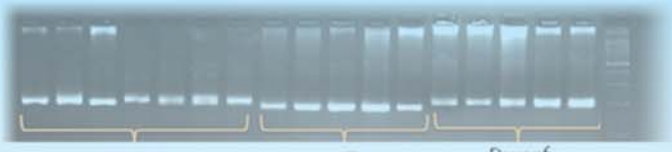
मुख्य अनुसंधान उपलब्धियां

RESEARCH *Highlights*

2015-2020



25 years of Farmers service

भाकृअनुप - भारतीय तेल ताड़ अनुसंधान संस्थान
पेदवेगी - 534 450, पश्चिम गोदावरी जिला, आन्ध्र प्रदेश
ICAR - Indian Institute of Oil Palm Research
Pedavegi - 534 450, West Godavari Dt., Andhra Pradesh
Website: https://iiopr.icar.gov.in

2021
रजत जयंती समारोह
Silver Jubilee Celebrations

RESEARCH HIGHLIGHTS
(2015-2020)

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Pedavegi - 534 450, West Godavari Dt., Andhra Pradesh
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Preface

ICAR-Indian Institute of Oil Palm Research (ICAR-IIOPR) released a number of technologies which help oil palm growers in reducing cost of production by increasing the production and productivity. Recently, Institute also released three high yielding (More than 22.44 - 27.23 t/ha/year) varieties *viz.,* Godavari Swarna, Godavari Gold and Godavari Ratna for Andhra Pradesh, Tamil Nadu and Maharashtra states, respectively. The world class research at this institute bringing more smiles to the farmers by doubling their income through various farmer friendly technologies along with suitable inter-cropping and mixed farming systems. Design and development of molecular markers for fruit form and dwarf trait facilitated marker assisted selection (MAS) for desirable traits at early stage which reduced cost and land. The conventional, molecular and resource use efficient technologies aid to further reduction of cost of production, increasing productivity with an aim to doubling the farmers income. Along with research, IIOPR conducting several capacity building programmes to the farmers, processors, state level agricultural and horticultural officers and Scientists. Efforts are being put for attaining self sufficiency in planting material by establishing clonal seed garden and more seed gardens to meet the demand of oil palm farmers and stakeholders. The present research highlights of the last five years (2015-2020) indicate the remarkable achievements of the institute recognised at the National and International level.

I am confident that ICAR-IIOPR will reach more heights in frontier areas of oil palm research and development.

06-02-2021
Pedavegi

(R. K. Mathur)
Director

Contents

Research Highlights (2015-2020)

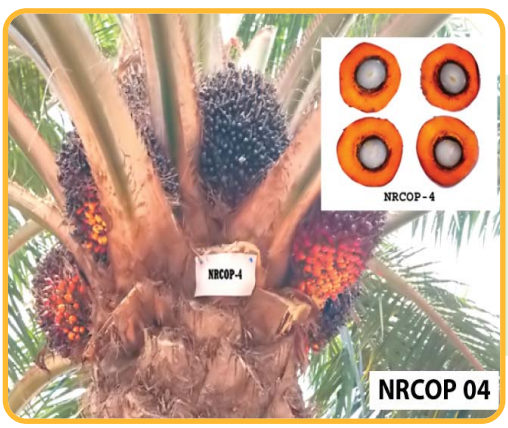
GENETIC RESOURCES MANAGEMENT

Three Oil Palm varieties recommended for release

The XXVIII annual group meeting of AICRP on palms held at TNAU, Coimbatore on 7th June, 2019 recommended release of three hybrids *viz.*, Godavari Swarna, Godavari Gold, and Godavari Ratna developed by ICAR-IIOPR for Andhra Pradesh, Telangana and Maharashtra respectively.

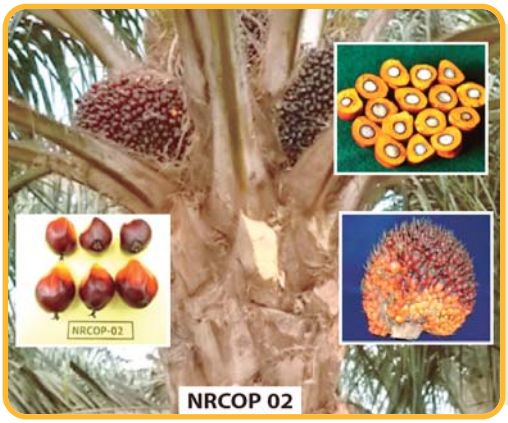
Salient features

- Fresh fruit bunch yield (27.23 t/ha/year)
- More number of bunches/ palm (11.74)
- High sex ratio (0.72)
- Mesocarp oil yield (5.79 t/ha/year)
- Oil/bunch ratio (21.28%)



Salient features

- High yielding (fresh fruit bunch yield, 26.87 t/ha/year)
- High mesocarp oil yield (5.71 t/ha/year)



Salient features

- Fresh fruit bunch yield of 22.44 t/ha/year
- Average bunch weight of 18.31 kg
- High sex ratio (0.70)
- High mesocarp oil yield (5.36 t/ha/year)
- High oil/bunch ratio (24.1%)

Development of high yielding and dwarf dura mother palms

- Eight dura palms (3 from 240D x 281D and 5 from 80D x 281D) recorded FFB yield of more than 220 kg/palm/year were selected

High yielding dwarf dura mother palm

Development of dwarf oil palm

Dwarf germplasm with better bunch index and canopy spread

- A dwarf palm (Palm no. 31) identified with annual height increment of 19 cm and a bunch index of 0.43.
- The mean canopy spread was 61.33 sq.m, which allows 23.76 per cent extra land area, as compared to currently followed spacing of 9x9x9m.
- Yield potential of the selected progeny is 33.01 MT/ha which in turn is equivalent to 6.6 MT oil per ha.

Development of high yielding and dwarf mother palms

- Identified Palm No.33 has a highest yield (181.70 kg), a greater number of bunches (21) and less height increment (18 cm) in comparison to other progenies by taking average (yield: 98.13 kg, no. of bunches: 14, height increment: 32.48 cm) of the same cross.
- Palm No. 47 has a highest yield (221.30 kg) and medium height increment (33 cm) in comparison to other progenies on an average (yield: 103.77 kg, height increment: 31.81 cm) of the same cross. A medium height palm (palm No: 72) having a greater number of bunches (22) with medium height increment (30 cm) in comparison to other progenies (No. of bunches: 15.40, height increment: 31.56 cm) of the same cross.

Palm No. 33

Palm No. 47

Palm No. 72

Dwarf progeny identified with good yield and medium height increment

Development of high oil yielding dura mother palm

- A dura palm (palm no. 35, Zambian source) is identified with highest oil yield (24.53 oil/bunc) thick shelled (7.50) FFB yield of more than 180 kg/palm/year with 20 bunches / year.

High oil yielding mother palm (a) Palm (b) Crown (c) Bunch(d) Spikelets (e) Fruits (f)Fruit cross section

Supply of dwarf planting material to farmers

4400 Dwarf D X P seedling were supplied to farmers for trial

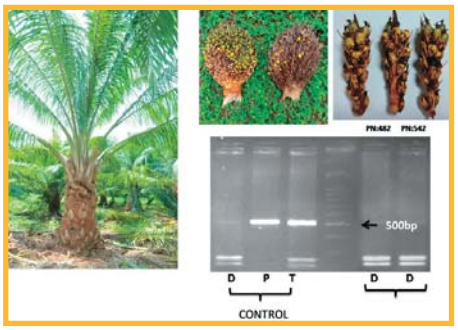
Dwarf DxP crossed seedlings (4400) were supplie d to farmers belongs to dendaluru mandal, nuzuveedu mandal, kamavarapulukota mandal, unguturu mandal, t. narsapura mandal and jangareddygudem mandals of west godavari district.

Identified promising mother palms for hybridization

Identified six promising dura palms in dura improvement plack, Pedavegi, which will be utilized as mother palms in breeding programmes to develop D X D crosses and D X P hybrids.

First report on identification of sterile dura palm

Identified sterile dura palm (No. 482) which has plant height of 140 cm, girth, 320 cm; number of bunches, 1; and average bunch weight, 4.10. Another sterile dura palm (No.542) has plant height of 105 cm, girth, 310 cm; number of bunches, 3; average bunch weight, 7.49. The fruit form of these two sterile dura palms confirmed with molecular markers. These two sterile dura mother palms recorded consistent sterile fruits.



Morphological and molecular chart of dura palm

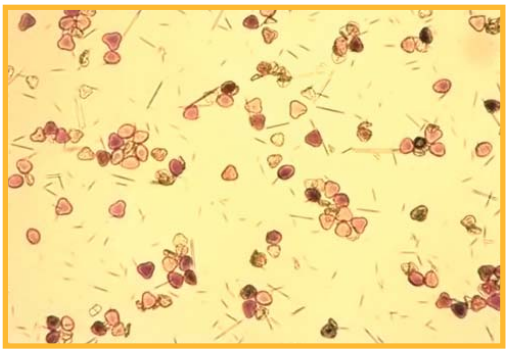
Identification of High yielding virescens dura genetic stock

Registered oil palm germplam

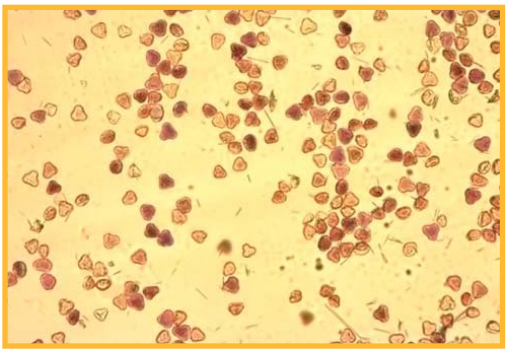
SN	National identity	Botanical name	Identity	INGR No.	Year	Novel Unique T rait(s)
1.	IC0597686	*Elaeis oleifera* (Kunth) Cortés	DOPRG22; Palm no. 45	17082	2017	Slow vertical stem growth (low annual height increment of 15 cm per year). Early fruit maturity (4.5 months) with long and slender bunch stalk. High fruit set of 53.4% than other oleiferas (28.0% to 46.0%).
2.	IC0597687	*Elaeis guineensis* Jacq	DOPR G53 (61)	17083	2017	Virescens fruit colour . Dura fruit forms.
3.	IC0597688	*Elaeis guineensis* Jacq	(DOPRG- 44-E 33)	17084	2017	Long bunch stalk (53 cm).
4.	IC0597689	*Elaeis guineensis* Jacq	DOPRG-54-E65	17085	2017	Sterile Pisifera palm. Virescens fruit.
5.	IC0597690	*Elaeis guineensis* Jacq	DOPR G23-48	17086	2017	Dwarf palm (12 cm annual height increment). High fruit set (69.09%).
6.	IC0597691	*Elaeis guineensis* Jacq	DOPR G21-221)	17087	2017	Slow vertical stem growth (low annual height increment of 25 cm per year). Compact palm with tenera (thin shell thickness of 1.56 mm) fruit form.
7.	IC0635046	*Elaeis guineensis* Jacq	Palm No. 47; IOPPV002 978	20042	2019	High yielding (221.30 kg/palm/year) and medium height increment (33.00cm) mother palms
8.	IC0635047	*Elaeis guineensis* Jacq	Palm No. 33; IOPPV002 964	20043	2019	High yielding (181.70 kg/palm/year), more number of bunches (20.50) and less height increment (18 cm) mother palms
9.	IC0635048	*Elaeis guineensis* Jacq	Palm No. 72; IOPPV003 003	20044	2019	More number of bunches (22.00) with medium height increment (30 cm) mother palms
10.	IC0635049	*Elaeis guineensis* Jacq	Palm No. 542; IOPPV003 721	20045	2019	Sterile Dura. virescence oil palm
11.	IC0635050	*Elaeis guineensis* Jacq	Palm No.482; IOPPV003 661	20046	2019	Sterile Dura. Broad leaf sheath
12.	IC0610027	*Elaeis guineensis* Jacq	Palm No.20; TTD1/DOPRG9 0	20047	2019	Pisifera with 98.5 % sterility. Nigrescence fruit form
13.	IC0610024	*Elaeis guineensis* Jacq	Palm No.47; AND24/DOPR G 87	20048	2019	Parthenocarpic pisifera palm. Good fruit set (68.62 %).

Pollen viability and storage analysis in oil palm

- *Oleifera* pollen which was having11.44 % viability has recorded 73.17 % decline and reached 3.06 % after 4 years of storage.
- With respect to interspecific palms, In case of IS 24, the viability has reduced only by 33 % after 26 months (original viability was 81.15 % and present viability was 53.82%).
- In case of IS48, the original viability of 71.5% was reduced to 49.8% after 19 months of storage, indicating 30 %reduction in viability.
- The results indicated the possibility of extending storage of pollen beyond one year at -20^{0}C.



Interspecific hybrid 24 (after 26 months)



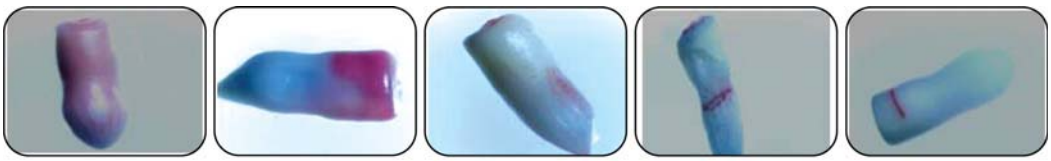
Interspecific hybrid 48 (after 19 months)

Novel method for hybridization in oil palm

- A novel technique has been standardised for controlled pollination in hybrid seed production of oil palm.
- The pollinating weevils (*Elaeidobius kamerunicus*) were sent through a device along with desired pollen to the female flower shortly after anthesis, after proper cleaning.
- A kit was designed to send the weevil along with pollen to the female inflorescence. Weevils along with pollen could reach a height of 22 feet in 6 minutes under controlled condition. Fruit set was normal.
- It opens a new way forward for controlled animated pollination to produce hybrids in plants which can be utilized even in crop improvement programmes.

Standardization of seed viability testing through Tetrazolium in oil palm

- Identified the best concentration and staining pattern in the zygotic embryo of oil palm Dura x Pisifera (D x P) cross through quick test.
- The viability of oil palm zygotic embryo can be tested with tetrazolium (TZ) solution at the concentration of 1% for 5 hours at 30^{O}C under dark condition. The staining colour may vary from bright pink or bright red or brownish red colour.
- The embryo should have a staining pattern in the top portion of embryo facing the operculum.



Various pattern of TZ staining on zygotic embryo

A method to protect the plumule and radicle of Oil palm germinated seeds during transport

- Oil palm germinated seeds are delicate and sometimes 10-20% damage occurs to the plumule and radicle happen during transport.
- To protect the seeds a paste approximately 2mm thickness of sodium alginate was designed to coat the neck of the plumule and radicle.
- It did not break when dropped from 2-3 meters. The paste did not affect the growth of the plumule and radicle of the seeds up to 30 days in the nursery and they were as well as the control seeds in crosses of Dura x Pisifera.

Oil palm germinated seed- a) before coating b &c) after coating

MOLECULAR BIOLOGY AND TISSUE CULTURE

First oil palm microsatellite database (opsatdb) published

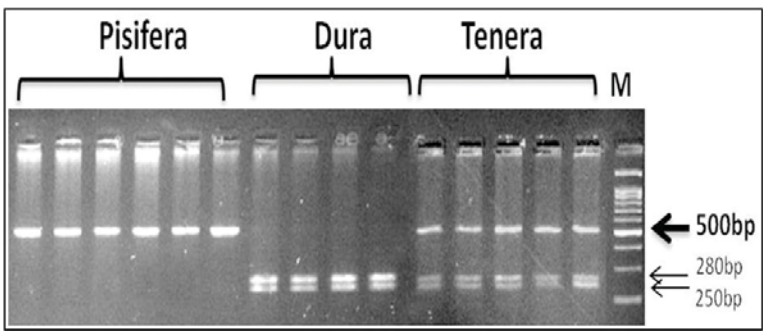
- Found a total of 245,654 SSR repeats across the 16 chromosomesof oil palm, of which 38,717 were compound microsatellite repeats.
- A web application, OpSatdb, thefirst microsatellite database of oil palm, was developed using the PHP and MySQL database (https://ssr.icar.gov.in/index.php).

The webpage of oil palm microsatellite database (OpSardB)

Launching of the database by Hon'ble Secretary, DARE and DG, ICAR

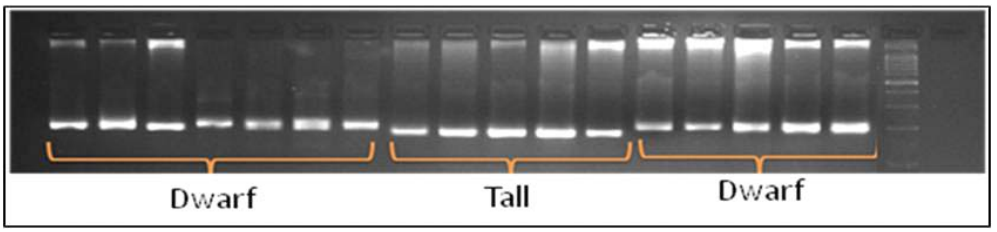
Development of CAPS marker for SHELL trait which governs fruit forms

- Identified one cleaved amplified polymorphic site (CAPS) marker for differentiation of oil palm fruit type
- Produced two alleles (280 and 250bp) in dura genotypes, three alleles in tenera genotypes (550, 280, and 250bp) and one allele in pisifera genotypes (550bp).
- The CAPS marker used in the present study facilitate selection and timely distribution of desirable high yielding tenera sprouts to the farmers instead of waiting for 4-5 years. This saves a lot of land, time and money which will be a major breakthrough to the oil palm community.



Microsatellite marker for identification of dwarf trait in oil palm

- Bulk Segregant analysis resulted in identification of a microsatellite marker which efficiently differentiate the tall and dwarf genotypes
- The marker was validated using genome-wide association study using 400 SSR markers on 320 African germplasm.The Association mapping results also identified that the marker identified earlier also showed association.
- The identified marker which showed similarity to asparagine is related to dwarfing in plants.Therefore,we believe that the gene for asparagine synthase-related protein could be a most possible candidate gene for the tree height in oil palm.



Molecular differentiation of dwarf and tall genotypes using microsatellite marker

Establishment of pure pisifera block

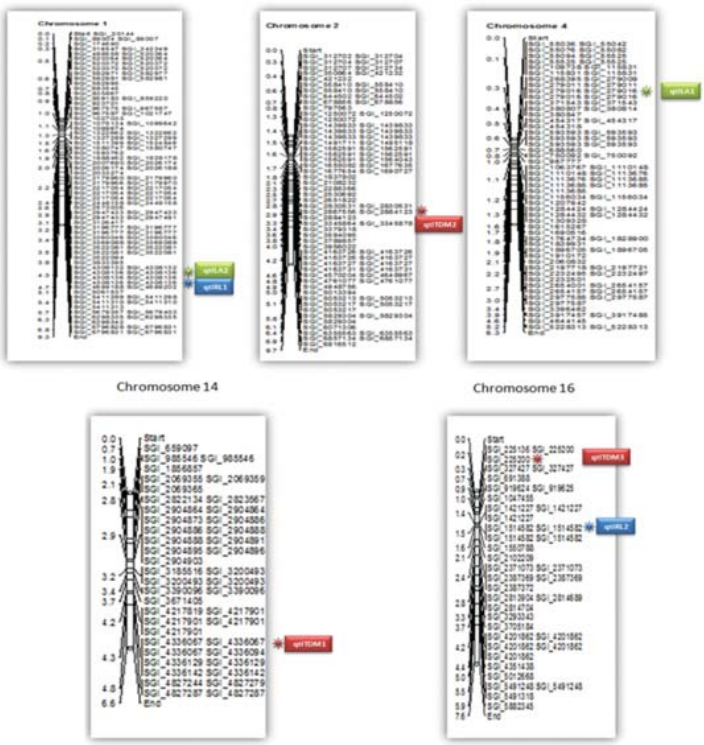
ICAR – IIOPR is proud to develop "Pure Pisifera Block" first of its kind in the World. The pisifera genotypes were identified at an early stage of seedlings through marker assisted selection which reduces time, land and cost.

Pure pisifera block

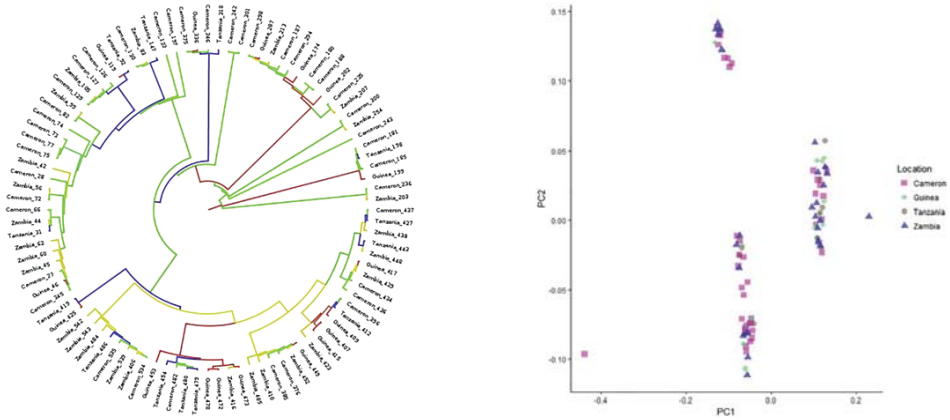
Genome-Wide Association mapping for important yield, oil yield and agronomic traits using Genotyping by Sequencing

GWAS for yield and oil yield related traits

- GBS generated 325 million - reads covering 50.78 Gb of sequence data, with an average of 3.4 million - reads per sample.
- The SNP loci, SGI| 593, 593| linked to QTNOB3 explained high amount of phenotypic variance (25.3%).The nucleotide sequences of linked genetic loci for OB were found to be similar to mitogen activated protein kinase - 5 (MAPK-5) protein which is a nearly fowering protein.
- The clustering pattern was based on geographic origin to some extent. However, there is a mixture of germplasm across the geographic origins. Few genotypes deviated from the three clusters.
- Three QTLs for total dry weight were located on chromosome 2, 14 and 16, all-together explained 40% phenotypic variance.



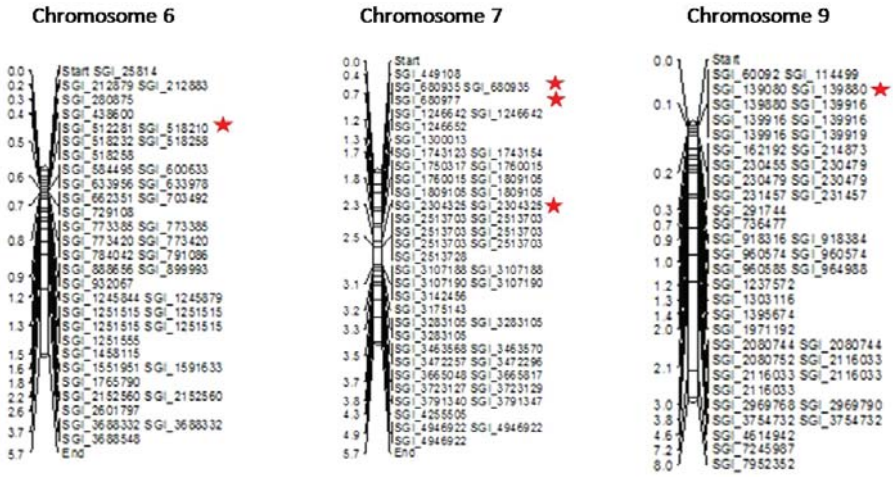
The location of QTLs on oil palm chromosomes.



The Dendrogram and PCA analysis of African germplasm evaluated for GWAS

GWAS for Stem height increment

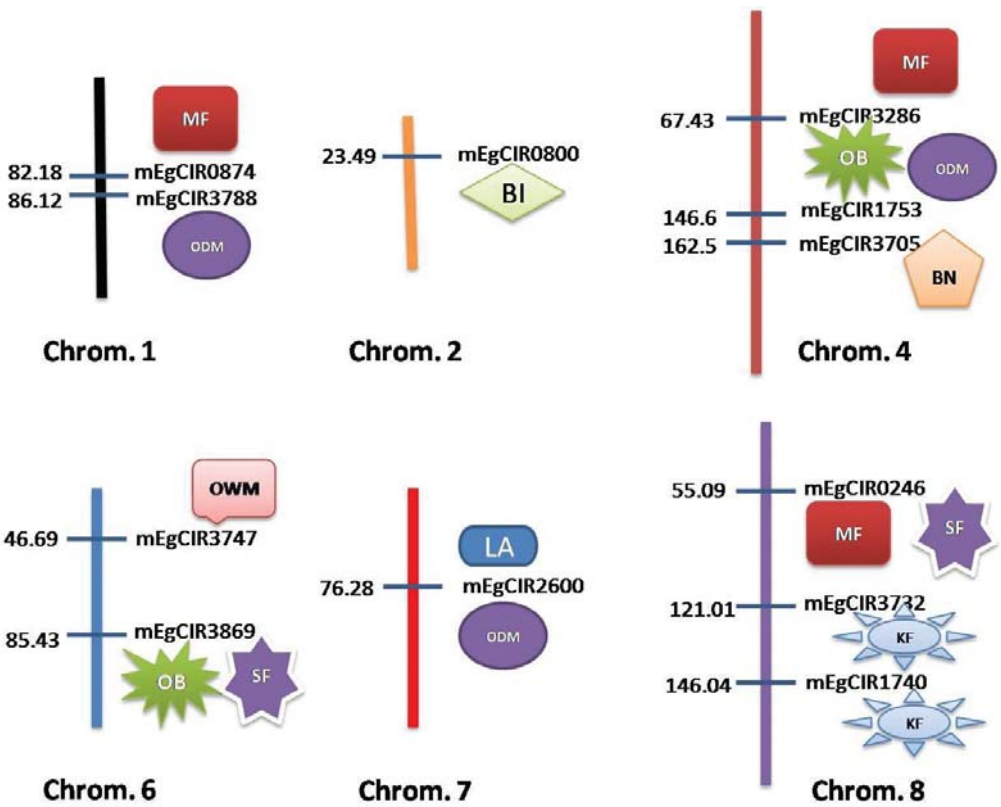
- Association mapping resulted in identification of five significant quantitative trait loci (QTLs) on chromosome 6, 7, and 9.
- Interestingly, three QTLs located on chromosome 7itself, while one each on chromosome 6 and 9 at a P value of < 0.00001.
- Out of the five QTLs, qtl on chromosome 7 was found to be highly significant which explained a phenotypic variance of 15% at a P of 2×10^{-5}.
- The blast results of qtl showed that it was found to be more similar to proteins consisted of families like auxin response factors (ARFs) and abscisic acid insensitive 3 (ABI3).



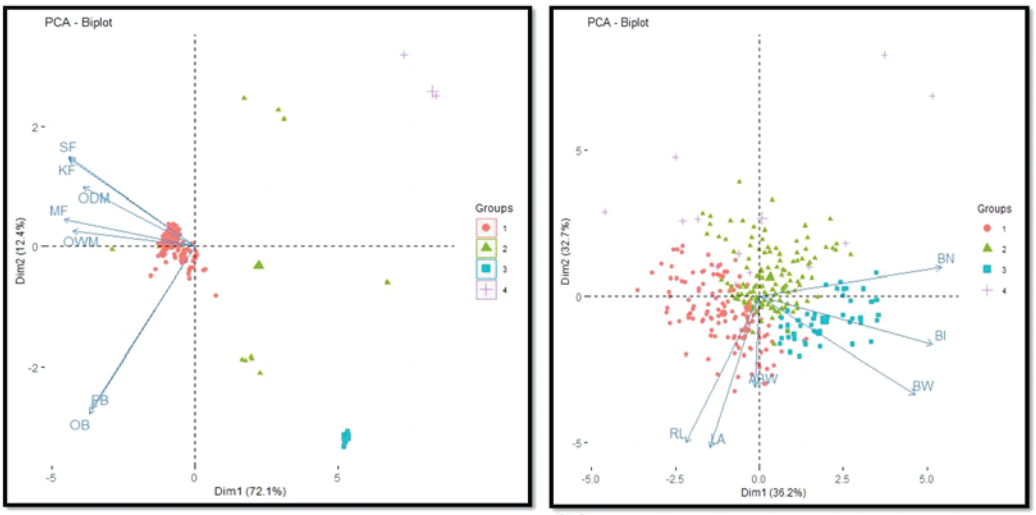
Location of the QTLs for stem height increment using SNPs by GBS method

Genome-Wide Association mapping for important yield, oil yield and agronomic traits using SSR markers

- This is the first report of GWAS on large number of 310 African germplasm using 400 SSR markers
- GWAS of six bunch yield and seven bunch oil yield traits with 400 SSRs resulted in identification 43 significant QTLs for by MLM approach.
- Seven SSR loci were found to be linked to ODM on chromosomes 1,4,7,10,12 and 15.
- The chromosomal region like 4, 10, 11 and 15 harbours majority of the QTLs for ODM, OWM and OB traits.



The location of important QTLs identified for traits likemesocarp to fruit, Bunch Index etc.



The principal component analysis of African germplasm for bunch parameters (a) and yield traits (b)

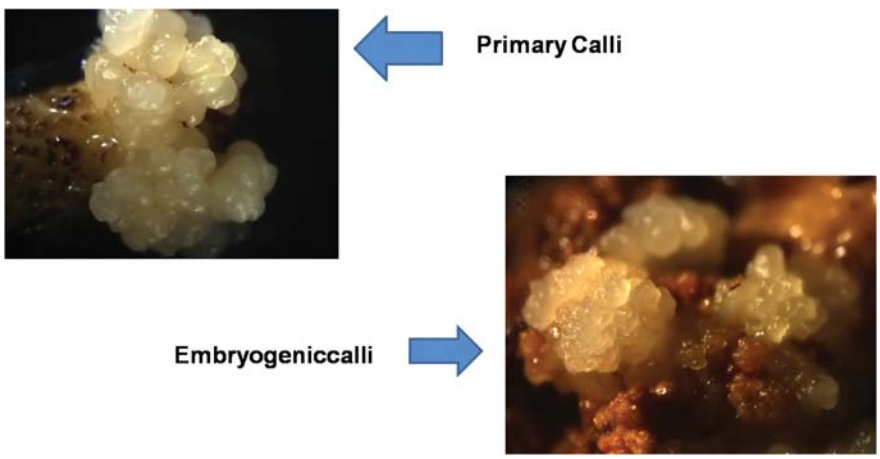
Standardization of oil palm tissue culture protocol

Inflorescence as explants

- Achieved Callusing percentage ranged from 3-55%, somatic embryogenesis ranged from 1.13 to 8.33%.
- Standardized four media which are responsive across genotypes

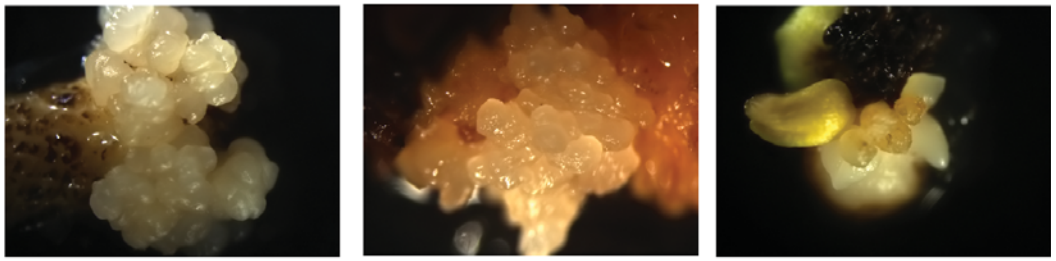
Callogenesis

- High callusing rate (5-54%) was observed in comparison to earlier method (8-10%) of callusing. Recently callus initiation also observed after 2 months of inoculation which helps in reducing time.



Somatic embryogenesis

- The somatic embryogenesis rate was improved to 8% from the earlier 2%. The somatic embryos were obtained from spear leaf and male inflorescence.
- At present, standardizing the media for higher multiplication of callus, somatic embryos and shooting initiation.



a) Primary calli b) Embryogenic calli c) Somatic embryos

Inflorescnce derived explants at various developmental stages

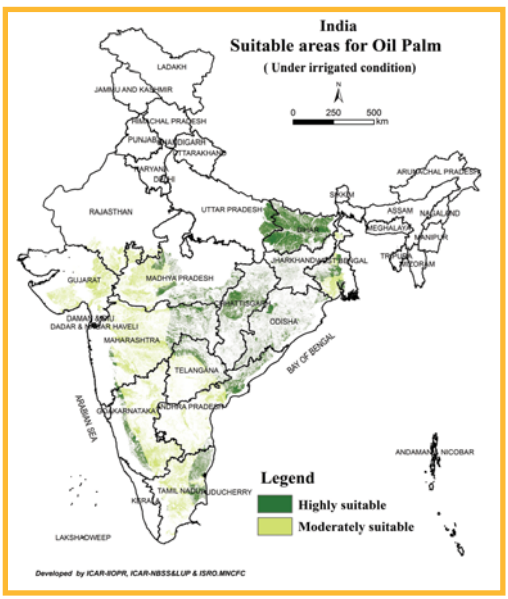
In vitro somatic embryogenesis and plantlet regeneration using zygotic embryos

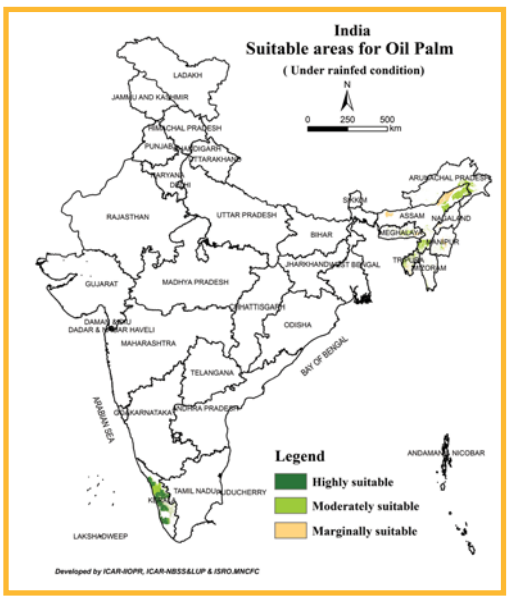
- The highest percent germination has been obtained in N6 media (74.1) which was on par with MS (68.5) and lowest in Y3 media (64.9).
- Among genotypes, Palode-1 has given highest percent germination (80.6) which was on par with the genotypes Palode-2 (75.5) & Costarican-1 (74.5) while Costarican-2 recorded the lowest percent germination of 46.2.

EFFICIENT RESOURCES MANAGEMENT

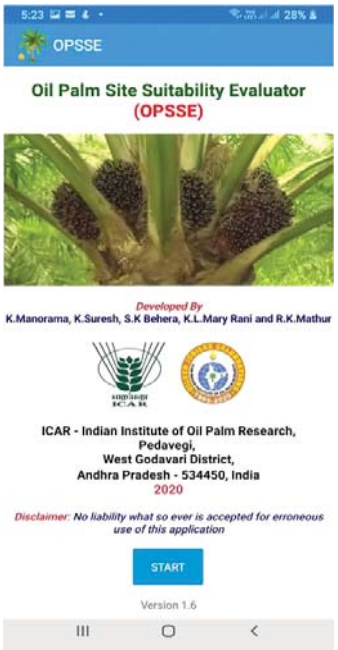
Delineation of suitable areas for oil palm cultivation in India

- For the first time in India, under an inter-institutional project with ICAR-NBSS&LUP, Nagpur, using Remote sensing and GIS techniques, ICAR-IIOPR has developed suitability maps for oil palm cultivation both under irrigated and rainfed conditions.
- Rainfall and temperature data from IMD, Pune(for the past 50 years), ground water information (from CGWB, Ghaziabad), the soil parameter data available at NBS&LUP has been utilized for this purpose. Slope data was generated through Digital Elevation Model from SRTM data.
- Critical parameters in oil palm cultivation were identified separately for both irrigated and rainfed conditions, weights and scores were allotted to main parameters and sub-classes. Then thematic maps were developed for each parameter.
- Through MCDA (Multicriteria Decision Analysis) technique of GIS (Geographic Information System) maps were developed for both irrigated and rainfed cultivation of oil palm separately.
- From LULC map of ISRO, the suitable land use for oil palm cultivation was only considered and accordingly, suitable areas were estimated districtwise under highly suitable and moderately suitable classes in irrigated conditions and under highly suitable, moderately suitable and marginally suitable categories in rainfed areas.





Oil Palm Site Suitability Evaluator (OPSSE)

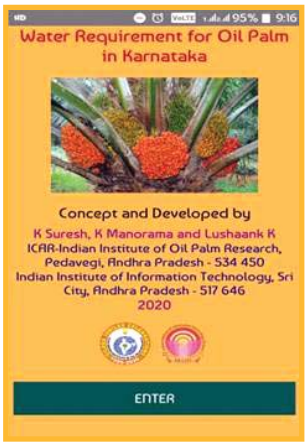


A mobile application has been developed by ICAR-IIOPR for evaluating site suitability of a particular site at micro level, for oil palm cultivation by considering soil, climate and topographic features into consideration. This is available in Google Play Store (https://play.google.com/store/apps/details?id=com.iiopr.opsse) and also as a desk top application.

- For the convenience of farmers/laymen, dropdown menus have been given for most of the parameters and images of critical parameters are embedded in "JPEG" format along with a brief description to make the user understand and choose correct value for data. The user can easily move forward and backward in all the four screens and change the input values at any stage.
- This tool is highly useful for policy makers and all the stakeholders of oil palm research & development including researchers, oil palm processors, state department of agriculture and horticulture officials, farmers and extension persons in taking appropriate decisions with reference to site selection for oil palm cultivation.

Mobile App on water requirement for oil palm in Andhra Pradesh

- ICAR-Indian Institute of Oil Palm Research (ICAR-IIOPR), Pedavegi in collaboration with Indian Institute of Information Technology (IIIT), Sricity and Sir CRR College, Eluru has developed static android mobile apps on Water Requirement for Oil palm for Andhra Pradesh, Karnataka and Tamil Nadu for the benefit of oil palm growers.



- With the help of this app, oil palm farmers can know the amount of water to be given to their plantations.
- The water requirement (per palm per day) can be calculated for a particular day or week or month, depending on their requirement.
- The App can be downloaded from Google Play Store by using the url:https://play.google.com/store/apps/details?id=iiopr.

Release of app by the Hon'ble MLA, Andhra Pradesh during Jal Shakthi Abhiyan.

Efficient nutrient management through Fertigation

Demonstration of fertigation technology to the stakeholders

Oil palm requires heavy doses of nutrients due to the production of huge biomass per unit area per unit time. Based on the uptake studies it was estimated that 1200 : 600 : 1200 g of NPK per palm per year is required to meet its nutrient demand. However, Fertigation being an efficient method to manage nutrient requirement, the technique has been standardized for oil palm with the help of venturi injection system. Under Fertigation, the nutrient requirement is estimated as 600:300:600 g of NPK per ha per palm and MgSO4 and Borax requirements are 250 and 50 g per palm in a year. The suitable fertilizers for this are DAP, Urea and MOP and the frequency of application is monthly. Through this technique, nutrient use efficiency of all the nutrients has become almost double.

This fertigation technique has been tested in farmers' fields of Makkinavarigudem and Challachintalapudi villages of West Godavari District in Andhra Pradesh, and found that this helped in improving net benefit by 15 per ent because of saving in fertilizer requirement and labour cost. From the Farmers' outlook it was also reported that the bunch size and appearance has improved after introducing fertigation in their farms.

S.No.	Treatment	Total fertilizer Costs(Rs/ha)	FFB yield (t/ha)	% saving of fertilizer costs
1.	Control	* 9633	18.4	—
2.	Fertigation	4664	23.1	52

Economics of fertigation in oil palm

Development of Site specific nutrient management

Through continuous efforts, ICAR-IIOPR has developed DRIS norms, critical leaf nutrient concentrations and sufficiency ranges of nutrients in soil for 8 states. Utilizing this information, an android mobile based application has been developed in the name of Soil and Leaf analysis based Oil Palm Nutrient Advisor for providing advisory to oil palm plantations both under soil application and fertigation.

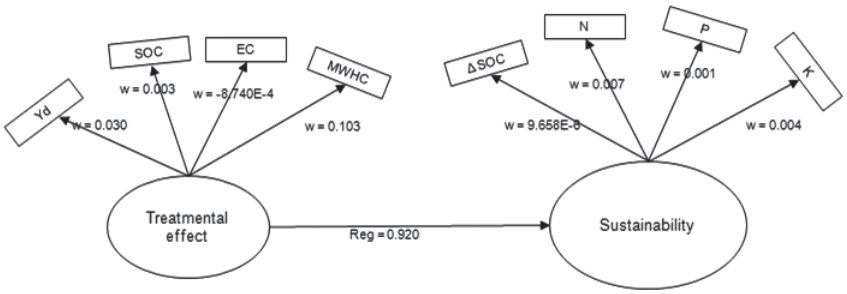
- With the help of this app, it is possible to estimate nutrient requirement for a given plantation of oil palm, based on soil and leaf nutrient analysis data
- The nutrient requirement (per palm as well as per given number of palms) can be calculated for each quarter in case of soil application and per month in case of Fertigation.
- Through this app, nutrient advisory can be generated for Andhra Pradesh, Goa, Gujarat, Karnataka, Mizoram, Tamil Nadu and Telangana states

This App can be downloaded from Google Play Store by using the url:

https://play.google.com/store/apps/details?id=com.iiopr.fertapp

Mulching and technological interventions enhanced sustainability in oil palm production

The impact of mulching with organic waste generated in oil palm plantations and adopting improved management practices on sustainability of oil palm production system under irrigated conditions, in tropical soils was evaluated in Farmers' plantations. Mulching and improved management in sole and intercrop (with cocoa) stands had better Soil Organic Carbon (SOC)content, CEC, water retention, nutrient availability and FFB production when compared with conventional system of OP production. Oil palm intercrop (with cocoa) with mulching and improved management recorded higher SOC content than sole crop within a time span of 6 years. From PCA analysis, FFB yield was found to be greatly influenced by MWHC, SOC, av K, exch Mg and av S. Mulching alone was also effective in intercrop stand to enhance SOC content, as intercrop also contributed for organic waste addition. Path analysis indicated that treatments with mulching and improved management could influence the sustainability. Decline in SOC content of soil in conventional cultivation (Farmers' practice) is a sign of soil degradation.



The impact of mulching in oil palm gardens

Milli-composting: An innovative technique for recycling biomass in oil palm plantations

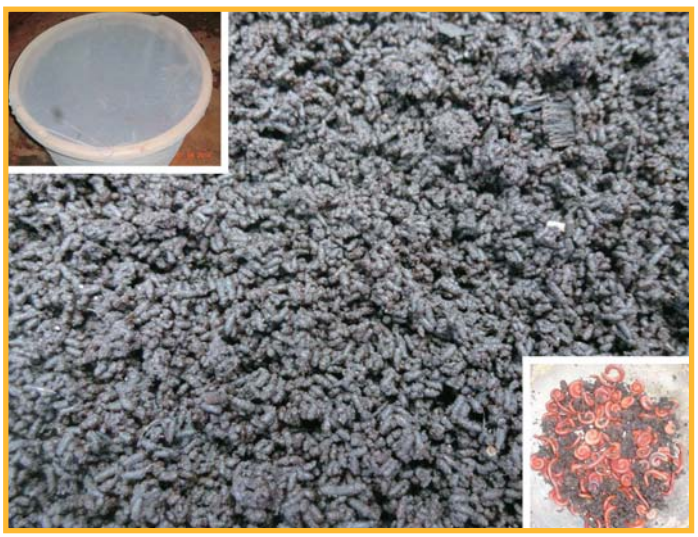
- The major challenge in oil palm plantations is conversion of huge quantity on farm biomass (7-8t/ha) to compost. The success of organic/sustainable farming relies on realization of potential of soil flora and fauna and their ability to support production process when soils are enriched with organic biomass.
- Millipede (*Trigoniuluscorallines* and*Xenobolus carnifex)* has been identified as an excellent composting agent for converting oil palm biomass to nutrient rich compost and its efficiency was found better than earthworms.
- Domestication and mother culture of millipedes have been standardized. Millipedes are hardy, amenable for domestication and quick multiplication round the year though the multiplication is higher in rainy season. Moist soil conditions, presence of biomass and favourable micro climate of oil palm plantations are providing congenial environment for the growth and development of millipedes throughout the year.

- Quality of milli compost is relatively better than that of vermicompost. The studies have proven that millipede cab be a right bio agent to convert surface biomass in palm basin itself (*in situ composting*) to rich compost with almost zero investment in oil palm gardens.

Parameter	Millicompost	Vermicompost
pH	7.01	6.25
EC (dS/cm^2)	0.35	0.52
N (%)	1.58	1.39
P (%)	0.26	0.27
K (%)	0.54	0.58
Ca (%)	2.58	2.13
Fe (ppm)	1186	1272
Cu (ppm)	134	42
Mn (ppm)	118	110
Zn (ppm)	85	72

Microbial population in millicompost and vermicompost.

Parameter	Millicompost	Vermicompost
Bacteria (10^6)	28	15
Fungi (10^4)	12	13
Actinomycetes (10^3)	26	7.5
Millipedes	270	-
Earthworms	-	330



Milli-compost and millipedes

OIL PALM BASED CROPPING SYSTEMS

Inter-cropping in mature oil palm plantations for doubling of farmers income

- Perennial crops like cocoa, heliconia, red ginger, torch ginger, banana, bush pepper, Java long pepper and cut foliage plants *i.e.*, asparagus, fish tail fern, dracaena, cordyline and philodendron have been identified as promising inter crops in mature oil palm plantations in Andhra Pradesh and Telangana State.
- Improved physico-chemical and biological properties of soil, root density and FFB yield of oil palm, control of weeds, favorable micro climate and finally enhanced productivity of the system are added major benefits from inter cropping in mature oil palm plantations.
- As per the experimental results, cocoa can be the most compatible companion crop for oil palm. Among the crops, higher cost benefit ratio has been worked out for bush pepper (1:2.70) when compared with oil palm alone (1:2.18).
- Fodder crops like Guinea and hybrid Napier performed well under micro climate of mature oil palm.
- The above listed perennial and annual intercrops and developed cropping systems can also be taken up commercially in other oil palm growing states.
- Interaction between oil palm and inter crops was complementary when compared to mono cropping. Hence, studies clearly indicate the potential for systems approach for improved productivity of gardens and way forward for doubling oil palm farmers' income.

Common name	Cocoa
Botanical name	*Theobroma cacoa* L.
Family	Sterculiaceae
Economic plant part	Beans
Spacing	4.5 x 4.5 m
Plants/ha	400
Crop period	25 years
Yield/ha	225 kg
Cost of production/ha (Rs)	40550
Net returns/ha (Rs)	16450
Cost benefit ratio	1:1.41

Cocoa in mature oil palm plantation

Common name	Red ginger
Botanical name	*Alpinia purpurata* V.
Family	Zingiberaceae
Economic plant part	Flower
Spacing	1.5 x 1.5 m
Plants/ha	1500
Crop period	5 years
Yield/ha	22,500 flowers
Cost of production/ha (Rs)	44,850
Net returns/ha (Rs)	67,650
Cost benefit ratio	1:2.51

Red ginger in mature oil palm plantation

Cost benefit analysis of oil palm based cropping systems

Component	Gross returns (Rs)	Production cost (Rs)	Net returns (Rs)	C:B ratio
Oil Palm alone	105430	52000	53430	1:2.03
OP+Cocoa	194864	70000	124864	1:2.78
OP+Red ginger	184695	71500	113195	1:2.58
OP+Heliconia	176140	74000	102140	1:2.38
OP+Bush pepper	240695	84000	156695	1:2.86
OP+Banana	194550	74000	120550	1:2.63
OP+Ornamentals	171690	64000	107690	1:2.68

Cost benefit analysis of vegetables, spices and medicinal plants grown in mature oil palm plantation.

Crop	Yield/ha	Gross income	Cultivation cost (Rs)	Net income (Rs)	CB ratio
Elephant foot yam	7.80t fresh	77,900	67,950	9,950	1:1.15
Colocasia	10t fresh	1,00000	44,460	55,540	1:2.25
Turmeric	1.63t dry	1,06,000	59,336	46,744	1:1.79
Ginger	3.5t fresh	2,66,000	92,000	1,18,000	1:2.89
Wild turmeric	1200kg dry	1,20,000	62,500	57,500	1:1.92
White turmeric	1282kg dry	1,28,200	62,500	65,700	1:2.05
Black turmeric	600kg dry	1,80,000	66,836	1,13,164	1:2.69
Mango ginger	7.2t fresh	1,80,000	72,000	1,08,000	1:2.50
Black ginger	400kg dry	2,00,000	82,950	1,17,050	1:2.41
Galanga	490kg dry	1,96,000	80,900	1,15,000	1:2.42

Long Pepper in Oil Palm

Bush Pepper in Oil Palm

Black turmeric in Oil Palm

Mango ginger in oil palm

Banana in oil palm


Aglaonema
(Aglaonema sp.)

Fodder crops as inter crops

View of oil palm based mixed farming system

The noteworthy observation of the system is the performance of poultry birds without additional inputs except the cost of birds purchased at the beginning. There was tremendous improvement in yield of oil palm in fodder cropped plot (26.67t/ha) when compared with the mono cropped (23.55t/ha) plot. Microbial population *i.e.*, bacteria, fungi and actinomycetes in inter cropped area was more as compared to mono cropped plot in the system. Macro nutrient (OC/N, P, K and Ca) contents in soil and leaf collected from the intercropped area and mono cropped area of the farming system were more or less equal. Higher cost benefit ratio has been worked out for mixed farming system (1:3.28) when compared with sole crop of oil palm (1:2.90) and a farmer can earn an additional income of Rs.60,000/ha/year from the system. Oil palm based integrated farming system with fodder crop (Guinea and Hybrid Napier grass), dairy (2 buffaloes+2 calves) and back yard poultry (25 Giriraj birds) has been found most suitable and profitable for Andhra Pradesh and Telangana State.

Cost benefit analysis of fodder crop based mixed farming systems

Component	Gross returns (Rs)	Cost of maintenance (Rs)	Net returns (Rs.)	C:B ratio
Oil palm alone	159575	55000	104575	2.90
OP+ Fodder crop	225890	71000	146890	3.18
OP+Fodder crop+ Dairy+Poultry	323390	98500	224890	3.28

- Hybrid Napier grass varieties DHN-6 (27.60t/ha) and KKM (26.15t/ha) and Guinea grass varieties BG-1 (25.29t/ha), Co3 (24.39t/ha) and DGG-1 (22.59t/ha) have been identified as shade tolerant and high fodder yielding varieties.
- Because of short stature and grassy nature, DGG-1 can be a most suitable variety for oil palm as grazing is very common in oil palm plantations.
- Therefore, the above listed fodder crop varieties can provide solid base for the success of integrated farming system in farmer's oil palm plantations in Andhra Pradesh and Telangana State.

Promising fodder crop varieties DGG-1 and DHN-6

Effect of palm oil mill effluent (POME) on growth of oil palm seedlings.

- Experiment was conducted to study effect of palm oil mill effluent (POME) on growth and vigour of oil palm seedlings.
- Among the treatments, the best results for important parameters like seedling height (151.40cm), number of leaves (18.50), number of leaflets (61), leaf area (3666cm^2), stem girth (27.87cm), number of primary roots (31.50) and total dry matter (449.75g) were recorded under 10% concentration of POME.
- Among the treatments, more bacterial and fungal population was recorded with 10% POME whereas actinomycetes count was noticed higher in RDF.
- The present results indicate that POME@10% is a good substitute for conventional practice and the same is recommended for commercial application in oil palm nurseries in India

Influence of cattle urine on growth of oil palm seedlings.

- Experiment was carried out to study influence of cattle urine on growth and vigour of oil palm seedlings.
- Buffalo urine was applied @2, 4, 6, 8, 10 and 15% to potting medium and results were compared with the RDF and the control.
- Among the treatments, the best results for important parameters like seedling height (148.98cm), number of leaves (16.25), number of leaflets (59), leaf area (2745.70cm^2), stem girth (27.40cm), number of primary roots (33.75) and total dry matter (425.50g) were recorded under 10% concentration of buffalo urine.
- More organic carbon and Ca were estimated with 10% buffalo urine whereas higher P and K in RDF in potting mixture. The treatment RDF recorded the highest level of N in leaf whereas better levels of K and Ca in leaf were noticed with 10% buffalo urine.
- Among the treatments, more bacterial and fungal population was enumerated with 10% urine whereas actinomycetes count was found higher in RDF. Hence, present results revealed that buffalo urine @10% can be used in place of chemical fertilizers in oil palm nursery.

PHYSIOLOGY, BIOCHEMISTRY AND POST HARVEST TECHNOLOGY

Determination of optimum time of harvest in oil palm with the help of its oil content and fatty acid profiles

- The present study elucidate variations in fruit weight, oil and moisture content in mesocarp along with fatty acid profiles during fruit ripening at 12, 14, 16, 18, 20 weeks after anthesis (WAA) of four commonly grown oil palm crosses *viz.,* United Plantations, Deli X Nigeria, Palode and Deli X Ghana under sub-tropical environment.
- The fruit weight and oil content in crosses increased from 12 to 20 WAA. The ideal time of harvest was at 20 WAA, which coincided with highest oil content.
- The moisture content in mesocarp decreased as fruit ripened. Six fatty acid profiles *viz.,* myristic (0.5- 2.1 %), palmitic (31.1- 45.1 %), stearic (2.8- 5.1 %), oleic (19.1- 43.1 %), linoleic (8.7- 32.4 %) and linolenic (0.4- 10.4 %) were identified by standardizing gas chromatograph parameters.
- Monounsaturated fatty acids and saturated fatty acids have increased in all crosses as fruits ripened from 12-20 WAA, while polyunsaturated fatty acids decreased during the process of ripening.
- Monounsaturated and polyunsaturated fatty acids were highest in Deli X Ghana cross, indicating its better oil quality.

Seasonal variations in oil content in different oil palm tenera hybrids

- Four families of oil palm tenera hybrids belonging to different sources viz., Malaysia, Palode, Deli X Ghana (DXG) and Deli X Nigeria (DXN) (planted during 2005) were taken up for the study.
- In the month of July, highest oil to bunch (%) was noticed in Malaysian hybrid followed by DXG and Palode source. While lowest value was seen in DXN source.
- Similar trend was seen during the August and November months also.
- During the month of September and October, DXG source recorded higher O/B percent followed by Malaysia and Palode hybrids.
- DXN source recorded highest O/B values followed by bunches belonging to Malaysia, DXG and Palode.
- The mean monthly values of oil to bunch percent (irrespective of sources) ranged from 18.32 to 22.85, with highest value during September, whilst lowest value was observed in the month of October.
- The mean oil to bunch percent of the different sources (irrespective of months) ranged between 18.26 % (in Palode source) to 23.02 % (in Malaysia source).

Ontogenetic changes in fruit weight and oil content from anthesis to maturity in tenera oil palm hybrids

- Ontogenetic changes in fruit weight and oil content in *tenera* oil palm hybrids from anthesis to maturity were conducted in Germplasm Block–III of ICAR-IIOPR, Pedavegi.
- The fruit weight increased as the fruits matured from anthesis to maturity in different tenera oil palm hybrids.
- Highest fruit weight (154.1 g) was observed during January and lowest weight (46.8 g) was recorded during March.
- Similarly an increasing trend in oil content was observed as the fruits matured. The oil content increased gradually up to 14th week and most of the palms attained maturity during 18th to 22nd week after tagging except in few palms which prolonged up to 24th to 25th weeks.
- Highest oil content (77.2 %) was observed in the month of June, whilst lowest oil content (54.0 %) was recorded during July.

Screening of oil palm germplasm for salinity tolerance

- Different physiological and biochemical parameters were carried in the different treatments (0.2, 0.4, 0.6, 0.8 and 1.0 % NaCl solution) at weekly intervals.
- Results revealed that physiological and biochemical parameters such as Relative Water Content (RWC), Membrane Stability Index (MSI), Chlorophyll pigments such as Chlorophyll a, chlorophyll b, total chlorophylls and carotenoids, Protein content (%), Nitrate Reductase activity (NR), Total soluble sugars decreased as salt concentrations increased, while antioxidant enzymes like Super Oxide Dismutase (SOD), melanoldehyde content (MDA) and Proline content (%) increased with increased salinity.

Relationship among CCM-200, chlorophyll contents and leaf nitrogen content in oil palm

- A study was carried out to determine the correlation between CCM200 readings with that of chlorophyll a, b and total chlorophyll, chlorophyll a/b, carotenoids and nitrogen percent.
- The results of the studied revealed that all the parameters studied were statistically significant. The CCM200 readings were positively correlated with all the parameters except chlorophyll a/b ratio.
- A high correlation was noticed in CCM200 reading with that of total chlorophyll content (0.722**) followed by chlorophyll a (0.721**), carotenoids (0.713**) and chlorophyll b (0.690**).
- The correlation was recorded between CCM200 with that of nitrogen percent was also significant.

Standardization of irrigation scheduling in oil palm based on crop factor with the aid of physiological and biochemical markers

- Studies on the relationship between methods of irrigation using crop factor on the physiological and biochemical responses of adult oil palms revealed that significantly highest relative water content (97.44%), photosynthetic rate (16.46 µmol $m^{-2} s^{-1}$) and stomatal conductance (0.307mol $m^{-2} s^{-1}$) were obtained in palms irrigated with micro-jet method of irrigation, whereas, significantly highest membrane stability index (25.26%) and chlorophyll content index (112.64) were observed with drip method of irrigation.
- Among the levels of irrigation water using crop factor 0.7 has recorded significantly highest photosynthetic rate (16.56 µmol $m^{-2} s^{-1}$) and stomatal conductance (0.295mol $m^{-2} s^{-1}$), whereas, relative water content (95.51%), membrane stability index (27.11%) and chlorophyll content index (126.25) were found significantly highest with crop factor 0.8.
- Significantly highest proline content (2.37%), total content of carbohydrates (9.77%), chlorophyll-a (2.38 mg/g), total chlorophyll (2.73 mg/g) and nitrate reductase activity (66.60 moles of nitrate min/g) were found with drip method of irrigation.
- Among the levels of irrigation crop factor 0.8 has recorded significantly highest proline content (2.56%), protein content (5.58%), chlorophyll-a (2.33 mg/g), lipid peroxidation (8.73 nmoles/g) and nitrate reductase (73.65 moles of nitrite/min/g) activities. Among the levels of irrigation using crop factors, significantly highest SOD activity was observed by application of irrigation water using crop factor 0.7 and 0.8 (0.03 and 0.03 units of mg protein /g FW respectively).
- Highest SOD activity was observed by application of irrigation water through drip method of irrigation using crop factor 0.8 (0.04 units of mg protein/g FW).

Development of labour saving tools and machineries for oil palm cultivation

Oil palm trunk chipping bucket

Oil palm trunk chipping bucket

- The experimental results showed that for complete fragmentation of 6-7 m palm 5.47 min. was required including felling time of 4.53 sec.
- The average no. of strokes required was 35. The average palm girth at base, middle and crown was 3.0, 2.19 and 2.39 m respectively, so the base region required more than one stroke for fragmentation.

CROP PROTECTION

Management of Rugose Spiralling White fly (RSW) in oil palm gardens

- Rugose Spiraling Whitefly, *Aleurodicus rugioperculatus* is an invasive pest to India.The incidence and intensity of the pest is increasing every year since its entryinto the country i.e. during 2016 in Tamil Nadu and Kerala and 2017 in AndhraPradesh causing severe losses to the growth of the plants. This makes the plants appearblack hindering the photosynthetic activity.
- The ICAR- IIOPR, Pedavegi has found the effectiveness of fungal microbialorganism *Isaria fumosorosea* (strain of ICAR-NBAIR, Bengaluru) onthe pest population. It is found killing the pest population during all the seasons. Since it is a microbial fungicide,pollution to the environment and resurgence problems are not cropped up.

- The multiplicationprocedures at both laboratory andfield levels were standardized forgetting maximum number ofspores per unit area.
- Use of turbo sprayer (Fig. 12) is found very effective in gettingmaximum mortality of the pest compared to traditional sprayers likeknapsack, foot pumps and power operated ones.
- The fungus is found fastdeveloped in jaggery and starch materials at ashort time of 15 days. Re-inoculation studiescarried out using the infected RSW confirms themortality of the pest due to the fungus *Isariafumosorosea* only. Hence it is also recommended to include in IPM practicesfor RSW
- Three applications of the developed culture at weeklyintervals along with detergent powders are effectivein controlling the pest population and hencerecommended.

TRANSFER OF TECHNOLOGY & ICT

Training programmes organized

Officers training programmes

The institute every year conducting number of training programmes to different stakeholder like farmers, processors, state department officials etc.

Year	Number of programmes	Number of participants
2015	16	235
2016	9	207
2017	11	340
2018	12	369
2019	8	200
2020	10	378
Total	**66**	**1729**

Farmers training programmes

Year	Number of programmes	Number of participants
2015	57	1882
2016	32	1605
2017	64	1996
2018	59	2661
2019	63	1891
2020	27	1036
Total	**302**	**11,071**

Capacity building programmes to officers of NE states

Year	Number of programmes	Number of participants
2015	1	16
2016	5	82
2017	1	2
2018	3	148
2019	-	-
2020	-	-
Total	10	248

Training programme conducted to NE region department officials

Model Training Course

Course Directors: Dr K.Manorama and Dr K.Suresh

A model training course sponsored by Directorate of Extension, Ministry of Agriculture and Farmers' Welfare on "Recent advances in Oil Palm production and special emphasis on emergence of new pest and its management" was organizedby ICAR-IIOPR

during 18-25th November, 2019. In total 18 participants from 7 different states participated in this 8 day programme. The participants of this training programme are from thestates viz., Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Mizoram, Odisha and Telangana. The programme covered all the aspects of oil palm right from seed production, nursery raising to harvest and processing. This included class room learning, practical demonstrations, factory and field visits. This enables them to be ready with action plans for conducting awareness campaigns on various pest, disease and nutrient disorders for proper management. All these field level campaigns are highly useful in successfully cultivating the oil palm in different corners of the country. There was also a good representation from women participants (40%). This gives a better platform to think about gender related issues also in implementing the recommended package.

Model Training Course on "Application of ICT Tools for Dissemination of Oil Palm Technology for Increasing Area and Production"

- It was organized by ICAR-IIOPR during 15-22 December, 2016 to impart knowledge and skills in use of ICT applications to disseminate agricultural technologies to the unreached.
- In total 14 participants from 7 different states viz., Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Arunachal Pradesh, Tamil Nadu and Telangana participated in this 8 day training programme.
- The programme covered aspects on Oil palm kisan mobile message services, Expert systems for diagnosis of pest / disease / disorders, Use of IT in oil palm research for Irrigation and Nutrient Management, Wireless Sensor Network (WSN) and Decision Support Model based Crop Advisory System, Digital Technologies in Agricultural Extension and Value Chain.
- Scope of Remote Sensing and GIS, CDs and Mobile Technologies in oil palm research and extension. Hands on experience was given in preparing content for SMS-text and audio, using the expert systems and decision support systems, generating weather charts and viewing spatial data of weather parameters, using interactive thematic maps, preparing short video film, conducting video conference session.

- Skills acquired by the participants during the training programme include content development for publishing text and voice message, publishing of SMS through m-kisan (farmers) portal, preparation of Reusable Learning Objects, preparing Voice based power point presentation., content preparation for mobile apps, script writing for one minute video production etc.

ASCI Sponsored Skill Development Programme on Job Role "Seed Processing Worker"

Two 25 days Skill Development Programme on "Seed Processing Worker" sponsored by Agricultural Skill Council of India (ASCI) under Skill India Programme was organized at IIOPR Research Centre, Palode during 7th – 31st March, 2018 and 7th Feb – 3rd Mar, 2019. Twenty 20 unemployed youth under each skill development programme from three nearby panchayats *viz.* Palode, Nanniyode and Peringamala were trained on various aspects of seed processing. The skill development programmes imparts theoretical and practical knowledge on cleaning and drying of seeds, seed treatment, packing and labelling of seeds, seed storage, quality assurance, safe handling of machineries and employability & entrepreneurship skills. In addition, exposure visits to vegetable seed production and processing facility at CoA, KAU, Vellayani and a private seed production company at Puliyangudi, Tamil Nadu were organised.

Block Demonstration on Fertilizer management

Implemented Block Demonstration on "Fertilizer management in oil palm" since 2013-14, in Kolasib District, Mizoram in an area of 100 ha, belong to 60 oil palm growers under Tribal Sub Plan. Recommended fertilizers were provided to oil palm growers in two splits. Fertilizers were applied during onset of monsoon and cessation of monsoon. Yield of oil palm was significantly improved under rain fed conditions during last three years.

Total no of farmers	Area in Ha	Production in Mt 2012-13	Production in Mt 2013-14	Production in Mt 2014-15	Production in Mt 2015-16	Production in Mt 2016-17
60	100	274 (2.74 t/ha)	399 (3.99 t/ha)	592 (5.92 t/ha)	1081 (10.81 t/ha)	1252 (12.52 t/ha)

Farmers FIRST programme

Following technological interventions were implemented under Farmers FIRST programme, for assessment and refinement, details are as follows.

Module	Intervention	Villages covered	Area covered (ha) / Animal (No.)	Number of Households covered
1.Crop based module	Weather based irrigation scheduling in oil palm	2	228	57
2.Crop based module	Nutrient application to oil palm through fertigation	2	100	50
3.Crop based module	Integrated pest management of leaf eating caterpillar and bag worm in oil palm	2	150	59
4.Crop based module	Integrated disease management of Basal Stem Rot (*Ganoderma sps.*) in oil palm	2	80	55
5.Crop based module	Mechanization of harvesting of bunches in oil palm	2	500	250
6.Horticulture based module	Coconut and Oil Palm based cropping system	2	25	50
7.Livestock based module	Fodder grass for live stock	2	40	20
8.NRM Based module	Recycling of biomass obtained from oil palm plantation	2	1180	169
9.NRM Based module	Doubling farm income by introducing fish in farm ponds in coconut / oil palm cropping system	2	41	103
Total		2	2344	813

Farmer - Scientist Interface meets organised under Farmer FIRST Programme

Programme organised	No. of programmes	No. of participants
Demonstrations	24	828
Interface Meetings	2	135
Field Visits	62	755
Awareness Campaigns	1	50
Training Programme	2	54
Total	**91**	**1822**

Dr. Trilochan Mohapatra, Secretary DARE and DG, ICAR, New Delhi visited the oil palm fields of Farmers FIRST Village at Challachintalapudi, West Godavari district, A. P. on 05.05.2019, he witnessed the interventions implemented under the project. Participated in the stakeholders meet on "Doubling the Farm Income" and addressed the stakeholders. He also saw the demonstration of harvesting of bunches from tall palms, chaff cutter for oil palm biomass waste decomposition and use of vermibeds for biomass decomposition. Dr. Mohapatra while addressing the meet, stressed the need of utilizing resources efficiently to increase yield and reduce inputs use for doubling the farmers income.

Seed and Planting material distributed

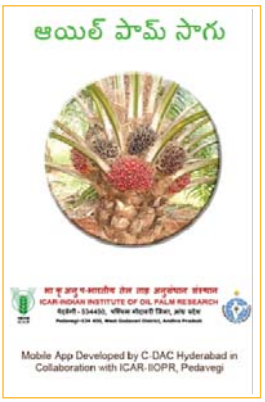
S. No.	Name of the Company	Seeds distributed (Year wise)				
		2014-15	2015-16	2016-17	2017-18	2018-19
1	OPIL Seed Garden	735,000	808,500	664,650	826,082	701,641
2	IIOPR (RC), Palode	80,000	78,000	30,000	69,300	25,000
3	Rajahmundry Seed Garden	256,200	319,900	235,000	199,300	160,000
4	Taraka Seed Garden	211,470	51,660	194,880	166,660	152,020
5	IIOPR, Pedavegi	54,600	38,850	46,200	116,500	69,300

Area Covered (Year wise)

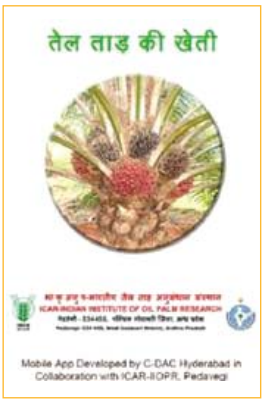
S. No.	Area Covered (Year wise) (Ha)				
	2014-15	2015-16	2016-17	2017-18	2018-19
1	4083	4492	3693	4589	3898
2	444	433	167	385	139
3	1423	1777	1306	1107	889
4	1175	287	1083	926	845
5	303	216	257	647	385
Total	**7429**	**7205**	**6504**	**7655**	**6155**

Development of Mobile App on Oil Palm Cultivation Practices

English
English : goo.gl/F4CDDV



Telugu
Telugu : goo.gl/cCSs7p



Hindi
Hindi : goo.gl/9LPEiI

- Recommended practices for oil palm cultivation in India in the form of text and images.
- Climatic requirements, cultivated variety, planting season, planting, population, spacing requirements, cultural practices, management of oil palm plantations during juvenile period and adult plantations.

Mobile App on Oil Palm Nutrient Management

English
English : goo.gl/xlb5HA

Telugu
Telugu : goo.gl/9Fbdt4

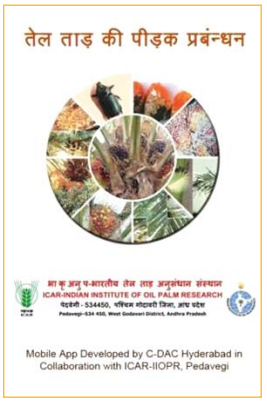
Hindi
Hindi : goo.gl/QDYfil

- Symptoms of nutrient deficiencies in oil palm and their management.
- The content is explained in the form of text, images and also short video films.

Mobile App on Oil Palm Pest Management

English
English : goo.gl/fY5ypf

Telugu
Telugu : goo.gl/urXMpd



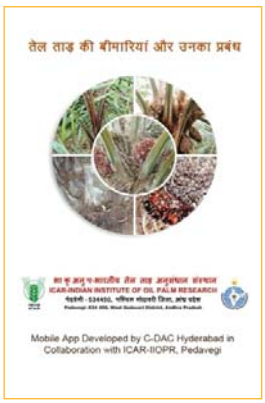
Hindi
Hindi : goo.gl/qQA2dB

- Symptoms of pest infestation in oil palm and their management
- Explained with help of text and images.

a. Mobile App on Oil Palm Disease Management

English
English :goo.gl/p7I7Vi

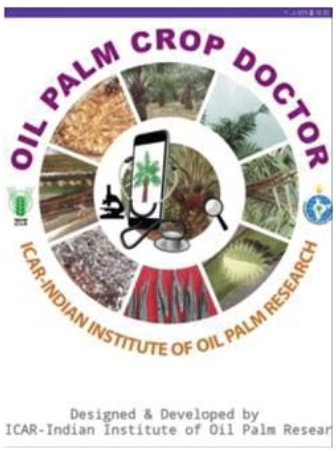
Telugu
Telugu :goo.gl/QykO69



Hindi
Hindi :goo.gl/UpvyeC

- Symptoms of disease infection in oil palm and their management
- Explained with the help of text and images.

Oil Palm Crop Doctor (Intractive Mobile App)



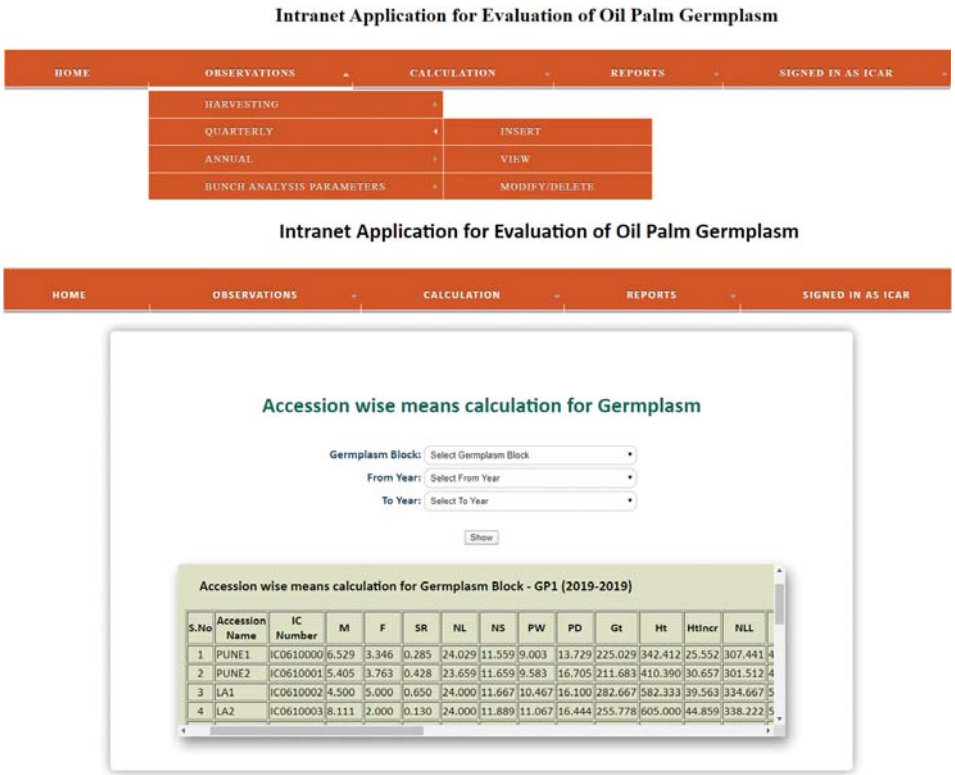
- This will facilitate to know about pest, disease and deficiencies and their management. It helps to send an enquiry to ICAR-IIOPR on oil palm cultivation aspects and get a reply from the research institute within a short time.
- App has the required technical information on oil palm cultivation in the form of text, image and videos and also fertilizer calculator that could be made available to the stakeholders without any cost. App supports English language.

ICAR-IIOPR Website redesigned

Redesigned and developed the institute website. Along with the static content about information of the institute, its research and development activities and oil palm technologies. The website also has dynamic pages for asking queries in form of text along with attachments and Registration for receiving the mobile message services on oil palm technologies. The research papers on oil palm published by the institute are also available which can be queried based on keywords. The oil palm technologies are available to the users in the form of text and audio files which can be retrieved.

Intranet Application for Evaluation of Oil Palm Germplasm

- Intranet application for evaluation of oil palm germplasm was designed and developed using php 5.6.4, HTML 5, CSS with database in MySQL 5.0.11.
- Homepage displays observations, calculations and reports as main menu options wherein harvesting, quarterly, annual and bunch analysis observations can be recorded and viewed under the observations menu.
- While calculations menu enables the user to perform palm-wise calculations and accession-wise means, reports menu provides reports on accession-wise growth and yield, palms that are high yielding, palms with low height increment, palms having high bunch index value.
- These reports help in selection of germplasm for required traits.



Oil palm kisan mobile message services

Oil palm technologies were desisimated in 5 vernacular languages through SMS and Voice messages.

Year	No of messages	Reach to Mobiles
2015	548	943179
2016	213	1350041
2017	69	1344000
2018	25	193000
2019	28	210719
2020	31	299175
Total	**914**	**4340114**

Video films and Short videos

Developed short video films on management practices in oil palm cultivation *viz.,* irrigation, fertilizer, mulching, green manure and cover crops, intercropping, nutrient management, pest management, disease management.

Irrigation Management in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Fertilizer Management in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Mulching in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Green Manuring and Cover Crops in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Intercrops in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Management of Nutrient Deficiencies in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Pest Management in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

Disease Management in Oil Palm. ICAR-Indian Institute of Oil Palm Research, Pedavegi.

The Golden Palm – A digital video film on oil palm cultivation practices. 30 min. ICARIndian Institute of Oil Palm Research, Pedavegi.

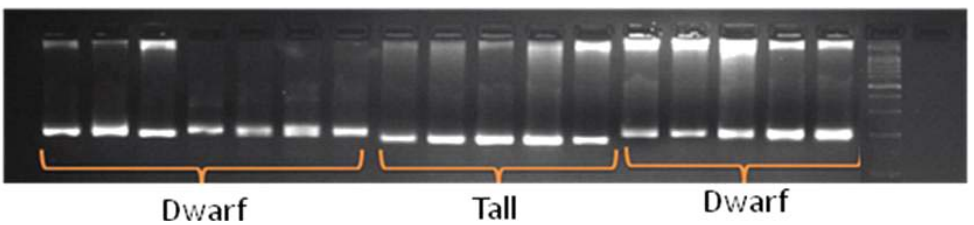
ICAR-IIOPR Marching Ahead (English and Hindi). A digital video film on activities of ICAR – IIOPR. 12 minutes. ICARIndian Institute of Oil Palm Research, Pedavegi.

Patents applied

1. "Design and development of oil palm ablation tool" Indian Patent Application Number: 3937/CHE/2014 – Publication date: 22-08-2014 (Application awaiting Examination)

2. "A process and kit for insect facilitated controlled pollination in oil palm" Indian Patent Application Number: 201641044994 –Publication date: 17-02-2017 (Application awaiting Examination)

3. "A method for identification of dwarf oil palm plant using microsatellite markers" (Filed with Indian patents) Patent Application No: 201941042841, published in patent office journal dated: 22-11- 2020.



Inter-Institutional collaborations

ICAR-Indian Institute of Oil Palm Research, Pedavegi is maintaining linkages with the following National level Institutions for the promotion of oilpalm research and development:

- ICAR-Central Institute of Agricultural Engineering, Bhopal
- ICAR-Central Plantation Crops Research Institute, Kasaragod
- ICAR-Indian Institute of Horticultural Research, Bangalore
- ICAR-National Bureau of Plant Genetic Resources, New Delhi
- ICAR- National Bureau of Soil Survey and Land Use Planning, Nagpur
- ICAR-Central Tobacco Research Institute, Rajahmundry
- ICAR-National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM), Mau, Uttar Pradesh
- Department of Science and Technology (DST)
- Department of Agriculture, Cooperation &Farmers Welfare (DAC&FW), Ministry of Agriculture & Farmers Welfare, Govt. of India
- State Departments of Agriculture/Horticulture, Govt. of Andhra Pradesh, TamilNadu, Karnataka, Kerala, Goa, Gujarat, Chhattisgarh, Maharashtra, Odisha, Mizoram, Tripura, West Bengal
- State Agricultural/Horticultural Universities of oil palm growing states
- Entrepreneurs involved in oil palm development ICAR-IIOPR is implementing the following externally funded projects and inter-institute collaborative research projects:
- Mahalanobis Institute, New Delhi

Resources generated

S. No	Year	Revenue generated (Rs. In lakhs)
1	2018-19	63.0
2	2017-18	130.0
3	2016-17	69.29
4	2015-16	81.38
5	2014-15	75.61

SUCCESS STORIES

Highest yield obtained in oil palm by adopting micro irrigation and split application of macro & micro nutrients

Farmer: Inapakolla Madhava Rao, East Godavari Dt., A. P.

Adopted triangular method of planting, entire land was filled with tank silt for better moisture conservation, adopted Micro irrigation for effective utilization of water, save power & ground water and reduce weed growth, regularly applying Farm Yard Manure (FYM) @ 100 kg per palm in two splits, adopted fertilizer application in four splits per year, after harvesting of bunches (34 harvests per year), cut fronds are made into 4-6 small pieces and used as mulch in the palm basin. Applying organic manure twice in a year to each palm. Cow dung is used one time in a year. Farm Yard Manure is used for second time. This practice is being adopted to obtain sustained high yield of 40 tonnes /ha.

Crop wise income, cost-benefit ratio, gross and net income

Crop	Yield	Price (Rs.)	Gross income/ ha (Rs.)	Cost of cultivation/ ha (Rs.)	Net income / ha (Rs.)	Cost Benefit Ratio
Oil palm	40 tonnes FFB/ha	8500 / tonne FFB	340000	145750	194250	**0.75**

Adopted intercrops in Oil Palm paved way for "Doubling the Farm Income"

Farmer: **VandanapuSuryachandra Rao**, West Godavari Dt., A. P.

Adopted Micro irrigation for effective utilization of water, save power & ground water and reduce weed growth. Every three months, regularly applying Farm Yard Manure (FYM) and Vermicompost to obtain sustainable yields. Adopted fertilizer application in six splits per year. Hegot inspired by seeing intercropping systems developedby ICAR- Indian Institute of Oil Palm Research, Pedavegi. He collected planting material of long pepper from Indian institute of oil palm research and developed a demonstration plot in his field. While raising nursery and intercrops in oil palm and Coconut, he invited fellow farmers and inspired them to adopt intercrops for effectively utilizing the horizontal and vertical space. Adopted intercrops i.e. long pepper, cocoa and banana in oil palm. Since inception,

adopted harvesting of Fresh Fruit Bunches (FFB) of oil palm with aluminium pole attached with sickle and avoided manual harvesting. Square method of oil palm planting with 9 m space was adopted to utilize horizontal and vertical space for inter crops. Planted banana and cocoa as an intercrops in oil palm. Took up long pepper in oil palm to utilize vertical space he introduced the long pepper in the district for the first time and the marketing is facilitated through M/s. Dauber India Ltd., through buy back system. He multiplied the planting material, made available to the farmers free of cost. Arranged awareness campaign on cultivation of long pepper as intercrop in oil palm and coconut.

Crop wise income, cost-benefit ratio, gross and net income

Crop	Yield	Price (Rs.)	Gross income/ ha (Rs.)	Cost of cultivation/ ha (Rs.)	Net income / ha (Rs.)	Cost Benefit Ratio
Oil palm	23 tonnes FFB	8500 / tonne FFB	195000	82500	112500	0.73
Banana	750 (Bunches)	120/bunch	90000	25000	65000	0.38
Cocoa	235 kg	160/kg	37600	15000	22600	0.66
Long Pepper	125 kg	400/kg	50000	6250	43750	0.14

Obtained sustainable yield in oil palm by adopting fertigation, in-situ decomposition. Could double the farm income by intercropping

Farmer : **SimhadriAppaji Srinu**, West Godavari Dt., A. P.

Adopted triangular method of **planting,** Adopted **Micro irrigation** for effective utilization of water, save power & ground water and reduce weed growth. He adopted fertigation in his field for the first time in the village. He is also using the waste decomposer to decompose the waste generated in the field and providing to the crops through fertigation. **Modified the fertilizer dose m**anaged the dosage of fertilizers to meet the demand of both the main crop and inter crop. Fertilizers and waste decomposer are being provided to main crop and intercrop through fertigation. Reduced the cost of fertilizers by half thus saved cost of fertilizers (inputs) and labour.

Crop wise income, cost-benefit ratio, gross and net income

Crop	Yield	Price (Rs.)	Gross income/ ha (Rs.)	Cost of cultivation/ ha (Rs.)	Net income / ha (Rs.)	Cost Benefit Ratio
Oil palm	25 tonnes FFB	8500/ tonne FFB	212500	83750	128750	0.65
Cocoa (intercrop in oil palm)	3.75 qt.	15000/qt	56250	25000	31250	0.80

ENTREPRENEURSHIP DEVELOPED

Entrepreneurship developed with the following Indian companies on the licensing of oil palm tissue culture protocol.

S. No.	Company
1	Bejo Sheetal Bio-Science Foundation (BSF), Jalna, Maharashtra
2	Vijaya Phyto Farms Private Limited (VPFPL), Hyderabad
3	SristiAgro Biotech Pvt Limited, Howrah
4	Sheel Biotech Limited, New Delhi

RESEARCH PUBLICATIONS

NAAS Rating	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Number of articles published in <6.0 NAAS rating	3	5	-	2	9	4
Number of articles published in >6.0 NAAS rating	5	7	10	3	2	5
Total publications	**8**	**12**	**10**	**5**	**11**	**9**

AWARDS/RECOGNITION

- Dr. R.K. Mathur received prestigious most outstanding professor award for his professional achievement by World Education Congress on 27th October, 2020

- ICAR-IIOPR Awarded second prize for the best stall in the category of ICAR institutions, in the National Horticultural Fair 2019, held at ICAR-Indian Institute of Horticultural Research, Bengaluru during, January 23-25, 2019

- Dr. M. V. PrasadReceived the Rytunestham foundation awardand presented with Padmasree Dr. I. V. SubbaRao Rytunestham Purasakaram-2017 on October 3, 2017 by Hon'ble Vice president ofIndia Sri. M. Venkaiah Naidu, at Atkur village, Krishna Dt., Andhra Pradesh.

- Dr. M. V. Prasad Received best research paper, oral presentation on "Voice Message Services ICT tool for dissemination of oil palm technologies" (by Prasad, M. V., Mary Rani, K. L.,Sundera Rao, N. and Sowjanya, P.) in the National Conference on "Digital and engineering technologies for precision agriculture and value addition" organised by College of Agricultural Engineering, Bapatla, Guntur district, Andhra Pradesh during February 26-27, 2018.

- Dr. B. Kalyana Babu, Senior Scientist(Biotechnology) received ICAR- Lalbahadur Shastri Outstanding Young Scientist Award for the year 2017 (Crop and Horticultural Sciences).

- Dr. B. Kalyana Babu, received Jawaharlal Nehru Award for outstanding Doctoral Thesis Research in Agricultural and Allied Sciences (Crop Sciences) for the year 2015' on July 16, 2016.

- Dr. K. Suresh, received best oral presentation award for his research paper entitled "Evaluation of drought tolerance in oil palm hybrids using drought sensibility indices" during the "International Symposium on Biodiversity, Agriculture, Environment and Forestry" held at Ooty, Tamil Nadu during December 11-12, 2015.

- ICAR- Indian Institute of OilPalm Research received firstprize in the Krishi KalyanAbhiyan (KKA) programme implementation conducted at Vizianagaram district, Andhra Pradesh at national level.

- Dr. Sanjib Kumar Behera, Senior Scientist received Associate Fellowship of Andhra Pradesh Akademy of Sciences (APAS), Amaravathi, Guntur, and Andhra Pradesh for the year 2016 on November 07, 2016 in recognition of contribution towards science and technology.

- Mr. A. Dhana Raju, Skilled Supporting Staff has been awarded cash prize under "Cash Award Scheme for Supporting Category Employees of ICAR" during the 87 Foundation Day ceremony of ICAR held at Patna on July 27, 2015.

- Mary Rani KL et al., received Best poster award for the poster titled "Software aid in selection of promising germplasm for oil palm improvement trials" during the National Seminar on "Technological Innovations in Oil seed Crops for Enhancing Productivity, Profitability and Nutritional Security" organized during February 7-8,2020 at Hyderabad.

- Sunitha received best paper National oil seeds seminar held at ICAR-IIOR, Hyderabad on the paper entitled "Influence of integrated use of microbial inoculants andinorganic fertilizers on growth and nutrient dyanamics of oil palmseedlings" during February 7-8, 2020.

- Dr. M.V. Prasad Received best research paper, poster presented on "Chipping bucket - A feasible approach for oil palm trunk disposal" (by Preethi, P., Vidhan Singh, T. V., Prasad, M. V.,Ramajayam and Mathur, R. K.,) in International Symposium on Horticulture: Priorities & emerging trends, held during 5-8 September 2017 at ICAR-IIHR, Bengaluru, Karnataka.
- Dr. L. Saravanan, received Fellow Award 2017 from Society for Plant Protection Sciences, New Delhi.
- Dr. P. Murugesan has been conferred with Fellow of Indian Society of Plantation Crops
- Dr. L. Saravanan, receivedAward for Excellence in Research – SouthAsian Education Awards 2017 presented by Education expo TV, Research and Branding Company, Noida.
- Dr. P. Preethi, received Best oral paper (II prize) – International Conference on New Approaches in Agriculture, Food and Environmental Sciences organized by Andhra Loyola College, Vijayawada, Andhra Pradesh onDecember 22-24, 2016
- Dr. B. Kalyana Babu, received Best Poster award-1 International conference on Agro Biodiversity, at New Delhi held on November 06-09, 2016.
- Kalyana Babu B received Best Oral presentation (First Prize) during National Symposium on Potential crops for food and nutritional security at TNAU, Coimbatore for the paper entitled "Molecular approaches for improvement of oil palm germplasm".
- Kalyana Babu B received best oral presentation during National Seminar on "Climate smart Agriculture for Sustaining Crop Productivity and Improving Livelihood Security (27.02.2020 to 28.02.2020) at Annamalai University, Chidambaram, Tamil Nadu.
- Venu MVB received Best Oralpresentation at National oilseeds seminar held at ICAR-IIOR, Hyderabad.
- Felicitation for achieving first inIndia in implementation of KKA Programme

TRAININGS ABROAD

Dr. R.K. Mathur, Director to Europe during 21-30 September'2019

- Dr. R.K. Mathur attended Executive Development Programme- International component organized by AdministrativeStaff College of India (ASCI) and coordinated by ICAR-National Academyof Agricultural Research Management(ICAR-NAARM), Hyderabad.

- Dr.P.Murugesan and Dr.K.SunilKumar visited MPOB, Malaysia during 12-18, October 2015 under Oil palm germplasm exchange programme

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