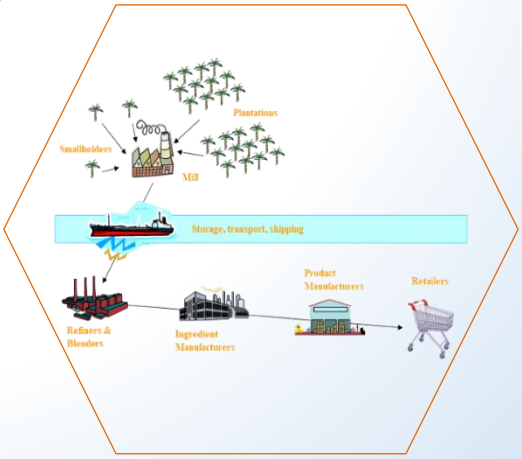
आज़ादी का अमृत महोत्सव

Training Manual

on

Cultivation, Processing and Marketing of Oil Palm



सत्यमेव जयते
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Govt. Of India

OIL PALM PRODUCTION & MONITORING SYSTEM

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1 INTRODUCTION

Oil palm (***Elaeis guineensis***; Family: Arecaceae) is a native of West Africa and popularly known as African oil palm or red oil palm. It is grown extensively in South-East Asian countries, {Malaysia, Indonesia and Papua New Guinea (80- 90% of world's palm oil production)}, African countries (Nigeria, Ivory Coast, Ghana, Liberia, Sierra Leone, Cameroon, Republic of Congo and Zaire) and South American countries (Costa Rica, Panama, Columbia, British Guyana, Peru, Ecuador, Venezuela and Brazil). **Malaysia, Indonesia and Nigeria** are the chief producers of oil palm.

The oil palm crop is known to yield the highest edible oil. It has two distinct oils: palm oil and palm kernel oil. The former is extracted from the fleshy mesocarp of the fruit, while the latter comes from the kernel of the stony seed. Oil palm is widely used as a cooking medium due to its low price and its good consumer acceptance. It is also a raw material for making multiple oleo chemicals, such as plasticizers and soaps. Besides these, it can additionally be used in multiple other applications, such as bio-fuels and cosmetics.

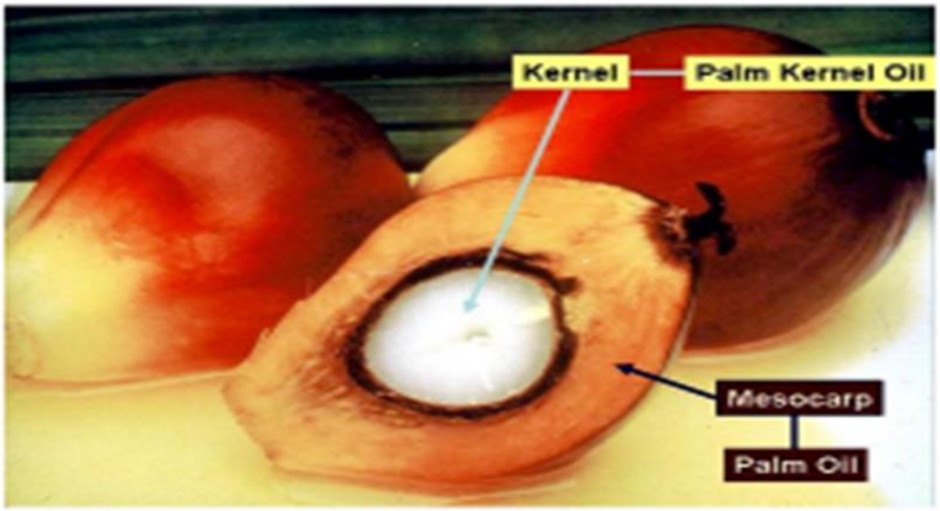


Figure 1.1 Palm Oil and palm kernel oil in a shell

Uses of palm oil

Palm oil is a versatile product which is used in a range of products across India:

- Household consumption and food services cover
- Industrial applications
- Cosmetics

- Bioenergy etc.

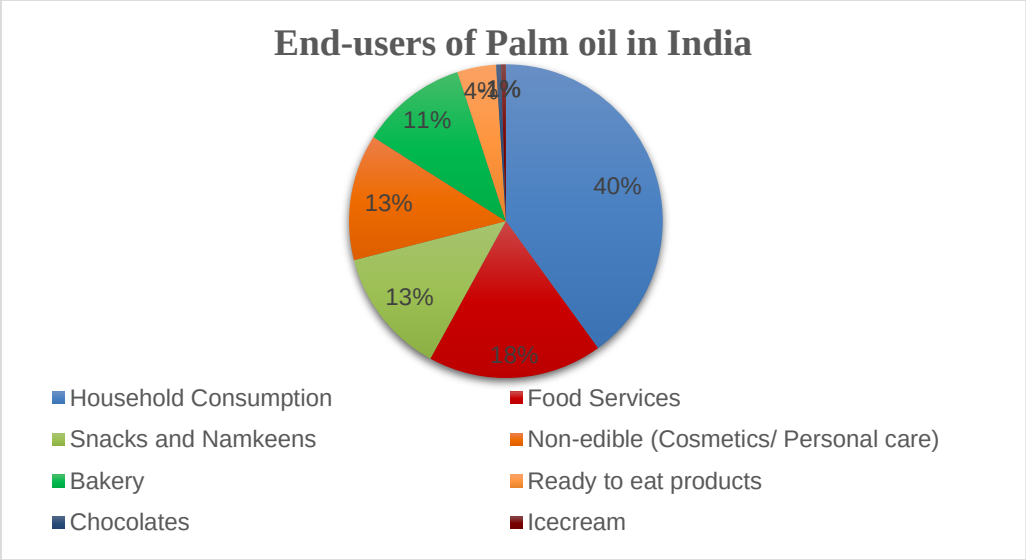


Figure 1.2 Scenario of Oil Palm in India[1]

1.1 Overview of Edible Oils in India

1.1.1 History

The oil palm was originally brought in for ornamental purposes by the National Botanical Gardens of Calcutta in 1848. Also, the development of oil palm from Nigeria was carried out by the Maharashtra Association for Cultivation of Sciences (MACS), Pune, from 1948 to 1954. This oil palm was mainly planted in various areas, including forest land, canal bunds, and irrigation systems. Commercial cultivation of oil palm started in 1972 to 1984 at various locations, such as the Little Andaman and Kerala. The Agriculture Department of Kerala first proposed to use oil palm for vegetable oil. A team from the state agriculture department was deputed to Nigeria to introduce the oil palm crop in the state. The seeds were imported from Nigeria and were brought to the state in 1960. They were then planted in a 40-ha area at Thodupuzha. This was regarded as the first systematic effort in the country to grow oil palm. (Kalidas et al. 2014)

1.1.2 Present Scenario

India has consistently increased its palm oil production over the last five years from – 275 lakh tonnes in 2014-15 to 365.65 lakh tonnes in 2020-21. India currently produces palm oil on more than 300,000 hectares (2021) (741,316 acres) of land and plans to cover an additional area of

[1] https://www.indiaspoc.org/images/I-SPOC-Biennial-Report.pdf

650,000 (160, 6184 acres) hectares by 2025-26. India requires 25 million tons of palm oil every year. The country produces around 10 million tons and imports a further 15 million from other countries. India's expanded coverage will help boost production by 1.12 million metric tonnes. Since the mid-1980s, the government has been implementing various policies aimed at increasing the country's edible oil production. The success of these initiatives, which were known as the Yellow Revolution, has made India almost self-sufficient in its edible oil production. From 1985 to 1993, the share of imported edible oils in the total edible oil supply decreased from 26.72 percent to 2.17 percent.

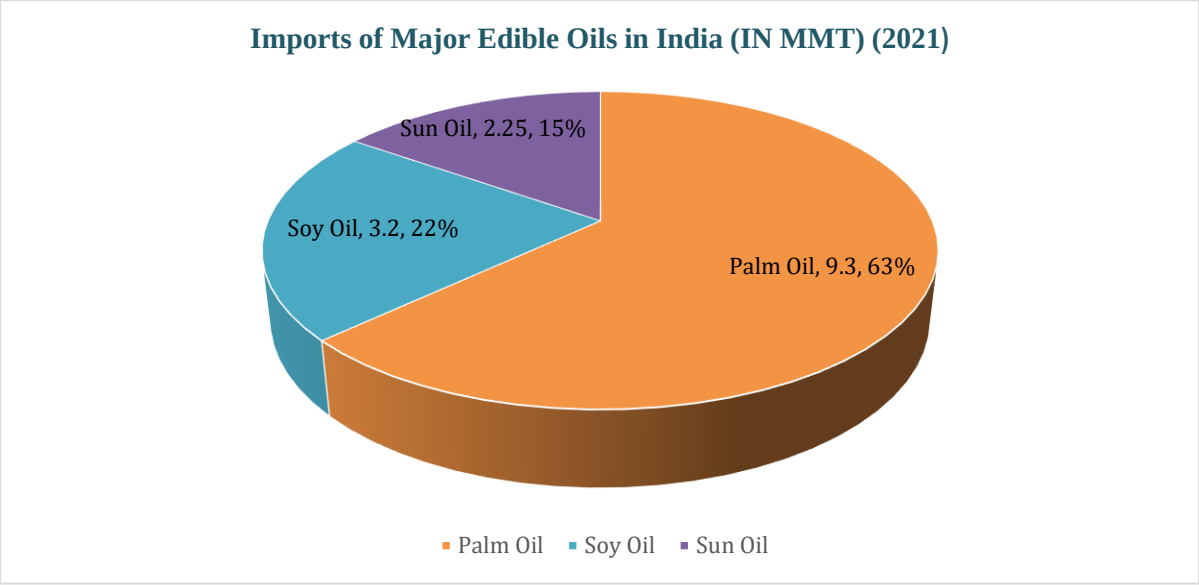


Figure 1.3 Imports of Major Edible Oils in India for the year 2021[2]

Of all the imported edible oils in India, the share of palm oil is about 63% followed by soybean oil with a share of 22% and sunflower at 15%. Import growth in respect of edible oils during the last decades is about 174%. The import figure of edible oils during 2019-20 reveals that India imported a total of 13.35 million tonnes of vegetable oils costing Rs. 61,559 crores. In 2018 India was the biggest importer of palm oil in the world and also the biggest importer of palm oil from Malaysia.

The per capita consumption is around 19.00 to 19.80 kg per person per annum over the last five years. Domestic edible oil production has not been able to keep pace with the growth in consumption. During 2019-20, domestic production of edible oils was 10.65 million tonnes

[2] *Source: Indian Vegetable Oil Producers' Association. Govt. of India*

from both primary (oilseeds) and secondary sources (coconut, oil palm, rice bran oil, cotton seed oil and TBOs).

1.2 GOVERNMENT INTERVENTION

In addition to being a major component of the vegetable oil economy, oil palm is also expected to play a significant role in the country's future supply. Due to its potential, the government has been expanding the area under it in order to bridge the gap between the domestic production and consumption. Government has continuously been making efforts to increase the area production of oil palm. For increased availability of edible oils in the country and to reduce the import burden, various interventions since 1991-92 through schemes such as the Technology Mission on Oilseed & Pulses (TMOP), Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM), Oil Palm Area Expansion (OPAE), National Mission on Oilseeds and Oil Palm (NMOOP) and the National Food Security Mission (NFSM)–Oilseeds & Oil Palm were under implementation in 13 States viz; Andhra Pradesh, Telangana, Chhattisgarh, Tamil Nadu, Kerala, Gujarat, Karnataka, Odisha, Mizoram, Nagaland, Assam, Arunachal Pradesh, Manipur with the funding pattern of 60:40 in case of general States and 90:10 in case of North-Eastern States and hill States.

A comprehensive Centrally Sponsored Scheme, Oil Palm Development Programme (OPDP), was taken up during Eighth & Ninth Plans. During the Tenth and Eleventh Plans, Government of India had provided support for oil palm cultivation under Centrally Sponsored Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM). To boost oil palm cultivation, Government of India had implemented a Special Programme on Oil Palm Area Expansion (OPAE) under RKVY. During the XII Five Year Plan, a new National Mission on Oilseeds and Oil Palm (NMOOP) has been launched under which Mini Mission-II is dedicated to oil palm area expansion and productivity increases.

Mini Mission- II on Oil Palm: Andhra Pradesh, Chhattisgarh, Goa, Gujarat, Maharashtra, Mizoram, Karnataka, Kerala, Odisha, Tamil Nadu, Arunachal Pradesh, Assam, Bihar, Manipur, Meghalaya, Nagaland, Sikkim, Tripura and West Bengal. As a result of the developmental efforts over the years, the oil palm area which was 8585 ha in 1991-92, has increased to 3.70 lakh ha in 2020-21. Similarly, the production of Fresh Fruit Bunches (FFBs) from which oil palm is extracted, has increased from 0.21 lakh tonnes to 16.89 lakh tonnes in

2020-21. Crude Palm Oil (CPO) has increased from 0.01 lakh tonnes to 2.72 lakh tonnes during the same period.[3]

Considering the domestic demand for edible oils and to check the imports the urgency of scaling up oil palm is a matter of national interest and therefore the govt. of India has launched a new central sector scheme- '**National Mission on Edible Oils – Oil Palm'** in August 2021 to make country self-reliant in the edible oil sector. The scheme is initially announced to be implemented for 5 years i.e., 2021-22 to 2025-26. To support the oil palm and oilseed sector of the country, by launching the new scheme NMEO-OP, GOI has declared a substantially increased subsidy on the ongoing components & inputs required for oil palm cultivation, which were previously provided under National mission on Oilseeds and Oil Palm. Moreover, to insulate the farmers from the volatility of the international crude palm oil prices, the GOI has also formulate new price policies for the fresh fruit Bunches (FFBs) which will ensure the remunerative return to the oil palm farmers.

New Mission on Oil palm (2021) known as the National Mission on Edible Oils – Oil Palm (NMEO-OP)

Under this scheme, it is proposed to cover an additional area of 6.5 lakh hectare (ha.) for oil palm till the year 2025-26 and thereby reaching the target of 10 lakh hectares by 2030. The production of Crude Palm Oil (CPO) is expected to go up to 11.20 lakh tonnes by 2025-26 and up to 28 lakh tonnes by 2030.

- A new Centrally Sponsored Scheme with a special focus on the North east region and the Andaman and Nicobar Islands.
- A financial outlay of Rs. 11,040 crores out of which Rs. 8,844 crores are the share of Government of India.
- Assistance to seed gardens specially for North-East and Andaman regions.
- Price Assurance to Oil Palm farmers for Fresh Fruit Bunches.

Under NFSM-Oil palm, financial assistance is being provided to the farmers @ 85% cost of planting material and @ 50% cost of other components such as maintenance cost of new plantations for four years, installation of drip-irrigation systems, diesel/electric pump sets,

[3] https://nfsm.gov.in/Guidelines/NMEO-OPGUIEDELINES.pdf

bore-well/water harvesting structures/ ponds, inputs for inter-cropping in oil palm (during gestation period), construction of vermi-compost units and purchasing of machinery & tools etc.

The Fresh Fruit Bunches (FFBs) production and Crude Palm Oil (CPO) have increased from 21,233 MT and 1,134 MT respectively (1992-93) to 10.34 lakh (Provisional) and 1.63 lakh MT (Provisional) respectively during the year 2019-20. At present, Andhra Pradesh, Karnataka, Tamil Nadu, Mizoram and Odisha are major oil palm growing states.[4]

Foreign Direct Investment (FDI) Policy: 100% FDI is also permitted in the Palm Oil plantations.

The Price Policy: For the first time, the concept of Viability price (VP) for the fresh fruit bunches (FFBs) has been introduced in the country, which will be the mechanism for the assured returns to the farmers. This will take care of the fluctuation of international crude Palm oil price and will guarantee a price of the FFBs with an objective formulation. The VP of FFBs shall be declared by the Department of Agriculture & Farmers Welfare in the month of November each year and this will be 14.3% of the annual average price of CPO of the last 5 years' price adjusted with wholesale Price Index (WPI) of all India. Further, for assured payments to the farmers, a concept of Formula Price (FP) has also been declared by GOI, which will be 14.3% of average monthly (of the preceding month) landed COP price. The FP will be used for calculation of Viability Gap funding every month.

In this new scheme, if the payment to the farmers by the industry is below the Viability Price, the Government of India will provide a viability gap funding to ensure that the farmers payment reaches the Viability Price. While, for the calculation of Formula Price, a constant of 14.3 % of CPO has been taken, for the minimum industry payment to the farmers, this will increase gradually. To give impetus to the North Eastern states, especially because of existing terrain, tough conditions & need for investment in the industry, the Government of India has declared to provide a special payment for NER to ensure that the farmers are paid at par with the rest of India.

[4] https://agricoop.nic.in/sites/default/files/Web%20copy%20of%20AR%20%28Eng%29_7.pdf

Table 1.1 Annual Action Plan allocation fund for implementation of Centrally Sponsored Scheme NMEO-OP for the year 2021-22 (Rs. In lakh)

States	Govt. of India	State Share	Total
Andhra Pradesh	4886.95	3257.97	8144.92
Arunachal Pradesh	1685.4	183.44	1868.33
Goa	6.01	4.00	10.01
Chhattisgarh	182.68	121.79	304.47
Gujarat	178.72	119.149	297.87
Telangana	3616.50	2411.00	6027.49
Tamil Nadu	278.70	185.80	464.50
Assam	47.25	5.25	52.5
Manipur	755.26	83.96	839.18
Mizoram	1015.73	112.86	1128.59
Karnataka	745.66	497.11	1242.77

2 CULTIVATION OF OIL PALM

2.1 OIL PALM POTENTIAL AREA IN INDIA

The reassessment committee of ICAR- Indian Institute of Oil Palm Research (IIOPR) 2020 has assessed in the year 2020, a total 22 states covering 284 districts have been identified with 27.99 lakh ha potential area, an area of 18.37 lakh is in the general states, and 9.62 lakh in the NE States. Presently in the North East the coverage is around 38,992 hectares against the potential of 9.62 lakh hectares, leaving much scope for expansion. During 2020-21, the production of CPO was around 2.72 lakh tonnes, obtained from 1.87 lakh hectares of fruiting area.

However, the potential districts having more than 4000 to 5000 ha will be given special focus for oil palm area expansion and productivity enhancement of FFBs. The State Governments will develop long- term agreement between farmers, processors and states through the Oil Palm Act or any other mechanism prevalent in the state. They will also involve industries, ICAR, KVKs in the formulation, prioritization of activities & identification of beneficiaries at grass root level and ensure involvement of Panchayati Raj Institutions (PRI).

2.2 GENERAL POP OF OIL PALM IN BRIEF [5,6]

Climate and Temperature	1800 mm to 3000 mm rainfall, 22℃ to 24℃ Min. temp. 29℃ to 33℃ Max. temp. Sufficient temperature at least 5 hours a day, > 80% RH
Soil	deep loamy alluvial soil, well drained, rich in organic matter and well-balanced soil pH
Planting season	May, June and July
Age of seedlings for planting	1 year old, 1m in height, 20-25cm girth at collar region and around having 12-13 functional leaves
Plant population	Can accommodate 143 plants in 1 ha, 57 plants in 1 acre

[5] *https://kvk.icar.gov.in/API/Content/PPupload/k0208_29.pdf*
[6] *https://iiopr.icar.gov.in/index.php*

Planting distance	Plant at a spacing of 9m X 9m X 9m following equilateral triangular system
Pit size	60cm X 60cm X 60cm (length, breadth and depth)
Irrigation management	100 litres to 350 litres of water per day depending upon the crop season. Do not grow oil palm if assured and adequate irrigation facility is not available. Basin method of irrigation can be taken up when irrigation water is not a constraint. Required quantity of water is to be given at 4-5 days’ interval.
Basin making	1 m from the main trunk in the 1st year and 2m in 2nd year
Harvesting time	When the fruit colour changes from purple to orange colour, and the single fruit could easily fall off from the bunch
Cultivated Variety	Tenera is the ruling hybrid and it is a cross between thick-shelled Dura and shell less Pisifera. Tenera has a thin shell, medium to high mesocarp content and high oil content.
Weeding	Take up regular weeding manually or with the use of only recommended herbicides. Use preferably contact herbicides.
Flowering	Oil palm comes to flowering 14-18 months after planting. It produces both male and female flowers separately on the same palm. Male and female phases do occur naturally in consequent cycles in a palm.
Ablation	Removal of male and female flowers produced in the early stages of plantation. This enables the plant to gain adequate stem girth, vigour and develop adequate root system.
Pollination	Oil palm is a highly cross-pollinated crop. Wind and insects assist pollination, but wind pollination is not adequate. Effective pollinating insects can help.
Mulching	Mulching of oil palm basins is essential to conserve moisture as well as to control weeds. Mulching can be done with dried leaves, male flowers, husk, empty bunches etc.

Harvesting	While harvesting a stalk length of 5 cm alone should be left. Harvesting should be done at 10-12 days' interval. During rainy season, harvesting should be done at closer interval of 6-7 days as ripening is hastened after hot summer. In young plantations, we get more bunches with less bunch weight and in adult plantations the bunch weight is more but the bunch number is less.
Yield	At yield stabilizing period (4-8 years): 12t/h At yield stabilized period (>8 years): 20t/h FFBs are highly perishable in nature and therefore, require crushing within 24 hrs of harvesting. Therefore, creation of processing units is a pre-requisite for under taking area expansion of oil palm.

Amount of water required by oil palm is very less compared to that of other water exhaustive crops.

Table 2.1 Water requirement of Oil Palm in comparison with other crops

Crop	Water requirement (lakh litres /ha/Y)	Water productivity (Litres)
Oil Palm	95	2163/kg oil
Paddy	300 (2 seasons)	3000 /kg rice**
Sugarcane	133	1157/kg sugar
Banana	120	-

Source: IIOPR – Technical Bulletin on Irrigation Management in oil palm, 2013

*** IRRI Bulletin, 2007*

2.3 VARIETIES

There are three naturally occurring forms of the oil palm fruit, termed dura, tenera, and pisifera. Most cultivars are the Tenera form which produces fruit with higher oil content. The only variety recommended for commercial cultivation is tenera, which is a hybrid between dura and pisifera.

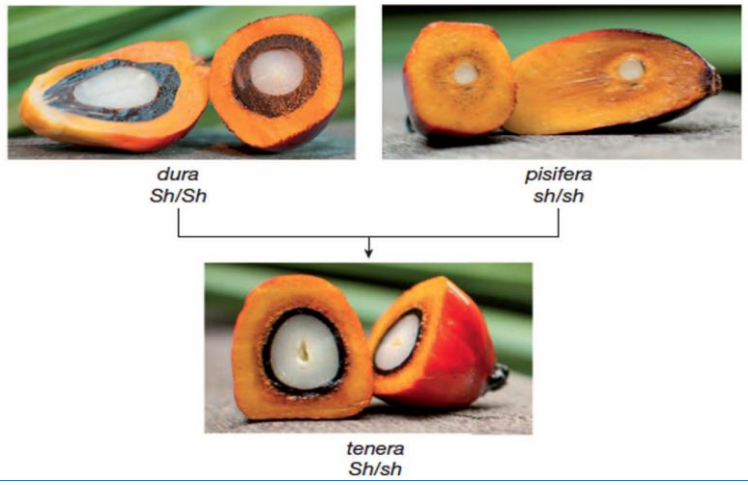


Figure 2.1: Tenera hybrid (thin) from dura (thick); pisifera (shell-less)[7]

2.4 NURSERY PRACTICES

For high-yield material to reach its potential, the best growing practices need to be adopted and nursery practices are essential in this process. This is inevitably the first stage in preparing material for field planting and one that is critical. It is a phase which determines the quality and performance of the adult palm. The fruits are separated from the bunch and seeds are extracted by scraping off the exocarp and mesocarp with a knife, or by retting in water. The seeds are then dried by spreading them on concrete or wooden floors under shade for two days. Such seeds can be stored for 3-9 months at about 27 ºC without much reduction in viability. Seeds are soaked in water for five days, changing the water daily. Thereafter, the seeds are spread out to dry for 24 hours. The dried seeds are put in polythene bags and placed in germinator maintained at a temperature of 40 ºC.

After 80 days, the seeds are removed from polythene bags, soaked in water for 5 days changing the water daily and dried in the shade for two hours. The seeds are then put back into bags and kept in a cool place in order to maintain the moisture content. Germination commences in about 10-12 days. The percentage of germination obtainable by this method is 90-95. Raising nursery Polybags (preferably black) of 400-500 gauge measuring 40 x 35 cm are used. The young plants (seedling or ramets) are removed from the pre-nursery after about two to three months, or when four to five leaves have emerged. Roots will begin to emerge from the drainage holes in the planting bags after two months, thus these emerging roots will be disturbed during the potting-on process. Culling of abnormal plants should be carried out at this time. The bags are

[7] *https://www.cshl.edu/full-genome-map-of-oil-palm-indicates-a-way-to-raise-yields-and-protect-rainforest/*

filled with topsoil and compost and are arranged at a spacing of 45 x 45 cm and one sprouted seed is dibbled per bag. 10-14 months old healthy seedlings with 1-1.3 m height from base and 13 functional leaves with good girth at collar are used for planting. Seedlings up to 24 months' age can also be used.

Growing young oil palm plants (seedlings and ramets) in planting bags of various sizes has been tried, tested and developed. Small planting bags proved to be convenient for sowing germinated seeds and planting tissue culture-produced ramets, which are then transferred to larger bags in the main nursery. This is also cheaper than field nursery practices (described briefly below). Growing young palms in bags reduces labour costs and provides a convenient means of transporting plants from the nursery to the field.

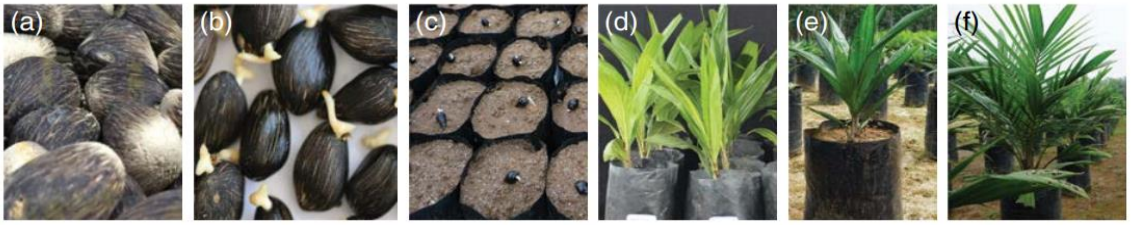
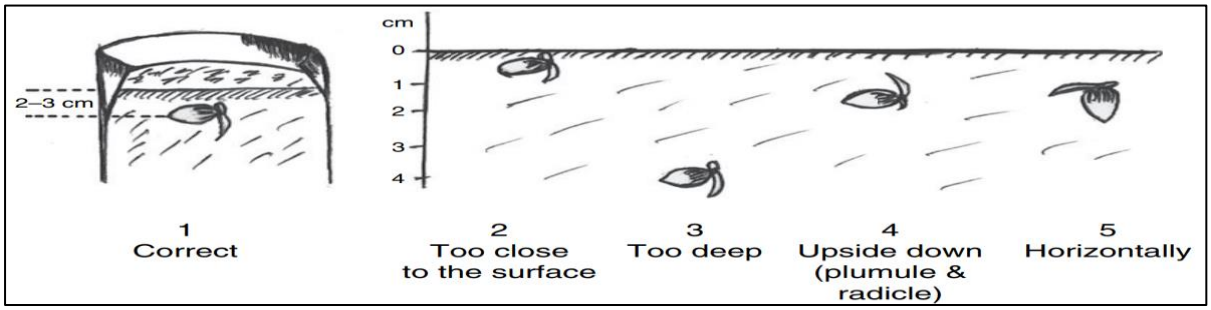


Figure 2.2 Seed and seedling development in an oil palm nursery[8]

a) Un-germinated seed; b) Germinated seed ready for sowing (0 weeks); c) Sowing seedlings; d) Seedlings in small bags ready for transplanting (12 weeks); e) Transplanted seedling in big bag with spacing (main nursery); f) Palms in big bag ready for field planting (36–48 weeks)

Figure 2.3 : The germinated seed placed on top of individual bags in the bed



[8] https://www.worldcat.org/title/nursery-practices-in-oil-palm-a-manual/oclc/1097462731

Figure 2.4: Watering after planting

Figure 2.5: Examples of abnormal seedlings—

a) Narrow leaf; b) Crinkled leaf; c) Twisted leaf; d) Rolled leaf

Figure 2.6: Placing young plants to their new bags and young plants placed in their new bags

Figure 2.7: Transportation of young palms to the field[9]

[9] *https://www.worldcat.org/title/nursery-practices-in-oil-palm-a-manual/oclc/1097462731*

Direct planting of oil palm germinated seed in the field is possible, but there are several problems. First, there is a significant risk of damage from animals (especially insects and rodents). Secondly, the plants generated will not be uniform and abnormal palms cannot be discarded. Thirdly, there is wastage of time in crop production: palms take longer to mature and bear fruit, compared to planting field-ready plants raised in a nursery[10]. Thus, direct field planting is generally neither practical nor economical and so is not recommended.

2.5 Cultivation Practices for Oil Palm

2.5.1 Plant Biology

Oil palm can reach 60-80 ft. in height in nature, but is rarely more than 20 or 30 ft. in cultivation. Leaf bases are persistent for years, and prominent leaf scars are arranged spirally on the trunk of mature palms where bases have fallen. Leaves are up to 25 ft. in length, with leaflets numbering 200-300 per leaf, about 3-4 ft. long and 1.5 - 2.0" wide, with entire margins. Leaflets cover the distal 2/3 of the leaf, and the lower 1/3 is spined with spines increasing in length acropetally.

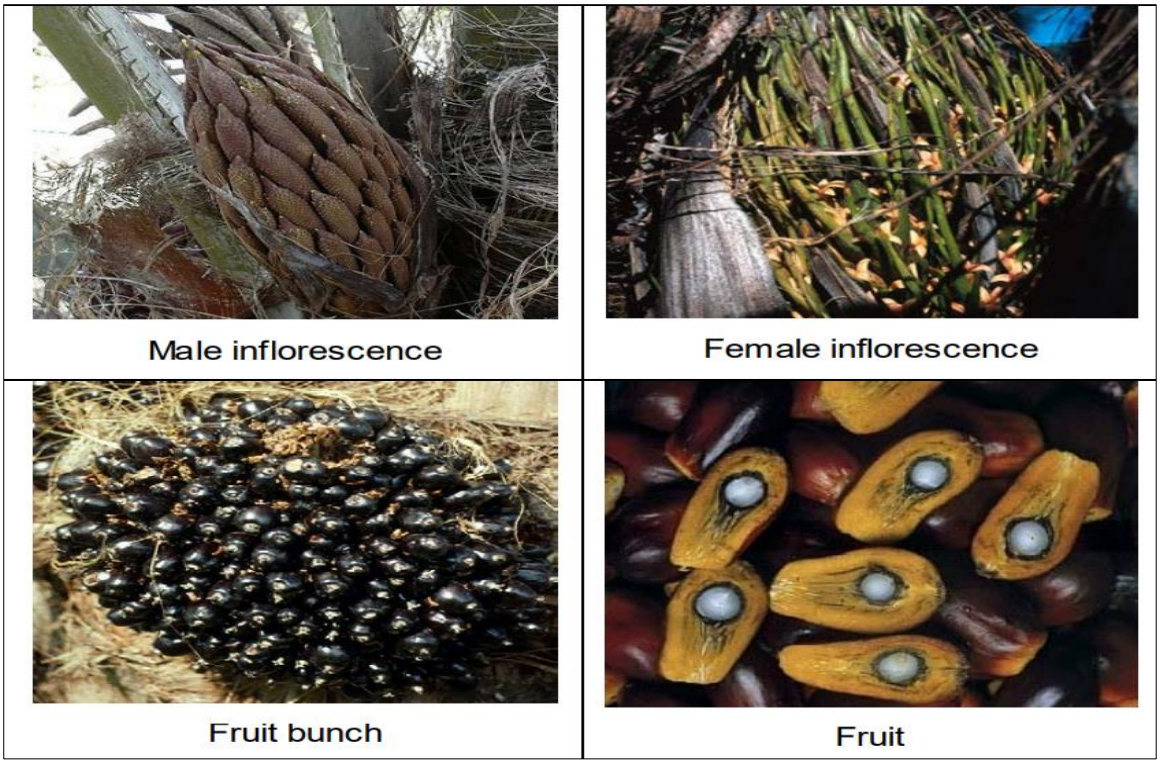


Figure 2.8: Botany of Oil Palm[11]

[10] https://catalogue.nla.gov.au/Record/1478450
[11] http://eagri.org/eagri50/HORT282/lec20.html

2.5.2 Climatic Requirements

Oil palm is a humid crop. Requires evenly distributed rainfall of 150mm/ month or 2500-4000mm/annum. Rainfall distribution in India is not even and adequate. Hence grow oil palm under assured irrigation conditions by adopting recommended practices. Crop comes up well between 29-33°C max. and 22-24°C min. temperatures and with bright sunlight for at least 5 hrs. per day. Humidity of more than 80% is required to come up well.

2.5.3 Soils

Best-suited soils are moist, well-drained, deep, loamy alluvial soils, rich in organic matter with good water permeability. At least one-meter depth of soil is required. Avoid highly alkaline, highly saline, waterlogged and coastal sandy soils.

2.5.4 Cultivated variety

Tenera is the ruling hybrid and it is a cross between thick-shelled Dura and shell less Pisifera. Tenera has a thin shell, medium to high mesocarp content and high oil content. (Fig 2.1)

2.5.5 Planting

Best season for planting is June-December i.e., during monsoon. In case of planting during summer, adequate irrigation, mulching and growing cover crops like sun hemp in the basin would help in avoiding hot winds during summer. 12 -14 months old healthy seedlings with 1-1.3m height and 13 functional leaves are recommended for planting. While planting, 143 plants per hectare should be maintained with a spacing of 9m x 9m x 9m (triangular planting). Planting should be done in pit size of 60 cm x 60 cm x 60 cm (length, breadth and depth).

Apply 250g Di Ammonium Phosphate or 400g Single Super Phosphate, 50g Phorate and mix with the soil at the base of the pit. Immediately after er planting, form basin and give copious irrigation.

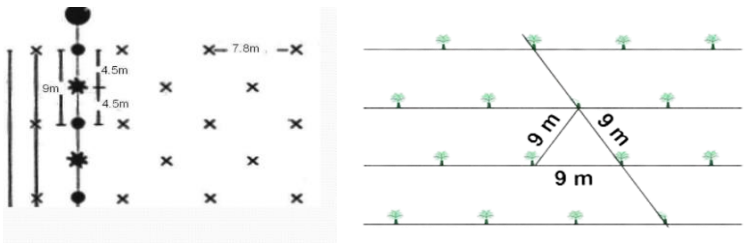


Figure 2.9 Spacing for Oil palm[12]

[12] http://odihort.nic.in/sites/default/files/Oilpalm-Cultivation-in-Odisha.pdf

2.5.6 Planting method

- Fill the gap in the pit with soil and press firmly leaving the top portion so that the seedling bowl will be 25 cm below the ground level.
- Immediately after planting form basin and give copious irrigation.
- Provide a wooden support if wind is more.
- Take care to see that the soil does not get accumulated at the crown region, which may lead to rotting of crown.
- In case of low-lying wet land soils planting should be done in raised mounds to avoid water logging and poor aeration.
- Do not store the seedlings for days together in open place after lifting and transporting to the farm.

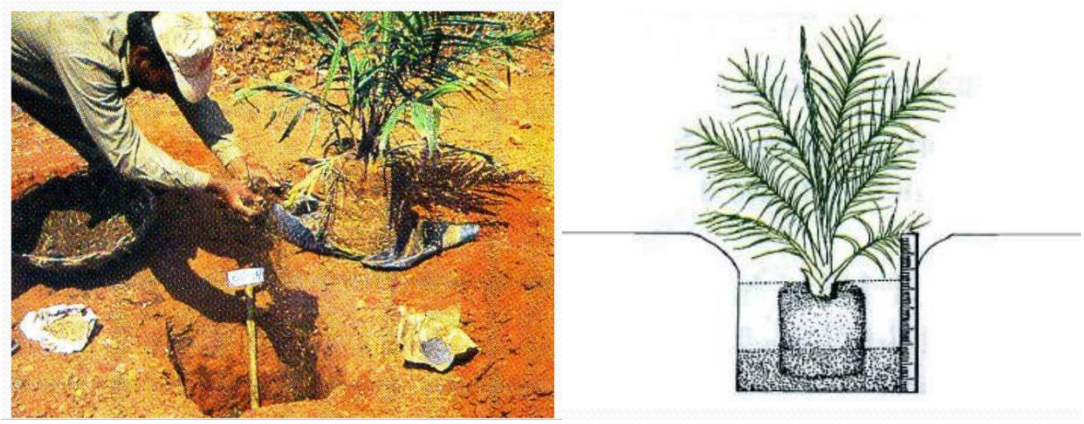


Figure 2.10 Method of planting Oil palm[13]

2.5.7 Irrigation Management

Oil palm requires sufficient irrigation, as it is a fast-growing crop with high productivity and biomass production. Do not grow oil palm if assured and adequate irrigation facility is not available. Insufficient irrigation will reduce the rate of leaf production, affects the sex ratio and results in inflorescence abortion and yield reduction. For grown up yielding palms of 3 years' age and above a minimum of 200-250 litres of water per day is must. However, in older plantations during hot summer this amount may be increased up to 300-350 litres.

When irrigation is not a constraint, basin irrigation can be taken up. Prepare irrigation channels in such a way that, the individual palms are connected separately by sub channels. If irrigation

[13] *http://odihort.nic.in/sites/default/files/Oilpalm-Cultivation-in-Odisha.pdf*

water is limited and land is of undulated terrain drip or micro sprinkler irrigation will be of advantage.

Figure 2.11 Basin and drip Method of Irrigation in Palm Oil

If irrigation water is limited and land is of undulated terrain drip or micro sprinkler irrigation can be advantageous. In drip system, a minimum of four drippers has to be placed for each palm. If each dripper discharges 8 litres of water per hour, 7 hours of irrigation per day is sufficient to discharge 224 litres per day. Drippers should be checked periodically for proper discharge of water. Basins must be adequately mulched, which will help to conserve moisture.

Figure 2.12: Sprinkler Irrigation for Oil Palm

Subsidy for drip irrigation for oil palm is available on the drip material, 50-70%, not exceeding Rs. 50,000/- per farmer. Please contact the office of the Assistant Director of Horticulture/Agriculture of the respective district.

Irrigation Management during summer

When temperature reaches > 40o C and RH is low, if heat waves exist during summer, the adverse climate will affect oil palm growth and yield. Hence necessary precautions need to be taken during summer in oil palm plantations (Water stress to the palm can be identified in oil palm with the presence of two or more unopened spindles on the crown).

If irrigation is provided through basin method, in light soils provide more frequently with recommended quantity. In heavy soils provide recommended quantity in less frequency. If irrigation is provided through micro irrigation, check the discharge of drip/jets.

Mulching: In order to avoid losses through evaporation, check weed growth and conserve moisture, practice mulching in the palm basins with coconut husk, oil palm empty fruit bunches, oil palm/coconut fibre, maize stalk, dried oil palm fronds etc.

Figure 2.13: Mulching in oil palm

2.5.8 Nutrient Management

Oil palm is a heavy feeder and demands a balanced and adequate supply of macro, secondary and micro - nutrients for growth and yield. For newly planted crop, the first dose of fertilizer can be applied three months after planting. Nutrient requirements are 400 gm of nitrogen, 200gm of phosphorous, 400 gm potash and 125 gm of magnesium sulphate in the first year; 800 gm of nitrogen, 400gm of phosphorous, 800 gm potash and 250 gm of magnesium sulphate in the second year; 1200 gm of nitrogen, 600gm of phosphorous, 1200 gm potash and 500 gm of magnesium sulphate need to be applied in third year onwards[14].

Borax @ 100 gm per palm per year is recommended when the deficiency symptoms are noticed. Fertilizers are to be applied in a minimum of three to four equal splits in a year. If good FYM is available, add 50 – 100 kg FYM or 100 kg green manure per palm along with the

[14] https://iiopr.icar.gov.in/pdf/FAQs.pdf

second dose of fertilizer application. Five kg of neem cake per palm can also be applied. However, care should be taken to reduce the nitrogen through chemical fertilizer in proportion to that available in FYM. Broadcast the fertilizers around the clean weeded basin, about 50 cm away from the palm base as the absorbing roots are concentrated there and incorporate fertilizer into the soil by forking. Irrigate the palms immediately after fertilizer application.

If the native soil fertility is high, nitrogen application can be reduced. Where yields are 30-35 t/ha amount of potash may be increased to 1800-2400 gms/palm/year. (3-4kg of muriate of potash/palm/yr)

If fertilizers are applied in the form of urea, single super phosphate and muriate of potash, following quantities may be applied in three to four equal splits.

Age of the palm	Urea (gms/palm/yr)	Single Super phosphate (gms/palm/yr)	Muriate of potash (gms/palm/yr)
First year	870	1250	667
Second year	1740	2500	1333
Third year and above	2610	3750	2000

If fertilizers are applied in the form of DAP, urea, and muriate of potash, following quantities may be applied in three to four equal splits.

Age of the palm	Urea (gms/palm/yr)	Diammonium phosphate (gms/palm/yr)	Muriate of potash (gms/palm/yr)
First year	700	435	667
Second year	1400	870	1333
Third year and above	2100	1305	2000

If fertilizers are applied in the form of Ammonium sulphate, Single super phosphate and muriate of potash, following quantities may be applied in three to four equal splits.

Age of the palm	Ammonium sulphate (gms/palm/yr)	Single super phosphate (gms/palm/yr)	Muriate of potash (gms/palm/yr)
First year	1942	1250	667
Second year	3883	2500	1333
Third year & above	5825	3750	2000

If fertilizers are applied in the form of Urea, complex fertilizers (10:26:26) and muriate of potash, following quantities may be applied in three to four equal splits.

Age of the palm	Urea (gms/palm/yr)	Complex fertilizer (10:26:26) (gms/palm/yr)	Muriate of potash (gms/palm/yr)
First year	703	769	333
Second year	1405	1538	667
Third year & above	2108	2308	1000

If fertilizers are applied in the form of Urea, complex fertilizer (17:17:17) and muriate of potash, following quantities may be applied in three to four equal splits.

Age of the palm	Urea (gms/palm/yr)	Complex fertilizer (17:17:17) (gms/palm/yr)	Muriate of potash (gms/palm/yr)
First year	434	1176	333
Second year	870	2353	667
Third year & above	1304	3529	1000

Other useful Information related to fertilizer application

If provision exists in the drip system, it is always good to give fertilizers through drip irrigation.

Frequency of fertilizer application: Fertilizers can be applied in 3 / 4 splits in oil palm. Based on the soil (sand) type more number of splits is also advised.

Method of fertilizer application: Fertilizers are to be applied in 3 / 4 equal split doses starting from June. After er application of fertilizers, magnesium and boron can be applied with a 2-3 days gap respectively. Broadcast the fertilizers around the clean weeded basin, about 50 cm away from the palm base as there exist the absorbing roots and incorporate fertilizer into the soil by forking with iron rake. Irrigate the palms immediately after er fertilizer application.

Basin management

During first year, basins of 1-m radius, second year 2- m radius, and the third year 3- m radius are to be taken around the palm by removing the soil from inside so that the soil will not accumulate at the collar region. Basin area of oil palm represents its active root zone. Hence it must be kept clean and weed free to avoid competition for nutrients and water[15].

[15] https://iiopr.icar.gov.in/pdf/Recommended%20Practices.pdf

Figure 2.14: Basin management in Oil Palm

2.5.8 Weeding

Regular manual weeding should be taken up. Herbicides, preferably contact herbicides should be used. Among systemic herbicides, Glyphosate (750 ml/ha/ year or 17.5 ml/basin) is recommended for effective weed control. Weedicide is applied while weeds are in early growth stage for effective control. Weedicide is applied on a clear sunshine day, with 8 hours of dry atmosphere after spray. Avoid irrigation while weedicide is applied. The effect of weedicide would be seen in one-week after er application. Apply 2/3 times in a year if weed density is more. Mulching, growing cover crops and intercrops also reduce weed growth.

Translocated herbicides like Paraquat which is inactivated when contacted with soil are also used. Herbicides such as 2, 4-D, 2, 4-5-T, halogenated aliphatic acids Dalapon and TCA are found to produce abnormalities in oil palm seedlings and are to be avoided. Herbicide mixtures of 2 kg i.e., of Paraquat with 3 - 4 kg Atrazine Monuron and Diuron per ha sprayed/ground applied twice a year has been found to give control of weeds.

Figure 2.15: Mechanical, manual and chemical weeding in Oil Palm

Mulching in addition to conserving moisture, maintain soil temperature, add organic matter and nutrients mainly potassium, improve physical and biological properties of soil and check weed growth in the basin area.

2.5.9 Pruning

Pruning operations cannot be done in oil palm. However older leaves, senile leaves, pest or disease affected leaves can be removed selectively. Only the lower dried and diseased leaves must be pruned. Any damage to petiole or stem will attract disease organisms.

2.5.10 Inter-cropping

Oil palm is a wide spaced perennial crop with a long juvenile period of three years. A lot of horizontal and vertical space both above and below ground is available. This space can be used to generate income during the juvenile phase of the crop. Crop selected for intercropping should be compatible with the main crop and should not compete with the oil palm for light, water and nutrients. Crops like vegetables, banana, flowers, tobacco, chillies, turmeric, ginger and pineapple etc. can be grown. In case of maize, sorghum, and sugarcane proper spacing needs to be given. Oil palm crop should not be affected due to shade and root competition of inter crop. While growing pulses like green gram, black gram, cowpea and oilseeds like gingelly, groundnut which do not require frequent irrigation, care must be taken to irrigate oil palm regularly, so that oil palm does not suffer for lack of water.

While raising intercrops avoid tying or cutting of oil palm fronds, which will reduce photosynthetic activity and avoid ploughing close to the palm base, which will cut the absorbing roots and thereby reduce intake of water and nutrient. Allow oil palm to grow freely.

Maximum number of green leaves should be retained on the palm, only the lower dried and senile leaves must be pruned. Severe pruning must be avoided, as it will adversely affect the growth and yield.

- ✓ Do not cut the oil palm fronds.
- ✓ Do not tie oil palm fronds close to the stem for inter-cropping, which will reduce photosynthetic activity.
- ✓ Do not plough close to the palm base, which will cut the absorbing roots and thereby reduce intake of water and nutrients. Maximum number of green leaves should be retained on the palm.

Cocoa as an intercrop

Cocoa can be grown as intercrop in oil palm when, oil palm attains age of 10 – 12 years or 5 – 6 meters' height. Cocoa should be planted in a single row in the inter row spaces of oil palm @ 158 plants per acre or 395 plants per hectare. Care should be taken to avoid excess sunlight or complete shade while cocoa is planted. Cocoa should not compete for water and nutrients with oil palm; hence water and nutrients need to be provided separately as per recommendation.

Figure 2.16 Oil Palm as an intercrop with Banana, chillies, pineapple and elephant foot Yam

2.5.11 Flowering

- Oil Palm comes to flowering 14 -18 months after planting.
- It produces both male and female flowers separately on the same palm (monoecious).
- Male and female phases do occur naturally in consequent cycles in a palm.
- Some individual trees may exhibit a phenomenon of producing more male inflorescences and a smaller number of female inflorescences.
- Overall, there should be an average of 10-12 bunches per tree per year.

Causes for increased male inflorescence

Insufficient irrigation and irrigation at longer intervals

Non-application of recommended doses of fertilizers and other manures in appropriate quantities and time. Excessive pruning of fronds.

Ploughing deeply and close to the palms damaging the active feeding roots.

Figure 2.17 a) Male inflorescence b) Male inflorescence and female Inflorescence

Ablation

Ablation is the removal of male and female flowers produced in the early stages of plantation. This enables the plant to gain adequate stem girth, vigour and develop adequate root system. Flowering starts from 14th to 18th month after planting. Start ablation immediately after the appearance of inflorescences on the palms. They can be removed easily by hand pulling. Ablation can be extended up to 2-1/2 to 3 years depending upon the plant growth and vigour.

Pollination

Oil palm is a highly cross-pollinated crop. Wind and insects assist pollination, but wind pollination is not adequate. Effective pollinating insects like *Elaeidobius kamerunicus* helps in good pollination and fruit set. Release of this weevil after 2-1/2 year of planting is advisable. If the plants are not having good girth and vigour, release the weevils after 3 years.

Figure 2.18: Manual pollination of oil palm and Elaeidobius kamerunicus (pollination weevil for oil palm)

2.5.12 Harvesting of oil palm

Harvesting should be aimed at recovering the whole harvestable produce without loss of oil or loose fruit.

Good harvesting Indices

- Fruits in the bunch turn yellowish orange
- 5-10 fruits from each bunch drop on their own
- When pressed hard with the fingers, orange yellow coloured oil exudes from the fruit

Figure 2.19: Ripe oil palm bunch

Harvesting Method

- In tall and older plantations harvesting can be done with the help of sickle attached to an aluminium pole of 12 ft. height. (1.5" inner diameter and 2 mm thickness). By using male and female joint, the height of the pole can be increased by fixing additional poles of 12 ft. height.
- While harvesting a stalk length of 5 cm alone should be left
- Harvesting should be done at 10-12 days' interval.
- During rainy season harvesting should be done at closer interval of 6-7 days as ripening is hastened after hot summer.

Figure 2.20:Harvesting of Oil palm

Figure 2.21: Oil palm Harvesting tools[16]

2.5.13 Yield

- Yield of FFB/ha: 15 - 30 t
- No. of bunches / palm/year: 5 - 12
- No. of fruits/bunch: Above 2000
- Av. bunch weight: 25 kg
- Weight of fruit: 30 gm
- At yield stabilizing period (4-8 years): 12t/ha
- At yield stabilized period (>8 years): 20t/ha

[16] http://odihort.nic.in/sites/default/files/Oilpalm-Cultivation-in-Odisha.pdf

2.6 INTEGRATED DISEASE MANAGEMENT IN OIL PALM

So far it is observed that only a few diseases are prevalent on Oil Palm in India. Among which, the important ones are mentioned below.

a) Stem Wet Rot / Stem bleeding: *Theilaviopsis paradoxa (de seynes)*

Figure 2.22: Stem wet rot in oil palm

Symptoms[17]

- The characteristic symptom is the exudation of reddish-brown fluid from the cracks in the stem
- The fluid trickles down to several feet on the stem and the exudates dries up forming a black crust. The tissues below the cracks turn yellow and decay. As the disease progresses, more area underneath the bark gets decayed and the bleeding patch extends further up.
- The vigour of the tree is affected and seed yield is reduced.
- The tree is not killed outright but become uneconomical to maintain. In extreme cases, the trees may become barren and die.

Effect

- The affected palm usually will have a cavity of variable size filled with rotten fibrous mass at the centre of the stem.
- Rotting mass will be generally bright yellowish in colour.
- At the base of the stem it is fibrous usually black in colour and slightly wet.

[17] https://niphm.gov.in/IPMPackages/Oilpalm.pdf

Disease Management

- Improvement in agronomic practices, providing drainage, avoid flooding of the field.
- Early detection of the disease and trunk surgery can save the palm.

Early detection of the diseased palms

- In case of suspected palms for confirmation of the disease, a sharp iron rod may be pierced into the stem base, which gives out some liquid.
- If the liquid gives petrified smell, the palm should be subjected to trunk surgery immediately.

Figure 2.23: Trunk surgery

Trunk Surgery

- Trunk surgery is done to excise all affected fibrous tissues from inside the trunk. First the outer stem tissues and frond butts should be chiselled.
- The inner most disease tissues including yellowish lesions which are generally seen along with the border of healthy and diseased tissues also should be removed.
- When the surgery is completed a protective covering with carbendazim (1%) + monocrotophos (1ml) paste followed by hot coal tar should be given to prevent the wound invading micro-organisms and insects.

Precautions

- Do not allow water to stagnate in the fields, avoid flooding of the field.
- Do not leave the tissues exposed after trunk surgery. Give protective coat with coal tar and fungicides immediately or on the following day.
- Don't use copper fungicides.

b. Bud rot disease: *Phytophthora palmivora* (Butler)

The most common bud rot pathogen is ***Phytophthora palmivora***.

Figure 2.24: Bud rot disease in Oil palm[18]

(Spear leaf and next youngest leaves of this juvenile palm are exhibiting extensive necrosis due to a bud rot pathogen. Photo by M. L. Elliott.)

Symptoms

- Yellowing of the spear leaves which subsequently turns to brown.
- The first indication of the diseases is seen on the central shoot of the tree (spindle)
- The basal tissues of the spear completely get rotted, as a result it collapses and can easily pulled out.
- The rotten tissues emit offensive odour.
- Continuous and unchecked rotting leads to total destruction of meristem and ultimately death of the palm.
- The entire base of the crown may be rotten emitting a foul smell; the central shoot comes off easily on slight pulling
- The leaves fall in succession starting from the top of the crown. The leaf falling and bunch shedding continue until a few outer leaves are left unaffected. But within few months the infection leads to complete shedding of leaves, within subsequent wilt and death of the tree.

[18] https://niphm.gov.in/IPMPackages/Oilpalm.pdf

Management[19]

It is possible to cure very effectively, if the disease is detected in the early stages i.e. when the spindle starts showing symptoms of withering, yellowing and dropping down.

- The affected spear should be pulled out along with the decayed tissues.
- The affected tissues in the crown should be removed and drenched with fungicide solution, like Streptomycin sulphate + Carbendazim @1 gram/litre of water or Thiram (0.1%)
- For treating advance stage disease affected palms, first of all, the leaves surrounding the spear should be cut and the affected tissues of the meristem should be removed layer by layer till fresh tissues are seen. Once the affected tissues are completely removed the exposed tissues of the apical bud should be cleaned and smeared with 1% Carbendazim solution. The exposed portion should be covered with dried leaves or perforated polythene sheet.

Precautions

- Do not delay in giving treatment.
- Curative measures like removing the rotten tissues, crown surgery should be done as early as possible after the initial symptoms are seen.
- The rotten tissues and spear removed from the affected palms should not be left in the field. Those should be collected and burnt.
- While doing crown surgery to remove the rotten tissues care should be taken not to split or damage the apical bud.

c) Basal Stem Rot: *Ganoderma lucidum* (Karst)

Generally, the disease incidence can be expected in the coastal estates where the old plantations are already affected by the disease and soils are infected with the pathogen**.**

Symptoms[20]:

- The trees in the age group of 10-30 years are easily attacked by the pathogen. The fungus is soil-borne and infects the roots. The most usual symptoms are yellowing,

[19] http://odihort.nic.in/sites/default/files/Oilpalm-Cultivation-in-Odisha.pdf
[20] https://niphm.gov.in/IPMPackages/Oilpalm.pdf

withering and drooping of the outer fronds which remain hanging around the trunk for several months before shedding.

- The younger leaves remain green for some time and later turn yellowish brown.
- The new fronds produced become successively smaller and yellowish in colour which do not unfold properly.
- Soft rot occurs in the bud with a bad newly formed leaves wither away. More often the spindle is blown off leaving the decapitated stem.
- The wilting plants also show bleeding patches near the base of the trunk.
- A brown gummy liquid oozes out from the cracks in the tree which slowly result in the death of outer tissues.
- As the infection advances, fresh bleeding patches appear above the old once, up to 3-5 meters' height.
- The decay of the basal portion occurs slowly and tree succumbs to the diseases in 2-3 years.
- In the advanced stages of infection, the fungus produces fruiting body (Bracket) along the side of the basal trunk.
- The roots of wilting trees show discoloration and severe rotting.

Figure 2.25: Basal stem rot (Ganoderma lucidum) in Oil Palm)[21]

[21] https://www.sciencedirect.com/science/article/pii/S1319562X21000863

Management[22]

There is a little hope of saving the affected palms as by the time symptoms are visible more than 50% of the basal stem tissues get affected. However, the disease progress can be checked by-

- Field Sanitation: Removal and destruction of the dead and diseased palms in order to prevent the spread of the disease.
- Isolation of diseased Palms: The palms in the early or middle stages of the disease should be isolated from the neighbouring palms by taking trenches of 1 m deep and 30 cm wide.
- Affected palm should be given 5 kg of neem cake/year.
- The disease affected and apparently healthy palms should be treated with 10 ml. Calixin (tridemorph) or 10 g Aureofungin sol (in 100 ml of water) per palm through root feeding.
- The suspected disease palms should be uprooted and destroyed immediately as soon as they are noticed.

Precautions

- Do not plant the Oil Palm seedlings in the area where Ganoderma disease of coconut is prevalent or the area is prone for the Ganoderma.
- Water movement, ploughing and other management practices should not be allowed to move from the disease affected palm site to the other areas of the garden.

d) Bunch Rot: *Marasmius palmivorus* (Sharples)

Bunch rot disease is one of the important diseases affecting the fresh fruit bunches thus causing direct economic loss. Diseased bunches left on palms itself spread the disease from one bunch to another bunch of the palm.

Symptoms[23]

- In the early stages of infection, whitish or pinkish-white mycelial threads can be seen over the bunch surface, especially at the base of the subtending frond.

[22] http://odihort.nic.in/sites/default/files/Oilpalm-*Cultivation*-in-*Odisha*.pdf
[23] https://niphm.gov.in/IPMPackages/Oilpalm.pdf

- The fungus penetrates the mesocarp of the fruit and causes a soft, brown, wet rot which is sharply defined from healthy tissues. If affected fruits are left on the palm, the rot ultimately dries out, leaving the fibrous tissues of the mesocarp with abundant mycelial growth of the pathogen.
- The mycelial threads spread to other bunches and grow over, and inside, the frond bases. In the later stages of infection, abundant fructifications can be seen on bunches which have been extensively colonized.
- Resting spores capable of surviving in soil and plant tissues for several months

Figure 2.26: Bunch rot in Palm Oil

Management

- **Sanitation**: Before on-set of monsoons, crown cleaning by means of removing the dead inflorescences, bunch stalks, aborted bunches etc. will help in reducing the inoculum build up and harbouring of pathogen.
- **Chemical Control**: To check the spread of the disease and to eradicate the inoculum of the fungus, crowns of the infected palms should be thoroughly cleaned and sprayed with 0.1% Carbendazim solution.

Precautions

- Do not leave the rotten, aborted bunches and dried inflorescences on the crown.
- Don't use copper fungicides. Oil palm is sensitive to them.

2.7 INTEGRATED PEST MANAGEMENT

A. Pests of National Significance

Insect pests

i. Spindle bug: *Carvalhoia arecae* (Miller) (Hemiptera: Miridae)
ii. Root grub: *Leucopholis burmeisteri* (Brenske) (Coleoptera: Melolonthidae)
iii. Rhinocerous beetle: *Oryctes rhinoceros* (Linneaus) (Coleoptera: Scarabaeidae)
iv. Red palm weevil: *Rhynchophorus ferruginous* (Olivier) (Coleopteran:Curculionidae)
v. Case worm: *Pteroma pendula* (de Joannis) (Lepidoptera: Psychidae)

B. Pest of Regional Significance

Insect and Mite pests

i. Scale: *Aspidiotus destructor* (Signoret) (Hemiptera: Diaspididae)
ii. Mealy bug: *Dysmicoccus brevipes* (Cockerell) (Homoptera: Pseudococcidae)
iii. Termites: *Odontotermes obesus (Rambur)* (Isoptera: Termiitidae)
iv. Nettle caterpillar: *Thosea andamanica* (Holloway) (Lepidoptera: Limacodidae)
v. Mite: *Tetranychus piercei* (McGergor) (Acarida: Tetranychidae)

A. Pests of National Significance

1. Spindle bug: *Carvalhoia arecae* (Miller) (Hemiptera: Miridae)

Biology

- **Egg:** Eggs are laid singly between the leaflets of the spindle. The eggs hatch in 9 days.
- **Nymph:** There are five nymphal stages and it is completed in 15-24 days. The light violet brown nymphs have greenish yellow border.
- **Adult:** Adult bugs are brightly colour red and black.

Figure 2.27: Spindle bug in Palm oil

Damage symptoms

- Spindle bug - generally noticed in nursery seedlings and plantation planted young seedlings.
- Adults and nymphs of spindle bug live in the innermost two to three leaf axils.
- Suck sap from the spindle of leaves
- Necrotic lesions which later on turn into dry brown patches.
- In severe infestation the spindle fails, to open.

Natural enemies of Spindle bug

- **Predators:** King crow, Ground beetles, Wasp, Spider

Management

To control the bug, polythene sachets are filled with Phorate 10 G (Thimet 10G), @ 2g per sachet, pin pricked and placed in the innermost two leaf axils – one sachet each in a leaf axil. These are to be transferred to the youngest leaf axils as and when new spindles emerge. The same sachets can be used for 6 – 8 months.

2. Root grub: *Leucopholis burmeisteri* (Brenske) (Coleoptera: Melolonthidae)

Biology

- **Egg:** These beetles lay eggs in soil mostly up to 10 cm depth. Eggs hatch out in about three weeks.
- **Larva:** The grub period with three instars is completed within 7 to 8 months.
- **Pupa:** The pupation is in soil in cocoons of mud. This period lasts about one month.
- **Adult:** The adult beetle is chestnut brown in colour.

Figure 2.28: Root grub

Damage symptoms

- Root grubs or white grubs occur mostly in sandy and sandy loam soils.
- They are voracious feeders on roots. Adult beetles emerge during May-June few days after receipt of pre-monsoon showers, between 6.30 to 7.30 PM.
- The early instar grubs feed on the roots of grasses and other humus. The second and third instar grubs of these beetles feed on tender and mature roots of the palm. In severe cases, the bole of the palm is also eaten up. They feed on roots of intercrops like banana, cocoa, tapioca, yam etc.
- In oil palm seedlings, the feeding on roots results in dropping and drying of leaves
- Affected seedlings come off easily since the entire root system is usually eaten up. Palms with few years of infestation show a sickly appearance, with yellowing of leaves, tapering of stem, and reduction in yield.
- The palms may topple in case of severe loss of root system.

Natural enemies of Root grub

- **Parasitoid:** Scoliid wasp
- **Predators:** False vampire bats, Garden lizards, Wild boar

Figure 2.29: Root grub infestation in Oil Palm

Management

Cultural control

- Fill the seedling bags with the soil free from root grub infestation
- Exposure of grubs by ploughing or digging the soil during pre and post monsoon periods

Mechanical control

Collection and destruction of beetles during their emergence from the soil in the evening hours

Install light traps @ 1 trap/acre and operate between 6 pm and 10 pm.

Biological control

Conserve entomopathogenic nematodes such as *Heterorhabditis* spp. And *Steinernema* spp.

3. Rhinocerous beetle: *Oryctes rhinoceros* (Linneaus) (Coleoptera: Scarabaeidae)

Biology

- **Eggs:** Yellowish-white, measuring 3 mm in diameter and laid inside rotting vegetative matter. Initially oval in shape, they begin to swell about a week after laying and hatch within 11-13 days.
- **Grubs/larvae:** The larval stages are usually yellowish-white in colour and may grow to about 60-100 mm long. Development of the larva takes 80-200 days: first instar takes 10-21 days, second instar takes 12- 21 days and third instar takes 60-125 days.
- **Pre-pupae:** The pre-pupa is somewhat similar in appearance to the larval stage, except that it is smaller than the final larval instar. Shrivelled in appearance, it shakes its body actively when disturbed.
- **Pupae:** Pupa is yellowish-brown in colour and measures up to 50 mm in length. The pupal stage lasts 17- 30 days.
- **Adults:** Stout-looking adults, dark brown to black, shiny, 35-50 mm long and 20-23 mm wide, with prominent horn on head. The males having a relatively longer horn than the female. The males can be differentiated more accurately by having a rounded shiny terminal abdominal segment while the female has a relatively hairier tail. Adults may live up to 6 months or more.

Natural enemies of Rhinoceros beetle

- **Predators:** Tiger beetle, Squirrels, Barn owl

Figure 2.30: Rhinoceros beetle[24]

[24] *picture courtesy: https://www.flickr.com/photos/drlianpinkoh/5391807225*

Management

Mechanical control

- Remove and burn all dead coconut trees in the garden (which are likely to serve as breeding ground) to maintain good sanitation
- Plant a cover crop to deter egg laying by females as they do not lay eggs in areas covered by vegetation
- Collect and destroy the various bio-stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits.
- Examine the crowns of tree at every harvest and hook out and kill the adults
- Set up light traps following the first rains in summer and monsoon 200 period to attract and kill the adult beetles
- Set up rhino-lure pheromone trap @ 1/ac to trap and kill the beetles

Biological control

- Soak castor cake at 1 kg in 5 l of water in small mud pots and keep them in the oil palm gardens to attract and kill the adults.
- Treat the longitudinally split tender coconut stem and green petiole of fronds with fresh toddy and keep them in the garden to attract and trap the beetles.
- For seedlings, apply 3 naphthalene balls/palm weighing 3.5 g each at the base of inter space in leaf sheath in the 3 inner most leaves of the crown once in 45 days.
- Apply mixture of either neem seed powder + sand (1:2) @150 g per palm or neem seed kernel powder + sand (1:2) @150 g per palm in the base of the 3 inner most leaves in the crown.

1.4 Red palm weevil: *Rhynchophorus ferruginous* (Olivier) (Coleopteran: Curculionidae)

Biology

- **Egg:** Eggs are creamy white, oblong and shiny. The average size of an egg is 2.62 mm long and 1.12 mm wide. Eggs hatch in 3 days and increase in size before hatching
- **Grub/larva:** The larvae can grow up to 35 mm long and can be recognised by the brown head and white body. The body is composed of 13 segments.
- **Pre-pupa:** The pre-pupal stage lasts for about 3 days
- **Pupa:** pupal period varies from 12-20 days. Pupae are first cream coloured but later turn brown. The surface is shiny, but greatly furrowed and reticulated. The average length of pupae is 35 mm and the average width is 15 mm.

- **Adult:** Adult weevils are reddish brown, about 35 mm long and 10 mm wide and are characterized by a long-curved rostrum (snout). Dark spots are visible on the upper side of the middle part of the body. The head and rostrum comprise about one-third of the total length. In the male, the dorsal apical half of the snout is covered by a patch of short brownish hairs, the snout is bare in the female, slenderer, curved and a little longer than the male. The longevity of the weevil ranges from 2-3 months, irrespective of the sex. In captivity, the maximum life span of the adult was 76 days for the female and 113 days for the male.

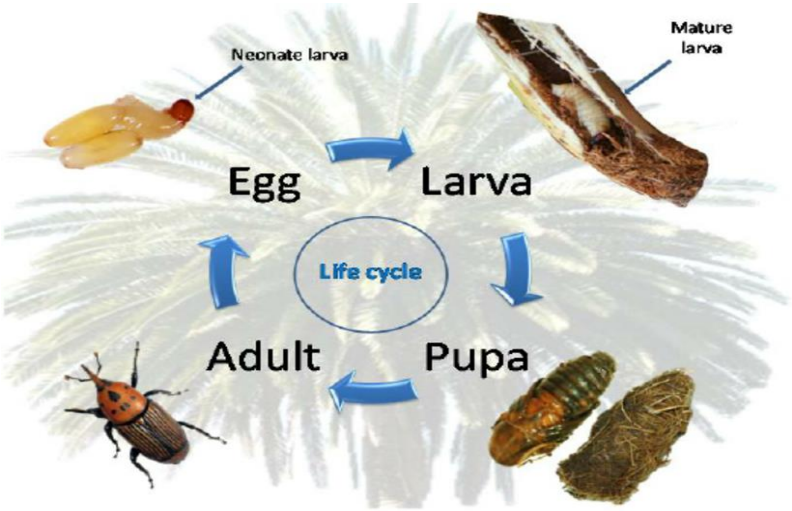


Figure 2.31: Red palm weevil lifecycle[25]

Damage symptoms

- It is very difficult to detect *R. ferrugineus* in the early stages of infestation. Generally, it is detected only after the palm has been severely damaged. Careful observation may reveal the following signs which are indicative of the presence of the pest
- Some holes in the crown or trunk from which chewed-up fibres are ejected. This may be accompanied by the oozing of brown viscous liquid
- Crunching noise produced by the feeding grubs can be heard when the ear is placed to the trunk of the palm. A withered bud/crown
- Chewed plant tissues in and around opening of tunnels with a typical fermented odour
- Fallen empty pupal cases and dead adults around a heavily infested palm
- Breaking of the trunk or toppling of the crown in case of severe and prolonged infestation.
- Drying of Offshoots in date palm

[25] https://www.researchgate.net/publication/288786774_Biology_and_Management_of_Red_Palm_Weevil

Figure 2.32: Holes on trunk[26] and ejected chewed-up fibres from trunk[27]

Natural enemies of red palm weevil

Predators: *Dendrocitta vagabunda parvula*

Management

Mechanical control

- Remove and burn all wilting or damaged palms in coconut gardens to prevent further perpetuation of the pest
- Avoid injuries on stems of palms as the wounds may serve as ovipositional sites for the weevil. Fill all holes in the stem with cement
- Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem.
- Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ kg or toddy 2½ litres + acetic acid 5 ml + yeast 5 g + longitudinally split tender oil palm stem/logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.
- Install pheromone trap @1/2 ha

Biological control

Fill the crown and the axils of top most three leaves with a mixture of fine sand and neem seed powder or neem seed kernel powder (2:1) once in three months to prevent the attack of rhinoceros beetle damage in which the red palm weevil lays eggs.

[26] http://www.cabi.org/cpc/datasheet/47472
[27] http://www.agritech.tnau.ac.in/expert_system/coconut/coconut/coconut_pest%20and_diseases.html

1.5 Case worm: *Pteroma pendula* (de Joannis) (Lepidoptera: Psychidae)

Biology

Pteroma pendula was the dominant bagworm species infesting oil palm Plantation. This species had six instar stages. Dimorphism was observed in pupa and imago stages. Female emerged as apterous and vermiform-like, and male emerged as moth. P. pendula had a lifespan of 50.4 ± 1.8 days.

Damage symptoms

- Holes on the leaves
- Occasional defoliation
- Cone shaped bags on the underside of leaves

Figure 2.33: a) Holes on Palm Oil leaves b) Cone shaped bags[28]

Natural enemies of Caseworm

- **Larval parasitoid:** *Pediobius anomalus*
- **Predator:** *Oecophylla smaragdina*

Management

Cultural control

Cutting and burning affected and dried leaves

Biological control

Conservation and augmentation of parasitoids such as *Pediobius anomalus*

[28] https://vikaspedia.in/agriculture/crop-production/integrated-pest-managment/ipm-for-oilseeds/ipm-strategies-for-oilpalm/oilpalm-insect-pests

B. Pest of Regional Significance

1.1 Scale: *Aspidiotus destructor* (Signoret) (Hemiptera: Diaspididae)

Damage symptoms

- It occurs more in summer. Scale insects' affects leaves of palms.
- A severe infestation, scale forms a continuous crust over flower spikes, young nuts and lower surface of leaves.
- On leaves, *A. destructor* causes scales with yellow spots developing where the crawlers have settled and grown into adults.
- Nymphs reside and develop in leaf by sucking the sap.
- Entire leaves may turn yellow to brown and fall. Sooty mould may develop. The bright yellow colour of affected palms is clearly visible from a great distance.

Figure 2.34: a) Scale on leaves b) Yellow spots on leaf[29]

Biology

- **Egg:** hatching the young scales on the undersides of the leaves
- **Nymph**: Covered with circular waxy secretion
- **Adult:** The scale is bright yellow and round or reddish (female) and oval (male) covered with semi-transparent greyish white flat scale. Females are always wingless and remain under their scale their entire life. Adult males have one pair of membranous wings, move about actively in search of females and do not feed during adult stage.

[29] https://agritech.tnau.ac.in/crop_protection/coconut/crop_prot_crop_insect_oil_coconut_12.html

Figure 2.35: a) Nymph b) Adult of Aspidiotus destructor

Management

Chemical Method

Spray Fish Oil Rosin Soap (FORS) 2.5% or spray Malathion. A second round is given after 20 days.

Biological Method

Release of predatory *Coccinellids* beetle, *Chilocorus Nigritius* is found to be effective.

1.2 Mealy bug: *Dysmicoccus brevipes* (Cockerell) (Homoptera: Pseudococcidae)

Damage Symptoms

- Mealy bugs colonize on all tender plant parts like bases of spear leaf, spadix and inflorescence Mealy bugs infest the unopened heartleaf and inflorescence. It feed plant sap. Leaves are yellowing and dry up
- As a result, the leaves become highly stunted, suppressed, deformed and present a crinkled appearance. It is often confused with the leaf rot symptoms
- The affected inflorescences are malformed and do not open

Figure 2.36: Colony of Mealy bug[30]

[30] https://agritech.tnau.ac.in/crop_protection/coconut/crop_prot_crop_insect_oil_coconut_13.html

Management

Cultural Method

- Remove leaflets harbouring these insects and destroy them.
- Collection and destruction of infested plant parts
- Collect planting material from unaffected plantation
- Insecticidal soap is a safe and effective alternative to conventional insecticides. You can use bleach-free dishwashing liquid (1 and 1/2 teaspoons per one quart of water) in place of commercial insecticide soaps.
- Homemade control of plant scale can also be achieved with oil spray. Mix two tablespoons of cooking oil and two tablespoons of baby shampoo in one gallon of water. This can also be mixed with one cup of alcohol to help penetrate the insect's shell

Biological control

Release *Coccinellid* beetle, *Cryptolaemus montrouzieri* @ 10 / tree

Chemical control

Infestation by mealy bugs can be controlled by spraying with dimethoate at 0.03% or methyl demeton at 0.025%

1.3 Termites: *Odontotermes obesus (Rambur)* (Isoptera: Termiitidae)

Identification of the Pest

- Adults: Cream coloured, tiny insects resembling ants with dark coloured head
- Pest population occurs round the year but population maximum during June – Sep coinciding with the onset of monsoon

Figure 2.37: Termites and its infestation in Palm Oil

Damage Symptoms

- Termites are likely to cause damage to transplanted seedlings particularly in the earlier stage. (Wilting of seedlings)
- Base of trunks plastered with runways made of soil and fibres

Figure 2.38: Mature oil palm attacked with red-brown termite mud work on trunk of tree[31]

Management

Cultural control

- Locate termite mounds in or near the oil palm nursery or garden and destroy adoption of plantation sanitation by disposal of organic matter in nursery soil and covering germinating seeds with a layer of river sand
- Copious irrigation

Chemical Method

- Spray Copper Sulphate 1% or Cashew Nut Shell oil 80% or spray Chlorpyriphos @ 3ml/lit of water, Neem Oil 5% or NSKE 20% to preserve plaited leaves from the termite attack.
- Apply calcium at the base of the trunk for control of termite attack.
- Swabbing with neem oil 5% once on the base and up to 2 m height of the trunk for effective control.

[31]https://www.researchgate.net/publication/257527942_Termite_Attack_on_Oil_Palm_Grown_on_Peat_Soil_Identification_of_Pest_Species_and_Factors_Contributing_to_the_Problem

1.4 Nettle caterpillar: *Thosea andamanica* (Holloway) (Lepidoptera: Limacodidae)

Identification of the Pest

Larvae are slender and greenish in colour with yellow coloured head.

Damage Symptoms

- Nettle caterpillars - stinging spines which can cause nettle rash on contact with the skin.
- Caterpillars feed on the leaves
- Infestation – mostly occur in outer whorl of fronds and middle whorl of fronds.

Management

- Cutting and burning the badly affected and dried leaves.
- Spraying with Carbaryl 50% W.P. 0.1% is recommended (younger larvae are more susceptible)

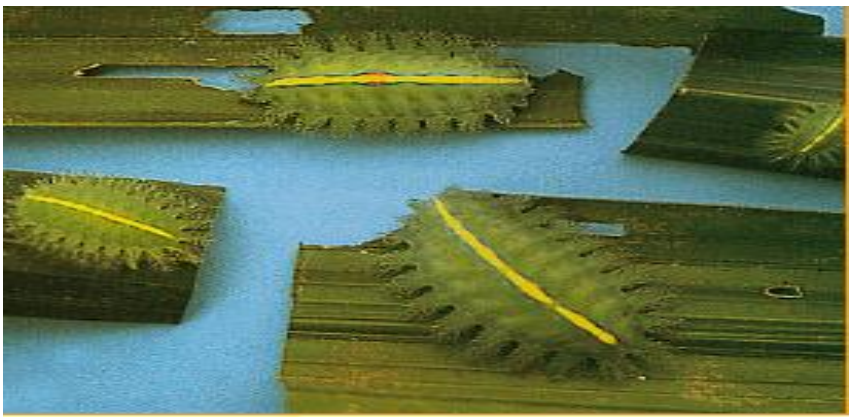


Figure 2.39: Nettle caterpillar on Palm leaves[32]

1.5 Mite: *Tetranychus piercei* (McGergor) (Acarida: Tetranychidae)

Damage Symptoms

- Mites suck the sap from the leaves.
- Attacked leaves - discoloured and look speckled.
- Nursery and young palms are severely disrupted.

Management

- Application of Sulphur or Tetradifon or Binapacryl.
- Application of Dicifol 2ml/lit or wettable sulphur 2g/litre.

[32] https://agritech.tnau.ac.in/crop_protection/oilpalm/oil_palm_5.html

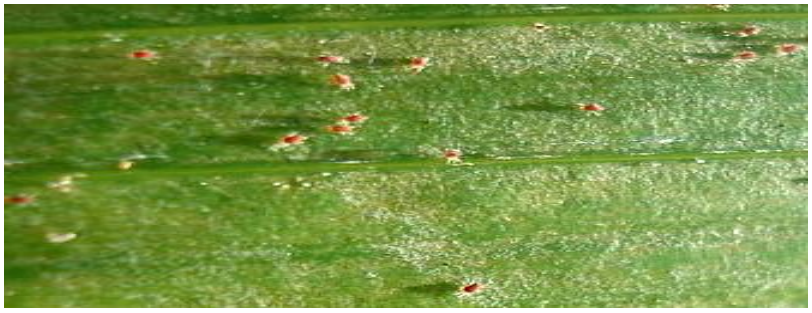


Figure 2.40: Mites on Palm oil leaves

2.8 DEFICIENCY AND DISORDERS

Nutritional constraints due to imbalanced and inadequate application of nutrients are the major limitations to oil palm producers. By proper nutrient management one should be in a position to overcome the nutrient deficiencies and disorders. Otherwise, if one correctly the deficiency /disorder, it can be rectified by the application of that particular nutrient either by soil application or foliar spray.

a. Nitrogen

Characteristic yellowing symptoms are developed under N deficiency conditions. Nitrogen is found to be essential for rapid growth and fruiting of the palm. It increases the leaf production rate, leaf area, net assimilation rate, number of bunches and bunch weight. Excessive application of nitrogen increases the production of male inflorescence and decreases female inflorescence thereby reducing the sex ratio[33].

Figure 2.41 Yellowing of leaves as a result of Nitrogen deficiency

[33] https://agritech.tnau.ac.in/horticulture/horti_plantation%20crops_oilpalm.html

b. Phosphorus

Phosphorus deficiency does not produce leaf symptoms in oil palm. However, the trunks of affected palms are narrow and tapered[34].

c. Potassium

Potassium is the nutrient required by oil palm in largest amounts, and deficiency symptoms develop on most soils unless K fertilizer is applied. Continued K deficiency leads to a progressive decline in yield and plant health. A number of different symptoms indicate K deficiency or an imbalance of K with other elements. The most typical and widespread form of K deficiency is known as “confluent orange spotting”. The first signs of K deficiency are pale green spots on the pinnae of older fronds. In a more advanced stage, the rectangular spots become orange-yellow and transmit light when held up to the sky. Later, the tips of leaf pinnae start to dry up. In very severe cases, entire older fronds may dry up. Some palms show symptoms similar to K deficiency known as “genetic orange spotting”.

Figure 2.42 Potassium deficiency in Palm leaves

d. Magnesium

Severe Mg deficiency results in the development of bright orange colour in older fronds. The orange discoloration is very pronounced on the upper rank pinnae exposed to sunlight, whilst lower rank and shaded pinnae remain green. Leaf veins also stay green for a longer period. Older fronds dry up and die under conditions of severe Mg deficiency. Planters should be able to distinguish between Mg and K deficiency and a healthy leaf.

[34] https://niphm.gov.in/IPMPackages/Oilpalm.pdf

Figure 2.43. Magnesium deficiency in oil palm

e. Manganese

Manganese (Mn) deficiency is not common, but has been reported on soils with high exchangeable Mg status and insufficiently compacted peat soils where palms are suffering from drought. Manganese deficiency shows as a yellowing of interveinal areas. In contrast to Mg deficiency, the symptoms are found on young rather than on older fronds. The symptoms are equally pronounced on upper (sun exposed) and lower (shaded) rank pinnae. Manganese deficiency can occur on peat and very sandy soils and is sometimes associated with high leaf Mg status.

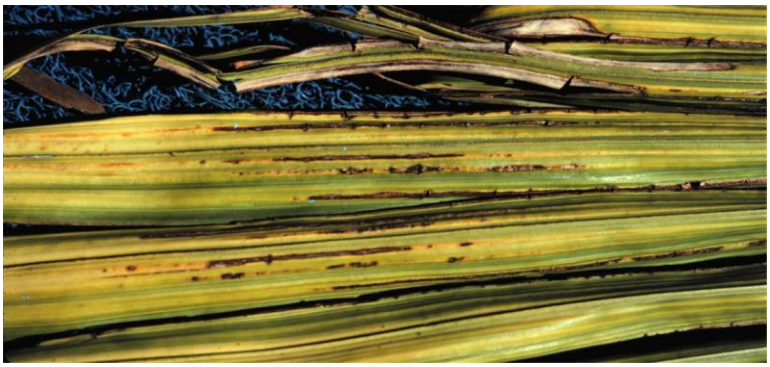


Figure 2.44 Close-up of leaflets in Mn deficiency

f. Zinc deficiency

Zinc (Zn) deficiency is not common in oil palm but may be induced under high soil P status and occurs on ultrabasic and ultramafic soils with high soil pH. It is also believed to be a factor involved in the "Peat Yellows" condition found on peat soils. Zinc deficiency has also been reported on shallow peat soils overlying sand, particularly where large amounts of soluble P fertilizer have been applied. It appears as small, narrow white streaks on lower and mid-crown fronds. A different condition that produces blotchy leaf symptoms has also been identified tentatively as Zn deficiency.

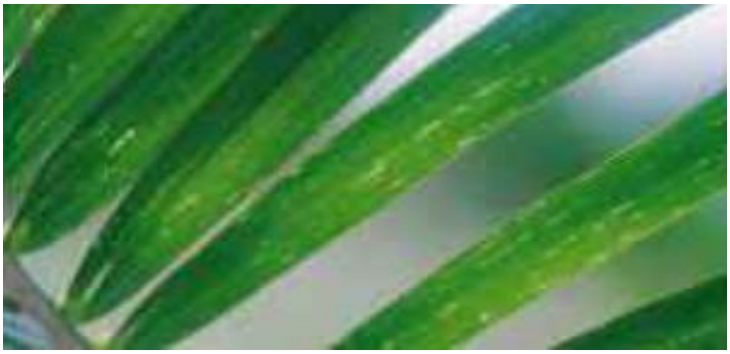


Figure 2.45: Zinc deficiency

g. Iron deficiency

Iron (Fe) deficiency is very rare in oil palm and occurs where soil pH is very high (i.e., more than 7.5). The deficiency has been observed where palms are grown over coral outcrops or on spots where white ant hills have been levelled. It is easily identified, as symptoms appear first on the youngest fronds, which appear droopy and show diffuse blotchy yellowing and white freckles.

Figure 2.46 Iron deficiency in Oil Palm

h. Other Micronutrients

Micronutrient elements, iron, manganese and zinc are not generally found limiting in the nutrition of oil palm on acid soil conditions. Boron deficiency is occasionally found on young palms in the plantation showing a reduction of leaf area in certain leaves producing incipient little leaf, advanced little leaf with extreme reduction of leaf area and bunching and reduction in the number of leaflets and fish-bone leaf. The fish-bone leaves are abnormally stiff with leaflets reduced to projections. Leaf malformations including hook leaf and corrugated leaflets are some other associated symptoms. Soil application of 50 - 200 g borax dehydrates, per palm, depending on age, and severity of symptoms is practiced for correcting the deficiency.

3 PROCESSING OF OIL PALM

Research and development work in many disciplines - biochemistry, chemical and mechanical engineering - and the establishment of plantations, which provided the opportunity for large-scale fully mechanised processing, resulted in the evolution of a sequence of processing steps designed to extract, from a harvested oil palm bunch, a high yield of a product of acceptable quality for the international edible oil trade. The oil winning process, in summary, involves the reception of fresh fruit bunches from the plantations, sterilizing and threshing of the bunches to free the palm fruit, mashing the fruit and pressing out the crude palm oil. The crude oil is further treated to purify and dry it for storage and export[35].

Large-scale plants, featuring all stages required to produce palm oil to international standards, are generally handling from 3 to 60 tonnes of FFB/hr. The large installations have mechanical handling systems (bucket and screw conveyers, pumps and pipelines) and operate continuously, depending on the availability of FFB. Boilers, fuelled by fibre and shell, produce superheated steam, used to generate electricity through turbine generators. The lower pressure steam from the turbine is used for heating purposes throughout the factory. Most processing operations are automatically controlled and routine sampling and analysis by process control laboratories ensure smooth, efficient operation. Although such large installations are capital intensive, extraction rates of 23 - 24 per cent palm oil per bunch can be achieved from good quality Tenera.

Conversion of crude palm oil to refined oil involves removal of the products of hydrolysis and oxidation, colour and flavour. After refining, the oil may be separated (fractionated) into liquid and solid phases by thermo-mechanical means (controlled cooling, crystallization, and filtering), and the liquid fraction (olein) is used extensively as a liquid cooking oil in tropical climates, competing successfully with the more expensive groundnut, corn, and sunflower oils.

Extraction of oil from the palm kernels is generally separate from palm oil extraction, and will after be carried out in mills that process other oilseeds (such as groundnuts, rapeseed, cottonseed, shea nuts or copra). The stages in this process comprise grinding the kernels into small particles, heating (cooking), and extracting the oil using an oilseed expeller or petroleum-derived solvent. The oil then requires clarification in a filter press or by sedimentation.

[35] https://www.fao.org/3/y4355e/y4355e04.htm

Extraction is a well-established industry, with large numbers of international manufacturers able to offer equipment that can process from 10 kg to several tonnes per hour.

3.1 PROCESSING IN DETAIL[36]

The fruit's oil content is very low at the early stages of fruit formation. The growth of oil is fast up to about 50% of the mesocarp weight as the fruit approaches maturity. In the mature fruit, however, the exocarp becomes soft and lipolytic enzymes are more easily attacked, especially when the fruit is removed from the bunch. Cutting the bunch from the tree and allowing it to fall to the ground by gravity is the harvesting process. Harvesting activities like Harvesting, transportation, and handling of bunches can cause fruit to be damaged, to prevent spoilage fruits are processed as soon as possible after harvest, within 48 hours. Generally, bunches are transported to processing unit in wooden baskets.

a. Bunch receiving:

Fresh fruit is delivered in bunches or loose form from the field. The quality of the bunches that arrive at the mill determines the quality standard of the products. Genetic, tree age, agronomic, environmental, harvesting technique, handling, and transport are all field factors that influence the composition and final quality of palm oil.

Sterilization of bunches

Sterilization or cooking means the use of high-temperature wet-heat treatment of loose fruit. Sterilization uses pressurized steam to destroy bacteria and thus oil-splitting enzymes and stop hydrolysis and autoxidation.

b. Threshing

The fresh fruit bunch consists of fruit embedded in spikelets growing on the main stem. After sterilization of the bunches of fruit the first process is to detach the fruit from the bunch, leaving the spikelets on the stem.

c. Digestion of the fruit

Digestion is the process of breaking down or rupturing the oil-bearing cells in the fruit to release the palm oil. A steam-heated cylindrical vessel with a central rotating shaft carrying a number of beaters arms is the most common digester used in palm oil industry, about 20 minutes, the

[36] http://niftem.ac.in/newsite/wp-content/themes/niftm/assets/pmfme/dpr/palmoildpr.pdf

fruitlets will be stirred and steam will be continuously injected into the digester to maintain a temperature of 95-100°C. The aim of digestion to loosen the mesocarp from palm nut and break oil cells.

d. Extraction the palm oil

By applying mechanical pressure to the digested mash, the extraction stage aims to squeeze the oil out of a mixture of oil, moisture, fibre, and nut.

e. Clarification of oil

Clarification's main objective is to separate the oil from any entrained impurities. Palm oil, water, cell debris, fibrous material, and ‘non-oily solids' are the impurities that come out of the press. The mixture is very thick (viscous) due to the non-oily materials. As a result, hot water is added to the press output mixture to thin it out. Water is added in a 3:1 ratio. To remove coarse fibre, the diluted mixture is filtered through a screen. The screened mixture is boiled for one or two hours before being allowed to settle by gravity in the large tank. The palm oil rising to the top because it is lighter than water. Decant the clear oil into a reception tank. There are still traces of water and dirt in this clarified oil. The moisture content of the oil must be reduced to 0.15 to 0.25 percent to avoid increasing (Free fatty acids) FFA through autocatalytic hydrolysis. Any remaining moisture is removed by reheating the decanted oil in a cooking pot and carefully skimming off the oil from any encrusted dirt.

f. Oil storage

Prior to being dispatched from the mill for further refining processes, the purified and dried oil is transferred to a tank for storage. Because the rate of oxidation of the oil increases with storage temperature, it's usually kept at 50°C using hot water or low-pressure steam-heating coils to avoid solidification and fractionation.

g. Kernel recovery

The press residue is consisting of a mixture of fibre and palm nuts. The sorted fibre is covered and allowed to heat up for two or three days using its own internal exothermic reactions. The fibre is then pressed in spindle presses to extract second-grade oil, which is commonly used in soap production. The nuts are separated from the fibre by hand or mechanically. Before packing, the kernels are dried in silos to a moisture content of about 7%. The nuts are usually dried before being sold to industries that process them into palm kernel oil.

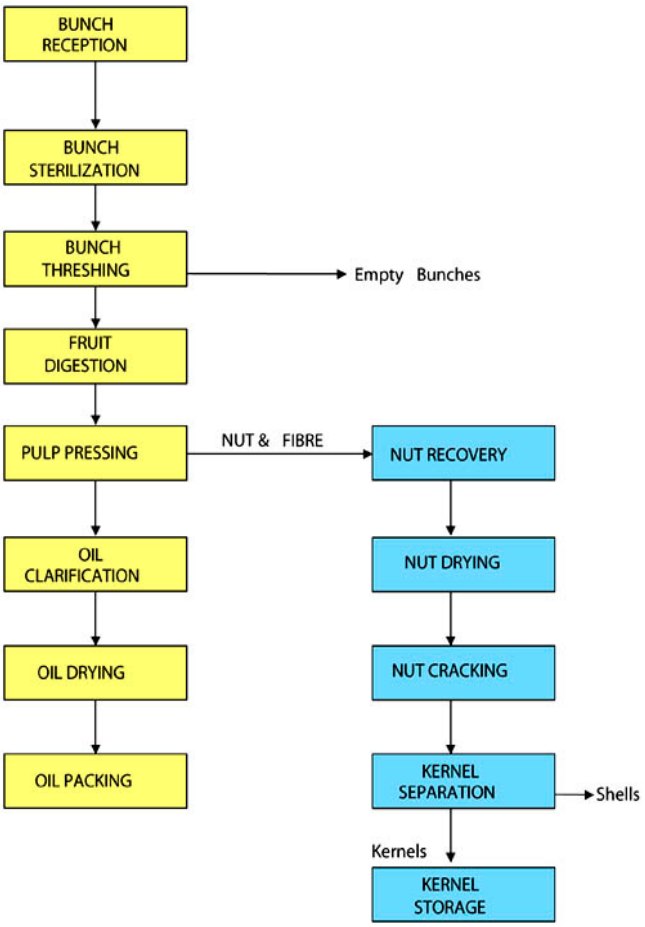


Figure 3.1: Oil palm processing unit operations[37]

3.2 MACHINERY & EQUIPMENT[38]

Machine Name	Description	Machine Image.
Pressurized vessel sterilizer	The objectives of this machine are sterilization of the fruit bunches for 90-120 minutes to eliminate the contamination, easily releasing fruit from bunches and fruit softening.	
Rotating Drum Thresher	The uses of this machine are to separate the fruit from bunches. Sterilized bunches are fed in this machine and the fruits are extracted from the bunch and exit through the holes.	

[37] https://www.fao.org/3/y4355e/y4355e04.htm
[38] http://niftem.ac.in/newsite/wp-content/themes/niftm/assets/pmfme/dpr/palmoildpr.pdf

Mechanical Digester machine	The prime objective of these digester machines is to break down the oil-bearing cells in the fruits in order to release the palm oil.	
Screw press	The uses of this press are to extract oil from the mesocarp of digested oil palm fruit.	
Filter press machine	The filter press is used in liquid/solid separation.	
Jacketed heating vessels	The use of this vessel to boil the screened mixture is for one or two hours before being allowed to settle by gravity in the large tank.	
Oil clarification and storage Tank	These tanks are used for Clarification and storage of extracted oil, the mixture of oil, water, and non-solids are stored to allow the sludge to settle to the bottom.	
Material handling and other Equipment's	These Equipment's are used for material handling. Other equipment's like boiler, industrial pumps, testing equipment's, etc are also used.	

Figure 3.2: Machines used in oil palm processing units[39]

Figure 3.3: Oil palm processing unit[40]

[39] http://www.palmoilmillplant.com/related-products/palm-oil-mill-process.html
[40] http://www.palmoilmillplant.com/related-products/palm-oil-processing-unit.html

4 MARKETING OF OIL PALM

4.1 VALUE AND SUPPLY CHAIN

Market in India is mainly driven by large volumes in the food and cooking oil sectors that accounts for 90%, with smaller volumes, which accounts for 10%, in consumer goods such as processed food and cosmetics. Here, a significant portion of Indian consumers buy so-called loose palm oil, without any brand association. Therefore, establishing a transparent supply trail becomes difficult in these conditions. Further, palm oil for cooking is primarily used by commercial establishments, government procurement and in low to middle-class households. Government procures imported palm oil in bulk through its trading agencies for distribution and sale to lower income consumers at subsidies rates in the interest of food security during periods of price inflation. The widespread use of palm oil and reliance on imports have prompted the Indian government to devise schemes to promote domestic production by increasing plantation acreage in the country. Currently, a number of large Indian companies including ITC, Godrej Agrovet, and Ruchi Soya are engaged in oil palm cultivation in India. Many of their plantations are in collaboration with provincial governments, particularly in the southern states of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu.

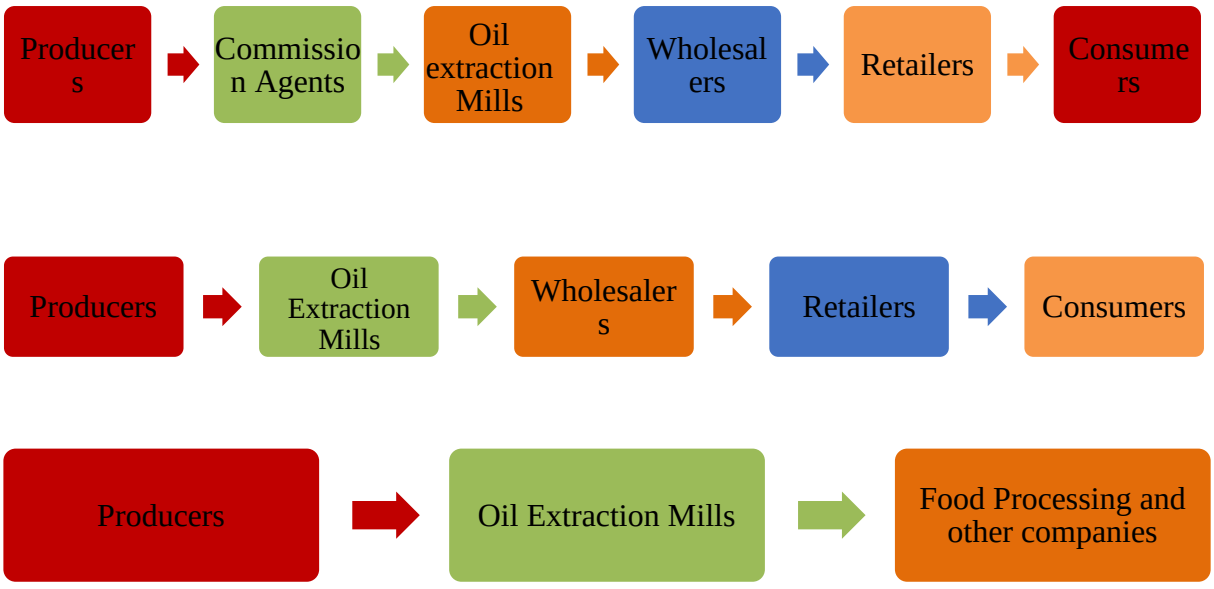


Figure 4.1: Examples of Marketing Channels for Oil Palm

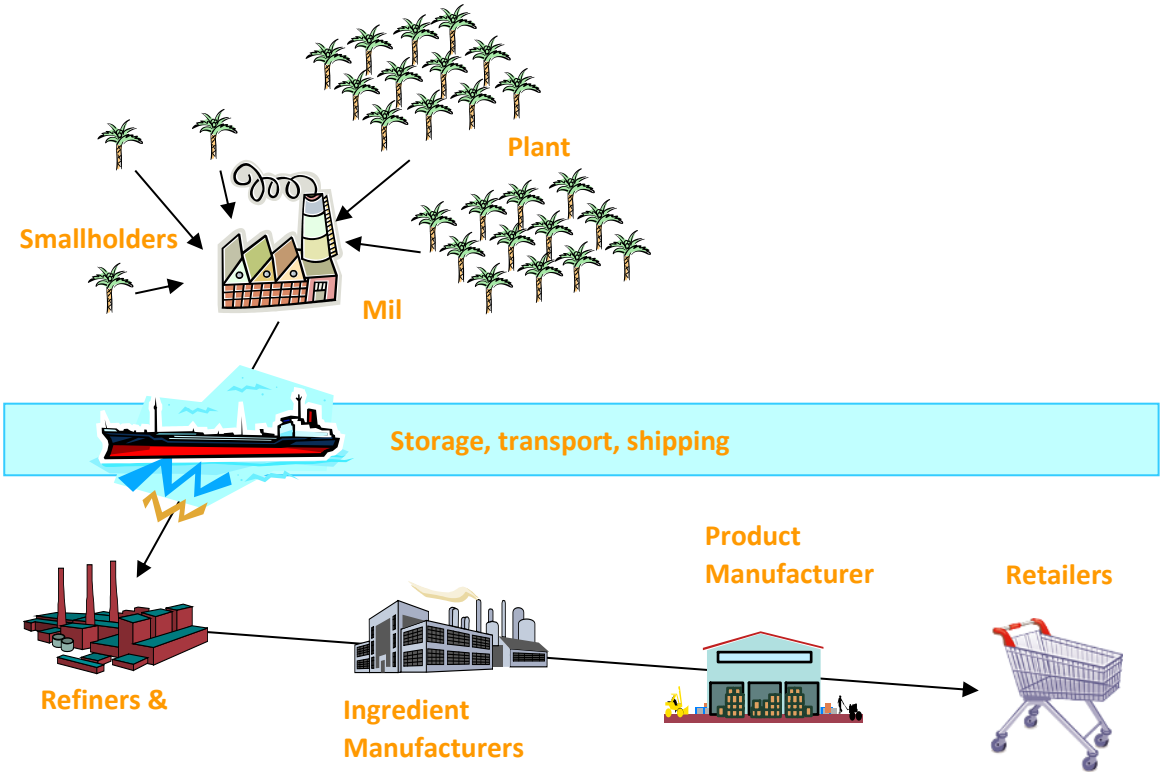


Figure 4.2 Palm Oil Supply chain[41]

Table 4.1: State-wise list of the processing mills established so far in th,e country

Sl. No.	Name of the Unit	Sector
A. Andhra Pradesh		
1	APOILFED, Pedavegi-West Godavari	A.P. Govt. Subsidiary Unit
2	M/s. Radhika Veg. Oil Pvt. Ltd., Garividi-Vijaya Nagaram	Pvt
3	M/s. RSIL, Ampapuram-Krishna Distt	Pvt
4	Simhapuri Agro Products Ltd., Manubrola-Nellore	Pvt
5	M/s. Godrej Oil Palm ltd., Pothepalli-West Godavari Distt.	Pvt
6	M/s. Godrej Agrovet, Oil Palm ltd., Chintampalli	Pvt
7	M/s. RSIL, Peddapuram-East Godavari Distt	Pvt
8	M/s. Nav Bharat Agro Products, Jangareddygudem-West Godavari Distt.	Pvt

[41] Presentation by Roundtable on Sustainable Palm Oil (RSPO), Kuala Lumpur, Malaysia

9	3F Oil Palm Agrotech Pvt. Ltd. Yernagudem Village Devarapalli Mandal West Godawari Distt.	Pvt
10	M/s. Agro Co-operative Corporation, Butchiyyapeta (M), Vishakhapattnam Dist.	Pvt
11	M/s Sri Srinivasa Palm Oil Mill, Srikakulam dist.	Pvt
12	M/s Subrahmanyeswara Agro Products, Siripalli Ainavilli Mandal, East Godavari	Pvt
13	M/s Lakshmi Balaji Oils, Tekarandi (V), Vizianagram dist.	Pvt
B. Telangana		
14	A.P. Oilfed (Khammam District)	A.P. Govt. Subsidiary Unit
15	M/s. Telangana State Co-operative Oilseeds Growers Federation Ltd.(except theMandalsallotted to M/s Godrej Agrovet)	Coop
16	M/s. Pre-Unique (India) Pvt. Ltd	Pvt
17	M/s Ruchi Soya Industries Ltd.,	
18	M/s. Vishwatej Oil Industries Pvt Ltd.	Pvt
19	M/s. Matrix Security and Surveillance Pvt. Ltd	Pvt
20	M/s. Ramcharan Oil Industries	Pvt
21	M/s.Suven Agro Industries Pvt. Ltd.	Pvt
22	M/s. Tirumala Oil Chem India Pvt. Ltd.	Pvt
23	M/s. KN Biosciences (India) Pvt. Ltd.	Pvt
24	M/s Godrej Agrovet Ltd.,	Pvt
25	M/s Lohiya Edible Oils Private Limited	Pvt
C. Karnataka		
26	M/s. Bhadravathi Balaji Oil Palm Ltd. (BBOP Ltd.), Shimoga	Joint Venture of State & M/s. B.B.O.P.Ltd.
27	Govt. Oil Palm Processing mill, Kabini, Mysore. Leased to M/s Ruchi Soya industries Ltd.	State Government (leased to M/s. Ruchi Soya industries Ltd.)
28	M/s. Simhapuri Agri Tech Company Pvt. Ltd., Davangere	Pvt
30	M/s. 3F Oil Palm Agrotech., Koppal	Pvt
D. Tamil Nadu		

31	M/s. Godrej Agro Ltd., Varanasi, Ariyalur dist.	Pvt
E. Kerala		
32	OPIL, Yerror Estate, Kollam	Public sector
F. Andaman & Nicobar		
33	Andaman & Nicobar Islands	State Government
F. Gujarat		
34	Shri Kalyan Agri. Crops Sales & Processing Coop. Society Ltd., Navasari	Cooperative Sector
G. Odisha		
35	M/s Lakshmi Balaji Oil Mills (P) Ltd. Attada, Rayagada	Pvt
36	Godrej Oil Plantations Ltd.	Pvt
37	3F Oil Palm Agrotech Pvt. Ltd.	Pvt
38	Ruchi Soya Industries Ltd.	Pvt
39	Vaidehi Palms Pvt. Ltd.	Pvt
40	Ingaran Biotech	Pvt
H. Mizoram		
41	M/s Godrej Agrovet Ltd. Kolasib Dist.	Pvt
42	M/s Ruchi Soya Industry Ltd.,	Pvt
43	M/s 3F Oil palm Agrotech	Pvt
I. Arunachal Pradesh		
44	3F Oil Palm Agrotech Pvt. ltd	Pvt
45	Ruchi Soya Industries Ltd	Pvt

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6 SHORT VIDEOS ON OIL PALM-AVAILABLE ON YOUTUBE

Irrigation Management in Oil Palm (2.31 Min)	**https://www.youtube.com/watch?v=SUHUhvQcdDQ**
Fertilizer Management in Oil Palm (3.29 Min)	**https://www.youtube.com/watch?v=X1iJ8k6D42M**
Pest Management in Oil Palm (4.31 Min)	**https://www.youtube.com/watch?v=c1navCCwX8I**
Disease Management in Oil Palm (4.51 Min)	**https://www.youtube.com/watch?v=41d7asABW-4**
Management of Nutrient Deficiencies in Oil Palm (1.51 Min)	**https://www.youtube.com/watch?v=oZS2xoPKlPc**
Intercrops in Oil Palm (1.56 Min)	**https://www.youtube.com/watch?v=i-xl2ntSo90**
Mulching in Oil Palm (1.08 Min)	**https://www.youtube.com/watch?v=dTqwCt2GqmA**
Green Manuring and Cover Crops in Oil Palm (1.35 Min)	**https://www.youtube.com/watch?v=_HtkDCNLHkQ**

7 ANNEXURE

Table 7.1Selected State-wise Potential and Cultivated Area under Oil Palm Cultivation in India (2018-2019)

(Area in Hectare)

States/UT	Potential Area Re-assessed in 2012	Total Cultivated Area (Up to March, 2019)
Andaman and Nicobar Islands*	3000	1593
Andhra Pradesh	419500	169197
Arunachal Pradesh	25000	2752
Assam	25000	1849
Bihar*	200000	0
Chhattisgarh	48000	5069
Goa	2000	958
Gujarat	260250	6159
Karnataka	260000	44992
Kerala	6500	5786
Maharashtra*	180000	1474
Meghalaya*	50000	0
Mizoram	61000	28914
Nagaland	50000	2472
Odisha	56000	22290
Tamil Nadu	205000	31958
Telangana	50000	19158
Tripura*	7000	530
West Bengal*	25000	0
India	**1933250**	**345151**

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

**Note: NFSM-OP is not being implemented*

Table 7.2 Selected State-wise Production of Oil Palm Fresh Fruit Bunches under Oil Palm Development Programme in India (2009-2010 to 2020-2021)

(In Metric Tonne)

States/UT	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21(P)
Andaman and Nicobar Islands	NA	NA	NA	0	0	NA	NA	NA	-	-	-	-
Andhra Pradesh	347892	385009	573024	790881	933981	1007553	1147780	1137398	1427828	1379215	1277760	1471521
Assam	0	0	0	0	0	0	0	0	-	-	-	2200
Chhattisgarh	0	0	0	0	0	0	0	18	5	6	279	6
Goa	1591	1878	2229	2056	2046	2146	3217	NA	1690	2281	1716	1717
Gujarat	6	26	91	134	158	409	523	775	996	1053	745	7425
Karnataka	6387	8337	9942	10112	9917	12638	14740	11912	1076	13238	12685	15877
Kerala	35100	41000	43200	41350	38350	40798	40611	34198	30220	30269	27201	27627
Mizoram	32	88	480	1339	1544	2096	3780	4796	5238	5298	4600	10563
Nagaland	-	-	-	-	-	-	-	-	-	-	-	280
Odisha	3464	5128	12720	2920	3639	3769	4569	4965	6702	6899	7106	0
Tamil Nadu	2080	2920	4743	5244	5495	6568	7810	7422	6995	7014	3798	3038
Telangana	29937	32176	46779	38624	52752	57873	75447	88119	147516	197632	208826	149488
Tripura	NA	NA	NA	NA	0	NA	NA	NA	-	-	-	
India	**426488**	**476561**	**693207**	**892660**	**1047881**	**1133850**	**1298477**	**1289603**	**1628266**	**1642905**	**1544716**	**1689743**

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

Table 7.3: Selected State-wise Quantity of Crude Oil Palm Obtained under Oil Palm Development Programme in India (2008-2009 to 2020-2021)

(In Tonne)

States/UT	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Andaman & Nicobar Islands	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-	-	-
Andhra Pradesh	43593	57402	63487	97987	127570	161566	170478	193562	190999	234696	232938	208359	240016
Assam	0	0	0	0	0	0	0	0	-	-	-	-	-
Chhattisgarh	-	-	-	-	-	-	-	-	-	-	-	-	-
Goa	393	279	329	394	372	371	388	581	436	379	411	309	305
Gujarat	0	0	0	0	0	0	NA	NA	-	-	-	-	-
Karnataka	1170	1118	1459	1740	1770	1736	2176	2538	2051	2224	2280	2184	2734
Kerala	7400	6600	6900	7500	7378	6303	6515	7015	5989	5191	4857	4825	4281
Mizoram	0	0	0	0	0	0	365	496	603	648	625	535	675
Odisha	476	589	871	2162	443	558	557	618	-	-	-	-	-
Tamil Nadu	366	365	486	759	1035	820	1019	1222	1194	938	1017	532	698
Telangana	4770	5100	5655	8494	6825	9373	10012	12499	8947	27274	37205	38050	39347
Tripura	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-	-	-
India	**58167**	**71453**	**79187**	**110541**	**138567**	**180727**	**191510**	**218531**	**210219**	**271349**	**279332**	**254794**	**288056**

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

Table 7.4: Consumption of Palm Oil in India

Consumption of Palm Oil in India (2015-2016 to 2019-2020)	
Year	**Consumption (In Million MT)**
2015-2016	59.38
2016-2017	61.60
2017-2018	66.99
2018-2019	73.06
2019-2020	71.48

Source: Indian Vegetable Oil Producers' Association. Govt. of India

Suppliers of indigenous seed sprouts in India

Following agencies / organizations are supplying indigenous seed sprouts from respective Oil Palm seed gardens in India.

1. NRC for Oil Palm, Pedavegi-534 450, West Godavari District, Andhra Pradesh.
2. NRC for Oil Palm, Regional Station, Palode, Pacha Post -695 562, Kerala.
3. Asst Director of Horticulture, Oil Palm Seed Garden, Rajahmundry-533 103, A.P.
4. Assistant Director of Horticulture, Oil Palm Seed Garden, Taraka, Mysore571 114, Karnataka.
5. M/s. Oil Palm India Ltd., Regd. Office: XIII-354, Old Star Theatre Road, P.B. No:1715, Kottayam South P O-686 039, Kerala.
6. M/s. Navabharat Agro Products Ltd., Uppalametta, Jangareddygudem-534 447, West Godavari District, A.P.

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