



# **A Survey of Status and Prospect of Oil Palm Cultivation in, Arunachal Pradesh, India**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **Abstract**

Oil Palm has been a highly controversial crop around the world. It has been introduced massively in the South-East Asia because of its economic profitability. However, it has also been criticized by various scholars for its negative environmental consequences. India has been the major consumer of palm oil over the years and more than 90% of its need is met up through imported source. Thus, in order to become self-sufficient, Indian government has been promoting expansion of oil palm cultivation. In the mean time oil palm has been introduced in Arunachal to meet the above target among others. The objective of this article is to analyze the geo-temporal trend of the oil palm cultivation in the study area and analyze the productivity of oil palm by accounting the yield per hectare. Thus, method such as trend analysis and descriptive statistics has been used to analyze the data collected. The data has been collected from both primary and secondary sources. Further, the result of the study suggest that the growth rate of oil palm has been declining ever since its

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inception. However, the actual growth has been in rise though the rate has declined. Furthermore, the study suggest that the productivity of the oil palm in study area has been much lower than the global average. But, the low productivity in this case is because of more than two-third of the area under oil palm in the study area is still under the juvenile phase of cultivation. Therefore, we conclude that the growth rate of oil palm is expected to be slow but the productivity is expected to increase, with the increase in production as the oil palm cultivation matures over the time. Further the study suggests that increasing yield, maintaining price stability, market access and implementing RSPO standards are the important factors for sustainable oil palm cultivation in Arunachal Pradesh.

**Keywords:** Oil Palm; South-East Asia; Arunachal Pradesh; trend analysis; descriptive statistics.

## 1. Introduction

Tropical palm, known as Oil palm (*Elaeis guineensis*) is native to West and Central Africa. For oil palm to produce at its best, the climate must be right (Abubakar et al., 2021). Daily ideal temperatures are between 27 and 28°C, with monthly maximums of 30-32°C and minimums of 21–24°C (Abubakar et al., 2021). The minimum temperature in the coldest month should be higher than 18°C (Abubakar et al., 2022a, 2022b). At temperatures below 15°C, seedling growth stops, and at temperatures below 18°C the growth also stops (Verheye, 2010). According to Oettli et al., (2018), the air should have a relative humidity of at least 85% and solar radiation should be at least 16 or 17 MJ m<sup>-1</sup>d<sup>-1</sup>. Furthermore, according to Verheye, (2010) and Paterson et al., (2015), oil palms normally require 150 mm of rain per month, with an annual rainfall of 2000–2500 mm and a maximum of 2-3 months of dry spell. Many different types of soils are suitable for the cultivation of oil palm until the soil is well drained (Abubakar et al., 2021). The main growing regions for the crop are low-elevation tropical lowlands, which were formerly covered in dense rainforests and in oil palm plantations, physical soil characteristics are more significant than soil fertility (Verheye, 2010). According to Verheye (2010), soil moisture content and other physical characteristics are more significant than nutrient availability, which may be adjusted with fertilizer application. Flat or gradually sloping terrain is the ideal location for agricultural planting (Abubakar et al., 2022a, 2022b)

Oil palm being a perennial plantation crop with high yielding potential is expected to show varied yield potential at different stages of life cycle, with an increase in age of the plantation yield increases and sustains till 30 years of age. (Latha. et al., 2023). At present oil palm plantation has gained much popularity, mainly in the South East Asia for their economic

profitability and increasing demand in the international market. Indonesia and Malaysia today constitute about 80% of the total oil palm production in the world (Fitzherbert et al. 2008), where over half of the expansion of oil palm between 1990 and 2005 occurred at the expense of forest and where the rate of forest clearance for oil palm is increasing (Koh & Wilcove 2007; Koh & Wilcove 2008). Most of its export is towards two major importing countries (India and China).

India is the second-largest consumer of oil palm in the world. It accounts for 12 percent of world consumption (NEDFi, 2020). It is also the largest importer of oil palm. It has to import almost 97 percent of its requirements for palm oil. In India, most of the available palm oil and its fractions are used for food uses, and some of it is used for non-food uses, such as the production of toilet soaps, cosmetics, rubber and polymer processing, pharmaceuticals, etc. Amongst all the state in India, Andhra Pradesh is the leading palm oil-producing state. Its production accounts for 83 percent of the country's production, followed by distant second and thired in the form of Telangana and Karnataka. Oil palm has been commercially cultivated in India since 1990.

Huge dependence on the imported palm oil led the Government of India to roll out various schemes to increase the area under oil palm cultivation, make India self-reliant and improve the livelihood of the Indian farmers. Therefore, various schemes have been rolled out since 1970s to achieve the above objectives.

In Arunachal Pradesh, oil palm cultivation started in 2012, with the establishment of nursery and office by private corporations in the district of Lower Dibang Valley and East Siang district. Today, Arunachal Pradesh reportedly has around 6500 hectares of standing oil palm cultivation (Department of Agriculture, Government of

Arunachal Pradesh) and the reassessment committee of ICAR-Indian Institute of Oil Palm Research (IIOPR) 2020, has assessed 1,33,311 hectare area to be fit for oil palm cultivation in 11 districts (Changlang, East kameng, East Siang, Lohit, Lower Dibang Valley, Lower Subansiri, Papumpare, Tawang, Tirap, West kameng and West Siang). As of today, Arunachal Pradesh has about 6000 ha, of land under oil palm plantation (Dept. of Agriculture, Government of Arunachal Pradesh).

Overtime the various studies regarding the social, economic and ecological aspect of oil palm has been has been conducted outside the state of Arunachal Pradesh but no such study has been conducted in the state. Thus, the objective of this article is to analyze the geo-temporal trend of the oil palm cultivation in the study area and analyze the productivity of oil palm by accounting the yield per hectare. These could provide guidance to multiple stakeholders, including mill owners, plantations, farmers, and regional governments, interested in improving the status of oil palm cultivation in the state.

## 2. Methodology

### 2.1 Study Area

**Location of the study area:** Arunachal Pradesh, also known as ‘the Land of rising sun’, is located at the easternmost corner of India. It extends between 26°29’N to 29°30’N latitude and 91°30’E to 97°30’E longitude. Arunachal Pradesh is bounded by Bhutan in the west, China in the north, Myanmar in the east and state of Assam in the south. It covers a geographical area of 83,743 sq km, which constitutes about 2.55% of the total geographical area of India. The climate of the state is influenced greatly by the Himalayan Mountains and large variations in altitude across the state. With alpine and tundra climates in the norther part of the state to temperate climate in the middle Himalaya and humid sub-tropical climate with hot summers and mild winters in the sub-tropical belt. The rainfall of Arunachal Pradesh is amongst the heaviest in the country receiving more than 3500 mm in a year. The state receives rainfall over a period of 8 to 9 months excepting in winter. Further, higher regions experience snow fall during winter. The average annual rainfall is 1000 mm in the higher elevations and 5750 mm in the foot hill areas. Average temperatures range from 15°C to 21°C during pre-monsoon, and the monsoon month

temperatures ranges from 22°C to 33°C, and the summer months temperatures sometimes are higher well over 37°C. Besides, the people in Arunachal Pradesh, values forest very highly due to their tribal-cultural affinity. The total forest and tree cover of the state is 666,430.67 sq km, which is 79.33% of the total geographical area (FSI, 2021). Forests in the state can be categorized as tropical, sub-tropical, pine, temperate and alpine with bamboos and grasses common in the degraded forests.

**Table 1. Selected villages from the study area**

Sl. No.	Village	Number of household cultivating oil palm
1	Bilat	4
2	Mirem	6
3	Lingka	4
4	Yagrung	15
5	Yapgo	13
6	Motum	11
7	Sigar	13
	Total	66

*Source: Department of Agriculture, Government of Arunachal Pradesh*

### 2.2 Data Collection and Survey Method

This study is based on the data collected from both primary and secondary sources. The primary data were collected using interviews with the head of the household in December 2024. A total of 57 head of 7 villages of East Siang district were interviewed. Further the secondary data were mainly collected from the State Agriculture Department and the collected data were analyzed using descriptive statistics and trend analysis.

#### 2.2.1 Selection of Study Area

Arunachal Pradesh has 28 districts, 11 of which have been bought under the oil palm plantation scheme by various government schemes. In this study, East Siang would be considered for our case study area because East Siang is one of the first district where oil palm was introduced and further it is one of the largest areas under oil palm cultivation in the state. In East Siang oil palm has been introduced in four circles i.e. Bilat, Mebo, Pasighat, Ruksin, and Sille Oyan (as per Agriculture Department, Govt. of Arunachal Pradesh) and within that there are 46 villages engaged in oil palm cultivation. In this study we have randomly selected 7 villages from across the district for our study purpose.

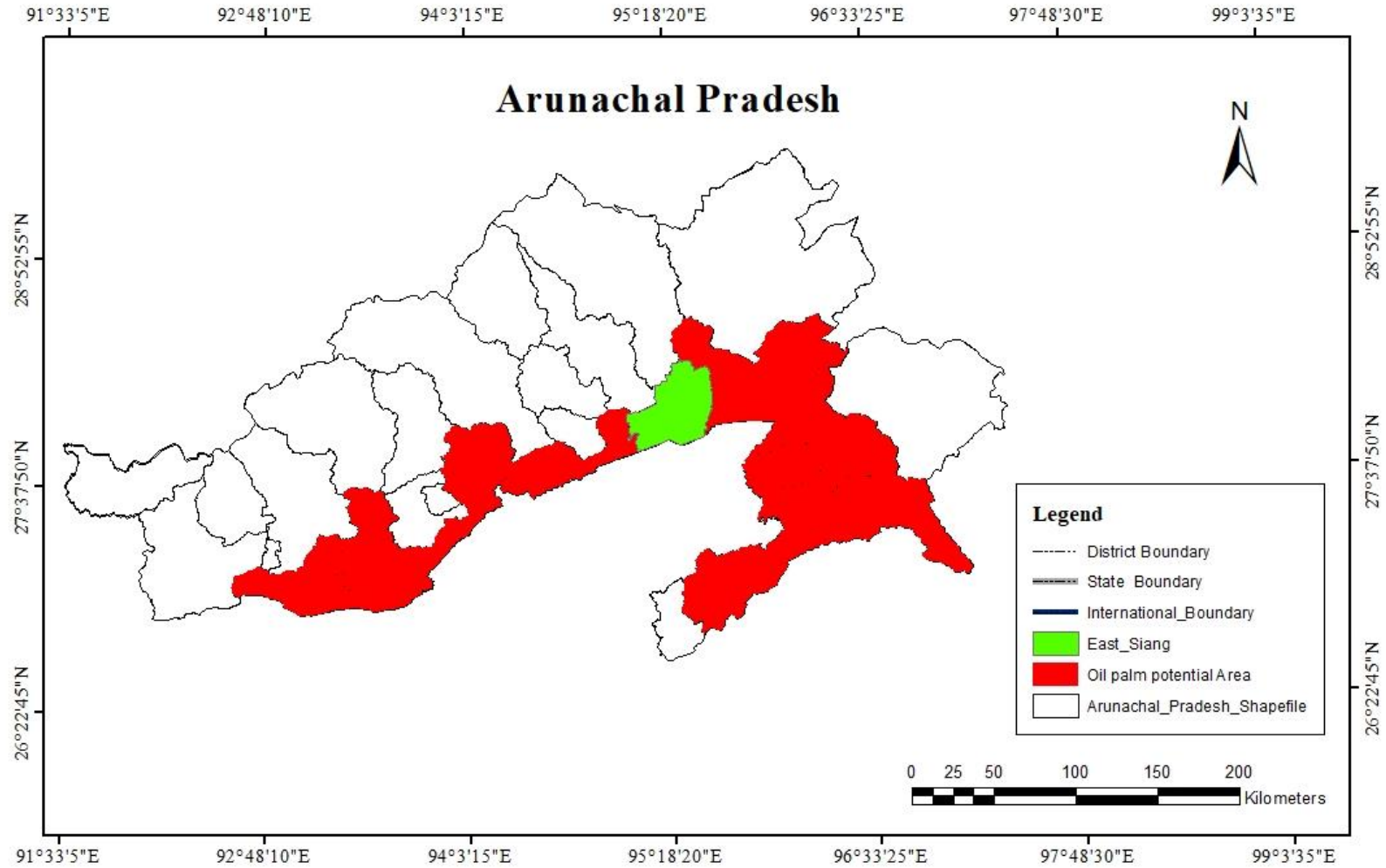


Fig. 1. Location Map of Arunachal Pradesh

## 2.2.2 Sampling Techniques

In this study, we have collected data from the household cultivating oil palm from the selected 7 villages. Therefore, in order to collect the household data, we have used snowball sampling method.

## 2.2.3 Sample Size

The number of households engaged in the oil palm plantation from 2015 until April 2023 has been collected from the Directorate of Agriculture, Government of Arunachal Pradesh, Naharlagun. Though the secondary source, the total number of households engaged in the oil palm plantation in the selected villages has been acquired, i.e., a total 71 households.

To determine an appropriate sample size, three criteria are needed, i.e., the level of confidence or risk, the level of precision, and the degree of variability in the attributes being measured (Miaoulis and Michener, 1976, cited by Israel, 1992).

In this research, the sample size would be calculated using the Taro Yamane method (1967). This method is used to determine the sample size from the given population. The formula is as follows:

$$n = N/[1+N(e)^2]$$

Where  $n$  is the sample size,  $N$  is the population size, and  $e$  is the margin of error.

In this research, a 95 percent confidence level and a margin of error of  $\pm 5$  percent, i.e., 0.05, have been taken. Applying the values in the formula (1):

$$n = 66/[1+66(0.05)^2] = 57$$

Therefore, the sample size ( $n$ ) is 57 households cultivating oil palm at a 95 percent confidence level, and a  $\pm 5$  margin of error will be taken.

## 3. Results

### 3.1 Potential area of oil palm plantation

As of April 2023, Arunachal Pradesh reportedly had around 6500 hectares of standing oil palm cultivation (Department of Agriculture, Government of Arunachal Pradesh), and the

reassessment committee of the ICAR-Indian Institute of Oil Palm Research (IIOPR) 2020 has assessed 1,33,311 hectares of land to be fit for oil palm cultivation, which represents 4.5% of the total geographical area (Table 1). Out of the total ten districts, Lower Dibang Valley (7.69%) and East Siang (6.66%) have the highest potential area suitable for oil palm cultivation.

The latest Oil palm potential area has been identified by the Reassessment Committee of ICAR-IIOPR, 2020 based on various parameter such as under irrigated condition, ground water level, rainfall (annual), minimum temperature and double/triple cropped areas. Further in case of rain fed category, the five parameters viz; rainfall, minimum temperature, elevation, slope, soil depth, and length of continuous dry period were identified to delineate potential regions (ICAR-IIOPR, 2020).

### 3.2 Status of oil Palm Cultivation

As per the Agriculture department of Government of Arunachal Pradesh, as of April 2023 Arunachal has 6437 ha. of its geographical area under oil palm plantation. Expansion of area under oil palm plantation started with various government policies such as Special Program on Oil Palm Area Expansion, National Mission on Oilseeds and Oil Palm (NMOOP), National Food Security Mission (NFSM)-Oilseeds and Oil Palm and National Mission on Edible Oil and Oil Palm (NMEO-OP). These missions were launched with the aim of augmenting the availability of edible oil in the country by harnessing area expansion and increasing crude palm oil production with the aim of reducing the import burden and improving the farmer's livelihood.

The data was collected from Agriculture department of Government of Arunachal Pradesh (from 2015-2023) to analyse the status of oil palm cultivation and changes over the time (Table 1). There has been tremendous change in the total area under oil palm cultivation, from mere 330 ha. in 2015-16 to 6473 ha. till April 2023. The year 2018-19 and 2020-21 has seen the largest growth of oil palm cultivation because of the introduction of government schemes such as, National Food Security Mission (NFSM)-Oilseeds and Oil Palm during 2018 and National Mission on Edible Oil and Oil Palm (NMEO-OP) during 2021 and various benefits attached along with those schemes.

Further, the area of state under oil palm has been divided into four zones, which were assigned to various companies through MOUs. The list of companies which entered into a MOUs with the State Government for oil palm development in Arunachal Pradesh are given as follows:

Recently, two private company has set up their mills in Niglok area of East Siang District by Patanjali Food Ltd. and Roing area of Lower Dibang Valley by 3F Oil Palm Agrotech Pvt. Ltd. to encourage farmers to expand the area under oil palm cultivation.

However, the growth of area under oil palm cultivation has been far below the target

expectation of area under oil palm cultivation. As per the NMEO-OP-2021, area under oil palm cultivation was expected to increase to about 16000 ha. by 2023. In reality only 6437 ha. area was brought under oil palm cultivation till April 2023.

### 3.3 Change in Area under Oil Palm Plantation

As seen in Table 1, the area under oil palm cultivation has grown tremendously since its introduction in the year 2012. However, the growth has not been equal for all the districts, some districts has led the trend of oil palm cultivation in the state (Fig. 2).

**Table 2. Potential area for oil palm in Arunachal Pradesh**

	District	Approx. Potential Area (Ha.)	Geographical Area	percentage
1	Lohit (undivided)	25,000	534400	4.68
2	Changlang	10,000	466200	2.15
3	Tirap	3,500	236200	1.48
4	Lower Dibang Valley	30,000	390000	7.69
5	East Siang (undivided)	24,000	360300	6.66
6	West Siang (undivided)	12,000	240200	5.00
7	Lower Subansiri	8,000	196200	4.08
8	Papum Pare & East Kameng	19,000	474500	4.00
	Total	1,31,500	2898000	4.54

Source: Techno-Economic Feasibility Report (2013-14)

**Table 3. District-wise Coverage of Areas under Oil Palm (2015-23) in Hectares**

District	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	Total
Tirap	5	100	90	40	14	60	30	12	351
Changlang	15	70	70	80	24	60	30	12	361
Namsai	60	150	100	50	15	130	80	12	597
Lower Dibang Valley	50	180	271	380	126	700	28	245	1980
East siang	200	250	307	234	68	500	25	52	1636
Papum Pare	0	0	5	230	35	380	25	41	716
Kamle	0	0	0	65	22	90	30	22	229
Lower Siang	0	0	0	0	50	240	27	22	339
Lohit	0	0	0	80	0	0	25	17	122
Pakke Kessang	0	0	0	0	20	80	20	22	142
Total for Year	330	750	843	1159	374	2240	320	457	6473

Source: Agriculture Department, Govt. of Arunachal Pradesh

**Table 4. Factory zones for oil palm development (Arunachal Pradesh)**

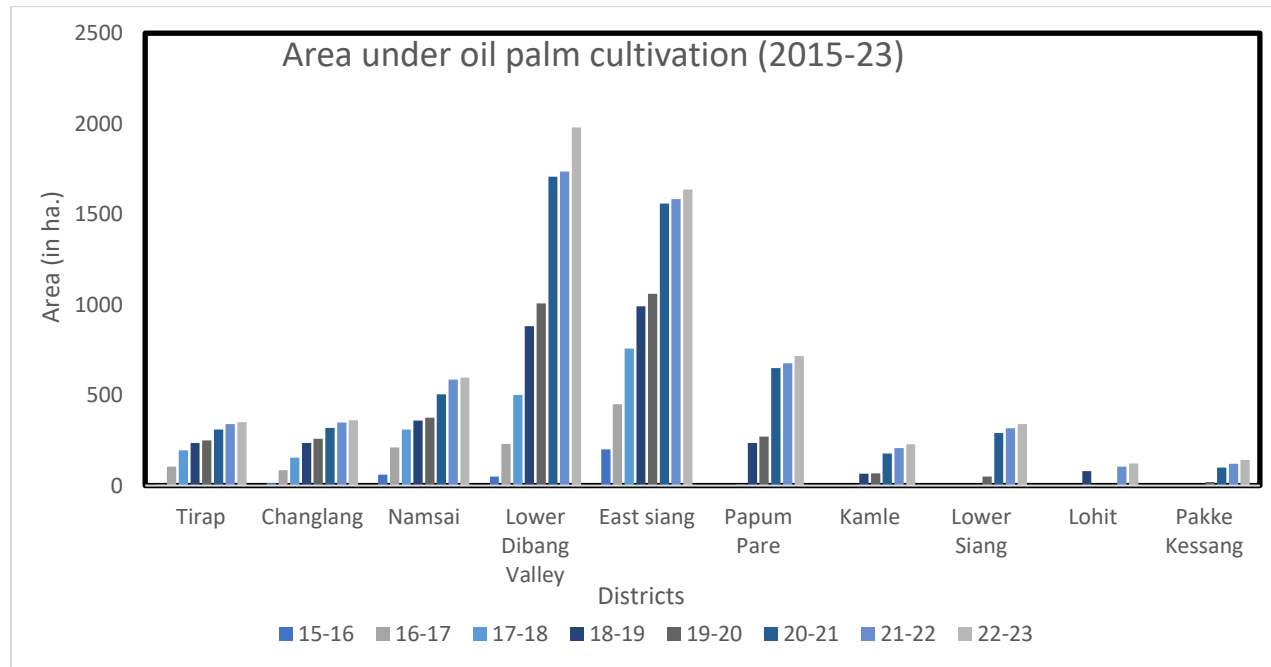
Zone	Districts	Processor Company
1	Changlang, Tirap, Lohit & Namsai	Patanjali Food Ltd.
2	Lower Dibang Valley	3F Oil Palm Agro-tech Pvt. Ltd.
3	East Siang	Patanjali Food Ltd.
4	West Siang, Lower Subansiri, Papumpare & East Kameng	Patanjali Food Ltd.

Source: Department of Agriculture, Arunachal Pradesh

**Table 5. Expected area under oil palm cultivation**

Year	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Area expansion target (in ha.)	1200	1500	1215	1738	1500	2240	2500	4000

Source: NMEOOP-2021



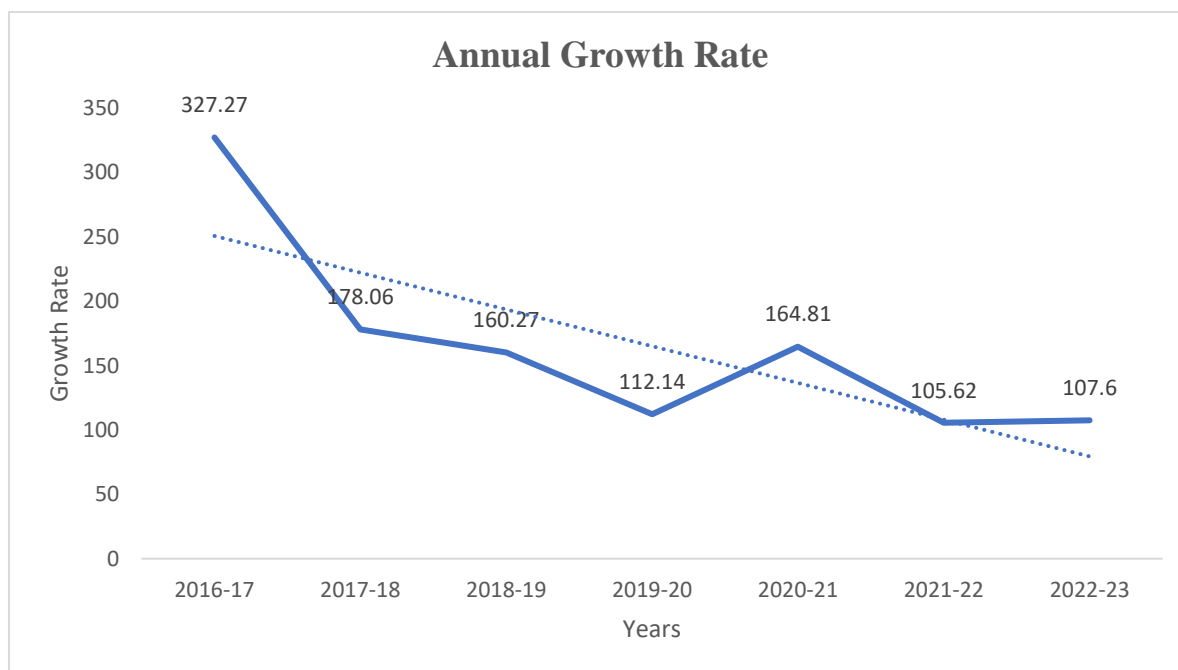
**Fig. 2. District wise growth of area under oil palm cultivation**

Source: Agriculture Department, Govt. of Arunachal Pradesh

**Table 6. Change in Area from 2015-2023**

Year	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Annual Growth Rate (in%)	327.27	178.06	160.27	112.14	164.81	105.62	107.6

Source: Agriculture Department, Government of Arunachal Pradesh



**Fig. 3. Trend graph of Annual growth rate of oil palm cultivation**

Both East Siang and Lower Dibang Valley have been the front runner of the state in oil palm cultivation. This trend have been facilitated due to reasons such as- large oil palm potential area, suitable climatic condition, progressive risk-taking farmers, Governmental schemes and introduction of palm oil mills by private players.

### 3.4 Annual Growth Rate

Table 4 shows that the growth rate of oil palm cultivation have been inconsistent. Initially in 2016-17 it has been there is a massive growth rate of 327.27% because of the low base effect. However as per the Fig. 3, the growth rate did not sustain its momentum and declined continuously for the next three years. A year with a higher annual growth rate than that of the previous one was seen only in the year 2020-21. The positive growth of 2021 was fueled by the introduction of the scheme National Mission on Edible Oil and Oil Palm (NMEO-OP)-2021. The trend of declining growth rate continued thereafter, but this time with much more

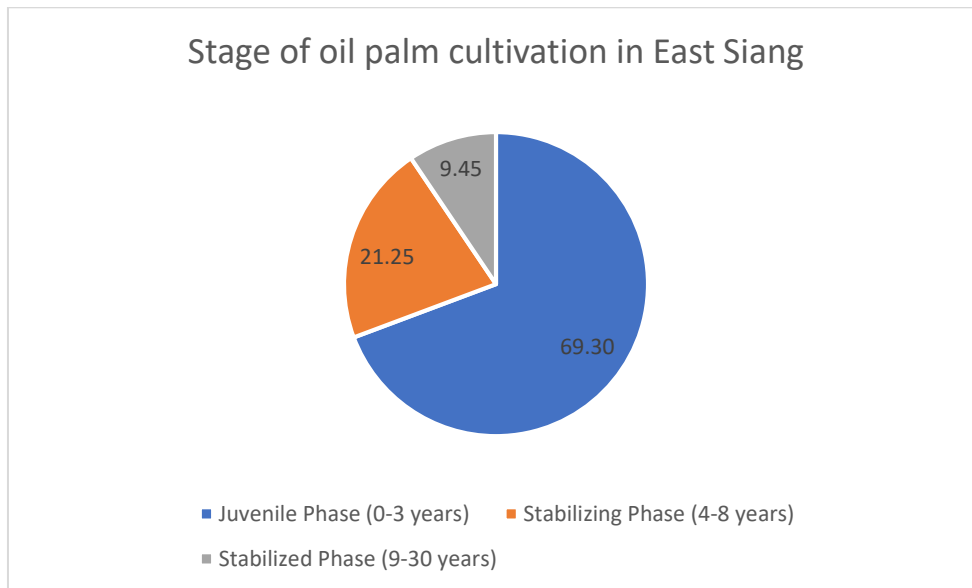
moderate declining trend because to relatively higher base effect.

## 4. Case Study of East Siang District

East Siang district entered the realm of oil palm in the year 2014 (Mongaby, 2022), and as of April 2023, about 1650 ha. of its geographical areas was under the oil palm cultivation. This district is one of the leading areas within the state, which is contributing to the growth of the oil palm cultivation in the state as a whole.

### 4.1 Stage of Oil Palm Cultivation

As per the Fig. 4, 69.3% oil palm cultivation is under juvenile phase, 21.25% under stabilizing phase and only 9.45% under stabilized phase. Therefore, about two-third of the cultivation is not bearing Fresh Fruit Bunches (FFB) and only about one-third of the cultivation is producing FFB and is contributing to the growth of annual production and increasing yield.



**Fig. 4. Stage of oil palm cultivation in East Siang District**

Source: Patanjali Food Limited, Pasighat

**Table 7. Status of oil palm cultivation and production in East Siang**

Sl. No.	Village	Area(ha.)	Production (kg)	Productivity (kg/ha/year)
1	Bilat	3.07	12500	4070.34
2	Mirem	7.88	9780	1241.75
3	Lingka	2.05	1000	488.04
4	Yagrung	3.44	4500	1307.00
5	Yapgo	13.58	5004	368.51
6	Motum	5.72	8000	1398.36
7	Sigar	5.09	1700	334.05
Total		40.83	42484	1040.56

Source: Field survey, 2024

#### 4.2 Area, Production and Productivity of Oil Palm Plantation

Based on the data collected from the field survey of 7 villages in East Siang district, the table-6 shows the village-wise area (ha), production (kg), and productivity of oil palm in 2024. The area of villages surveyed, ranges from 2.05 ha. the lowest to 13.58 the highest. The total area under the oil palm cultivation was 40.83 ha. Total Fresh Fruit Bunches (FFB) production during that year was 42,484 kg with the highest production of 12,500 kg in Bilat village and lowest being 1000 kg in Lingka village. Further in terms of productivity, yield per annum ranges from 334.05 kg/ha in Sigar village to 4070.34 kg/ha in Bilat village.

Data depicts that Bilat village has high productivity and some villages such as Mirem, Yagrung and Motum has moderate

productivity. Whereas, on the other hand there are some villages such as Lingka, Yapgo and Sigar which has very low productivity.

#### 5. Discussion

The inhabitant of the area of the study have traditionally been practicing subsistence-based agriculture with little market access. It was only in last few decades that plantation base agriculture had been introduced in the district, similarly oil palm was introduced in the district during last decade. Further the inhabitant of the area has its culture highly affiliated to the agricultural pattern and their forest and the products obtained from the forest. (S.Roy, 1997). It is only recently that the commercial agriculture in the form of monoculture-based plantation agriculture has been introduced to improve the livelihood standard of the farmers. Oil palm has also been introduced in Arunachal Pradesh by various

government intervention in the form of government schemes.

As per the techno-economic feasibility report, about 1,30,000 ha. of the state's geographical area is potentially suitable for oil palm cultivation. In NMEO-OP-2021, government of India has set the target of expanding area under oil palm cultivation to 1600 ha. by 2023 and 40000 ha. by 2023. However, as of 2023, only about 6,500 ha. of state has been brought under oil palm cultivation, which accounts for about 5% of total potential area. Further, growth of oil palm cultivation is mainly driven by only two districts alone (East Siang and Lower Dibang Valley), both of the district combined together, constitutes about 56% of total geographical area under oil palm cultivation.

As per the trend followed in the growth rate of area under oil palm cultivation in the state, it is clear that the rate of growth has been in decline, ever since the date when oil palm cultivation had been introduced in the state. However, though the growth rate oil palm is declining, the absolute growth of the area under oil palm cultivation has been increasing every single year but with varying degree of growth.

Further, oil palm is currently the world's main vegetable oil crop, is characterised by a very productive and a long-life span (around 25 years) and as Food and Agriculture Organisation (FAO), when provided with modern high-yielding varieties developed by breeding programs, under ideal climatic conditions and good management, are capable of producing in excess of 20 tonnes of bunches/ha/yr. However, in actuality the average productivity was stagnated at around 3 tonnes/ha/year (Woittiez et al., 2017).

In case of the study area, from the case study it can be seen that the productivity of oil palm cultivating villages were highly distinct. It ranged from 4070 kg/ha in Bilat village to 334 kg/ha/year in Sigar village. Overall, the average yield per annum was about 1000 kg/ha/year, which is much below the global average of >20 tone in ideal condition (FAO). Further oil palm is also expected to yield differently in different phase of its growth and it is expected to peak at the matured phase and the yield declines as the age of the plant becomes approximately 18 years (Woittiez et al., 2017). As per this case study about 69% of the oil palm cultivation was under the juvenile phase of its growth stage and is not

contributing to the oil palm yield. Therefore, the yield in the coming years is only expected to grow as most of the oil palm cultivation will enter the maturing phase. The, present study also reveals that the oil palm cultivation in Arunachal Pradesh is highly concentrated in few districts. East Siang and Lower Dibang Valley together constitutes more than 50% of area under oil palm cultivation. Thus, area under oil palm can be expanded over all the district which has been identified as potentially suitable for oil palm cultivation.

The growth of oil palm cultivation is gaining momentum slowly and steadily but it must also be kept in mind that the environmental concern such as destruction of natural forest for conversion to oil palm (Koh & Wilcove, 2007; Koh & Wilcove, 2008), reduction of biodiversity (Mandal and Raman, 2016) has been long linked to oil palm. Therefore, a thorough environmental examination is required before introduction of oil palm into any new piece of land.

## 6. Conclusion

In summary, oil palm in Arunachal Pradesh has been introduced with the help of various government schemes. Oil palm in the state has been introduced to reduce the import dependence and to uplift the livelihood of the cultivating farmers. However, while striving to attain the objective of the schemes, it needs to take care that the environmental concerns are addressed properly. In addition, increasing yield, maintaining price stability, market access and implementing RSPO standards are the important factors for sustainable oil palm cultivation in Arunachal Pradesh.

## Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

## Competing Interest

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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