USAID
FROM THE AMERICAN PEOPLE

CBL
Group

Coconut Cultivation HANDBOOK

Revitalization of Coconut Industry Through Climate- Smart Agriculture Technologies

COCONUT CULTIVATION

HANDBOOK

By

W.M.Ratnayake

Published By

Revitalization of Coconut Industry Through
Climate Smart Agriculture Technologies

Cartoons, Illustrations & Designed By

Center for Development Communication
www.cdcsl.lk

December 2024

From the Author

Coconut, Sri Lanka's largest plantation crop, holds a vital place in the country's economy. Approximately 70% of the nation's coconut production is consumed domestically, making it a staple in the local diet, second only to rice in calorie contribution. Beyond its nutritional value, the coconut palm plays a significant role in Sri Lankan culture and contributes over USD 800 million annually in foreign exchange through the export of coconut and coconut-based value-added products.

Despite an annual harvest of approximately 3 billion coconuts from the total cultivation area of 440,454 hectares, production remains insufficient to meet domestic consumption and support the industrial sector at full capacity. To address this shortfall, domestic production must increase significantly, with an annual target of at least 4.5 billion nuts.

Achieving this goal presents several challenges, including the adverse impacts of climate change, soil degradation in established coconut-growing regions, and the rising costs of inputs essential for cultivation. To overcome these obstacles, productivity must be enhanced in the traditional Coconut Triangle while promoting sustainable expansion in the Northern and Eastern provinces, where coconut cultivation is growing. Adopting climate-resilient practices and maintaining efficient plantation management are critical steps toward this goal.

This handbook has been developed to support coconut growers in implementing effective agricultural practices. It is based on the recommendations of the Coconut Research Institute and serves as a comprehensive guide to establishing and maintaining productive coconut plantations. Whether you are a seasoned grower or new to the field, this handbook provides actionable insights to help improve yields and ensure the sustainability of coconut cultivation.

W. M. Ratnayake
Technical Advisor
Project of Revitalization of Coconut Industry Through
Climate Smart Agriculture Technologies

Message from CBL Global Foods Ltd

It is estimated that Sri Lanka needs 4500 million nuts annually for domestic requirement and smooth operation of the coconut industry, while current annual production is around 3000 million nuts. Annual average coconut yield of Sri Lanka is about 3000 million nuts while annual yield potential is 12,000-15,000/ha.

Over the year's coconut yields have declined and water stress, poor fertility management, and increased air temperature due to climate change are considered main contributors. CBL Global Foods Ltd has identified a technology package with drip irrigation solutions, balanced nutrition program and intercropping systems to address the law productivity in coconut sector. With irrigation systems and balanced nutrition programs coconut yields can be increased up to 30% within a year and company expects to increase the productivity up to 100 nuts per tree (15,000 nuts/Ha) within three years by working with small, medium and large-scale coconut growers.

This handbook is developed by compiling best practices in coconut cultivation and management with recommendations of Coconut Research Institute and Coconut Cultivation Board along with experiences of the author by engaging in coconut industry for many years. Coconut growers, estate managers and any other interested parties will be able to use this handbook as a guiding in planning and management of the coconut cultivation. We wish to express our gratitude to USAID for financial assistance in developing and releasing this handbook in all three languages, Sinhala, Tamil and English.

CONTENT

Coconut Palm and

The coconut palm (Botanical Name : *Cocos nuciferaL.*) is a multipurpose perennial of the tropics belongs to the palm family (Arecaceae) and has a lifetime of 60-70 years. The growth and yield fluctuate according to the weather conditions and soil suitability of the growing area

Coconut leaves and the crown

A grown tree has 14-35 leaves.
Produces a leaf monthly.
A leafis 4-6 m in length (Depending on age and the cultivar)
One terminal growth point produce leaves
Leaf production is faster during vegetative stage
Becomes stable in elder stage
About 12-14 leaves are produced annually and their axes bear leaflets.

Soil condition for coconut cultivation

Soil: **A well-draining, deep, sandy loam (shallow and heavily clay soil is inappropriate) pH value : 5.5 – 7.5**

Flowers : The inflorescence is a spadix containing both male and female flowers. Female flowers per inflorescence varies 10-50. 50-70 % female flowers fall off and balance develop into nut that mature within 11-12 months.
Dwarf palms carry higher number of female flowers. Male flowers are numerous on spike. Generally, in dwarf verities male and female phases are overlapping

Environmental Conditions

The Stem

Stem grows straight up for about 10-25 m.
Similar to a cylindrical pillar.
Generally, no branching like other trees.
Stem get started to develop after 4-5 years of planting.
Base gets wider unusuall manner and stem develops on the base.
Swollen base or bole not found in dwarf varieties.
Matured leaves fall making leaf scars on stem while new leaves are formed.

Root system

Fibrous root system begins from the main trunk.
About 1500-8000 roots with a uniform thickness.
Most of the roots are centric from a radius of 1-2 m.
No root hairs.
Every root bears a root tip.
Active absorption area is just behind the root tip.
Resist high salinity.
Number of roots and the root length vary upon soil type and varity.

Environmental factors affecting growth

A well-distributed rainfall throughout the year (not less than 1500 mm)
Dry period should be less than 2 months.
Temperature around 27-30 $^{\circ}$C
Temperature difference between day and night and shall be less than 5 $^{\circ}$C
Relative humidity 80-90 %.
Essential to have sunlight well.

1

Establishing a Successful Coconut Cultivation

When starting a new cultivation, it is important to consider the planting distance, selection of a variety appropriate to the relevant weather and soil conditions, as coconut is a perennial crop which expected to be productive over 60 years if it managed well under recomended cultivation techniques. Accordingly, can expect a uniform growth and a higher production.

1.1. Recommended coconut varieties for planting

It is important to select the most suitable variety appropriate to the growing area as coconut is a perennial crop which offers economical advantages for a long period. The, Coconut Research Institute (CRI) has released following varieties.

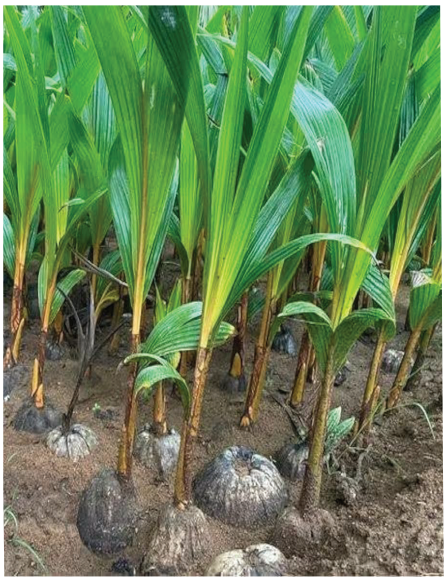
- Tall x Tall (C.R.I.C.60) – TT
- Dwarf x Tall (C.R.I.C.65) – DT
- Tall x San Ramon (C.R.I.C.S.L.98) – CRICSL 98
- Dwarf Green x San Ramon (C.R.I.C.S.L.2004) – DGSR Kapruwana
- Dwarf Brown x Tall (C.R.I.C.S.L.2012) – DBXT Kapsuwaya
- Dwarf Brown x San Ramon (C.R.I.C.S.L.2013) – DBSR Kapsetha
- Malayan Rathu Kundira x Tall (C.R.I.S.L.2020)
- Moorock Tall
- Plus Palm seedling (mother palm and plus palm) - PP

1.2. Types of coconut plants

When starting a cultivation, it is inappropriate to plant coconut seed nuts directly in planting holes as it is important to select most appropriate and healthy plants. Two types of coconut plants can be obtained from the nursery according to the method of raising seedlings in the nursery.

1.3. Bareroot seedlings

Coconut seed nuts are planted in nursery beds for about 7 months and released as healthy and strong coconut plants for cultivation.



1.4. Poly bagged seedlings

Coconut seed nuts are planted in pre nursery and later transpalnted into poly bags filled with a potting mixture, once seedlings get a height of 5-10 cm. After 4 months old, the plants are released to cultivation.

In this method, plants are not dying due to no damages to roots. Furthermore, plants can achieve a fast growth and thereby possible to establish a uniform coconut cultivation. These potted plants are highly resisting to drought conditions and also can keep for a shorter period before planting, untill appropriate environmental conditions are gained.

Check the following features when choosing a coconut seedling.

- Stout stem (collar region of seedling)
- Dark green leaves
- Broad leaves
- Short petioles
- Convex leaf surface
- Cosisting of 4-5 leaves
- Sharp ridges of leaves
- Free of pests and diseases
- More number of roots

1.5. Recommended planting densities

Based on the findings from long term experiments, the recommended planting density is 158 plants per hectare equal to 64 plants per acre.

1.6. Planting according to square method

The suitable method for a sole coconut cultivation and recommended planting distance is 26 ft (7.8 m). This distance must be maintained to ensure optimal growth as it prevents competitive interactions among coconut plants for sunlight.

Planting distance		Number of plants	
Feet	Meter	Per acre	Per Hectare
26 x 26	7.8 x 7.8	64	158

1.7 Wide-row method

When planning perennial intercrops which need more space such as Mango, Rambutan, Cashew etc. following planting distance shall be followed.

Planting distance		Number of plants	
Feet	Meter	Per acre	Per Hectare
26 x 32	7.8 x 9.6	52	128

1.8. Special Wide-row method

These distances are recommended when tea and sugar cane are main crops. Coconut is intercropped to provided additional income.

Planting distance		Number of plants	
Feet	Meter	Per acre	Per Hectare
26 x 40	7.8 x 12	42	102

1.9. Field marking (Lining in the field)

For a regular cultivation, once the planting distance is decided, the next step is to mark the planting holes. Planting holes should be marked in every direction of the field, by using a marked rope with the support of a measuring tape. For this, pegs of 1.5 – 2 ft (according to the number of plants), crow bar and a wooden mallet are needed.

Step – 01
About 13 ft from the boundary (to inside) mark the base line using a rope.

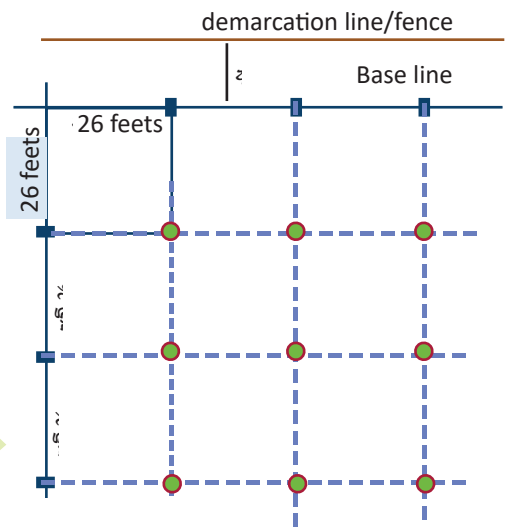
Step – 02
Mark using pegs considering the planting distance on the base line.

Step - 03
Mark a perpendicular line from a peg point on the base line. Use a measuring tape for this purpose.

Step - 04
From the base line, mark points using pegs on the perpendicular line considering the other planting distance.

Step - 05
As illustrated by the figure, mark planting holes from start to the end on the base line and on the perpendicular line.

Step - 06
Dig holes as the pegs are in the middle.



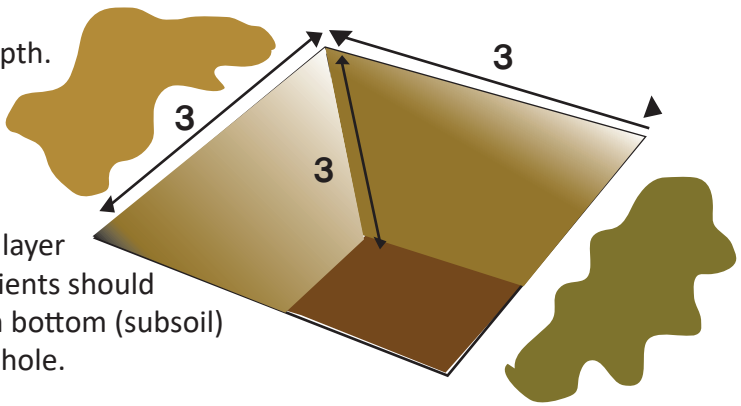
vertical line

Planting according to square method

1.10 Planting

• Establishing a new coconut cultivation in a land where no coconut cultivation is already exist known as a 'new cultivation' . Planting new coconut seedlings by removing an old plantation when its productivity lowers due to aging is known as 're-planting'. Planting in between existing rows of an old plantation and gradually removing old plants within 5-6 years period is known as 'under-planting'. Planting seedlings in an appropriate place in the home garden is known as ' home gardening of coconut'.

• If the planting land is an ideal place for a coconut cultivation with a sandy loam soil, the planting hole should be
3 x 3 x 3 ft in length, width and depth.
If the soil is hard with gravel, the planting hole should be 4 x 4 x 4 ft in length, width and depth.



• When digging the hole, the top layer soil with organic matters and nutrients should be put in one side while the soil in bottom (subsoil) should be put in other side of the hole.

• Spread a layer of coconut husks in the bottom, with fibrous side upward. Then spread a thin layer of top soil on that. Again, spread the second layer of coconut husks as before and fill the hole with top soil removed first during digging the hole. In general, around 30-35 coconut husks are needed for a hole.

• To fill the rest of the hole, the remained sub soil with low fertility should be made fertile. For that, both chemical and organic fertilizers can be used. A 10 kg of organic fertilizer in forms of cow dung /compost/chicken manure is adequate while 5 kg of goat or 5kg of wood ash is adequate.

Chemical fertilizer is recommended as the basic fertilizer and for this fertilizer mixture or straight fertilizer with dolomite shall be used. According to the area where your cultivating land is located, use the amount of fertilizer needed as given in the table below

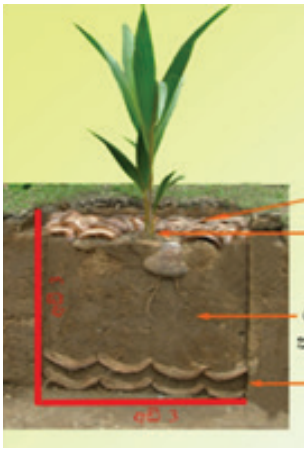
For Wet and Intermediate zones		For Dry zone	
Type of fertilizer	Amount	Type of fertilizer	Amount (kg)
Urea	250	Urea	250
Eppawala Rockphosphate	750	Triple Super Phosphate	350
Murate of Potash	250	Murate of Potash	250
Dolomite	1000	Dolomite	1000

If fertilizer mixtures are used for your convenience, use mixtures for relevant climate zone where your cultivating land is located, as given in the table below.

For Wet and Intermediate zones		For Dry zone	
Type of fertilizer	Amount	Type of fertilizer	Amount (kg)
Young Palm Mixture (YPMW)	1250	Young Palm Mixture (YPMD)	850
Dolomite	1000	Dolomite	1000

- Mix the aforementioned chemical and organic fertilizer amounts with the subsoil and fill the planting hole leaving a gap of 15 cm (6 inches) from the ground level. If the land is prone to water stagnation, it is recommended to fill the hole up to the ground level.

- Planting can be done according to 'Yala' and 'Maha' seasons and it is recommended to start planting when the rain begins. If the land is prone to water stagnation, it is recommended to start planting towards the end of the rainfall season.

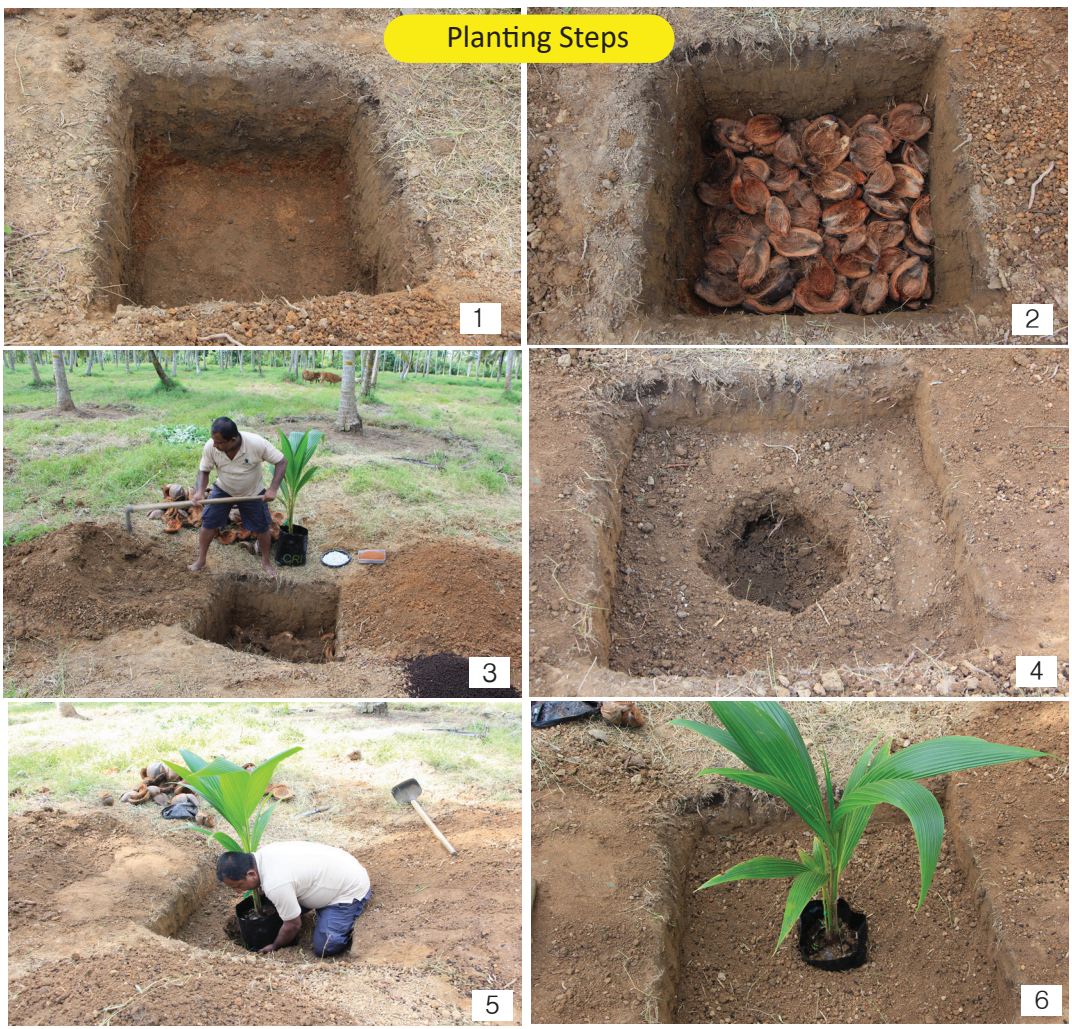


- If bare root seedlings are used, at first, old roots should be cut-off followed by immersing in a solution of insecticide as a remedy for termite attacks. It is recommended to dissolve 1-2 ml of an appropriate insecticide in 1 l of water and immerse the plants for about 3 minutes in it. When planting, plant the crop exactly in the middle of the planting hole.

.

• After planting, mulch using coconut husks, pieces of coconut branches, straw etc. for moisture conservation around the plant and for weed control. If a potted plant is used, take care to remove the bag/pot in a way not damaging the root system. For this, at first, carefully remove the bottom of the polythene pot by cutting and then remove soil in the mid of the hole adequately to place the plant. Then place the plant carefully and remove the polythene pot.

• Apply the insecticide solution used for bare root seedlings to prevent termite attacks, to moist the root areas.

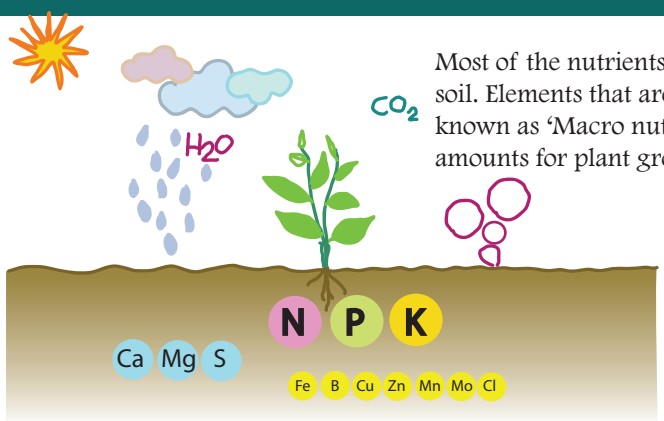


Steps of planting the potted-plants

Applying insecticide solutions to prevent termite attacks and watering after planting.

2

Fertility management & soil suitability for coconut cultivation



Most of the nutrients essential for plant growth are obtained from the soil. Elements that are needed in more amounts for plant growth are known as 'Macro nutrients and elements that are needed in micro amounts for plant growth are known as 'Micro nutrients.

Macro nutrients	Micro nutrients
C, H, O,	Fe, B, Cu,
N, P, K ,	Zn, Mn, Mo,
Ca, Mg, S	Cl, CO

- These essential nutrients are inadequate in most of the coconut growing areas. In addition, when coconut leaves, husks, and coconut spathe are removed from the land, adding nutrients into the soil by degradation of them is disturbed. Hence, supplying nutrients to soil adequately, as a remedy can be known as 'fertilizer application'.

- The nutrient requirements of a coconut palm vary according to its growth stage. In this basis , fertilizer recommendations for different stages have been introduced by the Coconut Research Institute (CRI). For this type of fertilizer application, recommended chemical or organic sources can be used.

2.1. Types of chemical fertilizer and time of application

- Chemical fertilizers are recommended as straight fertilizers or mixtures. You can choose a method at your convenience.
- Fertilizer recommendations are given according to different climate zones (wet, dry and intermediate zones). Fertilizers are normally applied when the soil is wet and after heavy rains end. This facilitates reduction of washing away of applied fertilizers.

When you are buying fertilizer, YPM* fertilizer is the recommended mixture for young plants and APM* fertilizer is recommended for bearing adult palms. Also, select the type of fertilizer according to the location of your land as the source of fertilizer vary according to climatic zone, when applying the nutrient "P" (Phosphorous). It is necessary to apply fertilizer once in six months for young palms and once a year for bearing adult palms.

* YPM : Young Palm Mixture, APM : Adult Palm Mixture

2.2 Soil suitability for coconut cultivation

Soil factors are very important like environmental factors for a successful coconut cultivation. When selecting a land for a coconut cultivation, it is important to search about suitability of soil as well. To fulfill this requirement, a land suitability classification is introduced for coconut farmers. Accordingly, it will provide a guidance for selecting a land for coconut cultivation and maintaining cultivation in that land. Coconut Research Institute has introduced 5 suitable classes and 2 non-suitable soil classes for coconut cultivation.

Suitability Class		Limiting factors	Management	Number of nuts for a year per hectare
S1	Highly suitable	No significant limiting factors	Growing cover crops. Maintaining a mulch in the manure circle Applying fertilizer regularly	15,000 or more
S2	Highly suitable to suitable	Nutrients and moisture may be limiting slightly	Adding organic matters to soil other than aforementioned factors.	12,500 – 15,000
S3	Suitable	Moisture may be limiting in short-term	Adding coconut husks filled holes other than aforementioned factors.	10,000 – 12,500
S4	Moderately suitable	Significant limiting factors are there. no soil aeration/water stagnating lands/lands subjecting to soil erosion	Adding contour drains other than aforementioned factors.	5,000 – 10,000
S5	Marginally suitable	All aforementioned factors are limited.	For lands with weak water draining, planting according to Ridge & Farrow method	2,500 – 5,000
N1	Temporarily non-suitable	Moisture and nutrients are strictly limiting factors. Aeration is also limited. Slopy lands with high salinity.	Altering the basic structure and developing the land.	Less than 2,500
N2	Permanently non-suitable	Not technically suitable for a coconut cultivation		

2.3. Basal dressing per plant at planting

Eppawala Rock Phosphate (ERP) is recommended for wet and intermediate zones. Triple Sper phosphate is recommended for the dry zone.

When buying fertilizer mixtures, it is recommended YPM-W for young plants in wet and intermediate zones and APM-W for bearing adult palms. If the land is in dry zone, select YPM-D for young palms and APM-D for bearing adult palms.

	Climatic zone	Source of fertilizer	Amount
Organic coconut cultivation	Any zone	Cow dung/chicken manure/compost	20 kg
		Or	
		Goat manure	15 kg
		Eppawala Rock Phosphate (ERP)	1 kg
		Dolomite	1 kg
Conventional coconut cultivation	Wet and Intermediate zone	Subsoil	
		Cow dung/chicken manure/compost	10 kg
		Or	
		Goat manure	5 kg
		with	
		Urea	250 g
		Eppawala Rock Phosphate (ERP)	750 g
		Dolomite	1 kg
		Or	
		YPM-W	1250 g
		Dolomite	1 kg
	Dry zone	Subsoil	
		Cow dung/chicken manure/compost	10 kg
		Or	
		Goat manure	5 kg
		with	
		Urea	250 g
		Triple Super Phosphate	350 g
		Muriate of Potash	250 g
		Dolomite	1 kg
		Or	
		YPM-D	850 g
		Dolomite	1 kg

Straight fertilizers that can be used for coconut cultivation should be used according to the age of the plant. Following table depicts the relevant amounts of non-mixed fertilizer that can be used for coconut cultivations of different ages in different climatic zones.

Climatic zone	Source of fertilizer	For a year according to the plant age					
		6 months	1-1.5 years	2-2.5 years	3-3.5 years	Until fruits bear	Fruit bearing cultivation
		Amount (g)					
Wet and Intermediate zones	Urea	190	225	305	375	470	800
	Eppawala Rock Phosphate	420	530	690	850	1060	900
	Muriate of Potash	190	235	305	375	470	1600
	Dolomite	500	500	500	500	500	1000
Dry Zone	Urea	190	235	305	375	470	800
	Triple Super Phosphate	160	200	300	360	400	400
	Muriate of Potash	190	235	305	375	470	1600
	Dolomite	500	500	500	500	500	1000
Wet and Intermediate zones	YPM-W young plant fertilizer mixture	800 g	1 kg	300 g	1600 g	2 kg	
	APM-W adult tree fertilizer mixture						3.3 kg
	Dolomite	500 g	500 g	500 g	500 g	500 g	1 kg
Dry zone	YPM-D young plant fertilizer mixture	540 g	670 g	910 g	1110 g	1340 g	
	APM-D adult tree fertilizer mixture						2.8 kg
	Dolomite	500 g	500 g	500 g	500 g	500 g	1 kg

2.4. Method of fertilizer application for young palms

- The size of the manure circle differs based on the age of the plant. Accordingly, the amount of fertilizer needed to apply based on the age should be broad cast and incorporate into the soil within the manure circle
- Use a mamoty or fork in a way to mix well with the soil.
- Mulch the manure circle using the coconut leaves, husks etc

Plant age	Size of the fertilizer curve
6 months	30 cm (1 ft)
1 year	60 cm (2 ft)
2 years	90 cm (3 ft)
3 years	120 cm (4 ft)
4 th year	150 cm (5 ft)
bearing palm	180 cm (6 ft)

1 Triple Super Phosphate (TSP)
2 Muriate of Potash (MOP)
3 Dolomite
4 Urea
5 Eppawala Rock Phosphate (ERP)

2.5. Fertilizer application at planting

Both organic & chemical fertilizers as given in table

Dig the planting hole

Add fertilizer to the soil (accumulating during digging the planting hole).

Mix fertilizer and dolomite with soil well

Add the mixture into the hole and fill it.

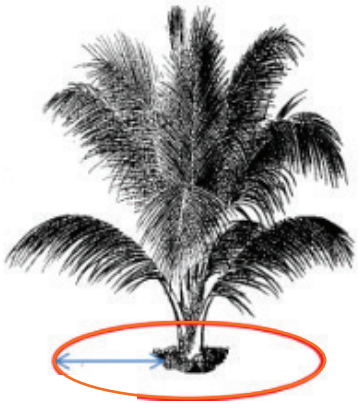
At Planting (6 months)

1 feet

1-1.5 years

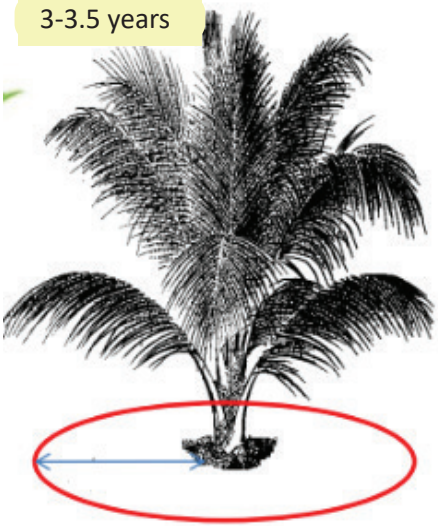
2 feet

2-2.5 years



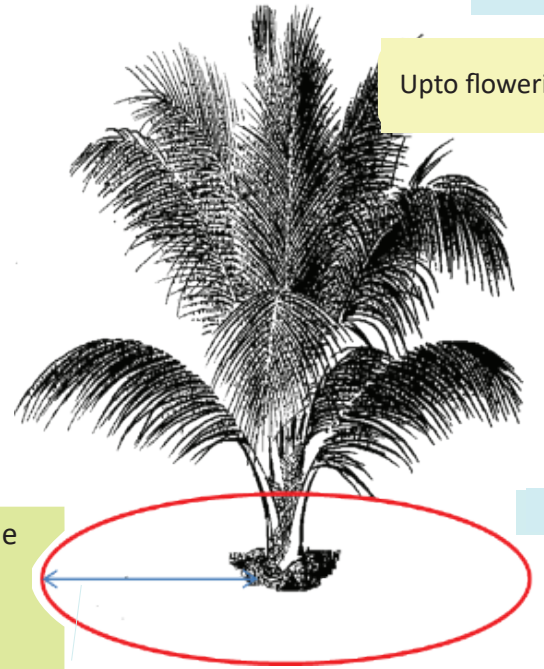
2 feet

3-3.5 years



4 feet

Upto flowering (4 yrs)



5 feet

- According to age of plant, spread the amount of fertilizer evenly in the manure circle
- Mix well with the soil
- Mulch the manure circle

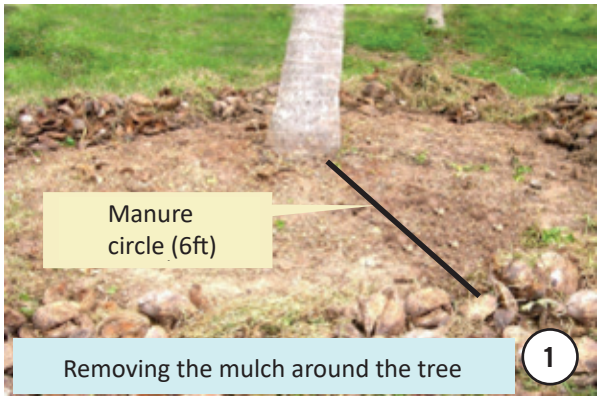
Steps of applying chemical and organic fertilizer

Removing the mulch around the plant

Spread the required amount of fertilizer

Mixing the fertilizer with soil.

Steps of applying fertilizer for bearing palms



- For hybrid / improved and high yielding varieties (Palms yielding more than 75 nuts in a year), apply 1.5 times of fertilizer as recommended above

We can get an idea about current status of the macro and micro nutrients required by the tree for a healthy growth and a maximum productivity, by conducting a soil experiment or a leaf analysis. Accordingly, can calculate the correct amount of fertilizer to be used during deficiencies.

2.6. Applying organic fertilizer

By applying organic fertilizer, it supports for the palm to get main elements and as well as minor elements and improves the fertility of soil by enhancing physical, chemical and biological (functionality of soil microbes) properties of soil. Furthermore, adding organic matter to soil can increase soil aeration gradually leading to develop a sound soil structure making the soil loosen. Heightened levels of organic matter support in increased capacity of water and nutrients holding by the soil.

2.7. Types of organic fertilizer

Fertilizer of animal origin

The prevalence of this type of fertilizer vary based on the location. For coconut cultivation, poultry manure, cow dung and goat fertilizer can be used.

Fertilizer of plant origin

For this purpose, can use Gliricidia, wild sunflower, Indian Ciral tree (Erabadu) etc. which can be easily grown in any part of Sri Lanka.

Compost

The quality of compost depends on the amount of nutrients it contains and, this vary based on the type of raw material used for preparation. A compost of high quality can be obtained, If considerably high amounts of manure of animal origin is used in addition to plant parts. Minerals obtained from mining such as Dolomite, Rock Phosphate and Potassium Sulphate can be introduced as “Organic Nutritional Sources”.

2.10. Method of applying organic fertilizer

When applying for plants, add fertilizer around the plant (until 1.5 years) within one foot from the base of the plant. Add chemical fertilizers also spreading around the plant by mixing with soil. Then mulch using any type of degradable items such as coconut husks or leaves. While aging, when starts flowering the manure circle should be widened for about 5 ft. For well-grown trees also, organic fertilizer and additional chemical fertilizers should be spread and mix up with soil within 6 ft range from the base of the plant and then it should be mulched.

Applying Gliricidia as an organic manure in the manure circle.

Adding chemical fertilizers additionally

As the nutrients released from common organic fertilizer used in Sri Lanka, is inadequate in fulfilling annul fertilizer demand, additionally, some amounts of chemical fertilizers have to be added.
For an organically certified cultivation, these additional nutritional requirements are fulfilled by minerals obtained by mining. (i.e. To fulfill K requirements, K2SO4 is used).

2.8. Integrated Nutritional Management and advantages

Fulfilling half of the recommended amount of fertilizer from organic fertilizers and the other half from chemical fertilizer is known as an "Integrated Nutritional Management".
Soil quality & fertility is improved due to improved soil characteristics by adding organic matters. Direct addition of the elements such as N,P, K and Mg which are essential for the growth of the plants. Addition of secondary and micro nutrients to the soil occures with the use of organic fertilizers.

2.9. Recommended ways of integrated fertilizer usage

Annual fertilizer demand of a well-grown palm according to Integrated Nutritional management

When using cattle manure (moisture 20 – 30 %)

Type of fertilizer	Amounts needed per year
Cattle manure	15 kg
Urea	400 g
Eppawala Rock Phosphate (Wet Intermediate zone)	450 g
Triple super phosphate (Dry zone)	200 g
Murate of Potash	1400 g
Dolomite	500 g

When using goat manure (moisture 20-30 %)

Type of fertilizer	Amounts needed per year
Goat manure	12 kg
Urea	400 g
Eppawala Rock Phosphate (Wet Intermediate zone)	450 g
Triple super phosphate (Dry zone)	200 g
Murate of Potash	1200 g
Dolomite	500 g

When using poultry manure (moisture 20-30 %)

Type of fertilizer	Amounts needed per year
poultry manure	12 kg
Urea	400 g
Eppawala Rock Phosphate (Wet Intermediate zone)	450 g
Triple super phosphate (Dry zone)	200 g
Murate of Potash	1175 g
Dolomite	500 g

When using Gliricidia (moisture 50-60%)

Type of fertilizer	Amounts needed per year
Gliricidia	25 kg
Urea	400 g
Eppawala Rock Phosphate (Wet Intermediate zone)	750 g
Triple super phosphate (Dry zone)	350 g
Murate of Potash	1300 g
Dolomite	750 g

However, when applying organic fertilizer for coconut bearing trees, dig a 3 ft width and 0.5 ft depth drain at 3 ft from the base of the tree. Then add organic and chemical fertilizer, mix them up and mulch. It is important to apply fertilizer when the soil is moisture or at the beginning of rainy season.

01 – Prepared manure circle
02 – Apply organic fertilizer
03 – Add additional chemical fertilizers
04 – Mixing
05 - Mulching

3

Production of Organic Fertilizer, Usage and Sustainable Management of Coconut Cultivation

- Applying fertilizer only doesn't support soil productivity,
- Fertilizers are expensive and harmful for the environment.
- It is essential to apply organic fertilizer to get a overall fertility.
- It is important to use Good Agricultural Practices (GAP) in managing soil in the land.
- Contour ridges, drains, cultivation of covering crops, intercropping, burying coconut husks, mulching using coconut leaves etc. improve environment of the soil microbes.
- For this, to produce organic fertilizer for self-use, it is easy to follow animal husbandry and intercropping within the same coconut cultivation.

Substances that are gained from soil depositions, and raw materials of plant or animal origin, that were subjected to degradation and can release plant nutrients are generally known as "Örganic fertilizer".

Different types of organic fertilizer

Substances obtained from natural depositions (Dolomite, Rock Phosphate etc.)

Dead matters of animal (Cow, Goat and Chicken manure)

Green Manure Plants

Why the organic matter in coconut lands decreases ?

Weeds use the organic matters in competitive way with coconut trees

Removal of coconut husks, leaves and branches from the land leads to minimum addition of organic matter to soil.

Fast degradation of existing organic matters due to direct exposure to sunlight

Washing away of organic matter from soil due to erosion

Extra plant materials are not added to the soil as most of the coconut cultivations solely bear coconuts only

Do you know the impact of decreasing the soil fertility in coconut lands?

May reduce the yield upto less than 40 nuts per tree.

Small fruits are formed with thin kernels.

Will be highly sensitive for diseases, pest attacks and nutrient deficiencies.

Hence, it is essential to add organic fertilizer to the soil in coconut lands to maintain it as a land of well bearing coconut cultivation to get sustainable yield

3.1. Properties improved by adding organic fertilizer

Physical properties

- Soil moisture : Increases the water-holding capacity of the soil
- Improves soil structure: amount of sand, clay and silt
- Improves soil aeration
- Improves color, depth and nutrients holding capacity.
- Reduces soil erosion

Chemical properties

- Can maintain the soil pH at an optimum level (condition of soil reaction)
- Increases the capacity of cation exchange (the ability of retaining nutrients)
- Increases the availability of nutrients such as N and P.
- Receives minor nutrients regularly.

Biological properties

- Increases the microbial density, growth and activity
- Increases the activity of macro-organisms (i.e. earth worms)
- Increases the suppression of diseases caused in roots.

3.2. Methods of supplying organic fertilizer

- By buying recommended/certified organic fertilizers from the market.
- In-situ organic manure production
- From properly degraded agricultural wastes.

3.3. Advantages of organic fertilizer use

By applying organic fertilizer, it supports for the pant to get main elements and as well as minor elements and improves the fertility of soil by enhancing physical, chemical and biological (functionality of soil microbes) properties of soil. Furthermore, this adds organic matter to soil and increase soil aeration gradually leading to develop a sound soil structure making the soil loosen. Heightened levels of organic matter support in increased capacity of water and nutrients holding by the soil.

3.4. Sources of organic fertilizer

Animal origin

The prevalence of this type of fertilizer vary based on the location. For coconut cultivation, poultry manure, cattle manure and goat manure can be used.

Plant origin

For this purpose, can use Gliricidia, wild sunflower, Indian Ciral tree (Erabadu) etc. which can be easily grown in any part of Sri Lanka.

Compost

The quality of compost depends on the amount of nutrients it contains and, this vary based on the type of raw material used for preparation. A compost of high quality can be obtained, If considerably high amounts of fertilizer of animal origin is used in addition to plant parts. Minerals obtained from mining such as Dolomite, Rock Phosphate and Potassium Sulphate can be introduced as “Organic Nutritional Sources”.

Organic fertilizers that can be prepared in the land

Green manure

Compost

Earthworm compost

Green manure

Green leaves and tender stems of plants that are fastly degrading can be introduced green manure.

Green manure that can be used as organic fertilizer

High yielding plants that grow fast after pruning.
Legumes that are having low C:N ratio (lower ratio of C:N means that there are high mount of Nitrogen. Such plants degrade easily.

Type of plants	Nutrients in % (relative to dried weight)			
	N	P	K	C:N ratio
Gliricidia	4.2	0.3	2.1	12
Erabadu	4	0.3	2.4	14
Wild sunflower	4.7	0.4	3.2	14
Gansuriya	3.4	0.3	2.2	14
Sunhemp	2.9	0.3	0.7	16

Glyricidia, Wild sunflower and Pureria can be grown in bitween rows of coconuts. Tptal “N/Nitrogen” requirement for a nut bearing coconut tree can be fulfilled by applying 30 kg of leaves of Glyricidia.

3.6 Growing Sun hemp as green manure crop

Around 20-25 kg of Sun hemp seeds are needed per one acre to cultivate as a green manure crop. After 10-12 weeks after cultivating plant materials should be bury under soil.

From this cultivation, worms can be controlled in root nodules. The amount of nutrients added to the soil by a Sunhemp cultivation in one acre is shown below.

Dried substances (kg)	Nitrogen (kg)	Phosphorous (kg)	Potassium (kg)
3000	54	18	36

3.7. Compost fertilizer

Organic substances that can be used for making compost fertilizer in coconut lands are listed below.

- Coconut branches
- Coconut husks
- Gliricidia leaves
- Wild sunflower
- Japan Jabara
- Weed fertilizer
- Crop waste
- Poultry manure
- Cow dung fertilizer
- Goat fertilizer

Refer extra reading “01” in this handbook for guidelines of making compost

- The optimum moisture level of raw materials should be around 50-60%
- Water supplying can be minimized by using green colored leaves.

3.8. Use of bio-charcoal to increase " C" levels of soil

Bio char is a substance produced by subjecting animal or plant substances to very high temperatures in an Oxygen free medium or medium with a very low amount of Oxygen.

- Bio-char is a fine porous material where the quality is decided according to the raw materials using and subjecting temperature.
- Improves physical properties of the soil.
- Act as a sieve which filters water and waste.
- Wastes are subjecting to degradation by adsorption.
- Absorbs soil nutrients from the surface and releases slowly.
- Retains toxic chemical substances and heavy metals without allowing them to absorb for the plants.
- Prevents stress for plants due to droughts by holding water in minute spaces and releasing slowly.
- Reduces soil acidity and facilitate nutrient supply for plants.
- Prevents removal of plant nutrients from soil.
- Forms high availability of Phosphorous in the soil.
- Increase microbes and earthworms in the soil

Refer extra reading "02" in this handbook for making bio char

Types of bio-char that can be used in coconut cultivation

01) Wood charcoal

02) Chaff charcoal

4

Soil moisture conservation in coconut lands

4.1. The necessity of soil moisture conservation

Water supply is a main factor which considers the plant growth and yield of the coconut tree.
A firm coconut production throughout the year can be expected well distribution of rainfall around 1300 – 2300 mm throughout the year. For a adult palm, the water requirement is around 40-60 liters per day and for a young palm it is around 10-15 liters per day. As there is no uniform rainfall a fluctuation in yield is observed.
Accordingly, by applying soil moisture conservation methods, retaining water supplying through rain and minimizing evaporation of water from soil should be achieved.

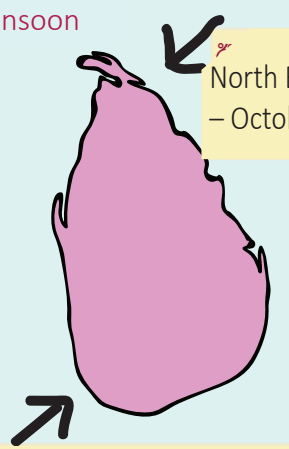
The water requirement is based upon the age, soil type and the variety

Age of the palm	Water requirement
Below 1 year	12 L
1 year	18 L
2 year	28 L
3 year	32 L
4-5 years	36 L
Above 5 years	40 - 60 L

According to the rainfall pattern, there are 2 main dry periods and 2 main monsoon periods.

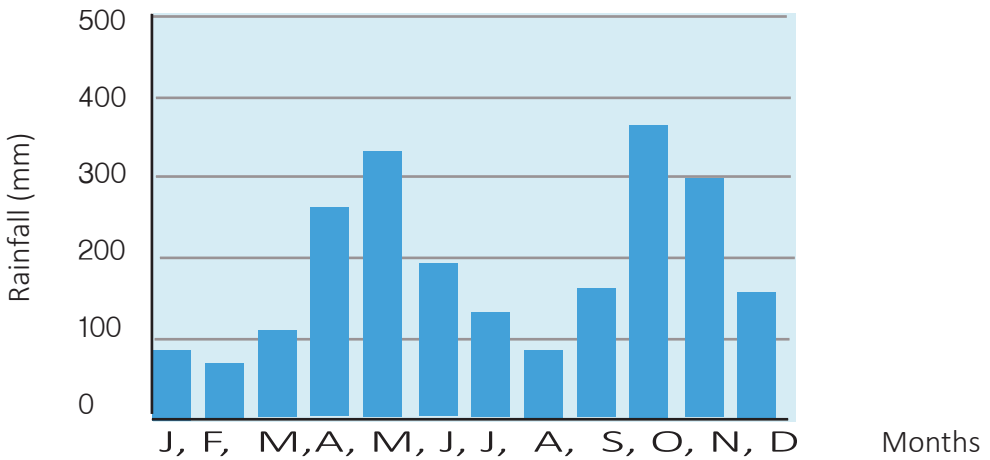
Dry periods – February to March, August to September

Monsoon



North East Monsoon – October to January,

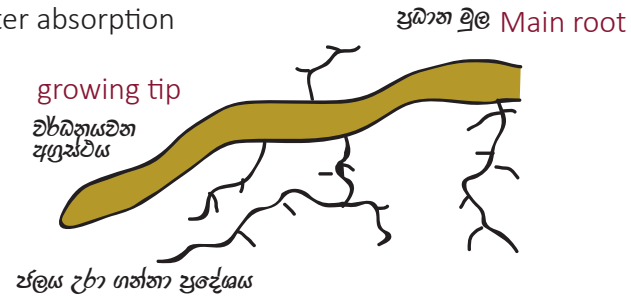
South West Monsoon – May to September

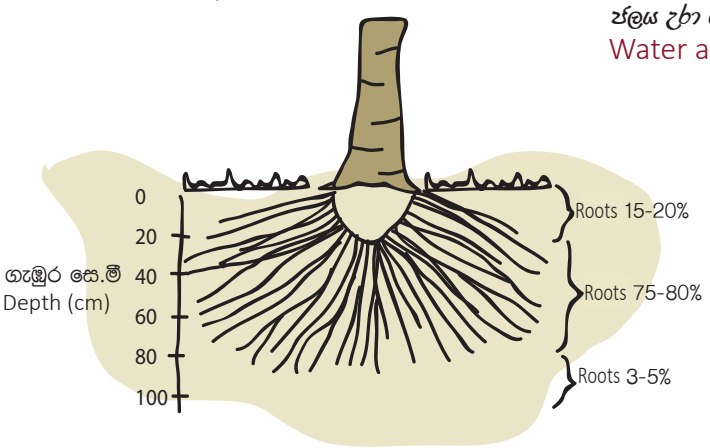


Due to the dry climates in February, March, August and September, immature nuts are fallen during March, April and September.

In each and every coconut root, there is a water absorption region near the growing point of the root.

If a prolonged drought persists, the outer cells of the area where water is absorbed from roots gradually thickens, inactivating the roots ultimately terminating the water absorption.

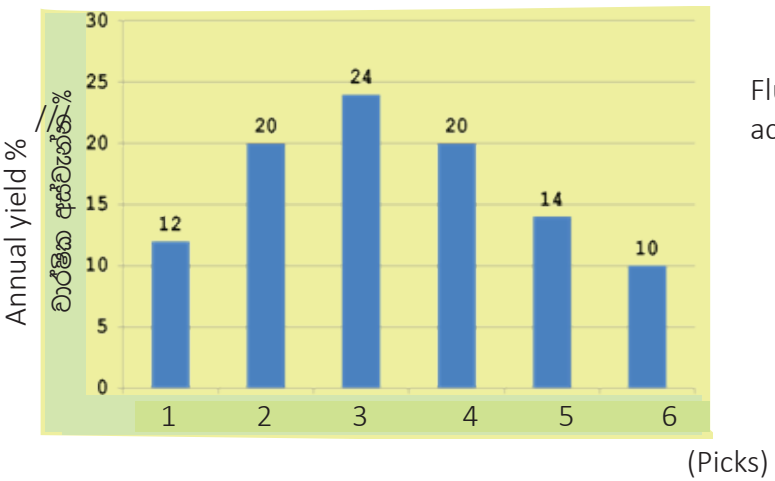




Spread of active root zone.

4.2. Pick wise yield variation in coconut

Two coconut bunches can be plucked when coconut plucking is done twice a month. Accordingly, 6 shifts can be plucked per year. The below graph illustrates the yield variation of the 6 picks. The gap between these pick is mainly because there is no uniform rainfall throughout the year.



Fluctuations in coconut yield according to pick

4.3. Drought effects on coconut cultivation

- At first, small plants are subjected to drought.
- The activity of growing tip gradually decreases or stop.
- Lowering or falling down of mature leaves of grown palms.
- Causes for formation of leaves and flowers.
- Reduce the number of female flowers.
- Falling of immature nuts
- Reduce the number of nuts and also the size of the nut in prolonged drought.
- Even death of adult palms in prolonged drought periods.

Accordingly, attention is must for methods of soil moisture conservation practices.

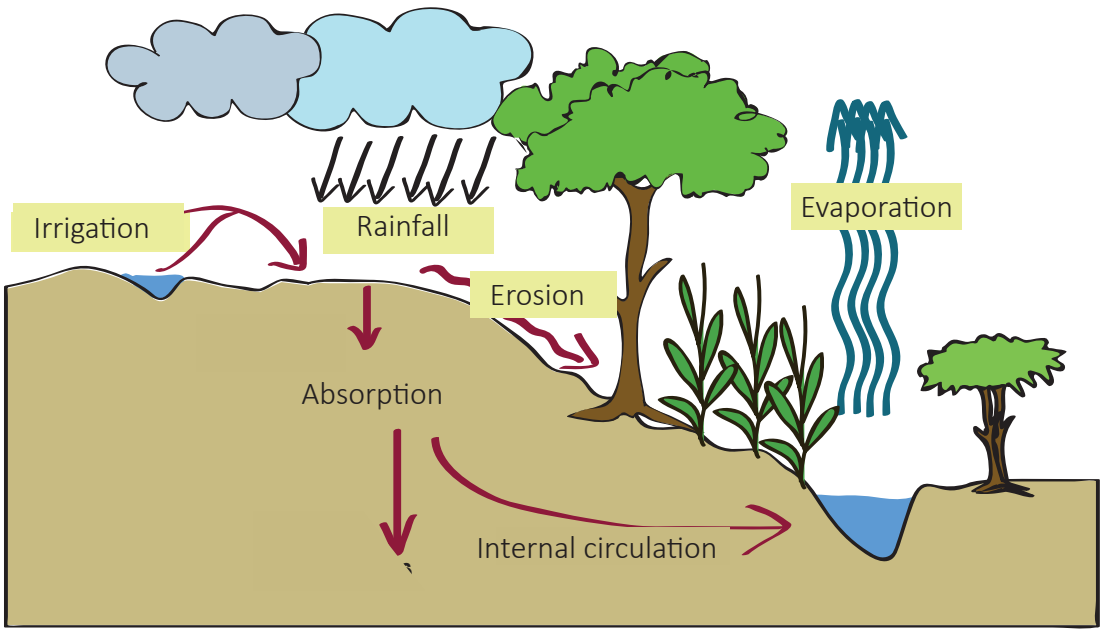
4.4. Extreme climatic events

Sri Lanka is currently experiencing changes in rainfall patterns and more frequent of extreme climatic changes such as irregular monsoon periods, flood, droughts and land-slides. Fluctuations in temperature and rainfall due to climatic changes impact on agriculture. This situation lead the changes in cultivating seasons, heightened impacts of pest attacks and diseases, water shortages.

Climatic changes influence on coconut cultivation. Accordingly, heightened tempera-ture of the atmosphere above 30 o C, leads to reduce the pollination. It is observed that, yield drop in cultivations which solely depends upon rain due to water stress during prolonged drought period.

4.5. Objective of soil and moisture conservation in coconut lands

To minimize the required moisture level for cultivation in the soil by increasing the rain water absorption and reducing evaporation losses.



4.6. Moisture conservation methods

- Mulching the manure circle
- Burying of coconut husks in pits
- Organic matter application to the soil
- Growing crop covers
- Opening of countour drains
- Construct stone terraces & SALT (Sloping Agricultural Land Technology)
- Construction of rain water harvesting ponds
- Application of organic manure for coconut palm

4.6.1. Mulching the manure circle

Covering the area of a radius of 6 ft from the base of the palm using degradable materials such as fallen coconut leaves, straw, coconut husks, crop reseduse etc.

To avoid emergence of tender root tips (‘kirimul’) and beetle attacks, the mulch should be placed at a feet distance from the base of the coconut tree.

It is appropriate to use slowly degradable materials as a mulch to remain it through out the dry period because fertilizer apply during the rainy period.

Benefits of mulching the manure circle

- Minimizes evaporation
- Minimizes soil erosion
- Minimizes soil temperature
- Suppressing weed growth
- Increase the amount of organic matter

Coir refuses as mulch

crop cover/live mulch

Coconut husk as mulch

Coconut branches as mulch

4.6.2. Use of coconut husks

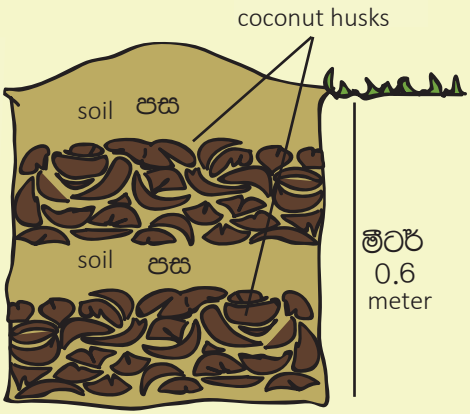
- A new coconut husk can absorb water 6 times of their weight during the wet season.
- The water absorbed during rainfall is released into soil later
- It is important to bury coconut husks at the beginning of rain
- The results of this application lasts for about 5-6 years.

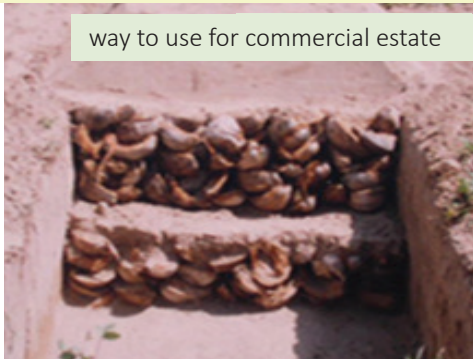
Coconut husks should be layered alternatively with soil.

After filling to the ground level, rest of the soil to be dumped on the pit.

It is adequate to apply in two layers in a commercial cultivation.

In a sustainable development of coconut cultivation, it is a essential to recycle coconut husks with soil.





way to use for commercial estate

Applying coconut husks for a cultivation can be done in several methods

01. Applying as a single hole in between two trees

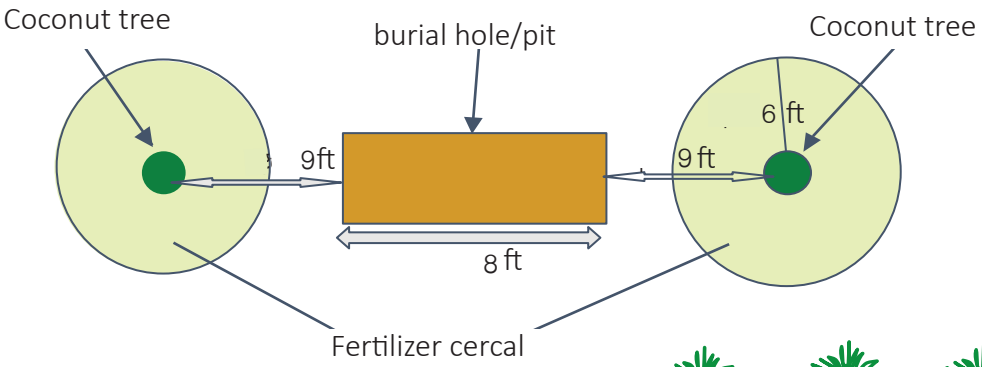
Number of holes per acre : 32

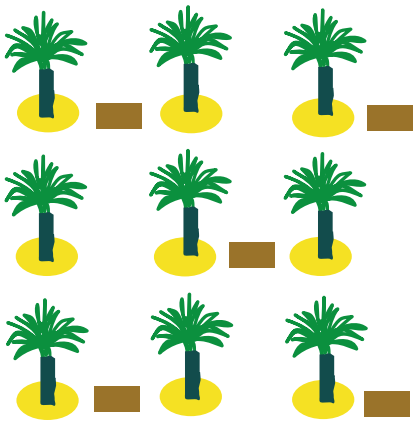
Size of the hole: L: 8 x W:4 x D:3 (ft)*

Number of coconut husks per hole – 500

This is experienced as the most productive method.

** (L) Lenght, (W) Width, (D) Depth (ft) feet*



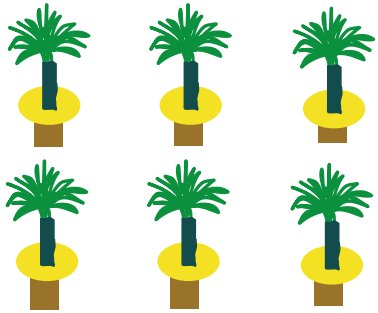


Husk pit should be arranged alternatively bitween two palms along coconut row as shows in the figure.

When preparing coconut husks pit in slopy lands, pit should be dug across the slope.

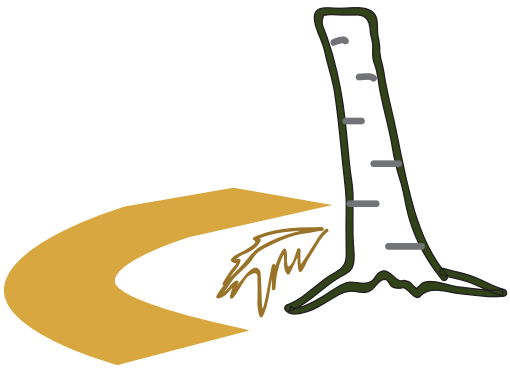
02. Applying as single holes

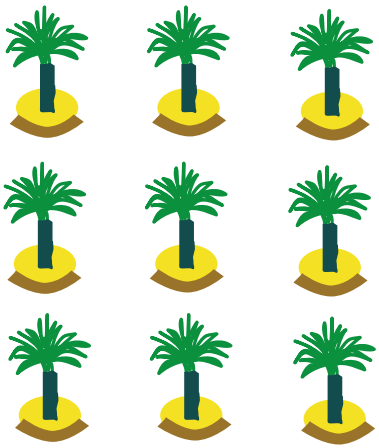
For a single pit : 250 coconut husks are reired
size: L: 4 x W:4 x D: 3 (ft)



03. Coconut husks pit just beyond the manure circle

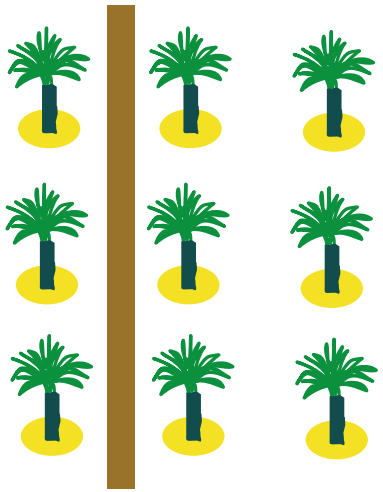
Length – 1/3rd of the manure circle
Width – 2-3 ft
Depth – 2 ft
This method is more effective for weak trees.





04. Burying coconut husks in large trenches in bitween rows

Size (pit in between rows): 3 ft x 3 ft
Appropriate for lands with excessive amount of coconut husks are avilable
This metho is not commonly used at present.



Mulching and burying coconut husks for young palms

Mulching for young palms

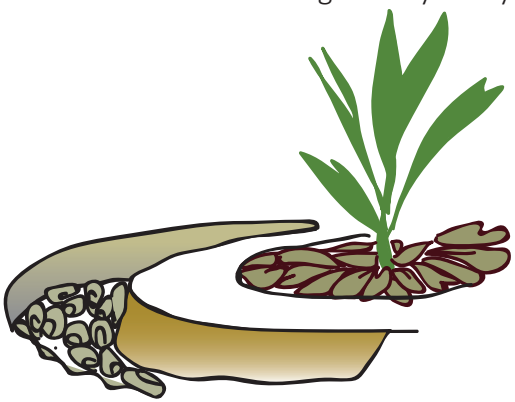
- Practicing soil moisture conservation methods during early growing stage is important.
- Apply two layers of coconut husks to the bottom of the hole when planting.
- When mulching, the size of manure circle depends upon the age of the plant.

Age of the plant	Radius of the round
6 months	1 ft
1st year	2 ft
2nd year	3 ft
3rd year	4 ft
from 4th year to flowering	5 ft

The recommended method has to be followed for cutting husk holes when trees grown after 6 years.

Burying coconut husks for plants

- Should prepare single coconut husks holes/pits after 2-3 years of planting.
- Coconut husks holes should be prepared as a half round outer to the mulching round.
- Depth – 0.6 m and width – 2 ft
- It is appropriate to shift husk pit from one side to another side in filling husks year by year



To minimize the effects on coconut seedling during the dry period

- Collect and tie up the leaves of the seedling
- Provide shade by covering the seedling
- Pay attention to prevent red weevil attacks
- Cut & remove droping leaves

Soil conservation in slope coconut lands

Soil conservation methods should be in place for slope lands due to following reasons

- Heavy soil erosion
- Drying off of water springs
- Due to low water holding capacity of the soil
- Soil becoming infertile
- Low-income generation from the land
- Filling ponds and tanks with sediments
- Blocking of surface water flow systems.

Appropriate soil conservation methods for sloping lands

Mechanical methods	Biological Methods:	Agricultural methods
stone ridges/bunds, Contour soil bunds, Terecing, Drainage drains for high rainfall areas	Grass ridges, Application of SALT method	Farming as hedge row, Minimum tillage, Mulching, Cover croping

Lands with a slope intensity higher than 30 % are not recommended for a coconut cultivation.

It is important to apply soil conservation methods for water conservation and protecting topmost soil from soil erosion to get a high-yield in lands with a slope intensity less than 30%.

When applying soil conservation methods, it is important to follow most appropriate methods according to the slop of the land.

It will be advantageous to prepare a contour map of the land to apply soil conservation methods for lands with a sloping intensity lower than 30 %.

Marking contour lines in a land

Contour lines are the lines drawn by connecting points of same altitude (elevation) .

Necessary items to mark lateral lines

'A' frame or Road racer or Abony leveler

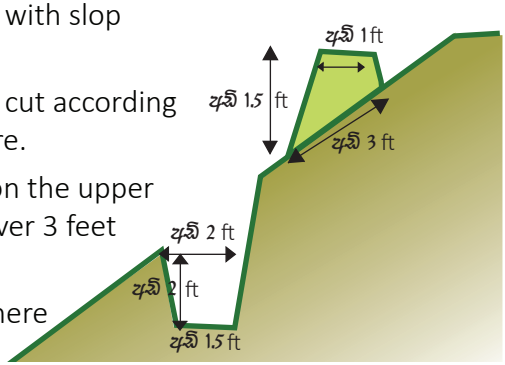
Making contour lines in a coconut land starts from the highest point of the land.

The distance between first line and the second line depends upon the intensity slope.

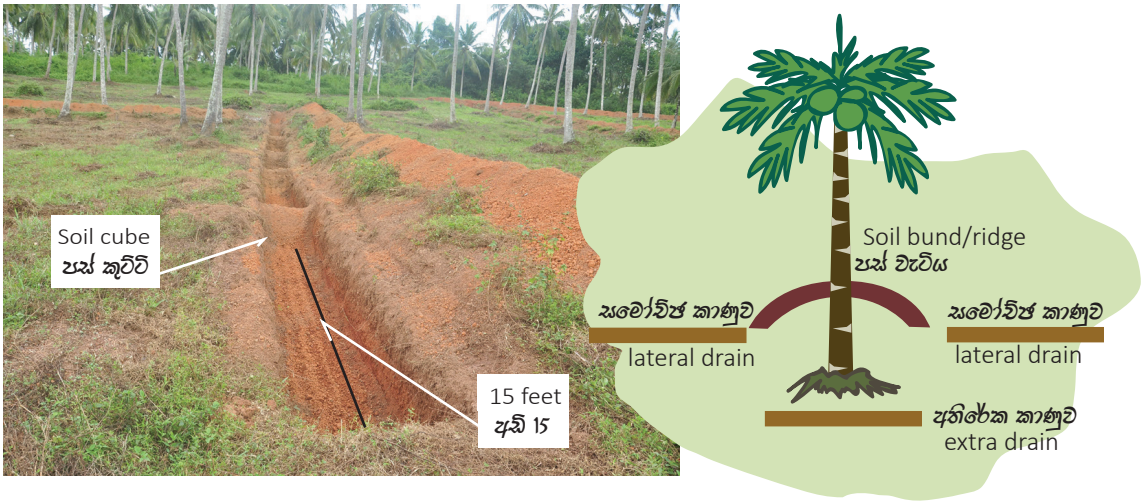
Slope	Slope intensity	Gap
5%	1:20	40 m
10%	1:10	20m
15%	1:7	15m
20%	1:5	10m

Contour drains

- It is appropriate to apply contour drains for lands with slop intensity greater than 10%
- After marking the contour lines, drains should be cut according to the measurements in the figure illustrated here.
- Removed soil from the drain should be heap up on the upper side of the drain to a hight of 1.5 feet & spread over 3 feet

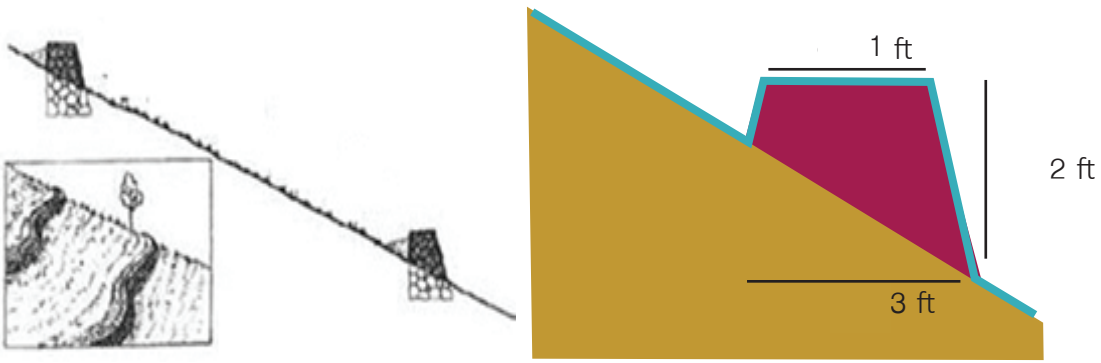


- Don't make bund/ridge just closer to the drain
- Prepare the bund at upper sides of the drains where the slope intensity of lands is less than 15 %
- Whereas, place the bund down to the drain where the slope intensity greater than15%
- Soil heap should prepared as 1ft away from the drain margin
- Soil erosion can be controlled by making the bund in a way spreading for about 3 ft area
- The bottom of the drain should be completely flat to prevent water flowing inside the drain and leave soil cubes in 15 ft away within the drain as in the figure
- This soil cube is dug for 6 inches inwards from the ground level
- When a coconut tree is encountered while continuing the preparation of contour drains, stop the drain preparation outside the manure circle and again start from the outer sides of the circle.
- After, prepare an extra drain of 12 ft in the slope side of the land and spread its soil outer the manure circle in a half curve with the soil ridge in the same contour drain as illustrated by the figure.



Contour Bunds

- Contour bunds can be applied instead of lateral drains in lands with a slope intensity less than 10%.
- To prepare these, can use soil, stones or coconut husks.
- Mark the lateral lines as in the contour drains and the gap between bund to be decided based on the way in which contour drains are applied according to the slope intensity of the land.
- It is less expensive to apply contour bunds and it is more economically friendly to contour drains.



Sloping Agricultural Land Technology (SALT)

- Sloping Agricultural Land Technology (SALT) is a technology introduced by Philippines to retain the fertility of soil and to minimize the soil erosion in cultivated sloping lands.

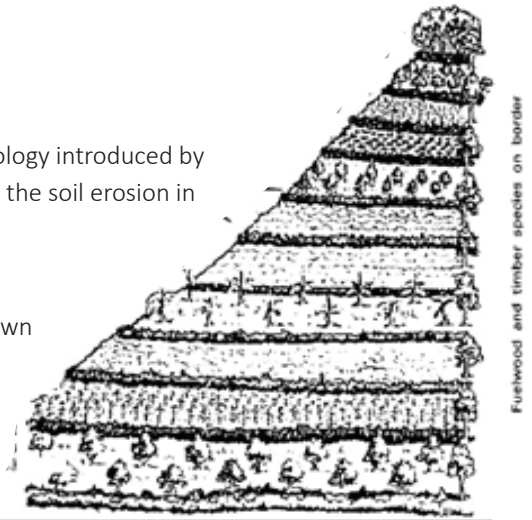
- In here, in between rows of legume trees crops are grown in 4-5 m widen rows and it can be introduced as strip farming.

- Applying this technology for coconut cultivation can be introduced as applying live fences

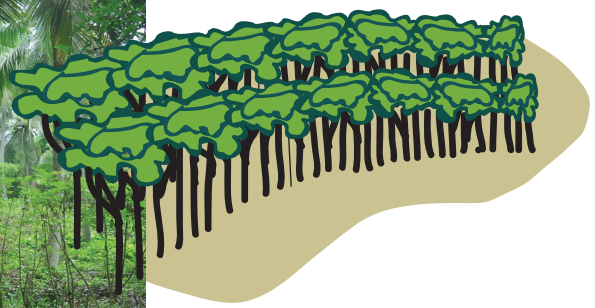
- Can be applied for lands with a sloping intensity greater than 10%.

- Nitrogen fixing trees like Gliricidia are planted in two rows along the countour lines.

- The gap between two live fences depends upon the slope intensity of the land.



Slop	Intensity	Gap
5%	1:20	40m
10%	1:10	20m
15%	1:7	15m
20%	1:5	10m

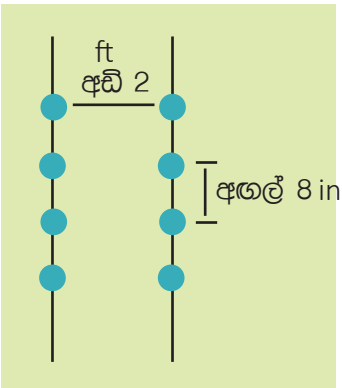


Characteristics for plants to be grown in double rows

- Should have higher growth rate
- Resist pruning
- Ability of growing as a bush
- As a good mulch and supply of more amounts of green fertilizer
- Able to use as animal feed
- Ability to reduce atmospheric Nitrogen

Recommended plant varieties to be grown in double rows

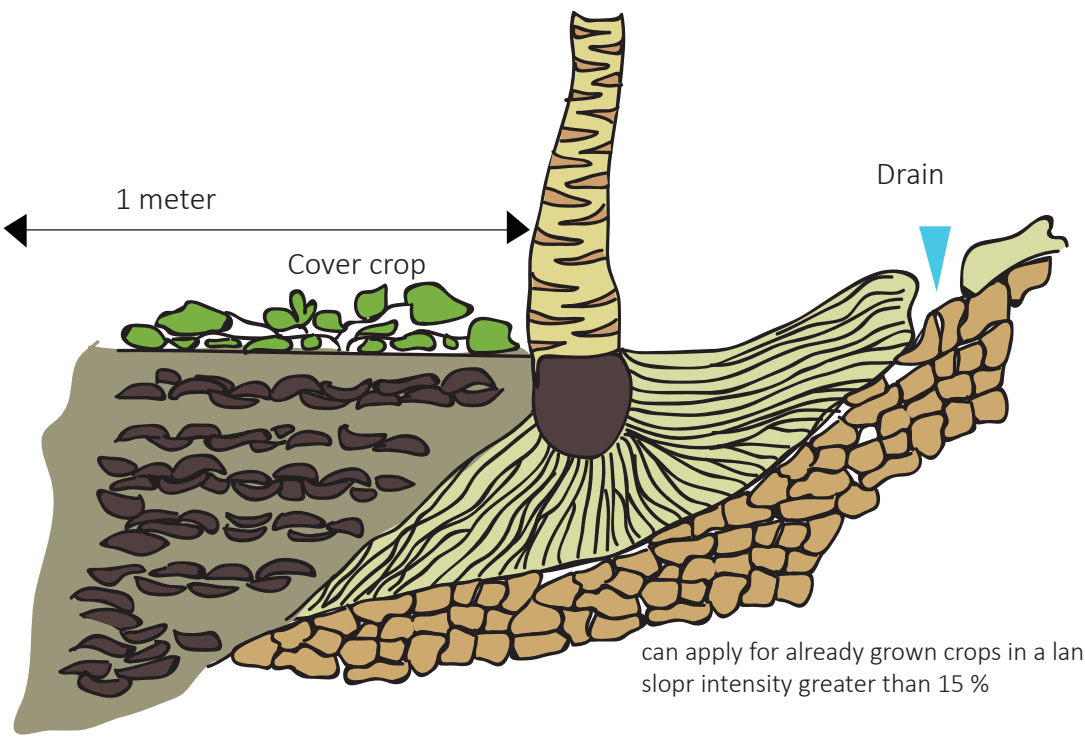
- Gliricidiya/Wetahiriya
- Kaliyendra
- Erabadu
- Pawatta
- Walsooriyakantha



- Gap between 2 rows is 2 ft and gap between two trees is 8 inches (2x8).
- The planting stems should be of 1 inch diameter and height of 3 ft.
- The branches of trees in the live fences should be pruned for every 4-6 months.
- The area in between 2 rows should be filled using branches, stones, coconut branches etc.

Terracing Method (Helmalu)

- Can be applied for already planted coconut palms in lands where the sloping intensity is greater than 15 %. Eg – Kegalle, Mawanella like areas
- This method is use to make manure circle for coconut trees in sloping lands. Accordingly, can conserve the moisture and nutrient status of soil.
- Terrace should be made for each and every palm as a half circle.
- To fillup the terrace, coconut husks and soil can be used.
- Stone spalls can be applied to strengthen the slopes.
- Growing cover crops to stop erosion within them.



can apply for already grown crops in a land with slopr intensity greater than 15 %

Growing cover crops in coconut lands

- Productive for large scale coconut cultivated lands
- Heightened soil erosion if such soil conservation methods are not applied.

By growing cover crops

- Reduce the speed of rain fall on ground.
- Helps in moisture conservation as the roots of these crops facilitate the infiltration of water to the deep layers of the soil
- Organic matters provide enormously as mulch for the soil and cover crops belonging to the legume species, supply Nitrogen to the soil.
- Reduces leakages of nutrients, soil temperature and weeds growth

Facters to consider for growing cover crops in coconut lands

- Should be a crop that grows fast and spread rapidly throughout the land.
- Resist the climate of the particular area.
- Nature of the soil
- Shades in the land
- Can select as creepers cover crops or bushes cover crops.
- Cover crops should dry off during drought seasons, and regrow in next rainy season.

Creepers as cover crops

Can select as legume creepers according to the climatic zones. For wet and intermediate zones, suitable plant varieties are Centrosima and Piureria.

Creeper cover crops suitable for wet and intermediate zones

Centrosima

Pureria

Creeper cover crops suitable for dry and intermediate zones

Centrosima

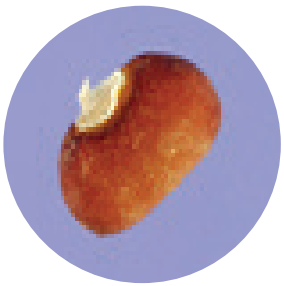
Ciratre

Planting cover crops

- Flowering occure in January and seeds mature in March and April.
- Should prepare a land free of weeds to expect a rapid growth of cover crops
- The land should be prepared by tilling using a disc plough and ‘harrow’ twice for levelling.
- Should plant cover crops before heavy rains begin.
- Should not prepare lands where a heavy sloping intensity is observed.

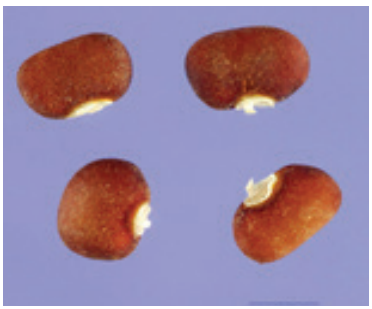
Collecting seeds

- Seeds for crops like Pureria doesn't produce seeds in every time of the year.
- Flowers bloom in early in the year and pods mature in March or April leading to seed dispersion.
- Should collect seeds during this period.
- Should store the seeds in the refrigerator after cleaning and pre-processing the seeds by drying them under sunlight.



Seeds treatment

- Seed treatments are carried out to break the dormancy in seeds of the cover crops
- Immerse seeds in hot water (80-85Co) (not boiling water) for about 3-4 minutes
- Allow to soak in 12-24 hours in normal water
- Drain off water and plant in the field before seeds dry.



Planting seeds in the field

- Can plant seeds in several methods

Broadcasting the prepared seeds in the field

Spread the seeds in the land except the manure circle and bury them under the soil by levelling the filed using a chain harrow

- The seed requirement for a hectare is about 8-10 kg.

Spreading seeds in rows as strips

- Should spread keeping about 60 cm gap among seeds
- Seed requirement: around 5-6 kg s per hectare.

Small square beds

Can establish cover crops in the field by planting seeds in small square beds in between coconut rows

Planting of cover crops in holes or drains

Can establish cover crops easily in holes where coconut husks or coir dust buried and on drains. The number of planting seeds required by this method is very low.

Maintenance of cover crops

As the crops grow slowly in first 2-3 months , weed suppression is essential for a good better growing of covericrops.

It is essential to control if cover crops grow fast and heavily.

To control creep type cover crops, they should be cover under the soil using a role or a disc plough

These covering crops die and act as a dried mulch during drought periods and it will regrow again during rainy season and spread everywhere.

Bush type cover crops

Plants like Gliricidia which have Nitrogen fixing ability can be grown as two rows in between coconut rows. Pruning can control the growth and pruned parts can be used as a fertilizer for coconut palms

Method of planting

Planting stems (matured for a certain extent having a diameter about 1 inch and height of about 3 ft) during rainy seasons.

Or planting stems in rainy season after rooting in nursery for about one month .

Collecting seeds and planting them in polythene bags during March/April and planting them in the field later.

Pruning and controlling

Pruning should be done at 3 ft from the ground level

in the wet zone : once in 3-4 months

in the dry zone : once in 6 months

Construction of ponds for rain water conservation

- A pond should be constructed in a place of estate where rain water can collect easely.
- Appropriate for coconut lands larger than 5 acres.
- Ponds are appropriate for lands in dry and intermediate zones.
- The amount of rainwater collecting can be increased by constructing in a way to get advantages as a source for a catchment area.
- Making a pond in low ends of a land leads to less benefits for the land. Hence, it is important to have it in middle of the land.

By rainwater conservation ponds,

- Increases the ground water level of the land
- Maintains moisture during dry periods.
- Can get water supply needed for cultivation purposes.

Additional measures for moisture conservation

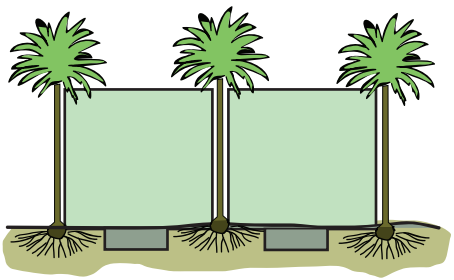
- Provide irrigation facilities
- Planting crops, applying chemical fertilizers, harrowing of lands should not be done during dry periods.
- Should not burn fire materials in coconut lands during dry period.
- Shoot dry off can be reduced by tying up the leaves of young coconut plants
- Minimize eating grasses by animals
- Plan irrigation facilities properly
- Frequent mulching of soil

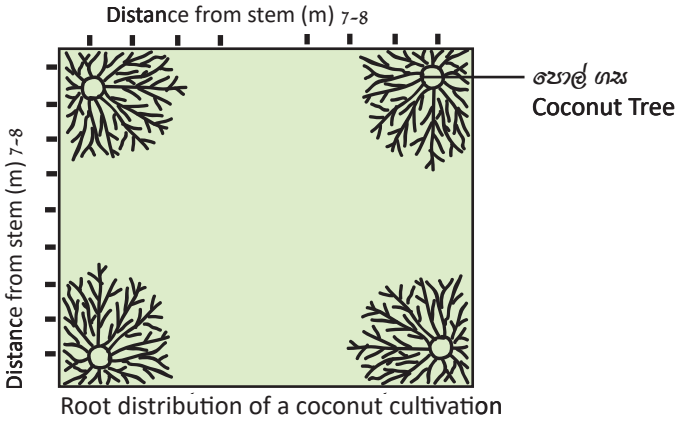
5

Intercropping in coconut lands

Most of coconut farmers maintain their lands as coconut monoculture. This leads to less productivity due to inefficient usage of the land space. It is confirmed that, high profits can be earned by growing other crops in the coconut land as coconut consumes around 1/3rd of the land. The factors to be considered during intercropping in a coconut cultivation are age of the coconut cultivation, soil suitability, climatic factors and market demand for intercrops to be cultivated.

Illustration shows the available space of the coconut land





Root distribution of a coconut cultivation

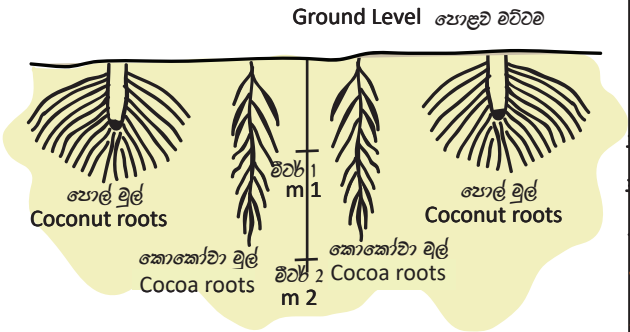


Illustration shows the vertical distribution of roots of Cocoa which is cultivated as an intercrop.

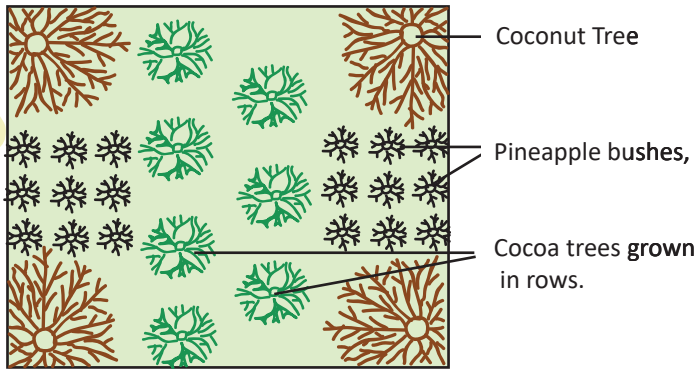


Illustration of horizontal distribution of the roots in a multi-cropping system.

Effects on coconut cultivation by different intercrops (Source: Gunathilake H.A.J (2016), Coconut Lands Management in Sri Lanka – Coconut Research Institute)

Crops	Average yield (Fruits Per year / hectare)	Increased %	Average Copra yield (To per year/hectare)	Increased %
Coconut mono cultivation	6123	-	1.79	-
Coconuts + Cocoa	7504	26	2.18	22
Coconuts + Coffee	8216	17	2.26	26
Coconuts + Pepper	6424	05	2.03	13
Coconuts + Clove	7191	17	2.13	19
Coconuts + Cinnamon	7633	26	2.35	31

5.1. Advantages from intercropping

- Increased the income from coconut land
- Increased the effective usage of sunlight falling to the coconut land
- Increased soil fertility due to increased organic matter content in the soil
- Maximum utilization of available resources in the land
- Increased coconut production
- Reduces soil erosion
- Creates a soil mulch
- Suppression of weeds
- Conserves soil moisture
- Increased the nutritional status of the soil

5.2. Factors to be considered for a successful intercropping program

01) Age of coconut trees and avilability of sunlight

Intercropping is most suitable for a coconut palms until age up to 5 years and after 25 years. Furthermore, keep in mind to cultivate intercrops Facing East-West direction to get maximum utilization of sunlight.

Suitable intercrops for a coconut cultivation

Age of the coconut cultivation	Sunlight receiving to the ground layer	Short term crops existing less than 1 year	Medium term crops existing for 4-5 years	Long-term crops existing more than 10 years
0-5 years	Receives without a limit	Vegetables, Turmeric, Ginger, Yams, Cereals	Pineapple, pasion fruit, papaya	-
6-20 years	Limited for ground layer	Ginger, Yams	-	Grass varieties
21-50 years	The top canopy of the trees is small. The light receiving level increased.	Ginger, Yams	Pineapple, Banana, passion fruit, Papaya, betel	Pepper, Cocoa, Cinnamon, Clove, Nutmeg, Cardamom, Grass varieties
51-70 years	Do coconut re planting or under planting	Vegetables		

02. Soil moisture

- Having an extra water supply for coconut lands in dry zone and intermediate zones help in making the intercropping a success.
- To avoid competition for soil moisture, all the inter crops should be grown 2 m away from the coconut palm.
- Can get a higher yield by using micro irrigation techniques for intercrops as well as for the coconut cultivation.

03. Plant nutrients
It is important to use recommended fertilizer for intercrops as for coconuts.

04. Soil characteristics
It is most appropriate to cultivate intercrops in coconut lands where soil suitability classes of S3, S4 and S5 can be found. However, a fertile soil should be selected for intercrops and the characteristics to be considered are as follows.
Soil texture
Water drainage
Capacity to retaining water in the soil
Soil pH
Cation Exchanging Capacity (CEC)

05. Rainfall and climate
The distribution of rainfall should tally with the water requirement of intercrops at its different stages of growing. Eg – Pepper for Wet and Intermediate zones, Buded Cashews and Lime for Intermediate and Dry zones.

06. Slope of the cropping land
Should plan in a way minimizing soil erosion
Eg – For slopy lands – Coffee, Pepper |
For lands with low slopes – Ginger, Pineapple

07. Processing and Marketing

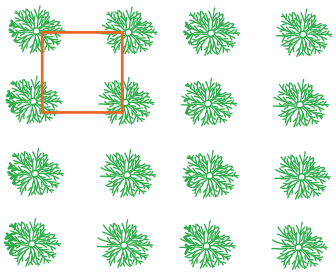
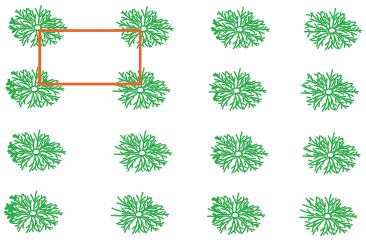
It is good to cultivate crops that are easly marketable as intercrops and should be aware and consider the marketing feasibility.

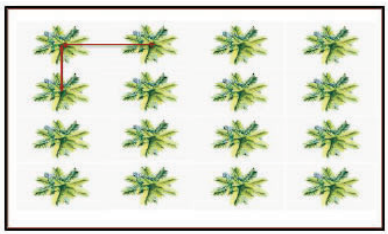
08. Labor requirement

More number of employing opportunities are created due to intercropping.

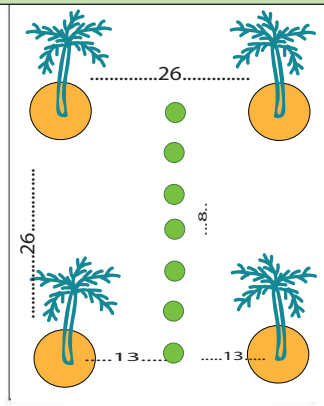
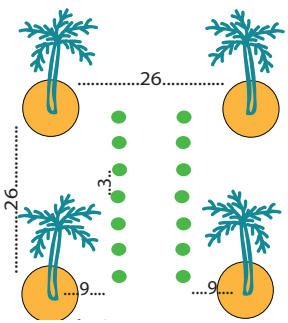
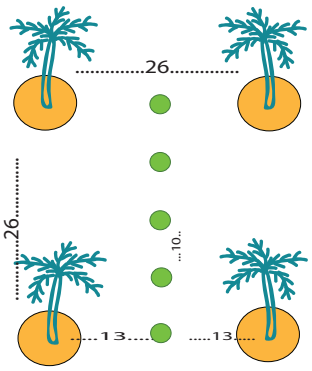
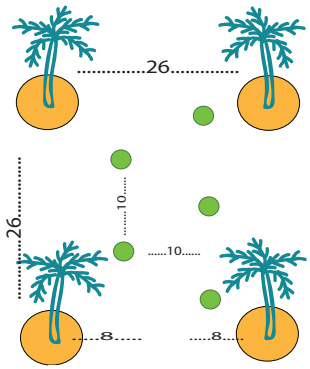
As some crops need higher labor requirment, should consider about that as well.

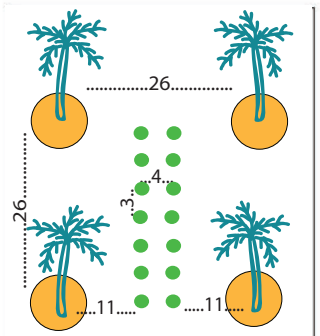
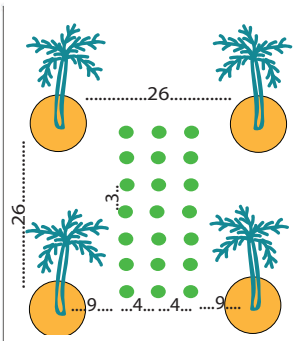
5.3. Crop plans for frequently used crops for intercropping with coconut

Method of coconut planting	Gap between plants in ft	Number of plants per acre	Agricultural details
Square Method 	26	64	• The most appropriate method of growing coconut plants for systematic coconut cultivation • Can grow annual/semi-perennial or some perennial inter crops.
Wide-row method 	26 x 32	52	• When expecting to grow perennial crops that need more space (i.e. mango, cashew, rambutan) under coconut in long term should select this method.

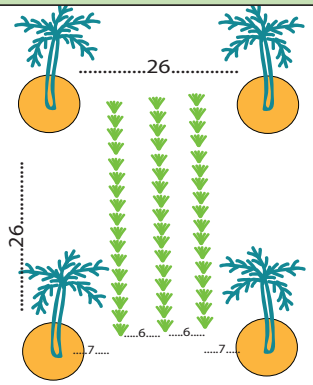
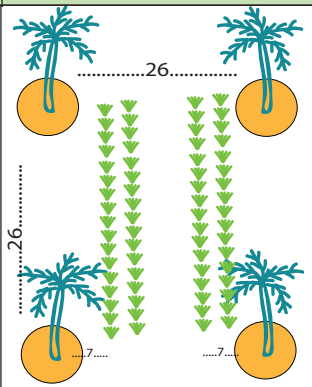
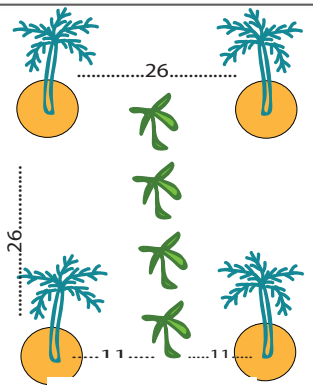
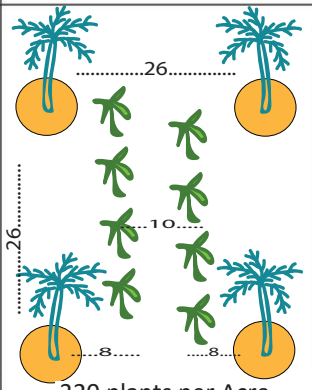
Special Wide-row method 	26 x 40	42	• When expecting to grow perennial crops such as tea or cane sugar under coconut, this method is preferred. • This recommendation is based on an optimum growth for both plants.

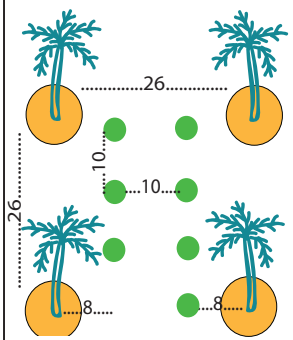
Perennial crops

Crop	Single row method	Double row method	Yield
ගම්මිරිස් **Pepper**	 160 plants per Acre	 320 plants per Acre	Can yield 2-3 kg of dried pepper per year/per vine after 5 years from planting
කොකෝවා **Cocoa**	 126 plants per Acre	 252 plants per Acre	Can yield 1 kg of processed cocoa beans per year

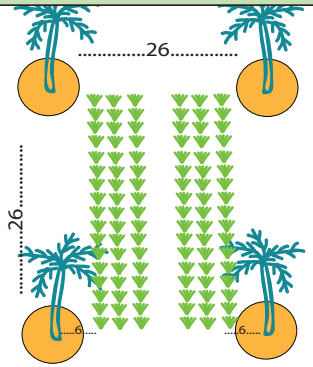
Cinnamon කුරුඳු	 850 plants per Acre	 1275 plants per Acre	3 cinnomon plants per hole Can yield 200-250 kg of Cinnamon per year per acre after 7 years from **planting.**

අර්ධ බහුවාර්ෂික බෝග

Crop	Single row method	Double row method	Yield
අන්නාසි Pineapple	 3500 plants per Acre	 5000 plants per Acre	Can get first yield within 12-14 months. In single row method, can yield 4500 kg per acre and in double-row method can yield 6500 kg per acre. Can yield for 3-4 years **from a properly grown cultivation**
Banana කෙසෙල්	 160 plants per Acre	 320 plants per Acre	Single row method is appropriate for ‘Ambul’ and ‘Ambon’ Double row method is appropriate for ‘Kolikuttu’

පැපොල් Papaya		 252 plants per ~~Acre~~	Can yield in 10-12 months Can harvest 30-40 fruits from a tree per year Yield for about 3 years

Seasonal crops (Duration less than one year)

Crop	Planting Method	Other details
ඉඟුරු/ කහ Ginger/ Turmeric	 22200 bushes per Acre	Appropriate to grow in 3 rows within a bed, with a gap of 1x1 between two rows. leave 6 feet from the base of the coconut palm Need 650 kg of seed rhizomes per acre Can yield 6500 kg per acre from a well-maintained cultivation.

6

Irrigation in Coconut Cultivation

Soil moisture is one of main factors affecting the growth and yield of the coconut palm. More than 1500 mm annual rainfall with uniform distribution throughout the year is important for the growth of the palms. Water absorption ability of the root system decreases when expose to low moisture level of the soil for longer period. The growth of the apical bud may be completely collapsed or highly affected due to prolong drought period. formation of female flowers and number of nuts per palm will be reduced and fall off of the imature nuts are some impacts of the drought. The size of the nut also gets reduced during the dry period. Sometime, coconut palms die when they expose to the prolong drought period.
Crop water requirement per day of the coconut palm depend upon the age, soil quality and the other environmental factors.

Age (year)	Water requirement (liters)
Below 1 year	12
1	18
2	28
3	32
4-5	26
5	40-60

Water gets naturally off from the coconut land through the evaporation and transpiration. This amount of water is required to be reabsorbed for the palms from the soil. There is negative impact over mechanism of the palm, If the available water to be absorbed is limited. Therefore, under this situation, coconut yield can be reduced greatly or even palms could die . The removed water from the soil should be supplied by rain or irrigation to become it unlimited factor.

Accordingly, the quality water in required volume has to be supplied to the coconut cultivation at right time through appropriate method of water supply.

6.1. Factors to be considered when selecting an irrigation method

01) Water source and its nature

Having a stable water source which does not dry off during a drought period is very important. The water sources that can be used for irrigation are,

- Tube wells
- Drains or small canals
- Agro -wells constructed in coconut land/estate
- Tanks
- Pool/ponds constructed on grounds

02) Characteristics of the water source

Characteristics of a good water source are

- Should have a potential to provide water during dry periods
- Should have a good water supply capacity
- Good quality water
- Higher recharging capacity after water use
- Legally complying water source

It is important to verify that water source is suitable for irrigation by testing a sample in a laboratory

03) Soil factors

Soil properties such as water retention, water drainage, soil porosity, ability of removing excess water from soil etc. are considered as important. A soil with the potential to drain water at a medium rate can be considered as a good factor for irrigation.
It is important to consider investment capacity of farmers, types of inter crops growing, labor requirements and the nature of the land etc. when selecting a irrigation method for water supply.

6.2. Different methods of irrigation

Even though farmers tend to irrigate water during dry periods by using different methods such bringing water using buckets by labors, water pumping, and supply through drains to manure circles etc. These are considered as ineffective method of water supply. Now farmers are motivating to use improved and new technology applied methods of water supply.

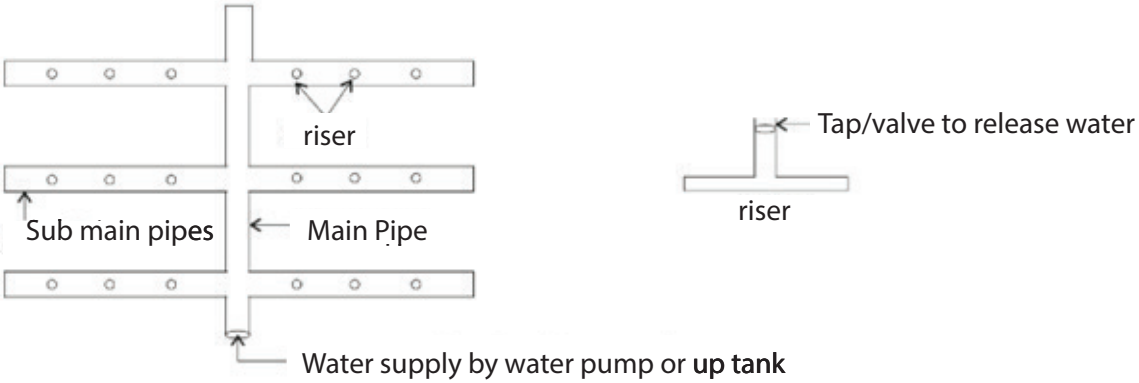
6.3. Improved methods of irrigation

01) Sprinkler method
A method suitable for a plantation with inter crops and for coconut nurseries.

02) Riser method / irrigation through hose pipes

A method which uses a main pipe s ystem and a sub main pipe system which is buried 1-2 ft under soil and four risers per acre to draw water up and then manually irrigated through a hose pipe.

This is a method most popular among farmers as economical, however low in effeciancy. In here, water can be taken through directly water pump or by using an overhead tank.



The diameter of PVC pipes should be determined on the basis of extent of the land. The riser which obtains water should be 1 inch (”1”) in diameter and a hose pipe of 1 inch is normally fixed for it. A diameter of 2 inches or greater than that should be provided for the main pipe system and the sub pipe system considering the land extent as well. All the trees/plants in the land can be irrigated by maintaining a gap at least 100 ft in between risers. Considering the location and shape of the land, the main pipe can be located at the middle of the land or from the corner.

03. Drip irrigation

Water is directed to the root zone of the palms slowly at several locations of the manure circle using dripers. This method effectively fulfills the daily water requirement of the plants while saving water. For this, it is important to get water from a high-quality water source free of salts. Even though this method is highly effective, it needs big investment and should focus more on repair and maintenances in the system.

Drip irrigation is done in two main methods based on the place of water issued to the soil.

01) Drip irrigation over the soil surface

02) Drip irrigation in the sub-surface of the soil

Laying pipe system for sub-surface irrigation system

Here, water is supplied to the root zone of the palm through a lateral pipe system as per daily water requirement of the palm. The water quantity supplied within a unit time varies depending on the type of the dripper used. Damages to the lateral pipe system by animals and machineries is higher in surface irrigation than in sub-surface irrigation where pipe system is under the soil.

The way of opening drains for sub surface irrigation

7

Pest and Disease Management in Coconut Cultivation

Mainly, three types of pests can be identified which cause damages to young and bearing coconut palms. Those are, main pests that pose deadly impacts for the cultivation through out the year in almost every area, minor insect pests and mammal pests.

Can increase and secure the yield by a better and proper management. Hence, it is important to keep in mind about disease and pest management of coconuts.

7.1. Main pests

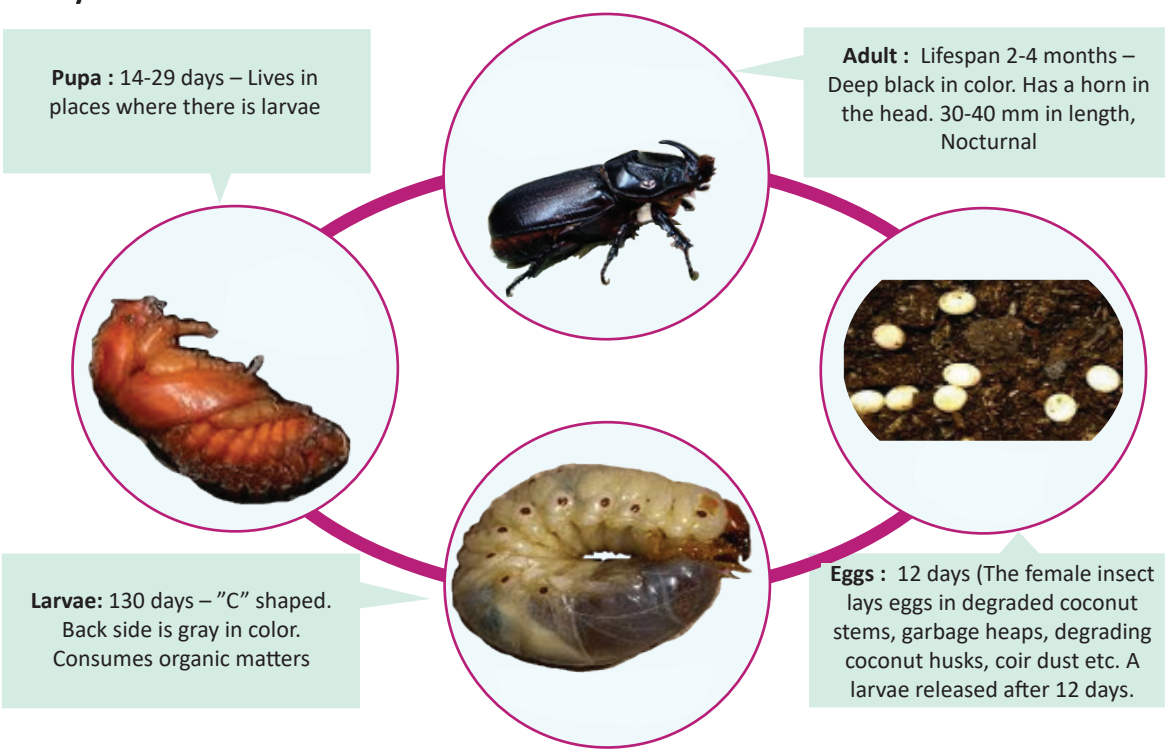
- Red weevil attack
- Black beetle attack
- Coconut mite attack
- Plesispa insect attack
- Coconut caterpillar attack
- Termites attack

7.1.1. Black beetle and Its management (*Oryctes rhinoceros*)

- A pest that invades every stage of the coconut life cycle.
- Can see in all coconut growing areas
- Adult causes the damage
- Retardation of young palms & seedlings
- Occational death of seedlings
- Retardation of growth in asdult palms

The beetle bores and enter into the soft area of the bud and feed on the soft tissues. The removed parts during feeding can visible in the affected areas. After the damage when unfold the leaves they exist characteristic geometric shapes. When damage for seedlings during very young age, dying off or weakened trees with malformed leaves can be observed.

Life cycle



Identification of the damage

- The adult beetle bores & enters into the base of the bud and feed on the soft tissues.
- Removing fiber like parts after feeding can be observed in the bud area
- Can observe geometric cuts in branches
- Deformations in young coconut leaves and buds.

Control of the pest

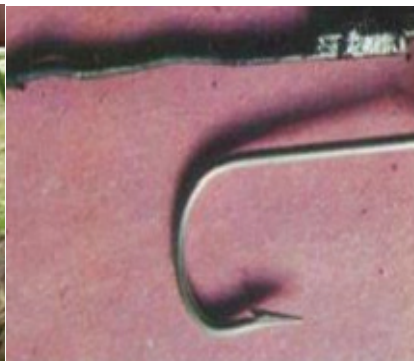
Agronomical methods

Can minimize breeding by regular disposal of parts of coconut palms, garbage heaps, and cow dung heaps etc. as beetle lays eggs in degrading organic matter.

Eg –

- applying organic fertilizer for the cultivation properly earthed
- Removing beetle in the bud using a pointed metal hook
- Place about 2 naphthalene balls into each of the innermost leaf axils.
- If engine oil/kerosene is applied, be careful not to damage the bud. Hence, apply on leaf axils near the buds.

- Frequent observation of the seedlings and young palms and remove adult beetles using a pointed metal hook.
- Placing a mesh around the plant base and adding a cover around the base of the stem will prevent the reach of black beetles.


Use of pheromones

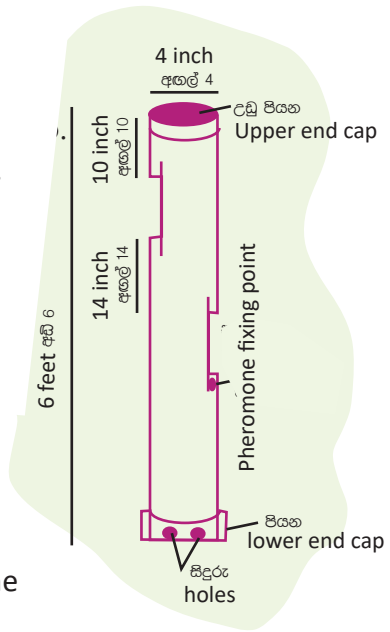
Can use black beetle pheromones to trap the grown beetle and remove it.

Places to get the pheromone

- Coconut Development Training Center, Bandirippuwatta, Lunuwila
- All regional offices of the Coconut Cultivation Board

Method of arranging the pheromone trap

- Take a PVC pipe with a diameter of 4-6 inches and height of 5-6 ft.
- Prepare two windows as shown in figure in opposite sides of the pipe.
- Pierce a hole ½ inch above one of the holes to hang the pheromone
- To drain off rain water, pierce 4 holes in the lower end at two sides.
- Fix a end cap/curd pot/plastic jug well at the bottom with holes.



Fixing the pheromone trap in the field

- Tying to a supporting pole to stand in the field or to a well grown tree

- It is not necessary to fix in the same area where damage occur

- It is appropriate to fix open area at the corner or boundary fence in the area where damage is present

- After 7-10 days of applying the pheromone trap, should remove the insects weekly from the trap.

- Should apply a new pheromone when the strength of pheromone reduces when it reachs the end of its active period.

Chemical control

- When the damages are serious placing small pockets of Carbosulfan or Carboduran mixed with sand, in between leaf axils.
- Carbosulfan – 10 g per seedling plant, 20 g per a adult palm
- Carboduran – 15 g per seedling, 30 g per a adult palm

7.1.2 Red weevil attack *(Rhynchophorus ferrugineus)*

- Spread in all coconut growing areas
- A pest for both young and adult palms
- Cause fatle damage
- Severe damage can be seen in palms with age 3-10 years

Life cycle

Pupa: 20 days
– lives in a fibrous cocoon

Adult : 3-4 months lifespan, reddish brown in color, has a horn in head, have black spots on the head, flies, nocturnal

Eggs; Releases a larva in 3 days
– Female insect lays eggs on new wounds of the stem. Reasons for wounds are external animals, human activities and natural cracks.

Larva : 55 days
white in color, have strong mouth parts, eat soft tissues of the trunk

Female insects lay eggs on cracks in leaf axils, natural cracks in the trunk, wounds occurring on the trunk due to human activities, cracks in areas where roots develop near the ground or damage causing due to black beetle attack.


Nature of the damage and identification

- Red weevil lay eggs in cracks of the base of the stem caused due to rapid growth of palm
- Very difficult to identify a palm of damage at its initial stage
- Damage are done by grubs (larvae)
- A large number of larvae feed on tissues of the trunk and crown
- The palms die by falling from the trunk and crown
- It is common that unable to save palms if the attacks are identified at initial stage.



Signs of the presence of red weevil

- Holes (1.25 – 2cm) observed near the vicinity of the crown and basal area of the trunk. Fiber like things are thrown out from such holes.
- A brown colored viscous liquid oozing out near the holes
- Discolored outer rinds of holes
- When placing the ear on the trunk, crunching noise by feeding grubs inside the crown could be heard.
- Yellowing of leaves and withering and slanting buds
- Presence of fibrous cocoons at the base of the petioles

Red weevil detector

Can clearly identifies the crunching noise due to feeding of tissues.

Following agronomic practices can be used to control damage

- Frequent inspection of the trees and maintaining field hygiene
- Tree inspection – Holes and oozing points from the base of the palm to the crown
- Apply used engine oil to small cracks and put sand & cement mixture for larger holes.
- Adding soil to the base of the trunk
- Regular water supply pattern
- Being vigilant about alternative host plants (Arecanuts, Kithul etc.)
- Burying of damaged trees after cutting them correctly.

Using biological methods

Red weevil pheromone

Red weevil pheromone is a complex chemical compound produced by male red weevils. It belongs to the group of aggregating pheromones.
Can get more efficiency by using for lands with a greater extent than 5 acres

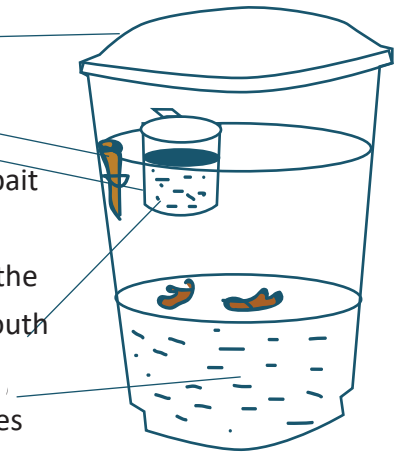
By using these pheromones, can aggregate both male and female insects. These pheromones which contain 4-methyl-5-nanol are prepared artificially in laboratories and hand over to farmers in small tubes.

These pheromones should be placed in traps specialized for them and insects are trapped in these.

Preparing the pheromone trap

Utensils needed

- Plastic container
- Pheromone vial
- Small container with bait
- A sugar and yeast mixture used as bait

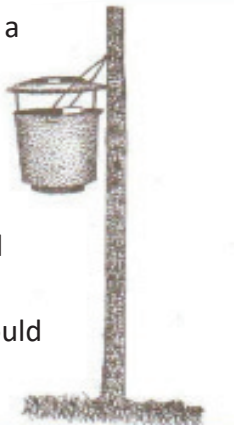


Method of preparing the trap

- Fix the small container with bait in the plastic container near the upper mouth of the plastic container
- Fill a soap solution for about 3 inches within the plastic container
- The upper side of the pheromone vial (thin side) should be carefully placed on the holder fixed near the upper mouth of the small container
- Should tie on the trunk in an accessible height of a trunk
- Can fix traps in several places of the land for a maximum suppression
- Can use wooden stems to fix pheromone traps in a coconut seedling cultivation
- Should apply as a one trap for a ½ acre
- Should clean the traps once a week
- The soap solution and the bait should be refilled
- If the pest attacks are very high, replace the pheromones for every 4-5 months.

Facts to be considered when placing the trap in the field

Pheromone traps should be applied if all the other recommended methods (applying used engine oil on wounds, burning out damaged tree, injecting insecticides to trees with a possibility of saving) of suppressing the pest attack do not work out properly.



- The traps should be placed on a wooden holder or else with a tree other than coconut
- mostly appropriate to place the traps near fence boundaries or in a separate bare place bit away from the cultivation
- Should remove insects in traps once a week
- Should replace the soap solution and the toddy or sugar and yeast mixture from time to time
- At sometimes, it takes time to reach insects for the trap, should allow that time
- Should replace the pheromone once in 3 months depending on the severity of the damage
- Can observe a suppression in the infestation due to use of pheromones.

Red weevil pheromone can be obtained from the Coconut Development Training Center at Bandirippuwatta, Lunuwila or from any regional office of the Coconut Cultivation Board.

Recommended chemical control methods

Application of Monocrotphous (60 % S. L.)

Recommended dosage per palm

- 10 ml for a palm where the trunk is not developed
- For a palm with a thin trunk (base circumference lesser than 100 cm) – 30 ml
- For a palm with a widely grown trunk (base circumference greater than 100 cm) – 40 ml

• Before applying Monocrotphous, should remove 2 bunches of matured coconuts from the tree of damage

• Should not consume coconuts from that particular tree within 2 months of application

• For seedlings where the trunk is not developed, apply 10 ml with 500 ml of water, mix it well and apply for the crown in a way to moisture the buds well.

Injecting the trunk

• For tees with a well grown trunk

• Select a place in the damaged tree with healthy tissues from two sides of the tree

• For the two places inject to a depth of 10 cm, inclined 45° angle in lower sides, using a auger or an electric drill with a diameter of 12 mm

- Apply half the amount for a one hole using a syringe
- Apply the other half for the other hole
- After a week, cover the holes with a mixture of sand and cement
- If an oozing of a liquid is observed at a severe attack, make 2 holes again after 2 weeks and inject.

Application of 20% Thiomethoxam and 20% Chlorantraniliprole

Can observe this in different trade names

The recommended amount for a tree and the method of application

This should be prepared by using a 4 g packet in a 250 ml of water.
The solution should be applied for 1-2 ft for the trunk in holes made on two sides and about 30 ml of the solution for each hole. If the height of the tree is greater than 5 ft, pierce two holes at the limit of 5 ft range and apply around 30 ml for each hole. Close the holes using a concrete consisting of sand after 3 days from the treatment.

7.1.3. Coconut Mite and its control *(Aceria guerronis)*

- An introduced pest that can be observed in dry zone areas of the country
- Firstly, reported in Kalpitiya peninsula during end of 1997
- Spread in every coconut cultivated districts of Sri Lanka
- The damage is done by Aceria mite.

Biological characteristics of Aceria

- Not visible to naked eye
- Have a body shape similar to a long worm
- Have thin hairs in the body
- Body size: length – 205-255 microns, width – 32-35 microns
- Two pairs of legs in the front side
- Life cycle is around 10-12 days
- Spread by wind
- Spread due to walking through bunches
- Can observe as large agglomerated colonies beneath the perianth

Characteristics of the damage

- Damage can be observed mostly in immature nuts
- Can observe the damage as a white triangular patch beginning from the perianth on immature nuts
- Later, this white patch turns into brown and the dried peel is visible as scratched by a sharpen tool
- Can observe severe cracks on the peel
- Deforms the shape of the nut and gradually become small, later becomes brown and dry
- Can observe cracks and sticky substances on the surface of the nut
- Under heavy infestation, damages nuts may fall prematurely

Post stage of the damage

Harvest loss

- Formation of irregular nuts
- Small nuts in size
- Falling of immature nuts
- Difficult to dehusk the nuts
- Unable to sell 30-40 % of the nuts

Managing damage

- Being aware about the damage and related characteristics
- Recommend different control methods
  Depending on the nature and severity of the attack
    - Spraying palm/vegetable oil and Sulphur mixture
    - Adding predator mites

Palm/Vegetable oil and Sulphur mixture

Ingredients to prepare 1 liter of mixture

- 200 ml of palm oil/vegetable oil (1 cup)
- 800 ml of water (4 cups)
- 12 g of soap powder (2 full tablespoons)
- 5 g of wetted Sulphur (moist powder) – 1 full tablespoon
- Mix water, soap powder and Sulphur and then add palm oil into this mixture and mix well

Application method

- Knapsack sprayer or power sprayer can be used by joining flexible plastic tube between the tap and the lance of the sprayer. A bamboo or aluminum pole can be used to reach the crown as in the picture
- 1 liter of the solution is adequate for a palm
- Recommended to spray twice a year (in February and July or August) at the beginning of dry periods where the rainy periods terminate
- The patches due to attacks separate from the perianth and the damage stops.
- The damage is minimized in newly developing immature nuts, after the treatment.

Recommendation to release the predatory mites

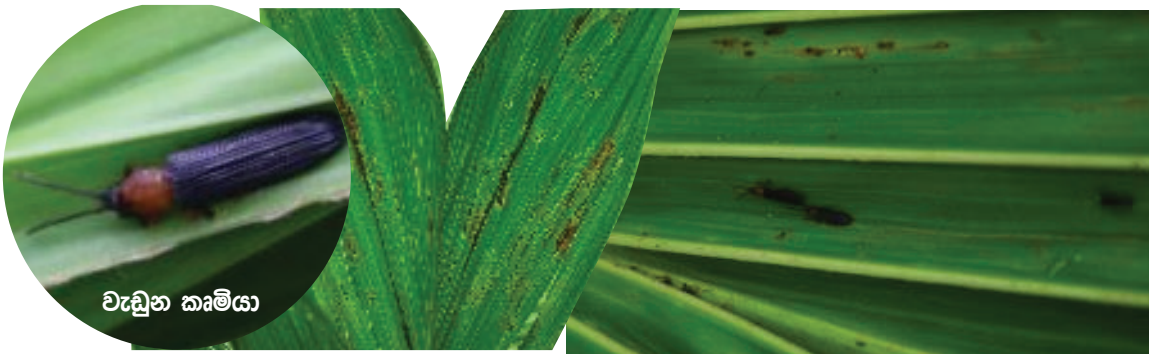
- The predator mite is named as *Neoseiulus baraki*
- Can reduce the harvest loss
- Produced in laboratories and released to farmers
- Should apply 16 mite packets to 16 coconut palms in one acre of land (1 packet for 4 palms)
- Should release three times a year during dry periods in a way well spread all over the cultivation
- Mite damage cannot be suppressed 100%, however, the harvest loss can be reduced.

7.1.4. Plesispa (*Plesispa reichi*) damage

- This beetle was first reported from Badalgama in Gampaha district in 1997 and now spread throughout the country.
- Spread through nurseries as infested plants are transporting to different areas
- Damage to coconut seedlings
- Highly spread all over the Coconut triangle
- Can be seen occasionally in grown palms

Damage and its characteristics

- Spend all the stages of the life cycle on the coconut plant
- Grown insect and the grub eat soft tissues of the unopened leaves in the bud
- The plant growth retards during severe attacks
- Plants die occasionally
- The damage is visible as long lines in attacked leaves by the grown insect and the grub attack is visible as round patches. These can be observed in brown color after the leaflets open.



Recommended insecticides for managing attacks

- Carbosulfan
- Dissolve 3 ml of recommended insecticides in 1 liter of water
- Apply the recommended insecticides once in two weeks until damage dissapear

Applying insecticides

- Bring closer the nozzle of the 'Knapsack' sprayer to the bud and apply solutions deep inside. Good to apply in the morning.
- Apply for every plant in the nursery, even though there are no attacks observed and all the other trees belonging to Palm species.
- Remove unnecessary coconut plants and other plants of the palm family from the cultivating land.

7.1.5. Termites attack

- Damage the coconut husk and the base of the plant

Characteristics of Damage

- Withering of the buds of the newly planted palms
- Easy detachment of the withered bud
- Can observe the damages caused for the husk when observing the nut
- Can observe membranes made from sand by splitting the seedlings and collar region

Suppression of attacks

- Maintaining cleanliness in the land by removing termite hills, degraded substances, broken trees etc.
- Using a solution of 1-2 ml of 20% Imidacloprid dissolved in 1 liter of water
    - Immerse plants in this solution for about 3 minutes before planting
    - If a potted plant, should apply to the soil area around the roots to make it moist well
    - Mulches with termites' attacks around the plant should treat with termiticides

7.1.6. Coconut Caterpillar *(Opisina arenosella)*

- Another main pest found in coconut cultivation
- Can be seen prominently in dry zone areas.
- Can be seen prominently in dry periods of the year
- Can be observed in lands where previous attacks observed and lands in the vicinity to those lands
- At sometimes, newly infested areas are reporting
- Gradually reduces the yield under heavy infestation to the coconut leaves

7.1.7 Moth

Nature of the pest

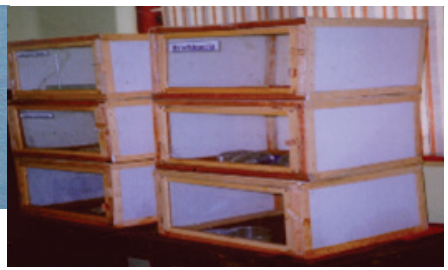
- Adult moth is ash brown in colour
- 12 mm in length
- Lay eggs in clusters on the lower side of the leaves
- Small caterpillars are pink in color and later turn into greenish brown colour
- Caterpillar feeds on the superficial leaf tissues while living inside the galleries

Nature and identification of the damage

- Damage caused by caterpillars eating tissues in the lower sides if the leaves
- Green patches are observed first in the damaged leaves and then gradually turns into brown color and dry off.
- Leaves get a burnt nature in severe attacks
- Damaged trees can be identified by observing for dried patches in the lowest branches of the tree
- Caterpillars can be observed in clusters made of tiny leaf pieces and excreted materials, underside of the damaged leaves
- Can damage nuts as well

Management

- No overlapping stages can be observed in the life cycles of the coconut caterpillars. (Can observe only a stage within one period of the life cycle).
- Can release several types of parasitoids into lands with coconut caterpillar attacks.
- These parasitoids are released by matching the life stages of the life cycle of the coconut caterpillar
- Accordingly, target and release the appropriate larvae / pupae parasitoids to damaged plantations
- Parasitoids are growing as internal/external of the pest body



Larvae parasitoids

- *Bracon hebator* (External parasitoids)
- *Goniozus nephantidis* (External parasitoids)
- *Eriborus trochanteratus (*Internal parasitoid)

Pupae parasitoids

- *Tricosphillus puplovara* (Internal parasitoid)
- *Brachemeriya nepantidis* (Internal parasitoid)

Method of releasing parasitoids

Should get a report on level of infestation from the Coconut Development Officer in the area.

Places to get parasitoids

- From breeding centers of Coconut Cultivation Board in Batticaloa, Hambanthota and Mundalama
- From the breeding center of Coconut research Institute

Chemical methods

Recommend to inject 8 ml of Monocrotophous if parasitoids fail to control in severe epidemic attacks

7.2. Minor pests in coconut cultivation

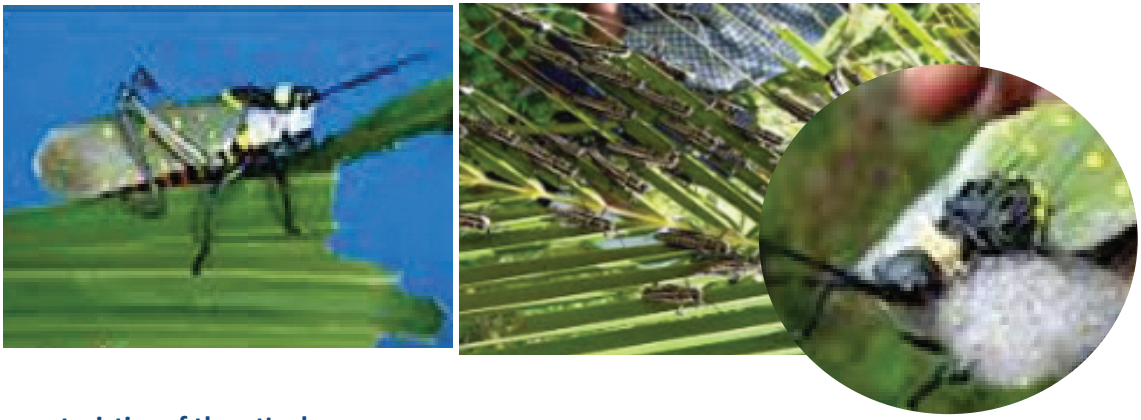
Pests that increase significantly at a certain time of the year
Higher possibility of suppression naturally
Can apply short-term suppression methods

1. Yellow spotted locust (*Aularches miliaris*)
2. *'Kuseetha'* caterpillar (*Parasa lepids*)
3. *Elymnias* caterpillar (*Elyminias hypermnestra*)

4. Scale insect /*Korapothu krumiya* (*Aspidiotus destructor)*
5. White fly (*Aleurodicus cocois*)

7.2.1. Yellow spotted locust *(Aularches miliaris)*

- Grown locust is large insect
- Can observe yellow spots on front pair of dark green wings
- Bright yellow thorax
- Female locust lay eggs as pods in the soil
- Nymphs (baby locust) coming out from eggs are similar in shape for grown locust, however small in size and wings are not fully developed.
- Prominent in plantations near forests in the wet zone



Characteristics of the attack

- Eat leaflets leaving only the eakle. The attacks done as groups are somewhat severe

Control

- Can destroy the eggs in the soil by turning soil or ploughing
- Weed controls, if pests remain hiding among weeds,
- Collecting pests and destroying by firing them in the evening
- In severe attacks, can spray insecticides such as Marshal 20 S.C. during nymph stage.

7.2.2. ‘Kuseetha’ caterpillar *(Parasa lepida)*

- Grown moth is green in color
- Have a brown edge in front wings
- Female moth lay eggs on underside of the coconut leaflets
- Caterpillars coming out from the eggs, eat parts of coconut leaflets and grow
- Can see green colored lines on either side of the body
- Have hairlike spikes overall the body
- Contacting those hairs are toxic
- Grown larvae build pupae cocoons underside of the leaves or trunks
- Later develops as a moth

Control

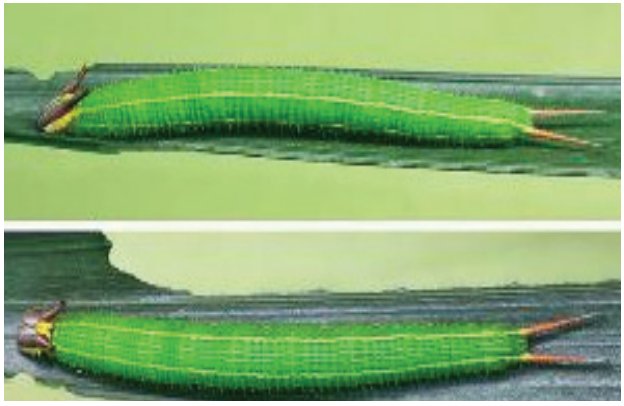
- Larvae parasitoids are available in nature
- Can control by pupae parasitoids and by predators
- Should inject 8 ml of Monocrotophous into the trunk at severe attacks

7.2.3. Elymnias caterpillar *(Elymnias hypermnestra)*

- Caterpillar is green in color. 40 mm in length.
- Back end of the abdomen can be observed as two spikes.
- Can observe well-grown, two hairy spikes in the head.
- The grown moth is a butterfly its forewings with reddish orange in color.
- Can observe white colored dotted lines in edges of the wings
- When wings are expanded larger for about 55-75 mm.

Damage and its characteristics

- Damage nursery plants and field planted seedlings
- The female butterfly lay eggs on leaflets of coconuts or any other trees of Palm species.
- Caterpillars coming out from eggs eat coconut leaves.
- Eat leaflets of the leaves with eakle as cut by a scissor

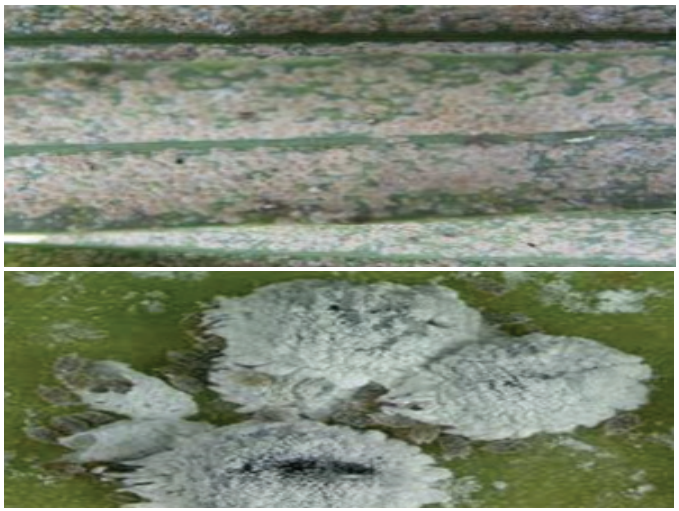


C

- Destroying after hand collecting
- Mix 3 ml of Carbosalphan with 1 liter of water and spray

7.2.4. Scale Insect (*Aspidiotus destructor*)

- Minor pest which can be observed seasonally
- Attack leaves of coconut palms
- Prominent in longer drought periods as it is favorable for breeding. Reduced infestation during rainy periods.



Characteristics of the damage

- Damage starts from the lower leaves and gradually spreads to upper leaves
- Can identify the damage by tiny yellow patches observed in suspected plants
- Can observe insects of light pink color on undersides of the damaged leaves
- Damage coconut flowers and small nuts.

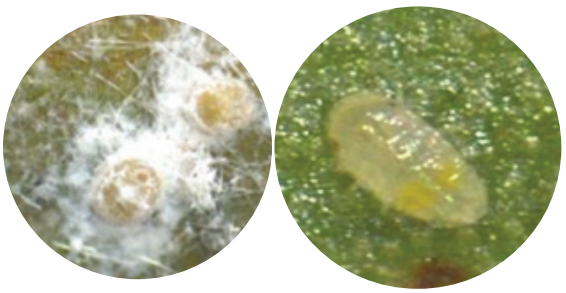
Control

- Controlled by natural predators
- Lady Bird Beetle (LBB) insects which are in black and brown color can be observed undersides of the damaged leaves and they eat scale insects.
- At severe attacks, spray 4 ml of carbosalfan of 20% dissolved in 1 liter of water using a 'Knapsack' sprayer.
- Inject 8 ml of Monocrotophous to the trunk of coconut palm.

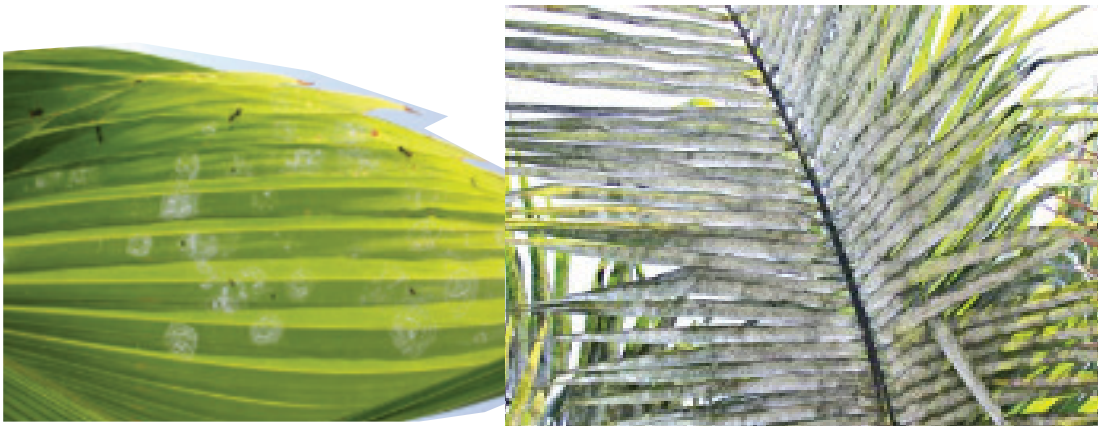
7.2.5. White Fly (*Aleurodicus cocois*)

- An insect which sucks the sap of the coconut leaves
- Eggs are oval in shape and yellow in color
- Irregular, spiral shaped/having white wax around/semi-circular spread eggs

Characteristics of the damage



- Laval stage & adult moths suck juice from undersides of leaflets
- Can observe excreted excess fluid deposit on the surface on the lower leaves
- They are like honey dew and sticky in nature
- Yield lost is minimum under lower infestation
- Pests spread slowly from external leaf rounds to the internal leaf rounds
- Loss of chlorophylls lead to yellowing of leaves. Hence retarded photosynthesis causes to reduce the yield.



Climatic features contributing to the spread and areas of spread

General whiteflies are more abundant during the period of worm weather. Prominent in coconut cultivations of the wet zone. Can be seen in Kegalle, Gampaha, Kurunegala, Rathnapura and Mathale district also.

Control

Controlled by natural predators

Hymeopteran parasitoid
Encarsia sp

Lady bird ***beetles-***
Jauravia sp

Chemical suppression

- Dissolving 3 ml of Thiamethoxam in 10 liter of water or
- Dissolving 20 ml of Carbosulfan in 10 liter of water or
- 2.5 g from a mixture of Chloran[Chlorantraniliprole]amethoxam dissolved in 10 liters of water

Spray until leaves get moistened by one of the solutions prepared as above.

Agronomic methods

Trapping of moths by sticking to a grease applied yellow colored polyethene which is wind around the trunk of a palm

7.3. Mammal attacks in coconut cultivation

Mammal pest attacks on young and bearing coconut palms is a concerning issue for coconut growers in various region of the country. Several mammal species including rates, monkeys, wild boars, and wild elephant have been known to cause damages to coconut palms leading reduce yield and even palm death.

Attacks during seedling stage	Attacks during nut bearing stage
Wild boars Bandicoot Hedgehog/ procupine Indian pangolin Rats	Monkeys Wild elephants Bats Giant squirrels

Following methods can be applied to control attacks from wild pigs, hedgehogs and Indian pangolins

01) Placing barrels

- Putting half cut barrels around the plant as a cover
- Should fix well to the soil
- Make as a pointed end at the upper end
- Should aerate the plant during dry by piercing holes in the barrel

02) Erecting wooden stems around the plant and covering by polythene

03) Engaging soil filled tyres around the plants

- Large tyres are used for this
- Filling soil to tyres and putting around the plant as shown in figure (one above the other)

04) Other suppression methods

- Building a fence around the plant using Gliricidia stems standing closely
- Spreading black stone pieces around the plant
- Covering around the trees with plates or outer peelings of timber
- To control the entrance of wild pigs hair pieces are spread around trees during dry periods

Attacks during nut bearing stage

Monkeys, Rats, Wild elephants, Bats, Giant squirrels

Rats attack

- They attack for small immature nuts
- Nuts fall due to such attacks
- Plates are fixed to suppress rats (a plate of 1.5 ft in length and 5 ft in height is built around the trunk). Due to this, rats are avoided from climbing up the trunk from the ground
- Trimming the tips of branches where the trees are grown closer in a way to touch each other's branches
- Cleaning the crown of the tree and destroying rats' nests.

Wild elephant attacks

- Building an electric fence for a commercial coconut cultivation
- Planting 'Hana' plants in ridges made around the land by cutting drains and soil removed for upper sides of the drain.
- Establishing a lime cultivation around the land
- Making noises by lighting up sound and fire crackers to chase away elephants
- Lighting up out of the cultivation by fires.

Attacks from monkeys, giant squirrels and rats

- Attack coconuts
- Using air rifles to control (Should execute these fearing methods in a way not to harm the animal)
- Sounds and sky crackers can be used

7.4 Main diseases in coconut cultivation

- Bud rot
- Stem bleeding
- Ganadoma/Rotting of the roots and basal areas
- Leaf rot
- Weligama leaf wilt disease
- Crown basal rot
- Leaf blight disease
- Drying off of leaves in coconut plants
- Drying off of leaves in coconut seedlings, basal drying and rotting

7.4.1. Bud rot disease

- Causal agent is *Phytophthera palmivora*
- Causal agent is prominent in coconut cultivation in the wet zone
- The bud completely destroys and ultimately palms die off
- Destructs any age group

Symptoms

- It is found that this disease is prominent in palms of age 5-45 years
- Withering of the spear leaf
- Becomes brown and dry off
- When the fronds are pulled out it detach easily
- Releases a very foul odor
- Healthy leaves are green in color at early stages and later they dry off
- Ultimately, the bud and the dried fronds detach and fall off

Disease management

Infected crown should be cut and burn
If the disease is diagnosed earlier, infected crown should be cut off and should moistened the bud well with a fungicide which contains 1% copper or a fungicide solution which contains Metalaxyl (prepared by 4 g of fungicide in 1 l of water) once in two weeks.
To save the trees around the infected tree, can apply moistening the bud area by using 6 g of Dithiocarbamate fungicide/ 4 g of a fungicide containing Metalaxyl dissolved in 1 liter of water once in three weeks during rainy periods.

Making fungicide bags and treating the plants

Take a 6 x 6-inch square shaped gunny piece and place handful of coir dust and tie up to make a small bag. Immerse the bag in a 1% fungicide solution which contains copper and dry off in air once it gets fully wet.
Place one bag in the axil of the youngest leaf.
When a new emerges emerges, it is important to keep the bag near the base of the newly emerged spear leaf monthly.
It is important to manage diseases by applying a balanced fertilizer mixture

7.4.2. Steam Bleeding

Causal agent is *Ceratocystis paradoxa* fungi
Lowering of the yield in a considerable amount and dying off of the palms
Can observe that the disease is rapidly spreading in cultivations
Recorded from different areas of coconut cultivation

Occasions where oozing out from the trunk can happens

Due to thunder shocks and fire shocks
Red weevil attacks
Excessive use of fertilizer
Flooding after a drought
Ganadoma disease

7.4.3. Stem borer attacks

Symptoms of disease

- Patches spread in lengthwise on the surface of the trunk
- Oozing out a brownish liquid from cracks in the areas with patches
- Degrading of internal tissues in the areas with patches.

Disease management

- The trunk is infected only through wounds and cracks observed on the trunk
- It is important to manage the plantation in a way not to cause wounds or cracks on the trunk
- Applying a fungicide containing Copper / Bodo mixture on the cut areas of the infected parts
- Water supply especially during a severe drought
- Improving drainage in water logging fields
- Control the stem borers
- If an oozing out is observed after a thunder shock, should allow to drain off the internal fluid out by making holes in the trunk

7.4.4. Ganadoma / Roots and basal rot

Causal agent – *Ganoderma boninesnse*

Symptoms

Oozing out of brownish, thick liquid from the cracks observed in the base of the trunk
Hanging of withered and yellowed leaves in the outer whorl of the palm (The fungi destroy the internal tissues and the root system of the plant)
After the infection, falling of branches and bunches and later crown falls off.
Falling off the palm from the base
Can observe Ganadoma fungal mushrooms around the base of the tree as a reddish-brown round, when the attacks are severe.

Method of spreading the disease

Easily transferring
Spores from the causal agent spreading disease spread by forming fruiting body of mushroom within the soil and infect the roots
Diseases are spread by contact of the infected roots with healthy roots

Avoiding the spread of the disease and suppression

Burning the infected trees and parts cut off from the infected trees

Cutting drains around the tree

Applying fungicides for infected trees

Cutting off the parts rotting under the infected areas where oozing out continues until the healthy tissue meets and also with a part of the healthy tissue

Should apply fungicide solution containing 1% of Copper or Bordo mixture on places of cut

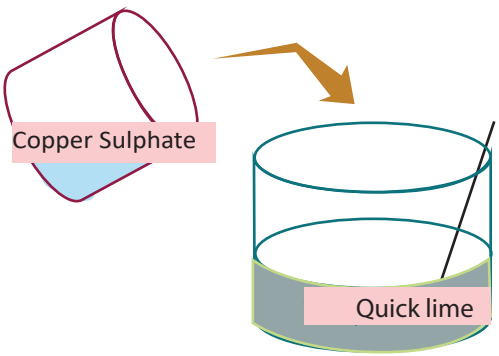
After 10 days should apply liquid tar on those wounds

Preparing the 1% Bordo mixture

Materials needed

- Quick lime/lime soda ash (Calcium Oxide)
- Water
- Copper Sulphate

Dissolve 1 kg of quick lime in 50 liter of water in a plastic vessel. Separately dissolve 1 kg of Copper Sulphate in another plastic vessel. Then gradually add the Copper Sulphate mixture into the mixture of lime and mix slowly using a wooden stick.

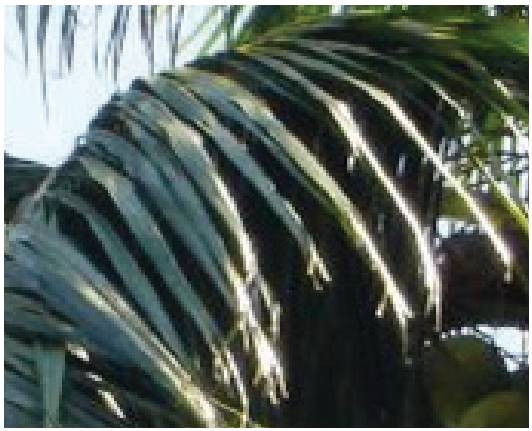


7.4.5. Weligama leaves wilt disease

An epidemic spreading in the Southern province

Causal agent is a phytoplasma. This disease is first recorded in Weligama area in Matara district in end of the 2006.

The symptoms of this disease is similar as the disease which leads to withering of leaves in Kerala region of India.



Symptoms

It takes a longer time to show the symptoms

The leaflets become flaccid and develop marginal necrosis

Yellowing of leaves

The leaf edges show a burnt nature in severe cases.

Reduction of yield

Management

Farmers should be aware whether there are trees with such symptoms in their own plantations. As there are no exact treatment for this disease, measures should be taken to stop the spread of the disease to other regions.

The infected trees should be cut off from the ground level and should burn out the parts of the crown. Used engine oil should be applied to places of cut. Plant parts with be causal agents should not be transported out.

It is said that the variety green dwarf (*'Kola Kundira')* is somewhat resistant to this disease.

One of the main management strategies to control the spread of the disease is introduction of 3 km protective zone at the boarder of the infected area. Regular infection has to be carried out to keep this area free from diseases by removing the infected palms.

7.4.6. Basal rot disease

Infect to the nursery seedlings and newly planted seedlings

Due to the tissue infection done by soil bacteria by entering through the growth point of the seedlings, such places rot gradually and die off.

When bacteria infect through the attacked places by black beetle in young plants, the basal area gradually rots.

High moisture also leads to the infection

Symptoms

Firstly, can observe the withering and discoloration of the bud
After that drying off occurs. Furthermore, the bud and the basal area of the crown begins rotting.

Managing the disease

Planting in a way to uncover the basal region (collar region)of the plant

Removing the mulch around the plant during rainy periods and stopping the water supply

Improving the drainage in the soil

Destroying the diseased plants

7.4.7. Leaf blight disease

A disease that can be observed in every area.
Can be infected by any age group of coconut
However, these kinds of fungal attacks can severely damage the seedlings
Weakening and obstacles are posed on regular growth of the palms.


Causal agent

Caused by two parasitic fungi known as

- *Pestalotiopsis palmarum*
- *Bipolaris incurvate*

In Sri Lanka, the most prominent leaf blight disease is mainly due to *Pestalotiopsis palmarum*

Other factors contributing for the infection and spread

High humidity in the environment
Weak drainage in the soil
Dry weather conditions
Deficiency of Potassium
Heavy application of Nitrogen fertilizer

Symptoms

At first, yellowish-brown tiny spots appear on the leaflets
Gradually emerging of big areas in brown colors in leaves starting from merging of spots which turn to gray patches with dark brown margins
Firstly, can observe in lower leaves of the palm
At sometimes, fungi infect the coconut branches

Management of diseases

Improving drainage in the soil
Water supply during dry periods
Removing heavy shades
Using balanced fertilizer
Can successfully control the disease at epidemic situations by using fungicides.

7.4.8. Drying of leaves in plants

A disease that occurs in nurseries and immediately seedlings are planted in the field.
Causal agent – *Curvularia lunata (Cochliobolus lunatus)*

Symptoms

The main symptom is drying off of the plants from the bottom

This drying off starts from old leaves and gradually spread to young leaves

When infected, plants weakened and if not treated, the infection becomes severe and may lead to dying off of plants

To avoid the disease

Agronomic practices

Weeds suppression/control
Improving the water drainage of the land
Water supply during dry period
Applying balanced fertilizer to the cultivation
Applying fungicides containing 1% of copper if the disease spread as an epidemic

7.4.9. Drying and rotting of leaf base

It is recorded this occurs in nurseries where saw dust is used as a mulch
A fungus is the causal agent

Symptoms

The white colored fungal mycelium can be observed in base of the coconut palm and leaves and later it turns into brown color and rots leaves the dried areas
If the infection begins when the plant emerges, all the branches of the small plants get rot.
As the fungi grow slowly, new fungal infections cannot be observed in coconut plants that grow faster
If infected plants are planted, the rotting of the roots may lead to dying of the plants.

Disease suppression

Do not use saw dust as a mulch in disease prone areas
Applying a solution of fungicide which contains the chemical ‘Tebuconazole’. This can be prepared by using 4 ml of the fungicide dissolved in 1 l of water
If the roots are rot in the field plants, can apply this fungicide solution (5-10 l) to well moist the basal region of the plant.

8

Accounting and Documentation for Coconut Cultivation Management

8.1. Introduction

- land resources should be efficiently utilized to gain maximum profits from a coconut land
- Should apply farm management principles.
- Should recognize farmers needs and targets
- Accordingly, should prepare a plan for farm management
- For an effective management of the farm, shall have sound technical knowledge and documents on all activities taken place within the farm.
- The Farm Manager is responsible in taking correct decisions continuously and should have a better understanding of engaging staff in appropriate and relevant services.
- Should have an understanding on labor laws and norms.

8.2. Proper identification of all resources in the land

- An idea should be gained regarding the maximum yield that can harvest according to the soil suitability of the coconut land. (For this purpose, can use the classification of soil suitability presented by Coconut Research Institute).
- Should have an idea on the amount of water that can be supplied from natural water sources in the areas especially during dry periods and also about the rainfall pattern of the area.
- It is important to record rainfall by using a simple rain gauge.

- A census report on the estate should be prepared according field numbers by numbering of the palm in each block.
- Should number separately as bearing palms, nonbearing palms, palms that have reduced yield.
- Should note down the entire number of acres in the land and as well as cultivatable land amount.
- Other than numbering coconut palms and conducting a census, it is important to consider about trees with a timber value and number those trees as well.
- Should gain an understanding on the geographical situation of the land
- Should have an understanding on the type of soil conservation method to be followed according to the sloping intensity of the particular land.
- Should decide the agricultural activities to be carried out based on the soil and counter maps of the land

8.3. Use of technical knowledge for coconut cultivation and intercropping

- Selecting suitable plants for the cultivation
- Applying fertilizers from the time of planting to nut bearing stage.
- Applying fertilizer to manage adult palms
- Soil moisture conservation
- Weeds control
- Pest and disease control
- Inter-copping
- Water supply etc.

It is responsibility of the manager to conduct all these activities in technically sound manner

8.4. Plucking coconut harvest and identification of relevant documents

- Should prepare the harvesting calendar at the beginning of the year.
- If harvesting is done monthly, plucking only a one bunch of coconuts.
- If plucking is done once in two months, should pluck two bunches of coconuts
- The harvest differs from pick to pick

- Note down the harvesting results in a easy method enabling comparison with previous harvests.
- Calculating the annual coconut yield
- Calculating the profit by using cost of production and selling price for a coconut.

8.5. Preparing estimates

At the beginning of every year, budget estimation should be calculated for every development activity planning to be conducted in the respective year.

Estimated Cost

Recurrent expenditure	Capital expenditure
• Employee wages • Employee Provident Fund • Employee Trust Fund • Travelling chargers • Building maintenance chargers • Road repairs • Machinery maintenance • Transportation • Insurance services • Buying fertilizers • Plucking coconuts • Other value-added products	• Constructions (Building, roads) • Purchasing machineries • Establishing water supply and irrigation systems

8.6. Usage of machineries

- Nowadays, it is more profitable to use machineries and equipment as it is more effective than labor due to high labor wages and difficulties in finding manpower.
- Furthermore, it is faster and more profitable to engage machineries and equipment in digging and filling holes, cutting drains, cutting trees and weed suppression.

8.7. Labor requirement

- At least, there should be a one well trained skill labor per 5 acres of land.

- It is unable o conduct land development activities properly, when it is difficult to find adequate manpower as the need arises.
- To address urgent labor requirements, have to supply manpower based on contracts.

8.8. Cost Control

- Should try to minimize cost of production.
- According to current situation of expenditure, should calculate coconut the cost of production to cultivate in an acre. This may vary according to development requirements of the land.
- Under good agricultural and management practices, it takes around 5 years to initiate of the coconut plantation.
- It takes around 10-12 years to come into maximum bearing of nuts and generate a profitable income by the plantation.
- By inter-cropping in the first 3-4 years, can settle the investment done for coconut cultivation. Accordingly, it is more effective and productive to have an intercropping system during cultivation.

8.9. Identification of documents and records that are used for plantation management

To successfully manage the plantation, all daily routine activities should be recorded.

Following records are used to capture the harvest.

1. Watchers' coconut record book
2. Record for fallen coconuts
3. Coconut counting record
4. Coconut harvest record
5. Coconut clearance record
6. Dried /Copra record

8.9.1. watcher's coconut record book

As an example, assuming that the coconut land is divided into three fields as A, B and C, watchman's daily collection should be recorded as given in below table.

A (Field)			**B (Field)**			**C (Field)**		
2024 – 01st pick			2024 – 01st pick			2024 – 01st pick		
Date	Input	Total	Date	Input	Total	Date	Input	Total
24.01.01	2	2						
24.01.02	3	5						
24.01.03	4	9						
24.01.04	2	11						
24.01.05	6	17						
24.01.05	9	26						
24.01.06	10	36						
24.01.07	12	48						

8.9. Record for fallen coconut

The figures recorded by the watchman regarding fallen nuts, is daily calculated and recorded in the above office record by the Field Officer in Charge. The signatures of both watchman and the Field Officer in charge should be mentioned in those records.

8.10. Documents and models using for the calculation of coconut harvest

Forms to be handed over by the land owner regarding counting coconuts, clearance of coconuts and processing of copra.

Coconut harvest record

Year ..... Month .....

Name of the land .....

Pick ..... Harvest receiving : Fallen nuts : Start ..... End .....

Plucked nuts : Start ..... End .....

Annual Estimate

Estimate for this Pick

Harvest declaration

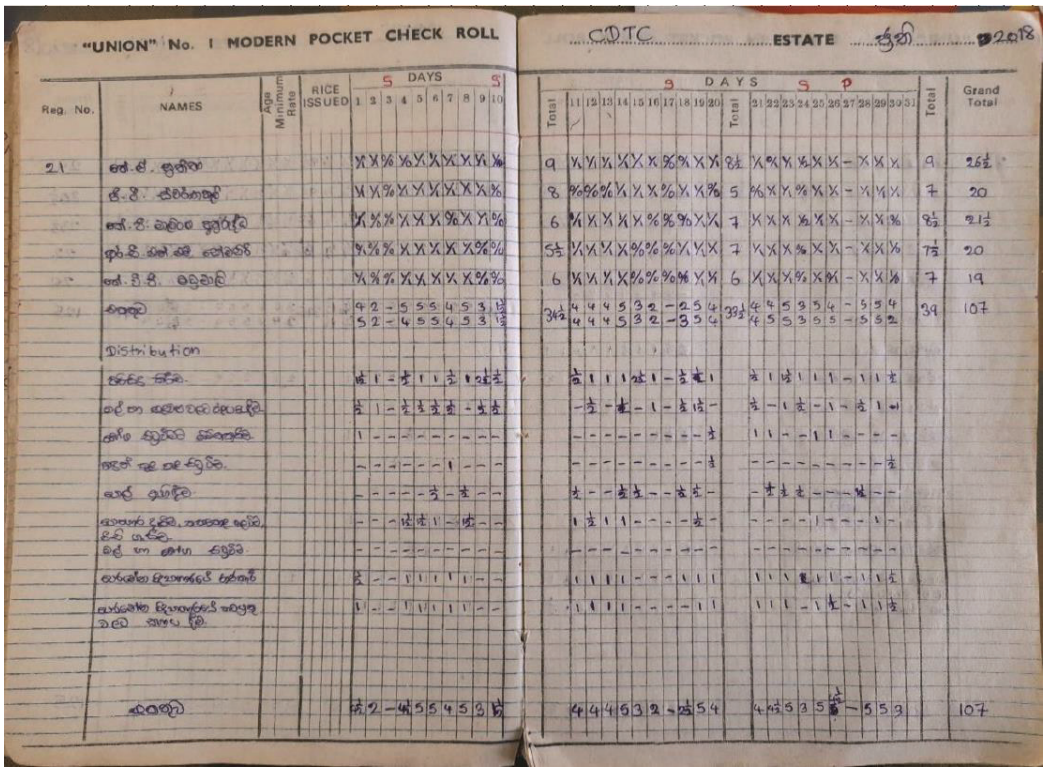
Field No.	Number of bearing palms	Number of fallen nuts	Number of plucked coconuts	Total number	Number of nuts in this pick in previous year	Fluctuation (- / +)		Number of nuts per palm this year	Number of nuts per palm in the last year	Fluctuation (- / +)
						Number	%			Number
This pick										
Previous pick										
Up to now										

Documents related to labor control

- Pocket check roll
- Work distribution record
- Large check roll
- Event advance / Special wages register
- Leave payment records

Pocket Check roll / Master book with distribution

The attendance of check roll employees is recorded in this book. The image of a filed check roll is given below.



Large Check roll

This is the record of payment for check roll employees. This includes,

- Employee attendance
- Daily wages
- Name and possession of the employee
- The types of advances received by the employee during the particular month
- Employee Provident Fund and charges for harvest received by the employee on a loan basis
- The balance salary payment is recorded etc. are recorded separately.

Employee salary record / pay sheet

Below gives an example for a employee

EPF No.	Name	No. of working days	Daily wage	Wage to be paid	Deducted (EPF 10 %)	Other	Total of deductions	Remaining salary
35	**B. A. Sisira**	**26**	**1000/=**	**26000.00**	**2600.00**	**250.00**	**2850.00**	**23150.00**

Event advances / Special wage advances record

- An event advance/special wage advance records are maintained in an office of a plantation for,
- To facilitate re-charging of annual advance payments from check roll employees
- When paying these advance payments, two owners of EPF should signed as guarantors (An advance record presented is shown below).

EPF No.	Name	Amount	01 Guarantor (EPF No.)	02 Guarantor (EPF No.)	Year …….						
					Jan	Feb	Mar	April	May	June	Total
35	B.A. Sisira	5000	36	45	835	833	833	833	833	833	5000
36	H.M. Neel	5000	45	35	835	833	833	833	833	833	5000
95	D.A Anil	5000	81	67	835	833	833	833	833	833	5000
	Total	15000	-	-	2505	2499	2499	2499	2499	2499	15000

Documents and records for financial control

- Financial documents / Cash book
- Ledger
- Important to maintain sources of income and related records.
- In addition, for large scale plantations, documents and records like fixed assets documents, inventories, documents relating to animals and rainfall data records are maintained.

METHODS TO MAKE COMPOST

Heap method

- Free from stagnating water and level ground with proper drainage, light & mild shade is suitable
- Level the ground & make in a way not to collect water
- Mark the size of the heap (length and width)
- First spread a layer of dried leaves for about 6-8 inches in height
- Add a layer of animal fertilizer on that layer for about 3 inches in height

- Place plant and animal wastes layer by layer for about 5 ft in height. When spreading likewise, should add innoculant (old compost) between each layer.
- For 1000 kg of raw materials, spread 50 kg of rock phosphates on the layers.
- After spreading, cover with a polythene by leaving a space of about 10 inches from the bottom and tie well using a piece of rope.
- Test for moisture and temperature once in every week. If moisture is inadequate, add water
- Should maintain a hand feeling temperature within the heap in first 4 weeks If the temperature is lowered, check for moisture and add water accordingly.
- First figure labels – Rough raw material layer, layer of broiler manure, Gliricidia, Cow dung/poultry manure, grass, cow dung/poultry manure, pieces of banana stem

- Do the first turn after 4 weeks and re-heap. Keep covered as previous.
- Do second turning after 4 weeks from 1st turning and do 3rd turning after 4 weeks from the second turning.
- After each turn, cover heap with polythene. it can be used as a fertilizer after 3rd turning.

- If decomposing is inadequate even after the third turning, re-heap and moist well. Keep for extra 2 weeks.
- Decomposing can be speed up by adding innoculant and water during each and every turn

Attention..

If there is no animal waste, spread dried plants and raw green leaf alternatively.

If the using raw materials are too much dry, water should be added to moisten when a layer is spread.

If the using raw material is too much wet, take care to spread them on a dry layer.

A greater yield of compost can be obtained if animal fertilizer is used in relative to the use of green leaf matter.

Accordingly, you can produce high quality compost within 3- 3.5 months and can use after sieving through a 4 mm mesh, packaging in small bags and storing in non-wet place.

Increasing the quality of the compost

Use more amount of animal waste and legume crops to get more Nitrogen.

Mix chaff charcoal (5% of the total weight of produced compost) to increase the amount of Potassium

Using more wild sunflower as a raw material

Use 5% Eppawala Rock phosphate to increase the amount of Phosphorous

PRODUCTION OF VERMICOMPOST

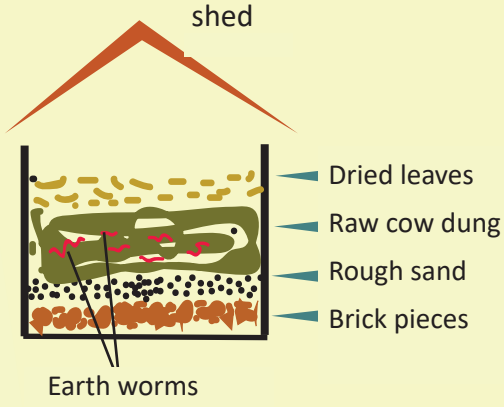
Manure produced from plant and animal waste with the support of earthworms can be introduced as 'Vermicompost'.

Breeding earth worms

- Add a wet sack immersed in a solution of cane sugar jaggery on a heap of garbage in the homegarden. Add raw cow dung on it as well.
- After a week, can observe a large number of red earthworms' under-side of the sack. Take them out and put in a container with raw cow dung.

Multiplication of earth worms

- Pierce a half of a 200 liter plastic barrel at its bottom to drain off water
- Place that in an place with adequate shade
- Spread roofing tiles or bricks pieces in the size of 2 inches at the bottom of the container
- Add a 2 inches layer of rough sand on that, and add a 2 inches layer of raw cow dung on that
- Add earthworms on that raw cow dung layer.
- After that, add a layer of straw/dried leaves/plant leaves and moisten adequately
- After a month, can observe that earthworms are multiplied.



Production process of vermicompost

01) Tank method
02) Barrel method

Tank method

- This method is highly suitable for commercial production
- A building with a roof is necessary to supply shade
- The tanks built in this should be of dimension as required (in general 6 ft in width, 3 ft in height and 10 ft in length)
- It is necessary to layer the bottom of the tank with concrete or cement
- If not cemented, earthworms will move into soil and the nutrients may leak
- If the tank bottom is built little inclined with holes in the wall base, and letting the solution flow out will generate liquid vermi wash liquid fertilizer.

Production process of vermicompost in tanks

- Spread a layer of leaves and waste for a thickness of 6 inches for the bottom of tanks. Add a layer of cow dung on that and another layer of leaves and waste for about 2 feet height.
- Fill the tank accordingly and add the cow dung mixture with worms in a way spreading uniformly on that. Then moist the tanks as needed and provide shade and ventilation. Important to maintain the optimum moisture.
- After a month, it is observed that added organic matter converted into vermicompost.

Separating worms from vermicompost

- Heap the prepared vermicompost near one edge of the tank
- Collect raw cow dung, leaves & waste to space side of other end
- Let the side of compost to dry If possible, get sunlight
- Moist and provide shade and ventilation adequately, the side where raw cow dung and leaves and waste are collected.
- Accordingly, after a week, can observe that worms in vermicompost are moving towards the other side with raw cow dung, leaves and waste.

- After a week remove compost from that heap a height of one feet per day from the top to bottom.
- Accordingly, continue likewise until the dried compost matter on the top finishes (worms try to prevent sunlight and move other side where new raw materials are heaped)
- Later fill the tank completely with a new organic matter and cow dung mixture
- Accordingly, can produce vermicompost continuously.

Barrel method

- This method can be used to produce vermicompost in small scale. A container made of cement, plastic or metal can be used. The height of the container should be 3 ft maximum. The bottom should be sealed well.
- Pierce the wall near the bottom to drain off water. Keep that in a well shaded place.
- Should make at least a temporary hut to get shade.Provide a dried leaves and waste layer to the bottom of the container for 6 inches thickness

- Add a layer of organic matter and cow dung above that layer for a thickness of 2 ft.
- On that spread cow dung and prepared red earthworm mixture uniformly.
- Provide moisture, ventilation and shade needed for that container.
- Can get vermicompost after about a month.

- Can collect liquid vermicompost as well through the holes at the bottom

Advantages of vermi compost

- Higher in quality. The time taken to prepare compost is less. No need of turning the heap.
- The labor requirement is very low
- In addition to nutrients for the crop growth, this contains compounds increasing plant growth, antibiotics, soil enzymes and favorable microbes.
- By using vermicompost, the crop yield increases in the amount and as well as in the quality
- Also increases the resisting ability of facing infections and pest attack

Producing Bio-char

Materials needed

- Gliricidia, Ipil Ipil like strong wood parts
- Top & bottom removed large barrel of 2-2.5 ft diameter and mouth opened barrel with a 1 ft diameter
- This should be 1.5 ft lesser in height than the big barrel
- Coconut shells and wood pieces to facilitate firing

Large and small barrels

Preparation

- Make windows in the large barrel near the bottom]
- Lay the materials needed to produce bio-char in the small barrel and close the lid
- Keep the small barrel 7-8 inches higher from the ground level using the support of bricks
- Keep small barrel in the mid and then the large barrel
- Then fill small pieces of wood, coconut shells, saw dust etc. into the gap between the small and the large barrel
- When the materials fire, add more and keep the firing continues for about 1.5 hours
- After firing, take the char out and moist and blow out using water
- Then take out the small barrel immediately and pour out the bio char in it and add water and blow out

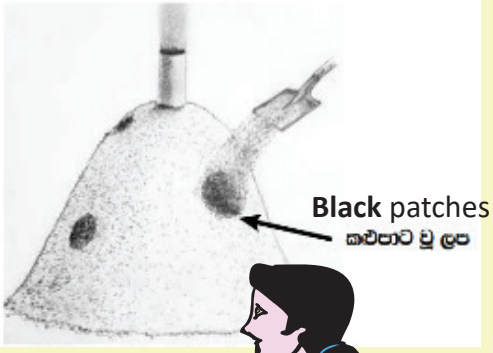
Chaff/Rice husk char
Produced by half-firing of rice husk under controlled conditions

Preparation
Can use two methods for this
01. Kunthan Chimney method
02. Heap method

Kunthan Chimney method
- Take a good barrel attach a smoke tube to the bottom of the barrel by welding as shown in the figure
- Prepare a Kunthan chimney by making holes in place to place of the barrel
- Place a small fire by using wood, coconut shells etc.
- Wen firing goes well, keep the chimney on the fire using bricks
- Heap up rice husk covering the chimney in full
- After about 4 hours can observe black patches in place to place of the rice husk heap
- Before fire comes out from those places, cover the patches with unburnt rice husk
- Important to use tools like a spade or a mamoty for this purpose
- After about 6 hours remove the rice husks around the chimney carefully using a mamoty or another tool and take out the chimney
- Remove the remaining leftovers in the middle of the rice husk heap and add water to prevent further firing of half fired rice husks


Chimney

Covering black patches by burnt husks



When putting water, all the rice husks should be converted into black char. Don't pour water on the heated barrel at any time.

Preparation of rice husks char by Kunthan chimney method

Kunthan chimney

Heaping up rice husk

Covering black patches with rice husk

Mixing half burnt rice husks

Preventing further burning by adding water

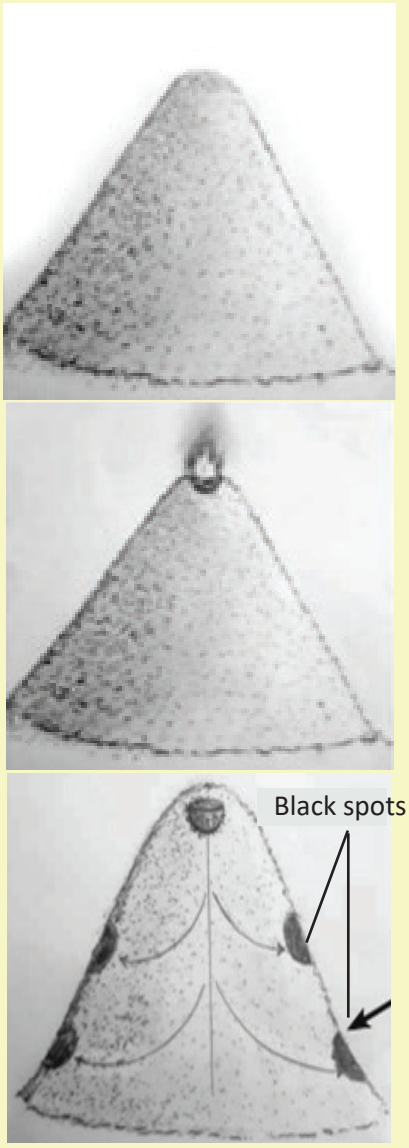
Heap method

- Heap up rice husks in a dry area
- Make a hole on the top of the heap and keep a well fired coconut husk and cover it
- After about 4 hours, fire may spread from the top of the rice husk heap to the bottom and around surface
- At this moment cover the emerging black patches on the heap from unburnt rice husk
- After about 6 hours it is observed that all rice husks are becoming black in color
- At this moment, if unburnt rice husk observed, mix them using a spade or a mamoty
- After, sprinkle water to prevent further firing of half bunt rice husks

Practically, when preparing rice husk char in this method, you can fire up the heap around 5 pm in the evening and blow off the heap at about 5 am in the following day morning.

About 700 kg of dried husk is needed to produce 250 kg of char.

About 10 kg of dried rice husk can be filled into a 50 kg Urea bag



Fire spreading from the top of the heap to the bottom and surface

Revitalization of Coconut Industry through Climate Smart Agriculture Technologies

This handbook is made possible by the generous support of the american people through the United States Agency for International Development (USAID). The contents do not necessarily reflect the views of USAID or the united states government.

Cartoons, Illustrations & Designed by : CDC - Center for Development Communication
www.cdcsl.lk