COCONUT HUSBANDRY

Recommended Practices in Kenya

Authors: Pole Finyange, F.K. Muniu, Dorothy Wachenje and Omar Kiponda
1. INTRODUCTION

Introduction
The coconut palm (Cocos nucifera) is a perennial tree crop that is widely cultivated in more than 86 tropical countries of the world with a total production of 54 billion nuts per year. The palm produces nuts throughout the year when climatic conditions are favorable and is one of the most important food security crops. The palm is also regarded as the tree of life owing to its wide range of over 120 products for domestic and international markets. It was introduced to Kenya in the 16th Century by the Portuguese. Its cultivation spread rapidly and it became an industrial crop of considerable economic importance during the 20th Century. Its production and marketing were handled by the Arab traders and white settlers on big plantations until the 19th century when small-scale farmers started growing it. Today the coconut is mainly a small-scale farmer’s crop. Over 80% of coastal farm households derive their livelihood either directly or indirectly from the coconut tree.

Origin
Coconut originated in the Indian-Indonesia region and float-distributed itself around the world by riding ocean currents. (Perera, et.al, 2009, Elevitch, 2006)

Distribution
The coconut has spread across the tropics mainly aided by seafaring people. Coconut fruit in the wild are light, buoyant, and highly water resistant. It is claimed that they evolved to disperse significant distances via marine currents (Foale, 2003).

In Kenya, majority of the coconut trees are found in the Coastal Counties of Kwale, Mombasa, Kilifi, Tana River and Lamu. Taita Taveta, a Coastal highland County also has a small population of coconut trees; with the area under production continually increasing on yearly basis. Other areas with potential for coconut production include Busia and Homa Bay in the Lake Victoria region and Tharaka Nithi in Eastern region. The total area under coconut farming in Kenya is estimated to be 200,000 acres. Many (92%) of the trees are in the ages of 20-60 years. The rest (8%) of the coconut tree population is beyond the economic age limit of 60 years, and are either low nut producers or non-productive at all.
**Classification**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Scientific and common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom</td>
<td>Plantae – Plants</td>
</tr>
<tr>
<td>Subkingdom</td>
<td>Tracheobionta – Vascular plants</td>
</tr>
<tr>
<td>Super-division</td>
<td>Spermatophyta – Seed plants</td>
</tr>
<tr>
<td>Division</td>
<td>Magnoliophyta – Flowering plants</td>
</tr>
<tr>
<td>Class</td>
<td>Liliopsida – Monocotyledons</td>
</tr>
<tr>
<td>Subclass</td>
<td>Arecidae</td>
</tr>
<tr>
<td>Order:</td>
<td>Arecales</td>
</tr>
<tr>
<td>Family:</td>
<td>Arecaceae / Palmae – Palm family</td>
</tr>
<tr>
<td>Subfamily</td>
<td>Arecoideae</td>
</tr>
<tr>
<td>Tribe:</td>
<td>Coccoeae</td>
</tr>
<tr>
<td>Genus:</td>
<td><em>Cocos</em> L. – coconut palm</td>
</tr>
<tr>
<td>Species:</td>
<td><em>Cocos nucifera</em> L. – coconut palm</td>
</tr>
<tr>
<td>Binomial name</td>
<td><em>Cocos nucifera</em> L.</td>
</tr>
</tbody>
</table>

**Uses**

The coconut palm is used both as a cash crop and food crop. There are hardly any parts of the coconut palm that are left unused. Below is a list of the various coconut products and by-products produced in Kenya.
1. Mature coconuts
2. Virgin coconut oil
3. Coconut cream and milk
4. Brooms
5. Door mats
6. Chior fibre
7. Coco peat
8. Copra oil
9. Descicated coconut
10. Chior ropes
11. Vinegar
12. Cococ syrup
13. Cocowood
14. Ornaments
15. Tender coconut water
16. Charcoal/ briquettes
17. Tooth picks
18. Toddy
19. Makuti

**Types of coconut in Kenya**

Coconut is classified largely in to 2 types in Kenya: The East African Tall (EAT) and the Dwarf coconut. This classification is based on the most conspicuous difference between the two groups: the height of a mature tree. In other countries, hybrids are a third group available after breeding efforts. Kenya is in the process of importing and developing hybrid coconut varieties.

General variations between the two major groups are summarized below:

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>EAST AFRICAN TALL</th>
<th>DWARF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarf coconut</td>
<td>The East African Tall</td>
<td>Hybrid (CRIC 60) variety in Sri Lanka (get a good photo of the tall)</td>
</tr>
<tr>
<td>Petiole and nut colouration</td>
<td>Green to brown</td>
<td>Bright colours of green, yellow, pink, orange.</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Number of leaves/fronds</td>
<td>12-18 leaves per year</td>
<td>20-22 leaves per year</td>
</tr>
<tr>
<td>Life span</td>
<td>Up to 80 years</td>
<td>Up to 40 years</td>
</tr>
<tr>
<td>Age at first bearing</td>
<td>5 – 7 years</td>
<td>3- 4 years</td>
</tr>
<tr>
<td>Economic life span</td>
<td>More than 50 years</td>
<td>Less than 50 years</td>
</tr>
<tr>
<td>Stem size and shape</td>
<td>Enlarged, mostly ball shaped at the base</td>
<td>Thin, with a cylindrical or tapering base</td>
</tr>
<tr>
<td>Nut sizes</td>
<td>Medium to large</td>
<td>Small to medium</td>
</tr>
<tr>
<td>Oil content</td>
<td>Relatively higher</td>
<td>Relatively less</td>
</tr>
<tr>
<td>Nut Yield in number</td>
<td>Up to 140 nuts per tree per year</td>
<td>Up to 200 nuts/tree/year</td>
</tr>
<tr>
<td>Reaction to harsh weather, pests and diseases</td>
<td>Less sensitive</td>
<td>More sensitive</td>
</tr>
</tbody>
</table>

**Hybrids**

Hybrids have intermediate characteristics but with a higher nut yield than the first two types. Hybrid coconut is not yet commercially available in Kenya.

### 2. THE PLANT AND ITS ENVIRONMENT

**Coconut Botany**

The coconut **palm** is monoecious, i.e., has male and female flowers on the same inflorescence, called a spadix, that develops within a woody sheath or spathe. The **tree** is composed of a crown of fronds borne on a single unbranched stem with aerial growth from a single growing point. A 40-year old palm typically attains a height of 20–22 m (66–72 ft.).

The **leaves**, called fronds, are evenly distributed in all directions from the growing tip. Until about an age of 1 year, leaves remain entire. A leaf remains on the palm for about 3 years and thereafter, shed leaving a permanent scar on the trunk. The age of an adult palm is correlated with the number of leaf scars. The number of scars on the stem, divided by 13, gives the approximate age of the palm in years (Mahindapala 1991).

**The Inflorescence**
The coconut inflorescence is enclosed in a double sheath or spathe, the whole structure known as a 'spadix' which is borne singly in the axil of each leaf. The palm is monoecious, i.e. its inflorescence carries both male and female flowers. The male flowers are more numerous than the female flowers. The former are borne on the top portion of spikelets which are attached to a main axis or peduncle. The female flowers are situated at the base of the spikelets.

The male flowers are the first to open, beginning at the top of each spikelet and proceeding towards the base. After each flower opening, the pollen is shed, and male flowers abscise, the whole process taking just 1 day. The male phase, however, takes about 20 days in most palms but this may vary according to season and variety.

A female flower remains receptive from 1 to 3 days. Depending on the environmental conditions and variety, the female phase may begin a few days or later after the spathe has opened and lasts 3-5 days in tall palms and about 8-15 days in dwarfs. A normal inflorescence may have 10-50 female flowers. With natural pollination, 50-70% usually abort and fall off, especially those which emerge during severe dry weather. The remaining flowers develop into fruits, which take about 12 months to mature.

The length of the male and female phases is affected by climatic environment and usually do not overlap in the tall types, such that self-pollination rarely occurs. In some dwarfs, particularly the
Malayan Dwarf, overlapping of the male and female phases and between spadices usually takes place, promoting selfing. Hence, these dwarfs are reasonably homozygous.

The fruit
Once pollination and fertilization occur, fruits set and develop to maturity in about 12 months, or less than 1 year for some dwarf cultivars. The fruit is a fibrous drupe but with a smooth outside skin (exocarp), which may vary from green to red brown or even ivory. The coat (mesocarp) in the young coconut is white and firm. On the other hand, the ripe nut has a fibrous mass, the husk, from which coir is obtained. Within this fibrous mass is the nut with a hard shell (endocarp) enclosing the kernel (endosperm). Between the shell and the kernel is a thin brown seed coat (testa). It adheres firmly to the kernel which is the white flesh, about 12 mm thick lining the central cavity containing the nut water. Towards the end of maturation, the volume of water in the cavity decreases considerably which may be due to absorption by the endosperm tissue or to evaporation. Matured nuts have a sloshing sound of water inside when shaken. Fruits harvested for planting are referred to as seed nuts.

The Stem
The stem develops from the single terminal bud called the ‘cabbage’ which is the palm's only vegetative growing point. It has a swollen base called ‘bole’. Under favorable conditions, the foundation of the trunk of a young palm reaches full development within 3-4 years.

In the tall types, the base of the trunk is up to 0.8 m in diameter, tapering quickly to about 0.4 m (Child 1974). Once formed, the trunk does not change much in diameter. If variation occurs from base to crown, this is not caused by biological factors but by climatic conditions and cultural practices. Stem growth is fastest at early stages, which can be as much as 1.5 m per year.

**Roots:**
The palm has adventitious roots continually produced from the basal about 40 cm or so of the trunk. It has no taproot or root hairs but has lots of primary roots which bear large quantities of rootlets. The main roots grow out somewhat horizontally from the bole and are mostly found within the topsoil. The main branches grow deeper and may extend laterally to as much as 10 m. The roots, having no cambium, are noticeably uniform - the main roots reaching a maximum diameter of about 1 cm. The root tip is the actively growing region and behind it is the absorbing area whose epidermis is a single layer of thin-walled cells that gradually thicken and become impervious with age. In old roots, the epidermis disintegrates and exposes the hard hypodermis which is generally red. Most roots are to be found within the top 1.5 m of soil, around a 6 m radius around the stem base. Decayed roots are regularly replaced by new roots that emerge from the basal stem.

**Ecological requirements**

**a) Soils.**
Coconut palms have the best competitive advantage on sandy shorelines. Their ability to grow in infertile and saline soils, tolerate short inundations of the roots in salt water, and thrive in a wide range of pH environments gives coconut palms this advantage. Coconut palms are naturally found on coarse sandy soils, but their ideal growth medium is well-drained fertile loam or clay soils. Ideal PH range is 5.5-7 although the palm can tolerate pH ranges from 4.5-8. The tree cannot tolerate water logging within its root zone.

**b) Temperatures:**
The palms requires a mean annual temperature of between 21-30 °C (mean max of hottest months 28-37 °C, mean minimum of coldest months 4-12 °C and coldest tolerated temperature of 0 °C (32 °F) (Chan and Elevitch 2006; Last 2001). Freezing will kill seedlings and young palms and prolonged exposure will kill older palms (Chan and Elevitch 2006).

**c) Rainfall**
The level of precipitation required is not less than 1000 mm, but the most preferred is 1500-2500 mm (60-100). Ideally, the precipitation should be evenly distributed throughout the year (Chan and Elevitch 2006; Last 2001). A supply of ground water by seepage from upslope or a reachable water table could mitigate a lack of rainfall (Last 2001). Inadequate water supply is not well-tolerated and results in faster dropping of fronds, death of emerging fronds, premature fruit drop, and poor fruit crop in later years (Chan and Elevitch 2006; Last 2001; Prado et al. 2001). Poorly draining soils receiving the sufficient rain quantities could become water-logged; two weeks of water-logged soil kills coconut palms (Chan and Elevitch 2006).

d) **Altitude:**
Coconuts grow well in elevations ranging between 0-600 m above sea level; however, exceptions exist especially in Kenya where coconuts have been grown at higher elevations.

e) **Sunlight:**
Coconuts can grow in shade but nut production will be adversely affected (Chan and Elevitch 2006; Last 2001).

3. **COCONUT PROPAGATION**
Coconut is primarily propagated through seed. Attempts at clonal propagation and embryo culture have so far been employed in some countries. Establishment through seed propagation can take two ways:

1. **Direct Planting** - This is where quality seeds are planted in well dug planting holes from where they germinate and grow, without need for further transplanting. Trees established in this way don’t suffer a possible transplanting shock, though it may make it difficult to manage them in case of drought and pest attack.

2. **Nursery establishment** - Seedlings can be raised in nurseries and managed until they attain the transplanting stage.

**Good/Desirable Coconut mother plant qualities**

a. Mature (30 years and above)
b. High and stable yield – nuts, wine or tender coconut water (*madafu*)
c. Big nut size;
d. High growth vigor;
e. Pests, disease and drought resistance/tolerance
f. Any other valuable traits as observed or described by the framer

**Good/Desirable seed qualities**

a. Mature: should dry up in the tree
b. Free from pests/disease attack – skin should be smooth
c. Big size, especially if aim is to plant trees for nut production
d. It should contain water inside
Quality seed for planting

Seed Selection

Objective

To ensure the propagation of only those nuts with good/ desired characteristics selected from the best trees available in the farms.

- The seeds are collected as soon as they have ripened (The American Horticulture Society, 65). In order to ensure the production of quality seedlings, there is need to carry out proper seed selection.
- Discoloration and a foul odor when the nut is cut is an indication that the seed is not fresh and, therefore, is less likely to germinate.

Preparing the Seed for planting

- To hasten germination, slice the seed nut a bit and remove part of the husk on one end at the side of the three eyes.
- Soak the seed nut in water for two to three days. This will weaken the outer coat, allowing it to germinate more easily.
- When soaking, be sure to change the water daily to reduce incidences of pathogens
- For large quantities of seeds, they can be heaped together and covered with sisal gunny bags. Water is then applied by sprinkling until the gunny bags are completely soaked.
Nursery Management
After obtaining quality seeds, the next step is to germinate them in a nursery to get seedlings for transplanting to the main seed bed. This process takes a minimum of six months.

Sowing the Seed in the nursery bed
In tropical environments, the seed nuts are sown outdoors. High humidity is essential for germination, therefore, constant mist should be provided to prevent the seed from drying.

Process of germinating the seed (Primary nursery)
- Identify, demarcate the nursery area and plough it well
- Create trenches to bury the nuts at 1 foot apart from one another
- **Laying the nuts**: Place the nut end to end or side by side in the trench, with the broadest side of the nut at the bottom; and the front end (with eyes) lower such that the water wets the shoot.
- Another method of sowing the seed nut in the nursery is to place the seed with the end that had been attached to the tree pointing upward and the pointed end in the dug trench. Cover the seed partially; bury with soil to about ¾ of the nut being under soil.
- Mulch if need be and maintain the place moist always
Secondary nursery
Where germinated seedlings cannot be planted within 2 months’ time, there is need to transfer them to a secondary nursery under well-spaced conditions. They are planted in holes of 1 foot depth at a spacing of 2 feet between lines, and 1 foot between seedlings within the line. Manure is needed. Seedlings can stay in the secondary nursery for a further 3 months before being ready for the farm. Potting can be done at this stage if required.

4. MANAGEMENT PRACTICES

Land preparation
The area should be cleared of felled trees/shrubs, stumps, weeds and other obstructions and then ploughed and harrowed to improve soil tilth. Clearing of debris from thick vegetation is primarily necessary to eliminate possible breeding sites for the destructive rhinoceros beetle.

**Preparation of planting holes**
Prior to digging of holes, farm layout should be put in place by using pegs. This indicates the centre of the hole where the sprout of the seedling to be planted later on will have to be aligned. Holes should be dug at 60 x 60 x 60 cm size, however, due to climate change larger sized holes of 90cm*90cm*90cm and 1m x1m x1m for low rainfall areas are recommended. This operation commences as early as 2 months before planting to allow for weathering of the soil on the sides and bottom of the holes. Weathering is encouraged to promote early root-soil contact.

![Planting area](image)

**Spacing/ Seed rate**
Spacing depends upon the planting system and soil type in general the following spacings are recommended under different planting systems in sandy soils and other soil types. These spacings are however recommended for pure stand systems.

<table>
<thead>
<tr>
<th>Planting system</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangular</td>
<td>7.6m</td>
</tr>
<tr>
<td>Square</td>
<td>7.6x7.6m, 8x8m, 9x9m</td>
</tr>
<tr>
<td>Single</td>
<td>6.5m in rows - 9m between rows.</td>
</tr>
<tr>
<td>Double Hedge</td>
<td>6.5 to 6.5m in rows - 9m between pairs of rows</td>
</tr>
</tbody>
</table>

This gives a pure stand plant population of 49, 64, 72 and 82 plants per acre for the EAT and Dwarf coconut respectively.

**Note** that in farms where intercropping is desired, a wider spacing of 12m x 12m and 10m x 10m is recommended for the tall and dwarf varieties respectively.
Time of transplanting the seedlings
- Seedlings can be transplanted at the onset of the rains, especially the long rains for rain fed conditions.
- Under irrigated conditions, it is advisable to take up planting at least a month before the onset of the rains so that the seedlings get well established before the heavy rains.
- Planting can also be taken up at the onset of the short rains.
- In low-lying areas, due to inundation during rainy period, transplanting may be done after the cessation of the rains.

Seedling selection before transplanting into seedbed
- Is carried out once the seedlings are ready for transplanting to the main seed bed.
- Remove all abnormal looking seedlings e.g. those with multiple shoots, thin or leggy, etiolated, albinos or seedlings which have a yellowing coloration before transplanting to the main seedbed.

Time of transplanting the seedlings into the seedbed
- Before transplanting, the pits are filled up with top soil and two buckets of well decomposed farm yard manure.
• If there is chance for termites attack, apply a termiticide inside the small pit before planting.

• Then make a small pit inside the big pit at the centre, so as to accommodate the nut attached to the seedling.
• Chop off all damaged roots on the seedling prior to planting. This enhances speed of establishment.
• Plant the seedling inside this pit and fill up with soil, the remaining shallow hole of about half a foot is for water catchment around the stem in those areas of low rainfall.
• Press the soil well so as to avoid water stagnation.

b) Care of young palms in the plantation
• The transplanted seedlings should be shaded and Irrigated adequately during the dry months to reduce water loss by the plant.
• Mulch can be applied to conserve soil moisture by use of dry grass, coconut leaves or husks, however, if the area has termites, the mulch should not come in to contact with the seedlings
• The fields should always be maintained weed free since weeds tend to compete with the palms for nutrients.

Inter-cropping
Only minimum tillage is required for the young coconut palms in the plantation. Inter-cultural operations are mainly intended to control weeds and to provide aeration to the soil. If these objectives are met, any tillage system (ploughing / digging, making mounds) is as good as another and can be followed depending upon the local conditions.

Mulching
The objective is to suppress weeds and at the same time retain some moisture. One layer of dried coconut husks or dry grass is placed around the newly planted coconut seedlings from the base to a radius of 50 cm. In areas where there are incidences of termites, the husks should be drenched with a termiticide.

Green Manure and Cover Crops application
This will help to increase the organic matter content of the soil and will also prevent soil erosion in coconut gardens. They also fix nitrogen into the soil. The following Green manure / cover crops are recommended for cultivation in coconut gardens.

- Cowpeas
- Mucuna
- Dolichos
- Beans
- Green grams
- Gliricidia maculata

Sow the green manure / cover crops during April-May with the onset of rains and plough in and incorporate into the soil during August-September.
Care of old palms in the plantation

Weeding
Coconut trees, like other crops suffer competition from weeds, and progressively decline in yields.

- Coconut trees should be kept weed free at all times for better yields.
- Weeding twice a year is adequate for most environments of coconut growing.
- Generally, for the first 2 years of transplanting, a radius of about 1m should at a minimum, be kept weed free. This should extend to 2m radius in subsequent years.
- Where possible, complete weeding of the farm is recommended.

![Complete farm weeding of a coconut plantation](image)

Manuring

- Regular manuring from the first year of planting is essential to achieve higher productivity.
- Depending on the age of the coconut palms, 20 - 50kg organic manure should be applied per palm per year with the onset of the rains, when soil moisture content is high.
- Different forms of organic manures like compost, farm yard manure, bone meal, fish meal, blood meal, neem cake, groundnut cake can be used.
- Broadcast the manure around every coconut tree base on a 2 meter radius then slightly plough it in to the soil with a fork *jembe*. 
Applying manure (left) and mixing soil with manure (right) after weeding

Table 1. Fertilizer schedules for application in coconut palms of different ages

<table>
<thead>
<tr>
<th>Age of Palm</th>
<th>Nutrient dosage</th>
<th>Amm. Sulphate</th>
<th>Urea</th>
<th>Super Phosphate</th>
<th>Rock Phosphate (single)</th>
<th>Muriate of Potash</th>
</tr>
</thead>
</table>

1. **General Recommendations**
   a. **Average management practices**
      - 3 months 1/10 of full dose: 165 75 95 60 115
      - 1 year 1/3 of full dose: 550 250 320 200 380
      - 2 year 2/3 of full dose: 1100 500 640 400 760
      - 3 years onwards full dose: 1650 750 950 600 1140

   b. **Good management practices**
### Mulching

To improve water retention around the tree base, a layer of mulch can be applied around the plant in various ways.

<table>
<thead>
<tr>
<th>Time</th>
<th>Dose Description</th>
<th>1/10 of Full Dose</th>
<th>1/3 of Full Dose</th>
<th>2/3 of Full Dose</th>
<th>Full Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>1/10 of full dose</td>
<td>250</td>
<td>110</td>
<td>180</td>
<td>115</td>
</tr>
<tr>
<td>1 year</td>
<td>1/3 of full dose</td>
<td>800</td>
<td>360</td>
<td>590</td>
<td>380</td>
</tr>
<tr>
<td>2 year</td>
<td>2/3 of full dose</td>
<td>1675</td>
<td>720</td>
<td>1180</td>
<td>760</td>
</tr>
<tr>
<td>3 year onwards</td>
<td>full dose</td>
<td>2000</td>
<td>1080</td>
<td>1780</td>
<td>1140</td>
</tr>
</tbody>
</table>

### Husk Burial

- Burying fresh or dried coconut husks around the palm is a very beneficial practice particularly for moisture retention especially in drought prone areas.
- The husk can be buried either in linear trenches taken 3 m away from the trunk between rows of palms or in circular trenches taken around the palm at a distance of 2 m from the trunk.
• The trenches may be dug at 0.5 m wide and at the same depth. Place the husks in layers with concave surfaces facing upwards and covered with soil.
• The beneficial effects of husk burial will last for about 5-7 years.

Irrigation
• It is a good practice to provide water to coconut trees in times of dry weather where this is possible.
• Observations have shown that coconut trees reduce flowering during the dry season and flower vigorously in the rainy season.
• Keeping the root zone moist all the time, where such is possible would be a positive way of improving coconut productivity.

Intercropping
This refers to the planting other crops in between coconut trees. Peas, beans, bananas, pineapples, vegetables have been used as interplant crops in Kenya.

Benefits of intercropping:
• Constant income for farmers especially in the young (unproductive) stages of coconut trees
• Where land is scarce the farmers maximizes on the use of available land.
• Cover crops such as sweet potatoes, peas etc. protect soil from erosion.
• Leguminous inter-planted crops (e.g. pigeon peas and beans) fix nitrogen into the soil for the benefit of coconut trees.
• Green manure and post-harvest crop residue improve soil structure and fertility.
• As the farmer weeds for the annual/seasonal crops, the coconut trees are also freed of weeds at no extra costs.

Note: Adopt a wider spacing when intending to intercrop with tree or non-shade plants

Pest and disease management
Coconut pests and diseases are still one of the major factors contributing to low production in coconut plantations. In Kenya, most farms are pest infested and hardly can one find a pest free plantation. It is therefore advisable to know the types of pests and diseases that are of economic importance and their management options.

1. Pests
The table below gives a list of the major coconut pests and their control practices.
| **Rhinoceros Beetle**  
*Oryctes monoceros* | **Coconut mites**  
*Aceria guerreronis* |
|-------------------|-------------------|
| • The pest feeds on unopened fronds, flower buds and the growing part (tip) of the stem  
1. This results in V-shaped notches on leaves, holes on stem, and unopened flowers, stunted growth and death of especially young plants | • The damaged nut and turns brown and scaly, young nuts may fall off.  
• Those that survive are deformed; are small and with a thin layer of meat.  
• Poor quality of husk fibre.  
• Germination of affected nuts is usually low. |
| | • Selection for resistance is the best measure; select seed nuts from trees that are not seriously affected.  
• Proper supply of water reduces the damage.  
• Proper fertility maintenance; some nutrients such as boron boost plant resistance to mites.  
Use of neem based products |
| | • Farm hygiene - burn dead parts of plants  
• scouting  
• Physical removal of adult beetles from leaf bases.  
• Fill affected leaf axils with sand.  
• Chemical spray with Lamdacyhalothrin based chemical around the new leaf axils  
• Use of hooks to kill the beetle |
| | • Use of hooks to kill the beetle |

21
| Correid bug (Pseudotheraptus wayi) | This is an insect that sucks sap from young nuts and even cashew nuts. They can cause damage of 80-90% of the total crop. The nymphs and adults suck young nuts that are 1-5 months old leading to: • Premature nut fall • Badly scarred and gumming nuts • Small nuts with less copra • Poor husk quality Most serious coconut insect pest problem Rampant in East Africa including Kenya | • Red weaver ants “Majimoto” are natural predators. • Encourage predators by intercropping coconut with citrus. • Chemical control: spray on the inflorescence after the receptive phase of the female flowers with an appropriate chemical, e.g. Imidachlorid |
| Termites (*Coptotermes formosanus*)<br>Look for a better photo | Feed on various parts of the crop both in the nursery or field.<br>Young plants may die during germination.<br>Old trees fall off or die, roots having been eaten off. More damage is during the dry season. | Help termite enemies/predators (birds, insect predators) to feed on the insects.<br>Traditional methods for controlling termites - use of repellent plants such as neem seeds and leaves as mulch; ‘Mvuga’ and ‘Mwatsa’ interplanted in the field.<br>Chemicals: Drench soil around the trees, or swab the affected trunk. Murphy ant killer, Thunder, Sulban and Concord have been used successfully.<br>Watering trees well discourages some types of termites.<br>When applying mulch avoid direct contact between mulch and the tree base. |
### Mealybugs

- Mealybug infestations of above-the ground plant parts start with the appearance of crawlers (the first- instar nymphs) on the underside of the leaves on terminal shoots, stems and other plant parts.
- Heavy mealybug attack appears as white, waxy masses of mealybugs on stems, nuts and along the veins on the underside of leaves. Heavy infestations usually result in coating of adjacent stems, leaves and nuts with honeydew and sooty mould.
- Severely infested plants may wilt due to sap depletion; leaves turn yellow, gradually dry and ultimately fall off. Feeding on nuts results in discoloured, bumpy, and scarred nuts, with low market value, or unacceptable for the fresh fruit market.
- Conserve natural enemies. Mealybugs are usually controlled by a wide range of natural enemies.
- However, use of pesticides may kill these natural enemies leading to mealybug outbreaks.

### African palm weevils

**(*Rhynchophorus phoenicis*)**

- Larvae (grubs) penetrate into the living tissues of the palm, feeding on the shoot and young leaves, where the insect completes its development in about 3 months.
- The damaged tissues turn necrotic and decay. Sometimes the grubs feed on the growing point killing the palm. Grubs are whitish-yellow, legless, and oval in shape; their head is reddish brown, and is armed with strong mandibles.
- Fully-grown grubs are 5 cm long. The pupal stage is passed within a cocoon of vegetal debris made by

The primary means of control for African palm weevil is preventative, using cultural and sanitary methods.
The grub at the end of its development. The African palm weevil usually damages young palms, yet may also, in exceptional cases, cause damage to mature crops.

### Coconut Scale

- A number of scales feed on leaves and fruits of coconut palms. The most damaging is the coconut scale.
- Eggs are protected underneath the scale or shell of the mother insect until they hatch. Hatched young scales leave the maternal scale, take up a position and start feeding. They do not move afterwards. They are found mainly on the undersides of the leaves, but frond stalks, flower clusters and young nuts can also be attacked. A severe infestation forms a continuous crust over flower spikes, young nuts and the lower surface of leaves. The leaves become yellow and eventually die. The crown dies leading to collapse of the infested plant. Attacks of young nuts cause shriveling of nuts leading to premature nut falls.
- Mostly young coconut trees of up to 10-15 years are vulnerable to damage.
- Scales may infest palms throughout the year, but damage is usually more severe during the dry season. Neglected plantations are particularly susceptible.

- Conserve natural enemies. They usually keep scales under control. Ladybird beetles and parasitic wasps are particularly effective in controlling the coconut scale.
- Avoid or restrict movement of infested plants in areas where the coconut scale is not a problem, to avoid spread of the scale.
- Destroy infested plants and plant parts. This may help to eradicate scales from new areas. However, this scale is difficult to eradicate due to its wide host range.
- Provide good growing conditions for the palms. Healthy palms in well-drained soils are seldom seriously infested.
Diseases

<table>
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<tr>
<th>Diseases</th>
<th>Symptoms</th>
<th>Management</th>
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| Bole rot \( (\text{Marasmielus infescocophilus}) \) | - The first symptoms which are noticed on 8 or more years old palms are a frond wilt and a crown rot, followed by a primary bole rot.  
- Highest mortality is among seedlings and young palms up to 8 years old. Where the disease occurs sporophores are sometimes common on exposed roots, dead seedlings and the soil surface where diseased palms have been removed.  
- The fungus appears to be a persistent colonizer of coconut debris in the soil.  
- Mycelial cultures from infected bole tissues and from sporophores are highly pathogenic to seedlings, and slowly invade older tissue.  
- \( M. \text{ cocophilus} \) reaches the inner bole tissues only through the roots, as they get wounded during weeding and during uprooting of seedlings in the nurseries. | - Destroy affected trees by burning.  
- International movement of coconut germplasm should follow the technical guidelines recommended by FAO/IBPGR \( (\text{Frison and Putter, 1994}) \). The guidelines state among other things that seed nuts should not be transferred directly from countries in East Africa where \( M. \text{ cocophilus} \) infections are known to occur, to areas not affected by the pathogen.  

**Cultural practices**  
Suggested control measures are:  
(1) selection of seedlings in nurseries and subsequent transplanting should be done as early as possible  
(2) During transportation, handle the seedlings carefully, prune and disinfect damaged roots.  
(3) Avoid obtaining seedlings from affected areas.  
(4) Carry out periodic soil sterilization of nurseries  
(5) Avoid cultivation in between palms, where disease is present. |
<table>
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<tr>
<th>Lethal Yellowing Disease (Phytoplasma)</th>
<th>Bud rot (also called heart rot) caused by the fungus <em>Phytophthora palmivora</em>.</th>
<th>No known control measures.</th>
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<tbody>
<tr>
<td>• Seedlings may become infected through roots damaged during transplanting from nurseries to the field.</td>
<td>• Bud rot (also called heart rot) caused by the fungus <em>Phytophthora palmivora</em>.</td>
<td>• Use genetically resistant ecotypes (&quot;Malayan Yellow Dwarf&quot;) and hybrids (&quot;Malayan Yellow Dwarf&quot; x &quot;Panama Tall&quot;). This is the only practical long-term solution to lethal yellowing.</td>
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<td>• Premature nut fall, starting with the oldest nuts.</td>
<td>• The fungus enters into the plant by infecting tender host tissues (leaves, buds or young nuts).</td>
<td>• Avoid movement of planting materials from affected areas, and cut down and destroy affected trees.</td>
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<td>• Blackening of youngest opened inflorescence after nut fall.</td>
<td>• Affected leaves turn yellow and later brown.</td>
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<td>• Yellowing of the old leaves rapidly spreading upwards.</td>
<td>• The heart leaf becomes chlorotic, wilts and collapses.</td>
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<td>• Affected leaves often hang down forming a skirt around the trunk for several days before falling.</td>
<td>• The disease may spread to older, adjacent leaves</td>
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<td>• Death of the plant</td>
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<tr>
<td>Bud rot (<em>Phytophthora palmivora</em>)</td>
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<td>• Remove and destroy infected debris and infected coconut trees. This helps to reduce spread.</td>
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<td>• Do not irrigate nurseries at dusk or at night to avoid prolonged periods of free moisture.</td>
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<td>• Plant resistant varieties. Malaysian dwarf varieties, such as &quot;Malayan Yellow Dwarf&quot;, &quot;Bali&quot; &quot;Tall&quot;, &quot;Malayan Yellow Dwarf&quot; x &quot;Palu Tall&quot; hybrids, and other varieties originating in South-East Asia, show resistance.</td>
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and spathes, producing a dead centre with a portion of living leaves. 
- Light brown to yellow, oily, sunken lesions may be found on leaf bases, stipules or pinnae. 
- Internally, the tissues beneath the bud are discolored pink to purple with a dark brown border. 
- Affected leaves progressively drop. 
- Infected nuts show brown to black necrotic areas with a yellow border developing on the surface; internally, they have a mottled appearance. 
- Young nuts are highly susceptible and fail to mature, they then fall off the tree; older infected nuts ripen normally.

## Harvesting and storage

### Harvesting methods
- Climbing
- Power tiller operated ladder
- Climbing cycle / equipment
- Use of trained monkeys

### How the harvesting is done
- Harvesting of coconuts is commonly done by climbing the tree with the help of a rope ring round the feet or ankles of the climber or by using a ladder.
- On reaching the top, the climber taps the nut in the lowermost bunch with its harvesting knife to test its maturity.
- If satisfied, the bunch is cut at the base of the stalk where it drops down to the ground.
• If the ground is very hard or if tender nuts are to be harvested, the bunches are lowered by using a rope. The climber also cleans the crown and removes the dry leaves, sheaths and spathes.
• In the West Coast and certain areas where coconut leaves are required for thatching houses, one or two lowermost leaves are also cut down at the time of harvest.
• The cutting down of green leaves is not recommended as it affects the yield of trees to some extent.
• In some places where the trees are not tall, harvesting is done by cutting the bunches with a knife, attached to a long bamboo pole.
• Nuts which are to be stored for making copra should not be harvested until they are completely mature and dry.

Yields
• Average yield: 30 – 80 nuts/palm/year depending on the variety.
• Dwarf varieties-40 – 60 nuts/palm/year
• Tall varieties -30 – 80 nuts/palm/year
• Hybrid varieties – 200 – 300 nuts/palm/year

f) Postharvest handling
• Harvested nuts should be kept with their husks intact under shade conditions. This will increase their shelf life to a maximum period of six months.
• Dehusking of nuts should be done using either a pointed iron bar or a strong and pointed stick (5 cm diameter). The use of a panga may damage the shell.
• Dehusked nuts should not be exposed to sunlight as the shells will crack causing quality deterioration.
• Harvested tender nuts should be carefully handled during transportation and stored in cool and dry places under shade to increase their shelf life.

Value addition and marketing
There are five main primary products from the coconut tree at farm level: nuts, *madafu*, wine, makuti/makanja, and coco-wood from dead/unproductive trees. The modern coconut farmer needs to establish a marketing channel for all these, with an aim of maximizing profits. As much as possible, farmers are encouraged to value add their primary produce in order to enhance their profits. Sample value addition activities include utilization of coconut fronds (*makanja*) to make *makuti* and brooms, making of copra from nuts, virgin coconut oil from fresh nuts, husk fibre and ropes from husks, and coco-honey from fresh wine.

With regards to marketing, it is recommended that all coconut products be marketed through farmer groups and cooperatives. This gives farmers a stronger bargaining power by minimizing middlemen, and also enables the linking of buyers with farmer groups through contractual arrangements. All farmers are therefore encouraged to either form and register, or join such common interest groups and participate actively in their management.

References


Ferguson, John. (1898). All about the "coconut palm" (Cocos nucifera) (2nd edition).


Rachel, Assa Rebecca; Konan Konan Jean-Louis; Prades Alexia; Nemlin Jean; Koffi Ernest. 2010. Physicochemical characteristics of kernel during fruit maturation of four coconut cultivars (Cocos nucifera L.)