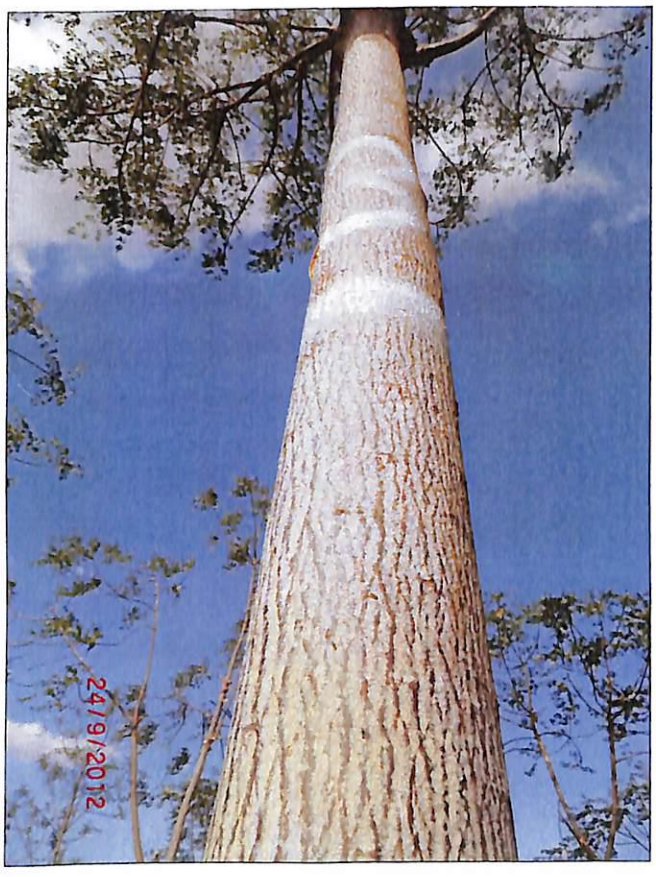
Training Notes for Distributors of Improved *Melia volkensii* Seeds and Seedlings



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Cover photos:
Left: Melia Candidate Plus Tree (CPT)
Top right: Extracted Melia seed
Bottom right: Melia seedlings

Foreword

Melia volkensii is a fast growing drought tolerant and termite resistant tree found only in Eastern Africa. The species produces high quality timber which can be harvested in 10-12 years. Apart from its highly valuable timber, it is also a good source of fodder, hence it has a high potential for improving livelihoods of dryland rural communities.

Melia is readily accepted for planting in eastern drylands of Kenya but can also do well in a number of areas in coast region. Although the acceptance of *M. volkensii* is high, actual planting is still low and its seedlings production has depended on seeds collected from general sources.

Kenya government and some non-governmental organizations are promoting Melia planting in the drylands. Kenya Forestry Research Institute (KEFRI) with support from Japanese International Cooperation Agency (JICA) has, as part of the Melia breeding programme, established seed orchards of Melia for production of improved seed for quality Melia plantations. The orchards have started yielding improved seed. The seed will be made available for raising nursery stock for establishment of high quality Melia plantations in the drylands. It is important that communities planting Melia only utilize the improved seed using recommended best practices.

These notes will be useful in training distributors of improved Melia seeds and seedlings for plantation development and mainstreaming Melia growing as a viable economic enterprise in arid and semi arid lands of Kenya.

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Table of Contents

1 Introduction to *Melia volkensii*

1.1 What is *Melia volkensii*

Melia volkensii is a high value indigenous, fast growing and drought tolerant tree species found in Arid and Semi-Arid Lands (ASALs) of eastern Africa. It grows well mostly on sandy soils, sandy loams, or sandy clay soils with good drainage. It grows from sea level to 1700 meters above sea level with mean annual rainfall of 250 - 1000 mm and temperature range of 26 - 38 °C. Melia is locally known as Mukau (Kamba, Tharaka, Mbeere), Tile (Boran), Bamba (Oromo), Maramarui (Samburu), Boba (Somalis) and Kirumbutu (Taita).

1.2 Why grow *Melia volkensii*

Melia is fast growing (up to 20 meters in 10 to 15 years), multipurpose tree providing high quality termite resistant timber that is used in making high quality furniture. Other products of Melia include poles, posts, fodder, medicine, firewood, and bee forage. In 2012, KEFRI started the Melia improvement programme in collaboration with JICA and FTBC. The initiative will make available genetically improved seed to be distributed for planting programmes.

2 Principles of Tree Seed Production

2.1 Types of tree seed sources

Tree seed sources are either selected from existing vegetation or are established. Seed sources from existing vegetation are general seed sources, selected single trees and selected seed stands while established seed sources are established seed stands and seed orchards.

2.1.1 General seed source and selected single trees

A population of better performing and healthy trees mostly from natural forests or in planted areas is selected and used as sources of tree seeds and designated as general seed source. If there are individuals of outstanding performance, these individuals can be selected and designated as selected single trees seed source rather than collecting seed from the whole tree population.

2.1.2 Selected seed stand

This is a stand of trees that has been chosen as a site for collection of seed as a secondary purpose. The primary purpose could have been for timber, fuel, soil conservation etc.

2.1.3 Established seed stand and seed orchards

These are tree stands deliberately established for production of high quality tree seed. A seed orchard usually consists of families of superior genetic quality and is planted at regular spacing and specific design by tree breeders.

2.2 Principles of seed collection and handling

Seed collection and handling comprises of activities that can be grouped into 4 main categories. These are activities prior to seed collection, activities during actual collection and processing and storage activities. The specific activities are:

Flower survey: This is conducted in order to determine abundance and distribution of flowering in the seed source and assists in predicting the amount of final seed crop.

Seed survey: This observes seed maturation and determines the right time for collection and an estimate of the expected seed yield.

Planning of seed collection: This includes acquisition of necessary permits, determination of amounts to collect and mobilizing resources required.

Seed collection: There are two main methods of collecting tree seed, either ground collection or crown collection depending on tree species, characteristics of the site and nature of seed / fruit.

Seed processing: In trees, what is generally collected are fruits which have to be processed to get clean seed. Seed processing will therefore mainly include extraction of seeds from fruits, cleaning, and drying. There are various methods of extraction depending on nature of fruits such as depulping (for pulpy fruits), threshing (mostly for dehiscing pods), drying and tumbling (for cones), and cracking for hard nuts. Although most tree seed withstand drying, a number of seed do not.

Seed storage: Seed are stored to ensure their availability when required. Most tree seed require drying to withstand storage. Tree seed is usually stored in airtight containers in dry, cool environment to prolong storage life. Seeds that do not withstand drying should not be stored and should be sown soon after collection and processing.

Seed documentation: Documentation captures all details during the stages of seed production and distribution. It gives seed an identity that enables follow-ups such as for quality assurance for the client by the producer.

2.3 Principles of tree seed quality

Tree seed quality is a measure of the potential performance of trees when the seed is planted under optimal conditions. Seed quality is determined by genetic composition, physiological and physical components. Genetic quality is determined by characteristics inherited from parents (genes). Physical quality depends on seed size, colour, age, pest and disease, and purity while physiological quality is determined by seed maturity, moisture content and germination ability. High quality seed generally have high viability, is of high nursery performance, is of known source, is genetically improved and it is properly documented. Genetic improvement for Melia volkensii has been initiated by Kenya Forestry Research Institute.

3 Breeding for Production of Improved *Melia volkensii*

3.1 Principles and objectives of tree breeding

Tree breeding or genetic improvement is the process of improving the genetic quality of a tree species based on specific objectives that are end use based. The objectives relate to improvement of adaptability, productivity, and end use product quality e.g. wood. Tree breeding aims to develop plantations that are superior to their predecessors in terms of end use. Techniques in tree breeding include; plus tree selection, establishment of seed orchard, controlled crossing and progeny testing. Tree breeding is a cyclic process of selection and reselection with successive improvement over time.

3.2 Selection of Melia Candidate Plus Trees (CPTs)

100 CPTs were selected from 13 populations spanning areas of natural occurrence of Melia in Kenya. The selection process involved reconnaissance in sites of natural occurrence of the species, followed by actual selection within a viable population. Individual tree selection involved comparison of 5 potential trees and picking the candidate tree based on comparison of key attributes; height; diameter, growth vigour, stem straightness, branching habit, absence of spiral grains, and absence of signs of pests and diseases compared to 5 surrounding Melia trees. Each of the CPT was assigned a unique name, code and number as its identity. In addition to selection of CPTs, site characterization within areas of occurrence of the selected plus trees was done. This included documentation of geographic location data, vegetation type, soil type and climatic conditions of the site.

3.3 Establishment of first generation seed orchards

Two 11-hectare first generation clonal seed orchards were established each at Tiva in Kitui and in Kibwezi. The process started with raising of Melia rootstock in the nursery followed by collection of 30 scions from each of the 100 CPTs and grafting on the rootstock. Each individual graft was labelled using original CPT identity and its pre-planned planting position in the field. The grafted seedlings were nurtured in the nursery for 3 months before planting in the field. The grafted seedlings were planted at a spacing of 6 x 6 m in a completely ploughed field using a design that allows for random mating.

3.4 Progeny trials

Progeny testing is the process of evaluating the genetic worth of CPTs to confirm that the exhibited desirable traits are heritable and can be expressed in subsequent generations. Eight (8) progeny tests have been planted in sites that are representative of Melia growing zones in Kasigau, Voi, Kitui, Kibwezi, Marimanti, Embu, and Ikithuki.

In undertaking the progeny trials, single tree seed collection was done in the orchards, seedlings raised and used for establishing the trials. The seedlings were planted and managed as prescribed for Melia plantations for the purpose of data collection to determine the genetic worth of the original parent trees (CPTs). Data from the progeny trials will be used in improving the existing orchards and developing second generation and subsequent orchards. However, seed collection in the orchards and its use in plantation establishment will in the meantime still go on.

3.5 Seed production and management of Melia seed orchards

Indication is that Melia is cross pollinated with pollen from a flower of an individual pollinating the flower of another tree. Consequently, Melia trees raised from seeds contain traits of both parents. The Melia seed orchard has been designed and located so as to maximise random mating and minimise contamination from outside sources. Optimum flowering require adequate exposure of branches to sunlight. Consequently, Melia trees in the orchards are occasionally pruned to ensure such adequate exposure to sunlight. It is recommended that each tree in the orchard should have the number of branches not exceeding 15. For ease of seed collection, the trees in the Melia seed orchards are maintained at a height of about 5 meters through lopping. Seed productivity in the orchards is being determined.

4 Collection and Processing of Melia Seed from the Orchards

4.1 Flower and seed survey

Melia generally flowers and seeds throughout the year with peak flowering and collection time being April – May and July - August. The same trend has been observed in the orchards.

4.2 Fruit collection

Melia seed should be collected when they are ripe. Yellow fruits though mature are not ready for collection until they have developed brown patches. Collection in the orchard should be undertaken at individual tree level with fruits from one tree kept separately up to processing. Collection is done from the crown by either hand-picking or use of looping shears to cut branch-lets bearing ripe fruits. Canvass sheet or net should be spread under the tree to trap the fruits during collection. Collected fruits should be carried in gunny bags and always kept under shade.

4.3 Fruit processing and storage of Melia nuts

Fruits should be weighed and depulped. Depulping is done using a mortar and pestle or hitting with a plank of wood. Depulped nuts are then thoroughly washed and dried under direct sun for at least two days. Dried nuts are weighed and stored awaiting extraction. Dried nuts from different ramets of the same clone (family) are mixed and stored in airtight containers under cool dry conditions.

4.4 Seed extraction

Melia should be extracted when ready for sowing. Melia seed is extracted by cracking the nut using a Melia nut cracker. However, cracking the nut with a knife and hammer is equally effective if handled by an experienced person. Once seed is extracted, it should be sown as soon as possible. On average, 8 kg of fruits yield 1 kg of nuts while 1 kg of nuts yields 200 seeds. The number of seeds per kilogram of extracted seed ranges from 4,000 to 4,500.

5 Melia Seed Pre-sowing Treatment and Management of Seedlings in the Nursery

Sowing of Melia seed during the cold season should be avoided as low temperatures are not favourable for Melia germination.

5.1 Pre-sowing treatment

Seeds are nipped by breaking the curancle (as shown in the photo 1) and soaked in cold water for 12 to 24 hours. During soaking, fungicide e.g. Ridomil or Benlate (5 g/l) is mixed with the water to control fungal infections. After soaking, the seeds are slit longitudinally starting at the point of nipping to the other end of the seed using a sterilized razor blade or scalpel (photo 2). The slit should be restricted to the seed coat. Slitting allows leaves to be released on germination.

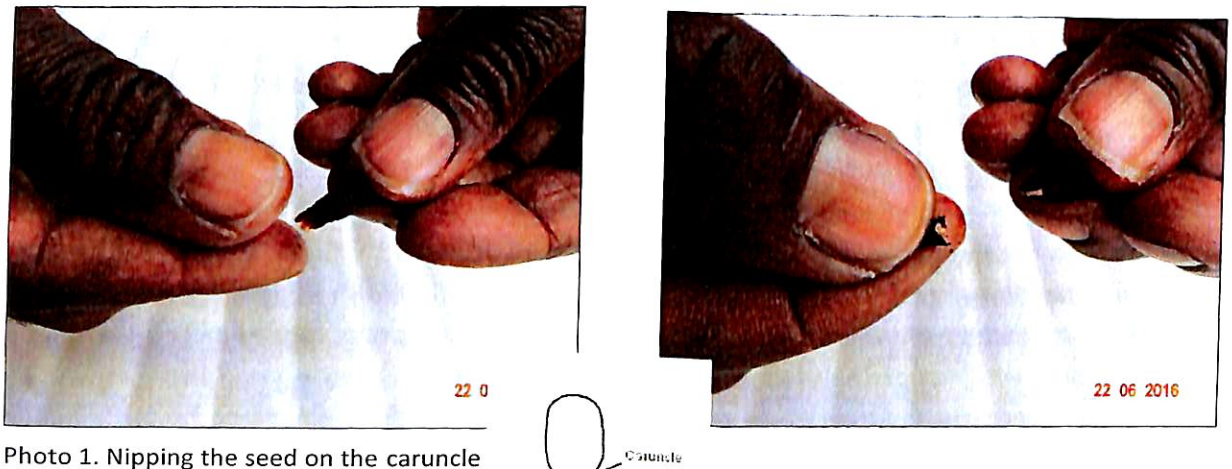


Photo 1. Nipping the seed on the caruncle

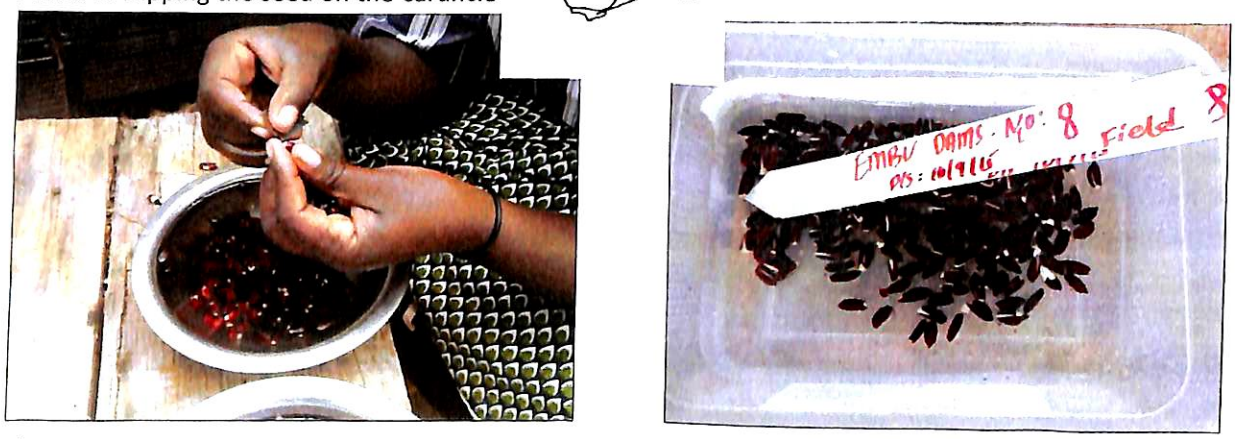


Photo 2: Slitting Melia seed longitudinally after soaking in water (left) and pretreated seed (right)

5.2 Seed sowing

For optimum germination, Melia seed should be sown on sterilized river sand. The sand is sterilized by drenching it using 450 ml of sodium hypochlorite solution (e.g. JIK) per 20 litres of water and also sprayed with a fungicide (e.g. Ridomil). The sterilized sand is placed in germination bed, a non-mist propagator or a plastic basin. Seed are sown by placing the seed on the sterilized sand and covering with

a layer of sand equal to double the length of the seed. The sand is watered thoroughly using sterilized water. After sowing, the germination media is covered with a clear polythene sheet. A space of six inches between the polythene sheet and media should be allowed to avoid contact of the tender germinating seedlings which cause mortality. Watering of the bed after sowing is done only when necessary by observing the wetness of the germination media. Melia will germinate in 3 to 6 days.

5.3 Pricking out

Pricking out is the process of transplanting germinants from seedbed to the pots. Prepare potting medium composed of soil, sand and manure in the ratio of 3:1:1 and fill the 6x9 pots with the medium and thoroughly water in readiness. The recommended pricking out time is 1 to 3 days after germination as late pricking out results in higher shock and mortality of germinants. Uproot germinants from the seedbed using a piece of stick (dibbler) and place them in a basin of water to avoid root desiccation and shock. Select only healthy seedlings to transplant into the pots and throw away deformed / damaged ones. Keep pricked out seedlings under moderate shade (50 - 75%) for a month before transferring to an open nursery area.

5.4 Managing Melia seedlings in the nursery

Melia seedlings are only watered when the pots are dry. Over-watering predisposes seedlings to fungal attack. The polythene tubes and the whole Melia nursery area should be kept clean and free of weeds. The seedlings should be protected from pests (especially red spider mite) and diseases especially fungal through spraying. Spider mites are controlled using different pesticide e.g. *Dynamec* and fungal diseases through Ridomil at the manufacturers recommended rates and frequency. The nursery should also be well protected from browsers. Root pruning of the seedlings should be undertaken to avoid the roots embedding into the ground. Root pruning is undertaken through lifting of the seedlings or cutting any protruding roots with a knife or placing the tubes on a polythene sheet.

At least two weeks before transplanting into the field, Melia seedlings should be prepared for harsh field conditions through hardening off. This is done through reducing the watering frequency and exposing the seeding to more direct sunshine. Melia seedling is ready for transplanting to the field when they attain at least 30 cm high.

6 Transplanting and Management of Melia in the Field

6.1 Site selection and preparation

Sites for planting Melia should be selected and prepared well in advance before the onset of rains. Suitable sites should have sandy soils, sandy loams or sandy clay soils with good drainage. Sites prone to flooding should be avoided as the species is sensitive to water logging. Melia does not grow well on shallow soils and those with hardpans.

The area to plant Melia should be completely ploughed to improve water infiltration and reduce competition from weeds. After ploughing, staking should be done at a spacing of 4 x 4 meters or 5 x 5 meters during the dry season. Pitting is also done during the dry season by digging a pit of 45 cm x 45 cm

x 45 cm. Refill the holes starting with original top soil just before the onset of rains and mark the centre of the pit with a stake. The depression left after refilling with top soil will allow the collection of water which is important for initial seedling growth.

6.2 Field planting

The ideal planting season for Melia is during the long rains which occur in October to December rains in the eastern and northern drylands but in April - May in coast region. Start planting as soon as the rainy season begins and enough soil moisture build-up attained. To test if the soil has enough moisture, dig up some soil from the lower horizons of the planting pit after a few days of continuous rain but on a non rainy day. Then squeeze this soil in your hand. If the soil particles form a muddy wet bond, then this is ideal planting time. Planting should be done early in the morning before the sun becomes too hot. For planting make a hole the size of the seedling container is made in the middle of the planting pit. After planting, the surface around the seedling is compacted first by hand and then gently by foot to increase contact between seedling roots and soil. It is important to ensure that no water collecting basin is left around the base of the planted seedling.

6.3 Tending and management

Tending and management in Melia involve weeding, protection, debudding, pruning and, disease and pest control.

Weeding: For young Melia to grow well, ensure complete weed control for the first 3 years. Complete weed control can be achieved through intercropping with legume crops.

Protection: The major problem experienced in growing Melia is browsing of young trees by domestic and wild animals. Planted Melia should be fully protected from browsers for up to 2 years after planting,

Debuding: (removal of young buds): This is recommended to start as early as one month after planting. During debuding, all leaves on the seedling should be left intact. Buds if not removed develop into branches which lower the growth rate and quality of timber.

Pruning: Branches at the canopy level should be reduced to avoid overhanging and bending of the main stem. Pruning also becomes necessary when debudding was not done. It is therefore important to debud as frequently as necessary.

Singling: Forking is rare in Melia. However, a few seedlings may fork naturally. In such cases singling should be done by removing the weaker stem as early as possible.

Disease and pest control: Melia has few significant pest and diseases at field level. However, there are reported cases of cankers and mites. Any cases of pests and diseases should immediately be reported to KEFRI.

6.4 Harvesting and utilization

Melia is harvested for timber in 12 - 15 years. With breeding, improved Melia stock could be ready for harvesting in 10 - 12 years. Improved Melia is expected to be harvested mainly for high quality timber

with yields estimated to improve by 20%. Currently, it is estimated that a hectare of standing Melia with a stocking of 300 trees yield timber valued at 3.6 million based a yield of 300 ft per tree and a farm gate price of 40 shillings per ft of 6 x 1 planks. With breeding and correct management, the value is expected to be about 4.3 million shillings per hectare. It is notable that the increased value is also realized earlier due to shortening of rotation.

7 Documentation of Improved Melia Seed/Seedling Distribution and Use

Documentation is important part of use of improved Melia seed and seedlings. It is important to document seed distribution, raising of seedlings in the nursery, distribution of seedlings, seedling management in the nursery. Key parameters that need to be documented are shown in Table 1.

Table 1: Important records to keep for improved Melia

Activity	Record details
1. Seed distribution	Species, batch number, customer details, weight required, weight issued, date of dispatch, seed sowing instructions, expected number of seedlings
2. Seed sowing and pricking out	Species, date of sowing, seed batch number (identity) amount of seed sown, date of pricking out, number of seedlings pricked out
3. Seedling management at nursery	Species, Seed batch number (identity) Tending activities (weeding, control of pests and diseases, date of root pruning, date of hardening off, number of ready seedlings, observations
4. Seedling distribution	Species, seed batch number, customer details, number required, number issued, date of dispatch, planting instructions

8 Institutional, Policy and Legal Environment Applicable for Distribution of Improved Melia

The current seed act (Seed and Plant Varieties Act, CAP 326) mainly deals with agricultural crop seeds. However, regulations to control production and trade in tree seeds are under development (Seed and Plant Varieties Act (Tree seed regulations). Under the Regulations oversight authority on tree seed will be vested with the National Tree Seed Advisory Committee. The Committee will be responsible for registration of Tree Seed Dealers. Tree Seed Dealers will be required to have necessary equipment for collection, processing and storage of tree seed and basic training in tree seed production.

Kenya Forestry Research Institute is developing requirements for Tree Seed Dealers (Distributors) of improved Melia seeds and seedlings. For one to be registered as a distributor of improved Melia seed and seedlings, one must;

- have own or registered group nursery,
- be available for training by KEFRI and implement the learnt practice,
- deal exclusively with the improved material provided by KEFRI,
- grant access to facilities and seed/ seedlings for inspection by KEFRI whenever required, and,
- be willing to train others about Melia

KEFRI has developed mechanisms for tracking and identifying improved Melia germplasm through DNA techniques. It is therefore easy to establish when non improved Melia is passed off as improved material. Such misrepresentation is prosecutable under Kenyan law.

Kenya Forestry Research Institute

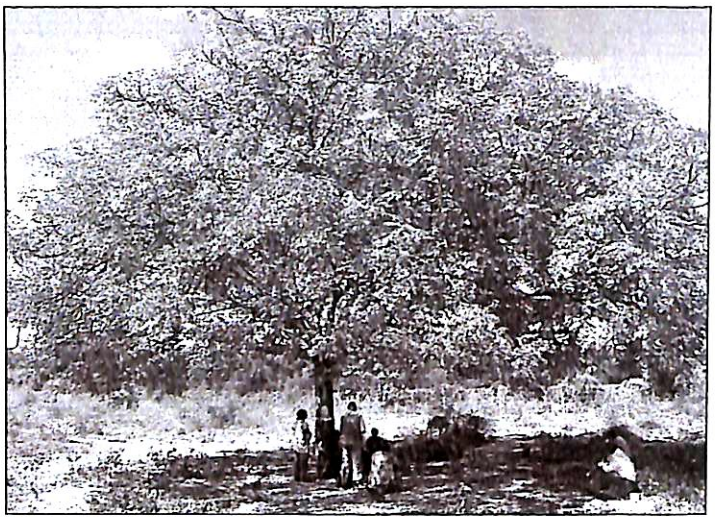
Japan International Cooperation Agency

Training Manual for Distributors of Improved *Melia volkensii* Seed and Seedlings

1 Introduction to *Melia volkensii*

What is *Melia volkensii*?

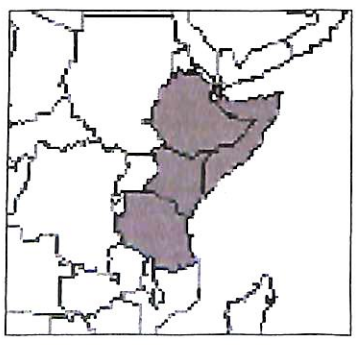
Melia volkensii **is an indigenous tree species**

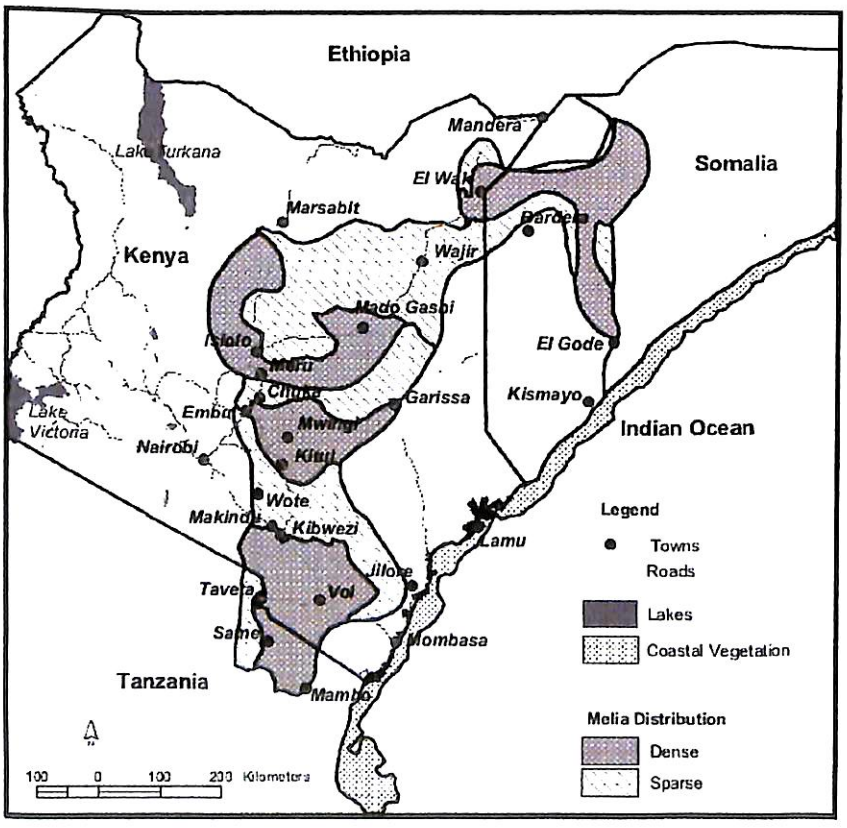


Found in arid and semi-arid areas mainly in Somalia, Kenya, and Tanzania with rainfall of 250-1000 mm.

The tree is known as Mukau (Kamba, Mbeere, Tharaka), Mpendabure (Swahili), Kirumbutu (Taita) and Maramarui (Samburu/ Maasai)

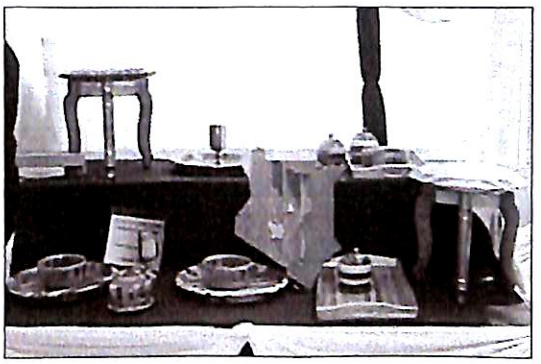
Melia volkensii
Distribution map in Kenya, Somalia and Tanzania



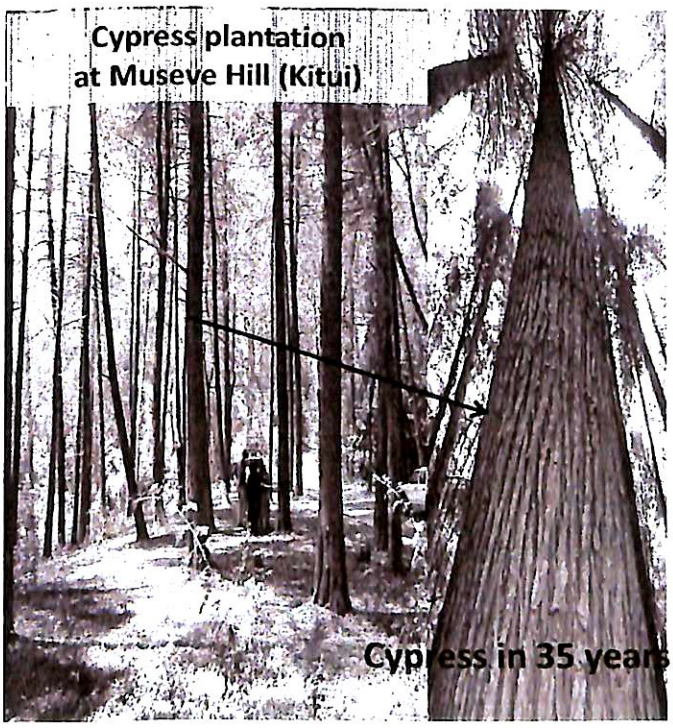


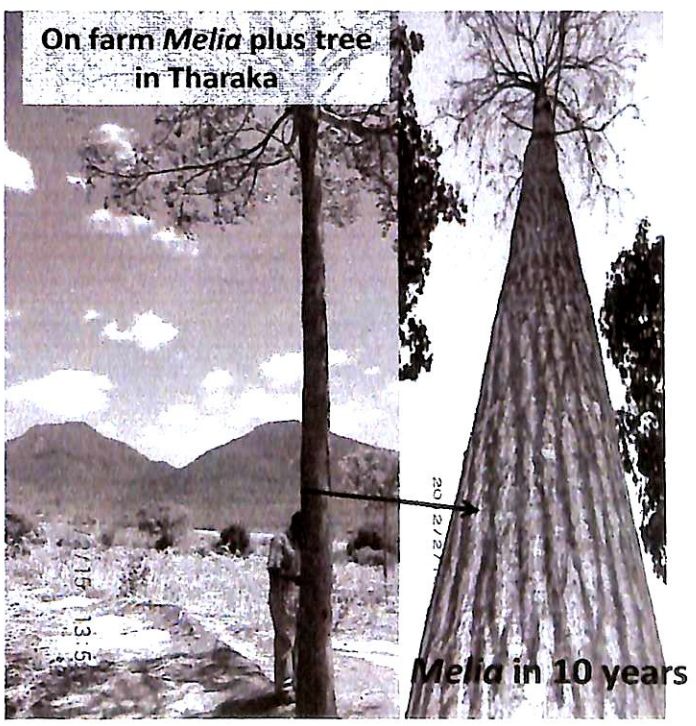
Why grow *Melia volkensii*?

- A drought tolerant, termite resistant tree that produces high quality timber (used for making high value furniture, doors and windows frames)
- Provides fodder and fruits for animals



Comparison of Melia growth to Cypress





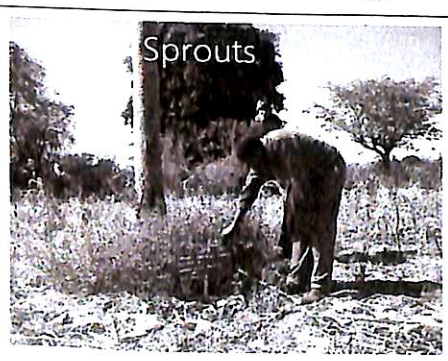
- Fast growth: Up to 20 m height in 10-15 years (unusual in arid areas)
- Faster growth is expected in improved *Melia volkensii*

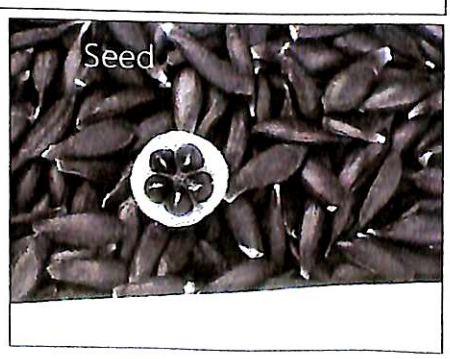
Where should we plant *Melia volkensii* ?

- Arid and semi-arid areas
- Rainfall: 250-1000 mm
- Altitude: 0 -1700 m above sea level
- Soils: It grows well on most sandy soils but prefers sandy/loamy or sandy clay soils with good drainage

Melia propagation methods

- Sprouts from injured roots regenerate and are managed on farm
- Grafting is used to propagate high value stands like orchards
- Other propagation methods for Melia (cuttings and tissue culture) are at research stages
- Melia is mainly propagated through seed





2 Principles of Tree Seed Production

Sourcing of tree seed in Kenya

- About 60% of all tree seed used is produced at the farm level. The rest is sourced from KEFRI
- Farmers produce seed mainly for own and neighbourhood use from any existing tree in their surroundings

Types of seed sources

- General seed source
- Selected seed sources
  - Selected single trees
  - Selected seed stands
- Established seed sources
  - Seed stands
  - Seed orchards

Principles of tree seed collection and processing

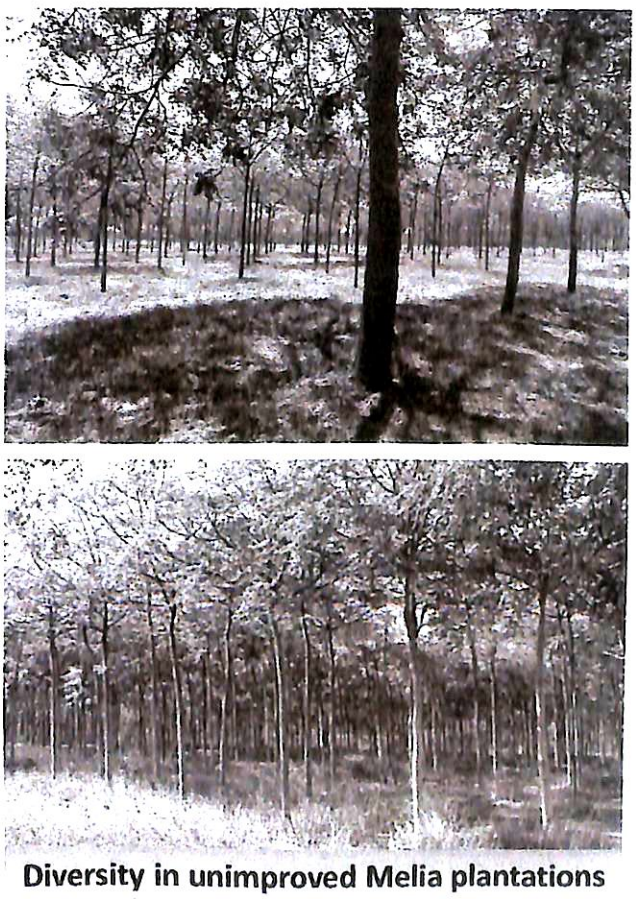
- Flower survey
- Seed survey
- Planning for collection
- Actual collection
- Processing
- Storage
- Documentation

Seed Quality

- Those which can germinate and produce healthy and strong seedlings
- Those which can effectively be stored until required for sowing
- Those containing inherent potential to produce quality products
- Those that represent a large genetic diversity i.e. collected from many individual plants
- In summary, seed quality is an aggregate of:
    - Genetic quality
    - Physical quality
    - Physiological quality

Melia volkensii seed situation

- About 95% of all Melia seed used in Kenya is from general and farm sources
- In 2012, improved *Melia* seed orchards were established in Tiva and Kibwezi
- The orchards will make available more genetically improved seed to be distributed for planting programmes



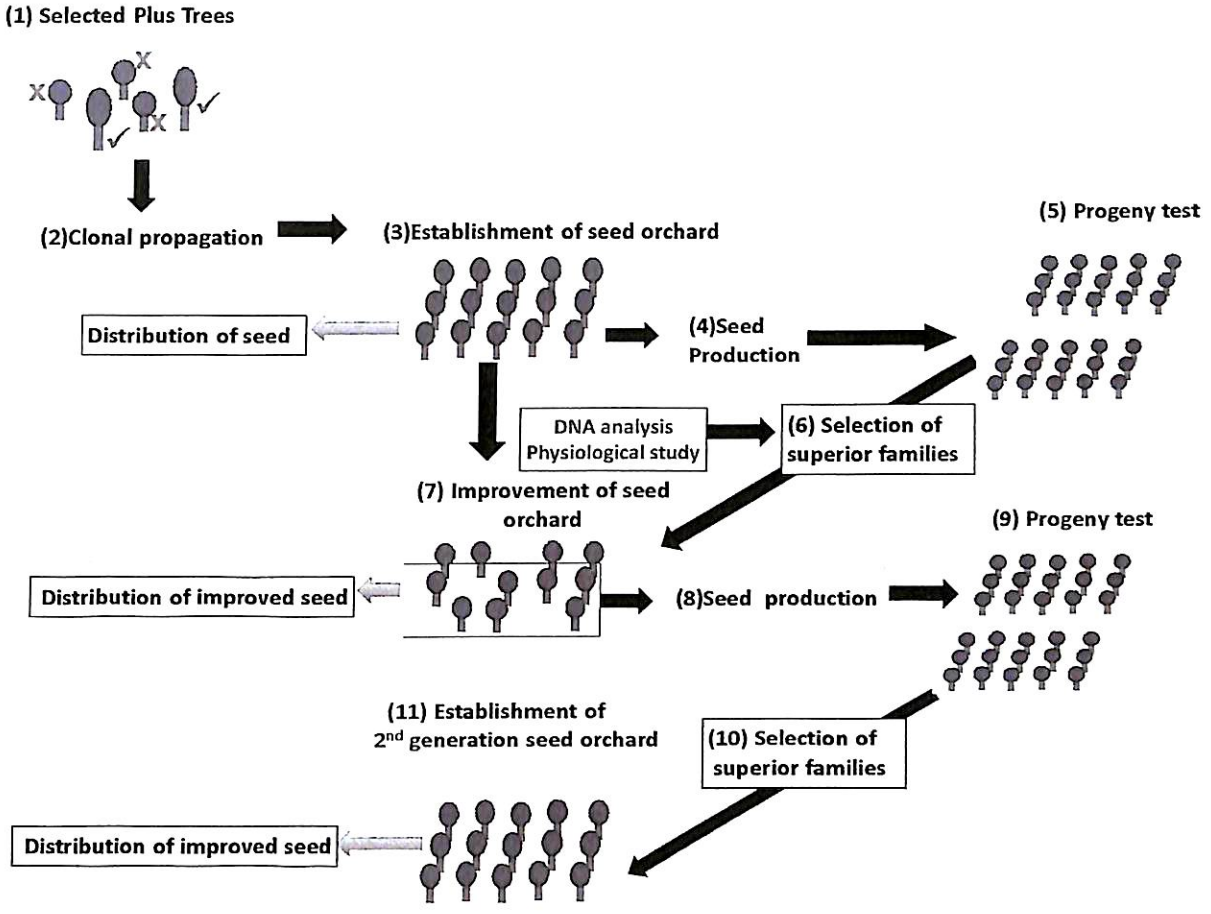
Diversity in unimproved Melia plantations

3 Breeding for Production of Improved Melia

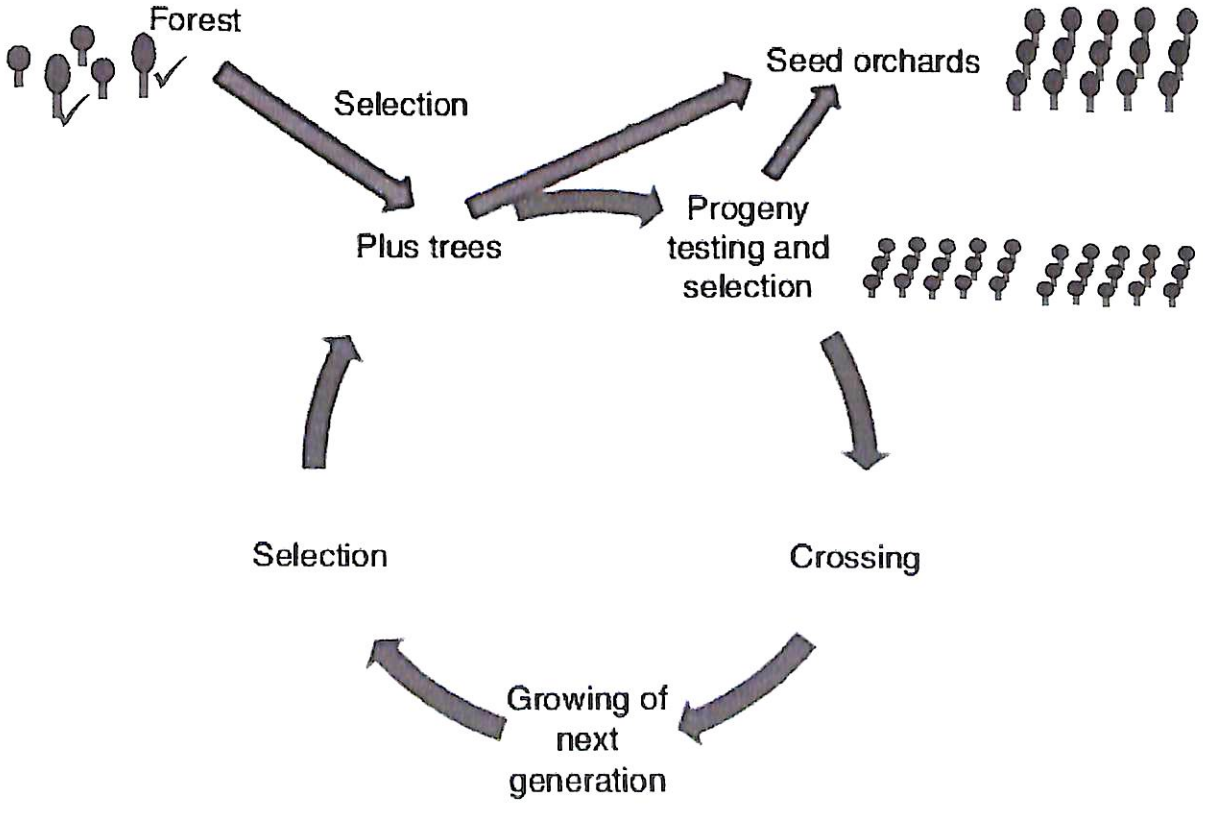
Process of tree breeding

- Selection of candidate plus trees (CPTs)
- Establishment of improved seed orchards
- Progeny tests and evaluation of CPTs
- Removal of inferior families for improvement of overall quality of seed orchards
- Production of improved seed

Overview of tree breeding



The Breeding cycle



Objectives of tree breeding

- Increased adaptability (survival and growth on more sites differing from the original range of the species
- Increased productivity (increased volume production) e.g. timber
- Improved quality (e. g. improved wood properties for end use)

Selection criteria for *Melia volkensii* CPTs

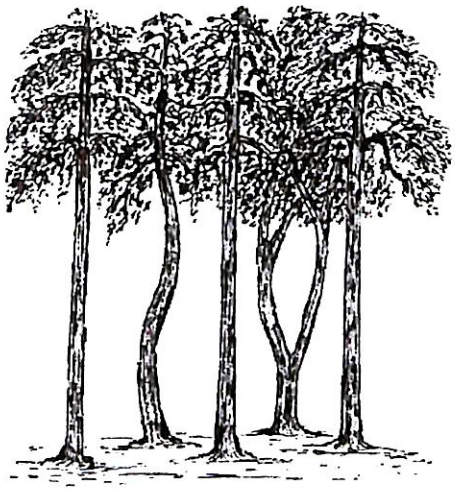
Population Characteristics

- Selection done in viable populations that allowed individual tree comparisons. Isolated trees were avoided

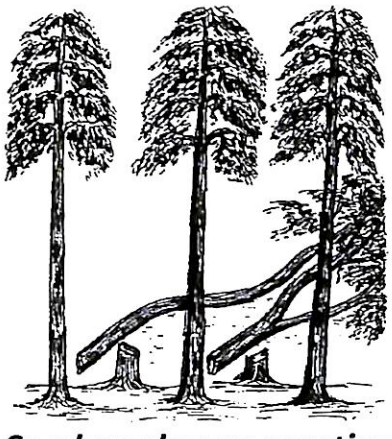
Individual Tree Characteristics (CPTs)

- The tree are in the dominant or co-dominant crown class (at or above the general tree canopy level) within the immediate tree surroundings
- Superior in height and diameter growth in comparison to surrounding 5 trees
- Stem form, straightness
- Light-medium branching, less steep angled branches
- Free from insect pests and free of any signs of diseases
- Not crooked or twisted stems/branches, No spiral grain

Why do existing Melia trees in your surroundings, haves inferior characteristics

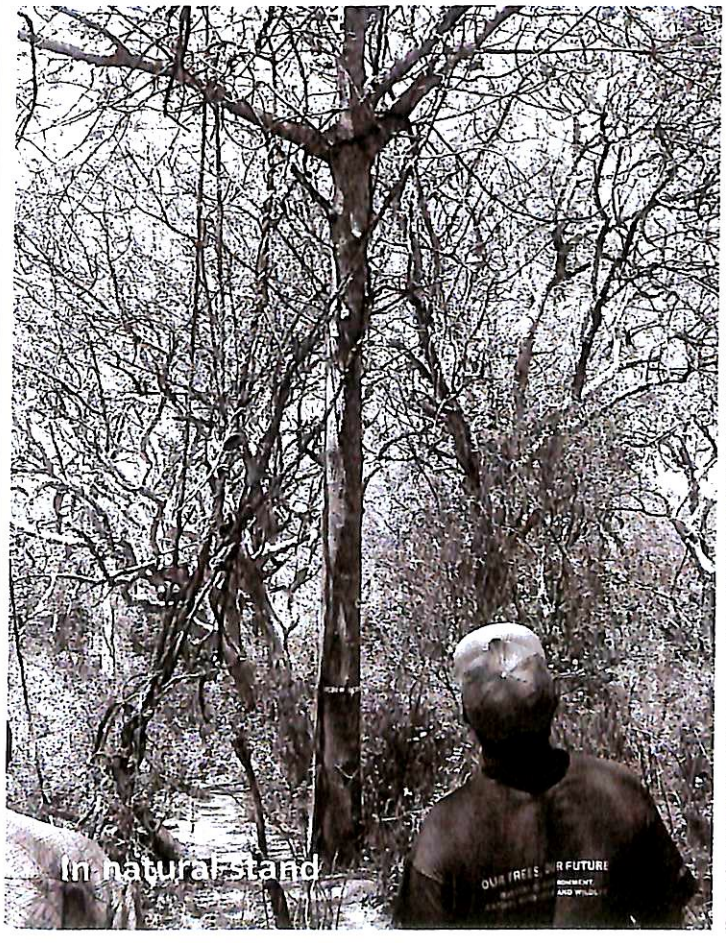


People's practice



Seed producers practice

Generally, when the people harvest timber trees, they cut better and large trees with straight bole first and leave malformed trees . Therefore, when the good trees are decreased, very few good characteristic trees will remain.

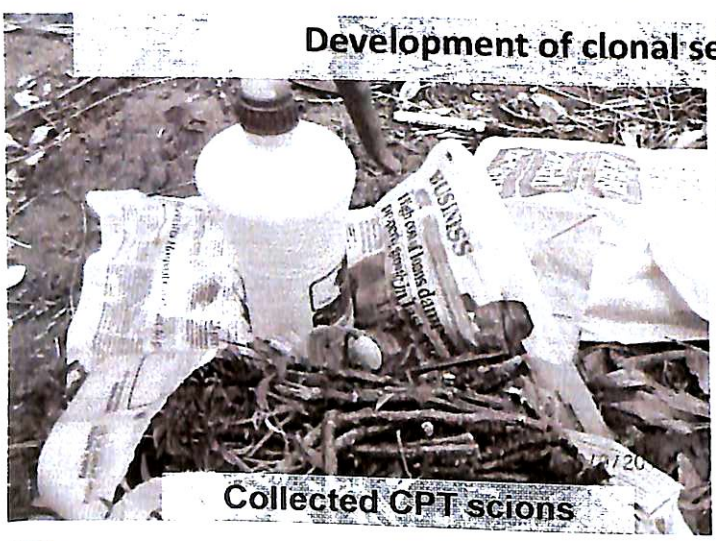


Selection of Candidate Plus Trees (CPTs)

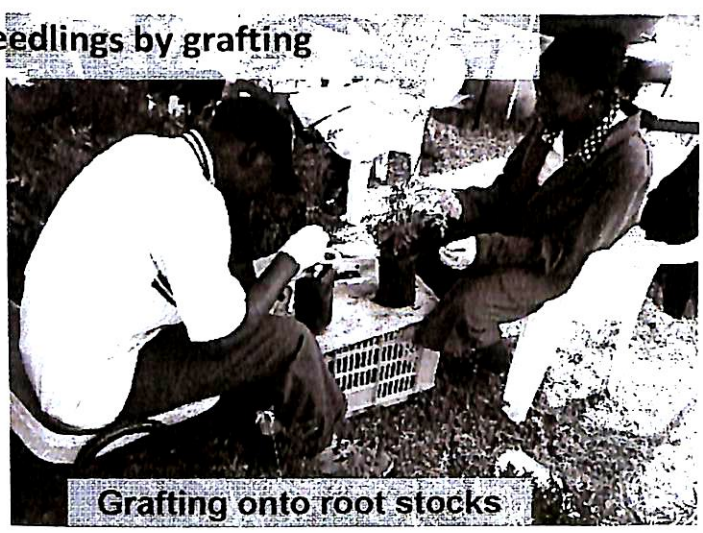
Seed orchard establishment/Principles

- Seed orchards are established from high quality materials for seed production
- All the 100 CPTs of Melia were grafted each with 60 scions in the nursery. The grafts were used in establishing 2 clonal seed orchards in Kitui and Kibwezi
- Each orchard contains 3000 trees and an area of 11 Ha

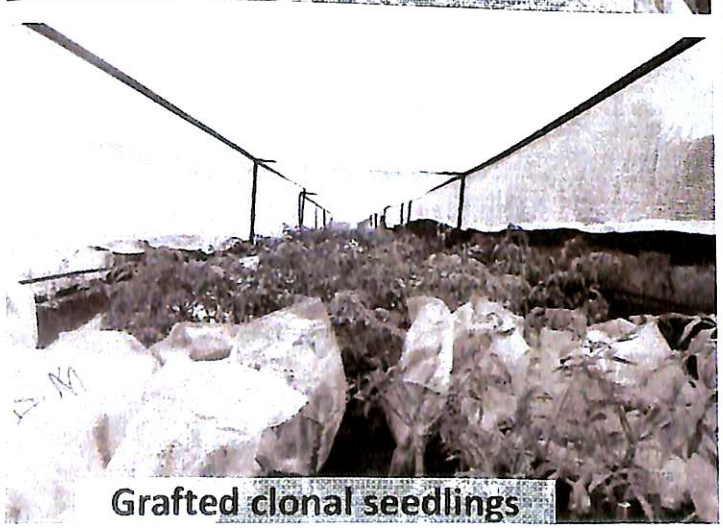
Development of clonal seedlings by grafting



Collected CPT scions



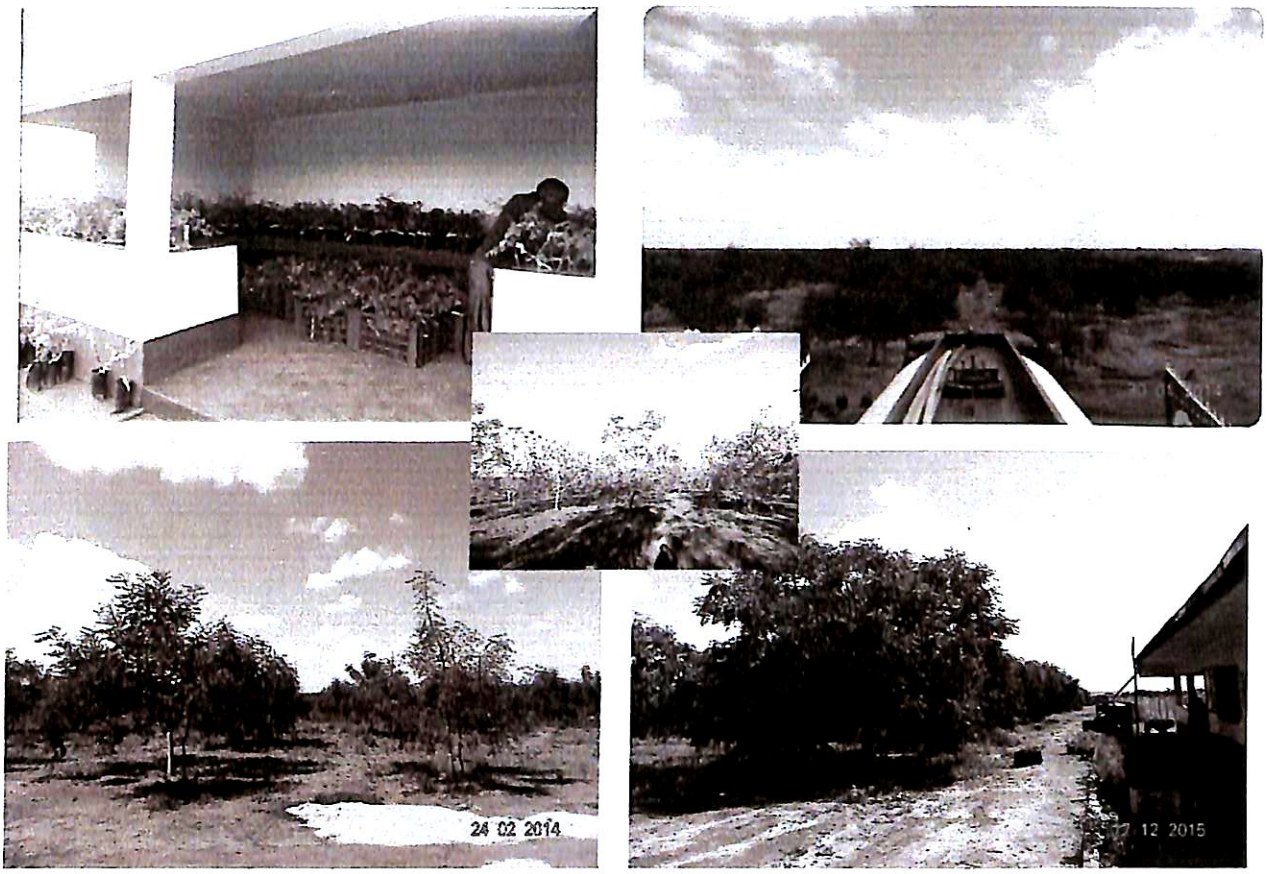
Grafting onto root stocks



Grafted clonal seedlings

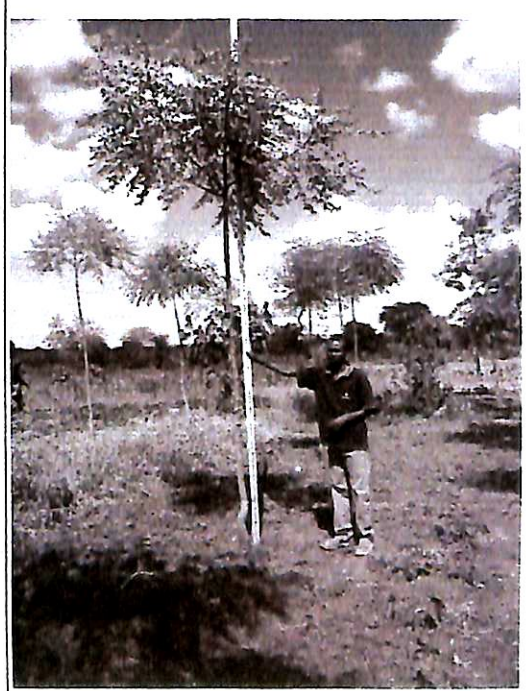
Labeled and ready to plant

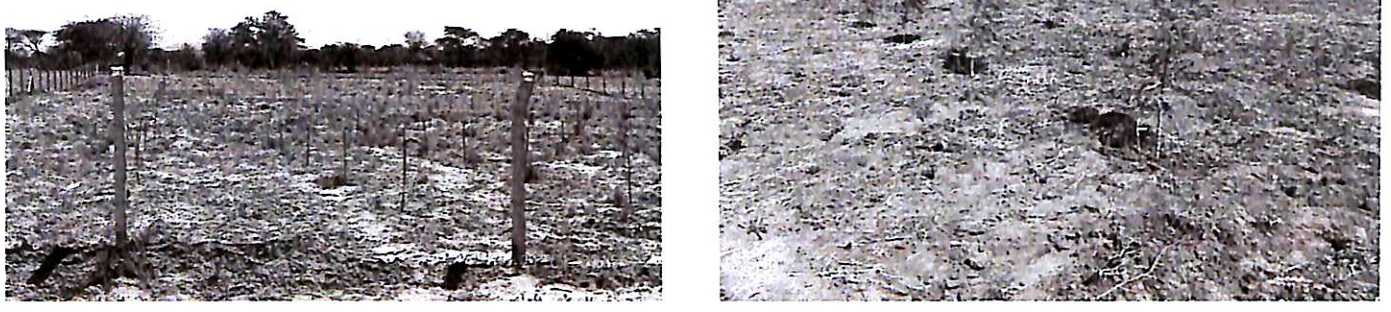
Established *Melia volkensii* seed orchards

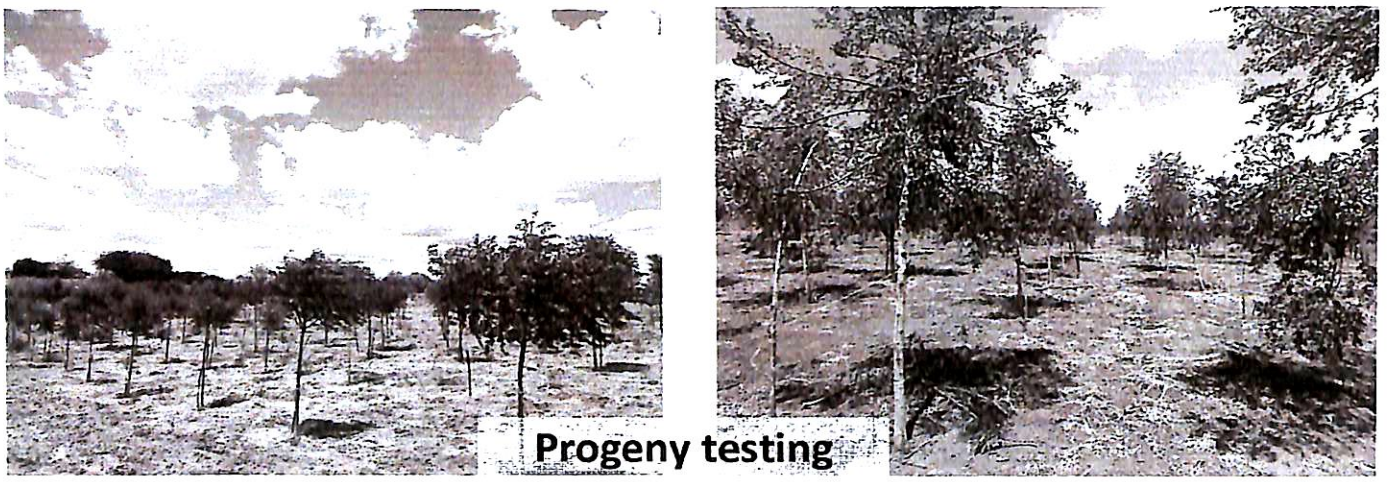


Progeny testing

- **Seed produced from tree improvement breeding efforts are used to establish progeny tests to:**
  - **1) provide genetic information about the selected parent trees**
  - **2) Assess adaptability for difference areas**
  - **3) provide an improved population of trees from which the next generation of select trees is made**
- **The results are used to assess the genetic worth of the original selections, to make selections for the next generation**





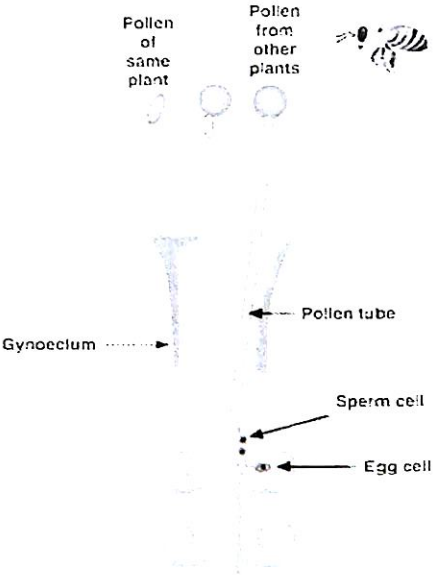


Progeny testing

4 Seed phenology in Melia

Pollination in *Melia volkensii*

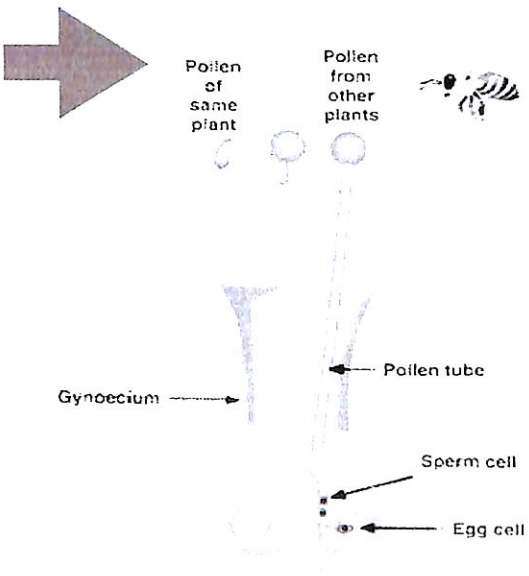
- Seed production in plants including Melia requires pollination
- Pollination is transfer of pollen from anther (male part) to the stigma and eventually the ovary (female part)
- Pollination leads to fertilization when pollen grows through flower into the ovary and fusion of male and female gametes occurs (see figure)
- *Melia* is an insect pollinated species and most likely by bees.



In a flower

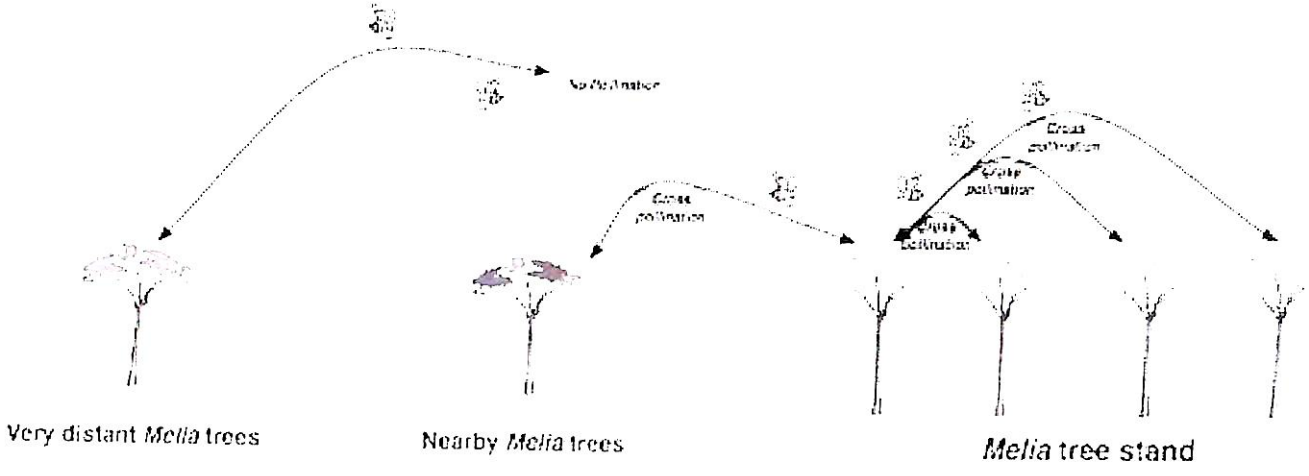
Pollination in Melia cont.

- Some flowering plants like *Melia* are mainly cross-pollinated. They need another individual of same species
- That is why every *Melia* tree has mixed traits of both seeding mother tree and other tree which provided pollen



In a flower

Pollination process in Melia



Management of Melia seed orchards

- Aim to improve the quantity and quality of the *Melia* seed produced
- It also improves the genetic qualities by eliminating undesired characteristics
- Protection against damage, weeds, insect and disease attacks
- Pruning and lopping to improve seed yield and ease of collection

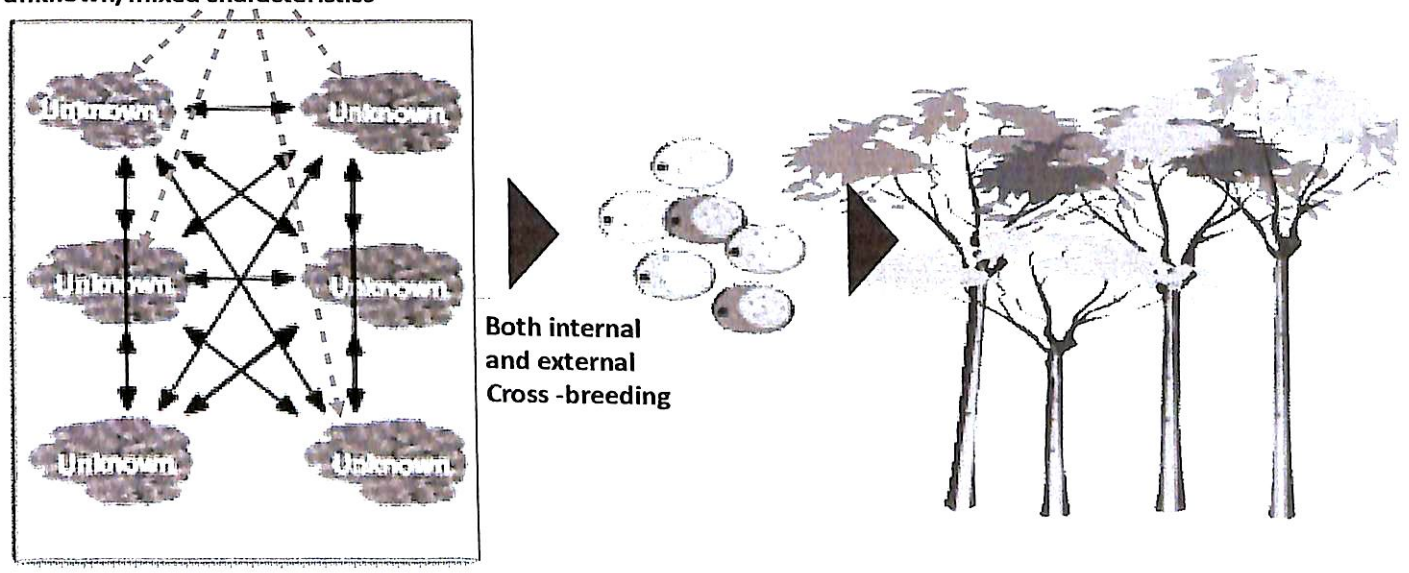
Seed production in seed orchards

- Establishment of seed orchards is such that it is designed and located to prevent contamination from other unimproved
- Orchards are located at least 200 metres from the nearest unimproved Melia

Melia seeds from general sources

Open site

Pollen come from nearby *Melia* trees which have unknown/mixed characteristics

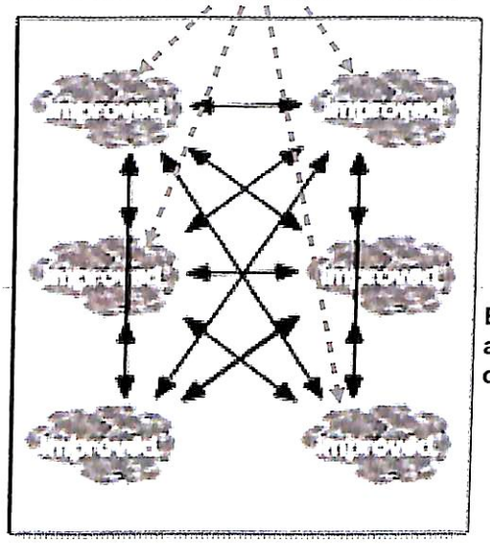


Unknown/mixed characteristics & performance trees

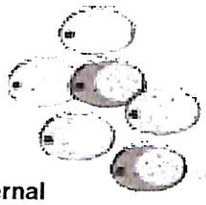
Seeds from improved tree stands

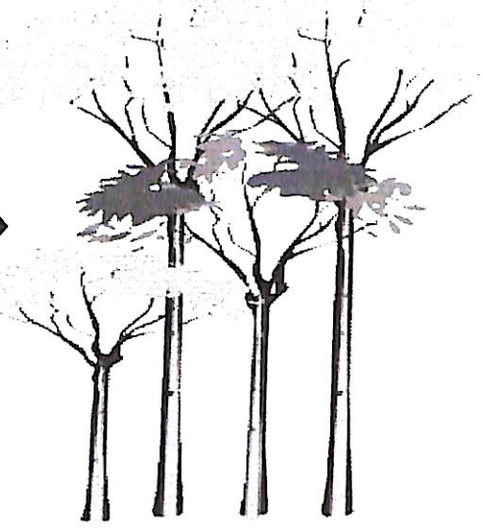
Open site

Pollens come from nearby *Melia* trees which have unknown characteristics



Both internal and external cross-breeding



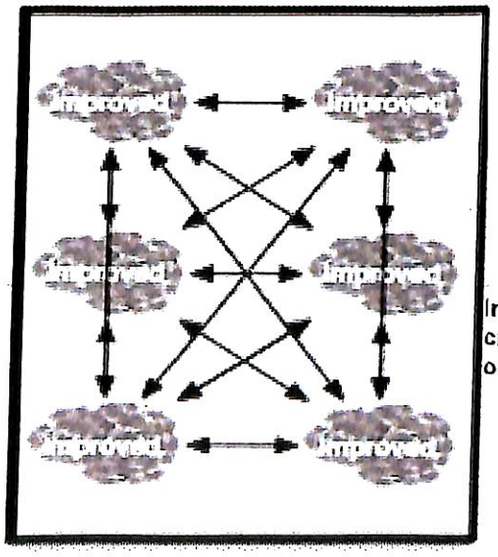


Good characteristic & performance trees with Unknown characteristic & performance trees

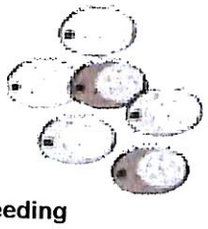
Seeds from improved seed orchard

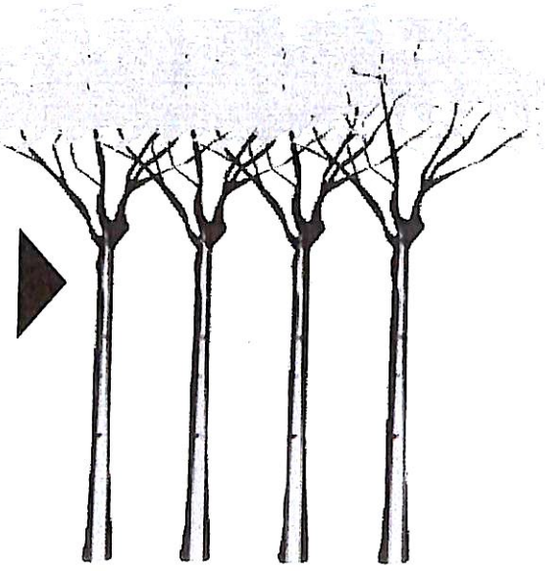
Isolated from surrounding trees

Very few pollens come from outside



Internal cross-breeding only





Good characteristics & performance trees only