Chapter 9: Popular Agroforestry Tree Species

As we've learned, trees planted using agroforestry technologies in the first phase of the Forest Garden Approach are an important step in the continuous pursuit of sustainable land management. Establishing a sustainable agroforestry system will occur over a number of years. The first year or two are extremely important as participating families must have some level of success and want to see some harvestable products or clear benefits that will keep them engaged and committed. After the initial pioneer species are established, sites are protected, and soils are revitalized through the use of a combination of the agroforestry technologies described above, diversifying the system will become much easier.

In the first phase of the Forest Garden Approach, you will start with a low number of species, perhaps just three or four. Though we do recommend native species when they host the desired characteristics required by the technology and climate, non-native, naturalized species that have been researched and used in agroforestry projects for decades often better meet the growth, production, and service needs of the system. Regardless of the species, the trees you select and plant during the first phase must include multipurpose, fast-growing (MPFG) trees that have as many of the following characteristics as possible, relevant to the purpose for which you are planting them:

- Fast-growing
- Nitrogen-fixing
- Produces an abundance of leaf litter
- Able to grow back quickly after pruning, coppicing, or pollarding
- Able to grow in degraded, erosive, nutrient-poor soils
- Compatible with crops
- Deep taproot with minimal lateral root growth
- Multi-purpose – trees that provide a variety of useful products (e.g. fodder, green fertilizer, & fuelwood) and ecosystem services (e.g. erosion control and soil improvement)

As for the exact species for your Forest Garden, it is ultimately you and your family who will make that decision. Discuss species selection with your project technicians, fellow farmers, and representatives from the local department of forestry or natural resources if you have any questions.

Below is a brief list of the most common and useful tree species or genera that TREES recommends, including a description of the tree, its products, services, and uses, growing requirements, propagation recommendations, and pictures.

Leucaena spp.

Overview: Fast growing, deciduous small tree or shrub, reaching up to 20 m tall. Native to the American tropics, improved varieties of Leucaena are now being developed on nearly every continent. It is predominantly self-pollinating and therefore gives forth offspring similar to the mother tree. Use of *L. colinsii* and *L. salvadorensis* is mostly in Central America.

Products:
Wood: Coppiceable, dense wood good for fuelwood and pole timber.
Fodder: The high percentage of crude protein and digestibility, and the copious amount of nutritious leaf litter production make Leucaena trees an excellent fodder sources. However, it contains mimosine, an irregular amino acid that can cause hair loss and stomach issues, and should be fed in limited amounts to non-ruminant, single-stomach animals (none at all to horses or mules). For ruminant animals (cattle, goats, sheep), it can be fed up to 25% of the diet.
Green Fertilizer: Leaves are high in nitrogen and are great as an organic fertilizer.

Agroforestry Uses:
Windbreaks: Good, tall filler in windbreaks because leaf density is full yet not too thick, space ~3-4 meters apart.
Living Fences: Fast growth speed makes it great for live fence posts as long as animals do not eat the seedlings before they mature.
Alley Cropping and Contour Planting: Nitrogen fixing; can be planted on flat terrain or in contour lines on slopes, Leucaena makes great hedge rows that produce organic fertilizer, pole timber, and serve as windbreaks. FUEL: Quality fuel and charcoal.
Apiculture: Leucaena is in bloom almost throughout the year, providing constant forage for honey bees.

Characteristics: Growths rates are fast, and crown shape and branch formation are all similar. Narrow canopy up to 20 meters tall, sometimes higher. Very coppiceable, growing back quickly after cutting. It is a heavy seeder, however, with the undesirable ability to colonize quickly if not managed carefully.

Site Requirements: Grows best in full sun, though can handle partial shade. Tolerant of many types of soil and terrain, but tends not to fare well in acidic soil. Can tolerate light frost though will likely be defoliated.

L. leucocephala: Altitude 0-1500 m; Rainfall 650-3,000 mm
L. collinsii: Altitude 100-900 m; Rainfall 500-1,000 mm

L. salvadorensis: Altitude 200-1000 m; Rainfall 800-2,000 mm

Propagation: *L. leucocephala*: Boil water, remove from heat, place seeds in the water and allow to soak for 2 minutes, then add cool water. Soak for 24 to 72 hours. Another option is to scarify the seed coat. Make sure not to damage the radicle/embryo (the pointed side of the seed). *L. collinsii*: Boil water, remove from heat, place seeds in the water and allow to soak for 30 seconds, then add cool water. Soak for 24 to 72 hours. Scarification is more effective. Make sure not to damage the radicle/embryo (the pointed side of the seed). *L. salvadorensis*: No pretreatment required.

Pests and Diseases: A myriad of insects, fungi, and animals attack Leucaena, yet few cause serious damage. Widespread leaf loss from psyllids in the mid-1980's is less of a concern for new, more resistant varieties. Adult trees have very few problems, though seed loss by seed weevils and flower loss by moth larva have been reported. Grazing animals are by far the greatest problem!

Calliandra calothyrsus

Overview: Calliandra calothyrsus is a small, thornless, often multistemmed and bushy tree. Native to Central America and introduced to Java in 1936, where it became well-established, Calliandra produces excellent fuelwood and green fertilizer, and is highly valued by apiculturalists. Leaves are high in nitrogen and are used as a fertilizer and sometimes as livestock fodder. In tropical areas it can be established at elevations above 1500 meters it develops best between about 250-1000m. Calliandra is a great pioneer species used to reclaim degraded lands.

Products:
Wood: Branches do not produce great pole timber, but as it is a very coppiceable tree that is fast-growing, multi-stemmed, and thornless, it is great for fuelwood. Calliandra should be coppiced at 20-50cm above the ground to facilitate the best resprouting and prevent fungal infections.
Fodder: Leaves and pods are rich in protein (22%) and do not contain any toxic substances, however it has does have high concentrations of tannins that can reduce digestibility.

Agroforestry Uses:
Soil Improvement and Land Reclamation: Calliandra thrives on slopes, marginal soils, and degraded agricultural land. It improves soil by fixing nitrogen and producing high amounts of leaf litter.
Alley Cropping: High leaf biomass production and high-protein leaf material, even on less fertile soils, make it ideal for use in alley cropping systems.
Living Fences: With numerous stems to weave through adjacent trees, it can form an impenetrable barrier.
Apiculture: Nectar-rich flowers produce constant, high-quality fodder for bees, allowing for year-round honey production (pic 8B).

Characteristics: Vigorous nitrogen-fixing, bushy tree. Fast growth rate to 4-6 meters tall (known to reach 12m), growth of 3-5 meters is possible in the first year. Branches tend not to develop into straight poles. Crown is moderately heavy and sheds leaves in seasonal climates. Has both superficial and deep-growing roots.

Site Requirements: Good in humid tropics, tolerates rainfall as low as 700mm, but thrives in areas with 2000-4000mm. Avoid areas with poor drainage where waterlogging occurs. Prefers light soil textures and slightly acid conditions, but can grow in a wide

array of soil types. Tolerates altitudes from 250 to 1800 m. Moderately shade tolerant. Moderately drought resistant, but during severe drought the tree will die off and come back with the rains.

Propagation:
Tree Sacks: Soak the seed in water for 24 hours. Seed 2 per sack, cover with ¼ inch of soil and keep moist. Outplant at 20-50cm height, when root collar is 0.5-1.0cm.
Bareroot: Plant pretreated seeds in nursery bed, allow to grow to 75-100cm which takes about 4 months. When ready to outplant, prune the roots at 20 cm and the top at 30cm, strip leaves. Whether propagated with sacks or bareroot, weeds should be cleared before planting and monitored during the first year.

Pests and Diseases: Calliandra tends not to suffer from major pests or diseases. Mature trees should be coppiced cleanly 50cm above ground to avoid infestations in the fissures of harvested stumps.

Faidherbia albida

Overview: Also called *Acacia albida*, *Faidherbia albida* is a large, thorny tree, reaching up to 30m in height, with spreading branches and a rounded crown. It is native to many countries across Africa, and is commonly considered one of the best agroforestry trees for intercropping in fields. The tree responds well to coppicing, but be sure to make clean cuts, as improper lopping can cause wounds, predisposing it to attacks by pathogens.

Products:
Fodder: The leaves and pods are palatable and can provide an important source of protein for livestock in the dry season.
Wood: *F. albida* is commonly used for fuelwood. It does not make a great timber due to staining and twisting, but it is easy to work by hand.

Agroforestry Uses:
Shade and Shelter: *F. albida* is often protected on farms to shade coffee as well as livestock in the dry season.
Reclamation: Its spreading root system offers excellent protection to the banks of rivers and streams.
Alley Cropping: Shedding its leaves in the rainy season, it provides nutrient-rich green fertilizer when crops need it most. Being leafless during the rainy season also reduces competition for sunlight with the crops. Repeated pruning during periods of average biomass production stimulates leaf production.
Dead and Living Fences: The thorny braches can be chopped off to form a dead fence, which is extremely important to place around a newly-planted living fence where there is risk of attack from roaming livestock. It also makes a great barrier for the outer row of a living fence.
Apiculture: It has the advantage of producing flowers at the end of the rains while most sahelian species flower before them, so can be used as a main source of bee forage at this time.

Characteristics: Due to an inverted phenology—i.e. it keeps its leaves during the dry season to provide shade, and drops them in the rainy season to fertilize crops—it is commonly considered one of the most effective intercropping trees for green fertilizer.

Site Requirements: *F. albida* grows on the banks of seasonal and perennial rivers and streams on sandy alluvial soils or on flat land where Vertisols predominate. It thrives in climates characterized by long summers, or a dry season with long days. It tolerates

seasonal waterlogging and salinity but cannot withstand heavy clayey soils. It can grow between 300-2700m, receiving 250-1000mm of rainfall.

Propagation: Propagation is most successful using tree sacks. The seed should be removed from the pods before planting, and pretreated by pouring hot water on them and allowing them to soak for 24 hours. Scarification is also an effective pretreatment method.

Pests and Diseases: Bruchid beetles attack the seeds, so collect seeds early and remove it from the pods to avoid infestations.

Sesbania spp.

Overview: Thought to be originally from Egypt, *S. sesban*, narrow-crowned, deep-rooted, single or multi stemmed shrub or small tree, 1-7 m tall.Though short-lived, one of the major advantages of sesbania over other forage trees and shrubs is its rapid early growth rate, which can be exploited by intercropping it with other slower establishing species for earlier yields. It can be difficult to establish in unprotected areas due to high favorability by livestock. *S. sesban* (pic 8D) and *S. grandiflora* (pic 8E) share many qualities, though *S. sesban* is better for drier climates.

Products:
Fodder: Sesbania leaves are high in nitrogen and is an excellent supplement to protein-poor roughage for ruminants, which readily eat leaves and young branches. The crude protein content is generally greater than 20% and often above 25%, with high digestibility. Though when grazed, the brittle tree may break too easily, exposing it to fungal attack, so it is best used in a cut-and-carry system, with stems removed cleanly from the tree.
Wood: Highly coppicable, it is a popular source for fuelwood and charcoal because it produces a high amount of woody biomass in a short time which, although soft, is relatively smokeless, quick kindling, and hot burning.

Agroforestry Uses:
Alley Cropping: Sesbania is easy to establish, it grows rapidly, and coppices readily, providing mulch of high nutrient content and making it a promising tree for alley cropping.
Soil Reclamation: It is commonly planted on fallow land for soil improvement due to its fast growth and nitrogen-fixing characteristics. Harvested leaves and stems make a rich compost or green fertilizer.
Windbreaks: Applicable as a stand-alone species around vegetable gardens, or planted with taller species for protecting large crop fields.
Living fences: Sesbania is a low-growing, bushy plant, whose fast-growth makes it ideal for quick living fence establishment. However, it must be protected from livestock or it will not survive early browsing.

Characteristics: Sesbania is a fast growing, short-lived tree that grows many branches. It tends to develop into a shrub or small tree about 4 to 15 meters tall. Flowers for either species can be yellow, pink, purplish, white or red.

Site Requirements: Tolerates saline, acidic, or waterlogged soils. Prefers between 500 and 2000 mm rainfall. *S. sesban* is able to grow at elevations between 100 and 2300 meters.

Propagation: Seed storage is orthodox, maintaining viability for 2 years, but the seeds are very susceptible to insect attack and should not be stored for more than 1 year.
S. sesban: Scarification is recommended. Make sure not to damage the radicle/embryo (the pointed side of the seed).
S. grandiflora: Scarification with nail clippers works but because of the small size of the seeds you can also easily soak them in cold water for 24 hours. Make sure not to damage the radicle/embryo (the pointed side of the seed).
Seed 2 seeds per sack 12 weeks before outplanting. Weeding around seedlings recommended in the first month after outplanting. Barestem propagation is possible as well.

Pests and Diseases: The seed is commonly attacked by insects. Leaves, stems, and branches are susceptible to attack by caterpillars, weevils, stem borers, bacteria and fungi. Burn infested plants.

Senna siamea

Overview: *Senna siamea*, also called Cassia tree, is a fast growing evergreen native to Southeast Asia. It tolerates both arid lands and tropical climates. Because of its fast growth and quick regeneration from coppicing, it is applicable to many agroforestry systems. It is very popular in arid regions, particularly West Africa.

Products:
Fodder*: S. siamea* is widely grown for fodder, but the tree is prone to browsing. Leaves are highly toxic to non-ruminants such as pigs and poultry, so these animals should be kept away from the trees.
Wood: The dense, dark wood of S. siamea makes good fuelwood, though it does produce a lot of smoke. It produces high-quality charcoal. The timber produced by the tree is very hard, resistant to termites, strong, and durable, but difficult to work. It is often used for cabinet making, handles, and poles for construction.

Agroforestry Uses:
Windbreaks: Good, tall filler in windbreaks, space at 3-4 meters.
Living Fences: Growth speed makes great living fence posts. Grown as a living fence hedge, it effectively increases water infiltration capacity of soil and combats soil erosion.
Soil Improvement: Though not nitrogen-fixing, its high biomass production does make for a green fertilizer.

Characteristics: *S. siamea* will grow in a range of climatic conditions but is particularly suited to lowland tropics with a monsoon climate. It will grow only when its roots have access to groundwater, and the maximum length of the dry period should not exceed 4-8 months. Rainfall as low as 500mm may inhibit growth from exceeding 5 meters, yet rainfall up to 1500mm can allow growth to 20m. Lateral roots have been reported to compete with crops in alley cropping, so should be kept out of gardens and crop fields (though makes a great windbreak/boundary planting). Seeds all year round. Produces large quantities of biomass, but does not fix nitrogen.

Site Requirements: Performs best on deep well-drained fertile soils, but will grow on degraded lateritic soils provided drainage is not impeded. The species is intolerant of saline soils. It grows best at an altitude between 0-1200 m with annual rainfall of 400-2,720 mm.

Propagation: Pretreatment is not required for S. siamea. Sow 4-5 seeds per sack, but not too deeply (only ~1/2 cm deep). Keep soil moist, in plenty of sunlight. Propagation by cuttings up to 2 meters in length is possible, as is direct seeding, though early seedling growth can be slow, so it is better to start S. siamea in nurseries. Weeding is necessary for the first one or two years of growth during which they require pruning to develop a straight trunk.

Pests and Diseases: Insects are quick to attack harvested or splintered wood.

Grevillea robusta

Overview: *Grevillea robusta* is a deciduous medium-sized to large tree 12-40 m tall, with a dense, conical crown. It is a fast-growing evergreen timber tree native to the Pacific Islands and Eastern Australia. It has become very popular in East Africa, often replacing eucalyptus for timber production, and growing in popularity in Central America. Grevillea grows well in tropical highlands and lowlands.

Products:
Wood: Good for medium strength poles and fuelwood, coppiceable. Plant in woodlots (2.5 m x 2.5 m) and rows (2-2.5 m between trees). Harvest branches by pruning high, leave about 1/3 of the branches after pruning to support regrowth. It also produces high-quality fuelwood and charcoal.
Mulch: High leaf litter covers the ground, making Grevillea a good source of natural mulch.

Agroforestry Uses:
Apiculture: The golden, nectar-rich flowers of *Grevillea robusta* are attractive to bees and make for great honey production.
Windbreak: Grevillea is a good tree for windbreaks, spaced at ~3 meters and combined with shorter species, though the branches may split and break under very high winds.
Intercropping: It is a good shade-species for tea and coffee. Cut roots around trunk to 30cm whenever planted next to crops to minimize competition from Grevillea's lateral root systems (Kalinganire, 1996).

Characteristics: *Grevillea robusta's* complex, shallow root system allows for efficient nutrient uptake, even in poor soils. However, it does compete with crops if roots aren't pruned. Leaves produce a chemical that inhibits growth of other plants, but no major problems regarding this issue has been reported. It is not resistant to persistent, strong winds as the wood can be brittle and break away under high pressure. In its natural range, the species is semi-deciduous, shedding most of its leaves in the dry season, and can stand up to 6 months of drought.

Site Requirements: Grevillea is found in both dry and wet climates (600-1,700mm) and can tolerate drought for up to six months. It grows from sea level up to 2300 m. It prefers neutral to highly acidic, well-drained soils (best in slightly acidic). It is not very shade-tolerant, and flowers best in open, sunny areas.

Propagation: It is best sown in tree sacks, and extreme heat may hinder germination rate. No pretreatment is required, and it germinates readily in a moist environment. Seed in sacks 1/2 cm deep and keep the soil moist. Cuttings can be easily established using shoots from seedlings or saplings, which can also be air-layered. Place cuttings 7.5-10cm long in sacks or directly into the field, about 3.5 cm deep.

Pests and Diseases: In humid regions, *G. robusta* is vulnerable to attack by fungal diseases. Attack by termites can be a problem when planted on dry sites in Africa. In the Caribbean, it has often been attacked by scale insects.

Albizia lebbeck

Overview: *Albizia lebbeck* occurs extensively throughout the India, Thailand, and Malaysia. It has been used widely for roadside planting in dry areas, and has been cultivated extensively and is now naturalized in the West Indies and Africa. *Albizia lebbeck* is very suitable for the southern sahel. It can withstand long, hot, dry periods and cold winters.

Products:
Fodder: The leaves, flowers, and pods of *A. lebbeck* make good fodder.
Wood: It has a very decorative, heavy wood of moderate strength and durability. The wood is easy to work and can be used for a variety of finishing purposes and general construction. It also provides a high-energy fuelwood.

Agroforestry Uses:
Apiculture: Its large flowers are fragrant, attracting bees. *A. lebbeck* is highly regarded by bee-keepers for the light-colored honey its nectar provides.
Soil Improvement: A nitrogen-fixing tree, produces a nutrient-rich green fertilizer/mulch.
Intercropping: It is an excellent companion plant, commonly grown as a shade tree in pastures, tea, coffee and cardamom plantations.
Windbreaks: It is a good windbreak tree, but not in areas with little to no precipitation. .

Characteristics: Medium-sized deciduous tree that most often grows to about 15-20 m tall with a diameter of 50 cm. It is fast-growing and can reach 30 meters in areas with high precipitation. It tolerates long, dry periods, and light frost.

Site Requirements: *A. lebbeck* grows best in full sun, but will tolerate partial shade. It prefers loamy soils, but can grow on sandy, weathered soils as well. It tolerates acid and alkaline soils, as well as salt spray.
A. lebbeck: Altitude 0 -1,800 m; Rainfall 500-2,500 mm

Propagation: It is best established using potted seedlings, although bare-rooted seedlings, direct seeding and cuttings have all been used successfully. Seed pretreatment involves scarification then pouring hot water over them and allowing them to soak for 24 hours. Germination improves after storage for 2-4 years, but satisfactory germination (50-60%) has been obtained from fresh seeds. Sow 2 seeds/pot, then leave them in the nursery for 15-18 weeks under partial shade before transplanting at the beginning of rainy season.

Pests and Diseases: Susceptible to damage from high winds and from attacks by insects and rodents.

Moringa oleifera

Overview: Moringa has been referred to as "Nebeday" for it's strength and tendency to "never die". It is popular in backyards throughout Asia, Africa, and Central America, and is considered by many to be a 'miracle tree' as the edible leaves are both flavorful and highly nutritious and has the ability to significantly reduce food insecurity.

Products:
Food: The leaves, young pods, flowers, and horseradish-tasting roots are all edible. The leaves are most often cooked in sauces or similarly to cabbage or spinach, and are very high in Vitamin A & C, calcium, protein, iron, potassium, magnesium, and other vitamins and minerals. Nutritious tea is made with the leaves to provide a nutrition boost, especially for pregnant women and children. Leaves, dried in the shade and pounded, can be mixed with peanut butter, chocolate spread, or any other food as a vitamin additive.
Wood: Soft, spongy wood is very coppiceable but really only used for light construction work or for fuelwood when little else is available.
Oil: Extracted from mature pods, moringa oil is a light, clean, non-drying oil that can be used as a lubricant for even very small machine parts, as well as for cosmetics and perfumes.
Other: Powder from crushed seeds can be used to coagulate and settle dirt and bacteria out of water for purification.

Oil extracted from the mature pods (oil of Ben) is yellowish, non-drying, good keeping qualities but eventually turns rancid. It is used as a lubricant, in cosmetics and perfumes,

Agroforestry Uses:
Soil Improvement: The green leaves make a useful mulch, and the press cake left after oil extraction from the seeds can be used as a soil conditioner or fertilizer.
Living Fence: Straight trunks make good living fence posts. Seeds germinate and cuttings take root easily, and are used particularly around houses and gardens to provide both protection as well as an easily-accessible food source.
Intercropping: The tree provides semi-shade, useful in Forest Gardens where intense direct sunlight can damage crops.

Characteristics: Moringa grows quickly and tends to have an open, undeveloped crown and spindly branches. Though trees can reach 8 meters, the constant breakage of branches when leaves are harvested tend to limit their growth to 3-4 meters tall.

Site Requirements: Moringa has a strong tap root and is highly drought resistant, but requires at least 500 mm of rainfall. It prefers a lot of direct sun, yet is known to survive mild frost. It prefers neutral to slightly acidic sandy soils though tolerates a wide range of conditions.
Altitude: 0-1000 m in elevation; Rainfall: <500 mm

Propagation: Moringa naturally regenerates well. Cuttings between 20cm and 4m can be used. Direct seeding does very well also, and the seeds require no pretreatment. Fresh seed will sprout in 3-5 days. Sow moringa seeds in sacks, coverd with ~1cm soil. For leaf production, seed moringa in a bareroot bed with ~10cm between seeds, do not outplant, harvest 1/2m tall seedlings by cutting them about 10cm from the ground, keep bed moist and all seedlings will regrow for continued leaf harvests.

Pests and Diseases: Root rot has been reported at times; avoid prolonged waterlogging.

Gliricidia sepium

Overview: Native to the United States and Central America, Gliricidia is a nitrogen fixing tree widely known in the Americas as "Madre de Cacao" or "Madera Negra". Because of it's high output of hard wood and nutrient-rich leaf litter, it can play a major role in agroforestry systems. After *Leucaena leucocephala, G. sepium* is believed to be the most widely cultivated multipurpose tree.

Products:
Wood: It produces a strong, durable, termite resistant wood used in heavy construction, and for tools, posts, and furniture. It also produces a good-quality fuelwood and charcoal, burning slowly without sparking, and with little to no smoke.
Fodder: Its leaves are rich in protein, low in fibre and tannin, and highly digestible. However there have been reports of non-ruminants showing signs of poisoning from it. It is not widely used for fodder because animals may dislike the taste, but palatability improves when the leaves are left to wilt overnight.
Pesticide: *G. sepium* seeds and bark can be used as a rodenticide (it has been called 'mouse killer') and general pesticide. Mix mashed seeds or boiled bark with food bait to kill rodents.

Agroforestry Uses:
Alley Cropping: Gliricidia is easy to establish and is a great species for alley cropping. It produces abundant leaf litter that has a high concentration of nitrogen making it an excellent green fertilizer.
Living Fence: Though lacking thorns, it is relatively easy to establish as living fence hedges, especially when propagated by cuttings. The straight trunks also make great living fence posts. Living fences of Gliricidia have been shown to reduce the incidence of disease in groundnut crops.
Apiculture: The flowers are very attractive to honeybees, making it a good species for supporting honey production.
Shade and Shelter: *G. sepium* is widely cultivated as shade for perennial crops (tea, coffee and cocoa). It is also used as a nurse tree for shade-loving species. Attributes contributing to its value as a shade tree include its fine, feathery foliage giving light shade, and the ability to withstand repeated pruning and to resprout vigorously.
Soil improvement: As a green fertilizer, *G. sepium* increases soil organic matter. It is a drought-resistant and valuable water-conserving species because in the dry season it sheds most of its leaves, reducing water loss through transpiration.

Characteristics: Gliricidia has a very fast growth rate, reaching as high as 4.5 meters in a few months from cuttings. However, it is known to have a strong lateral root system that can sometimes inhibit growth of surrounding vegetation.

Site Requirements: Gliricidia grows in soils ranging from pure sand to deep alluvial lake-bed deposits, a wide range of soil types. It performs well on marginally saline vertisols, but does not tolerate highly acidic soils.
Altitude: 0-1600 m in elevation; Rainfall: 600-3500 mm

Propagation: Trees are best propagated in sacks or by cuttings. For sacks, no seed pretreatment is needed, sow 2 seeds per sack 8-12 weeks before outplanting. Small cuttings may be placed in sacks or directly in the ground. They may need some water during the first dry season because root structure may not be as developed as those started from seeds. Larger cuttings, 15cm wide and 2 m long, allow for fastest growth. Scrape the base of the cutting to encourage rooting. Place 2 m cuttings ½ m in the ground a couple weeks before heavy rains begin.

Pests and Diseases: Not a target of any specific pests, though reported to be one of hundreds of plants that host the pink mealybug, a serious (sub) tropical pest around the world. Notably, it is resistant to the psyllid *Heteropsylla cubana*, which has caused serious devastation to *Leucaena leucocephala*.

Azadirachta indica

Overview: Thought to be from India and Myanmar, this broad-leaved evergreen and cousin of mahogany has been introduced and established throughout the tropics and subtropics for its highly valued hardiness, its almost year-round shade, and its multiple wood and non-wood products. It is said that it grows almost anywhere in the lowland tropics.

Products:
Wood: A. indica is a species of the mahogany family, and although it has some of the characteristics of a cabinetry wood, it is not ideal. Nevertheless it is used to make wardrobes, bookcases and closets, as well as packing cases because its insect repellent quality helps to protect the contents from insect damage. The main stem of the tree is also widely used to make posts for construction or fencing because the wood is termite resistant. It makes high quality charcoal and has long been used for fuelwood; best if coppiced at 1.5 to 2 meters.
Pesticide: Submerge leaves and crushed kernels (pic 8Z) in water overnight to make a great natural pesticide. Neem has over 20 active chemicals, the most important of which is azadirachtin, which help to repel and distort the reproduction cycles of numerous insects, nematodes, fungi, bacteria, and even viruses. The seeds contain the highest concentrations of the compound. Solution should be applied once every week on garden vegetables, field crops, and tree nurseries. Neem is not poisonous to humans.
Oil: Neem oil has been used traditionally as a topical treatment for skin symptoms in both humans and livestock, but it should not be ingested orally. Leaves can be used when making soap to give it antimicrobial and insecticidal properties. Warning: direct sunlight on leaves will destroy the pesticide ingredient.

Agroforestry Uses:
Windbreaks and Living Fences: Tolerance to most soil conditions, high survival rate, drought resistance, and resistance to grazing animals make neem a solid pioneer tree for reforesting lands, delineating field crops, or trying to establish any type of border planting (ie windbreak, living fence).
Soil Reclamation: It is drought resistant with a well-developed root system capable of extracting nutrients from the lower soil levels. Neem cake (the residue left after extracting oil from the seeds) can also be used as an organic manure and soil amendment.
Apiculture: Clusters of small white flowers attract many bees. Pesticides are not present in the honey (National Research Council, 1992).

Characteristics: Up to 30 meters tall, trunk usually not thicker than 1 meter. Very fast growth rate, up to 6 meters in a year. Very coppiceable. Neem tends not to be planted among gardens or alley-cropped with field crops because it absorbs a lot of water and may outcompete other plants. Seeds often dispersed by birds and fruit bats that eat the sweet yellow fruit around the seed kernels.

Site Requirements: It grows almost anywhere. It can withstand dry, infertile soil, as well as acid soils, and is lightly salt-tolerant. Waterlogging can kill it, and it dies in freezing temperatures. It performs better than most species on shallow, stony, sandy soils, or in places where there is hardpan not far below the surface.
Altitude: 0-1500m in elevation; Rainfall: 400-1200mm annually

Propagation: *A. indica* is easily raised in sacks, bareroot planting is possible, and fresh seeds can be direct-sown under existing vegetation. Not seed pretreatment is required. The seeds do not normally store well over 6 months, and depulping and cleaning the seeds considerably improves the germination rate. Seed in sacks 12 weeks before outplanting. Propagation by cuttings is possible, but propagation by seed is most common.

Pests and Diseases: *A. indica* has few serious pests, but several scale insects have been reported to infest it.

Ziziphus mauritiana

Overview: The genus Ziziphus belongs to the Rhamnaceae family, and has about 100 species of deciduous or evergreen trees and shrubs distributed in the tropical and subtropical regions of the world. The fleshy seed coat of several species are rich in sugars and vitamins, and this fact has made Ziziphus species important fruit trees for many centuries.

Products:
Food: Fruits of all Ziziphus species are edible. The drupes are eaten fresh, pickled, or dried and the juice can be made into a refreshing drink. Fruits are sold on local markets and consumed at household.
Fodder: Its leaves and twigs can be used as high nutritional fodder for livestock.
Wood: Ziziphus is an excellent fuel-wood tree and makes that good charcoal.
Medicine: Fruits are applied on cuts and ulcers, employed in pulmonary ailments and fevers. Sometimes mixed with salt and chili peppers to be given for indigestion. The seeds are sedative and are taken, sometimes with buttermilk, to halt nausea, vomiting, and abdominal pains in pregnancy.

Agroforestry Uses:
Living Fence: The trees are excellent for living fences. When coppiced, the branches grow laterally and can easily woven with neighboring branches. The sharp thorns deter most animals.
Soil Stabilization: Planting Ziziphus reduces the rate of desertification and soil erosion in deserts by stabilizing sandy tracts and dunes.

Characteristics: *Z. mauritania* is a vigorous grower and has a rapidly-developing taproot. Depending on the seed source and how it is managed, it can be a bushy shrub 1 to 2 m high, or a tree 10 to 30 meters, erect or wide-spreading, with gracefully drooping branches and downy, zigzag branchlets, thornless or set with short, sharp straight or hooked spines.

Site requirements: Ziziphus lives in a wide range on climates. The tree is drought resistant and can survive salinity and waterlogging. It grows best in sandy loam soils, which may be neutral or slightly alkaline, but it will grow on a wide variety of soils. It is also able to survive injury and fire damage.
Altitude: 300-1000m; Rainfall: 20 to 2200mm

Propagation: No pretreatment is needed, but storage of seed for 4 months before sowing improves germination. Will germinate in 3-4 weeks if you remove fleshy seed coat and crack hard outer shell before sowing. For fastest germination, extract the internal seed from the hard shell. This is easiest done utilizing a mortar and pestle. Be careful not to damage the fragile seeds in the process. Sow 3-4 seeds per sack. Seeds require full sunlight to germinate, and seedlings should be grown in full sunlight.

Pest and Disease: The greatest enemies of the jujube in India are fruit flies, *Carpomyia vesuviana* and *C. incompleta*. It has been found that treatment of the ground beneath the tree helps reduce the problem.

CHAPTER 9: REFERENCES

1. More information on the species listed in this chapter as well as a large variety of other useful agroforestry tree species can be found on The World Agroforestry Center's Agroforestree Database at: http://www.worldagroforestry.org/output/agroforestree-database.