



## *Gliricidia sepium* (gliricidia) Fabaceae (legume family)

gliricidia, Mexican lilac, mother of cocoa, Nicaraguan cacao shade, quick stick, St. Vincent plum, tree of iron (English); *immortelle*, *lilas étranger* (French); *madre de cacao* (French, Spanish); *rechesengel* (Palau)

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### IN BRIEF

**Distribution** Widely naturalized in the tropical Americas, Caribbean, Africa, Asia, and the Pacific islands.

**Size** Medium tree to 15 m (50 ft), typically reaches 10 m (33 ft) in height; size is usually controlled by regular pruning in cultivated environments.

**Habitat** Grows best in warm, seasonally dry climates with 900–1500 mm (35–60 in) annual rainfall and elevations 0–1200 m (0–4000 ft).

**Vegetation** Where introduced, associated with a wide variety of cultivated crops.

**Soils** Grows in sands to clays, preferring freely draining soils with pH 5.0–8.5.

**Growth rate** Fast in early years, or when annually pruned back, over 2 m/yr (6.6 ft/yr).

**Main agroforestry uses** Living fence posts, crop shade, improved fallow.

**Main products** Fuelwood, fodder, mulch/organic matter.

**Yields** Fuelwood from stands harvested every 2–3 years are 10–20 m<sup>3</sup>/ha (143–286 ft<sup>3</sup>/ac).

**Intercropping** Has been used for shade and organic matter with cacao, coffee, vanilla, tea, yam, and other crops.

**Invasive potential** Moderate potential for invasiveness, has naturalized in many areas, but is usually not considered to be a pest.



Boundary planting of gliricidia.

## INTRODUCTION

Gliricidia (*Gliricidia sepium*) is a medium-size, semi-deciduous tree that typically grows to 10 m (33 ft) (occasionally reaching 15 m [50 ft]) in height, with a broad canopy. Native to Central America and possibly northern South America, its cultivation is now pantropical. It grows best in tropical, seasonally dry climates. The tree thrives in deep, well drained soils, although it tolerates shallow or skeletal soils that have high available calcium levels. Because of its ability to grow in slightly saline calcareous soils, gliricidia is suitable for cultivation in atoll environments.

It is a fast-growing, nitrogen-fixing tree used throughout the tropics for the many environmental services and products it provides. Gliricidia is widely used to provide crop shade for cacao, coffee, and other shade-loving crops, living fence posts for pasture and property boundaries, and as a fallow tree to improve degraded land. The tree is also an important source of green manure, fodder, and fuelwood. Its ease of propagation by seed and small and large cuttings makes it a very easy tree for farmers to multiply quickly. It is probably the most widely cultivated multipurpose agroforestry tree after *Leucaena leucocephala* (Simons and Stewart 1994).

## DISTRIBUTION

### Native range

Because gliricidia has been cultivated from pre-Colombian times, the precise native range is difficult to determine. It is certainly native to Mexico (from about 25°30' N) and Central America (to 7°30' N in Panama) and may also be native to northern South America in Colombia, Venezuela, and the Guianas.

### Current distribution

The species has been cultivated and has naturalized widely in tropical America, the Caribbean, Africa, and Asia. In the Pacific islands, it is found in American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawai'i, Kiribati, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu.

## BOTANICAL DESCRIPTION

### Preferred scientific name

*Gliricidia sepium* (Jacq.) Kunth ex Steud.

### Family

Fabaceae (legume family)

### Subfamily

Faboideae (Papilionoideae)

### Tribe

Robinieae

### Non-preferred scientific names

*Galedupa pungam* Blanco

*Gliricidia lambii* Fernald

*Gliricidia maculata* var. *multijuga* Micheli

*Gliricidia maculate* (Kunth) Walp.

*Lonchocarpus maculatus* (Kunth) DC.

*Lonchocarpus roseus* (Miller) DC.

*Lonchocarpus sepium* (Jacq.) DC.

*Millettia luzonensis* A. Gray

*Robinia hispida* L.

*Robinia maculate* Kunth

*Robinia rosea* Miller

*Robinia sepium* Jacq.

*Robinia variagata* Schltldl.

### Common names

#### Pacific islands

gliricidia, Mexican lilac, mother of cocoa, Nicaraguan cacao shade, quick stick, St. Vincent plum, tree of iron (English)

*immortelle*, *lilas étranger*, *madre de cacao* (French)

*rechesengel* (Palau)

#### Other regions

*almácigo extranjero*, *amory celos*, *bien vestida*, *desnodo*

*florecido*, *floresco*, *madre de cacao*, *madre negro*, *mataratón*,

*mataraton*, *palo de hierro*, *palo de parque*, *piñón*

*amoroso*, *piñón de cuba*, *piñón florido*, *varita de San José*

(Spanish)

*gamal* (Indonesia)

#### Size and form

Gliricidia is a small, thornless, semi-deciduous tree 3–15 m (10–50 ft) in height with a trunk up to 30 cm (12 in) in diameter at breast height (dbh). The canopy diameter is about the same as the height for most provenances if not pruned. The tree may have single or multiple stems and tends to have a diffuse, irregular crown. In agricultural environments, the size and shape are often greatly modified by repeated lopping to suit the farmer's goals.

## Flowers

Racemes or panicles 5–12 cm (2–5 in) long are borne at the base of leaves. The individual flowers have a light green (tinged with red), five-toothed calyx and a corolla of five whitish-pink or light purple petals. The flower has a typical pea-flower shape with a broad standard, two oblong, curved wings, and two united petals. There are 10 whitish stamens and a pistil with a red ovary and a whitish style.

## Leaves

The alternate, pinnate leaves, 15–30 cm (6–12 in) long, have a silky pubescence when young. There are 7–17 leaflet pairs and a terminal leaflet. The leaflets are elliptical or lanceolate, 3–6 cm (1.2–2.4 in) long and 1.5–3 cm (0.6–1.2 in) wide, short to long-pointed at the tip, and rounded to short-pointed at the base.

## Fruit

The fruits are flattened pods, 10–15 cm (4–6 in) long, that contain three to eight seeds. They are yellow-green, becoming yellow and finally brown or blackish at maturity. Flowering and fruiting begins between 1 and 5 years of age.

## Seeds

The seeds are circular and flat, about 10 mm (0.4 in) in diameter, shiny, and light to dark brown. There are 4700–11,000 seeds/kg (2100–5000 seeds/lb), varying considerably among seed sources. The seeds are dispersed when the pods dry sufficiently that the two halves separate and curl explosively, propelling the seeds as far as 25 m (82 ft) away from the mother tree.

## Bark

The bark is smooth to slightly fissured and gray to brown.

## NAME DERIVATIONS

- *Gliricidia* from Latin *glis*, “dormouse” and *caedere*, “to kill” and the Spanish name *mata-ratón* refer to the tree’s rodenticidal properties.
- The epithet *sepium* means “of hedges” which is the use of the tree Jacquin observed in Columbia in the mid-eighteenth century.
- “Mother of cocoa” and the Spanish *madre de cacao* refer to the plant’s frequent use as a shade tree for cacao.
- “Quick stick” refers to the ability of cuttings to quickly and easily root and grow into new trees.
- “Tree of iron” and the Spanish *palo de hierro* refer to the hard, durable wood.

## Rooting habit

*Gliricidia* propagated from cuttings produces an extensive, shallow, lateral root system. Seedlings develop taproots, but it is unclear if the taproots endure throughout the life of the plant. One study of trees from seedlings on coastal sands reported poorly developed taproots and well developed lateral roots.

## Similar or look-a-like species

*Gliricidia* looks superficially like several other leguminous tree species. The foliage can be confused with various shower trees that are frequently used as ornamentals, such as *Cassia javanica*. Shower trees have clusters of cream, pink, orange, yellow, or red flowers resembling in shape and size large bunches of grapes hanging from small branches. The flowers have five petals of similar size and shape. In contrast, *gliricidia* has pea-like flowers in clusters



**Flowers and leaves.** INSET FLOWER PHOTO BY J. PARROTTA, OTHERS BY C. ELEVITCH





Left: Nearly mature seedpods turn from green to yellow (shown here), then dry to brown or blackish at maturity. Right: Bark of a 10-year-old tree. PHOTOS: C. ELEVITCH



Although the leaves are similar in appearance to *gliricidia*, the large clusters of ball-shaped flowers distinguish the shower tree (shown here). PHOTO: C. ELEVITCH

that are much more modest in size, and whitish-pink to light purple in color.

## GENETICS

### Variability of species

Differences within *gliricidia* populations have been recognized in stem length, biomass production, flower color, seed size, number of racemes per tree, number of pods per tree, and synchrony of flowering. One study (Simmons 1996) noted 2.5 times as many pods per tree in Monterrico than in Belen Rivas provenance. A high correlation ( $r = 0.73$ ) between raceme number and pod number was noted, but without provenance or family variation. Another study (Simons and Dunsdon 1992) noted provenance variations

in wood and foliage production. Of these, the variation in wood production was highest. Southern provenances (Guatemala and Nicaragua) were generally good performers, while northern provenances (Mexico) were generally poor performers. There is genetic evidence that one provenance (Masaguara) is escaped from domestication and another (Pedasi) has undergone a severe genetic bottleneck, i.e., undergone a large reduction in genetic variability.

### Known varieties

There are no formally recognized varieties.

### Culturally important related species in the genus

In the genus *Gliricidia*, three species are currently recognized: *G. sepium*, *G. brenningii*, and *G. maculate*. *Gliricidia brenningii* has many tiny leaflets, tiny appendages at the base of the leaflet stalks, and longer, darker pods. *Gliricidia maculate* has leathery leaves and usually white flowers in pendulous inflorescences. *Gliricidia sepium* has somewhat elongated, papery leaves, and pink flowers in upward-curved to erect inflorescences. Members of the genus are obligate out-breeders (i.e., cross-pollination between two individuals must take place for seeds to develop), and interspecific hybridization is common between *G. maculate* and *G. sepium* in areas where they grow in proximity. *Gliricidia sepium* is widely cultivated both within and outside of its native range. *Gliricidia brenningii* and *G. maculate* are cultivated within their native ranges for living fence posts and ornamentals but are not commercially cultivated and are generally unknown outside of their ranges.

### Genetic resources where collections exist

Germplasm collections have been made by the Internation-

al Livestock Centre for Africa (ILCA), Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Costa Rica), and Oxford Forestry Institute (OFI, UK). Trials have been conducted by the OFI/Oxford and the University of Hawai'i.

## ASSOCIATED PLANT SPECIES

Gliricidia grows naturally in deciduous or semi-deciduous dry forests. The species is a pioneer, colonizing disturbed areas, and so may be found in secondary forests; it is rarely or never found in old-growth high forests.

### Associated species commonly found in native habitats

Gliricidia may be found associated with most of the species of the deciduous dry forests of Meso-America. Some commonly associated genera are *Acacia*, *Bauhinia*, *Bursera*, *Brosimum*, *Caesalpinia*, *Calicophyllum*, *Combretum*, *Crescentia*, *Dalbergia*, *Enterolobium*, *Guazuma*, *Haematoxylum*, *Juliania*, *Lonchocarpus*, *Lysiloma*, *Pithecellobium*, *Senna*, *Simarouba*, and *Swietenia*.

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

As a relatively recent introduction to Pacific islands, gliricidia is generally found below elevations of 350 m (1150 ft) and generally only on farms, but to a limited extent in urban areas, where it is associated with a wide range of mainly introduced cultivated species.

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

In Central and South America in disturbed habitats and where introduced, it is commonly associated with *Tabebuia* spp., *Cordia* spp., *Albizia* spp., *Guazuma ulmifolia*, *Leucaena leucocephala*, and *Ricinus communis*. In the rest of the tropics, it is associated with the agricultural crops cacao, vanilla, coffee, tea, yam, pepper, vegetables, grains, pasture grasses, and other crops.

## ENVIRONMENTAL PREFERENCES AND TOLERANCES

### Climate

Gliricidia grows best in warm, seasonally dry climates with moderate mean annual rainfall. It also grows well in areas with precipitation distributed evenly throughout the year

and where there is higher rainfall, although seed production is less reliable.

### Elevation range

0–1200 m (0–4000 ft)

### Mean annual rainfall

(600–) 900–1500 (–3500) mm ([24–] 35–60 [–140] in)

### Rainfall pattern

The tree grows in climates with summer, winter, bimodal, or uniform rainfall patterns.

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

3–9 months

### Mean annual temperature

20–27°C (78–81°F)

### Mean maximum temperature of hottest month

27–36°C (81–97°F)

### Maximum temperature tolerated

42°C (108°F)

### Mean minimum temperature of coldest month

14–23°C (57–73°F)

### Minimum temperature tolerated

8–10°C (46–50°F). It does not grow well in areas where the night temperature drops below 5°C (41°F) and does not tolerate frost (<0°C [32°F]).

### Soils

The tree does best in deep, medium-textured, well drained, fertile soils, with near neutral acidity. It tolerates rocky (shallow or skeletal) soils that are high in available calcium, and soils with textures from sands to clays. Gliricidia fails or grows poorly on cool, wet, compacted, poorly aerated, very acidic (below pH 4.2), or highly alkaline soils (above pH 9.0).

### Soil texture

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

### Soil drainage

It prefers freely draining soils and tolerates seasonally impeded drainage.

### Soil acidity

The tree prefers acid to neutral/mildly alkaline soils (pH 5.0–8.5).

### Special soil tolerances

Gliricidia can grow in shallow, slightly saline, slightly sodic, and moderately infertile soils. It also tolerates calcareous soils, such as those of atolls.

### Tolerances

#### Drought

Gliricidia tolerates seasonal droughts and climates with mean annual rainfall as low as 600 mm (24 in).

#### Full sun

It grows best in full sunlight.

#### Shade

The tree tolerates only light shade. Seedlings that are planted in heavy shade can survive but will not grow. Seedlings that have been suppressed by shade for even 3–4 years will recover and grow rapidly if the sheltering overstory is removed.

#### Fire

Gliricidia is native to areas of Central America prone to perennial fires. It is often top-killed by fire, but young trees readily regenerate by sprouting from the root collar.

#### Frost

The tree is intolerant of frost.

#### Waterlogging

It tolerates brief flooding, but heavily compacted soils or areas prone to waterlogging should be avoided. It can grow in areas with anaerobic or seasonally anaerobic subsoils, although it is not long-lived in such conditions.

#### Salt spray

Gliricidia can grow in light salt spray. In fact, it is native to many plant communities along the Pacific coasts of Mexico and Central America, which indicates good salt tolerance.

#### Wind

The tree tolerates trade winds very well, even in wet areas, where it holds its leaves year-round. The trees are moderately resistant to hurricane-force winds, losing leaves and branches but

surviving. Trees grown from cuttings are more vulnerable to windthrow than seedlings.

### Abilities

#### Fix nitrogen

Gliricidia is a good nitrogen fixer, although not as good as many other nitrogen-fixing trees (see table below). Nodulation with *Rhizobium* normally occurs in the native and in Central and South American naturalized ranges within 3 months of planting. For Pacific island and other habitats where the tree is newly introduced, the planting holes or nursery media may be sprinkled with rhizobia bacteria inoculant cultures. Alternatively, crude liquid inoculant can be made by collecting soil from the root zone under healthy gliricidia trees, mixing with water, and straining off the particulates to make it easier to sprinkle.

#### Nitrogen fixation for some important agroforestry trees (after MacDicken 1994)

Species	kg/ha/yr	lb/ac/yr
<i>Casuarina equisetifolia</i>	40–100	36–90
<i>Erythrina poeppigiana</i>	60	54
<i>Gliricidia sepium</i>	13	12
<i>Inga jinicuil</i>	35–40	31–36
<i>Leucaena leucocephala</i>	up to 274	244



**Gliricidia growing near coast of Upolu, Samoa, where it is subject to wind and salt spray.** PHOTO: C. ELEVITCH



### **Regenerate rapidly**

The tree regenerates rapidly following cutting or other top damage.

### **Self-prune**

The trunks are usually clear of side branches below the main crown, although many provenances have short trunks with large, spreading branches.

### **Coppice**

The tree can be managed for coppice production of firewood, stakes, fodder, and green manure. It regrows very well after pruning, especially if cut only during periods of active growth (rather than during the dry or cool seasons) and if about 10% of the foliage is left on the tree.

### **Pollard**

Pollarding is the pruning back of all branches to a framework on a regular basis (usually annually). *Gliricidia* is tolerant of pollarding and forms a new crown quickly; this is common practice for *gliricidia* used as live fence posts in pasture in situations where there is a use for the wood or where there is enough scarcity of fodder to justify the effort.

## **GROWTH AND DEVELOPMENT**

### **Growth rate**

Initial growth is rapid (up to 3 m [10 ft] in the first year), slowing until a final height of 3–15 m (10–50 ft) is reached. The tree has a moderate life span of up to 50 years and often becomes hollow and declines before dying.

### **Flowering and fruiting**

Flowering and fruiting may begin as early as the end of the first growing season and almost always begins by the fifth growing season. Flowering occurs during the dry season, depending on the local climate. If rainfall is evenly distributed throughout the year, flowering may occur at any time, irregularly throughout the year, but in lower quantities compared with seasonal climates.

### **Reaction to competition**

New plants are susceptible to competition from grasses during the first year. Once above the grasses, *gliricidia* is a good competitor. It has been used to reclaim intractable grass swards.

## **PROPAGATION**

*Gliricidia* is easily propagated by seed or large cuttings. Seedlings are produced in nurseries in pots or bags and are ready for outplanting within 2–3 months. Direct-seeding experiments have given good germination and early survival, but good weed control for the first few months is required. As a living fence post, this species is often propagated by cuttings. Tissue culture has also been done successfully but is rarely used in practice.

### **Propagation by seed**

(after Wilkinson and Elevitch 2003a)

#### **Seed collection**

*Gliricidia* is highly variable in form and productivity, and for this reason superior provenances (e.g., “Retalhuleu” and “Belen Rivas”) should be sought out for propagation (Simons and Dunsdon 1992). Time of flowering and seedling varies with climate, elevation, and dry season duration. Trees usually flower in the dry season (November–March in Kona, Hawai‘i; January–March in Mexico; December–May in Puerto Rico). The time between flowering and pod ripening can be very short, 5–7 weeks in some areas. During certain years, and for certain provenances, seed production can be very low.

As the seedpods dry they release their seeds (dehisce) explosively, flinging them up to 25 m (82 ft) away from the tree. For this reason, seed collectors must observe carefully and collect seedpods from the tree when they are ripe but before they dehisce. Seedpods are 10–15 cm (4–6 in) long and 12–15 mm (0.5–0.6 in) wide. Each contains three to eight seeds. Pods are collected after they turn from yellow-green to brown but before they are dry enough to curl and release their seeds.

Pods are collected with a minimum of effort by hand from low branches or with pruning poles from moderately sized trees. Pruning trees back to a stump 1–2 m (3.3–6.6 ft) in height during or after the seed harvest controls tree size and promotes flowering the next season. The highest seed-producing areas (in Puerto Rico) receive around 1250 mm (50 in) of mean annual precipitation. Areas with 1900 mm (75 in) or more rainfall have produced little seed. Although usually not recommended, seeds may also be collected from the ground, particularly in dry areas.

#### **Seed processing**

Ripe pods are spread out in the sun on plastic tarps or a concrete slab. As they dry in the sun, the pods curl and explode, making a popping sound. The drying area should be covered with a fine mesh netting to prevent seeds expelled from dehiscing pods from escaping the area. Once the



Seeds drying on a tarp in the sun. The fragments of dried seed pod will be removed along with other particulates before storage  
 PHOTO: C. ELEVITCH Right: Same-age seedlings that are inoculated with *Rhizobium* (left) are much more vigorous than those that are not inoculated (right). This holds true for the life of the tree. PHOTO: K. MUDGE

seedpods are dry and crunchy, seeds that are still attached to pods are separated by hand or with a thresher. Seeds are further dried to 6–10% moisture.

### Seed storage

The seed is orthodox, meaning they remain viable after being dried. At a moisture content of 6–10%, and free of pests, seeds can be stored in an airtight container at 4°C (39°F) for over 10 years and retain viability of up to 90% (Allison and Simons 1996). Insect pests can be killed by freezing fully dried seeds at -10°C (14°F) for 48 hours prior to storage.

### Pre-planting treatments

No scarification is necessary. Soaking seeds overnight in cool water will cause them to swell, hastening germination. For fresh seed collections free from insect infestations, germination is usually high, over 90%. Germination takes 3–15 days.

### Growing area

Seedlings are best grown in full sun in an uncovered grow-

ing area. Root-training tubes 14 cm (6 in) deep and 3.8 cm (1.5 in) in diameter work well, as do polyethylene plastic bags 10 x 15 cm (4 x 6 in), when laid flat.

### Germination

Seeds are placed in containers filled with premoistened potting medium and covered with about 5 mm (0.2 in) of medium and a thin layer of mulch (such as poultry grit, fine gravel, or finely screened volcanic cinder). Water is applied with a fine-headed sprayer to keep the medium moist. Daily watering is usually necessary, by hand or with an automated system. At seeding time or within 2 weeks of germination, seedlings should be inoculated with rhizobia bacteria, either manufactured or made from nodules or soil collected from under a compatible host. Early inoculation with rhizobia ensures good nodulation and growth.

### Media

A standard well drained potting medium such as 50% peat moss, 25% perlite, and 25% vermiculite, amended with a little compost, lime, gypsum, micronutrients, rock phosphate and potassium, can be used.



### Time to outplanting

When grown in full sun and under optimal conditions, seedlings are ready to plant out in 8–12 weeks. About 8 weeks after germination, seedlings are double-spaced to allow maximum penetration of sunlight and air circulation. Assuming seedlings were inoculated with rhizobia bacteria at an early age, no additional nitrogen fertilization is necessary, although a very light topdressing of slow release 8-8-8 fertilizer will aid in growth and development. Remove any weeds that enter the seedling flat. Insect problems are usually minimal, although an occasional infestation of aphids or scale may be treated with an approved garden soap or similar product.

Seedlings should never be allowed to dry out, but watering frequency may be reduced to cause temporary, moderate water stress to harden seedlings before outplanting.

### Approximate size

Seedlings are ready to plant at a height of 20–30 cm (8–12 in) with a stem diameter at the base of about 8–10 mm (0.3–0.4 in).

### Guidelines for outplanting

Survival is usually very high for this hardy, nitrogen-fixing species. Controlling grasses and other competitive weed growth around the tree until its canopy overtops the height of the weeds is key to good growth and survival. Thereafter, the tree will hold its own, and in fact is used in Indonesia and West Africa to reclaim grasslands infested with blady grass (*Imperata* sp.). On sites with adequate rainfall, trees can easily attain 2–3 m (6.6–10 ft) in height after a year of growth. A planting study on a sandy site in Puerto Rico had 72% survival and seedlings reached 3.8 m (12.5 ft) in 28 months.

### Propagation by direct-seeding

In direct-seeding, an area is prepared at each planting spot, cleared of weeds, and cultivated to a depth of 50 cm (20 in) if the soil is compacted. Seeds are planted at a depth of 5 mm (0.2 in).

Direct-seeding is often the best method for outplanting. It is often cheaper because it eliminates nursery container growing and transplanting. The drawbacks of direct-seeding include risk of predator damage (e.g., rats, birds, etc.), lack of rains to sustain the newly germinated seeds, and the mandatory frequent maintenance that must be done to ensure weeds do not overcome the small seedlings.

### Propagation by cutting (after Wilkinson and Elevitch 2003b)

Cuttings are often used instead of seedlings, especially in wet areas where seed production is usually poor and soil moisture is favorable for starting cuttings directly in the ground. *Gliricidia* generally roots very easily from large cuttings, making this the preferred method of propagation in many areas. Other advantages over seedlings are:

- Large cuttings are usually taller than the weeds and can easily be seen for early weed maintenance.
- Many farmers set fence-post-sized cuttings and immediately nail the fence wires to them. Those that take root are maintained as living fence posts, and those that do not root are replaced with new cuttings after they rot off, until a complete living fence system is established. Smaller-diameter cuttings can support fence wire a few months after establishment.
- Cuttings are vegetative clones of the mother trees and therefore can be easily selected for desired qualities such as upright growth.
- Large cuttings provide crop shade within a relatively short period of time.

The disadvantages of using cuttings include:

- They are many times the size and weight of seedlings, so they are harder to transport and require a much deeper planting hole.
- Cuttings are genetically identical to the parent plant and therefore large plantings might be more susceptible to disease and insect attack.
- Parent trees are able to produce fewer cuttings than seeds.
- Cuttings are more vulnerable to windthrow.

Root development of *gliricidia* from cuttings is poor compared to trees grown from seed. For live fences, the benefits of quick establishment and resistance to animal attack usually outweigh this consideration. For windbreaks or forestry, establishment from seedlings is recommended.

### Collecting cuttings

Normally, large cuttings 2–2.5 m (6.6–8.2 ft) long and 6–15 cm (2.4–6 in) in diameter are used for quick establishment of live fence posts supporting barbed wire or hog fencing. For growing in dense stockades, smaller woody cuttings 50 cm (20 in) long, 1–2 cm (0.4–0.8 in) in diameter, and at least 6 months old are used. *Gliricidia* is highly variable in form and productivity; select cuttings from trees with more upright form for best results for live fence posts.

Cuttings can be taken any time of year, although the ideal

time for deciduous trees such as gliricidia is when the new growth is appearing, usually at the onset of the rainy season.

If cuttings are transported, they should be covered or kept in the shade and should not be allowed to dry out or to be bruised. Protect cuttings from bruising during transport by padding with leaves or a blanket.

### Harvesting cuttings

Make a clean cut with a sharp pruner or saw. The top should be cut at an angle to preclude water accumulation and rotting on top of the cutting. The angled cut also indicates which side to plant upwards. Cuttings should be pruned clean of major side branches and leaves.

### Storage of cuttings

It is ideal to outplant the cuttings immediately. If this is not feasible, cuttings can be stood up in shady conditions and covered with wet sackings or sprinkled frequently. In Central America, farmers often harvest cuttings during the waning moon, followed by 1 week lying horizontal and 3 weeks in the vertical position with the rooting end down, and planting during the next waning moon (Allison and Simons, 1996). In Puerto Rico, they wait for what they consider to be the correct phase of the moon to harvest the cuttings and plant immediately.

### Preparing cuttings

At planting time, the lower 30–40 cm (12–16 in) of the cuttings are usually “wounded” using a sharp knife to make several small incisions through the bark to promote side rooting. Without these cuts, roots usually only emerge from the base of the cutting, making for a potentially weak root structure and susceptibility to windthrow.

### Growing area

Cuttings are normally planted directly in the field. For cuttings 2–2.5 m (6.6–8.2 ft) tall, the lower portion is buried 30–50 cm (12–20 in) deep. For smaller cuttings, generally about 20% of the cutting’s length should be underground. Planters should make sure to plant cuttings correct side down. As described above under “Abilities,” the planting hole should be inoculated with rhizobia culture or a crude inoculant made from nodules or soil.

After placing the cutting, ensure there is firm soil contact with the cutting to promote side rooting and to prevent movement in the wind. Soil should be moist during early



Barbed wire mounted on a stockade fence of gliricidia cuttings. PHOTO: C. ELEVITCH

establishment, but not overly wet. Irrigation may be necessary during dry spells until the cuttings are established.

### Guidelines for outplanting

Removing weeds from the base and root zone around cuttings is important for high success rates. Placing a weed barrier such as a sheet of cardboard or other biodegradable material can greatly reduce the time necessary for weed control.

In areas without adequate rainfall, cuttings should be irrigated once or twice a week until they are well established (i.e., 4–6 months). Overwatering can cause rotting of gliricidia cuttings. Controlling grasses and other competitive weed growth around the tree until its canopy overtops the height of the weeds is key to good growth and survival. Once established, very little maintenance is required.

Cuttings are usually planted for live fence posts, with wire strung between posts. Spacing for live fence posts ranges from 0.5–3 m (1.6–10 ft) between cuttings. For pig containment, gliricidia is also used as live fence posts to make a physical barrier from the tree trunks reinforced with wire mesh, corrugated iron, or organic material; 30 cm (12 in) apart or less is typical spacing for this purpose. Live fences sometimes contain a mix of other species such as *Morus* spp. (mulberry), *Hibiscus* spp., or *Erythrina* spp., in the Pacific, or with *Tabebuia* spp. and *Bursera simaruba* in the Americas.





Top left: Cuttings prepared for planting. Right: Without wounding the lower 30–40 cm of bark, this tree only formed roots at the very base of the cutting, and it was easily toppled in a strong wind. Bottom left: Because this horizontal cut at the top of the cutting retained rainwater, rotting has taken place down into the center of the tree, compromising its health and strength; for this reason, it is best to make the top cut at a 30–45° angle. PHOTO: C. ELEVITCH

## DISADVANTAGES

### Potential for invasiveness

*Gliricidia* has naturalized to a limited extent in a number of locations outside its native range, particularly in disturbed environments such as roadsides and abandoned agricultural land. As a light-demanding species, it is unlikely to invade dense plant communities. It has not been reported to be an aggressive invader or a serious pest and is not considered an invasive plant in the Pacific (PIER 2003).

### Common pest problems

It is susceptible to aphids (*Aphis craccivora* in Puerto Rico). The leaves of aphid-attacked trees seasonally become blackened and fall prematurely. No data is available on aphid control, but conventional application of insecticides

registered for aphids would probably be effective. In addition to aphids, the tree is susceptible to mealybugs, scale insects, and some foliar diseases, in certain areas and under specific circumstances, but these are rarely major problems. Entrance of heart rot fungi can be avoided by protecting the trees from breaks in the bark. However, this cannot be avoided when trees are used for living fences and lopped for firewood or fodder. It is suggested that the trees be replaced as they begin to decline in health and vigor.

### Host to crop pests/pathogens

None reported.



## AGROFORESTRY/ENVIRONMENTAL PRACTICES

### Mulch/organic matter

It is lopped for mulch and green manure in agroforestry applications and regrows very rapidly given sufficient soil moisture and warm temperatures.

### Soil stabilization

Gliricidia is planted in contour hedgerows (alley cropping) on sloping lands susceptible to erosion. The hedgerows hold soil together and, when properly planned and managed, can slow erosive surface run-off.

### Pest control

There is some evidence that gliricidia can protect certain crops from various fungal, insect, and viral pests. For example, in one experiment, intercropped gliricidia hedges were associated with reduced rust and leafspot in groundnuts (Stewart 1996). In other studies, gliricidia hedges acted as a diversionary host to an aphid that spreads the rosette virus in groundnut, and to a live-wood tea termite (Stewart 1996). It has also been shown to be associated with reduced stem-borer damage in rice (Wiersum and Nitis 1997).

### Crop shade/overstory

Gliricidia is a popular shade or nurse tree for crops including coffee, tea, cacao, pepper, passion fruit, and vanilla, in many varied spatial arrangements. Spacing of about 10 x 10 m (33 x 33 ft) interspersed with crops such as coffee and cacao is common. In addition to providing a favorable envi-

ronment for certain crops, the shade it provides helps suppress light-demanding weeds. The shade trees are pruned seasonally to maximize benefits to the understory crop, and to minimize competition for water and nutrients.

### Alley cropping

It has been intercropped in alley cropping systems with maize, cassava, taro, cucurbits, and other food crops. In such systems, pruning gliricidia back regularly provides mulch for the crops and controls competition by the gliricidia for light, water, and nutrients.

### Homegardens

The benefits of shade, nitrogen fixation, nutrient cycling, mulch, and fuelwood production can be the same on a smaller scale as for farms.

### Improved fallows

It is planted by seed or cuttings as a nitrogen-fixing fallow crop. It has been used to reclaim land infested with blady grass (*Imperata cylindrica*) by shading out the grass—it has been shown to be superior in this respect to leucaena (*Leucaena leucocephala*) and also does not present the weed risk of leucaena.

### Living fences

Gliricidia is one of the most widely used species for living fence posts in the tropics.

### Fence posts

Cuttings that do not take root, often up to 50% of those planted, serve as temporary fence posts, which hold up the fencing material during the process of establishing living gliricidia fences.

### Boundary markers

Gliricidia is sometimes planted to mark property boundaries.

### Windbreaks

Although the tree tolerates wind fairly well, it is alone minimally efficient as a windbreak due to its thin crown and deciduous habit in dry regions. If carefully planned, gliricidia can be used as one species in a multi-row windbreak, where the other species offer sufficient protection during the period when the gliricidia crown is bare. It should usually be planted on the windward side of taller species. In warm areas without a dry season, gliricidia trees can be pruned two or three times a year to maintain full, lush growth. By planting two rows alongside one another and pruning each row alternately 3–4 months



Gliricidia provides shade and organic matter in a cacao orchard. PHOTO: C. ELEVITCH



**Living fence post supporting barbed wire, strong enough to contain pigs.** PHOTO: C. ELEVITCH

apart, a dense windbreak to 3–4 m (10–13 ft) in height can be achieved, while also providing a regular source of organic matter or fodder.

### **Silvopasture**

Living fence posts and field boundary trees can provide fodder when periodically lopped. Animals often are allowed to browse the trees in older plantations.

### **Woodlot**

Gliricidia is a good producer of high-quality fuelwood, both in dedicated woodlots and incidental with other uses. Trees grown for fuelwood are either coppiced on rotations of 1–5 years or harvested and replanted after 6–8 years.

### **Native animal/bird food**

The foliage is consumed by browsing animals. The bark and seeds are not known to be eaten by any mammal or bird. The tree is used as nesting habitat by some species of birds.

### **Host plant trellising**

Gliricidia is used as support for pepper, yam, passion fruit, and vanilla. It is very suitable as crop support due to its upright growth after pruning and the appropriate amount of dappled shade it provides for many crops.

### **Bee forage**

Gliricidia attracts honeybees, carpenter bees, and a wide range of insect pollinators, and it provides limited cover for birds and mammals. In areas with a pronounced dry season, it flowers profusely and is a very good honey plant for the nectar it produces.

### **Coastal protection**

Because of gliricidia's ability to grow in exposed coastal environments, and even in shifting sands (Simons 1996), it has potential for agricultural use in near-shore agricultural environments.

### **Ornamental**

It is planted in residential lots, parks, and on roadsides where small trees are required. It produces copious quantities of lilac-colored flowers when grown in environments with a pronounced dry season.

## **USES AND PRODUCTS**

### **Leaf vegetable**

Cooked gliricidia leaves and flowers are said to be eaten boiled or fried. Placed in containers with bananas, the leaves hasten ripening of the bananas.

### **Honey**

The flowers attract honeybees and are a good source of nectar.

### **Medicinal**

Crushed fresh leaves are applied as a poultice. In Mexico, the plant is used as an antihistaminic, antipyretic, expectorant, and diuretic. Extracts of gliricidia have been shown to have high anti-fungal activity (Stewart 1996).

### **Animal fodder**

The leaves (cut branches with leaves attached or directly browsed from low plants) are widely used as cattle and goat fodder. There are few toxicity problems with ruminant animals. Experiments have shown similar benefit in using gliricidia fodder and mineral mixtures as supplements to grass pasture. Yields of fodder range from 2 to 20 t/ha/yr and can make a significant contribution to dry-season forage. Silage preparation of gliricidia leaves mixed with



## LORE

According to Caribbean folklore, planting gliricidia near houses and fields will control rats and mice. Fallen seeds supposedly attract rats and mice that eat them and die of poisoning.

a small percentage of molasses or sugarcane has shown promise (Stewart 1996).

### Beautiful/fragrant flowers

The lilac-pink flowers make this a memorable ornamental. However, the flowers are not fragrant.

### Timber/wood

The wood is light to dark olive-brown, very hard and heavy, strong, coarse-textured, with an irregular grain. It seasons well and, although difficult to work, takes a high polish. It is highly durable (termite- and fungus-resistant), and valued for house construction and corner fence posts (CABI 2003). Gliricidia timber has been used for posts, railroad ties, construction, furniture, tool handles, and farm implements. The small diameter of the timber and short pieces available, usually less than 30 cm (12 in) in diameter and 2 m (6.6 ft) in length, preclude most commercial use of gliricidia timber.

### Fuelwood

Fuelwood produced from gliricidia is used locally for cooking, heating, and drying tobacco. It rarely requires splitting, is of moderately high density (47 to 75 g/cm<sup>3</sup>), and has a caloric value of 4900 kcal/kg (2230 kcal/lb). In woodlots the first harvest can be carried out after 3–4 years, giving wood yields of 8–15 m<sup>3</sup>/ha (114–215 ft<sup>3</sup>/ac) (CABI 2003). Yields may reach as high as 3.5–4.5 kg/tree/yr (1.6–2.0 lb/tree/lb) in Central America. Annually coppiced fuelwood in the Philippines produces fuelwood volumes of 23–40 m<sup>3</sup>/ha (330–572 ft<sup>3</sup>/ac). The wood is also sometimes used for charcoal production. Production of fuelwood has reached commercial levels in only a few locations such as the Philippines.

### Craft wood/tools

Stems and branches are sometimes used for tool handles.

### Toxin/insecticide/fish poison

Roots, bark, and seeds are toxic due to the presence of tannins, afrormosin, medicarpin, and isoflavins. The botanical and common names and folklore suggests that the seeds or other parts are useful as a rodenticide. Tests of leaf and wood extracts have shown insecticidal and anti-microbial

activity. A leaf extract used in Latin America to bathe animals every 7–14 days has been found to sharply reduce the incidence of torsalo (tropical warble fly) in goats.

## URBAN AND COMMUNITY FORESTRY

Gliricidia is suitable for ornamental use in residential and public landscaping, parking lot islands, and along residential streets because of its moderate size, clean appearance, and colorful flowers. Care must be taken that trees are planted in soil that is at least moderately fertile and uncompacted.

### Size in an urban environment

It is easily shaped to a desirable size and form by periodic pruning. It is generally kept at 3–6 m (10–20 ft) in height



With profuse flowering during the dry season, and deciduous habit, gliricidia makes an interesting specimen tree. PHOTO: C. ELEVTICH



and 2–4 m (6.6–13.2 ft) in crown spread, requiring annual or biannual pruning. When regularly pruned with a framework of side branches (pollarding), gliricidia has a similar appearance to the common landscaping shower trees, e.g., golden shower (*Cassia fistula*) and pink and white shower (*C. javanica*), except that gliricidia is deciduous in areas with a pronounced dry season.

### Rate of growth in a landscape

The tree generally grows rapidly at a rate of 1–2 m/yr (3.3–6.6 ft/yr) in early years, slowing to a few cm per year after 6–8 years. Trunk diameter growth is about 2 cm/yr (0.8 in/yr).

### Root system

Damage to curbs, sidewalks, and foundations is unlikely unless the tree is both very large and planted in close proximity to such features.

### Products commonly used in a Pacific island household

Gliricidia is still relatively uncommon in the Pacific but is increasingly important in Fiji, Vanuatu, Hawai'i, and other regions.

### Light requirements

Full sun is recommended; otherwise, with increasing shade, growth slows and the canopy becomes sparse.

### Water/soil requirements

Irrigation is generally not needed except in very dry climates (<600 mm [24 in] of mean annual precipitation). Planting in waterlogged soils should be avoided.

### Life span

Good data are not available on lifespan. Gliricidia under favorable conditions can be expected to live up to 50 years, but it is certain that the species is not long-lived.

### Varieties favored for use in a homegardens

Although there are no formally described varieties, individual trees vary in form from low and spreading to tall and upright (columnar). The tree is usually propagated by cuttings that are clones of the mother tree and grow with the same habit. Therefore, cuttings should be taken from trees with desired qualities for a particular purpose.

### Seasonality of leaf flush, flowering, fruiting

Flowering occurs at the beginning of the dry season when the trees have lost their leaves. In the native range this oc-



Due to its deciduous habit in seasonally dry climates, gliricidia does not make a good year-round single-species windbreak or privacy barrier. PHOTOS: C. ELEVITCH

curs between November and March. Fruit development and maturation occurs at the end of the dry season. In areas with even rainfall throughout the year, the trees never completely defoliate, and flowering occurs irregularly, but lightly, throughout the year. Fruits often fail to develop in areas with evenly distributed and high rainfall.

### Exceptional ornamental values

Gliricidia is a very beautiful tree when in bloom, although flowering usually occurs during periods of leaf loss. Its clean appearance and moderate size gives it character during the rest of the season.

### Use as living fence, hedge or visual/noise barrier

In addition to its use as living fence posts, when pruned regularly to maintain lush, leafy growth, gliricidia makes a fine hedge, especially in wetter climates where it remains leafy year-round.

## Maintenance requirements

Pruning is generally not needed if an open crown at the natural height of the tree (8–15 m [26–50 ft]) is desired. Regular pruning can be done to force trees into desired shapes (hedges, below view planes, etc.) and to encourage lush, leafy growth.

## Nuisance issues

Aphids cause the trees to drip honeydew, which is sticky, attracts ants, and can discolor cars, furniture, etc.

## Hazards

In dry areas the seedpods tend to open explosively when ripe, especially on hot days. The seeds are thrown up to 25 m (82 ft) from the tree, which can present some danger to people. In high winds, branches can shear off, particularly from trees grown from cuttings and during periods of rapid growth. The roots, bark, and seeds are poisonous to humans and many animals if ingested. Old trees often become hollow, especially those that have received injuries from fence staples, mowers, or by pruning, and because of the weakness they are prone to trunk breakage and windthrow.

## COMMERCIAL PRODUCTS

Much of the value of *gliricidia* is not commercial but the farm services it provides including living fence posts, green manure, shade, fodder, windbreak, etc. There are several areas where there is commercial potential, however. Because much of the commercial seed available is inferior germplasm (unselected for productivity) (Stewart et al. 1996), there is a market for seeds from the better provenances. Similarly, there may be local markets for cuttings from selected germplasm for use in planting living fence posts, shelterbelts, etc. In certain areas, there may also be a market for *gliricidia* fuelwood.

## Fuelwood

### Spacing

Fuelwood plantations in Central America are typically established with 1000–5000 trees/ha (400–2000 trees/ac) for rotations of 5 years. In Asia, fuelwood plantations are set out at 1 x 1 m (3.3 x 3.3 ft) to 2.5 x 2.5 m (8 x 8 ft) spacings for pruning at 1- or 2-year intervals.

### Management objectives

Trees may be pruned at ground level in fuelwood plantations or intercrop plantings or cut above the wire height in living fences.

## Yields

Fuelwood yields from stands harvested every 2–3 years are 10–20 m<sup>3</sup>/ha (143–286 ft<sup>3</sup>/ac). Wood production from a living fence has been reported at 9 m<sup>3</sup>/km (57 ft<sup>3</sup>/mi). Yields vary greatly depending on provenance (genetic source).

On intermediate quality sites in Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, and Panama, annual fuelwood increment reached a peak of 4.5 kg/tree (9.9 lb/tree) at 2 years of age, although cutting usually takes place on rotations of 5–8 years. Statistical analysis for site index, mean tree height, basal area, and dry fuelwood for plantations 12–60 months of age are available (Hughell 1990).

## Processing required

Fuelwood is often stacked and dried for a few weeks before marketing.

## Markets

Fuelwood markets are usually close to the point of origin.

## INTERPLANTING/FARM APPLICATIONS

In many countries such as Indonesia, Brazil, and Costa Rica, cacao is traditionally established under the shade of trees such as *gliricidia*, *Erythrina poeppigiana*, *Inga* spp., and other species. These shade trees are used due their rapid growth, ability to biologically accumulate atmospheric nitrogen, ease of establishment, adaptability to many different site conditions, and ability to regrow vigorously after pruning. During establishment, the shade trees are planted within the cacao orchard at a spacings of 2 x 2 m to 4 x 4 m (6.6 x 6.6 ft to 13 x 13 ft) for a cover of about 30–55% shade. After 2–3 years as the canopy of cacao closes, the shade trees are usually thinned to a spacing of 6 x 6 m (20 x 20 ft).

## PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

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

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

## *Gliricidia sepium* (gliricidia)

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