SILVICULTURE:

17 SIZE . . . h = 5-15 m

18 DESCRIPTION . . . Deciduous

19 FORM . . . . . poor

20 LIGHT REQUIREMENTS . .-

21 OTHER CHARACTERISTICS Copices; fire resistant; fixes nitrogen; requires wide spacing; tolerates browsing and lopping; uses water economically during dry season; fast growing.

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . . . . -

ROLE IN LAND USE:

23 . . . . . Land stablisation prior to re-afforestation; live-fences; agricultureal shade.

TIMBER:

24 DENSITY . . . . . .-

25 NATURAL DURABILITY . . . . . Very durable

26PRESERVATION . . . . . .-

27 SAWING . . . . . .Difficult

28 SEASONING . . . . . Easy

29 OTHER FEATURES . . . . . Hard; tough; irregular grain; termite resistant.

UTILIZATION:

30 SAW TIMBER . . . . . Raiway sleepers; heavy construction; locally for furniture.

31 ROUNDWOOD . . . . Posts; tools; fuelwood (c.v. 20,570 kJ/kg).

32 OTHER PRODUCTS . . . . .Honeyflora; green manure; fodder (N.B. leaves toxic to horses; roots, bark and seed toxic to man); rat poison (seed)

NURSERY:

33 SEED SOURCES . . . . . Nicaragua; Costa Rica.

34 SEEDS PER KILOGRAMME 6,500-7,000

35 STORAGE . . . . . up to 12 months.

36 PRE-TREATMENT . . . . . Soak overnight in hot water, plant immediately.

37 PLANTING STOCK . . . Potted; branch cuttings.

38 SPECIAL REQUIREMENTS. -

39 GERMINATION AND GROWTH . . . 90-100% germination in 7 days. Plantable size in 3 months.

PRINCIPAL PESTS AND DISEASES:

40 ……..Termites; ‘scale insects’ in E. Africa.

PRINCIPAL REFERENCES: 16 48 121 131

Leucaena leucocephala (leucaena)

Origin

Central America.

Ecology

Annual rainfall: 600-2500 mm.

Normal temperature range: 10-33 °C

Altitude range: 0 to 1000 m.

Seasonal adaptability: 5-6 months.

Soils: Soil pH of 6.8-9.0. Cannot grow well on acid soils.

Light requirement: Strong.

Other site limitations: Yields decline rapidly at higher elevations; unsuitable above 500 m

Description

Height at maturity: 10-20 m.

Diameter at breast height (1.3 m) at maturity: 40 cm.

Form: Poor to excellent.

Coppicing ability: Excellent.

Growth: 8 m in height and 5 cm in diameter in 3 years.

Other: Fixes nitrogen.

Primary advantages

Fast growth on good sites; coppices well; wood used for poles, pulp, and fuel; leaves are good fodder supplement.

Primary disadvantages

Leucaena psyllid (Heteropsylla cubana) is an important defoliating pest, although new varieties offer resistance. Because the foliage contains the toxin mimosine, non-ruminants should consume only 5-10% leucaena in total diet. Can become a weed.

Products and Yields

Wood products: Fuelwood, post, poles, pulp, small timber; typically yields 20-40 m^3/ha/year

Fuelwood: Good; 4200-4600 kcal/kg, wood density 0.7-0.8. With its fast growth, this makes it a good species for short-rotation fuelwood plantations, though heavy seeding can reduce yields.

Fodder: Good feed supplement (25-30% protein), except that it contains mimosine. Ruminant bacteria can be provided to ruminants to detoxify mimosine. High digestibility.

Other: Young shoots and leaves may be eaten, in some countries seeds are also eaten after cooking.

Propagation

Planted seedlings or direct seeding. Seedlings must be weeded. Hedgerows are commonly planted in double rows, starting from seed sown 20 cm apart. New hybrids with L. diversifolia developed in Taiwan and Hawaii, U.S.A.

Seed Treatment

Soak in boiling water for 2-3 minutes, the nleave in water at room temperature for 2-3 days. Sow soon after treating.

Management

Coppicing, lopping, pollarding. Rotations of 6 months for small fuelwood, up to 10 years for poles. Fodder can be harvested at 2-4 months in hedgerows, lopping at height of 70 cm-1 m.

Agroforestry Uses

Hedgerows, alleycropping, intercropping, intercropping, Commonly intercropped with cassava, maize, papaya, and sweet potato.

SPECIES: Leucaena leucocephala (lam) de Wit (Salvador type)

TAXONOMY:

1 FAMILY . . . . Mimosaceae

2 synonyms . . . . Leucaena glauca Benth.

3 LOCAL OR TRADE NAMES. . .Leucaena

NATURAL OCCURRENCE:

4 LATITUDES……..15-17 °N

5 AREAS……S.W. Mexico and Central Guatemala.

CLIMATE:

6 ALTITUDINAL RANGE . . . . 0-800 m

7 MEAN ANNUAL RAINFALL . . . . 600-1,00 mm

8 RAINFALL REGIME . . . . . winter/summer

9 DRY SEASON . . . . . 2-6 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . .24-32 °C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . 16-24 °C

12 MEAN ANNUAL TEMP. . . . . .20-28 °C

SILVICULTURE:

17 SIZE . . . h = 15-20 m

18 DESCRIPTION . . . Evergreen/deciduous

19 FORM . . . . . Acceptable

20 LIGHT REQUIREMENTS . .- Strongly demanding; shade tolerant in youth.

21 OTHER CHARACTERISTICS . . . Aggressive colonizer; coppices; fixes nitrogen; frost tender.

PRODUCTION:

22 VOLUME (M^3/HA/AN) 30-40

ROLE IN LAND USE:

23 . . . . . Soil improvement; agricultural shade; agroforestry..

TIMBER:

24 DENSITY . . . . . .S.G. 0.50-0.59

25 NATURAL DURABILITY . . . . . -

26PRESERVATION . . . . . .Easy

27 SAWING . . . . . Easy

28 SEASONING . . . . . -

29 OTHER FEATURES . . . . . .

UTILIZATION:

30 SAW TIMBER . . . . . Light construction; boxes

31 ROUNDWOOD . . . . Building poles; transmission poles; fence posts; fuel (c.v. = 19,492 kJ/kg) and charcoal; shortfibre pulp.

32 OTHER PRODUCTS . . . . . Fodder (toxic to ruminants if not mixed with other feeds).

NURSERY:

33 SEED SOURCES . . . . . Philippines; Hawaii; Australia; Costa Rica; Mexico.

34 SEEDS PER KILOGRAMME 26,000-30,000

35 STORAGE . . . . . Ambient temperature for several years.

36 PRE-TREATMENT . . . . . Soak in water heated to 80 °C, for two minutes.

37 PLANTING STOCK . . . Potted

38 SPECIAL REQUIREMENTS. Soil may require inoculation with a Rhizobium starain for nitrogen fixation.

39 GERMINATION AND GROWTH . . . . Germinates in 8-10 days.

PRINCIPAL PESTS AND DISEASES:

40……

The high resistance of the Hawaiian type has yet to be confirmed for this type. Camptomeris leucaenae: potentially serious leaf-spot disease in Latin America.

PRINCIPAL REFERENCES: 79 109 119 120 121 329

Leucaena leucocephala

Leucaena, Ka thin yak

Mangifera indica

Mangifera indica (Mango)

Origin

South and Shouteast Asia.

Ecology

Annual rainfall: 300-2700 mm.

Normal temperature range: 9-36 °C

Altitude range: 0 to 1600 m.

Seasonal adaptability: tolerates 6-8 months dry season

Soils: Most soils, deep sandy loams-heavy clays; must be well drained.

Light requirement: Strong.

Description

Height at maturity: 15-25 m.

Diameter at breast height (1.3 m) at Maturity: 60-100 cm

Form: Spreading crown, short bole 2-3 m in height.

Coppicing ability: None.

Other: Does not fix nitrogen.

Primary advantages

Good fruit tree that grows well on poor soils and dry sites; also produces wood and adequate fodder.

Primary disadvantages

Does not fruit well without a pronounced dry season.

Products and Yields

Fruit: Five-year-old trees can yield 20 fruits/year; at 10 years, 500 fruits/year; at 15 years, 1,500 fruits/year; at maturity, over 200 fruits/year. In a plantation, this can mean almost 60 tons/ha/year. Wood products: Furniture, fuelwood, utensils; plywood, wood density 0.48-0.58.

Fodder: Not good, but young leaves can be eaten by some animals.

Other: Trees are pollinated by bees, so honey production can be good but seasonal.

Propagation

Grafting, seed, shield budding. Grafting from good varieties ensures a high-quality fruit tree with known qualities.

Seed Treatment

Store seed for up to 3 months in charcoal, sealed in a plastic bag at room temperature. Do not cool seeds.

Management

Pruning improves form and removes dead growth and weak shoots. Prune or thin plantations as the trees mature.

Agrofoestry Uses

Intercropping systems and homegardens.

Mangifera indica (mango)

Mango, kok mango, Mak muang

Melia azedarach (China berry)

Origin

South and Southeast Asia.

Ecology

Annual rainfall: 600-2500 mm.

Normal temperature range: 3-37 ° C

Altitude range: 0 to 2000 m.

Seasonal adaptability: Poor.

Soils: Well drained, fertile, with slight acidity (pH of 5.5-6.5) is best.

Light requirement: Medium to strong.

Description

Height at maturity: 10-25 m.

Diameter at breast height (1.3 m) at maturity: 1-1.5 m.

Form: Fair.

Coppicing ability: Good.

Other: Does not fix nitrogen.

Primary advantages

Good for veneer and plywood.

Primary disadvantages

Short lived and has a brittle crown.

Products and Yields

Wood products: Fuelwood, timber, tools. Yields of 5-10 m^3/ha/year are normal; large diameter trees are often hollow.

Fuelwood: Wood density of 0.45-0.66 and calorific value of 4600-5200 kcal/kg is normal.

Fodder: Generally not used, but goats are sometimes fed the leaves.

Other: Oils and insecticides from the fruit.

Propagation

From seed or cuttings. Transplant at about 1 month of age.

Seed Treatment

Remove seed from fruit and soak in water for a few days to speed germination. Seed remains viable for up to one year.

Management

Manage for fuelwood by copping. Short rotations of 10-15 years are recommended.

Agroforestry Uses

Used in boundary plantings and as a shade tree.

Melia azedarach

Kadau sang, Bestard Cedar, Persian Lilac, Bead tree, China berry, China tree, Pride of Indica, Pride of China, Umbrella china berry, Lia, Lilac

Three species in Thailand: Melia azedarach, Melia dubia and Melia toosendan.

Origin

From Iran to Himalayan mountains. Thailand to Japan, eastern Australia, and Papua New Guinea, Brazil, Argentina.

Thailand: In all areas except southern, eastern, low central Thailand.

Ecology

Annual rainfall: 1,200 mm

Altitude range: up to 500 m / 50 - 800 m Seasonal adaptability:

Forest Description: On hill sides, by streams, flat areas in evergreen forest. Found in mixed stands with makhaa, praduu, njaang trees.

Soils: Light. Good drainage, cannot tolerate water-logged areas

Light requirement: High.

Other site factors: Adaptable to local conditions.

Description

Height at maturity: 30 m Diameter:

Growth: Fast growing. Hight growth in one plot at age of 1-3, 4-5, 6, and 11 years 5-10, 10-15, 15-20. 20-25 m. At eleven years the diameter at breast height was 15-25 cm.

Primary advantages Useable in 15 years

Primary disadvantages

Not tolerant to strong winds. Susceptible to heart rot.

Products and yields

Wood products: Easy to saw, beautiful grain. Usable in making plywood, building. Other: Dye made of and medicine made from wood.

Propagation

Propagation by seed, cuttings, eyes, but seeding is the easiest. The fruit will mature from September to January. The mature fruit is light yellow. To separate seeds from fruit first soak in water until soft and wash flesh off of the seed shell. Open the seed shell by hitting or cutting. 1000 fruits weight 2.1158 kg, 1000 seeds weigh 22.07 grams.

Seed Treatment

Can store 1 - 2 years at room temperature, or even longer in a plastic bag at 12°C. Germination 60% in 5 - 8 days. Place seed in 80°C water for 30 minutes. Plant in sand mixed with rice husk ash 1:1. Cover with sand and water twice a day.

Management

Plant in 5 x 8 inch poly-hags with growing material consisting of top soil, sand, rice husk ash, and compost at a ratio of 4:2:2:1. Out-plant after 6 months. Seedling should be about 30 - 50 cm tall with root length of 0.3 - 0.5 cm ? . Planting hole 30 x 30 x 30 cm. Use 1 kg compost and 50 gm rock phosphorous. Plant at 3 x 3 m or 4 x 4 m spacing. Trim 1/3 of branches off of 2 year and older tree to maintain good form. In 10 - 15 years prune crown. Prevent tire damage.

Moringa oleifera (horseradish tree)

Origin

South Asia.

Ecology

Annual rainfall: 750-2500 mm.

Normal temperature range: 9-37 ° C.

Altitude range: 0 to 1000 m.

Seasonal adaptability: Good.

Soils: pH 5.5-7.5; can grow on soils with low fertility; best on alluvial soils.

Description

Height at maturity: 12 m.

Form: Small tree, umbrella shaped, light crown.

Coppicing ability: good.

Other: Does not fix nitrogen.

Primary advantages

Has a number of food, fodder, and fuel uses; grows well on poor, dry soils.

Products and Yields

Fuelwood: Has wood density of 0.32 (air dry) 4600 kcal/kg. Burns very fast.

Fodder: Leaves are used.

Food: Young pods are eaten; dried seeds eaten like peanuts; root from seed-grown trees used as horseradish substitute.

Other: Oil from seeds is known in trade as Ben or Behen oil and used locally as an edible oil, illumination, lubrication and cosmetics; bark and leaves reported to be medicinal.

Propagation

Seedlings, cuttings, direct sowing.

Seed Treatment

None required.

Management

Can be coppiced, lopped, pollarded, or pruned for fuelwood.

Agroforestry Uses

Light crown density allows it to be interplanted with many kinds of annual crops.

Morus alba (mulberry)

Origin

Asia.

Ecology

Annual rainfall: 600-1400 mm.

Normal temperature range: 8.5-37 ° C.

Altitude range: 250 to 2200 m.

Seasonal adaptability: Can withstand 6 dry months.

Soils: Slightly acidic soils are good, soils with pH 5.8-6.5 are best. Does not like alkaline soils. Prefers soils deeper than 80 cm, with poor yields on soils shallower than 30 cm.

Light requirement: Strong.

Description

Height at maturity: 12 m.

Form: Short with branching beginning at the base of the tree.

Coppicing ability: Excellent.

Growth: 2 m tall in 3 months from coppice.

Primary advantages

Provides main food source for silkworms; berries for jams and jellies.

Primary disadvantages

Not compatibale with many crops. Damaged by browsing animals. Fields need to be manured or fertilized to maintain productivity.

Products and Yields

Timber: Excellent wood for sports industry.

Fodder: For silkworms, rabbits, swine, and cattle.

Food: Berries eaten fresh and cooked as jellies and jams.

Propagation

Cuttings, layering, grafting. Cuttings are the easiest; pick shoots about 4 months old, and select 20 cm of the stem for cutting (3-5 nodes); may be planted in the field after root growth is initiated, about 5,000-9,000/ha. Good rains should be available for growth.

Management

Lopping, pollarding, pruning, or coppicing. May be cut at waist height to allow easy picking of leaves and to maximize yield/ha. 15 kg of leaf is needed to produce 1 kg of silkworm cocoon. Mulch should be plowed into the soil at a depth of 30 cm. Weeding is necessary.

Agroforestry Uses

Limited due to its need for direct sunlight and large area to produce enough leaves for a silkhouse. However, mulberry can be used in hedgerows and windbreaks. Planted as an understorey to irrigated Dalbergia sissoo in Pakistan.

SPECIES: Peltophorum pterocarpum (DC.) Heyne

TAXONOMY:

1 FAMILY . . . . . .Caesalpiniaceae

2 SYNONYMS . . . . P.ferrugineum (Decne.) Benth., P. inerme (Roxb.) Naves

3 LOCAL OR TRADE NAMES . . . . Jemerlang laut (Malaysia; Copper pod; Yellow flame.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 1-5^{o} N

5 AREAS . . . . Sri Lanka; S. India; Malaysia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0,1-1,000 m

7 MEAN ANNUAL RAINFALL 1,000-1,800

8 RAINFALL REGIME . . . . . .summer

9 DRY SEASON . . . .4-6 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . 32-36^{o} C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .9-16^{o} C

12 MEAN ANNUAL TEMP. . . . . .24-27^{o} C

SOILS:

13 EXTURE . . . . .Medium/Light

14 REACTIONS . . . . . Free draining

15 RAINAGE . . . . . Tolerates poor soils.

16 OTHER CHARACTERISTICS . . . . .. Tolerates slightly saline soils and poor, dry soils.

SILVICULTURE:

17 SIZES . . . . . h = 20-30 m

18 DESCRIPTIONS . . . . . Spreading, ornamental tree. Deciduous.

19 FROM . . . . . .Acceptable

20 LIGHT REQUIREMENTS . . ..-

21 OTHER CHARACTERISTICS . . . . Copices; windfirm; fast growing.

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . -

ROLE IN LAND

USE:

23 . . . . Shade in coffee and cacao plantations; reclamation of Imperata grasslands.

TIMBER:

24 DENSITY . . . . . .-

25 NATURAL DURABILITY . . . . . -

26 PRESERVATION . . . . . -

27 SAWING . . . . . -

28 SEASONING . . . . -

29 OTHER FEATURE . . . . . Hard

UTILIZATION:

30 SAW TIMBER . . . . Boxes; furniture.

31 ROUNDWOOD . . . . . Fuelwood

32 OTHER PRODUCTS . . . -

NURSERY:

33 SEED SOURCES . . . . Malaysia; France; Cambodia.

34 SEEDS PER DILOGRAMME 12,000-20,000

35 STORAGE . . . . . Boiling water, soak till cool.

36 PRE-TREATMENT . . . Potted; stumps; large branch cuttings.

37 PLANTING STOCK . . . . -

38 SPECIAL REQUIREMENTS. . . . . -

39GERMINATION AND GROWTH. . . . 60-80% germination in 7 days. Plantable size in 5-6 months.

40 . . . . . -

PRINCIPAL REFERENCES:

Peltophorum pterocarpum

Mai sa kham

Peltophorum dasyrachis (P. pterocarpum)

Mai sa kham, Mai sa phang

Original

Naturally located on the edges of dry evergreen forests in North, Northeast and Southeast Thailand

Ecology

Forest description: Dry evergreen forest

Soils: Can grow in varied soil conditions, even in poor or damaged soils if enough moisture is available.

Light requirement: High

Description

Height at maturity: 30 m

Diameter: -

Form: Young tree will develop low branches, but as age increases the trunk will be straight.

Growth: Is a pioneer species. Fast growing.

Products and yields.

Wood products: Easy to saw and plane, polishes well. Sawn timber is pink or browning pink with straight or wavy grain, medium rough. Can be use for building in shade e.g. floors, ceilings, inside walls, furniture, boxes, tools, and gun stocks.

Other: Leaves which fall can be used as fertilizer. Bark is used as traditional medicine to treat diarrhea, excess gas and other conditions.

Propagation

By seeding. The pods will ripen in April – May each containing about 4-8 seeds. The old pod is dark brown. The pods should be collected from the tree when light brown. The pod does not break open when ripe. Sun dry the seed for 2 or 3 day when the pod is dry remove the seeds. 25 000 – 30 000 seeds/kg.

Seed treatment

Germination 97% after 1 month storage. Can be stored up to 12 months. Seed in nursery.

When seedling is 1-1.5 inches tall transplant in poly-bag. When seedling is about 3- 5 months it ca be out-planted.

Management

Should not be planted during the heave rains of rainy season as the water content of the soil will be to high. Protect from fire. Give special attention to young trees in dry season. Plant at 2x4m, 2x8,4x4, or 4x8 m spacing, depending on the desired use and conditions. Trim regularly as tree grows to promote a good form

SPECIES: Pinus merkusii & de Vriese (continental provenances)

TAXONOMY:

1 FAMILY . . . . . .Pinaceae

2 SYNONYMS . . . -

3 LOCAL OR TRADE NAMES . . . . . Tenasserim pine; Merkus pine.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 11-21° N

5 AREAS . . . . . Mainland S.E. Asia from N. W. India to Cambodia.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0-9000 m

7 MEAN ANNUAL RAINFALL 1,000-2,800

8 RAINFALL REGIME . . . . . .summer

9 DRY SEASON . . . .2-5 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . -24-32° C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .18-24° C

12 MEAN ANNUAL TEMP. . . . . .21-28° C

SOILS:

13 EXTURE . . . . .Light/Medium/heavy

14 REACTIONS . . . . . Acid

15 RAINAGE . . . . . Free draining

16 OTHER CHARACTERISTICS . . . . . Adaptable to most soil conditions.

SILVICULTURE:

17 SIZES . . . . . h = 30-40 m; d = 60-90 cm

18 DESCRIPTIONS . . . . . Evergreen

19 FROM . . . . . .Exceptional

20 LIGHT REQUIREMENTS . . .. Strongly demanding

21 OTHER CHARACTERISTICS . . . . Windfirm; fire resistant; termite resistant.

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . 8-10

ROLE IN LAND USE:

23 . . . . -

TIMBER:

24 DENSITY . . . . . .S.G. 0.65-0.80

25 NATURAL DURABILITY . . . . . Moderately durable

26 PRESERVATION . . . . . Easy

27 SAWING . . . . . Easy

28 SEASONING . . . . Easy

29 OTHER FEATURE . . . . . -

UTILIZATION:

30 SAW TIMBER . . . . Heavy construction; light construction; boxes.

31 ROUNDWOOD . . . . . Transmission poles; longfibre pulp; veneer/plywood; fuel (c.V. = 22,876 kJ/kg).

32 OTHER PRODUCTS . . . Resins

NURSERY:

33 SEED SOURCES . . . . Thailand

34 SEEDS PER DILOGRAMME 30,000-40,000

35 STORAGE . . . . . Short viability.

36 PRE-TREATMENT . . . None

37 PLANTING STOCK . . . . . Potted

38 SPECIAL REQUIREMENTS. . . . . Grass stage in seedling. Requires mycorrhizae.

39GERMINATION AND GROWTH. . . Germinates in 10-12 days. Plantable size in 8-10 months

PRINCIPAL PESTS AND DISEASES:

40 . . . . . Less prone to shoot borer attack than P. kesiya. Susceptible to damping off in nursery.

PRINCIPAL REFERENCES: 29 30 34 107 152

Pinus merkusii (continental provenances) Pine, Mai pek

Psidium guajava (guava)

Origin

Central and South America

Ecology

Annual rainfall: 700-3700 mm.

Annual temperature: 9-33 ° C

Altitude range: 0-200 m.

Seasonal adaptability: Less than six months.

Soils: Prefers acidic soils.

Other site limitations: Susceptible to frost.

Description

Height at maturity: 10m

Form: Short or no bole, spreading crown.

Coppicing ability: Good.

Growth: At 20 years, up to 12 m in height 20 cm diameter.

Other: Does not fix nitrogen.

Primary advantages

Bear fruit at 2 years, continues to produce fruit until 30 years old. Tolerates a wide range of soil conditions.

Primary disadvantages

Ma become a weed.

Products and Yields

Fruits: Typical yields are 400-500 fruits/tree/year for a 8-10-year-old tree propagated from seed. Grafted trees may yield 1000-1200 fruits at that age.

Fuel wood: yes

Other: Leaves used to treat diarrhea.

Propagation

Seedlings, grafted stock, or root suckers. Grafting can be by approach grafting or bud. Transplant seedlings when they are 30cm in height, normally after 5-7 months.

Seed treatment

Seeds may remain viable for up to 1 year.

Management

Plant at about 6x6 m. Prune to remove suckers and shape the tree.

Agroforestry Uses

Used in homegardens, intercropping, and roadsides.

Psidium guajava
Guava, Kok mak sida

Pterocarpus indicus (red sandalwood)

Origin

Southeast Asia to Solomon Islands.

Ecology

Annual rainfall: 1500 mm.

Normal temperature range: 18-33 ° C

Altitude range: 0-100 m.

Seasonal adaptability: tolerates 3-4 months dry season.

Soils: Well-drained loamy soil, neutral pH is best, but tolerates sandy to clay soils.

Light requirement: light demander.

Description

Height at maturity: 33m.

Diameter at breast height (1.3 m) maturity: 200 cm.

Form: variable.

Coppicing ability: good

Growth: 0.5-2 m in height, 1-4 cm in diameter per year.

Other: Trunks fluted and butteressed, bears fragrant yellow flowers. Nitrogen fixing.

Primary advantages

Easy to establish in a wide range of soils. Valuable timber.

Primary disadvantages

Little experience in plantations. Can be invasive.

Products and Yields

Wood products: High value furniture timber, poles/posts, fuelwood, charocal.

Fuelwood: 4880 kcal/kg

Other: ornamental planting.

Propagation

Seed or cuttings up to 3 m long by 10 cm diameter.

Seed treatment

Pretreatment: non or soak in hot water for 24 hours.

Pterocarpus indicus
Red sadawood, Pradoo baan

Pterocarpus macrocarpus

Mai dou, Burmese Ebony, Burma Padouk, Nara

Origin

Laos, India, Indonesia, Thailand, Burma, Southern Vietnam

Ecology

Annual rainfall: 500-5000 mm propagated naturally best in dryer and open conditions. Normal temperature range: 4.4-11.1 ° C (cold season) cannot tolerate frost, 37.7 -44.4 ° C (hot season)

Altitude range: 100 – 750 m

Seasonal adaptability: dry season 6-7 months

Forest description: Mixed dry deciduous and dry evergreen.

Soils: Sandy loam. Can grow in shallow and rock soils, but grows slower and produces more

Branches. pH 6.0-7.5. Good drainage.

Light requirement:

Other site factors: Grows in both flat and mountainous areas.

Description

Height at maturity: 20-30 m

Diameter: 1.5-2.5 m

Other: Resistant against disease and insects and competing vegetation.

Products and yields

Wood products: one sample in Kanchanaburi province 2x4m spacing at 4 year d =8.63 cm, h = 6.43 m. wood density 0.92. Natural durability 14 years. Easy to saw. Hard, yellowish white, core is reddish brown, straight grain. Useaable for exterior and interior building, furniture, and tools.

Other: Bark can be used as a dye and contains tannin.

Propagation

By seedling, cuttings, grafting. Seeding is most common method of propagation. 3,200-3,400 seeds/kg. Seeds ripen between October and November. The seed stay on the tree for a long time and should be collected before too old. Store at about 4^{o}C in closed plastic. Can be stored in such conditions for many years.

Seed treatment, nursery instructions

Romove wings, plant in seed bed 1 kg seeds/m^2 and cover lightly with fine sand or burnt rice husk to maintain moisture. Should be planted from November to February because of favorable temperature and lower disease risk. This time also correlates with the ripening of the seeds on the mother tree. When the seedling has two a pair of leaves and is about 5-6 cm high it can be planted in poly-bags (5x8 inch). The growing material should consist of top soil mixed with sand, burnt rice husk and manure. Coconut husks with slow dissolving chemical fertilizer could be an alternative growing material. Use 5 gm/tree. Water every morning and evening until germination. Trim toe roots regularly. Trim to maintain equal heights so shorter plants get equal sun, remove diseased plants. Harden before outplanting by reducing watering, 15 days of once a day, 15 days of every other day. Trim seedling to about 15 cm. Trim roots evenly.

Management

Out plant at beginning of rainy season in 25 x 25 x 25 cm hold. If out-planted in dry season the seedlings should be at least 16 months old, seedlings from the former year, trim the leaves off, leave

small indentation to collect rain water. If there is vegetation present some can be left standing to provide shade during dry season but should be removed at the beginning of rainy season. Trim lower branches off up to 6 meters hight. Plant at 2 x4 m or 4 x 4 m spacing. The large crown will cover the ground reducing weeds and will promote good form.

Agroforestry uses.

Wind break, retains moisture in soil, prevents soil erosion, nitrogen fixing, falling leaves add organic material to soil.

Shorea robusta (Sal)

Origin

Bangladesh, India, Nepal.

Ecology

Annual rainfall: Under 1000-4600 mm

Normal temperature range: 1-47 ° C

Altitude range: 100-1100 m.

Seasonal adaptability: Tolerates dry season of 3-4 months.

Soils: Well-drained sandy or clay alluvial soils Tolerant of alkaline, saline soils and waterlogged soils.

Light requirement: Light demander, but can tolerate light shade.

Other site limitations: Seedlings intolerant of fire, frost and susceptible to insects, fungal and parasitic damage.

Description

Height at maturity: 35 m.

Diameter at breast height (1.3 m) at maturity: 100 cm.

Form: Good, long clear bole.

Coppicing ability: Good.

Growth: 20 m in height, 30 cm in diameter in 30 years.

Other: Bark is thick, dark brown, with deep longitudinal fissures. Leaves 12-25 cm by 10-15 cm.

Flowers are in panicles at leaf base or twig tip. Individual flowers are 2-3 cm wide, with 5 pale yellow pointed petals

Primary advantages

Good durable timber, produces marketable resin.

Primary disadvantages

Does not tolerate arid conditions.

Products and Yields

Wood products: Timber for strength and durability: beams, electricity poles, railway sleepers etc. Yield 2.5-3.0 m^3 /ha/yr.

Fuelwood: 5400 kcal/kg.

Fodder: Shoot, leaf give medium quality fodder; seeds also edible.

Other: Oleoresin from tapping the trunk, is sued for incense, as a fumigant , mixing with industrial waxes, in paints and varnishes, caulking boast, plywood glue, medicine. The oleoresin yields “chua” oil on distillation; oil from the seeds is used for cooling, lighting and making soap; tannin from the bark.

Propagation

Seed by natural regeneration, direct sowing or nursery-raised; also from seedling stumps.

Seed treatment

Collect in middle of fruiting period and sow immediately as viability is rapidly lost.

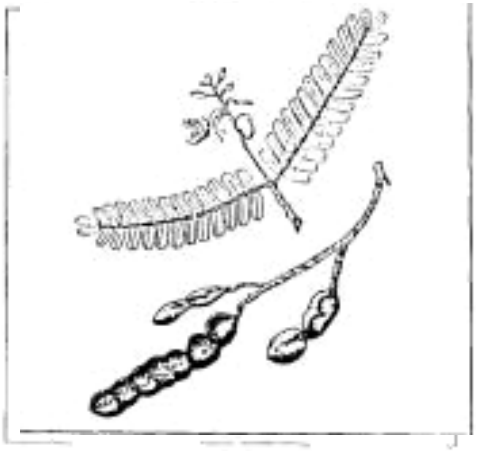
Management

Seedlings need protection from fire and frost.

Agroforestry Uses

Intercropping. Successful plantations of Shorea robusta have been raised in several states in India through Taungya system under which agricultural crops are raised with the trees for the first 4 to 5 years.

Tamarindus indica (tamarind)



Origin

Eastern tropical Africa.

Ecology

Annual rainfall: 250-2700 mm.

Normal temperature range: 9-37 ^{o} C

Altitude range: 0 to 1500 m.

Seasonal adaptability: Good, tolerates 6-8 months dry season.

Soils: Variety of well-drained soils, acidic or alkaline; does not like heavy clay or very acidic or waterlogged soils.

Description

Height at maturity: 20-25 m.

Diameter at breast height (1.3 m) at maturity: 50-70 cm.

Form: Fair to poor; branching starts about 2-3 m on trunk.

Coppicing ability: Fair to good.

Primary advantages

Fruit is marketed worldwide in sauces, syrups, and processed foods. Improved fruit varieties are available, especially in Thailand, Grows on a wide range of sites and in semi-arid conditions.

Primary disadvantages

Slow growth, fruit can be damaged by insects or browsing animals.

Products and Yields

Fruits: Up to 10-50 kg per tree. Qualiy depdnds on the variety and on insect damage.

Wood products: Small timber, excellent charcoal.

Fuelwood: Used for charcoal and fuelwood in some locations.

Fodder: Leaves and young podsd are good fodder.

Other: Young leaves, shoots and flowers are sometimes curried or eaten raw. Leaves are used as medicine for livestock, for cughts and colds.

Propagation

Commonly by seed, but improved varieties must be grafted.

Seed treatment

Pour boiling water over seeds and let cool, or nick seeds with a knife (scarification).

Management

Improved fruit varieties are often grown as single trees. Orchards have been established in Thailand.

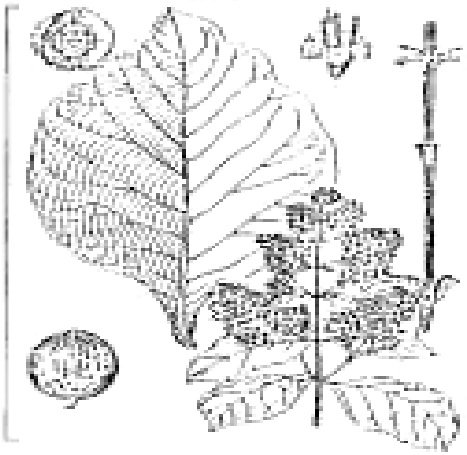
Agroforestry Uses

Excellent shade and avenue tree. Common as single tree in cropped fields or home gardens. Also planted as windbreak.

Tamarindus indica

Tamarind, Kok mak kham

Tectona grandis (teak)



Origin

South and Southeast Asia.

Ecology

Annual rainfall: 1250-3000 mm.

Normal temperature range: 10-40 ° C

Altitude range: 30 to 900 m.

Seasonal adaptability: tolerates 3-4 months dry season.

Soils: Light sandy-loam, well-drained soils, not shallow; pH of 6.5-7.5.

Light requirement: Strong

Description

Height at maturity: 40 m.

Diameter at breast height (1.3 m) at maturity: More than m.

Form: Good.

Coppicing ability: Good in young trees.

Growth: 10-year-old stand can reach 25 m height.

Other: Fast height growth in young stands.

Primary advantages

High-quality timber; Well understood management systems.

Primary disadvantages

In pure stands of this species, health and vigor decline rapidly between ages 10-20; epicormic branching is common and insect damage (stem borer) increases. Good quality seed in short supply. Few uses apart from timber.

Products and Yields

Wood products: Timber, poles. Mean annual increment growth of 8-14 on young stands with 3-5 being common in older stands. Heartweod is resistant to rot, decay, and termites.

Fodder: Poor, not commonly used.

Propagation

By seedling stumps, seedlings, direct seeding, cuttings, tissue culture. Remove stumps from the seedbed at the age of 1 year; they can be stored for up to 6-8 months in dry sand with protection from the weather. Survival rate of stumps after storage is usually over 90%

Seed treatment

Several methods are used: alternative soaking and drying, removal of the exocarp, air drying, and in China treating with hot sand. Seed can be stored for 1-2 years in dry conditions.

Management

Coppicing and pruning. Frequent thinning prolong the health and vigor of plantations.

Agroforestry Uses

Used in taungya and other intercropping systems, but only in first two years of growth. If grown at wide initial spacing, good stem quality is lost.

7

TAXONOMY:

1 FAMILY . . . . . .Verbenaceae

2 SYNONYMS . . . -

3 LOCAL OR TRADE NAMES . . . . . Teak, Tec; Teca.

NATURAL OCCURRENCE:

4 LATITUDES . . . . . 12-25^{o} N

5 AREAS . . . . . The Indian subcontinent, Burma, Cambodia and Thailand.

CLIMATE:

6 ALTITUDINAL RANGE . . . . . .0-900 m

7 MEAN ANNUAL RAINFALL 1,250-3,000

8 RAINFALL REGIME . . . . . .summer

9 DRY SEASONS . . . .3-6 months

10 MEAN MAX. TEMP. HOTTEST MONTH . . . . . -25-32^{o} C

11 MEAN MIN. TEMP. COLDEST MONTH . . . . . .18-24^{o} C

12 MEAN ANNUAL TEMP . . . . .22-26^{o} C

SOILS:

13 EXTURE . . . . Medium/heavy

14 REACTIONS . . . . . Natural/Acid

15 RAINAGE . . . . . Free draining

16 OTHER CHARACTERISTICS . . . . . Better growth on fertile and deep soils. Often leads to soil erosion in pure stands.

SILVICULTURE:

17 SIZES . . . . . h = 30-40 m; d = 90-250 cm

18 DESCRIPTIONS . . . . . Deciduous; older trees fluted.

19 FROM . . . . . Acceptable/exceptional

20 LIGHT REQUIREMENTS . . .. Strongly demanding

21 OTHER CHARACTERISTICS . . . Coppices; moderately fire resistant; substantial provenance variation; drought sensitive; early flowering spoils form.

PRODUCTION:

22 VOLUME (M^3/HA/AN) . . 6-18

ROLE IN LAND USE:

23 . . . . -

TIMBER:

24 DENSITY . . . . . .S.G. 0.58-0.82

25 NATURAL DURABILITY . . . . . Very durable

26 PRESERVATION . . . . . Difficult

27 SAWING . . . . . Fair

28 SEASONING . . . . Easy

29 OTHER FEATURE . . . . . Premier fine hardwood. Decorative, tough and strong; silica in wood; dust may irritate skin.

UTILIZATION:

30 SAW TIMBER . . . . Heavy construction; light construction; furniture; boxes; boat-building.

31 ROUNDWOOD . . . . . Building poles; transmissison poles; fence posts; fuel (c.v. =21,353 kJ/kg) and charcoal; veneer/plywood.

32 OTHER PRODUCTS . . . -

NURSERY:

33 SEED SOURCES . . . . India; Thailand; Trinidad and elsewhere where established as an exotic.

34 SEEDS PER DILOGRAMME 800-2,000

35 STORAGE . . . . . Dry; without difficulty for several years.

36 PRE-TREATMENT . . .Alternate soaking and drying frequently practiced.

37 PLANTING STOCK . . . . . Stumps; potted stock

38 SPECIAL REQUIREMENTS. . . . . -

39GERMINATION AND GROWTH. . . Germination ofteh protracted; up to 60 days. 70% viability. Several embryos per seed. Plantable size in 12 months.

PRINCIPAL PESTS AND DISEASES:

40 . . . . . Generally halthy. Atta ants may cause defoliation in first year. Root rots in Africa. Leaf skeletonizer in Asia.

PRINCIPAL REFERENCES: 4 5 16 51 52 57 69 100 107 109 128 152

Tectona grandis (teak)

Origin

Southeast Asia.

Ecology

Annual rainfall: (mm): 750 to 2000 mm.

Normal temperature range: 20-35 ° C

Altitude range: 0 to 300 m.

Seasonal adaptability: Drought resistant.

Soils: Light sandy or rocky saline soils.

Other site factors: Wind resistant and tolerant to self spray.

Description

Height at maturity: 25 m.

Diameter at breast height (1.3 m) at maturity: 30 cm.

Form: Medium tree, horizontally whorled branching. Bole is often short and crooked.

Growth: 2m/year for young trees.

Primary advantages

Can withstand saline sandy soils, and salt spray; good shad tree

Primary disadvantages

Heavy branching, short bole.

Products and Yields

Wood products: Firewood, pulp, small timber for boat and house construction etc.; plywood; railway sleepers; yields of 22-36 tons/ha at 10-years.

Fluewood: Wood density of 0.59; also used for charcoal

Other: Fruits may be eaten roasted or even raw. A popular ornamental and shade tree. Tannin and dye (black) from bark, leaaves, fruit, roots. Medicinal uses. Seed oil is a substitute for almond oil.

Propagation

By seedling, planted when 20-25 cm tall. Seedlings can tolerate shade, so weeding is not needed.

Seed treatment

None needed; if seed is extracted from the fruit, germination is fast and uniform. Fruit may be planted whole but germination period varies up to 2-3 months.

Management

For fuelwood, commonly managed on a 10-15 year rotation

Agroforestry Uses

Homegardens, as shade tree, soil stabilization.

Xylia xylocarpa (X. kerrii)

Mai deng, Iron wood, Jamba, Pyinkado, Irul

Origin

Laos, North, South, Central, Northeast Thailand

Ecology

Altitude range: up to 1000 m a.s.l.

Forest description: Dry Evergreen, Mixed Deciduous, Evergreen.

Soils: Loamy/light (sandy), good drainage

Description

Height at maturity: 25 m

Diameter: -

Form: Straight if grown in deep soil or knotty if soil is too shallow.

Products and yields

Wood products: Wood density 1.18. Red or reddish brown, wavy grain, hard, durable, flexible, polishes well. Can be used for building, joists, beams, floor, parquet, walls, boats, tools, carts, bridges, pillows, railroad sleepers, harrows, plow handles, mortars, pestles, looms, spears.

Natural durability: 10 -18 years

Fuelwood: makes good quality charcoal

Other: Medicine. Seeds can be eaten.

Propagation

Collect seed pods from ground or collect from three between February to March.

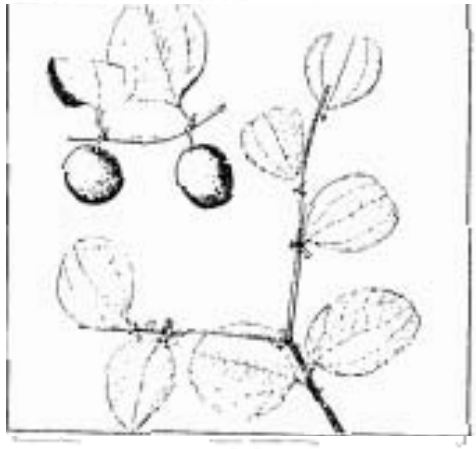
Seed treatment

Sun dry the pods until they break open and release the seeds. Dry seeds before storing. Seeds can be stored up to a year, but germination rate begins to decrease after 4 months.

Management

In one test plot 3 day old seedlings, watering them every day, two times a day. The reported survival rate was high. The seed bed material should be loam mixed with clay and cattle manure at a rate of 4:4:1 in order to get good results. Plant in the beginning of rainy season, one month before out-planting, the seedings should be hardened by watering only once a day for one week and then every other day. Finally move seedlings to a sunny place.

Ziziphus mauritiana
(Indian jujube)



Origin

Southeast Asia.

Ecology

Annual rainfall: 250-2000 mm.

Normal temperature range: 9.5-37 ° C

Altitude range: 0 to 600 m.

Seasonal adaptability: Excellent dry season tolerance.

Soils: Most soils, tolerates alkaline soils.

Light requirement: High

Other site factors: Can withstand light frost and high temperatures.

Description

Height at maturity: 5 m.

Diameter at breast height (1.3 m) at maturity: 30 cm.

Form: Short tree, spreading crown; branching starts about 1-2 m up trunk.

Coppicing ability: Good.

Growth: Slow initially, but satisfactory once established.

Other: Spiny foliage.

Primary advantages

Fast growth in low-rainfall areas; multiple uses; fruit is consumed widely throughout the tropics. Excellent fodder and forage.

Disadvantages

Can become a weed; spiny foliage limits some uses; fruit quality is variable. May be damaged by browsing animals when young.

Products and Yields

Wood products: Tool handles, other small timber uses for hard, close-grained wood.

Fuelwood: Good; wood density greater than 0.60, reported up to 0.90.

Fodder: Excellent; leaves sold as fodder in parts of India.

Other: Leaves can host the la insect, which secretes a resin used in making shellac, and the tasar silkworm.

Propagation

Usually by seedlings. Can be direct seeded. Improved fruit varieties must be grafted.

Seed Treatment

Seeds are usually cracked before sowing.

Management

Coppicing, lopping, pruning, or pollarding. Must be managed to keep root suckers from spreading into pastures and other areas.

Agroforestry Uses

Its thorny nature make s it very useful as a living fence; also in homegardens and border plantings.