

Plantation crops are those which are used or whose product is used only after processing. These are the crops which are cultivated on an extensive scale in a large continuous area, commercially by an individual or any company and the produce has to be cured before they are put to use.

Plantation crops have high value commercially. They have greater economic importance. They play vital role in improving the economy of the country.

Economic importance :

- Most of the plantation crops are export oriented
Ex : Cashew nut, betelvine, Arecanut and Tea.
- Plantation crops earn foreign exchange for the country and they occupy 75% of the total earnings from the export of the agricultural produce.
- These crops occupy 2% of the total cultivated area in the country but generate maximum income of 16,000 millions per annum.
- Plantation crops provide employment to the million of people
Ex : In cashew nut plantations, it is providing employment for > 3 lakh people in processing factories.
- They support many of the ancillary industries and rural cottage industries. Ex : Coconut coir industries and cashew nut.
- Plantation crops help in conserving the soil and ecosystem. Ex : Tea, coffee plantations grown in hilly tracks having slopes obstruct the soil erosion. Cashew nut cultivation in waste and barren lands contains soil erosion.

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COCONUT

(Cocos nucifera)

F : Palmae

Origin : Indo Malayan region

Known as 'Kalpavriksha'

Importance of Kalpavriksha :

- It is the most useful palm of the world.
- It provides nutritious food
- Gives refreshing drink – Coconut water.
- Gives oils of edible and non-edible oils
- Fibre from coconut has commercial value
- The shell is used for fuel and industrial uses
- Coconut also produce thatch
- Used in alcoholic beverages
- Also used for preparation of miscellaneous products; Arts, Crafts and mulching purpose.
- Coir and pith is used as soil media
- It is an important source of vegetable oils
- On average it has 65% of oil content in kernel when compared to oil palm
- Copra and coconut oil are traditional commodities in world market.
- It provides employment to more than 10 million people directly or indirectly
- It is supporting ancillary industries like copra manufacturing, coir manufacturing and oil milling industries
- Export of coir and coir products earning nearly 260 million rupees/annum.

Botany :

Coconut is a tall unbranched palm growing to a height of 15-30 m. it has a stout trunk raising from the swollen base which is known as bole. It is surrounded by a mass of fibrous

roots. The stem is terminating into a radiating crown of leaves. Leaves are known as fronds. Leaves are large, long, pinnately compound. Palm is monoecious produces one inflorescence is enclosed in a strong tough double sheath called as spathe. When fully grown, it splits longitudinally and releases the inflorescence. Each inflorescence having main axis and 30-40 flower bearing spikelets. Male flowers are 250-350, mostly they will appear on the terminal portion of the spikelet. Female flowers appear at the basal portion of the spikelet. Female flowers are known as buttons. They are 2-5 in number and male flowers contain 6 stamens. Female flowers are tricarpic ovary.

Male flowers open earlier than female flowers leading to cross pollination. Female flower production is high during March-May and female flower production is done during September-January. Insects are the pollinating agents.

Fruit is known as drupe, large in size, one seeded, round, ovoid in shape and the fruit has smooth thin green skin known as exocarp below which there is a thick fibrous hook known as mesocarp. Under this mesocarp or hook there is a nut having hard outer layer known as endocarp or shell. There is a testa which will be off brown or red which is adhering to the endocarp. There is a thick albuminous white endocarp which is known as meat or kernel enclosing the cavity filled with water. There will be an embryo at the tip of the meat.

Dwarf varieties	Tall varieties
1. Short statured (5 m)	Tall statured (30 m)
2. Live upto 40-50 years	Live upto 80 years
3. Earliness in bearing (3-3 1/2 years)	Late bearing (8 years)
4. Trunks are without a bole	Have short trunk with a bole
5. Fully developed leaf, measures 4 m rarely	Fully developed leaf, measures 6 m
6. Exhibit alternate bearing habit	Regular bearers
7. Autogamous (self pollinated)	Allogamous (cross pollinated)
8. Nuts are small, copra is soft and leathery with low oil content	Nuts are medium to large; copra, oil and fibre are of good quality

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|-----|--|--|
| 9. | Mainly grown for tender suits and ornamental purpose

Ex : Chowgat orange, dwarf; gangabordam; Malaya orange dwarf | Grown commercially for copra, oil etc.

Ex : East coast tall, west coast tall in India Laccadive ordinary, Laccadive micro grown in Lakshadweep, Andaman and Nicobar islands |
| 10. | Yields long. Poor quality of copra of 60-65%

95% of coconut cultivated area in A.P.is under East coast tall. | Yields 700-1000 nuts/palm/year

Copra : 165-175 gm/nut. Oil 7% |
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Climate :

It is growing under various agro-climatic conditions. But essentially consider as tropical plant, growing @ 26⁰N, 26⁰S latitude. Though it is tropical plant, not tolerate extreme temperature. It is confined to a height of 600 m MSL. At equator, it is cultivated at an elevation of 1000 m MSL.

Coconut requires humid, warm climate with an annual temperature of 27⁰C but the average diagonal variation should not exceed 7⁰C. It will not furnish well where the annual mean temperature is <20⁰C because this temperature impels the fruiting and flowering.

Coconut requires annual sun shine hours of 2000 hours with atleast 120 sun shine hours/month for the good potentiality. It comes up well in shade conditions. In shade, it becomes lancy without fruiting. It can tolerate wide range and high intensity of rainfall. Average annual rainfall is 2000 mm distributed uniformly gives good growth and yield. When there is no equal distribution of rainfall, drainage status, moisture holding capacity of soil yields reduced drastically.

Soil moisture deficit during summer months hamper nut production. Slight winds desirable but not the cyclones.

Soil :

It is adaptable to wide range of soils, light soils to heavy soils. In case of heavy rainfall are as, well drained soils are best. In poor rainfall areas with long dry spells deep fine soils with good water holding capacity are best.

But mostly clay and black cotton soils are subjected to water logging. But this is not suitable to coconut. Mostly, coconut is grown well in sandy soils. They give good crop if assured irrigation is given and manuring even sandy soils give good yields.

The laterite soils deep into 1 m without rocks had pan and also alluvial and red sandy loam, silt loams are also best soils if they provided with good drainage conditions. Alkaline and saline soils are not suitable. pH should be 5.2-7.0.

Land preparation :

Land must be prepared well. Ploughing must be done deeply and repeatedly in all directions. Remove all the rocks and root positions and level the land. If any slope is existing contour bunding or bunch terracing must be done. If water table is high throughout the year which leads to water logging conditions, raised mounts or beds must be prepared giving irrigation or drainage channels.

Planting :

Planting must be taken at beginning of south west monsoon. If irrigation facilities are available, planting must be taken even during May month also. Similarly in heavy rainfall area planting need to be taken up at the end of monsoon season. The new planting can be avoided the water logging conditions.

Spacing :

Depending on the variety soil type and type of culture spacing is varied.

For all tall varieties – 7-7.5 m in Triangular system; 7-9 m in square system

For dwarf varieties – 6x6 m in square system

When coconut is grown for monoculture, closer spacing is adopted and when grown as mixed or intercrop, wider spacing is adopted.

Digging and filling of pits :

Pits of 1x2x1 m are dug out during summer and left for weathering. Before planting, pits are filled with top soil mixed up with river sand, wood ash bone meal, MOP and also for the control of termites, 50 of follidol dust. In case of sandy soils, 2 layers of coconut husk can be a..... at the bottom of the pit and filled with soil.

After filling the pit, it must be watered for setting up the soil. The seedlings transplanted in the centre of the pit. After planting, seedlings must be stacked and watered.

Manuring :

Manural dosage of adult palm (tales) under rainfed conditions (kg/year/palm)

Once in year @ July-August

Year	FYM	N (g)	P (g)	K (g)
I & II	25	150	100	150
III	50	300	200	400
IV & V	75	450	300	650
VI onwards	100	600	400	800

Under irrigated conditions, the dosage recommended is double (twice in year @ June-July and Nov-Dec).

Organic manuring depending on the age increases. It must be applied during monsoon season. A trench can be dug around the tree and manuring should be done in that trench which is 2 m away from the base of the plant.

Irrigation and moisture conservation :

- Response to manures will be increased with irrigation
- Increased female flower production
- In light soils, low rainfall areas during long deep spell, the water should be irrigated.
- Basin flood or drip irrigation methods should be followed

- To conserve the moisture
- Mulch the with coconut husk
- coconut (5-6 year decomp) husk/dusk (8-10 year decomposition)
- Buried alternatively at a depth of 0.5-1 m and 2 m away from the trunk.

Coconut husk uses :

- Acts as sponge and retains 8 times moisture to its net
- Retains moisture 6 times to its net
- Retains moisture slowly during day spell
- Adds K

Intercultivation :

Ploughed twice in winter and twice in rainy season Ploughing, digging and racking is done in basins and between the rows. Due to this aeration, infiltration of water contacts the formation of matting of roots and weeds.

Cover cropping :

- Checks the soil erosions
- Protects the soil from exposure to direct sun
- Contacts the rain drops affects on the ground
- Weeds may increase the organic matter in
- Add N.

Ex : Legumes

Mimosa invota

Stylosanthus grocilis

Galopogonium mucunoids

Intercropping :

Because of coconut's long pre-bearing period and lot of space between the rows we can go for intercropping. It is advisable till coconut comes to bearing. Intercropping is discontinued after coconuts come to bearing. Intercropping is again taken up after it reaches to the age of 25 years.

Ex : Banana, Vegetables, groundnut, turmeric, ginger, tapioca, sweet potato and elephant foot yam

Mixed cropping : Grow long duration crops.

- The crops should be shade requiring crops/tolerant
- They must be manured adequately and separately
- They must be irrigated adequately and separately

Ex : Cocoa, nutmeg, cinnamon and black pepper

Harvesting :

Tall varieties begin flowering 5-7 years after planting

Dwarf varieties – 3 years after planting

They come to bearing after 2-3 years after commencement of flowering. Then they produce continuous flowers and fruits as one inflorescence/month; 12 branches/year.

11-13 months period takes for maturity after flowering.

Harvesting done depending up on the purpose for tender nuts – harvest @ 6-7 months old.

Harvesting indices :

- Brown colour of the husk
- Hollow round on tapping
- Total number of harvests : 8-10
- Harvest for green husk – 10-11 months old
- For copra and oil – 11-12 months old
- For seed purpose – 12 months

- 45 days interval, the nuts harvested during summer and 60 days interval during rain.

Yield :

Varies depending on varieties, cropping systems, pests and diseases.

Rainfed conditions : 60-80 nuts/palm/year

Irrigated conditions : 80-100 nuts/palm/year

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OIL PALM

(Elaysis guineanssis)

F: Palmae

Origin : West Africa

American oil palm – South America

Commonly also known as African oil palm, Red oil palm

Economic use :

Gives important vegetable oil

These are the highest oil yielding palms

On an average, yields 2.5-4 t/ha

Coconut yields 0.6-1.6 t/ha only

Extensively cultivated in Malaysia, Indonesia and Srilanka

Oil palm was introduced to India in 1834 (plant not survived) and later in 1930. Again introduced in 1970 where commercially cultivated in India. Introduced to Kerala first. 1970 – Introduced oil palm India Limited Later ICAR committee recognized almost 10 states in India; A.P., Assam, Goa, Karnataka, Kerala, Maharashtra, Orissa, T.N., Tripura and W.B. In A.P.,

identified 10 districts. They are Srikakulam, E.G., W.G., Prakasam, Visakhapatnam, Krishna, Nellore, Vizag, Guntur, Khammam.

Botany :

Oil palm has unbranched stout tree. It grows to a height of 15-30 m. its height depends on variety and environmental conditions. Crown contains 30 leaves or fronds. These fronds are compound with a prominent petiole. They arise in whorls. Palm has strong root system to withstand strong cyclones and hailstorms.

Inflorescence is spadix and is axillary. Spadix is enclosed in a spathe. This spathe splits longitudinal exposing the flowers. Spadix has main axis having 4 or more laterals which has the flowers. Flowers are the florets.

Palm is a monoecious. Male and female flowers are separate but present on same plant. The individual flowers in female spadix arranged spirally on the axis and each spikelets protected by fine wax. Female flowers emit pleasant fragrance which attract insects helped in pollination.

Male inflorescence born on a large peduncle and contain long finger like spikelets. Each spikelet bears 1100-1200 small flowers. Oil palm is a cross pollinated plant. The main agent for cross pollination is wind and insect *Eeidobius kamarunicus*

The fruit bunches net is 14-30 kg. Fruits are oval in size 2.5-5 cm long. They are dark green with violet tinge, ripening fruits turn orange or yellow colour. Fruits ripen in about 6-9 months after pollination. Fruit is a sessile drupe. Fruit consists of exocarp, mesocarp and endocarp i.e., shell. These are enclosing the kernel.

Climate :

Oil palm is considered as a tropical plant. It requires rainy tropical climate. Grows well in areas having mean annual temperature of 20-35⁰C. The mean annual rainfall ranging from 100-

1000mm. this rainfall must be well distributed with atleast 100 mm of rainfall/month. It can also withstand rainfall of 900 mm.

It can withstand drought for 2-3 months. Hot humid equatorial climate without long dry period is best. It requires plenty of sun shine hours. There should be frequent change of sunshine and rain. It comes up well from the elevation of 450 to 900 m MSL.

Soil :

Variety of soils are suitable for the cultivation of oil palm. Deep loamy soils rich in humus are suitable. Forest soils with loam and clay content in sub soils are suitable. Lateritic sandy and pure clayey soils are not suitable. Waterlogging soils are not suitable. Oilpalm can tolerate salinity upto 0.5%.

Land preparation :

At the beginning of rainy season, land preparation is started. Clear all the vegetation and plough the land thoroughly.

Digging and filling of pits :

Pits are dug out during summer season with the size of 60x60x60 cm following the spacing of 9 m in triangular system of planting. Pits left for weathering for 2-3 weeks. Pits filled with top soil, mixed with manures and fertilizers and then watered to settle down.

Planting :

Planting can be done during rainy season. Polybag is cut and seedling is separated from the poly bag intact with all of earth and root system. Seedling planted in the centre of pit. Collar region of plant should not be buried into the soil. Care to be taken that collar region is level to land surface. Deep planting is avoided. After planting, it is watered and seedling is protected and mulching can be done in basins. After establishment of seedling, manure and fertilization can be done.

Manuring :

Regular manuring programme is very essential

Fertilizer (kg/palm)	Age of palm (months after planting)								
	2	4	6	9	12	15	18	24	30
N	60	80	120	160	180	200	250	300	400
P ₂ O ₅	-	230	-	230	-	320	-	360	360
K ₂ O	150	150	150	180	240	300	360	600	600
MgSO ₄	-	250	250	300	300	300	300	500	500

FYM 25-10 kg/palm depending on age and type of soil This fertilizer dosage can be applied in 2 splits

Doses :I split @ June-July

II split W Sept-Oct.

A broad band/trench can be made around the palm underneath the spread of the leaves fertilizers applied in trenches and covered with soil and watered immediately

Intercultivation :

Weeding : Competition must be avoided between young developing plants and unwanted plants. Basins kept weed free. In case o young gardens, the barings or rings around the palm needed out. In case of bearing gardens, the entire land is ploughed/weeded twice in a year. Herbicides are not used to control he weeds.

Leaf pruning : It is done during the dry months. Prune dead, dried out and diseased leaves. Male inflorescences must be cut. It must be practiced to avoid shade by overcrowding leaves; uniform ripening of bunches of crown. It also avoids the obstruction at the time of harvesting.

Cover cropping :

Cover cropping checks the erosion

Suppress the need growth

Adds fertility to the soil

Ex : calapogorium mucunoides

Purarania phaseoloides

Denonsema pubescence

Flowering and cropping :

Production of fruit bunches start at the age of 3-6 years but peak bearing is observed when attain 8 years age. It will continue bearing upto 40 years or more. The fertility period is upto 60 years. The palm lives for about 100 years.

Harvesting :

Fruits harvested after full ripening.

Harvesting indices ; Change of fruit colour from red to orange

Dropping of fruits from bunches

After harvesting the bunches

Shifted to processing units within 24 hours.

Yield :

In A.P. the average yield is 20-25 t/ha – fresh fruit bunches

The oil yield is 4-6 tons.

Oil palm gives 2 distinct vegetable/edible oils. Oil yields from mesocarp of fruit is 20%. Oil yields from kernel of the fruit/seed is 26%. Total of 46% comes from the oil palm

ARECANUT

(Areca catechen)

F : Palmae

Origin : Malayan and Archepelago islands, Indian islands and E.I. island.

It is one of the important spices in India. Cultivated since pre-christian era. Commercially cultivated in India, Bangladesh and Sri Lanka. In India grown in Kerala, Karnataka, Assam (which accounts >90% of total area in the production of arecanut), T.N., Goa, W.B., Meghalaya, Maharashtra and Tripura. In A.P. grown in an area of 200 ha only. It provides employment to 6 million of people directly or indirectly.

Botany :

It is an unbranched smooth, cylindrical inflorescence called spadix enclosed in a spathe. It is a thorny, slender palm and grows to a height of 15-20 cm.

The spadix consists of main rachis and is divided into secondary and tertiary rachis. Both male and female flowers arise on them. Female flowers are unisexual. Male flowers arrange on upper part and mostly at dorsal end of secondary rachis. Male flowers are smaller than female flowers. Staminate flowers open earlier than pistillate flowers which encourage cross pollination.

Fruit consists of fibrous outer husk enclosing the single seed. Fruits are bright orange in colour. Fruit is nut and takes 30-35 weeks for the maturity.

Climate :

It is a tropical palm, comes well in different agro-climatic conditions and grown well from 1000m above MSL. Cultivation mainly continued to 28⁰N and S of the equator. Arecanut grows in areas which receive abundant well distributed rainfall hence it requires moist climatic regions.

Optimum temperature 15-30⁰C. it cannot tolerate extreme temperature and wide diagonal temperature. Banana is an intercrop in this plantations.

Soil :

Arecanut thrives well in variety of soils provided good drainage conditions. Red laterite, red loamy and alleviated soils are suitable. It cannot withstand water stagnation. Drainage must be provided in the areas of high rain fall regions like Assam and West coastal regions.

Land preparation :

Repeated ploughings must be done after the fine depth is obtained.

Digging of pits : Pits are dug out with a size of 90x90x90 cm with a spacing of 2.7x2.7m. pits filed with compost and tank with seedlings planted at the centre of the pit at the beginning to end of the monsoon.

Bananas planted in Arecanut to give protection for seed scorching. It is planted during May-June in well drained soils as Aug-Sept in clay soils.

In Tamil Nadu, banana is planted during June-July. Arecanut during October month is very susceptible to sun scorching. Plant rows may be planted in N-S direction at an angle of 30° towards west. Tall and quick growing shade trees raised in south and south west side to provide shade.

Irrigation and drainage :

Rainfed and irrigated crops, irrigate the crop once in 3-5 days. Arecanut is very sensitive to water logging conditions. Drainage must be provided at a depth of 30 cm, for every 2 rows of palms to drain out excess water.

Manures and fertilizers :

Manures and fertilizers should be applied at every year. Dosage of N, P and K = 100-40-140 kg/ha. 12 kg green leaf manure, compost can apply. Organic manure applied only once or a year at September and October given in 2 split doses.

I split : Sept and Oct (broadcast around the palm)

II split : March and April (rainfed) applied in a trench of 75-100 cm radius.

The recommended dosage for

If soils are acidic in nature, apply lime during 3 weeks prior to fertilizer application. Liming done at alternate days.

Intercultivation :

Control the weeds with a light digging, done at the end of monsoon by breaking the crust i.e., formed during irrigation. Hand weeding should be done regularly.

Cover cropping : Followed in the areas of slopy lands.

It prevents the soil erosion

Adds organic matter

Usually cover cropping practiced at the beginning of the season, which ads

Ex : *Stylosanthus gracilis*

Calapogonium murunoids

Interspacing between rows is utilized by growing the cover crops.

Intercropping with banana, ginger, turmeric and elephant foot yarn

Mixed cropping with beetle vine, nut meg

Yield :

Almost > 10 kg/palm

12.5 -15 q/ha.

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CASHEWNUT

(*Anacardium occidentale*)

F: Anacardiaceae

Origin : South America

Cashewnut is an exotic crop, introduced to south India by Portuguese during 16th century.

It can grow upto 200 latitude, and grown > 30 countries like India, Brazil, Tanzania, Kenya and Mossambe. India stands first in production of cashewnut. It produces 90% of world's exporting market.

In India, important states are Kerala, Tamil Nadu, A.P., Maharashtra, Goa and Karnataka. Others are W.B., Tripura and Pondicheri. In A.P., Guntur, West Godavari, Nellore and Prakasam districts.

Uses :

- A labour intensive crop. Needs more labour for processing.
- Provides employment > 4 million people.
- Earns good foreign exchange – 2% by exporting the agricultural products.
- It is nutritious food. Low in carbohydrates and rich in vitamins.

- Yields 40% of oil
- Testa is rich in tannins, used in leather industries. Testa which is adhering kernel can be utilized for poultry feeding.
- Very rich in Vit-C and five times more in citrus yields 10-20% of sugar.
- Astringent presenting cashewnut is not consumed but used for preparations of liquor, 'Feni' prepared in Goa.
- Cashew nut shells can be dried and make powder, used for animal feed. It is very rich in phenol used for preparation of paints, insecticides, baking and good preservatives.

Botany :

Cashewnut plant is an evergreen close spreading tree and reaches to a height of 10-15 m with primary and secondary branches. It has very strong tap root system by extensive network of lateral roots.

Two types of branching is in cashewnut

1. Intensive branching
2. Extensive branching

Intensive branching : shoots grow to a length of 25-30 cm, terminate into a panicle. 3-8 laterals will arise from below the panicle within 10-15 cm of the apex. These laterals again terminate into panicle in the next flowering season. This process of branching will be repeated giving plant to a bushy appearance.

Extensive branching : Shoots grow to a length of 20-30 cm and take rest. Buds will sprout 5-8 cm below the apex and then give further growth. This growth continues for about 2-3 years without lowering. This type of extensive branching gives the plant to a spreading habit.

This type of intensive and extensive branchings seen on same plant with varying extensions. High yields of > 60% of intensive branching, low yields < 20%.

Leaves are alternate and simple, glabrous, obovate, round, pinnately veined; young leaves are reddish brown to pale green gradually turns to dark green.

Cashew is a polygamous monoecious tree, flowers are bisexual or staminate and they are intermixed or present in the same inflorescence. In the inflorescence 95% are staminate and 5% are hermaphrodite. Inflorescence is terminal.

Flowering occurs in 3 phases

1. Male phase : Appear result in more staminate flowers
2. Female phase : More hermaphrodite flowers and then male phase.
3. Mixed phase : Most productive. It has staminate and hermaphrodite flowers.

Staminate flowers open earlier than bisexual flowers

Pollination is by insects – Flies, bees and anti and wind. Under normal conditions, 85% of perfect flowers are fertilized among these, 4-6% reach to maturity.

Remaining shed at various stages of the development. Cashew is having a fruit called as cashew apple. This cashew apple is fleshy peduncle. It is not the true fruit i.e., real fruit. Cashew apple is juicy, sweet and varies in size, shape, colour and taste. It is 5-7 times heavier than nut. It is the rich source of Vit – C and sugars.

Cashew nut is the real fruit. It is a drupe. It is kidney shaped, green colour, vary in size and shape and nut will be growing Shelling per cent is 13-30%. Nut encloses a soft kernel. It is the commercial product. Shell of he nut is sticky, resinous and corrosive oil called as cashew nut shell liquid (CNSL).

Climate : It is a heavy tropical plant, grown in wide range of tropical climate between 25⁰N and S latitude, grows upto elevation of 1000 m MSL. Profitable cultivation is observed at 600 m.

It requires annual rainfall of 500 mm comes up even under 300-400 mm. rainfall distribution should be even. Distribution of the rainfall is important than quantum of rainfall. Rainfall must be spread to 5-7 months with a well defined dry season for about 3-4 months before flowering.

It thrives under the temperature of 15-40⁰C. Cultivation is commercial in the areas with mean annual temperature not < 20⁰C, but it is sensitive to extreme dry conditions. It is exposed to these dry condition, leaves get scotch and drop-off. Flowers and fruits also drop.

Cashew is sensitive to cold conditions and also grown under wide range of nearer to sea coast upto 160 km, but excess humidity leads to pest and disease attack.

Soil :

Grown in wide varieties of soils. Laterite soils, red and coastal sands are preferable. Cashew is grown in marginal soils generally. In east coast areas, cashew is grown well in sandy soils. In west coast areas, grows well on lateritic soils, also grown on hilly slopes on western ghats.

Soils should be deep, feasible, well drained without any with water table @ 3 m depth is best suitable.

It can tolerate drought to some extent but cannot tolerate water logging. pH should be 6.0-7.5.

Preparation of land :

Clear up all the vegetative growth and plough until fine tilth obtained upto 4-5 cm and then level the land.

Pits are dug up 50x50x50 cm during April-May with spacing of 8-10 m and planted as square system. Pits left for weathering for 2-3 weeks. Pits refilled with top soil mixed with 25 kg of FYM. 2-3 months old seedlings or 1 year old growth are planted in the centre of the pit during July-August. Watering is done immediately after planting provide support for planting called staking.

Irrigation and manuring :

Cashew grown as rainfed and irrigated crop. It is a handy and drought tolerant plant. Irrigation must be provided during initial growth of 2-3 years, during summer irrigation must be given for better establishment of newly planted young trees.

Manuring :

Application of manures and fertilizers to get higher yields. During initial years vigorous growth. N applied once in 2 months.

Year	June-July			September-October		
	N (gm)	P	K	N	P	K (gm/plant)
I	25	25	25	25	25	25
I	100	25	25	100	25	25
III	150	40	60	150	40	60
IV	200	50	60	200	50	60
V	250	60	60	250	60	60

After 5 years; 500-125-125 g/plant/year in 2 splits

FYM : 25-50 kg/plant depending on the age. It is applied in the trench of 10-15 cm deep and 1-1 ½ m radius from the trunk and fertilizer mixed with FYM. Trench is covered and irrigation is given.

Intercultivation :

Weeding : The interspaces must be ploughed twice in a year starting from rainy seasons at the end of season. Ploughing controls weeds increase the infiltration rate of water into the soil. The young garden kept weed free by periodical weeding done in basins. After weeding, basins can be mulched with any dry leaves or paddy husk Mulching helps to conserve the soil moisture during summer.

Intercropping : Interspaces can be well utilized with GN, HG and cone ea. Also used for raising the nurseries of vegetables. In A.P., Orissa, interspace is used for raising the casuarinas. In Goa, it is used for Eucalyptus and Teak. In West coastal plane areas, coconut is grown as intercrop.

Pruning : Pruning is done. All side shoots must be removed upto height of 1 ½ m height. This helps the plant to give umbrella shape. Periodical pruning of diseased, rotten, criss-cross branches during blooming and harvesting periods i.e., June-December. Pruning helps the spread of diseases.

Flowering and harvesting :

Comes to fruiting in 3-5 years. Commercial bearing is only after 10 years. Comes to flowering only once in a year. The commencement of flowering season depends on the region.

In west coast region

In east coast region - January-February

Harvesting in west coast - February

Harvesting in east coast -April.

By May, all most all pickings can be completed. Fruits will be collected which are fallen down. In Goa, fruits picked up before they using preparation of berries. After harvesting, nuts are separated from cashew apple. These nuts sun dried for 2-3 days and stored in gunny bags.

Drying must be done properly because there will be discolouration on drying. Not also over dried, the nuts become brittle and breakage of kernels while processing.

Yield : Varies with variety, soil, rainfall, sex ratio, fruit set and management practices. Also varies with seedling progeny and region to region. In A.P. when plant is at the age of 15 years, nut yield is 1600 kg nuts/ha (16 q) higher.

Kerala : > A.P. yields.

Processing :

Kernel is enclosed in hard shell. Removal of kernel from hard shell is known as processing. It is done manually in a cottage industry. In Kerala at Quilon – More processing units in India.

In A.P., Palasa (Srikakulam), Vetapalem (Prakasam) and Mori, (East Godavari) units

Processing involves various steps :

1. Roasting
2. Shelling
3. Drying
4. Peeling
5. Grading
6. Sweating
7. Packing

1. Roasting : It is done by three methods.

1. Open pan method
2. Drum method
3. Oil bath method.

Cashewnuts roasted for easy shelling and loosen the kernel inside. Roasting can be done in the above three methods.

Open pan method : Nuts are roasted in perforated open pan, made of iron. It is kept over a fire. CNSL oozes out during roasting and drips through perforated holes causing heavy smoke fumes. Nuts catch the fire, water is sprinkled over the nuts to put-off fire, then thrown on ground quickly covered with soil for cooling and to absorb CNSL. CNSL not recovered.

Drum roasting : Nuts are roasted in a rotating metal drum. Drum is held in slanting position, rotating with handle and is heated from below. Nuts placed on one side of drum. Hotness of drum causes the fire of nuts within 3-5 minutes and nuts reach to other end of drum and get roasted. Temperature is 100-120°C. The CNSL comes out, nuts burn. The burning nuts are collected

from fire to put off by sprinkling water and by covering with soil. The rate of shelling and recovery of whole nuts is very high in this method. CNSL is not recovered.

Oil bath method : Nuts are held in wire trays and allowed to pass through the bath heated CNSL. Temperature 190-200⁰C. nuts take 1-3 minutes while passing through CNSL, nuts ruptured and then releases the shell liquid. Then the nuts are removed and kept for cooling. In this process 50% CNSL is recovered. This method helps in uniform roasting and eliminate the of nuts.

Shelling :

Process of breaking of nuts to extract the kernels – shelling. Roasted nuts broken with wooden Great care is taken to obtain whole nuts. After cracking this nuts, kernel is obtained with help of needle or wire. Shelling percentage is 15-30%.

Drying :

Extracted kernels dried in wire mesh trays, hot chambers at 80-90⁰C for about 6-7 hours. Drying helps to loosen the testa, which in adhering to the kernel and facilitate easy peeling.

Peeling :

Thin testa of reddish-brown colour is removed manually. Removal of thin testa from kernel is known as peeling. A laborious process. Care should be taken (Gives bitter taste).

Grading :

Grading is based on number of kernels. It is also done manually but grades which are common are:

- a) 210 count – Zamboo wholenut. Bigger size nuts. Best quality
- b) 240 count – Zamboo whole nuts, bigger size
- c) 280 count – American quality
- d) 320 count – Standard quality
- e) Splits count – Whole nut split into 2 halves
- f) Baby pieces

g) Broken butts

Sweating :

Drying makes grey brittle liable to easy breakage during package and transport. RH 80% for 5-6 hours and humidity is maintained. So kernels become less brittle and absorb moisture.

Packing :

Conditioned kernels packed by vita pack method. Tins fitted with kernels and vacuumised and filled with CO₂ and sealed. Packing must be done separately with gradings.

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CACAO

(Theobromo cacao)

F : Sterculiaceae

Origin : Amazon valley of South America

It is a beverage crop introduced by East India Company during 1796 and spread to Tamil Nadu and Kerala.

Commercialised during 1960s (During III five year plan).

Grown countries : Brazil, China, Ivory coast, Nizeria, Malaysia (Major) – 85% of world's area.

Major consumers : USA, USSR, Germany, Japan and France.

Cultivated in 30,000 ha in India. Grown as mixed crop in coconut and arecanut

Gardens in 79% area followed by Karnataka 19% and TN 3%. Annual production is 8000 tonnes. Kerala – 71% production, Karnataka 25% and Tamil Nadu 4%.

Exporting 1000 t/year.

Uses :

- Important food crop and as a beverage crop

- Fermented, dried, roasted cacao beans called as cacao ribs. They are used for preparation of cacao butter, powder and chocolate.
- Cacao ground to liquid form having 55-58% fat and this can be reduced to 28-33% known as Cacao powder.
- The liquid form after removal of fat content is known as cacao butter, used for preparation of chocolate, drugs and soaps
- Cocoa mass mixed with sugar and butter to prepare the chocolates. Different ratios of sugar and butter give different taste to the product.

Botany :

There are 20 species of cacao are present. Cola acuminata, the nuts produced by it are called as Cola nuts. It is producing a stimulating principle called as Coca cola. It is semi deciduous perennial plant, 5-8 m height with dense foliage of round canopy. Round trunk with 1-1 ½ m branches. Branches arise in the whorls in a horizontal fashion and branches are called as Jarguetts/fans. This process of branching is known as Jarguetting. The terminal growth ends up in jarguetting and further growth is by suckers, known as Chupans giving the plant to umbrella shape.

Jarquets grow vertically and they end up with jarquettes. This process continues. Cacao is called as cauliflorous plant, flowers and fruits born on the old wood on the trunk or main branch. Inflorescence is compressed cyme with short branches, and peduncle. Flowers are hermaphrodites.

Fruit is a pod. It is indehiscent drupe. Pods are varied in size, shape and colour. Pods are elliptical to ovoid in shape. Pods are ribbed to smooth, yellow/orange/purple or brown in colour. Seeds are present in pod are called as beans upto 20-25 in number. These are embedded in the pinkish/whitish/bluish mucilage. It will be acid to sweet and aromatic in taste. Seeds are flat, round and white or brown/purple and taste also differing from sweet to bitter in taste. Seeds have two white or purple cotyledons.

Cacao flowers are both self and cross pollinated. It takes place by thrips, ants and aphids. Fertilization takes place in 36 hours after pollination. Pods mature within 150-180 days. Pod colour turns to light yellow when it is ripe and then ready for harvesting.

Climate :

It is the crop of humid tropical region. It requires optimum temperature of 25⁰C, minimum of 15⁰C and maximum of 40⁰C. When the temperature is < 25⁰C, the growth of the trunk is flowering will be affected. Seasonal variation should to be too narrow and it grows best near to the equator and having 10⁰N and 10⁰S latitude and also comes up well at 20⁰N and S latitudes. It receives high humidity upto 80%. Though RH 80% is favourable, it encourages pests and diseases particularly under shade conditions. It is grown under lower attitudes, grown at a level of 700 m above MSL. Performs best when the elevation is 200-300 m.

It grows under wider rainfall of 1000-3000 mm per annum. It must have day season atleast for 3 months. Distribution of rainfall is more important than total amount of rainfall. 100-150 mm/month of rainfall is received atleast for 9 months in a year. Ideal rainfall is 1500-2000 mm. in low rainfall areas, it can be grown under irrigated conditions. Highly susceptible to strong winds because shallow roots. Hot winds to low humidity cause defoliation, dehydration of floral parts and organs.

Soils :

It can grow in wide range of soils. Rich in humus, rich in K, well drained soils. pH is 4.5-8.0. Neutral soils are best. The soils should be deeper > 1.5 m without any head pans particularly in low rainfall regions. It requires regular supply of moisture. Water table should be beyond 2-2.5 m. Cacao is well grown in low stored forest regions grow well under the shade of coconut and arecanut. It is sensitive to drought situation and water stagnation in soil.

Shade regulation :

It requires shade when plant are young, also grown up some extent. It grows best with 50% of sun light. It is established by 3 methods.

1. By planting the permanent shade trees. Plantations after cleaning the forest areas. It is practiced in West Indies and South America.
2. By thinning the existing jungles., West Africa.
3. Inter cropping/interplanting in coconut/arecanut plantations. Practiced in India, Srilanka, Malaysia and Newguinea.

Cacao can also be grown as a pure crop by thinning jungles. Shade can be regulated. Cacao grown with other crops to save land and extra income.

Spacing :

In arecanut plantations; 2.7x2.7 m grown in alternatively i.e., 5.4x2.7 m

In coconut plantation 7.5x7.5 m cacao can be planted as a single row following a spacing of 2.7x2.7 m cacao can be planted during South west monsoon, September-October and May and June.

Establishment of the plantation :

It is a shade loving plant. It requires adequate sun light. Extra branches should be pruned out for harvesting and spraying operations to carry out easily. Pruning also controls the pests and diseases.

Pruning is two types.

- 1) For development of shape..... shape pruning
- 2) Maintenance of pruning.

Shape pruning : Here, the Hjarquetting occurs during 1 year at a height of 101.5 m. there ill development of chupons. This can be checked out at this stage. Shape pruning is done by periodical removal of chupons during the initial stage itself. Shape pruning is continued and repeated till 3 carriers obtained giving firmly closed umbrella shaped. Canopy at about 2-2 ½ mt height.

Maintenance pruning : Remove all surplus branches, any > 5 pruned all side branches removed, if any branches growing upwards, they are nibbed/removed. Diseased, damaged branches can be pruned off.

Cropping :

Cacao comes to bearing II-IV year after planting. It gives 2 main crops i.e.,

I – October-January

II- Mid crop of April – June.

Off season crop : When grown under irrigated conditions.

Harvesting :

Harvested matured riped pods which turns to yellow or orange-yellow colour. They can be harvested at 10-15 clay by cutting stalks without injury to cushion area. Harvesting should not be delayed as it is characterized by vivipary.

After harvesting kept aside for 2-3 days then go for processing.

Yields :

Very low in India (Rodents and negligence). Dry beans yield – 4-5 q/ha

Average yield – 5-10 q/ha in other countries like Brazil and Malaysia.

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BETELVINE

(Piper betel)

F : Piperaceae

Origin :

Uses :

- It is a perennial aromatic creeper.
- Providing lively hood to more than 50lakh people.
- Leaf is chewed for digestion.
- Important in Hindu ceremonies.
- Rich in Vit-B, Vit-C
- Rich in Fe, Ca and P
- Also contain proteins, low fat (0.8), (6.1%)
- Rich in chlorophyll content, very proteinaceous.
- Very good tonic to brain, liver and heart
- Have cleaning effect of mouth

Grown in moist and sub tropical regions of India, Bangladesh, Burma and New guinea. In India, grown in M.P., Karnataka, Tamil Nadu, Assam, A.P., and West Bengal. In natural conditions, cultivated in Assam hills and West Bengal.

In artificially other parts of India (i.e., by growing the standards). In A.P., almost of Rayalaseema, Guntur, Nellore, Visakhapatnam districts. More production is from Rayalaseema regions and exporting to foreign countries and other states. Major importing countries are Pakisthan, Oman, Saudi Arabia, U.S.A and U.K. India is earning more than 1 crore rupees by exporting.

Botany :

Perennial, dioecious, climber and semi woody creeper, climbs with a support with adventitious roots born at the nodes. These roots can enter into cracks and of the support and get attached to the support. Because of sticky substances, it gets fixed to the support. Grows to a height of 3-4 m within a year. The leaf size varies with variety. Vine is dioecious plant with minute flowers. Floering is seen very rarely (in old plantations).

Climate :

It is a pseophyte. Forest conditions are suitable (shade, coolness and humidity), requires regular supply of water. Climate of tropical forest conditions in south west India and north

western Indian natural conditions. In artificial conditions, we should provide shade, humidity, moisture and structures like live plants in and around the garden. In north India, stone walls/brick walls are constructed around the garden to protect from the hot winds, day winds and cool winds. also erected. Requires rainfall of 250 cm/annum. Grown in very low rainfall areas of 25 cm rainfall under irrigated conditions. Grown upto elevation of 900 m above MSL.

Requires moderate temperature. Too low and too high temperatures are not suitable. Dry winds may the leaves and leaf tips (low market value). High wind speeds cause turning of the leaves. (On temperature cause early defoliation of the leaves).

Soil :

Requires high fertile soils, well drained soils with high moist retention capacity, cannot withstand salinity and alkalinity. Always avoid very deep soils with imperious layers. Also avoid saline soils. Under poor drainage conditions vines turn to yellow, and have very short life. Clay loams with humus with more availability of P and pH of 8 are very good soils. Particularly grown in banks of rivers, lakes and canals.

Propagation :

Propagated by terminal cuttings.

Land preparation :

Choose the soil application of bulky manure. If available river/pond silt help to increase water retention capacity. Plough the land repeatedly layout plantation.

Cropping :

Betelvine grown as intercrop in coconut and arecanut gardens, need not require special land preparations. If it is grow as pure crop, we have to grow wind break, shade plant and provide facilities for irrigation. Thinning should be done in forest areas and no need in already established garden.

Fencing :

Very thick and fine fencing or borbed fencing or can build a compound wall. Banana also grown as wind breaks (wild canes, bamboo). Wind breaks can allowed to grow upto 6 m to withstand speed winds. Standards are alive or dead plants. In natural forests, forest plants act as standards. When betelvine is grown as intercrop, coconut or arecanut plants are the standards. Sesbania, cassia can also be used as standards (commonly grown). Enthrina indica can also be grown but they have slow growth.

Advantages of *Sesbania grandifolora* : provides fodder, acts as standard.

Disadvantages : At the time of sowing, grows 2 sesbania and 2 Erythrina.

Sowing of standard :

Go for thick sowing, later thinning is done leaving 15-30 cm spacing. Sow when rain received during May-June. Sown on either side of ridges giving and spacing of 5 cm.

Training of standard :

Trunks should be smooth, don't allow side branches as it will obstruct the climbing of betelvine. Side branches can be removed upto 1.5 – 2 m height. Removing should be completed in 1 year

Disbudding can be done. Excess bit of standard is also not allowed. So do the stopping at a height of 4 m as the 4 m side branches will encourage and provide shade.

2 or 3 standard plants tile together to provide entire strength followed in Karnaaka and A.P. standards sometimes trained as Arch by tying the tops of one bed with second bed. If these are not followed, the leaves exposed to sun light and develop sun scald.

Types of planting :

Betelvine can be planted in 2 systems

- a) Bed system and b) Trench system

Bed system : Beds of 45 m length and 1.5 m width are prepared. Between the 2 beds, irrigation or drainage channels are provided. These beds are locally called as Peda.

Trench system : Trenches of 30 cm width, 30 cm depth are dug out. Cuttings are planted in these trenches. Terminal cuttings known as setts, are planted. They will be established within 3 weeks. First leaf will develop in a month, after establishment. Vine must be trained on to the support.

Training of the vine :

Training of the vine must be done 1 month after planting. Vines start training on ground. At this stage betelvine must be trained on to the standard plant. Training is done by tying the vines along the standard loosely with the help of gunny thread or banana leaf fibre with an interval of 15-20 cm. Vines can come in contact with standard and strike the adventitious roots at nodes which help to cling to the support. Training must be done at fortnightly intervals.

Lowering of the vine :

Very important in betelvine. It is done 1- 1 ½ years after planting. All the leaves present on the vine must be harvested except the terminal leaves. After harvesting of the leaves, the vine is removed and coiled carefully at the base of the standard dug up a small trench and buried the coil in the trench leaving 30-60 cm length of terminal growth. Trench is covered firmly and soil and light irrigation is given. After one month vines are trailed to the standard plant and cared until the next lowering of the vines.

Reasons for lowering of the vine :

Under natural conditions vines grow to a height of 3-4 m/year. And the vigorous growth produces normal size. Leaves will be reduced to these vines need rejuvenation in the vines.

Water requirement of vine is very high. When adequate water is not available, lowered vine requires less quantity of water. Yield/production of leaf mainly depends on the production of primary branches to more number of primary branches can be produced from these buried nodes.

Vine is lowered to make convenient harvesting. If lowering is not done, vine goes to top, under such conditions ladder is required to harvest. Preferably lowering should be done during

spring season. Lowering can be done and once in a year in A.P. during March-May. It can be done 2 times in Cuddapah. (June-July and December).

Irrigation :

Requires high quality of water. Soil must be moist and water should not stand in beds not more than half an hour. Drainage must be perfect. Otherwise decay of roots resulting defoliation. Frequent light irrigations are always advisable.

During monsoon – 8-10 days interval

During Winter 7-8 days interval

During Summer 3-4 days interval

In loamy soils, interval of irrigation is shorter compared to clay soils. Bed system requires more irrigation than the trench system. In low rainfall areas, more number of irrigations must be given. Less frequency of irrigation is given in full bearing vine. If excess irrigation at full

Manuring :

Application of organic manures like FYM, compost, sheep manure, river/tank silt and oil cakes like castor, fish meal to maintain high quality of crop.

I application	25-30 bags of groundnut cake applied during 2 months after planting (Nov-Dec) 100-120 cart loads of FYM-applied at 3 MAP
II application	100-120 cart loads of FYM-applied at 1 ½ MAP prior to lowering (Aug)
III application	100 cart loads of river/tank silt for pressing of lowered vine-immediately after lowering
IV application	25-30 bags of GN cake + 50-75 bags neem cake/ha should be applied in II-year of plantation

II, III and IV applications must be repeated in III and IV years.

Intercultivation :

Weeding and hoeing must be done regularly. Keep the garden clean without dead/diseased vines. Clean the fallen leaves and leaves of standard. Provision must be made for drainage during rains. Earthing up should be done at regular interval particularly during manuring.

Intercropping :

Inter crops not grows. But in Nellore, turmeric or ginger is grown along the irrigation channels. In T.N., Gogu is ciliated. Coconut or groundnut plantations, belladonna is grown as intercrop.

Betelvine can be grown continuous upto 5-10 years, depletion of nutrients by the development of pests and diseases. Betelvine must be rotated with other crops. In A.P., turmeric, banana, sugarcane and veg.

Karnataka – Tobacco, chilli, wheat and jowar

Assam – No rotation is followed. After completion they leave the land fallow for 2 years.

Harvesting :

Under good management, leaves can be harvested 3-6 MAP of setts, possible in A.P., T.N., Maharashtra. Plantations retained for 3 or > 3 years. Harvesting continued daily/weekly depending on the demand. In other states, harvesting starts 1 year after planting and plantation retained for more than 3 years.

Types of leaves :

In betelvine, there are kinds of leaves.

1. Matured leaf (Tunawar/Bondaku) : Exported to destination. Leaves will be ready by the time they reach to the destination.
2. Tender leaves/tellaku : Harvested to meet the demand of local markets/
3. Rejected leaf/Pothiaku : Harvested damaging or over matured leaves.

Chemical composition of leaves :

Constitution	Fresh leaf (%)	Bleached leaf (%)
Non-reducing sugars	1.3	0.29
Reducing sugars	0.43	0.83
Tannins	2.05	1.89
Oil	1.23	4.20
Ether extract	15.1	13.5

Harvesting of leaf is skillful job. Leaf cut alongwith petiole and with the help of nail/artificial nail and fixed to thumb. 4-5 leaves are picked per vine. 2-3 leaves from newly established garden or vine. Young and olden garden gives less yield. Middle age garden gives higher yield and high quality.

Yield :

In A.P., Assam and Kerala the yield is 12-25 lakh leave/year/ha

In A.P., life span is 2-3 years

Karnataka : 10years

U.P., Maharashtra : 6-10 years.

Grading :

Grading is according to leaf size. In some areas, graded according to the position of the leaf on the vine.

3 important grades in the betelvine are

1. Angular (Kalli leaf) : Harvested from main stem; Inferior – medium quality
2. Hatwan (Krapaku) : Harvested from the lateral branches; excellent quality
3. Modern (Teegaku) : Harvested other than main or lateral branches, mostly on ponds, poor and inferior quality.

After grading, packed according to size or maturity. Bundled, tied in banana leaf or wet paddy stem. 100-200 leaves are in bundle. Bundles kept in bamboo basket with paddy stem as bedding material so that leaves are not dry, basket covered with bamboo and stitched.

Middlemen are involved. Commission agents, wholesalers gather and collect the material from the farmer and sell to the retailer. At the time of transport, 30-70% leaf damage occurs if care is not taken. It takes 5-7 days to reach the consumer from the grower.

Bleaching of betelvine :

Specialized operation is followed in big cities done on small scale. Large quantity of leaf consumed as fresh small quantity is bleached.

Characters of bleached leaves :

- Contains medicinal value used in Ayurvedic medicine
- Recommended for chewing
- Contains more reducing sugars
- Essential oils are having more aroma and taste
- The oil strengthens the teeth

Selection of leaf to bleaching :

Collect healthy leaf from 3 years matured garden. Leaves collected from the vine of 3 months old after lowering of vine. Select the grade of or matured leaf, they will be tough and dark green.

Leaves are trimmed and removed the petiole.

Procedure : After trimming, the leaves are arranged spirally in bleaching chamber. Cylindrical G.I. open both sizes of 70-100 cm dia, 45 cm deep, 16,000-24,000 leaves can be accommodated. Dry banana leaves spread at the bottom to drain out excess water from leaves. Leaves are arranged 2-4 circular rings from periphery towards centre upto the brim.

A vertical column of clean space is left at the centre which helps in aeration. Tin is covered with moist gunny cloth kept in dark, well ventilated room. Summer bleaching takes place in 15 days, winter takes 15-20 days. At the end of bleaching, leaf attain uniform yellow

colour. During processing of bleaching, examine at every alternate day to remove the rotten leaves. Arrange the clear leaves and sprinkle the water to moist the leaves to lower the temperature in the chamber.

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COFFEE

(Coffee arabica)

F : Rubiaceae

Origin : Ethiopia

Non-alcoholic beverage or stimulant beverage.

Spread to India by Arabs (Bab a budan)

Introduced from Makka

Planted in Dattatreya peeta hills, Chikmaguluru district (Karnataka).

History :

In 1898 it is introduced in A.P. by Arab settlers. These settlers brought to Siricilla (Karimnagar), later introduced into Agency area (1920-1948). It came to commercial cultivation in 1960 due to forest department efforts; agency are of Visakha, Vijayanagaram and Srikakulam.

Coffee is grown in more than 70 countries. More than 50% of the world's area is confined to Brazil, Colombia and Ivory coast. In India it is confined to Kerala, Karnataka and Tamil Nadu. Later it is spread to non-traditional states like A.P., Assam, Orissa, Arunachal Pradesh and Nagaland. In A.P., Chintapally, Paderu, Maredupally, Sitampet, Araku valley, Anantagiri hills, Srikakulam and East Godavari districts. In India it is cultivated in 60% area (C.arabica). 40% is under C.conephora.

Uses :

- Non-alcoholic/stimulant beverage
- Good medicinal properties, gives comfort to brain, relieves from headache, litharge.

- Helps in digestion of food
- Coffee husk and coffee pulp is important byproducts. These are used as manures and fuel purposes and as a cattle feed.
- Alkaloid present is caffeine.

Botany :

It is evergreen perennial shrub. It produces two types of branches.

1. Orthotropic branches : Upright branches produces other branches and lateral branches.
2. Plageotropic branches : These are the branches produce only lateral branches. Fruiting occurs on laterals. On decapitation or topping. It produces the primary branches, secondary and tertiary branches and develops the canopy. Secondary and tertiary branches bear the fertile flowers appear in clusters packed at the nodes (10-60).

Fruit in coffee is drupe having 2 seeds called beans. Exocarp is juicy. Endocarp covers is called as parchment cell. Seeds are present in endocarp.

Characters	Arabica	Robusta
Ploidy	Tetraploid (2n=44)	Diploid (2n=22)
Plant stature	Small tree, shrubs or bushy under raining	Bigger tree than Arabica
Root system	Small deep rooted	Large shallow rooted
Branches	Persistent	Deciduous after harvest
Leaves	Dark green leaves	Pale green leaves
Flowering habitat	Flowers on new wood	On new/old wood
Bearing	Regular bearer	Irregular bearer
Flowers	Scaly, small traits, axillary, 4-5 inflorescences at each node	

Pollination	Self fertile/self pollinated	Self sterile/cross pollinated
Berries	Medium in size, 10-20/node, oblong to round shaped	Small, 40-60/node
Fruit dept.	8-9 months 2.47%	10-11 months 2.2%

Climate :

Majority exist in tropics 28⁰N and 30⁰S latitude. It is highly sensitive to frost. Water stress is essential to break the dormancy. Cold winter is favourable for flower bud initiation. After cool, winter it should be coupled with rains and high temperatures stimulates flowering and easily fruit setting.

Winds at the time of flowering affect the fruit set, high winds beak the branches so protect by raining the wind breaks. Hill slopes are very suitable. Well distributed rainfall and dry months during December-March is preferred. Summer showers will encourage flowering climatic requirement differ in Arabica and Robusta.

Parameter	Arabica	Robusta
Climate	Temperate climate in tropics	Warm humid
Elevation	900-1500 m	500-1000 m
Annual rainfall	1600-3000 mm	1000-2000 mm
Temperature	15-35 ⁰ C	29-30 ⁰ C
RH	70-80%	80-89%
Shade	Med-light shade based on elevation	Uniform thin shade

Direction	North, east and north-east	
Slope	Flat to gentle	Flat to gentle slope
Blossom rains	March-April	February-March
Back rains	April-May	April-May

Soils :

Average fertile soils. Physical properties like depth, drainage, aeration are important requirements (Arabica). Humus rich soil in tropical region. pH should be between 4.2-6.5. It can be grown on hill slopes and undulating topography. Best soils should be rich in humus. Deep soils, friable, porous with good water holding capacity, rich in K, slightly acidic, pH of 6-6.5 can be used. In India, mostly red and lateritic soils are generally used.

Land preparation :

It needs shade so removal of vegetation is not required. Retention of certain plants which provide shade is required by repeated ploughing, make it loose and friable. In larger areas, it can be divided into different blocks and rows. If land is sloppy, terracing or contour bunding can be followed. Coffee planted in square system of planting.

Spacing :

For Arabica : 2-2.5 m

Robusta : 2.5-4 m.

Digging of pits : (45-60 cm³) pits left for weathering. Pits filled up with top soil and forest soil in equal proportions go for disease free, vigorous rooted cuttings. After planting watering and stalling must be done.

Provision of shade : It is important as it requires partial shade where sun light is intense to maintain moisture and temperature of the soil. Shade consists lower and upper canopy. Lower canopy is temporary. Ex : following a spacing of 4x4 m. Silver oak is also used but it should be pruned and lopped.

Upper canopy : It is permanent basis.

Ex : Alberria lebeck, Artocarpus integifolia, Dalbergia latifolia, Ficus glomeralo with spacing of at the time of planting, thick sowing must be done later thinning should be done. It should be maintained 40-44 m above the coffee. Shade tree pruned and lopped.

Manuring :

It is a perennial. S nutrients required for protection of matured fruits to encourage fresh growth, as it requires for production of next growth. In heavy rainfall, sloppy areas, nutrients loss is due to rains and leaching. Flowering, fruiting are in pH peak periods for manuring.

Manuring schedule (kg/ha) :

Time of application or age of plant	Pre blossom	Post blossom	Mid monsoon	Post monsoon	Total
Arabica					
Young coffee	15-10-15	15-10-15	-	15-10-15	45-30-45
I-AFP					
II-AFP	20-15-20	20-15-20		20-15-20	60-45-60
IV-AFP	40-20-40	40-30-40	40-30-40	40-30-40	140-90-120
	40-30-40				
Bearing coffee (yield t/ha)	40-30-90	40-30-40	40-30-40	40-30-40	160-120-160
Robusta					
Bearing pt	40-30-40			40-30-40	80-60-80
Bearing	40-30-40	40-30-40		40-30-40	80-60-80

High level moisture must be provided by mulching, cover roping and also by pruning the shade trees.

Irrigation : Grown as rainfed crop. For young plantations, sprinklers are used.

Intercropping :

Intercrops are growing along the perennial crops like coconut. Robusta planted by 2.5x2.5 spacing in triangular system. 2 rows of coffee in between 2 rows of coconut.

Arabica grown 2x2 m, 3 rows are planted two rows of coconut. Tea can also be grown as intercrop. In Mandarin oranges, coffee can be grown as intercrop.

Soil management :

Conserves the soil moisture by scuffling. Soil stirring (dry mulch) to control weeds and moisture conservation. Mulching done in basins to conserve soil moisture to maintain optimum temperature, effective to control the erosion.

Weed control :

Crop should be free from weed by weeding 3-4 times. In established gardens 2-3 times/year. In monsoon, weeds can be controlled by slicing. Cut weeds at the end of rainy season. Gramanone is used @ 1.25 lit/450 lit water.

Liming :

Liming in heavy rainfall areas Co, Mg will leached. Soil acidity will increase. Usage of acid forming fertilizers will increase the acidity of soil. Acidity will have ill effects on the availability of nutrients to liming must be done.

Dolomite lime/agriculture lime are used. This applied at any time but maintain 1 month gap between liming, fertilizer application. Sufficient moisture must be maintained.

Cropping :

It comes to bearing 3 YAP. 5-6 YAP is commercial level.

Productive life : 30-50years.

Harvesting :

C.arabica comes to harvest earlier than robusta. Arabica takes 8-9 months and ready for harvesting during Nov-Dec. robusta takes 10-11 months.

Harvesting is done by hand. Riped berries hand picked. All berries do not ripe at area So number of pickings will be more may be 5-6 pickings. Injured over riped fruits kept separately, dried separately used for making cherry coffee.

Types of picking in coffee :

Fly picking : l-picking in main season. It is selective picking during Oct-Feb. riped berries are collected.

Main picking : Bulk yields are obtained. Well developed, fully riped berries are harvested 4-6 times at 10-15 days interval, started from December onwards.

Stripping : it is the final harvest and all the left over berries on plant harvested irrespective of ripening.

Clearing : It is the collection of dropped berried from the plant.

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MEDICINAL AND AROMATIC PLANTS

Common name	Botanical name	Family	Economic part
Medicinal			
Dioscoea	Dioscorea compositae	Dioscoreaceae	Tuber
Opium poppy	Paper somnifer	Apocyanaceae	Root
Sarpagandhi	Rauvolfia serpentine	Solanaceae	Bark
Solanum	Solanum kharianum		
Nuxvomica	Strychrus		Seed, root, bark