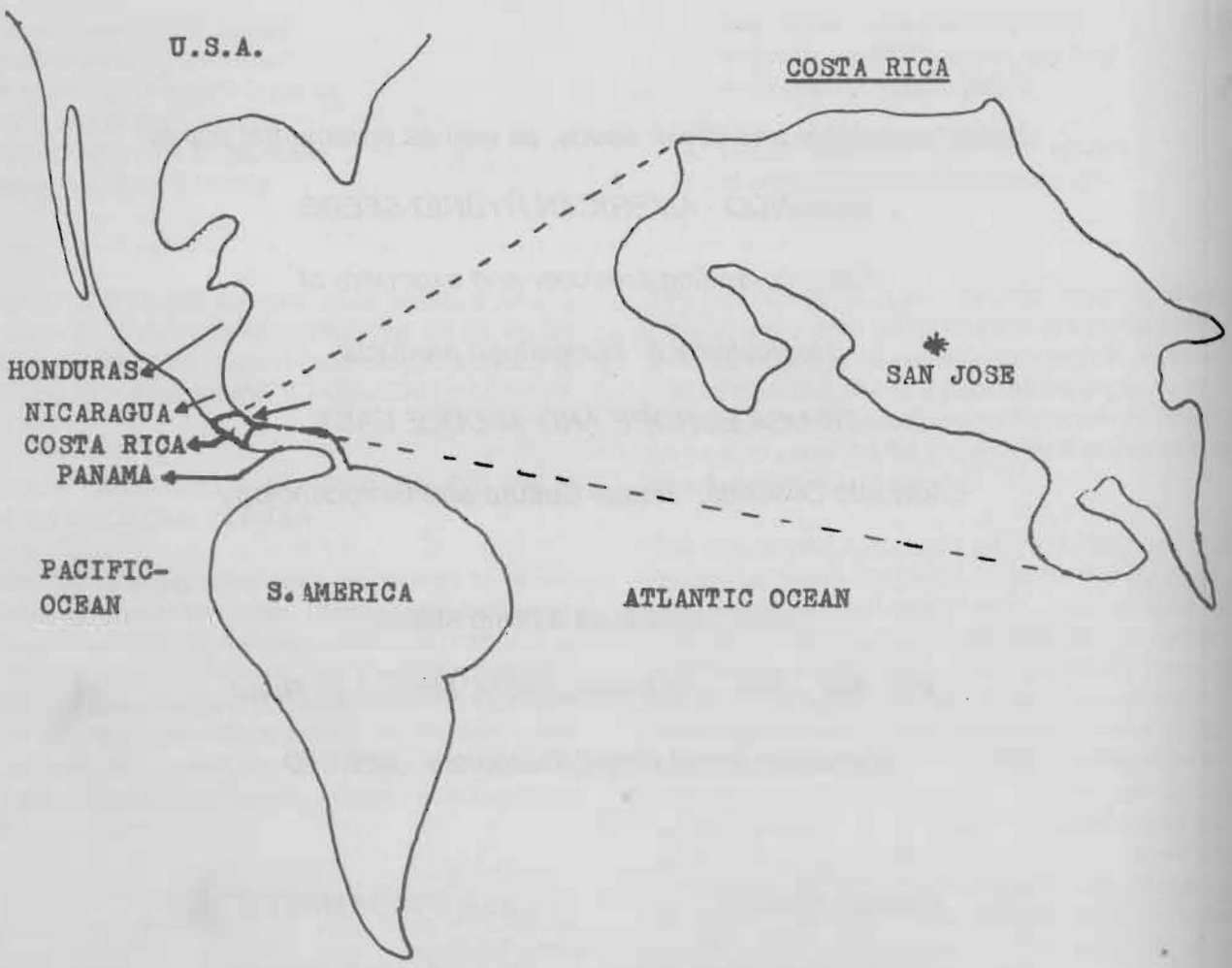
AGRONOMIC ASPECTS OF OIL PALM PLANTATION MANAGEMENT IN COSTA RICA, CENTRAL AMERICA

P Thomas Varghese*

INTRODUCTION

Costa Rica was discovered by Christopher Colombus in 1502 and he christened it "Costa Rica" meaning rich coast. This country in Central America is a model of democracy and political stability. It is also blessed with many tourist attractions such as classic jungles, mountains, white sand beaches and active volcano. Costa Rica lies between 8° and 11° N latitudes. It has a geographical area of 50900 sq. km. and a population of 3.5 million people. Situated in between the Atlantic and Pacific oceans, it has the land border with Nicaragua on the north and Panama on the south.



Map of Costa Rica

★ Scientist (SG) Agronomy, Central Plantation Crops Research Institute (CPCRI), Trivandrum, Kerala

As in Kerala state (India) which is also located in the same latitude, coffee, banana, oil palm, pineapple, coconut, cashew, black pepper, rice, most of the tropical fruit crops, vegetables and ornamental plants are commercially cultivated in costa Rica. As the population is sparse, large area is available for agriculture which is mostly mechanised.

Research and Development activities on production and processing of oil palm in the country are carried out by the Numar group. Of the different sister organizations under this group, ASD (Agricultural Services and Development) deals with seed production, seed distribution and technical consultancy on oil palm. Palma Tica conducts research, management of plantation and palm oil extraction. Various public and private enterprises in India have already imported large quantity of high yielding Tenera hybrid oil palm seeds from ASD, Costa Rica.

Tica. Of this the Coto division consists of approximately 7,000 hectares on the pacific coast near Panama border and Quepos divisions with 8,000 hectares further north again on the pacific coast. Details on climatic conditions of these two divisions are given in table 1.

The very high annual rainfall of around 4,000 mm at Quepos and low water deficit are important factors for higher yields at this region. The annual solar radiation at Quepos is 6.5 GJm^{-2} per year is yet another favourable factor. Temperature conditions in costa Rica are also within the optimum range for oil palm ie. an average maximum of 29 to 33°C and average minimum of 21 to 24°C. Soils are mostly alluvial of fine loamy with drainage problems in certain areas. These soils have high CEC,

Table 1. Climatic Details

A. QUEPOS DIVISION (1983-91)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Av.
Max. Temp.°C	31.3	31.9	32.1	32.2	31.2	30.6	30.8	30.4	30.3	30.0	29.6	30.7	31.6
Min. Temp.°C	21.4	21.7	22.3	23.3	23.2	23.3	22.7	22.7	22.7	22.4	22.4	22.1	24.3
Av. Temp.°C	26.4	26.8	27.2	27.2	27.2	27.0	26.7	26.5	26.6	26.2	26.0	26.4	26.7
Daily sun shine hours	7.6	8.5	8.6	8.6	5.1	4.1	4.3	4.4	4.6	4.7	4.4	5.7	5.8
Monthly rain fall mm	43.5	28.3	47.8	47.8	376.9	362.0	328.9	518.5	561.8	616.9	315.2	162.0	3493
Monthly Evaporation mm	143.4	147.2	179.6	179.6	133.0	120.1	113.2	117.9	126.2	124.0	105.8	120.7	143.8
B. COTO DIVISION (1985-91)													
Max. Temp.°C	32.3	33.7	34.0	33.4	32.2	31.8	31.4	31.5	31.4	31.1	31.2	31.6	32.2
Min. Temp.°C	20.0	19.3	20.7	21.7	22.0	22.5	21.6	21.4	21.9	21.7	21.7	20.8	21.3
Av. Temp.°C	26.6	26.9	27.8	27.9	27.7	27.2	26.5	26.5	26.8	26.4	26.6	26.2	26.9
Daily sun shine hours	8.06	8.8	7.55	5.83	4.81	3.86	4.0	4.0	3.57	3.77	4.86	6.6	5.36
Monthly rain fall mm	78.5	45.6	110.7	217.8	341.6	456.3	478.8	489.4	536.5	717.9	418.7	148.6	3992.9
Monthly Evaporation mm	135.87	150.6	167.2	140.7	121.8	107.6	108.4	98.1	102.5	95.4	106.2	122.4	121.4

Source : Annual Reports of Quepos & Coto divisions. ASD/Palma Tica, costa Rica

As an oil palm agronomist, it was an added experience to get acquainted with the knowhow of oil palm plantation management by the Numar group in Costa Rica which I wish to share with the readers of Indian Oil Palm Journal.

ENVIRONMENTAL CONDITION AND OIL PALM PLANTATIONS

The oil palm plantations of Costa Rica mainly consist of an area of 1,500 hectares owned by compania Palma

high Ca and high buffer capcity. The yield varies between 19 to 34 t/ha of Fresh Fruit Bunches (FFB) depending on the planting material and growing conditions. An average peak yield of 22 t/ha of FFB is obtained from 5th year to 20th year after planting and it declines thereafter giving around 17 t/ha during 25th year. Some of the promising Dura X Pisifera (DXP) materials such as Deli X Avros and Deli X Ghana give an average stable yield of 27 t FFB/ha. In good soils, yield

is as high as 30 t FFB/ha even for those DXP materials introduced from Malaysia which are more than 25 years old. In many areas of Costa Rica with no water limitation, yield up to 34 t FFB/ha is obtained. Under moisture stress, spear development is delayed and remain unfolded. In areas with high water table oil palm yields are better. In Coto division the average yield is around 19 t FFB/ha. Since there is no water deficit, the low solar radiation of 5.0 GJm^{-2} per year is considered to be the main reason for comparatively lower yields in this division. Soils here are mostly alluvial or fine loamy with drainage problems and the CEC is good. Magnesium and Chlorine are reported to be deficient in certain plantations.

Further weed growth is controlled by using a wide range of herbicides. Roundup or glyphosate is sprayed. The big trees are knocked down with the help of a D-8L caterpillar bulldozer of 335 HP equiped with a blade for felling which can clear 20 to 30 hectares and burned in situ and thus the field is kept ready for planting oil palm.

UNDERPLANTING IN OLD PLANTATION

Old palms above 25 years are killed by tree injection with 120 to 150 ml of Mono Sodium Metheno Arsenite (MSMA) in to the trunk. Different methods of sequential killing are practised. In most cases the entire old plantation is killed during the first year of underplanting. In certain larger plantations 50 per cent of palms in alternate rows are killed during first year of underplanting and remaining 50 per cent in the second year. In some other cases 33 per cent killing is done during first year of underplanting and the remaining 66 per cent during the second year or later after underplanting. The killed trees are sometimes retained as such in the field allowing natural decay. Field experiments on this area are also in progress.

Piling of cut Palm trees using a bull-dozer for burning and replanting

LAND PREPARATION

Land is prepared 2 to 3 month before transplanting. Ground covers are removed by manual labour and light roller towards the end of monsoon season. These covers are allowed to dry up and later burned. The first tillage is carried out using a subsoiler or a deep mould-board plough and the second one is done with a harrow.

Under planted oil palms inbetween old palms to be cut

NURSERY MANAGEMENT PRACTICES

Seedlings are raised in primary nursery by planting germinated sprouts in 2.5 cm deep holes in the centre of small poly bags containing potting mixture. Beds of 12 to 14 bags width are made for any convenient length. A mixture of top soil (66 per cent) palm shell or rice husk (33 per cent) is used as potting mixture in the nursery. Micro sprinklers are kept in between rows for irrigation. Water is sprayed three times in a day, each spray lasting for 45 minutes. Seedlings are kept in the primary nursery for three months.

For secondary nursery, black polythene bags of 40X53X0.015 cm with about 40 perforations of 0.5 cm diameter in the lower two-thirds of the bag are used. These bags are folded 7 cm at the bottom towards inside to give a round shape at the bottom when filled. About one kilogram of palm shell is taken in the bag and then filled with medium textured top soil. After planting germinated sprouts, palm shell is again added in 2 to 3 cm thickness as a mulch over the soil in the bag. Thereafter polybags are arranged in equilateral triangular method with a spacing of 90 cm between the bags which will accomodate 12,500 seedlings per hectare. Sufficient space is left for roads, drains and irrigation pipelines. 12 to 14 month old seedlings are mostly used for transplanting to the main field. Seedlings if retained for more than 18 months were not found ideal for planting. A 12 to 14 month old seedling which has 1 to 1.3 m height and 13 to 14 leaves is found best for transplanting.

Irrigation is given to the nursery at 5 to 8 mm of water per day (50,000 to 80,000 l/ha/day) using sprinklers. In nursery, shading is done using palm leaflets. The leaflet is bent and the two ends are fixed in the soil in poly bag to form an umbrella over four such small poly bags in primary nursery. In secondary nursery, two leaflets of good consistency are placed in opposite directions to cross one over the other in the same poly bag.

Transplanting to the main field is done with the onset of rains in April/May so that the young seedlings get the full benefit of rainy season.

Primary nursery seedlings shaded with palm leaf-lets

The fertilizer recommendation followed for nurseries is given in table 2.

Table 2. Fertilizer Recommendation for Oil Palm Nursery

Age of seedling (months)	Fertilizer N P K	Quantity per plant (g)
2	18-46-0	3
3	18-46-0	5
4	18-46-0	8
5	18-46-0	12
6	15-15-15 +	16+5
7	15-15-15 + borax (11 % B)	20+0.5
8	15-15-15 + kieserite	25+10
9	15-15-15 + borax	30+1
10	15-15-15 + kieserite	35+15
11	15-15-15 + borax	40+1.5

Source : ASD Pamphlet 2, Costa Rica

DENSITY AND METHOD OF PLANTING

The spacing recommended is 9X9X9 m in equilateral triangular system to accomodate 143 palms per hectare. Since good environmental conditions produce larger palms, lower population density is used under such conditions. The density of population generally recommended are 127 to 135 palms in very favourable conditions, 143 to 151 palms in moderate conditions and 159 to 160 palms under poor conditions.

In later years of planting, if necessary, certain palms are removed to reduce the density so that all the remaining palms get similar environmental conditions. This is done by systematic removal of one palm in every three or seven palms. In a trial conducted in Coto plantation, when the palm population was reduced from 143 to 95 palms per hectare, even after six years of its removal they continued to give the same yield per hectare.

In Costa Rica planting is done by taking cylindrical pits which are about 10 cm wider and 5 cm deeper than the poly bags in which the seedlings are grown. 150 to 300 g of diammonium phosphate is added to the pit, fertilizer is covered with a small quantity of top soil and then poly bag seedling with the ball of earth is placed in the pit such that the collar portion of seedling and ground surface are at same level compacted. Cover crops are also planned in the field.

FERTILIZER MANAGEMENT PRACTICES

The fertilizer doses recommended for mature plantations of Costa Rica are given in table 3.

Table 3. Fertilizer doses recommended for mature plantation

Division	N	P_2O_5 Kg/ha/year	K_2O	MgO
Coto	100	50	150-300	30
Quepos	120-300	25-50	150-300	

Source : Francisco Peralta (1992)

Though there is a general fertilizer recommendation, specific fertilizer recommendations are made based on regular soil and leaf nutrient analyses of different plantations.

Leaf nutrient contents are estimated for the plantations by taking 4 palms/ha as sample size. Sampling is done during the same month every year. Soil fertility classification and soil fertility maps of the plantations are made. Fertilizers are applied to weeded circle around individual palms. Ammonium sulphate is preferred as N source since the soils are neutral or alkaline (pH above 6.5). Fertilizers are applied every three months during the first year. Triple superphosphate or diammonium phosphate is used as phosphatic fetilizer. Potassium is supplied as Muriate of potash. Magnesium is applied either as Kieserite or as Epsum salt @ a kg per palm wherever required.

Nitrogen is usually given in three splits, phosphorous in single application and potassium in two applications. Fertilizers are spread by broadcasting it manually from a small container to the weeded circle of each palm when soil is moist.

If there is no legume cover, N is increased by 50 per cent from third year to fifth year. Specially made long hooks are used to lift the palm leaves when fertilizers are applied to young palms during the first year and second year. This practice will prevent fertilizers coming in contact with leaves of young seedlings. Nitrogen, potassium, magnesium and boron deficiency symptoms were observed by soil application on the crown by placing it in the spear axils @ 150 g per palm wrapped in tissue paper.

Empty fruit bunches (EFB) from the factory contain large amount of potassium. This is used to mulch the area in between palm rows in adult plantations. Mulching with EFB on the basin of young palms is also practised. EFB is applied @ 70 t/ha. Saprophytic fungi were found to develop over these bunches which hasten the degeneration of the waste. Being an organic source of fertilizer, this practice is found to increase P and K nutrition of palms in addition to the improvement in soil characters.

ASD has developed a special herbicide application method using a herbicide tank mounted on a trailor driven by bullocks. The tank has a capacity of 300 lbs in which herbicide is kept at 120 to 130 PSI pressure. The pressure regulator maintains a pressure of 45 PSI during application. Two rows are covered by two workers as the bullock moves between these two palm rows. Weedicides are sprayed to the palm circles with the help of knap sack sprayers. Manually operated Low Volume knap sack sprayers of 4 gallon capcity is also used in certain cases. For direct contact application, rope-wipe system is used for applying systemic weedicides. For control of narrow leaved plants in oil palm plantations glyphosate (round up) is used. Mixture of paraquat + diuron and glyphosate + oxyflurofan are also used for weed control.

IRRIGATION AND DRAINAGE SYSTEMS

Irrigation channels of about 45 cm depth and 1 m width are made for every six rows of palms using tractor mounted machanical device. These earthen channels act as furrows for irrigation during summer months and serve as drainage channels in rainy season. Water is let in and allowed to stand in these furrows on every day in

summer months. Average yield of irrigated adult plantations in Costa Rica is 27 to 30 t/ha for tenera material. There were young tenera palms growing near standing water supply sources without any ill effects. American oil palm (Elaeis olifera) is comparatively tolerent to water stagnation.

Irrigation of palms by check dams formed by blocking water flow of natural channels between small hills using wooden planks as shutters and then diverting them for irrigation to the plantation is also being practised. Horizontally cut half drums welded together and kept on rails are also used as a channel to carry water especially where it is required to cross some hurdles such as a small valley in the plantation.

LEAF PRUNING

Leaf pruning is carried out to facilitate inspection of ripening of bunches, harvesting and to remove old and dead leaves. The general recommndation is to leave one or two leaves below the ripe bunch at harvest so that there will be 38 to 42 leaves on the crown. If the palm is in its male phase, 5 leaves per spiral is retained to have 40 leaves on the crown. Pruning is generally carried out once in a year to remove 8 to 12 leaves from adult palm, once in nine months to remove 6 to 8 leaves from middle aged palm and once in six months to remove 4 to 6 leaves from young palm. Palm leaves thus cut are placed in avenue to clear of harvestors' paths.

COVER CROPPING AND INTERCROPPING PRACTICES

Bare soils are rarely seen in Costa Rica plantations since aggressive creepers which compete with weeds are grown as cover crops. Pueraria phaseoloides which fix 100 to 150 kg N/ha is found ideal in costa Rica. Pueraria usually dies after 10 years when the oil palm canopy closes. During this period bushy perennial legumes as Flemengia congetsa or Flemengia macrophylla are grown. They have deep root system and add litter to the soil. Other cover crops being tried in oil palm plantations are : Desmodium vellotinum, Desmodium cvlifolium, Centrosema macrocarpum, Canavalia congesta, Canavalia ensiformis, Arachis pintoi and Stizolobium Sp. Seeds are usaully treated with rhizobium cultures before sowing.

Intercropping is carried out in the initial four to five years with Hawaian Papaya. Intercropping is also practised in other American countries as in Brazil with black pepper and passion fruit, in Ecuador with soyabean and in Guatimala with cotton. Intercrops are planted along with planting of oil palm.

HARVESTING AND TRANSPORTING OF BUNCHES

In Costa Rica peak production is attained during 8th year. The yearwise production of FFB per hectare in general is as follows : First and second year - Nil; third year - 5 tonnes; fourth year - 12.5 tonnes; fifth year - 18.3 tonnes; sixth year - 23.4 tonnes; seventh year - 25.6 tonnes and eighth year - 26.5 tonnes per hectare. Many of the hybrids flower in 22 to 26 months and give 30 t/ha of FFB after yield stabilization. Frequency of harvesting is adjusted so that fruits that are about to ripe in a round of harvest will not be over ripe by next round. As a general rule harvesting is done when four loose fruits are fallen on the ground. Bunch stalks are always cut close to the bunch. For harvesting taller palms, telescopic aliminium poles with Malaysian knife totally weighing 12 kg are used. These harvested bunches are removed to the road by trolly, bullock carts or by a rope way. A bullock cart can carry about 1.5 t of FFB at a time. These are loaded into bigger trucks and carried to the factory.

In a harvest lot, unripe bunches should be less than 5 per cent and over ripe should be less than 7 per cent. Price of FFB is proportionately reduced according to the percentage of unripe and over ripe bunches harvested. Harvesting is done in seven days for young plantations and in 14 days for adult plantations. High yield peaks are observed in costa Rica during rainy season and low yields are obtained in dry season.

A chisel is used for harvesting bunches of young palms and Malaysian knife for adult palms. for every 4 to 6 rows there will be a carrying path. While bullock pulls a cart through this carrying path, a worker picks each harvested bunch using a pointed steel rod and releases it to the open cart one by one from behind.

Each harvester is allotted an area for harvesting and he is responsible for regular harvesting from this harvesting lot. Picking of loose fruits is done separately in 50 kg bags. Wages are paid to the harvesters based on the number of bunches harvested and age of the palms. Penality is charged based on percentage of over ripe or unripe bunches harvested. Periodic quality control inspections are carried out by supervisors in these fields. This arrangement has helped them in increasing harvesting efficiency of their plantations.

Transport of fruit bunches by bullock cart

CONCLUSION

Most of the agricultural operations of oil palm plantations in Costa Rica are similar to the practices that are being followed in the plantations of Kerala with certain modifications in details of operation. Planting of seedlings in circular pits particularly in heavier soils, recycling of empty fruit bunches by spreading them in plantation to supplement potassium and phosphorus, leaf axil placement of borax wrapped in tissue paper to correct boron deficiency symptoms, use of bullock carts for collecting and transporting of harvested fruit bunches from the plantations, application of herbicides using bullock driven pressure tanks connected to knap suck sprayers, payment of wages to harvesters based on age of palm, weight and ripeness of harvested fruit bunches are few agronomic aspects worth consideration for oil palm plantation management in India. Some of these management practices being followed in Costa Rica can be adopted in oil palm plantations of India with modifications wherever required.

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