Disclaimer
The information and recommendations set forth in this document are provided for general information and guidelines purpose only. ABC Agrobiotechnology (P) Ltd. cannot be held liable to any party for any damages direct or indirect incurred as a result of such party’s use or application of information in this documents in any way.
The value of teak wood is determined by tree attributes like diameter and straightness of the stem, length of clear bole, wood fibre straightness, and presence or absence of wood defects, such as those caused by branch knots, disease or insects. Appropriate silvicultural treatments improve the quality of teak trees and increase the value of their timber. Using improved germplasm produces trees that grow quickly with straight stems and other desirable attributes. Pruning young trees produces clean, knot-free stems and long, clear boles.

Thinning plantations reduces competition between trees for soil nutrients, water and sunlight, accelerating the growth of the stem diameter. Removing slower growing, diseased or poorly formed trees during periodic thinning allows the faster growing, better quality trees to achieve their growth potential. Fertilizing will accelerate tree growth resulting in higher yields and logs with larger diameters. Controlling pests and diseases will ensure healthy trees with few defects in the wood.

These general silviculture management techniques lead to specific activities.

-- Selecting good quality planting material
-- Preparing land for planting in ways that promote tree survival and growth.
-- Spacing plants at an optimum distance between for easy maintenance and fast growth.
-- Fertilizing to make essential nutrients available and improve tree health and growth rates.
-- Pruning branches from the boles starts when the trees are between 3 and 5 years old.

Pruning increases the clear bole length and reduces the occurrence of knots, increasing the quality and value of the timber. Pruning continues regularly halfway up the bole’s final height.

Thinning trees increases the space between trees as they become larger, reduces competition for nutrients, water and sunlight and ensures faster growth, greater volume and better wood quality in the remaining trees. Preventing and controlling pests and diseases results in healthier, more productive and higher value plantations. Harvesting mature trees for home use or market sale.
Activities in Teak cultivation

**Planting Material**

The growth and physical appearance of trees are influenced by characteristics they inherit from the mother tree and the conditions in which they grow. These are called genetic and environmental factors. A healthy stand of fast-growing trees that will yield high quality timber can be obtained from healthy, fast-growing clones derived from Plus Trees. Good quality planting material will result in to maximum growth when planted on suitable land and provided with good nutrients and treatments of tending. In contrast, poor quality planting material will grow poorly on any type of land even after providing good nutrients and tending.
Mother Plant Selection:
Select a tree that demonstrates superior performance compared with the trees surrounding it, looking for these characteristics:

-- Above average tree height and stem diameter.
-- Straight stem.
-- Long, clear bole that will get a good price at market.
-- Uniform crown, without heavy branches or double stems.
-- Free of pests and disease.
-- Good quality timber, meaning it is round.
-- Mature tree.

In unevenly aged teak stands, do not select a seed tree based on stem diameter alone, since diameter does not necessarily indicate better genetic quality. It could just indicate an older tree. In evenly aged stands, diameter and tree height are the important characteristics for selecting mother plants.
Stem diameter and height are not the best indicators to determine planting material quality. Good quality planting materials that are ready for planting have three features:

-- Strong roots with a porous medium. When seedlings are removed from the poly bag, the medium and the roots maintain a cylindrical form which is porous and not compacted.
-- A single, strong and woody stem. Seedlings are upright and strong, with a balanced stem diameter and height.
-- Healthy new leaves with no evidence of harm from pest or disease.

**Planting system**

Several planting systems are appropriate for teak including monoculture (single species), mixed species and agroforestry. Consider land conditions and land use before choosing the best planting system for teak. Apply an agroforestry system on fertile soil because the benefits from land use can be maximized. Besides selling the timber produced, farmers can also sell or use the agricultural products. Apply a monoculture or mixed species system on less fertile soil, rocky soil or rocky terrain to improve soil quality and to prevent and slides or land erosion. Apply mixed species or agroforestry to increase diversity of products for short, medium and long-term revenue. If the land is far from the landowner’s home, or the land owner does not have enough labour to conduct routine maintenance activities, monoculture or mixed species systems are more appropriate than agro-forestry.
Monoculture planting system

In the monoculture system only one species is planted. Farmers can prefer this system when they do not need multiple products from the land, for example, agricultural crops.

The advantage of a monoculture planting system is more timber volume and better and uniform quality timber can be produced from the same area of land, compared with the mixed species or agro forestry system. Monoculture systems are easier to manage because there is a single crop species. The disadvantage is that monocultures are more susceptible to pests and diseases.

Agroforestry planting system

In an agroforestry planting system farmers plant teak and agricultural or seasonal crops in one area. This system can be applied on or around farmland, including paddy fields. The advantage of an agroforestry system is that farmers gain short-term income from agricultural crops and, medium- to long-term income from timber. Maintenance activities for seasonal crops like tillage fertilization, etc. benefit the growth of teak. Agricultural crops in the Solanaceae family (chilies, tobacco etc.) should not be planted when teak is still young because they are hosts for wilt. An agroforestry system can also combine teak with plantation crops such as oil palm.
Mixed plantation system

A mixed plantation is planted with various tree species. The mixture of several tree species, with varying harvest schedules and canopy height, resembles a forest. This planting system offers several advantages like more resistant to pests and diseases, better use of growing space and root system, variation in land can be used more effectively, more resistant to wind and improved species diversity. The differences in timber harvest cycles and harvest of non-timber products create a steady and diversified income stream over the short, medium and long term. This diversified production can reduce the market risk associated with single crop systems. This system has two main disadvantages, (1) If teak is planted closely with fast-growing species, teak will face strong competition for nutrients, moisture and light resulting in slower growth. (2) Because of differences in production and rotation age, more caution is required when harvesting to prevent damage to surrounding trees.

The best tree species for intercropping with teak are species that are equally suited to the planting purpose and land conditions. Select tree species that are suited to the climate and conditions of the planting site. For example in highland areas, trees that intercrop well with teak include Neem (Melia azedarach). Teak on arid land are best combined with species that can grow well in dry areas, such as sandalwood (Santalum album). On relatively fertile land teak can be combined with fast growing species. Plan the species composition based on production periods and harvest times to diversify the medium- and long-term income. Teak can be planted in combination with one or several tree species with different growth cycles.

Land preparation:

Land preparation includes the following activities: site selection, clearing land of bushes and weed roots, stump destruction, ploughing, harrowing and stone removal. Land preparation is necessary to provide the best growing conditions possible for teak. Land clearing and tillage are done to reduce weeds and improve soil quality. Land clearing also reduces shade, since teak is a shade-intolerant species. Teak grows naturally in lowland areas from 0 to 1000 m above sea level with rainfall of 1250–3000 mm annually. However, to produce high-quality timber, choose sites that also have soils with high lime and clay content with distinct dry and rainy seasons located at less than 700 m above sea level. Sloping land is vulnerable to landslides and erosion so teak needs terraces. On rocky land monocultures or mixed plantations are more appropriate than agroforestry systems, because tillage for annual crop production is difficult.
Planting

Preparation before planting includes, arranging the space, installing markers, and Preparing planting holes. In a monoculture system, the most commonly used spacing are 2.5×2.5 m, 3×1 m, 2×3 m and 3×3 m.

Dense spacing will produce straighter stems and faster height growth, whereas wide spacing will produce larger stem diameters. Teak plantation with good spacing combination is dense spacing in the early stages in order to promote height growth, then thinning to promote larger stem diameter. In an agroforestry system, teak can be closely spaced within their rows with a wider distance between rows for planting seasonal crops as well as for better space for tending operations.

Consistent spacing offers several advantages. For example, it makes maintenance easy. The plantation will look good and clean. Makes the best use of space for trees to maximize growth of canopy, stem and roots. Reduces competition between trees for moisture and nutrients from the soil allowing the tree to maximize growth. Reduces competition between trees for light and improves air circulation, allowing the stem and canopy to grow healthy and also reduces the potential of tree damage due to strong wind.

Where the land is rocky or the soil layer is thin, uniform spacing may be too difficult. These conditions also make it difficult for seedlings to survive, so use irregular spacing. Saplings with dense spacing (minimum 1 m) on land where the soil layer allows saplings to grow. This requires a minimum soil depth of 20 cm. When the trees are about 3–5 years old, densely planted trees will require thinning to reduce competition. Select trees for thinning that have poor form or slow growth. Reduce spacing to a minimum of 2 m. The planting hole should be 30×30×30 cm. on rocky land, you can reduce the width of the planting hole to 10–20 cm. At each planting hole, place a marker made from bamboo or wood to indicate the location of the planting hole. Dig a planting hole using a sharp stake or handspike. If plant more than one saplings in a hole, wait one year, including one dry season, then select the seedling with the best growth to be retained. Remove the other seedling or transplant it to a hole where no seedlings survived.

If saplings are transported from far off place it may dry out from exposure or lack of water during transport. In such cases, seedlings should not be planted immediately. Maintain saplings seedlings near the planting site for 1 week; this allows them to adapt to the planting environment and recover from desiccation. Planting should be done during the rainy season or when rainfall has made the soil moist. Before planting, apply to each planting hole a basic fertilizer of 10 kg compost (derived from leaves) or manure (derived from cattle waste). Make sure that the manure used is completely composted and not harmful to the seedlings. Saplings can be planted 2–4 weeks after you apply the fertilizer. Remove the sapling from the poly bag carefully to keep the medium undamaged. Place the saplings into the planting hole, and backfill it with top soil or humus. Place soil from the bottom layer to the upper portion of the planting hole. Compact the soil by holding the seedling by the stem and slowly tamping down the soil around the seedlings with your feet. Place the seedling bag at the end of the marker, as a sign that the seedling has been planted and to demonstrate that the poly bag has been removed.
Maintaining teak
Teak grows well, grows fast, and produces high-quality timber when the land and trees are well maintained. Maintenance includes weeding, fertilizing, replanting, pruning, thinning, maintaining coppices and controlling pests and diseases.

Weeding:
In a young teak plantation weeds including vines, shrubs and grass need to be cleared regularly around teak trees. These weeds compete for light, water and soil nutrients. Left uncontrolled, the weeds could hinder the growth and even kill the teak trees. In a mature teak plantation after the canopy closes, weeding can be done less frequently. Under story weeds below mature trees generally die by themselves. You can effectively control weeds by intercropping teak trees with agricultural crops, because tilling for the crops also serves as weeding for the trees.

Fertilising:
Applying fertilizer when the trees reach 1, 2 and 3 years in age is recommended. The recommended dose per tree is 50 g of NPK in the first year, 100 g in the second year and 150 g in the third year. Apply manure or compost at a dose of 10 kg per planting hole before planting the tree. On acidic soils, soils with a low pH or soils with limited calcium (Ca), the area around the trees should be treated with lime (dolomite) to raise the pH. The recommended dose of dolomite is 150–250 g per planting hole, applied at the same time as the manure or compost. In agroforestry systems, applying fertilizer benefits both teak trees and agricultural crops. To apply fertilizer make holes with a small wooden stake on either side of the tree or crop. Another way is to apply fertilizer in holes 10-15 cm deep that ring the teak tree at a distance of 0.5–1.5 m from the stem, about the width of the tree’s canopy.

Infilling
Infilling is the replacement of dead plants with new saplings. Infilling maintains the intended spacing or density of teak trees in the plantation. Infilling is also useful for replacing broken, unhealthy or poorly growing plants and it should be done in the rainy season.
Pruning

Pruning is the removal of branches which increases clear bole height and reduces knots on the main stem. By removing unnecessary branches or twigs, the tree’s growth will concentrate around the tree’s main stem and its canopy. Wood removed through pruning can be used as fuel wood or sold at market, providing small holders with added revenue. Pruning can reduce the damage done by forest fires because the separation of the tree crown slows the spread of fire between trees. Pruning commences in the third year. Clear branches and twigs from the lower half of the tree. Pruning more than 50% can hinder the tree’s growth. Prune early in the rainy season. Prune when branches and twigs are still young and small. Prune each branch as close to the main stem as possible, without cutting the branch collar. The branch collar is the slight swelling at the base of the branch where it grows from the stem. Pruning the branch collar causes wounds that heal more slowly and also increases the risk of pests and diseases. If pruning is delayed, the removal of large branches will result in knot defects in the wood, pruning large branches also makes the tree more susceptible to pests and diseases. Pruning is done using special tools: pruners and pruning saws, small, young twigs can be pruned with a sharp sickle or machete. To protect the stem after pruning, cover each pruned place with a special paint or tar.

Pole pruners and pole saw used to prune branches

Effect of pruning on stem quality

Recommended height to which branches should be pruned

50%
Thinning

Competition for light, water and nutrients is greater in closely spaced plantations causing slower tree growth and tall, skinny stems. The removal of stressed, unhealthy and slow-growing trees will encourage better growth for the good quality trees that remains. (Good quality trees are fast-growing and healthy and have good stem form). Thinning helps maximize tree growth, prevent the spread of disease and distribute trees more evenly. The trees harvested during thinning can be sold to raise income. Any harvested trees with diameters greater than 10 cm can be used for construction timber while the smaller ones are suitable for firewood.

In monoculture teak stands, thin every 3–5 years until the trees reach the age of 15. Thinning should be conducted more frequently if only a few trees are cut per thinning. After most trees in the stand reach the age of 15 years, thin every 5–10 years. Select trees for thinning that are diseased, defective, slow-growing, stressed or have poor form. Poor form means the timber will be worth less at market. In understocked plantations, teak trees with poor stem form do not require thinning to maximize growth of the remaining trees, because competition is low. However, according to the experience of farmers harvesting those trees will produce coppice growth that will generate trees with straight stems. The number of trees left after thinning can be based on the height of the trees which is influenced by age and site fertility. When average tree height is 13.5–15.5 m, the number of trees after thinning should be 1000–1100 trees/ha. On fertile land, this can be achieved in 7 years, while on the low quality site it may require 15 years.

In a monoculture system with evenly aged and regularly spaced stands, thinning is relatively easy to perform. Slow-growing or depressed trees will be easily distinguished from the average and from fast-growing trees of the same age. For unevenly aged and irregularly spaced teak stands, thinning is more difficult. Here is some general guidance:

a. Focus on each tree. If one tree is cut, how will that affect the surrounding trees? If the tree is not cut, how will that affect the surrounding trees?

b. If the canopies are overlapping, it indicates that the stand should be thinned.

c. Cut the trees growing under the tree canopy (which do not get sufficient light), diseased trees and those with poor stem quality.

d. Trees do not require thinning if only the bottom section of the canopy is in shade.

e. Saplings or young trees growing in an open area should be retained to grow.

f. To maintain the diversity of tree size and age, for varied harvesting times, the remaining trees in the stand after thinning should still represent various ages and diameter classes.
Thinning to improve the quality of the remaining trees can also remove large, saleable trees. This is known as commercial thinning. Thinning teak plantations can be planned and conducted to promote savings. When funds are needed, growers can perform commercial thinning to harvest trees for market sale that will increase the value of the remaining trees at the same time. Perform a commercial thinning to remove large trees which will promote optimal and even growth of the remaining trees, open the canopy to allow smaller trees access to more light to grow faster and healthier and increase the spacing between stems.

Controlling pests and diseases

Pests commonly found in teak are:

Neotermes tectonae, they cause swelling on the trunk and branches. It can infest teak trees when they are as young as 3 years. But the infestation is visible only later, when trees are 7 years old.

Control:

Prevent the spread of Neotermes tectonae attacks by thinning regularly. Remove infected trees before the beginning of the rainy season when Neotermes tectonae begin to emerge. Cut and burn the infected parts of trees.

Chemical control to kill Neotermes tectonaeis accomplished with fumigant insecticides (phostoxin ¼ tablet) or insecticides containing fenpropathrin.
**Stem Borer:**

Monohammus rusticator, this pest can cause swelling of stems and holes in stems, often resulting in broken stems.

Xyleborus des truensbores transverse holes in the stem. Bore holes from this insect have black stains around the hole edge, which can be seen by peeling the bark. This insect commonly attacks teaks that are 5 years old or older.

**Control:**

Stem borers can be controlled with a fumigant insecticide of phostoxin, injected to the infected stem through bored holes. To avoid wetwood borer attack, teak should not be planted in areas without clear distinction between rainy and dry seasons. Wherever wetwood borer has attacked, that area should no longer be planted with teak. Clear weeds from around the bases of trees to reduce microclimate humidity and foster a habitat unfavorable to the wetwood borer. Insecticides used to eliminate the wetwood borer include Brash 25EC, Lentrek 400 EC, Dragnet 380 EC, Enborer 100 EC and Cislin 2.5 EC.

**Leaf eating Caterpillars**

Pyraustamachaeralis, Eutectonamachaeralis and Hyblaepuera are caterpillars that commonly eat teak leaves. Holotrichiahelleri and Lepidiota stigma are pupae, that attack the roots of teak seedlings and young trees between 1 and 2 years old. Trees wither and eventually die because of the root damage.

**Control:**

Caterpillar (Hyblaepuera) attack is not harmful to teak. Infestations only last about 1 week. When teak caterpillars become pupae they fall naturally from the tree. Measures taken to control teak caterpillars should not adversely affect the understory, which provides habitat for birds and other predators of teak caterpillar. When caterpillar attacks are severe, use an insecticide containing the active ingredient sdeltamethrin (Decis 2.5 EC), permethrin (Ambush 2 EC) or LAMDA sihalotrien (Matador 25 EC).
Diseases

**Bacteria Wilt**: The bacterium Pseudomonas tectonae causes wilt, this disease usually attacks teak seedlings or young teak trees. Early symptoms are the presence of light and dark brown patches, followed by leaf wilt and leaves turning pale or yellowish. The development of wilt may be gradual or sudden with leaves falling in a short period of time.

**Control:**
When the occurrence of wilt is minor, use a bactericide containing an active compound of streptomycinsulfate (Agrept 20 WP), dazomet (Basamid G), and oksolinik acid (Starner 20 WP). If you can see wilt symptoms on seedlings, destroy the seedlings immediately by burning.

Do not intercrop young teak trees with crops of the Solanaceae family (including aubergine, potato, tomato and chili), because those species can host wilt.

**Dead Shoot Disease**: The fungus Phomasp causes shoot disease. This disease usually occurs in young teak. Leaves are infected as they develop, resulting in dead leaves and shoots. Shoot disease results in irregular growth and deformed, crooked trees.

**Control:**
Remove infected shoots during the rainy season to avoid spreading the disease. Humidity within the plantation is reduced by pruning tree branches to increase airflow and sunlight. Apply fertilizer to stimulate plant growth and form of new shoots.

**Stem Crack**: The fungus Corticiumsal monicolor causes this disease. This occurs frequently and spreads quickly during the rainy season. The visible symptoms are discolored, black, limp, withered leaves that seem scalded. Thick layers of fruiting bodies develop on the bark, with bumps on the stems. Wounds and cracks appear on the trunk.

**Control:**
Remove Lantana sp. from near teak plantings because they are a source of fungal disease. Space teak trees regularly according to size or age of the tree. Maintain and prune regularly. Apply fungicide containing the active compound Carbendazim to control a fungal breakout.

**Stem Cancer**: Nectriahae matococca causes stem cancer. Symptoms are wilted leaves and the formation of dark black bumps on the surface of the stem. These bumps erupt and fissured, elongated wounds develop into holes in the trunk.

**Control:**
Host plants such as Lantana sp. should be cleared from land near teak plantations. Space the trees to allow adequate light exposure and good air circulation. Prune regularly. If infection occurs, eradicate the disease by scraping the wounded stem and then smear it with Bordeaux mixture 1 % or fungicide of Fylomac 0.5% or Antimuci 0.5% every three weeks.
Harvesting

To provide maximum returns, harvest teak trees when the tree is mature enough to produce good quality wood, at least 15–20 years old.

Teak trees should not be harvested by cutting on only one side to prevent breaking or damaging the high-value stem. First, determine the direction that minimizes potential damage to the tree being harvested and other trees. Before harvesting the tree, remove branches and twigs. Cut notches on two sides, then lower the stem to the ground in the direction it is falling. One side of the trunk is sawed parallel with the felling direction, that cut is called the fallen notch. The distance between the base and the upper part of the notch should be a maximum of 5 cm. The opposite side of the stem is then sawed up to the upper part of the notch, that cut is called the back notch.

Clear-Cut Harvesting:

In the clear-cut system all trees in a particular area are felled. This is usually done in a plantation of evenly aged teak.
Selective Harvesting system

In the selective harvesting system, trees are selected according to the need. This method is generally used in unevenly aged teak stands, or mixed plantations. This system is also practiced for commercial thinning.