REVIEW ARTICLE

The oil extraction rate (OER) in relation to cultivation of oil palm in India - A Critical Review

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ABSTRACT

Palm oil will continue to dominate the vegetable oil scenario as a major source of edible, non edible and industrial vegetable oil in the country. For sustainable production of vegetable oils, the oil palm is best source to deliver. To meet the vegetable oil demand, India adopted two pronged strategies of cultivating oil palm which is the highest oil yielding crop and importing edible palm oil is the major share. Irrigated oil palm in India is grown in 16 states in an area of 3.31 lakh ha with imported and indigenous planting material producing about 3.0 lakhs tons of crude palm oil. There are about 26 processing units in the country with total processing capacity of 584 tons/hr. Average fresh fruit bunch (FFB) yield level ranges from 15 to 20 ton/ ha/ year under normal management conditions, whereas some progressive farmers are harvesting 30 to 40 t/ ha/ year. No doubt that oil palm is a paying crop to the farmers. The average OER percentage is near about 17.5. Many factors are involved in realizing low OER and it is difficult to comprehend them individually. An attempt was made to review the OER percentage in the major oil palm growing states of the country and possible ways and means to increase the OER are discussed in this article.

Key words: Oil palm, oil extraction rate, India, crude palm oil (CPO)

INTRODUCTION

India is one of the major oilseeds growing, consuming, and importing country in the world. Oils play an important role in the Indian agricultural economy next to the food grains. The traditional oil seeds of our country *viz.,* groundnut, sesame, rape-seed, mustard, sunflower, safflower, soybean *etc.* are cultivated in an area of about 27 million ha in the country, could produce about 20.3 million tonnes of oil seeds with an average yield of 757 kg/ha (Rethinam, 2018). Vegetable oil consumption has increased considerably and resulted in continuous demand-supply-gap for edible oils which is being met by imports of vegetable oil to the level of 10.5 million tons and the demand will be 23.10 million metric tons Rethinam (2014). Having realised the efficiency of a high value perennial crop like oil palm which can produce one ton of crude palm oil in 0.22 ha of land; could give an average crude palm oil (CPO) yield of 4-6 t/ ha/ year and 0.4 to 0.6 t of palm kernel oil (PKO). The crop was introduced as irrigated small holder's crop in 1990s and demonstrations in farmers' fields and field performance in different states in small and marginal farmer's gardens have shown that oil palm can be successfully grown as an irrigated crop in the country.

A potential area of 19, 33,715 ha has been assessed suitable for cultivation of oil palm in 18 states of the country by a competent team constituted by Government of India. Reasonably good plantations established in the identified agro-climatic zones/ regions indicate the wide adaptability of the crop under irrigated conditions in India. There are also ample opportunities for raising inter/ mixed cropping at various stages of palm plantations.

CURRENT AREA UNDER OIL PALM CULTIVATION IN DIFFERENT STATES

Oil palm was first commercially planted during the year 1960 in the forest lands of Kerala and later in Little Andaman Islands. Currently oil palm is grown in an area of 3, 17,161 ha in 14 states identified as an irrigated crop with largest area is in Andhra Pradesh. In

Kerala and Mizoram, it is largely grown as a rain-fed crop. In general, the planting material *viz.,* the tenera hybrids in the oil palm growing states has both indigenous genetic material sourced from the seed gardens in Andhra Pradesh, Kerala and Karnataka established by using the parental source available at Palode, besides the tenera sprouts imported from Costa de Rica, Papua New Guinea, IRHO and Thailand. The dura and pisifera imported from Nigeria during 1975 and nurtured at ICAR-CPCRI Regional Station, Palode formed the indigenous sources for production of tenera hybrids.

TREND IN FFB PRODUCTION IN DIFFERENT STATES OF INDIA

Andhra Pradesh (including Telangana)

Andhra Pradesh, the major oil palm belt in the country endowed with good soil and quality irrigation water, emerged as the most suitable environment for cultivation of oil palm in India under irrigated condition. Among the major soil groups of Andhra Pradesh, red soils (Alfisols) occupy 65 per cent of the area and oil palm cultivation is concentrated in these soil conditions. Andhra Pradesh receives heavy tropical rains during June to September and October. The summer months are spread over February, March through June. In this weather condition successful gardens are maintained by farmers yielding 25 to 30 t FFB/ ha. Recent estimates compiled by Rethinam (2018) for the years 2005-06 to 2015-16 indicated that the combined states of Andhra Pradesh and Telangana accounted for 1, 72,429 ha of oil palm cultivation, produce 89.16 % FFB yield in the country, out of a total production of 12,82,823 tons. The FFB is processed in 13 oil palm mills.

1) For judging the FFB production in the major oil palm growing state of Andhra Pradesh the data obtained from West Godavari district is presented in Fig 1.The data shows a regular trend in the yield depicting two cycles of production, the main cycle starting from May to October when 60 per cent of yields are received in the processing mills and another cycle from November to April.

With little variation, the trend in FFB yield between months and between years is similar and the yield progressively increased over years (Fig. 2). During this period the palm oil mills are activity linked to grading, processing and oil extraction from mesocarp and kernel incidentally producing large quantities of EFB, mesocarp fiber and palm oil mill effluent (POME).

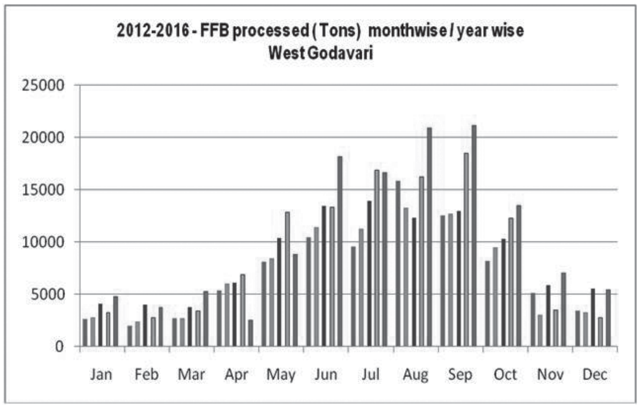

Fig.1: Trend in FFB receipts at different months during 2012-16 in West Godavari District, Andhra Pradesh (Y axis FFB in tons)

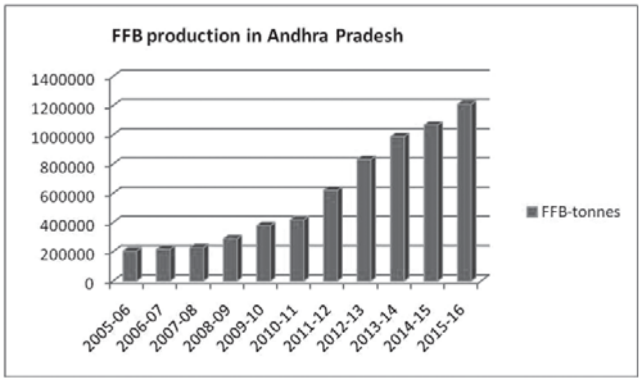

Fig. 2: Progressive increase in FFB yields in Andhra Pradesh

The variation in FFB yield of palms within a season and more pronounced between seasons is very much apparent in Andhra Pradesh plantations. Corley and Tinker (2003) suggested that such phenomenon is mainly due to fluctuation in bunch number which is determined many months before anthesis, long before the demand for assimilates become significant. During lean months of November to April, the bunch sink is reduced and the extra dry matter may be allowed / partitioned to vegetative dry matter production. Probably this may lead to more reserves of assimilates in the system which will influence the required energy for production of FFBs during the peak season. Since bunch production has been indicated as source limited, it is necessary that the palms may be fertilized adequately avoiding leaching losses in the rainy months especially in states which receive rains from south-west monsoon. Palms generally assumed to be irrigated based on Pan Evaporation data and considering the canopy radius.

Normally under good management, oil palm yield more or less stabilizes after 7th year of yielding and remains so with little variation up to 18-20 years and continues to yield unless otherwise replanted for obvious reasons. The FFB production increased over years due to (i) oil palm gardens planted earlier are maturing towards higher productivity and (ii) more newly planted gardens are entering to active reproductive phase.

Tamil Nadu: Currently oil palm is cultivated in 3374 hectares though the reassessed potential area is 2, 05,000 ha. Most of the oil palm plantation is raised on deep red soils classified as Inceptisols and Alfisols. The normal annual rainfall in Tamil Nadu is about 945 mm of which 48% is through the North East Monsoon and 32% through the South West Monsoon. The state is entirely dependent on rains for recharging its water resources; monsoon failures may lead to drought conditions. The pattern of FFB yields in Tamil Nadu agro-climatic conditions and seasonal variation in FFB yields is similar to that observed in Andhra Pradesh. The month of May to October can be considered as active FFB yielding phase in Tamil Nadu plantations also (Fig. 3).

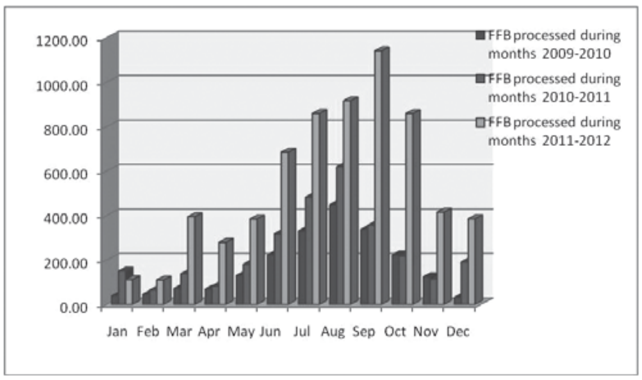

Fig. 3: FFB processed at different months during 009-10 to 2011-2012 in Tamil Nadu (Y axis FFB in Tons)

Karnataka: Karnataka has a history of planting oil palm with initiatives by the department officials on a commercial scale during 1990-91 under DBT and OPDP programme. Under a reassessed potential of 2, 60,000 ha, Karnataka has a planted an area of 50,156 ha (Rethinam, 2018). Karnataka is predominantly a red soil region and excellent plantations are raised in deep red soils. Karnataka has the FFB processing facility in four palm oil mills with the biggest facility is at Shimoga.

Kerala: Kerala, where oil palm is mostly under rain-fed conditions is managed by Oil Palm India Limited (OPIL) and United Oil Palm Planters and Extractors is cultivated in an area of 5, 776 ha out of 6, 500 ha potential area identified. Soils of Kerala are mostly acidic red soils classified as inceptisols and ultisols and support a good growth of palm plantation raised under rain-fed conditions. June to September receive the south west monsoon rains, leaving a dry period from October to May with occasional summer showers. Need based irrigation is a must for maintaining the productivity.

Mizoram: Oil palm cultivation started in Mizoram in the early 2000 and the present planted area is around 20,377 ha distributed in Kolasib, Lungle, lawngtlai, Mamit, Serchip, Aizwal and Saiha with assistance from ISOPOM, OPAE (RKVV) and NMOOP schemes. Mizoram is a mountainous track with highly acidic soils rich in available nitrogen and potash. Phosphorus appears to be the most limiting nutrient for growth. In general Mizoram hills receive an annual rainfall of 2500 mm concentrated in six months, leaving the rest of the period dry.

OIL EXTRACTION RATE (OER) AND ITS ESTIMATION

The OER is a measure of efficiency of entire palm oil production process, which is expressed as a percentage of CPO (Crude Palm Oil) extracted to the total weight of FFB processed. It is considered as a critical measure of (i) the efficiency of field plantation in producing FFB with high O/B ratio (ii) harvesting it efficiently, and (iii) efficiency of the plantation mill. Chang (2003) expressed that OER is a management tool to assess the quantity of FFB processed for an area of planted oil palm. In determining oil to bunch ratio in the laboratory, a representative FFB is selected from the harvested produce and dissected to its various components such as fruit-lets, spike-lets, mesocarp, nut, kernel and stalk etc before each component is subjected to physical and chemical characteristics. Alverado and Sterling (1998) opined that the bunches processed at the mill are highly heterogeneous and those analyzed at the laboratory during the study were chosen for their homogeneity. They concluded from their five years study (1990 to 1995) that proportion of fruit to bunch is the main factor in the oil content per bunch.

The NIFOR method as described by Black et al. (1963) is reported to be in general use for nearly 40 years (Corley and Tinker 2003) though some variations are introduced for estimating parameters like wet mesocarp to fruit ratio (WM/F), dry mesocarp to wet mesocarp (DM/WM) followed by estimation of oil to dry mesocarp (O/DM). Oil to bunch (O/B) is calculated from O/B = (O/DM) x (DM/WM) x (WM/F). According to Chan (1981), oil loss from mill processing averaged about 8% of the oil recovered. A factor of

0.855 is routinely used by IRHO (Institut Recherche pour les Huile et Oleagineux) to account for field and mill losses when converting laboratory O/B to mill OER. Multiplying the O/B by 0.855 gave 19.3% OER which agreed closely with the mill estimates. The standard field manual gives a clear understanding of the procedures for oil extraction from oil palm bunches and a review of the methods was done by Rao et al. (1983). Nurul and Ismail (2010) employed near infra red (NIR) scanning spectrometer for quick determination of actual oil content in oil palm fruit bunch. Pamornnak et al. (2013) proposed a technique to determine oil extraction rate of palm fruit based on the dielectric constant measurement at microwave frequency. The technique can achieves accuracy of 95.63% for OER determination.

The major palm oil producing nation, Malaysia has reported variation in OER (19.7% compared to 20.2% in the previous year) and also indicated possible reasons for the same (Kushira et al. 2017). The average OER declined, mainly due to prolonged dry weather arising from *El Nino* effect causing inferior FFB quality. The OER in Peninsular Malaysia, Sabah and Sarawak declined by 2.8%, 2.4% and 0.2% to 19.21%, 20.60% and 19.98%, respectively. Reports on the performance of oil palm in Thailand indicated that while FFB yields per hectare and per year have increased significantly despite fluctuations over the last twenty years, the overall OER in Thailand decreased by more than 2% from 1990-1994 to 2005- 2009 (Source: unpublished data, OAE 2010). In Philippines, pricing of oil palm is highly dependent on the world market and current exchange rates. Local rates are guided by the pricing formula: (Jo Villanueva 2017; Sawit 2011): (A x B) +(C x D) - P750/MT x 85%. Some norms for OER and KER are proposed as guiding factors in price formulations. Where: A=selling price/t of CPO: B-the OER based on average OER in the mill or few new planting (based on ± 1 below provided the crop quality does not exceed the limit as indicated in schedule B). C= the selling price per ton of Kernels of VAT: D= the average Kernel Extraction Rate of KER. PORLA, Malaysia had given the basic extraction rate in Malaysia

Table 1: The basic extraction rate for kernel based on the age of palm for tenera (DxP) progeny,Malaysia, (<3 to 18 years)

Age of palm	Peninsula		Sabah/ Sarawak	
	Extraction rate		Extraction rate	
	Oil (%)	Kernel (%)	Oil (%)	Kernel (%)
< 3	14-15	4.0-4.2	15-16	3.5-3.9
3-< 4	15-16	4.2-4.5	16-17	3.9-4.2
4-< 5	16-17	4.5-4.8	17-18	4.2-4.5
5-< 6	17-18	4.8-5.0	18-19	4.5-4.8
6-< 7	18-19	5.0-5.5	19-20	4.8-5.0
7-< 8	19-20	5.0-5.5	20-21	4.8-5.0
8-< 18	20	5.0-5.5	21	4.8-5.0
18 & above	19-20	5.0-5.5	10-21	4.8-5.0

Table 2: Basic extraction rate for kernel based on the age of palm for tenera (DxP) progeny, Malaysia (<5-25 years)

Bunch weight (kg)	Peninsula		Sabah/ Sarawak	
	Extraction rate		Extraction rate	
	Oil (%)	Kernel (%)	Oil (%)	Kernel (%)
< 5	14-15	4.0-4.2	15-16	3.5-3.9
5-< 6	15-16	4.2-4.5	16-17	3.9-4.2
6-< 7	16-17	4.5-4.8	17-18	4.2-4.5
7-< 8	17-18	4.8-5.0	18-19	4.5-4.8
8-< 9	18-19	5.0-5.5	19-20	4.8-5.0
9-<10	19-20	5.0-5.5	20-21	4.8-5.0
10-< 25	20	5.0-5.5	21	4.8-5.0
25 & above	19-20	5.0-5.5	19-21	4.8-5.0

(Source: FFB grading manual, PORLA, Malaysia) given in table 1 and 2, indicated that with the age of the palm the bunch weight increase and the extraction rate is also increasing.

THE OIL EXTRACTION RATE (OER) IN INDIAN OIL PALM PLANTATIONS

A brief account of OER obtained from the states of Andhra Pradesh, Karnataka, Kerala, and Mizoram is discussed below.

Andhra Pradesh: The monthly OER reported from palm oil mill in West Godavari district recorded for different months in 10 years from 2007-'08 to 2016-'17 was examined to study the pattern of yield and the OER realized over months and between years. The data can also be examined for the peak and lean season of FFB yield (Table 3, 4, 5 and Fig. 4).

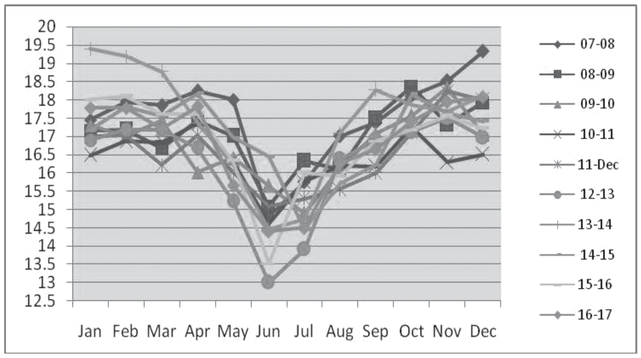

Fig. 4: Trend in OER % in different months of a year (2007-2008 to 2016-2017) West Godavari, A.P.

The trend in OER in a year over months is presented in Fig.4 clearly indicates seasonal variation in OER particularly a reduction in OER during the peak season of FFB yield. The 10 year data on OER realized in West Godavari oil palm plantations revealed the following

Table 3: Pattern of OER realized over Ten years during Peak season of FFB yield.

Month/ year	07-'08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	Average OER %
May	18.01	17.01	16.42	16.33	16.03	15.22	16.22	16.98	16.33	15.66	16.421
Jun	14.82	15.09	15.65	14.61	15.09	13.01	14.47	16.44	13.52	14.41	14.711
Jul	15.75	16.33	14.89	15.77	15.3	13.92	14.73	14.46	16.00	14.5	15.165
Aug	17.01	16.11	16.16	16.19	15.56	16.38	17.1	15.73	15.92	16.27	16.243
Sep	17.38	17.53	17.08	16.18	16.00	16.91	18.27	16.22	16.87	16.65	16.909
Oct	18.11	18.36	17.57	17.27	17.11	17.13	17.86	18.15	17.18	17.42	17.616
Average	16.847	16.74	16.295	16.0583	15.848	15.428	16.442	16.33	15.97	15.818	16.18

Table 4: Pattern of OER realized over years during Lean season of FFB yield

Month/ year	07-'08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	Average OER %
Jan	17.45	17.95	17.15	17.3	16.48	17.00	16.90	19.39	17.19	18.01	17.48
Feb	17.45	17.95	17.19	17.01	16.87	17.04	17.17	19.19	17.82	18.09	17.58
Mar	17.85	17.85	17.01	17.44	16.83	16.22	16.68	18.77	17.55	17.6	17.34
Apr	18.25	18.25	16.87	16.02	17.35	17.02	18.17	17.38	18.17	17.62	17.58
Sep	17.28	17.53	17.04	16.18	16.00	16.91	16.87	16.22	16.87	16.65	16.87
Oct	18.11	18.36	17.17	17.27	17.11	17.13	17.18	'18.15	17.18	17.42	17.65
Nov	18.52	17.33	19.19	17.27	18.23	17.5	17.56	17.64	17.56	17.95	17.80
Dec	19.33	17.93	18.09	16.51	18.00	16.97	17.21	17.42	17.21	18.08	17.66
Average	18.04	17.89	17.58	16.87	17.60	16.97	17.44	18.02	17.44	17.68	17.50

Table 5: Difference in mean OER content during the lean period and Peak period of FFB Yield (2007-'08 to 2016-'17)

Sl. No.	Average OER	
1	Lean period : November to April	17.50
2	Peak period : May to October	16.18
3	Difference	1.32

(i) seasonal variation in OER between peak and lean months of FFB yield to the tune of 1.32 % (Table 5) (ii) OER for the same month in different years varied from 14.711 to 17.66 and between years over months the OER was recorded as 16.39 to 17.53. (iii) The consolidated average for 10 years over months and years is recorded as 16.851 and (iv) The resultant variation in OER is below expectations under the given soil conditions, irrigation, nutrition and cultural management. (v) West Godavari plantations record low OER compared to East Godavari oil palm plantations (Fig 5). One of the reasons for low OER may be due to the fact that FFB from different age groups are processed and difference in the major soil groups on which oil palm is cultivated.

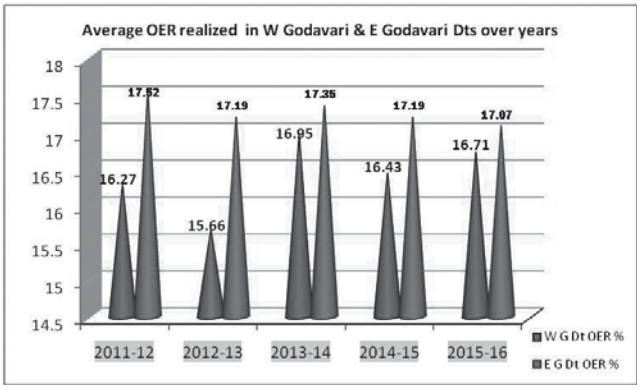

Fig.5: Difference in OER recorded between west and east Godavari plantations.

In the peak season of May to October when 65 to 70 of FFB yield of the plantation is produced, the average value of OER realized is 16.18. During the lean season of yield January to April (18.28%) and August to December (18.58%) the OER obtained is high. Corley and Tinker (2003) concluded that (i) there is seasonal variation in oil percentage and (ii) on the contrary to above findings they stated that fruits in the peak production months there is a tendency to have higher oil content than fruits from other times. In Andhra Pradesh, the peak FFB production periods also coincide with the rainy months during which period the sunshine hours in a day are between 4 and 5 hours in July, August, September compared to 8 hours/day during other months. A high load of fruit on the trees, under limited light conditions, may lead to a low amount of oil produced, which is then distributed among many bunches. Henson (1993) further added that more energy is needed to produce oil than carbohydrates, which imply that a high oil production cannot be compatible with a high bunch load in any particular palm. Nevertheless, the critical observation is that low OER coincides with peak season of FFB production. It is possible that the energy diverted for oil synthesis is diluted due to higher crop load. Probably this is the reason why even if FFB yields are increased, the OER did not show much increase than the regular values obtained in plantations. Hanif and Noor (2002) could not conclude on the reason that poor growth of inner fruits is caused by spatial limitations for development of mesocarp or a lack of assimilates as the reason for low OER.

Tamil Nadu: Available data on FFB yield and OER realized for the period 2009-10 to 2011-12 is presented in Table 6. The FFB yield gradually increased over years from 2009-10 to 2011-12 and the average OER realized

Table 6: FFB received at the mill and the OER obtained during 2009-10 to 2011-'12 in Tamil Nadu.

	2009-2010		2010-2011		2011-2012	
Month	FFB	OER	FFB	OER	FFB	OER
Jan	39.33	16.30	151.21	17.7	11.78	15.6
Feb	46.30	17.71	65.52	15.10	110.27	14.1
Mar	72.53	17.60	130.60	14.30	394.81	15.2
Apr	69.63	17.00	83.66	17.30	279.89	15.3
May	130.70	17.50	180.20	16.10	384.71	16.1
Jun	223.25	17.70	317.96	15.40	685.37	14.8
July	331.32	16.50	482.52	16.70	859.37	15.1
Aug	448.94	16.40	619.67	17.30	916.21	17.1
Sep	338.11	18.20	357.23	16.70	1141.02	17.6
Oct	222.88	20.20	218.28	17.90	859.18	17.0
Nov	124.65	18.40	113.74	16.00	415.76	15.3
Dec	31.94	17.75	191.41	16.90	385.39	18.4
Total/Average*	2079.57	17.61*	2912.18	16.45*	6443.76	15.97*

varied from 16.30 to 20.20 between months during this period. There is an increase in the yield of FFB and consequently receipt of bunches in the mill, but the OER recorded over the months and years is erratic when compared between years and does not follow any trend (Fig 6, 7) as otherwise normally be expected. Earlier most of the seedlings raised from sprouts imported from ASD Costa de Rica were planted which has reported potential of 25 to 28 % OER. Recent plantings are with more of indigenous and less of exotic sources like Univanich (Thailand). It is to be noted that in all environments whether it is in Andhra Pradesh or Tamil Nadu there is an underlying yield cycle as also quoted by Corley and Tinker (2003) elsewhere.

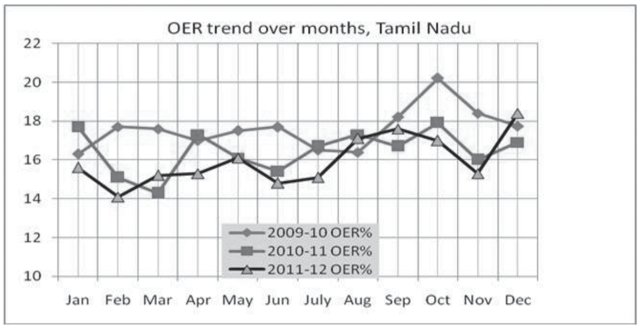

Fig. 6: Trend in OER at different months during 2009-10 to 2011-12in Tamil Nadu (Y axis OER %)

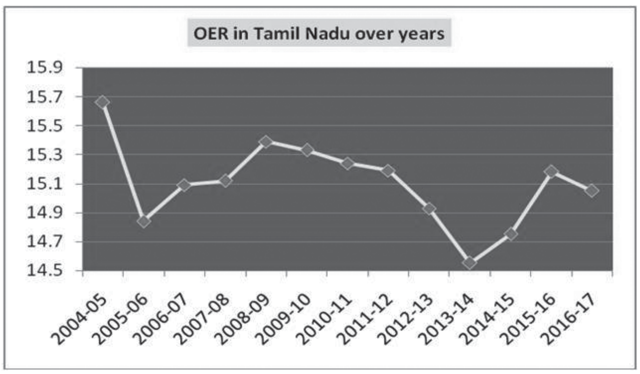

Fig 7: Yearly variation in OER in Tamil Nadu 2004-'05 to 2016-'17

Karnataka: The CPO production and OER realized for the years 1993-94 to 2001-02 was reported by Mary Rani and Sharma. Planted during 1990-1991; the OER reported for the year 1995-96 to 2001-'02 indicated that the average OER as 16.18 % (Table 7).

The available data of PAN-INDIA plantation in Karnataka reported for nine years 2009-10 to 2016-17 gives OER ranging from 19.30 to 17.50 with an average value of 18.00. The consistent results give an understanding that if the possible path ways that reduce the losses at plantation level and at the palm oil mill are controlled the OER can be maintained to a level of 20 to 21 per cent (Fig. 8).

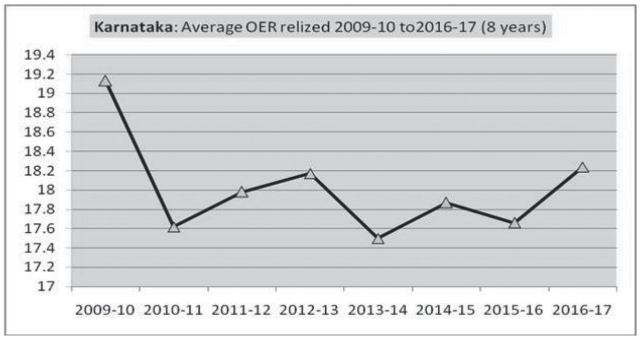

Fig. 8: Yearly variation in OER % in Karnataka 2009-'10 to 2016-'17

Goa: The OER recorded over 2003-04 to 2016-17varied from 16.15 to 18.07 with an average value of 16.814. The pattern of OER between years is depicted in (Fig.9). In Goa new oil palm plantations have not come up over the years as expected. The data from existing plantations indicated that as the age of the palms increased, the bunch weight has increased vis-à-vis the OER recovery especially from 2013-2014 onwards.

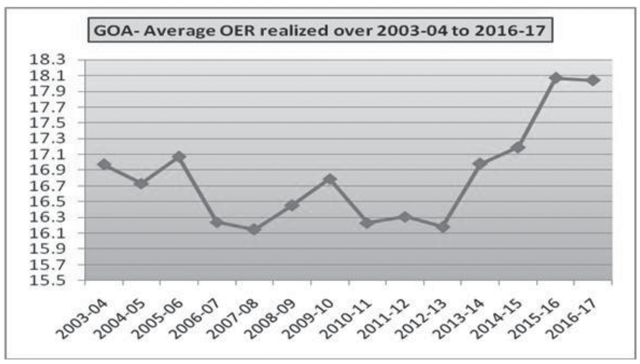

Fig. 9: Yearly variation in OER in Goa 2004-'05 to 2016-'17

Table 7: CPO and OER realized during 1993-94 to 2001-02 in oil palm plantation in Karnataka

Year	CPO (MT)	OER %	Year	CPO (MT)	OER %
1993-1994	28.92	12.18	1998-1999	535.51	16.00
1994-1995	163.85	13.68	1999-2000	738.76	16.10
1995-1996	347.91'	16.23	2000-2001	643.99	16.10
1996-1997	432.35	16.22	2001-2002	573.58	16.10
1997-1998	561.25	16.49	Average	580.90	16.18

Mizoram: Mizoram is mountainous tract where oil palm is a recent introduction. The average OER realized over 2014-15 to 2016-17 is 15.17 (Fig 10).

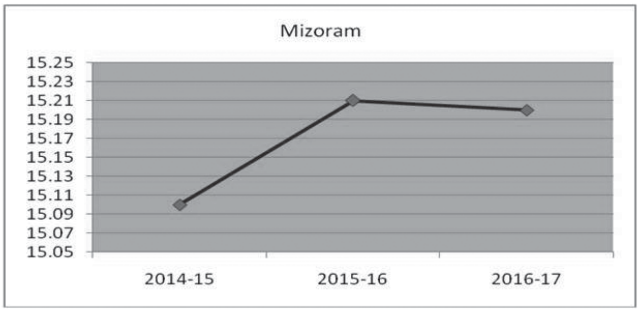

Fig. 10: Yearly variation in OER 2014-15 to 2016-'17.

The OER status for the year 2010-2011 to 2015-2016 was compiled for the state's growing oil palm (Table 8). For Andhra Pradesh, the premier oil palm growing state the OER % varied from 16.51 to 17.09 % for the period 2010-'11 to 2015-'16 with an average value of 16.82 %. For Telengana it was 16.91 % for 2014-15 and 2017-18. For Karnataka the average OER % for 2010-'11 to 2015-'16 barring 2013-'14 was 17.23 %. Tamil Nadu registered a six year average value of 15.68 %; Odisha 16.65 %, Kerala 16.65% and Goa 17.92 % for a five year period. Mizoram oil palm plantations the OER recorded 2014-15 to 2016-17 was 15.17. Considering all the above reporting it is realized that the OER % obtained in the Indian oil palm plantations is low and below expectations, is a matter of concern under given the technical guidance, promised OER at entry level of sprouts of both indigenous and exotic accessions (Table 12), irrigation, manuring and harvesting standards followed for the crop (Table 8).

The information in table 8 on average OER of oil palm plantations from eight states for the years 2010-11 to 2015-16 is discussed along with additional information on OER from oil palm growing states in the country. Earlier Rethinam (2014) compiled the FFB production from different states for the period 1992-93 to 2015-16 and the average OER was computed as 17.35 for the country. Data compiled for eight Oil palm growing states in the country indicate the average OER as 16.79. Taking into cognizance of the above information, the national average OER can be considered as 17.00%. The variation recorded in the data emerged from oil palm growing tracts in Andhra Pradesh, Tamil Nadu and Karnataka, the adopted agronomic interventions, gives an indication that there is ample scope to obtain OER to the extent of 20 to 21%. Considering the climatic setting for oil palm growth especially in Andhra Pradesh, Karnataka, Tamil Nadu, the favorable proven soil conditions and the management there is immense scope to improve the yield of FFB by 25 percent by adopting Better Management Practices (BMP) including the maturity/ harvest standards.

CONCLUSION

Oil palm cultivation under irrigation promoted during 1986 has really given dividend to farmers by getting FFB yields from 15 to 40 tons / ha /yr depending upon the management adopted by the farmers. Oil Palm development in the country is interlinked that farmers produce raw material and processors extract oil. There is absolute necessity for increasing the OER which will benefit farmers, processors and to the country as a whole by increasing the production of palm oil. Increasing OER % is a complex process which includes the use of DxP seeds having high yield and OER, optimum input management of nutrient, water plant protection, harvest at appropriate maturity, following harvest and post harvest standards; adapting good processing technologies etc. The farmers need to be educated and trained not only in growing oil palm but also in

Table 8: The OER % from the pooled data available for different oil palm growing states

S.No	State	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average OER
1	Andhra Pradesh	16.51	17.09	16.87	16.77	16.85	16.84	16.82
2	Karnataka	17.5	17.50	17.5	12.51	17.21	16.43	16.44
3	Tamil Nadu	16.64	14.47	19.73	13.22	15.04	14.98	15.68
4	Odisha	16.98	16.99	16.99	16.75	15.56	NA	16.65
5	Kerala	16.83	17.36	16.39	NA	15.93	NA	16.63
6	Goa	17.51	17.67	18.40	NA	17.98	18.06	17.92
7	Telangana	16.51*	17.09*	16.87*	16.77*	17.29	16.54	16.91
8	Mizoram	NA	NA	NA	15.1	15.21	15.2	15.17
	OER %	16.99	16.84	17.64	14.81	16.55	16.75	16.79

maintaining soil productivity, adopting the harvest and maturity standards. India should have a mandate on oil palm cultivation with a target to increase the average FFB yields to 25 tons/ha adopting good agricultural practices (GAP). In general the national target for OER can be 22 % and it is achievable by gearing up government mechanism to implement the programme with effective coordination, guidance, training, demonstrations and above all with a fair price to FFB. The triangle of farmers-processors-government should work together and the goal can be achieved.

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