Practical Manual No. 4

BAOBAB

Adansonia digitata

Field Manual for Extension Workers and Farmers










2006

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THE FRUITS FOR THE FUTURE PROJECT

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PREFACE

Fruits for the Future is a programme implemented by the International Centre for Underutilised Crops (ICUC) and its partner organisations, the World Agroforestry Centre (ICRAF) and the International Plant Genetic Resources Institute (IPGRI). This project provides information enabling further research on underutilised fruit trees, and also provides information on practical techniques that can be used by farmers and rural communities to increase their product output and ultimately the income from their land.

Demand for the production of scientific and extension materials on baobab has been provided by local, national and regional stakeholders, and has been documented through meetings in the region.

The information contained within this manual is for use in the field, and can be used by forestry and agricultural extension staff working with farmers in West Africa. The manual provides practical advice on propagation techniques, selection of high quality materials, and the management of baobab (*Adansonia digitata*) trees. Information is also provided on processing and marketing; however, the products and market strategies may vary from farmer to farmer and from country to country. This manual has been published in English. Any part of this manual can be freely copied or translated into other languages, in order to aid effective extension work. Should translation be necessary, please inform the publishers.

We would like to thank Dr Modibo Sidibe for the preparation of the information contained within this manual; Mr Oumar Mangara, Mr Aboubacar, M Sidibé and Ms Lucy Jackson for preparing the illustrations; and the staff of the Rural Economy Institute (IER), Mali. Mr David Jackson took responsibility for restructuring the manual into an agreed user-friendly format. Thanks also to Ms Barbara Richie of CABI for reviewing the pests and diseases of baobab.

The opinions expressed in this book are those of the authors alone and do not imply any acceptance or obligation whatsoever on the part of ICUC, IPGRI or World Agroforestry Centre.

Editors
2005

1. INTRODUCTION

Adansonia digitata L. belongs to the Bombaceae family and is known generally as the African baobab.

- Description: the African baobab is a deciduous, tropical fruit tree with a massive trunk supporting a tangled mass of small branches. It ranges in height up to 25 metres and the trunk may be up to 6–10 metres in diameter. The leaves are palmate with five sessile leaflets. The bark is smooth, silver-grey, pinkish-purple or dark grey in colour, and contains a yellow or green inner layer, which is composed of thick, tough, longitudinal fibres. It is a very long-lived, fast-growing tree (in its juvenile stage) and has a life span of hundreds of years.

- Flowering: the flowers are large, up to 12–15 cm in diameter. They are whitish with a large number of fused purple stamens through which the style protrudes. Flowering normally takes place between October and December in southern Africa, with fruiting from April to May. In West Africa, flowering is usually between May and June. The fruits are large (up to 24 x 12 cm) and oblong in shape, hanging from long stalks. They are greenish-grey when young and brownish when mature.

- Distribution: the African baobab occurs naturally in most of the countries south of the Sahara. It is generally associated with the savannah, especially drier parts. However, there are extensions of its distribution into forest areas, associated with human habitation. It appears that the current distribution is primarily determined by a minimum of 300 mm of annual rainfall. There are a further seven species of *Adansonia,* six of which occur naturally in Madagascar and one in northern Australia. It is generally accepted that the origin of the African baobab is tropical Africa, but it may have been introduced from one of the other regions.

- Habitat: baobab now grows widely in tropical climates that are characterised by a dry winter and a hot, wet summer.

- Human introduction: baobab has been introduced to countries outside of Africa, including northern Australia; many Asian countries: India, Sri Lanka, Indonesia and the Philippines; the Middle East; and the West Indies.

- Environmental characteristics: the tree is easy and cheap to cultivate, and usually free from any serious pests and diseases. It is normally left to grow until it dies naturally, because of traditional beliefs that dissuade felling. The tree provides shade to the soil beneath the canopy. Deciduous leaf drop acts as a soil conditioner by providing a humus-rich top layer, improving water retention. Holes in the trunk provide ideal nesting sites for birds, such as rollers, hornbills, parrots and kestrels. Eagles, vultures and storks frequently build their nests in the outer branches. Holes in trunks of baobabs near to villages are used for water storage

2. WHY GROW BAOBAB TREES?

☞ See Technical Note 1 in Part II.

The baobab is a multipurpose tree. It is a source of food, timber, firewood, medicinal extracts, fibres and other components. It can also provide a potential economic return to rural people. The different uses of the baobab are summarised in Appendix 1 and described below.

2.1 Nutritional value

In Africa, baobab plays an important role in human nutrition.

- Dried leaves
  - Rich in ß carotene, a precursor to vitamin A, important in the fight against cancer and heart disease.
  - Vitamin A is necessary for good eyesight. Insufficient levels in the diet can lead to blindness.
  - An excellent source of several trace elements, which can combat micronutrient deficiency.
- Young tender leaves
  - Rich in vitamin A and calcium.
  - Used as a vegetable and in sauce preparation.
- Fruit pulp
  - Exceptionally high vitamin C content.
  - Vitamin C is necessary for healthy teeth and gums, bones, skin and muscle.
  - Can fight infections and heal wounds.
- Fruit powder
  - 23 g of baobab fruit powder provide the daily recommended amount of vitamin C for an average adult.
  - Contains vitamins and other valuable nutrients, essential for normal human growth.
- Seed kernels
  - Contain edible oils and more protein than groundnuts.
  - Rich in the amino acid lysine, vitamin B1 (thiamine), calcium and iron.

2.2 Socio-economic value

- Baobab trees have potential for providing additional income to farmers. Fresh and especially dried leaves provide revenue to rural women and gardeners in the dry season when other field crop production is low.
- The processing and sale of baobab products, especially in urban areas, offer a secondary means of income. Baobab provides an income especially in times of drought and famine.
- Market prices vary widely according to the country of production and the season. In Senegal prices for baobab products have almost doubled to FCFC 60 – 80, (Euro 0.09 – 0.12 per kilo of fruit (Spore No 116 April 2005)
- Typical prices for products in the sahelian region are:
  - Fresh leaves, sold during the rainy season: US$ 0.06–0.18 per kg.
  - Dried leaves, sold in the local market: US$ 0.09–0.18 per kg, and for export: US$ 2.73 per kg.
  - Powder from dried leaves sold in the local markets of Mali: US$ 0.23–0.27 per kg.
  - Whole fruits, sold locally: US$ 0.18–0.46 per kg, but sold for export: US$ 6.4 per kg.
  - Powder from fruits sold in the local markets: US$ 0.73–0.91 per kg.

The baobab Fruit Company in Verona, Italy was established in 2001 to purchase and process

baobab fruit pulp from Senegal. The company imported 70 tons of raw material in 2003 and 140 tons in 2004. This is equivalent to 44 tons of fruit pulp with a value of Euro 83,000. (Gruenwald, J. and Galizia, M. 2005 The United Nations Conference on Trade and Development, BioTrade Initiative / BioTrade Facilitation Programme).

2.3 Medicinal

Baobab is used in traditional medicine throughout Africa and also in India.

All parts of the tree are reputed to have medicinal properties and have been used to treat various ailments.

- Leaves: Used to overcome fever, diarrhoea and urinary tract diseases.
- Fruit pulp
    - Used in the treatment of measles and smallpox.
    - Oil and pulp products have been produced and marketed internationally as 'Natural African' remedies.
- Bark
    - A decoction is used to treat toothache.
    - Used for fever and dysentery.
- Seeds (crushed): Applied to diseased teeth as a paste, to treat swollen gums.

2.4 Timber

- The wood of the baobab does not have value as timber.
- It is light and spongy, unsuitable for fuel, and easily attacked by fungus.
- However, it is used to make canoes and fishing floats.
- Wood pulp is suitable for processing into writing paper, for local use.

2.5 Cultural

This extraordinary tree is surrounded by myths and legends. Many virtues have been attributed to the baobab tree.

- Its presence is believed to be a good omen.
- Some ethnic groups in several West African countries think the baobab tree can guarantee the everlasting continuation of descendants.
- It acts as a ceremonial focus for hunters and others.

2.6 Environmental impact

Baobab trees have a positive environmental impact.

- They can reduce soil erosion. (Agribusiness – Corporate Farming in Senegal, New International List 108 February 1992. www.newint.org/issue108/nipped.htm)
- The canopy provides cover.
- The ability to withstand extreme stress from drought allows the tree to be grown on degraded or marginal lands where other species would not survive.
- The large white baobab flowers, which open at night, are pollinated by bats and other small mammals. The protection of these pollinators is important for the production of fruits.

3. WHERE TO GROW BAOBAB TREES

☞ See Technical Note 2 in Part II.

3.1 Climatic requirements for cultivation

- The tree generally bears its leaves for 7–10 months of the year; the remaining time is the vegetative rest period.
- This rest period is often shorter in previously forested areas and some irrigated lands.
- The tree has an outstanding ability to withstand severe drought and fire.

Table 1. Climatic requirements for cultivation of baobab trees

Climatic factor	Minimum	Maximum
Altitude (m)	Sea level	1700
Rainfall (mm)	300	1400
Temperature (°C)	5	40

3.2 Site requirements

For success in propagating baobab trees and to produce fruits, leaves, bark and other products, the farmer must attend to the following requirements:

- Land: the quality and size of the land available for tree planting will influence the economic returns from the tree(s).
- Water: although baobab is a hardy tree and can withstand high levels of drought, the tree will produce higher returns from intensive leaf production if irrigated regularly.
- Planting materials: seeds, scions or seedlings.
- Nursery: if the farmer wishes to grow baobab from seed, or to propagate his own trees through vegetative means, he will need a nursery (see Technical Note 3) and the equipment necessary for establishment.
- Protection (fence): baobab needs to be protected against animals, especially during its juvenile state.

3.3 Land use systems

- Baobab trees can be grown in home gardens, orchards and grasslands, or on field boundaries.
- Baobab is suitable for marginal land with poor soils where other crops do not grow well.

4. WHAT TO GROW

4.1 Morphological variability in baobab

There are no commercial varieties of baobab; however great morphological variability can be seen. One method of characterisation is to classify the trees by colour of the bark and the leaf characteristics. For example in Mali, the following morphotypes are identified.

Table 2. Morphological variability in baobab in Mali

Morphotype	Characteristics
Sirafing	Bark – dark grey in colour. Trunk – classified as black. Leaves squeak when touched and have a mild flavour.
Sirable	Bark – pinkish-purple in colour. Trunk – classified as red. Produces the highest quality, most delicious fruits.
Siradie	Bark – silver-grey in colour. Trunk – classified as grey. Recognised for its high quality fibre.

- The three morphotypes in the table above are grown in similar areas and have been selected based on their characteristics and the needs of the local people.
- Baobab is known by the following local names in the main sahelian languages: gouye (*wolof*), sito (*mandingue*), kiidé (*sarakole*), sira (*bambara*) and toayga (*moré*).
- Baobab also grows extensively in east and southern Africa savannah areas and make up part of the miombo woodlands.

4.2 Propagule type

There are two methods presently available for propagating baobab trees: seed propagation and vegetative propagation.

4.2.1 Seed propagation

This involves collecting seed, its preparation and direct planting into soil/compost.

The advantages of this method are:

- It is simple and easy to reproduce the tree.
- The trees are generally deep rooted, providing firm anchorage, able to absorb water and nutrients from a wide area for greater resistance to drought.

The disadvantages of this method are:

- The quality of the new offspring cannot be guaranteed (not true to type).
- The time taken for the tree to reach fruit-bearing age is usually longer than for trees propagated vegetatively.
- The trees tend to grow taller than those propagated by vegetative methods, which may affect tree management and harvesting.

4.2.2 Vegetative propagation

Vegetative propagation involves the growth of the new tree from a shoot, bud or cutting from a 'good quality' mature tree.

The advantages of this method are:

- The quality of the new tree is assured.
- The time taken for the tree to reach bearing age is usually less than for seed-propagated trees.
- The trees remain relatively short in stature, aiding management and harvesting.

The disadvantage of this method is:

- The trees are often relatively shallow-rooted.

The best time to begin propagation depends on:

- The local climate.
- Water availability.
- Method of propagation.
- Seed propagation is limited by the fruiting time of the mature, healthy trees from which seed is to be collected.
- Vegetative propagation should be carried out in the wet season, at the end of the dormant rest period, which lasts 2–5 months.
- This method may also be dependent on the availability of suitable seeds for rootstocks.
- Regardless of which propagation method is used, it is good practice to select a good quality tree from which to collect either seeds or bud wood material.

5. HOW TO GROW BAOBAB TREES

☞ See Technical Note 2 in Part II.

5.1 Selection of planting materials

- Planting materials (both seeds and cuttings) should be selected from a high quality, full-bearing tree.
- The tree should have a good crown and strong trunk.
- It should be disease-free with no signs of pest attack.
- It should be known to provide a good harvest of leaves or fruits (depending on the required harvest product).

Once a quality tree has been selected, it is necessary to prepare a nursery area for propagation. A nursery will:

- Provide protection to the plants when very small.
- Offer a greater chance of successful establishment later.

5.2 Nursery establishment

5.2.1 The nursery site

☞ See Technical Note 2 in Part II.

A plant nursery is an area where young plants are raised from seed or vegetatively propagated material, and then grown on.

- The size of a nursery is dependent on the number of trees required.
- It is unlikely that seeds will have 100% viability (in baobab most healthy seeds give 70–85% germination).
- Therefore it is usual to plant 30% more seed to allow for failure to germinate.
- Similarly, for vegetatively propagated trees, it is better to prepare a slightly larger area than for the exact number of trees required.

Considerations to be taken into account when selecting a site for the nursery are that the land should ideally:

- Be level, with good drainage.
- Be close to a good water supply.
- Be in a relatively sheltered area, with protection from strong winds.
- Be safe from potential flooding.
- Have no previous history of pest outbreaks.
- Be protected from stray or domestic animals.

The nursery may be placed under the partial shade of trees, or an overhead low-cost shade structure can be built to reduce sunlight intensity, and to prevent leaf scorch and rapid moisture loss.

When building an overhead shade:

- Care must be taken to ensure t the height of the structure is sufficient to allow easy access.
- If palm leaves or grasses are used, avoid using older materials as they can harbour fungi, such as mildew, which can be transmitted to the young plants below.
- The shade should allow about 30% sunlight to reach the top of the young plants and 60% to reach the sides.

Prior to building the nursery structure:

- Clear the ground of all weeds and pests.
- A plastic ground cover can be used to prevent weed re-growth.
- Lightly hoe the ground and top dress with clean sand and gravel or small stones.

5.2.2 Nursery containers and potting mixture

☞ See Technical Note 3 in Part II.

Potting mixture:

- The best medium for seed germination is standard nursery potting mixture containing three parts of topsoil, one part of sand and one part of compost, as this allows good drainage.
- Collect top soil from beneath trees or old ant hills and pass it through a sieve before mixing it.
- River sand can be used; however, if sand is obtained from beach sources it can be left out in the wet season on a well drained area to leach out the salt.
- Seeds may be germinated in nursery beds, pots or polythene bags.

Planting pots:

- Pots can be purchased or home-made from any available material, such as bags, clay, tin cans (punctured) or natural vegetation, e.g. banana leaves or woven baskets.
- Polythene bags, however, are highly suitable as they are less costly and less bulky than tin cans or clay pots.
- They should measure approximately 13–15 cm in diameter and 20–25 cm in depth, and be perforated to provide drainage.
- The bags/pots should be filled almost to the brim with potting mixture.
- When watering the seedlings, ensure that the upper rim of the plastic bag is not folded towards the stem, preventing water entering the soil.

5.3 Seed propagation

5.3.1 Seed collection and handling

Collection:

- The most suitable method of collecting seeds is to harvest fruits from high quality trees.
- Avoid collecting dropped fruits from the ground, because immature fruits may have fallen, and the fruits may also have remained on the ground for some time, leading to a loss in viability of the seeds or to infection from various pathogens.
- Other fruit sources include orchards and fruit stores.
- Fruits should appear healthy, showing no damage or disease.

Handling:

- Open the fruit pods to extract the pulp and seeds from the shell.
- Wash, air-dry and store the seeds in clean, dry, sealed and labelled containers in a cool dry place, to protect them from moisture, insects, fungal infection and attack by rodents.
- Avoid drying in full sunlight.
- Seeds should be examined for abnormalities.
- Light seeds that float on water generally germinate poorly and produce low quality or abnormal seedlings.
- Seeds can remain viable in storage for a number of years, provided they are kept cool and dry. Note that without sophisticated storage equipment and packaging, the longer the seeds are stored, the fewer are likely to germinate.

5.3.2 Seed pre-treatment

Baobab does not regenerate well in natural conditions. The seeds are known to remain dormant in the soil for several months before germination. Pre-treatment of the seeds is necessary in order to obtain fast and even germination. This involves breaking down the seed coat prior to sowing to enhance the entry of water and oxygen into the seed.

This can be done in a number of ways:

- Cutting (scarifying) the seed coat. This produces up to 60% germination. It is recommended for use with small seed lots.
- Cutting the seed coat and then soaking in cold water for 72 hours increases germination to 85–90%.
- Boiling the seeds in water for 5 to 7 minutes will also increase germination.

5.3.3 Sowing and germination

Seedlings can be raised directly in the field; however, they develop to be much stronger plants when germinated and cared for in the nursery.

Nursery sowing

Sowing:

- Plant one or two seeds in each pot to a depth of 1–2 cm.
- If planting in a nursery bed, the seeds should be 10–12 cm apart and then transplanted into pots at the 2 leaf stage.
- Keep the newly sown seeds in the shade for the first few days to protect them from dehydration by the sun.

Germination:

- Germination should begin 4–6 days after sowing and be complete within 18 days.
- Once germination is completed (the first two leaves have opened), increase light to the seedlings gradually over 4–7 days.
- After this period, the seedlings can be exposed to full light.

Aftercare:

- Water seedlings twice a day (morning and evening) during germination and the establishment period, which can last from 15 days to 3 weeks.
- To prevent the seedlings' roots growing through the bags, move the seedlings within the nursery 3 weeks after sowing, and then every 15 days until the plants are ready for transplanting.
- The seedlings are ready to be transplanted into the field after 3 months, or when they are 40–50 cm in height, or have 2–3 pairs of leaves.

Field sowing

- Make small holes in the soil and place 2 seeds at a depth of about 2 cm (the strongest seedling can be chosen later on).
- Sow seeds at a spacing of 5 x 5 m.
- The strongest seedlings can be selected 5–15 days after emergence (seed requirement is in general 800 to 1000 seeds or approx. 0.5 kg per hectare).
- Final spacing should be about 13 x 13 m if the space is available or if an orchard is planned.
- For intensive production of leaves in mixed cropping systems, usually in association with vegetables, the spacing of the trees should be 0.5 m x 0.2 m.

5.4 Vegetative propagation

☞ See Technical Note 4 in Part II.

- Vegetative propagation can be done throughout the year, but is less successful in the hot season.
- Baobab is usually propagated by stem cuttings or veneer grafting.
- Other methods, such as bud grafting and air layering can also be used.
- With all methods, it is important to choose shoots and branches that are free from pests, diseases and damage.

5.4.1 Stem cuttings

The easiest and cheapest vegetative method of propagating baobab is by stem cuttings; however, the success rate can be low.

- Collect all cuttings in the morning.
- On removal from the tree, wrap cuttings in moist cloth to prevent drying.
- Take cuttings from terminal branches, where possible, as success rate is higher than from other parts of the tree.
- Cuttings should be 5–10 cm in length.
- Remove all but the 2 most terminal leaves from the cutting. Trim the nodes from which leaves were removed with a smooth, clean, downwards cut.
- Cut the two remaining leaves in half to reduce the surface area available for transpiration and loss of water.
- Make a clean, fresh cut across the base of the cutting at a 45-degree angle.
- Dip the end of the cuttings evenly into rooting hormone (see below).
- Push cuttings straight into the soil to a depth of about 2.5 cm.
- Pinch out the shoot tip to encourage quicker root development rather than growth of shoots.

It is highly desirable to use rooting hormone, such as IBA (Indole-3-butyric acid), diluted in alcohol at 10%, 25% or 50% (depending on availability – 50% gives the best results), for a rooting success of 20%, with 15% survival after transplanting. The rooting success of cuttings without hormones is less than 2%.

Soil bed:

- A soil bed prepared prior to propagation will provide shade and protection for the cuttings.
- The soil bed should have upright poles and a roof, which can be made from grasses or palm fronds (see Nursery Establishment).
- Care must be taken to keep animals away from the rooting area.
- Water the cuttings regularly, but not excessively.
- Once established, they can be transplanted into the field.

5.4.2 Grafting

See Technical Note 4 in Part II.

The purpose:

- To join high quality, desirable plant material (the scion) to a rootstock.
- Grafting allows the selection of a root system that is:
    - Adapted to a specific climate and soil.

    - Shows resistance to local pests and diseases.
- To combine the rootstock with a high quality scion.

Equipment required for grafting:

- A clean, sharp knife.
- Plastic bags.
- Plastic tape (1.5–2 cm wide and 30–40 cm long). This can be cut from ordinary plastic bags if grafting tape is not available.

Veneer grafting is the most appropriate method for propagating baobab.

Scion collection and preparation

The scions should be:

- Mature
- 5–15 cm long
- 1 cm in diameter (slightly larger than a pencil)
- 6–9 months old
- With 1 or more buds

To reduce the juvenile period in grafted plants:

- Collect scions (cut with secateurs) from trees that are bearing fruit.
- Remove the leaves with a sharp knife.
- To transport, wrap scions in a moist cloth or newspaper and place in a plastic bag to keep them fresh.
- Scions can be kept for up to 8 days with approximately 46% success.
- The best rate of success (92%) is obtained with 1 to 2 day old scions.

Veneer (inlay) grafting

The rootstock:

- A rootstock is raised from seed.
- It is ready for grafting at about 3 months or when approximately 1 cm in diameter.
- Clear the stem of the rootstock of any soil or debris.
- Make a long, shallow cut in the rootstock at the point of active growth or where the bark separates easily from the wood, slanting inward to about a quarter of the total diameter of the stem.
- Make a short, second downward cut at the base of the first, removing a piece of bark and wood, and retaining 2 or more leaves below the grafting cut.

The scion:

- Select a scion with a similar diameter to the rootstock.
- Make a long, shallow cut at the base of the scion, to match that on the rootstock, with a short, slanting cut on the opposite side.
- When cutting the scion and the rootstock, use one stroke of the knife. This provides a smooth exposed surface, which aids the grafting union.
- The scion should fit tightly into the notch on the rootstock.
- It is important that once the cuts have been made, the surfaces are tightly matched together and quickly bound with tape.
- Tie the graft with the plastic tape, ensuring that the wound is entirely covered.
- Cut away the top of the scion to encourage the union, and cover and seal it with a plastic bag to prevent transpiration and loss of moisture.

- Remove the plastic bag after 2–3 weeks.
- Drying out of the exposed surfaces of the scion, rootstock or both may result in failure of the union.
- Once the union has healed and fresh growth occurs on the newly attached portion, the graft is successful. This should take approximately 2–3 months. The tape can now be removed to allow further growth of the grafted plant.

5.5 Field establishment

☞ See Technical Note 5 in Part II.

Mature baobab trees are well adapted to full sun and open areas.

When planting out they should **not** be placed:

- In boggy areas. The land should be freely draining.
- In heavy shade.
- Near refuse areas.
- Near animal enclosures where they are likely to get damaged.
- In highly saline soil or in areas of contamination with heavy metals, e.g. petrol spills.
- In areas subject to flooding.

Baobab can be planted along roadsides , around homesteads or home gardens, on agricultural land, in orchards, on high-density leaf production plots, or as scattered trees in open grasslands.

5.5.1 Land preparation

Land preparation:

- Carry out in the summer or at the onset of the rainy season to preserve the soil structure.
- Clear the area of scrub and big stones.
- Plough or lightly turn the soil 3–4 weeks prior to transplanting , then again after 15 days, and then again just before planting the seedlings.
- This practice controls the weeds, breaks up hard soil, and allows aeration especially when close planting for use as a vegetable or leaf production.

5.5.2 Transplanting

When transplanting seedlings or grafted trees, pay attention to the following concerns:

- Plant baobab seedlings from the nursery (seed or vegetatively propagated) in the field at 3 months of age or when 40 cm or more in height.
- When transferring the seedlings, take care not to damage the taproot if it has grown through the bottom of the plastic container into the nursery bed. (**Note**: Moving the seedlings regularly within the nursery will prevent the roots from growing into the nursery bed.)
- Cut away the bottom of the plastic container, taking care not to damage the roots, and make a slit in the side to allow expansion of the seedling roots. (**Note**: Dispose of old plastic bags and pots with care to avoid pollution with non-biodegradable materials.)
- Support field planted seedlings with sticks; within a year they can support themselves.
- In addition to transplanting young saplings, older trees can be transplanted from one place to another, if handled with care, in order to satisfy the need of the local communities.

Spacing:

- Plants produced for use as a vegetable should be spaced at 0.5 x 0.2 m.

- Those grown for their leaves and fruit should be spaced at 4 x 4 m or 5 x 5 m in home gardens.
- In a small orchard, 13 x 13 m is recommended.

Aftercare:

- Shade young seedlings from strong sunlight.
- Protect against wind and predators (mice and others).
- Use wire netting with a small mesh (1 cm) for vertical protection.
- Rats can be controlled by using traps or poisonous bait.
- If a number of trees are to be planted in an area of grassland grazed by animals, it will be necessary to consider fencing structures.

5.5.3 Pit planting

Pit planting is one of the commonest methods for planting fruit trees. It is time consuming, especially in rocky soils, but tree establishment has a good rate of success.

- Dig the pit 50 cm deep and 50 cm wide and loosen the soil on the pit walls and base. This will help the roots to grow and develop later.
- The tree should be positioned straight in the centre of the pit, with the root collar, the thickened part of the stem, between the roots and shoot, at ground level.
- Remove the plastic container.
- Fill the pit and the roots to ground level with the removed soil mixed with 10 kg compost or farm yard manure (all stones should be taken out before replacing around the tree).
- If there is insufficient soil after digging the pit, use topsoil to fill the pit.
- It is important to flatten the soil around the base of the tree up to ground level.
- Construct a small basin around the tree and apply 5-10 litres water.
- If frequency between rainfall events is low, then apply 4-5 litres water twice a week and especially during the first dry season.

5.5.4 Time of planting

- The best time for field planting or transplanting seedlings is at the beginning of the rainy season, particularly in seasonally dry regions.
- If water is constantly available, planting may be done throughout the year.
- The best time of day is late afternoon to early evening.

5.6 Field management

☞ See Technical Note 5 in Part II.

5.6.1 Weeding

Weeds compete with young trees for nutrients and water.

- Remove weeds from around the tree during the early stages of growth. This is known as ring weeding and is recommended for small orchards or individual trees wherever planted.

5.6.2 Irrigation

The amount of water required varies with the size of the tree and is dependent on local climate.

- In general, apply about 1–2 litres of water twice a week to the base of each young tree, preferably in late afternoon or early evening.
- Mature baobab trees require no irrigation.

- However, trees with regular irrigation have better growth and their period of vegetative rest is shorter.

5.6.3 Fertilisers

Organic and mineral fertilisers help to restore plant nutrients that are used by the tree for growth of twigs, leaves and branches, and fruit. Indicators for use of fertilisers include, poor growth, (may also be due to shortage of rain) yellowing leaves and light sandy soils which may be short of nutrients.

Mineral fertilisers can be costly or not locally available, and it is recommended to use farm yard manure, compost or green legume manures, especially at time of planting and for intensive leaf production. Mineral fertilisers may only be cost effective for intensive leaf production.

However if available, the following is recommended for planting new trees and intensive leaf production.

- Each field-planted tree should be top-dressed with 20 kg of manure before planting, and later a top dressing of 10–15 kg applied by spreading at the beginning of each wet season for the first five years.
- Home gardens with intensive leaf production in the dry season require 5 wheelbarrows-full (500 kg) of manure per 8 m^2, in a large orchard.
- Mineral fertilisers can be used, such as rock phosphate at 150 g PNT[1] / tree as a top dressing on saplings, or urea in low applications: 33 g / tree at the beginning of the rainy season, and 100 g / tree at the end of the rainy season.

Mature baobab trees grow and produce good crops without fertiliser, due to their extensive root system.

5.6.4 Pruning

Baobab requires little management.

- Regular pruning by shortening branches at the end of the rainy season allows better access to the leaves for harvesting and prevents the development of fruits in order to improve the food quality of leaves.
- Mature trees require very little pruning, except for removal of weak, dead and diseased branches to prevent the spread of disease and infection.

5.6.5 Intercropping

Intercropping can be practised with baobab trees.

- Suitable intercrops include pearl millet, other cereals groundnuts and vegetable crops.
- This practice can help control weeds and improve soil aeration.
- It provides an income or food before the baobabs start producing.
- If the baobab trees are grown primarily for leaf harvesting, pollard the trees to facilitate re-sprouting. Maintaining the trees in this way reduces competition with the intercrop.
- There can be competition for water and nutrients between the intercrop and the baobab tree. This can be alleviated by not planting the intercrop too closely to the baobab or if available, by increasing the amount of fertiliser and water given to the intercrop.

5.6.6 Windbreaks

[1] PNT is the natural phosphate extracted in Tilemsi (Mali).

Baobab trees can be used as a windbreak, and they also aid in soil conservation through protection from water erosion.

A suitable spacing of windbreak trees is 3–4 m between trees.

5.6.7 Protection from pests and diseases

Baobab does not have any serious pests or diseases. Fungal and viral diseases have been recorded on baobab, and several insects are known to attack the wood, fruit and young shoots. These include:

- The cotton bollworms *Helicoverpa* (syn. *Heliothis*) *armigera*, *Diparopsis castanea* and *Earias biplaga.*
- Cotton-stainer bugs such as *Dysdercus fasciatus*, *D. intermeius, D. nigrofasciatus*, *D. superstitiosus*, *Odontopus exsanguinis*, *O. sexpunctatus.*
- *Oxycarenus albipennis* as well as flea beetles, *Padagrica* spp.

See Appendix 2 for damage incurred and measures to control pests and diseases.

Control:

- Decis can be used to control insects that perforate leaves.
- Its use is dependent on the availability of the chemical.
- A decoction of the kernel of *Azadirachta indica* (neem) can also be used for insect control of baobab.

See Appendix 3 for information on chemicals, environmental impact and precautions for use.

Other minor disorders:

- A condition known as sooty baobab occurs periodically in sub-Saharan Africa and is related to lengthy periods of below average rainfall. It can be aggravated by intensive land use in arid areas. The "sooty" appearance is caused by the growth of a sooty mould (possibly *Antennulariella* sp. – Capnodiales); this is purely secondary. Archive records show that affected trees have later recovered.

- The fungus *Ceratocystis* causes rotting. Attack by this fungus is usually associated with invasion by bark beetles. The fungus can cause extensive rotting and will stain wood blue.

- Wilt fungi, e.g. *Fusarium solani* and *Graphium ambrizensis*, can affect the tree, usually after it has been damaged.

- Mistletoe, *Loranthus mechouvii*, has been found growing on the baobab. Other parasitic plants may also occur. These should be removed from the tree by hand before they become a problem, as heavy infestation of parasitic plants deprives the tree of nutrients and water. Heavily infested branches sometimes break off under the weight of parasitic plants, allowing entry of rot fungi.

6. HARVESTING

☞ See Technical Note 6 in Part II.

6.1 Harvesting time

6.1.1 Leaves

The leaves can be harvested from the tree at any age.

- Allow the tree to become well established for 6 months to 1 year before collecting leaves.
- In home garden conditions where water and nutrition are satisfactory, young leaves can be collected within the first year of planting, and used as a green vegetable.
- Leaves can be harvested all year round except during the vegetative rest period, which lasts 2 to 5 months, depending on the morphotype.

6.1.2 Fruits

The time for a baobab tree to reach its first harvest of fruits varies depending on the method of propagation.

- A tree propagated by grafting will come into bearing in 3–4 years.
- A tree propagated by seed may take 10–23 years, but if well tended in an open area may bear fruit in about 9 years.
- Management and local conditions also affect the time for trees to bear.

6.1.3 Bark

Bark can be harvested at any time. At the end of the rainy season (October in West Africa), farmers have time available, and baobab begins its vegetative rest period.

6.2 Fruit ripeness and yield

Pod skin colour does not change rapidly with maturity and individual fruits mature at different times, so harvesting should be carried out selectively.

- Fruits should not be harvested before they are fully ripe.
- Mature fruits should have a brown shell, while immature pods have a green-yellow colour.
- At maturity, the fruits are filled with a white, powdery pulp and the seeds become hard.

No specific data on the yield of the baobab tree have been collated because it is not a highly commercial species. Yield is likely to vary considerably from country to country, and is dependent on genetic and environmental factors.

6.3 Harvesting techniques

6.3.1 Leaves

Mass leaf harvesting is usually carried out from September to November in West Africa.

- Tools used during the harvesting of leaves are the sickle and machete or dolé (a tool similar to a machete, used in Mali).
- The machete or dolé is used when the petiole of the leaf (leaf stalk) is fresh and easy to cut.
- The sickle is used towards the end of the harvesting season when the petiole is lignified.
- Leaves are traditionally harvested by women in many parts of Africa for domestic uses.

- Men may climb the trees at the end of the dry season to harvest all the leaves by hand to stock up for the dry season, but this is practiced less as it can be dangerous.

6.3.2 Fruits

- Harvest fruit by hand picking, clipping with a hook mounted on a stick, or tools such as the machete.
- A sheet can be placed beneath the tree to collect the fallen fruits.
- When harvesting by hand it is necessary to climb the tree, which can be dangerous, and care should be taken to avoid accidents.

6.3.3 Bark

- Bark is stripped from the outer surface of the lower trunk using an axe-like tool
- If done properly, the bark can be harvested again in 2–5 years.
- However, it takes 6–10 years for the bark to return to the pre-harvest condition and regenerate completely.

7. PROCESSING AND STORAGE

☞ See Technical Note 7 in Part II.

7.1 Processing

The processing of baobab products can add value to the raw materials collected from the tree, by:

- Enhancing the preservation of the produce.
- Reducing the size of the products, which are easier to handle, transport and use.

The marketing pathways for baobab are not yet firmly developed and the majority of the produce is currently sold only when available.

7.1.1 Leaves

Leaf powder is the main processed product.

- Remove the harvested leaves from woody branches and leaf stalks.
- Cut into small pieces and sun dry for 2-5 days.
- Dry the leaves in the shade as this reduces the loss of β carotene.
- Grind the dried leaves and sieve to make powder for later use.

7.1.2 Fruit pulp

The pulp is the most commonly used part of the fruit.

- Leave the whole fruit to dry on the tree.
- Harvest the dried fruits.
- Crush the fruit shells and separate the seeds from the pulp.
- Grind the pulp and sieve to produce a powder.
- Keep the powder obtained in containers such as tins or jars.

Uses of fruit pulp:

- Fruit powder mixed with seed powder of baobab and millet porridge is used as a weaning mixture for young children.
- The shells can be used as small cups or bowls, or sold as various art objects.
- Drinks can be prepared by adding fruit pulp powder to previously boiled water, left to cool.
- Note that adding the fruit powder to boiling water will result in the loss of vitamin C.

7.1.3 Seeds

Seed powder:

- Separate the seeds from the pulp.
- Wash the seeds in water.
- Dry in the sun.
- Pound the seeds in a mortar.
- Sieve to make powder.

Uses for seed powder:

- Use in rice as a traditional food .

Seed oil:

- The seeds can also be pressed to extract the oil, useful in cooking and cosmetics. A simple oil press can improve both the quantity and the quality of the oil.
- The oil can be extracted by pounding the seeds, but this method produces low quality oil.
- Oil is not usually extracted locally, but is left to small and medium industries.
- The remaining cake can be used for cattle feed.

7.1.4 Bark

- Sun dry the bark.
- Hammer the bark to extract fibres.
- Soak the fibres so they become elastic for the twining process for the production of rope and other products.

7.2 Storage

7.2.1 Leaves

- Harvest, process and store leaves during periods of drought.
- Cans, jars and plastic bags provide sufficient protection as long as they are sealed to prevent moisture entering the leaves or leaf powder.
- Store container in cool, dry conditions.
- The leaves can be kept throughout the year until the next harvesting season without any noticeable loss in quality.
- To retain higher levels of vitamins, it is better to store dried whole leaves, rather than powder.

7.2.2 Fruit pulp

- Entire fruits are commonly stored on the roofs of sheds.
- The fruit pods will dry in the sun and the pulp and seeds will pull away from the inside of the shell, which can ease processing later.

- Fruits can be kept in this state, unopened, for several months (up to 1 year) and processed only when needed.
- Once processed, the pulp powder can be stored under similar conditions as the leaves, until the next harvesting season.

7.2.3 Seeds

- Dried and ground seeds can be stored under the same conditions as leaf and pulp powder.
- Seed oil is resistant to oxidization and can therefore be kept for up to a year.

7.3 Marketing

☞ See Technical Note 7 in Part II.

7.3.1 Local marketing

- Products sold in local markets are usually in the form of fresh fruits, pulp, leaves, craft products and bark (fibre).
- The marketing of baobab products usually involves a number of intermediary traders, with collection of products in rural areas and transport to urban centres.
- The market value of baobab products varies among regions, and is usually much higher in urban centres.
- The leaves and fruits of the baobab tree are staple foods in many parts of Africa, and for this reason leaves and fruits are sold in most African markets.

7.3.2 International marketing

- Products in international markets include pre-processed pulp and fibre, and seed oil.
- Countries exporting baobab include Burkina Faso, Cameroon, Mali, Niger, Nigeria, Malawi, Senegal and Zimbabwe.
- Overseas companies have taken an interest in baobab products particularly for use in cosmetics, and in herbal and health food remedies.
- The society Bui Sarl, Baobab Fruit Company, for example, buys fruits from producers for 125 FCFA (Franc Communauté Financière Africaine) (599 FCFA to US$ 1) per kg.
- Products marketed include baobab oil and fruit juice from Zimbabwe and Malawi.
- Phytotrade is a non-government organisation that helps African rural producers to develop and market their natural products for export.

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APPENDIX 1. MULTIPLE USES OF BAOBAB

Leaves	• Young, fresh leaves are cut into small pieces and cooked in sauces. • Leaves are also dried and powdered for use in soups or sauces. • Can be used as forage. • Used medicinally for the treatment of many ailments including overcoming fever, diarrhoea and diseases of the urinary tract. • Leaves (also fruit pulp and seeds) can be used as an antidote to the poison from *Strophanthus* (a tropical liana) species.
Fruit and pulp	• Commonly used as a substitute for milk in some rural areas. • Used as a flavouring in cooking in fresh and powdered forms. • Mixed with water to produce beverages. • Used as a substitute for cream of tartar. • Dried pulp is processed industrially and marketed as powder to take with liquid for enhancing nutrition. • The outer shells of the fruit can be used as pots for food and drink and can also be decorated and sold as art objects. • Fruit shells can also be used as fuel. • Pulp is used directly in making beverages. • Fruit pulp is used medicinally to overcome fever and treat dysentery.
Seed	• Used as a flavouring in cooking. • Used as a thickening agent in soups. • Can be eaten fresh, dried and roasted. • Used as a substitute for coffee. • Oil extracted from the seed can be used for cooking and for cosmetics. • The oil is also used to treat inflamed gums and diseased teeth (medicinal). • Used as a substitute for *Parkia biglobosa* seeds in soumbala, a traditional African dish widely traded in urban markets. • Seed cake is a good high-protein livestock feed.
Bark	• Fibre from the inner bark is widely used for making rope, cordage, harness straps, strings for musical instruments, baskets, nets, snares, fishing lines and cloth. • Green bark can be used to produce dye. • Bark is used widely for the treatment of ailments such as fever and dysentery (medicinal).
Wood	• Used in the construction of canoes and fishing floats. • Wood pulp can be processed into pulp for paper-making. • The hollow tree trunk is commonly used for water storage and in some areas of Africa as a tomb.
Root	• Root bark is used in traditional African and Indian medicine for the treatment of fever. • Fibre from the root bark can be used to make rope. • Used to produce a soluble red dye.
Gum	• Used as a painkiller and disinfectant for injuries.

APPENDIX 2. PESTS, DISEASES AND FUNGI OF BAOBAB

Common name	Scientific name	Nature of attack	Bio-control	Other controls
Cotton bollworms	*Heliothis armigera*, *Diparopsis castanea* and *Earias biplaga*	Leaf feeding by newly emerged larvae. Fruit boring.	*Heliothis* NPV, a naturally occurring nuclear polyhedrosis virus used as a biopesticide against larvae of *Heliothis* and *Helicoverpa* spp. in some countries. NPV must be ingested to be effective, and kills the larvae within 2–10 days. Trade names include: H-NPV® and Elcar®.	Remove affected parts. Weeding.
Cotton stainer bugs	*Dysdercus fasciatus*, *D. intermeius*, *D. superstitiosus*, (syn. *D. nigro-fasciatus*), *Odontopus exsanguinis*, *O. sexpunctatus*, *Oxycarenus albipennis*	Suck the sap of the leaves. Immature fruits fall.	No known bio-controls.	Remove affected parts.
Flea beetles	*Padagrica* spp.	Feed on plant foliage.	No known bio-controls.	Remove affected parts.
Cocoa capsid	*Distantiella theobroma*	Suck the sap of young foliage.	The ant *Dolichoderus thoracicus* has been tried with some success in Indonesia and Malaysia against cocoa capsids. This ant is not aggressive towards plantation workers.	Remove affected parts.

Long horn beetle	*Aneleptes trifasciata*	Attack and kill young trees by girdling.	No known bio-controls.	Remove affected parts.
Mealy bugs	*Rastrococcus iceryoides*	Suck the sap of the leaflets, mature and tender shoots, and leaf petiole bases. Leaves become chlorotic and defoliate. Immature fruits fall.	Ladybirds.	Remove affected parts.
Caterpillar	*Gonimbrasia berlina*	Feed on the leaves.	Micro-hymenoptera.	Remove by hand and crush.
Nematode	*Rotylenchulus reniformis; Meloidogyne* spp.	Feed on the roots.	No known bio-controls.	Flooding.
Macrofungi	*Daldinia concentrica; Trametes socotrana*	Wood decay fungi, usually enter through wounds in trunk or branches.	No known bio-controls.	Prune out dying and dead branches to limit spread of rot.
Powdery mildew	*Leveillula taurica*	Chlorotic spots on the upper surface of the leaf and a white powdery mass below; affected parts dry out, turn brown and break easily.	No known bio-controls.	Standard fungicides can be used e.g. Benlate and Sijolan.
Leafspot	*Phyllosticta* spp.	Irregularly round spots appear on the leaves.	No known bio-controls.	Standard fungicides can be used as above.
Mistletoe	*Loranthus mechouvii*	Parasitic plant growing on trunk and branches.	No known bio-controls.	Remove by hand before flowers set seed so birds and animals that will eat the seeds cannot pass them on.

APPENDIX 3. HEALTH AND SAFETY WHEN USING CHEMICALS

The following chemicals are examples of those that can be used for control of pests and diseases on baobab, together with the relevant health and safety advice for each.

DECIS

Active ingredients: Deltamethrin (chemical family pyrethroids)

Handling and storage:

- Users should avoid breathing the spray mist and avoid contact with eyes, skin or clothing.
- Accidental exposure to the concentrated product at high levels has been occasionally reported as causing skin irritation, numbness or tingling; however, no long-term effects have been reported.
- The insecticide should not be used near direct heat or open flames.
- The insecticide should be stored away from direct heat and from food and water to avoid contamination.

Environmental impact:

- Extremely toxic to fish and other aquatic organisms.
- It should be used with care when applying in areas adjacent to any body of water.
- It should not be applied directly to water, to areas with surface water, or to inter-tidal areas.
- It should not be applied when the weather conditions favour drift from the treated area, as drift or runoff from treated fields may kill fish and other aquatic organisms.
- Care must be taken when cleaning equipment to ensure that water is not contaminated by disposal of waste water.
- The insecticide is also highly toxic to bees following direct exposure.
- The insecticide should not be applied to, or allow drift to, areas where bees are actively foraging.

BENLATE

Active ingredients: Benomyl

Handling and storage:

- Users should wear protective clothing and avoid contact with the skin and eyes.
- The chemical may irritate the eyes, nose throat and skin.
- It should be stored in an airtight container and kept away from water or fire.

Environmental impact: Toxic to fish.

SIJOLAN

Active ingredients: Thiram + Heptachlore

Handling and storage: Users should be careful not to ingest the chemical and always wash their hands thoroughly after use. The chemical is made in Mali especially for the protection of cereals and legumes against seedling diseases; however, it is also used for baobab and other fruit trees. It is packed in small plastic bags of 10 g. It should be mixed with the seeds at the time of sowing. It is also possible to use this chemical to protect scions during the rainy season against fungal diseases.

Environmental impact:

- Low toxicity to man and other animals.

GLOSSARY

Abscise	When a leaf, flower or fruit falls off the plant naturally.
Air layering	A method of propagation where a cut is made in a woody stem and surrounded by damp soil or peat moss and held in place with a wrap (plastic). When roots from the plant can be seen the stem can be cut and the plant transplanted.
Bole	The trunk of a tree below the first major branch.
Bud	A rudimentary structure consisting of meristematic tissue and a potential to develop into a vegetative, reproductive or a mixture of structures.
Bud sticks	Current season's shoots containing vegetative or leaf buds.
Dormancy	Temporary stopping of growth.
Frond	Leaf of a plant with many divisions, e.g. a palm leaf.
Grafting	Method of propagation, by inserting a section of one plant, usually a shoot, into another, so that they grow together into a single plant.
Hormone	A biochemical product of a cell or tissue that can cause a change of activity in a cell or tissue elsewhere in the plant (organism). Rooting hormone is an artificial chemical which causes rooting in the tissue it is applied to.
Loam	A generally fertile and well-drained soil, containing clay, sand and a significant amount of decomposed organic matter.
Mother plant	The 'superior' or good quality plant from which cuttings, scion materials or seeds can be collected.
Node	Point on a stem from where leaves, shoots or flowers grow.
Nursery	An area or structure set aside for growth and protection of young plants.
Pinched	The terminal leaves may be removed using a finger nail or sharp knife; this may encourage growth in the roots.
Pollarding	A process whereby tree tops are severely cut back each year to the same spots on the branches, forming the growth of large, knobbly stubs, from which young shoots can grow.
Propagation	Production of a new plant, either by vegetative means involving the rooting or grafting of pieces of plant, or by sowing seeds.
Rootstock	The root system and lower portion of a woody plant to which a graft of a more desirable plant is attached.
Scarify	To scar, nick or cut the seed coat, to enhance germination.
Scion	A cutting from the upper portion of a plant, which is then grafted onto the rootstock of another plant.
Seed propagation	Production of a new plant by sowing seeds.
Soil bed	An area where soil is laid down for seeding.
Unpinched	Opposite to pinched, terminal leaves are not removed.
Vegetative propagation	Production of a new plant by vegetative means involving the rooting or grafting of pieces of plant.