Original Research Article

Economic analysis of oilpalm cultivation in India : A case of Andhra Pradesh state

ABSTRACT:

Aim: Present study was taken up with an objective to examine the economic viability and financial feasibility of oilpalm cultivation in Andhra Pradesh

Study design: Random sampling was used for the study. From each district, based on area proportionality 60 oil palm growers were selected.

Place and duration of study: The present study was based on primary data collected from 8 oil palm growing districts of Andhra Pradesh. Data was collected in the year 2021

Methodology: To study the financial feasibility, cost concepts given by Commisssion for Agricultural Costs and Prices (CACP), profitability measures like NPV, BCR, IRR and resource use efficiency were used.

Results: The results revealed that, the total cost during the pre-bearing period (initial 3 years) was Rs. 247831 per hectare which includes variable cost (Rs. 167267) and fixed cost (Rs. 80564). The total cost during bearing period (4^{th} to 15^{th} years only) was Rs. 1260177 with a variable cost of Rs. 669494 and fixed cost of Rs. 590684. The total cost (Cost C_3) of Oil palm and the net returns over Cost C_3 were found as Rs. 1666053 and Rs. 942092 pKer hectare respectively. The increased transportation costs of manures and non-availability of Farm Yard Manure led to the usage of more inorganic fertilizers by sample farmers. The resource use efficiency revealed that manures, fertilizers and annuity of drip system are underutilized whereas; labour and transportation costs were over-utilized.

Conclusion: Benefit-cost ratio on variable costs and total costs was 2.98 and 1.49 respectively at 7 per cent which determines that the oil palm cultivation is financially more viable and best suited for rich, large land owning farmers. IRR was 26.01 per cent at which NPV becomes zero. The NPV, BCR and IRR revealed that oil palm cultivation was economically viable in Andhra Pradesh.

Key Words: *Cost concepts, Feasibility analysis, Oil palm and Resource Use Efficiency.*

INTRODUCTION:

Oil palm is the highest edible oil yielding plant among perennial oil crops thus considered as golden palm. Two types of edible oils are extracted from oil palm. One is from the mesocarp of the fruit (known as crude palm oil) and the other is from Kernel (known as palm Kernel oil). Both these oils have edible value and are in great demand. Oil palm is low maintenance, high yielding crop but water guzzler requiring over 300 liters of water per tree per day. That's the reason it is grown mostly in Malaysia and Indonesia where it rains throughout the year. It starts yielding from the third year of planting. Mean while farmers raise intercrops for income generation during the pre-bearing period [1]. Globally, 729 lakh tonnes of palm oil was produced in 2020-21 among which Indonesia and Malaysia are the two major countries contributing 60 per cent and 24 per cent share of palm oil production respectively [2]. On the other hand, the world's major consumers and importers of palm oil are India, China, the European Union (EU), the United States (USA), Pakistan, Bangladesh, Nigeria, Philippines, and other countries [3]. Palm oil is used globally, with Malaysia being a major exporter, selling to over 150 countries worldwide. This global acceptance of palmoil is due to its competitive price vis-à-vis other oils and its suitability in various food applications such as frying, specialty fats, margarines, shortenings, vegetable ghee *etc*., [4] and also its production has been increasing by 9% every year in tropical regions [5]. In 2019, India ranked 17th among all the countries in crude palm oil production with 2.55 lakh tonnes (3.54 lakh ha). Among all the states (28 states) and Union terretories (8 UTs) of India, the leading producer of palm oil is Andhra Pradesh contributing 2.08 lakh tonnes of palm oil (81.77%) grown in an area of 1.75 lakh ha constituting 49.59 % to total area of country [6]. In 2020-21, 1.79 lakh ha of Oil palm cultivation have been covered under 8 districts of Andhra Pradesh [7] i.e East Godavari, Krishna, Nellore, Srikakulam, Vishakapatnam, Vizianagaram, West Godavari and Anantapuram are the districts in which oil palm is cultivated in Andhra Pradesh. The district wise area under Oil palm and state oil palm production is presented in T*able 1*. From 2015-16 to 2020-21, area under oil palm has increased from 1.49 to 1.79 lakh ha. The oil palm area of India which was 8585 ha in 1991-92, has increased to 3.70 lakh ha in 2020-21. Similarly, production has increased from 0.01 lakh to 2.72 lakh tonnes during the same period (Reports of NMEO- Oil palm).

For the year 2021-22 as on 29 March 2022, oil palm was estimated to be cultivated in an area of 0.91 lakh ha in Andhra Pradesh (3rd Advance estimates, 2021-22).

Table 1: Area and production of oil palm in Andhra Pradesh from 2015-16 to 2020-21

(Area in hectares and production in tonnes)

District/Year	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Srikakulam	3502	3664	3720	3806	3865	3958
Vizianagaram	11557	12034	12220	12597	13026	14101
Visakhapatnam	7394	7833	8010	8223	8355	8552
East Godavari	29025	30431	30960	32024	32983	34900
West Godavari	78427	81984	86480	90226	93992	93835
Krishna	15259	16298	16850	17802	19094	19514
Nellore	4064	4098	4170	4169	878	4336
Ananthapuram	282	282	282	282	282	293
Area- Andhra Pradesh (ha)	**149510**	**156625**	**162692**	**169197**	**172543**	**179489**
Area-India (ha)	**282566**	**316600**	**331476**	**345151**	**354596**	**370000**
Per cent area share of Andhra Pradesh	52.91	49.47	49.08	49.02	48.66	**48.51**
Production (Crude Palm Oil)- Andhra Pradesh (t)	193562	190999	234696	232938	208359	**240016**
Production (Crude Palm Oil) -India (t)	218531	210081	271351	279085	254815	**272000**
Per cent production share of Andhra Pradesh	88.57	90.90	86.49	83.46	81.77	**88.24**

*Note: *- 2nd Advance estimates, t – tonnes, ha - hectares*

Source: Andhra Pradesh statistics from Andhra Pradesh Horticulture department,

India statistics from various issues of Agricultural statistics at a glance, DES-India

The per-capita consumption of vegetable oils in India has increased from 10 kg/year in 2015-16 to 19 kg/year during 2020-21. During the oil year 2020-21 (November 2020-October 2021), India's

imports of edible oils has been the lowest in the last six years. However, in terms of value, it has increased by 63.5 per cent in 2020-21 as compared to 2019-20, reflecting the rise in international prices of edible oils [8]. In this context, India is highly dependent on imports to and oil palm plays a significant role to meet the edible oil requirements (out of 13.13 million tonnes of edible oil import, 63.36 % is contributed by palm oil). The oil palm sector in the recent past has witnessed a period of historically high prices with buoyant global demand especially from India and China [9]. As the domestic demand for edible oil in India has increased to 24.14 million tonnes, the demand-supply gap is met through imports of 13.13 million tonnes (54 % import is contributed by palm oil) and the domestic availability is 11.01 million tonnes [10]. For the year 2020-21, oil palm consumption was nearly 8.3 million tonnes accounts for 63.6% of total edible oil consumption in India. Eventhough, cotton and soya oils are widely been used for consumption in USA and western countries, its consumption is comparatively less in Asian subcontinent. Presently, the cotton and soya oils are being extracted from the genetically modified seed which is making the consumers non-preferable eventhough the negative effects on health were not scientifically proved. Thus cotton, soya oils being produced in India may be shifted for non consumption purposes like cosmetic preparation and gap arised may be corrected by producing more palm oil [11]. The area and production of Oil palm in India recorded a steady growth (F*igure 1*)

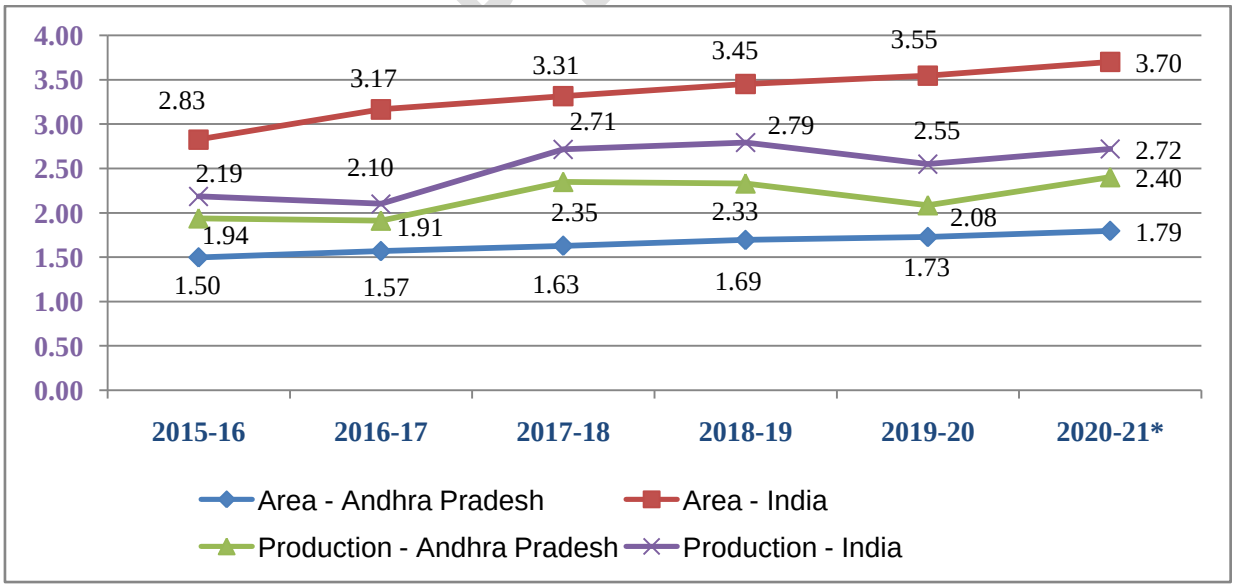

Figure 1: Area (in ha) and production (in tonnes) of Oil palm in India and Andhra Pradesh State

India imports about 8.3 million tonnes of palm oil, of which nearly half comes from Indonesia followed by Malaysia (3.8 million tonnes) and Thailand (0.5 million tonnes). In order to reduce the dependency of import on edible oils and save foreign exchange, the government has taken a series of steps to increase palm oil production like Oil Palm Development Programme (OPDP) during 1999-2000 under the "Technology Mission on Oil Seeds and Pulses (TMOP), Integrated Scheme of Oil Seeds, Pulses, Oil Palm and Maize (ISOPOM) in 2004-05. Later during 2014-15, Mini Mission-II under National Mission on Oilseed and Oil Palm (NMOOP) was announced. But factors such as water shortage, impact on groundwater, small landholdings and long gestation period have discouraged its large scale adoption [12]. In the year 2019, the Government of Andhra Pradesh has launched Rythu Bharosa Kendras (Farmers Assurance Centre) to bring-in transparency and ensure quality of services to the famers. The delivery of farm inputs (seeds, persticides, fertilizers) through Kiosk mechanism is one such service being rendered to the farmers. In April 2021, the state government with AP Oil Federation announced to procure Fresh Fruit Bunches (FFB) at Rs. 16,400 per ton. Also, the centre continued to push for a substantial increase in the area under oil palm cultivation and came up with National Mission on Edible Oils-Oil palm (NMEO-OP) very recently in August 2021 targeting to achieve 10 lakh ha by 2025-26 with a production of 11.2 lakh tonnes from the present level of 2.55 lakh tonnes and up to 28 lakh tonnes by 2029-30 with a special focus on northern region and Andaman and Nicobar Islands. The mission also provides planting material assistance from Rs. 12000 to Rs. 29000 per ha. After the government initiation of the oil palm mission to reduce dependancy on oil imports, the leading companies like Godrej Agrovet and 3F Oil palm considering investing about 500 crores each over the next five years for the expansion of oil palm cultivation in Arunachal Pradesh, Karnataka and Andhra Pradesh [13]. Also, the potential area identified for oil palm in India is 48.25 lakh acres in Andhra Pradesh, Arunachal Pradesh, Andaman and Nicobar, Assam, Chhattisgarh, Karnataka, Odisha, Tamil Nadu, and other north-eastern states. With the NMEO-OP mission, if the potential area is planted, India can increase palm oil production from the existing 2.81 lakh tonnes to 9.65 lakh tonnes which is nearer to our imports [14]. However, the proposed oil palm expansion is also confronted by important challenges that require attention such as the conversion of tropical rainforest and peat lands.

Low capacity utilization, sickness are the two other problems faced by oil mills and solvent extraction units [15]. Due to low capacity utilization of existing processing industries coupled with the low production of oilseeds led to the increase the dependency of vegetable oils tremendously by India and spending 46.5 per cent value of total agricultural imports (Rs. 1,47,445 crores in 2019-20) [6]. The increase in demand for edible oil coupled with reducing imports due to disruption in the supply chain network with the effect of covid-19 has led to a steep rise in the prices of edible oils. The price of palm oil has increased from Rs. 70 per kg in January 2019 to Rs. 158 in May 2022. To soften the prices of edible oils, the duty on Crude Palm Oil (CPO) has been cut to 5.5 percent from the earlier 8.25 percent and refined palm oil/Palm olein has been reduced to 13.75 percent from 19.25 percent on 13th February, 2022. Import of crude palm oil decreased by 22.82 per cent from December, 2021 to January 2022. Prices have crossed the higher level which was last hit during covid 2021. Prices moved upwards reacting to the news of tension between Ukraine and Russia. Demand for palm oil expected to increase as sunflower oil exports from Ukraine is affected. India imports its half of its palm oil from Indonesia unfortunately it has announced suspension of all cooking oil and raw material exports from 28th April, 2022. This has flared up prices in the Indian edible oil market, which is already under inflation. Recently, Indonesia lifts its palm oil export ban from from May 23, so the situation is likely to improve. In view of this, providing the status and put forthing of policy for oil palm cultivation felt important.

1. MATERIALS AND METHODS:

The present study was based on primary data collected from 8 oil palm growing districts of Andhra Pradesh namely East Godavari, Krishna, Nellore, Srikakulam, Vishakapatnam, Vizianagaram, West Godavari and Ananatapur. From each district, based on area proportionality 60 oil palm growers were selected. Data was collected in the year 2021. For calculating the cost of cultivation of Oil palm, data was tabulated and computerized separately for pre-bearing and bearing periods. The first three years include establishment costs and from 4th to 15th year are considered as bearing periods.

2.1 Estimation of Costs and Returns

The cost of cultivation of the oil palm was worked out by using various cost concepts given by Commission on Agricultural Costs and Prices (CACP) viz. Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3 as defined below:

Cost A_1 includes: value of human labour, bullock labour, machine hiring charges, planting material, manures, fertilizers; depreciation, irrigation, land revenue, interest on working capital and other miscellaneous expenses

Cost A_2 = Cost A_1+ Rent paid for leased in land

Cost B_1 = Cost A_1+ Interest on value of owned fixed capital assets

Cost B_2 = Cost B_1+ Rental value of owned land + rent paid for leased in land

Cost C_1 = Cost B_1+ Imputed value of family labour

Cost C_2 = Cost B_2+ Imputed value of family labour

Cost C_3 = Cost C_2+10% of Cost C_2 for the managerial functions performed by the farmer

Income measures namely gross margin, family labour income, net returns and farm investment income were computed using the following formula.

Gross margin/Farm business income = Gross returns - Cost A_1

Family labour income = Gross returns – Cost B

Cost B includes Cost A_1, Rental value of owned land and Interest on owned capital assets

Net returns = Gross returns – Cost C_3

Farm investment income = Farm business income – Value of family labour

2.2 Financial Feasibility Analysis

The life of oil palm was assumed to be 25 years. However, for computing costs and returns per hectare of oil palm-based on the opinion of sample producers the economic life was considered as 15 years. In this study, the financial returns of oil palm was estimated by considering the financial aspects like income on oil palm and income on intercrop. The costs taken into account were establishment cost, input cost and labour cost.

2.3 Evaluation of investments

Discounted cash flow technique was employed in evaluating long term projects in agriculture. These measures are advocated as tools or aid to evaluate and find out the worthiness of an investment, especially those of long term projects. The measures used in the analysis are Net present value (NPV), Benefit-cost ratio (BCR) and internal rate of return (IRR).

2.3.1 Net Present Worth/Value (NPV)

The net present worth is simply the present worth of the net benefit of a project discounted at the opportunity cost of capital. The criterion ranks the alternatives. Generally, the higher the net present worth better would be the preference. In computing net present worth, the difference between the present value of cost and benefits was discounted at 7 per cent, as this is the present prevailing bank rate of interest on working capital.

NPW = Present worth of benefits – Present worth of costs

$$NPW = \sum_{i=1}^{n} \frac{n_t - c_t}{(1+i)^t}$$

Where, B_t = Benefits in each year

C_t= Costs in each year

t = 1, 2, 3…….n (based on year of establishment)

n = Number of years = 15

i = Discount rate = 7 per cent

To select the project or to consider the worthiness of project investment, the net present worth should be positive.

2.3.2 Benefit-Cost Ratio (B-C ratio)

It is the ratio of discounted cash inflows and cash outflows which must be unity or more for an enterprise to be considered worthwhile. The minimum ratio required is 1:1, which indicates the coverage of costs without any surplus benefits. But, usually the ratio should be more than unity to provide some additional returns over the costs for a clear decision.

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

$$BCR = \frac{Present\ \ worth\ of\ benefits}{Present\ \ worth\ of\ costs}$$

2.3.3 Internal Rate of Return (IRR)

The internal rate of return is the rate of return that equates the present worth of benefits to the present worth of costs, which means the net present worth is zero. This represents the average earning capacity of an investment from the project.

IRR $=\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$ or NPW= 0

The internal rate of return is arrived at by interpolation technique by using different discount rates to see that the net present worth is equated to zero.

IRR = $[lower\ discount\ rate] + \left[\begin{matrix} difference\ between\ the \\ two\ discount\ rates \end{matrix}\right] \times \left[\begin{matrix} \frac{Net\ present\ worth\ of\ the\ cash\ flow\ at\ lower\ discount\ rate}{absolute\ difference\ between\ net\ present\ worths\ of\ the\ cash\ flow\ at\ the\ two\ discont\ rates} \end{matrix}\right]$

The internal rate of returns also ranks the different investment proposals for preference in the order of magnitude. The IRR should be more than the discount rate to be considered for viable investment and financial soundness.

2.4 Resource Use Efficiency

We used Cobb-Douglas production function to assess resource use efficiency following the methods [16]

$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} e^u$

Where,

Y = Total return from oil palm production
X_1 = Total cost of labour
X_2 = Total cost of manure
X_3 = Total cost of fertilizers
X_4 = Total transportation costs
X_5 = Annuity of drip system
a = Intercept
e^u= Error term

b_1, b_2, b_3, b_4 and b_5 are the regression coefficients to be estimated.

The level of resource use efficiency was calculated using following formula:

$r = \frac{MVP}{MFC}$,

Where, r = Efficiency ratio

MVP = Marginal Value Product; which is the value of incremental unit of output resulting from the additional unit of inputs.

MFC = Marginal Factor Cost which is equal to one since both dependent and explanatory variables are converted to monetary value, and is defined as the increase in the cost of inputs due to purchase of additional units of inputs.

Decision rule:

r= 1; Efficient use of resource

r>1; Underused of the resource

r<1; Overused of the resource

2. RESULTS AND DISCUSSION:

The cost of cultivation of oil palm during the pre-bearing phase is presented in *Table 2*. It showed out that of total variable costs in the first year of the plantation, major expenditure was incurred on drip system followed by manures, human labour, machine hiring charges, fertilizers and planting material with 30.89, 25.19, 19.61, 6.00, 5.57 and 3.45 per cent respectively. During the pre-bearing phase, the major expenditure of variable cost was incurred on manures, human labour, drip system, the annuity of drip system and fertilizers with 29.99, 20.26, 17.74, 12.18 and 10.11 per cent respectively.

The operations such as land preparation, digging of pits, planting, *etc*., utilized more human labour and hence the expenditure incurred on human labour was higher in the first year of establishment of oil palm plantation. The total cost during pre-bearing period was Rs. 247831.00 per hectare which included variable cost (Rs.167266.64) and fixed cost (Rs.80564.36). The intercrop cost was Rs. 143178.49 (most of the sample farmers grow maize and pulses as inter crop). The same results in some studies, wherein major cost was incurred on planting cost, irrigation, manures, fertilizers and plant protection chemicals [17].

The details in T*able 3* reveales the cost of cultivation of oil palm per hecare during the 12 years bearing period (4^{th} year to 15^{th} year). Ingeneral, the bearing period of oil palm is from 4^{th} year to 25^{th} year. The total cost during the bearing period was Rs. 1260177 with a variable cost of Rs. 669493.5 and fixed cost of Rs.590683.5. In oil palm cultivation, manures play a vital role in conserving moisture, soil quality and also improve the organic nutrients in the soil. But, the per cent share of manures during bearing period with the total variable cost has decreased from 35.37% to 26.42% and fertilizers has

increased from 8.28% to 10.10%. In one of the study, 88.8% of farmers utilize inorganic fertilizer obtained from government though they claimed that fertilizer supply is always untimely for their operations [18]. This is because oil palm is a gross feeder and requires an adequate supply of fertilizers for growth and yield. As the age of the orchard increase, utilization of manures decreases as the farmers use dried leaves, empty bunches as mulching. The other reason is that, due to the increase in transportation costs (1.60% to 6.34%) and the non-availability of manures, some farmers are replacing manures with inorganic fertilizers. In the same year Government announced the remunerative price for oil palm as Rs. 16400 per ton which led to increase in the rental value per hectare since 2 years which can be noticed from table 3. Due to the increase in Fresh Fruit Bunches (FFB) price per ton from Rs. 9043 in March 2020 to Rs. 17,951 in August 2021, farmers started cultivating oil palm and at present farmers are facing a shortage of saplings. It was observed that many farmers submitted indents to shift to oil palm crop.

Table 2: Cost of cultivation of oil palm during pre-bearing period (1st to 3rd year) in Andhra Pradesh (Rs. per hectare)

Particulars	Year 1	Year 2	Year 3	Total
Variable Costs				
Human labour	12905.75 (19.61)	10341.89 (20.63)	10645.70 (20.74)	33893.34 (20.26)
Machine hiring charges	3948.17 (6.00)	0 (0.00)	0 (0.00)	3948.17 (2.36)
Plant Material	2272.40 (3.45)	358.15 (0.71)	0 (0.00)	2630.55 (1.57)
Manures	16578.64 (25.19)	16670.03 (33.26)	16914.56 (32.95)	50163.23 (29.99)
Fertilizers	3663.01 (5.57)	3887.78 (7.76)	3942.12 (7.68)	11492.91 (6.87)
Plant protection chemicals	407.55 (0.62)	422.37 (0.84)	429.78 (0.84)	1259.70 (0.75)
Transportation costs	1400.49 (2.13)	741.00 (1.48)	741.00 (1.44)	2882.49 (1.72)
Drip irrigation system	20333.04 (30.89)	4662.08 (9.30)	4683.42 (9.12)	29678.54 (17.74)
Annuity of drip system	0 (0.00)	9761.44 (19.47)	10613.59 (20.68)	20375.03 (12.18)
Interest on working capital	4305.63	3279.12	3357.92	10942.68

	(6.54)	(6.54)	(6.54)	(6.54)
Sub Total	**65814.69**	**50123.86**	**51328.08**	**167266.64**
Fixed Costs				
Land revenue	205.00	205.00	205.00	615.00
Rental value of owned land	24700.00	24700.00	29640.00	79040.00
Depreciation	259.35	284.05	293.93	837.33
Interest on fixed capital	32.51	19.56	19.96	72.03
Sub Total	**25196.86**	**25208.61**	**30158.89**	**80564.36**
Total	**91011.54**	**75332.48**	**81486.98**	**247831.00**
Intercrop cost	46327.32	47068.32	49782.85	143178.49

Note: Figures in parentheses indicate per cent to total variable cost, 73% of farmers paid the drip cost in the first year and 30% of farmers paid in installments for 3 years
Source: Survey data

Table 3: Cost of cultivation of oil palm during the bearing period (4th to 15th year) in Andhra Pradesh (Rs. per hectare)

Particulars	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
Variable Costs													
Human labour	11660.87 (24.36)	12172.16 (24.41)	12725.44 (24.54)	12725.44 (24.52)	12725.44 (24.39)	12725.44 (24.08)	12725.44 (25.74)	12725.44 (24.30)	12725.44 (23.26)	14250.91 (22.01)	14374.49 (20.93)	16017.95 (21.93)	**157554.5 (23.53)**
Manures	16929.38 (35.37)	17094.87 (34.29)	17210.96 (33.19)	17210.96 (33.16)	17210.96 (32.98)	17210.96 (32.56)	17210.96 (34.82)	17210.96 (32.87)	17210.96 (31.46)	19053.58 (29.42)	19142.50 (27.87)	19290.70 (26.42)	**211987.8 (31.66)**
Fertilizers	3964.35 (8.28)	4334.85 (8.69)	4431.18 (8.54)	4431.18 (8.54))	4431.18 (8.49)	4431.18 (8.38)	4431.18 (8.96)	4431.18 (8.46)	4431.18 (8.10)	5973.74 (9.22)	6533.15 (9.51)	7372.95 (10.10)	**59197.3 (8.84)**
Plant protection chemicals	444.60 (0.93)	466.83 (0.94)	481.65 (0.93)	481.65 (0.93)	481.65 (0.92)	481.65 (0.91)	481.65 (0.97)	481.65 (0.92)	481.65 (0.88)	733.59 (1.13)	859.56 (1.25)	916.37 (1.25)	**6792.5 (1.01)**
Transportation costs	765.70 (1.60)	1333.80 (2.68)	2260.05 (4.36)	2260.05 (4.36)	2260.05 (4.33)	2260.05 (4.28)	2260.05 (4.57)	2260.05 (4.32)	2260.05 (4.13)	4408.95 (6.81)	4631.25 (6.74)	4631.25 (6.34)	**31591.3 (4.72)**
Annuity of drip system	10964.33 (22.91)	11194.04 (22.45)	11357.06 (21.90)	11391.64 (21.90)	11660.87 (22.35)	12288.25 (23.25)	9087.13 (18.38)	11828.83 (22.59)	14024.66 (25.63)	16106.87 (24.87)	18646.03 (27.15)	20021.82 (27.42)	**158571.5 (23.69)**
Interest on working capital	3131.05 (6.54)	3261.76 (6.54)	3392.64 (6.54)	3395.06 (6.54)	3413.91 (6.54)	3457.83 (6.54)	3233.75 (6.54)	3425.67 (6.54)	3579.38 (6.54)	4236.94 (6.54)	4493.09 (6.54)	4777.57 (6.54)	**43798.6 (6.54)**
Sub Total	**47860.28 (100.00)**	**49858.31 (100.00)**	**51858.98 (100.00)**	**51895.98 (100.00)**	**52184.06 (100.00)**	**52855.36 (100.00)**	**49430.16 (100.00)**	**52363.78 (100.00)**	**54713.32 (100.00)**	**64764.58 (100.00)**	**68680.06 (100.00)**	**73028.61 (100.00)**	**669493.5 (100.00)**
Fixed Costs													
Land revenue	207.48	207.48	219.83	219.83	222.30	222.30	229.71	234.65	234.65	239.59	242.06	242.06	**2721.9**
Rental value of owned land	29640.00	34580.00	34580.00	37050.00	41990.00	45695.00	51870.00	51870.00	56810.00	56810.00	69160.00	71630.00	**581685.0**
Depreciation	303.81	316.16	333.45	343.33	363.09	372.97	407.55	531.05	577.98	726.18	854.62	800.28	**5930.47**
Interest on fixed capital	20.45	20.95	22.13	22.53	23.42	23.81	25.49	30.63	32.51	38.63	43.87	41.69	**346.1**
Sub Total	**30171.74**	**35124.59**	**35155.41**	**37635.69**	**42598.81**	**46314.08**	**52532.75**	**52666.33**	**57655.14**	**57814.40**	**70300.55**	**72714.03**	**590683.5**
Total Costs	**78032.02**	**84982.89**	**87014.40**	**89531.67**	**94782.87**	**99169.44**	**101962.9**	**105030.1**	**112368.5**	**122578.9**	**138980.6**	**145742.6**	**1260177**
Yield per ha	**12.23**	**16.15**	**18.01**	**20.06**	**22.80**	**22.33**	**24.82**	**25.49**	**25.39**	**25.61**	**25.14**	**25.89**	**265.92**
Price per ton	**7500**	**7500**	**7500**	**8200**	**8500**	**8500**	**9100**	**9100**	**9500**	**9500**	**16400**	**16400**	**9808***

Note: Figures in parentheses indicate per cent to total variable cost
** Average price received in the study area over the year.*
Source: Survey data

The findings of *Table 4* indicate that the overall per hectare cost of Cost A_1 and A_2 of Oil palm in Andhra Pradesh was found to be Rs. 846864.9 (50.83%) and Rs. 1012045.9 (60.75%) respectively in which Cost A_1 includes fixed & variable costs and Cost A_2 includes Cost A_1 plus rent paid for leased in land. In sample farmers, the tenancy agreement is made between owners and tenants to share the produce in a ratio of 60:40 or 50:50 respectively or a fixed amount is paid to the owner as rental value which is added to Cost A_2. Cost B_1 and B_2 of Oil palm in Andhra Pradesh were observed to be Rs. 847283.0 (50.86%) and Rs. 1508008.0 (90.51%) respectively. The rental value of owned and leased in land were included in Cost B_2 and in Cost B_1 interest on owned capital assets was added to Cost A_1. Imputed value of family labour was accounted in Cost C_1 and C_2 to give a realistic picture of the total costs incurred. The imputed value of family labour was calculated and was 3.44% of total human labour. The Cost C_3 for oil palm growers in the sample area was Rs. 1666053.2.

Table 4: Cost concepts of oil palm cultivation (15 years grown plantations) in Andhra Pradesh

Cost	Rs. per hectare	% share with respect to Cost C_3
A_1	846864.9	50.83
A_2	1012045.9	60.75
B_1	847283.0	50.86
B_2	1508008.0	90.51
C_1	853868.8	51.25
C_2	1514593.8	90.91
C_3	1666053.2	100.00

The cost-return structure and income measures of oil palm cultivation per hectare for 15 years is presented in *Table 5* which showed that gross return was Rs. 2608145.32 which majorly depends on the price of FFB per ton. The net returns of oil palm per hectare were Rs. 942092.10 which is a measure of profitability and the gross margin was Rs. 1761280.41 which indicates that oil palm cultivation was profitable in the study area [18]. Cost of production of FFBs per ton was Rs. 6265.24. The family labour income which represents return over Cost B was positive with Rs. 12653183.29 and farm investment

income in which the value of family labour is removed from farm business income was positive with Rs. 1758614.41. As the study analyzed the feasibility of oil plam cultivation by using 15 years precceding data thus, the average price per ton was computed as Rs. 9808.00. More net returns can be expected in succeeding period because the government of Andhra Pradesh spent an amount of 80 crores and declared the remunerative price as Rs. 16400 per ton for oil palm fresh fruit bunches (FFBs) from 2019 onwards [19].

Table 5: Cost-return structure and income measures of oil palm plantation in Andhra Pradesh

S.No	Particulars	Costs
1	Labour costs	229869.76
2	Material costs	552149.06
3	Variable costs	836760.14
4	Fixed costs	671247.89
5	Total cost (C_3-Cost of cultivation)	1666053.22
6	Yield (in tonnes)	265.92
7	Price (Rs./ton)	9808.00
8	Gross returns / Farm business income	2608145.32
9	Net returns	942092.10
10	Gross Margin	1761280.41
11	Family labour income	12653183.29
12	Farm investment income	1758614.41
13	Cost of Production (Rs./ton)	6265.24

Source:survey data from 1st to 15th year of cultivation.

The economic viability of oil palm cultivation was tested using NPV, BCR and IRR. The results show that NPV was highly positive with Rs. 495134.79 per ha at 7 per cent discount rate indicating that oil palm cultivation was economically viable and financially feasible. This is in line with the study [20] stated that oil palm is feasible and profitable even at 30 percent discount rate. Benefit-cost ratio on variable costs and total costs was 2.98 and 1.49 respectively at 7 per cent which determines that the oil palm cultivation is financially more viable and best suited for farmers having own lands who can wait for 5

years before making profits. IRR was 26.01 per cent which was 3 times the cost of capital indicating the profitability of oil palm cultivation (*Table 6*). Similar findings were observed in some studies [21] in which benefit-cost ratio was 1.166 even at a higher discount rate of 24 per cent and IRR was calculated at 39.19 per cent. All the financial viability measures indicated that oil palm cultivation is a profitable proposition to the sample farmers in study area.

Table 6: Economic viability of oil palm cultivation in Andhra Pradesh

S.No	Particulars	Cost of capital (7%)
1	NPV (Rs./hectare)	495134.79
2	BCR on Variables costs	2.98
3	BCR on Total costs	1.49
4	IRR (%)	26.01%

The major resources used in oil palm cultivation are manures, fertilizers, labour, annuity of drip system and transportation cost. The Coefficient of determination (R^2) was 0.632 and showed increasing rate of returns with a production function as follows:

$$Y = 12.049\ X_1^{0.002} X_2^{0.852} X_3^{0.02} X_4^{0.002} X_5^{0.252}$$

The results of resource use efficiency (*Table 7*) revealed that manures and annuity of drip irrigation system were under-utilized whereas, labour, fertilizers and transportation costs were over-utilized. This was due to an increase in wage rate of laborers mainly due to the COVID-19 outbreak. The reorganization of resources as per the analysis may give the farmers better returns to scale.

Table 7: Estimation of Resource Use Efficiency (r) using Cobb-Douglas production function

Variables	Coefficient	MVP	MFC	r	Interpretation
Labour cost (X_1)	0.002	0.03	1	0.03	Over utilized
Manures (X_2)	0.852	9.22	1	9.22	Under utilized
Fertilizers (X_3)	0.020	0.82	1	0.82	Over utilized
Transportation cost (X_4)	0.002	0.16	1	0.16	Over utilized
Annuity of drip system (X_5)	0.252	3.99	1	3.99	Under utilized

CONCLUSION:

The total cost during the pre-bearing period (initial 3 years) was Rs. 247831 per hectare which includes variable cost (Rs. 167267) and fixed cost (Rs. 80564). The total cost during bearing period (4^{th} to 15^{th} years only) was Rs. 1260177 with a variable cost of Rs. 669494 and fixed cost of Rs. 590684. The utilization of manures during the bearing period has decreased from 43.49% to 25.80% and fertilizers had increased from 8.28% to 10.10% due to the increase in transportation costs (1.60% to 6.34%) and non-availability of manures; farmers replacing manures with inorganic fertilizers. Cost C_3 of Oil palm in Andhra Pradesh was found to be Rs. 1666053 per hectare and net returns over Cost C_3 was Rs. 942092 per hectare. Cost-return structure results showed that oil palm cultivation was profitable in the study area. Farm income measures revealed that family labour income and farm investment income of Oil palm in Andhra Pradesh was Rs. 12653183.29 and Rs. 1758614.41 per hectare respectively. NPV, BCR and IRR revealed that oil palm cultivation was economically feasible and financially profitable. Benefit-cost ratio on variable costs and total costs was 2.98 and 1.49 respectively at 7 per cent which determines that the oil palm cultivation is financially more viable and best suited for rich, large land owning farmers. Resource use efficiency showed that manures, fertilizers and annuity of drip system are underutilized whereas labour and transportation costs were over-utilized. Way forward in the form of policy options for the sustainable development of in this regard may include:

1. As the farmers are replacing manures with fertilizers like urea, the state government may include neem cake and other manures in Rythu Bharosa Kendra (RBK) Kiosk bookings.
2. As the fruit bunches must be shipped for primary processing just after plucking, there is a need to strengthen the domestic oil processing industry by raising capacity utilization from the existing 60% and setting up of new processing units closer to the farm gate may be done to facilitate immediate processing of bunches.
3. Proper measures need to be taken up to bear the transportations costs of fresh fruit brunches by companies with government assistance.

4. Oil palm crop is best suited and more economical for large farmers and farmers associated with industrial enterprises. Thus, In addition to promoting oil palm cultivation in a huge way, policy makers should recognize the need to produce traditional oil seeds and encourage the small and medium growers to cultivate groundnut, mustard, sesame, sunflower, safflower *etc*., to meet the domestic needs and exports.
5. As per the Central Government's initiative of bringing oil palm cultivation under an area of 10 lakh ha and with a production target of 11.20 lakh tonnes by 2025-26 is been well appreciated and if achieved will nullify the burden of imports on exchequer. This will not only improve self self sufficiency of edible oils in India but can achieve well deserved crop diversification in irrigated tracts.
6. The biological and managerial tools to surmount the challenges projected by the new expansion of cultivation initiative by Government of India, need more focused application with a developmental ecological balance mode, so that increased palm oil output could be more than beneficial to meet the highest projections for future vegetable oil requirements while minimizing adverse environmental consequences.

COMPETING INTERESTS:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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