Biodata of the Scientist

Division/Section:Crop Production

A.Personal information

1.Name(With Title): Dr. **K. SUNILKUMAR**

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1.a. Qualification: PhD (Horticulture)

2. Designation: Principal Scientist

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6. Countries visited: ___Malaysia

B. Professional information

1. Area of specialization:____Horticulture

2. Area of interest:___ Seed systems, Protected cultivation, Hitech horticulture, Urban farming, Breeding of horticultural crops

3. Number of institute projects completed(Add list):_11_____

4. Number of Institute projects being handled(Add list):_3_____

5. Number of externally funded projects completed(Add list):__8_____

6. Number of externally funded projects being handled(Add list):__1_____

7. Number of students guided for a) Ph.D_____b) M.Phil_____c) M.Sc___1_____

8. Number of students being guided for a) Ph.D_____b) M.Phil_____c) M.Sc__1_____

8.a. Information about the students under your guidance

Name of the student	Course undergoing (Ph.D/M.Phil/M.Sc)	Title of the project/Thesis	E-mail address
V.S. Aiswarya	MSc	Effect of minisett pretreatments on portray nursery of yam	vsaiswarya20@gmail.com
Pangi Anitha	MSc	Ginger (Zingiber officinale Rosc.) cultivation and	-

		quality seed production through hydroponic techniques	

9. Information on guide ship

Guide ship for Ph.D/ M.Phil/ M.Sc	University	Subject
PhD and MSc	IARI Mega univeristy, Bengaluru Hub	Vegetable science

10. Number of Research papers(Add list): __11 (above 6 NAAS score)_____total __30
11. Number of Books/Book chapters(Add list): _book-1, chapters- 13
12. Number of Technical Bulletins(Add list): 6
13. Consultancies offered (Add list and give a brief description):
14. Technologies developed(Add list and give a brief description):
15. Patents/Copyrights obtained (Add list and give a brief description):
16. Any other information:

Detailed information

3. **List of institute projects completed/being handled**

1. Dissemination of technology and ict applications in oil palm sector
2. Collection, conservation, cataloguing and evaluation of oil palm germplasm
3. Breeding for high yield in oil palm
4. Breeding for dwarfness in oil palm
5. Strengthening of seed gardens for indigenous seed production
6. Biotechnological studies in oil palm
7. Investigations on rapid multiplication of yams and aroids
8. Developing innovative techniques for seed production in tropical tuber crops and quality planting material production in cassava, sweet potato and chinese potato
9. Improvement of tomato to develop suitable variety for manipur
10. Improvement of brinjal to develop suitable varieties for manipur including agrotechniques
11. Development and transfer of tuber crops technology for the neh region
12. Development of suitable agrotechniques for pineapple in rainfed foothills of manipur
13. Development of grading system for oil palm ffb and estimation of factory level oer

14. Multidisciplinary approaches for transfer of technology and area expansion in relation to oil palm development in india

5. **Details of external funded Research Projects handled/being handled**.

S.N.	Title	Funding Agency	Budget (lakhs)	Period (from-to)
1	Popularization of climate resilient improved varieties of tuber crops for food, nutrition and doubling income with emphasis on wellness of tribal and marginal farmers in Kerala	Dept of Agriculture, Govt. of Kerala	356.527 lakhs	2019-2022
2	Development of quality standards for planting material in oil palm nursery (PI)	DAC, Ministry of Agriculture, Govt. Of India with allocation (RKVY/NMOOP)	1.Rs 6.20 lakhs	2013-14
			2.Rs. 6.50 lakhs	2014-15
			3.Rs 10.0 lakhs	2015-16
3	Optimization of pollen viability and storage techniques in oil palm (PI)	DAC, TMOP	10 lakhs	2011-13
4	Strengthening of oil palm genetic resources in India (Co PI)	DAC, TMOP	36.5 lakhs	2011-13
5	National network on integrated development of Jatropha (Co PI)	NOVOD Board, GOI	15	2005-2007
6	The technology mission for	DAC, GOI	41	2003-2007

	horticulture development in the north eastern region including Sikkim': MM-1(Co PI)			
7	Consultancy project on oil palm hybrid seed production at seed garden at Taraka (PI)	The Department of Horticulture, Govt. of Karnataka	Rs. 22.48 lakhs	2012-13 to 2013-14
8	Consultancy project on oil palm hybrid seed production (Co PI)	Navbharat Agro products Pvt Ltd, Andhra Pradesh	7.84 lakhs	2013-14

6. Details of external funded Research Projects being handled.

1	Empowerment of tuber crops farmers through sustainable use of resources and tuber crops technologies	SCSP-Institute, ICAR-CTCRI	41.5 lakhs	2024-25

10.List of publications

Sl. no	**Authors**	**Title**	**Journal**	**Volume**	**Page no**	**Year**
	Sunilkumar, K., Murugesan, P. Mathur, R.K. and Rajesh, M.K	Genetic diversity in oil palm (*Elaeis guinensis* and *Elaeis oleifera*) germplasm as revealed by	*Ind. J. Agric. Sci.*	**90**(4):	741-45	2020

		microsatellite (ssr) markers.				
1	R.K.Mathur **and K.Sunilkumar**	Selection of *pisifera* parents based on progeny performance of D x P oil palm hybrids	*Indian J. of Hort.*	72 (2)	278-281	2015
2	**Sunilkumar K.,** Mathur, R.K. and Sparjanbabu, D. S.	Efficacy of organic solvents for medium term storage of oil palm (*Elaeis Guineensis* Jacq.)	*Indian Journal of Agricultural Research*			2015.
3	Murugesan, P. And **Sunilkumar, K**.	Dwarf palms for future generations.	*Indian Horticulture*,	59(6)	10-12	2014
4	Murugesan, P. And **Sunilkumar, K.**	Enriching oil palm industry through American oil palm.	*Indian Horticulture*	59(3)	7-9	2014
5	Murugesan, P., K L Mary Rani, D Ramajayam, **K Sunilkumar**, R K Mathur, G Ravichandran, P Naveen Kumar and V	Genetic diversity of vegetative and bunch traits of African oil palm (Elaeis	Indian Journal of Agricultural Sciences	**85**(7)	892-5	2015

	Arunachalam,	guineensis, Jacq.) germplasm in India,				
6	**Sunilkumar, K** ., Mathur R K ., and Sparjan Babu , D S**.**	Differential pollen longevity in Dura and Pisifera oil palm fruit types (*Elaeis guineensis* Jacq.) and storage temperatures	Indian journal of Agricultural sciences	87(7):	893-8	2017
7	Murugesan, P Mary Rani, K L Ramajayam, D **Sunilkumar, K**., Mathur, R K Ravichandran, G Naveen Kumar P and V Arunachalam.	Genetic diversity of vegetative and bunch traits of African oil palm (Elaeis guineensis, Jacq.) germplasm in India.	Ind. J. Agricultural Sciences	87(9)	1184-9	2017
8	P. Naveen Kumar, R. K. Mathur, P. Murugesan*, A. G. K. Reddy, K. Sunilkumar, D. Ramajayam, G. Ravichandran	Seasonal variation in Fresh Fruit Bunch production in Dura Oil Palm.	Ind. J. Agricultural Sciences	87(9)	1184-9	2017
9	K. Suresh, M.Kiran Kumar,	Variations in photosynthetic	*Indian J. Plant Physiology*	**17** (3-4)	233-240	2012

	D. Lakshmi Kantha, R. Prasanna Lakshmi and **K. Sunilkumar**	parameters and leaf water potential in oil palm grown under two different moisture regimes				
10	**Sunilkumar, K**. and D.S. Sparjan Babu	Surface color based prediction of oil content in oil palm (*Elaeis guineensis* Jacq.) fresh fruit bunch	*African journal of Agrl. Res.*	**8** (6)	564-569	2013
11	Krishnakumar, C.R., Maheshwar, D.L. and **Sunilkumar, K**.	Record yield in oil palm achieved by woman farmer in Karnataka, India.	*The Planter*	**88** (1040)	831-833	2012.

11a.Book

Sunilkumar, K., Mathur, R.K., Ravichandran, G. and Somasundaram, G.2019. **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian institute of oil palm research, Pedavegi .p 100

11b.Book chapters

1. **Sunilkumar, K.** Rao, B.N.,Ngachan,S.V. and Kh. Hera Singh. 2003. Status of plasticulture in Manipur. In Plasiculture Interventions for agriculture development in North-East region.

(eds. K. K .Satapathy and Ashwanikumar), ICAR Research Complex for NEH Region, Umiam, Meghalaya, p 326-329

2. **Sunilkumar, K.** 2008. Black turmeric (*Curcuma caesia* Roxb): Its importance, ecology and conservation.2008. In Eco-planning and Biodiversity conservation. (Ed. G.P. Mishra), Avishkar Publishers, Jabalpur, India.
3. Mathur, R.K., **Sunilkumar,K**. and Murugesan,P. 2016.Prospects of interspecific hybrids in oil palm. In M.R.Dinesh and M.Sankaran (eds) Distant hybridization in horticultural crops published by Astral International Pvt.ltd., New Delhi.pp 103-109
4. **Sunilkumar, K**., Mathur , R. K., Kalyan babu ,B and Murugesan, P.2017.Oil palm *In* P.Chowdappa, Anitha karun, Rajesh, M.K and Ramesh S.V. (Eds) Biotechnology of Plantation Crops. Daya Publishing house, New Delhi. pp 241-260.
5. **Sunilkumar ,K. 2019.**Selection of parent palms *In: Eds* K. Sunilkumar *etal.(*2019*)* **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian Institute of Oil Palm Research, Pedavegi .
6. **Sunilkumar ,K.** and Ravichandran, G. **2019.** Hybridization In*: Eds* K. Sunilkumar *etal.(*2019*)* **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian Institute of Oil Palm Research, Pedavegi.
7. **Sunilkumar ,K. 2019.**Bunch analysis *Eds* K**.** Sunilkumar *etal.(*2019*)* **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian Institute of Oil Palm Research, Pedavegi .
8. **Sunilkumar ,K.** and Somasundaram, G.2019. Seed processing and germination, In:*Eds* K. Sunilkumar *etal.(*2019*)* **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian Institute of Oil Palm Research, Pedavegi.
9. **Sunilkumar ,K**. and Mathur, R.K., 2019. Quality control in hybrid seed production In*: Eds* K. Sunilkumar *etal.(*2019*)* **Oil palm hybrid seed production** (ISBN **81-87561-55-6)**. ICAR-Indian Institute of Oil Palm Research, Pedavegi.
10. Sunilkumar, K., Muthuraj, R., Suresh Kumar, J.2023. Importance of quality planting material in tropical tuber crops and CTCRI initiatives to develop seed system'. Sunilkumar, K., Muthuraj, R. and Suresh Kumar, (Eds) Advances in quality planting material production of tropical tuber crops. ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala:1-4
11. Sunilkumar, K., Suresh Kumar, J.2023. *In vivo* rapid multiplication of yams and aroids. Sunilkumar, K., Muthuraj, R. and Suresh Kumar, (Eds) Advances in quality planting material production of tropical tuber crops. ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala
12. Sunilkumar, K. 2023. *In vivo* and *in vitro* methods of quality planting material production in yams and aroids. In: *Sustainable Utilization of Genetic Resources of Neglected and Underutilized Tuber Crops for Climate Resilience and Nutritional Security*. Murugesan, P., Senthilkumar, K.M., Krishna Radhika, N., Visalakshi Chandra, C. and Mohan, C. (Eds.). ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala,ISBN: 978-81-957479-1-7, pp. 182-190.
13. Sunilkumar, K .2023. Protected cultivation for clean seed production in tropical tuber crops. Sunilkumar, K., Muthuraj, R. and Suresh Kumar, (Eds) Advances in quality planting material

production of tropical tuber crops. ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala

12. Technical bulletins

- **Sunilkumar, K**., Mathur, R.K. Navin Kumar, P.,Goutam Mandal and Arulraj, S. 2013.Proceedings of National Oil palm Seed Meet -2013'Directorate of oil palm research, Pedavegi p-24
- **Sunilkumar, K**. Mathur, R.K. Navin Kumar, P., Arulraj, S. and Nampoothiri, K.U.K. 2013.Methodologies for conducting crop improvement trials in Oil palm' Directorate of oil palm research, Pedavegi p-12
- **Sunilkumar, K**., Ramachandrudu,K., Sparjanbabu,D.S. and KochuBabu, M.2010.Tools and techniques for oil palm harvesting.Directorate of oil palm research, Pedavegi p-16
- Mathur, R. K., Murugesan, P., Prasad, M. V., **Sunilkumar, K**., Srinu, B., Praveen Kumar, B. and Ravi Kumar, K. 2014. *Do's and Don't's in oil palm hybrid seed production*. Directorate of Oil Palm Research, Pedavegi, A. P., P.12.
- Mathur, R.K., Murugesan, P., Prasad, M.V., **Sunilkumar, K**., Srinu, B., Praveenkumar, B. and Ravikumar, B. (ISBN 81-87561-28-9) *Ennapanayude sankara vitthulpadanam:Cheyyendathum cheyyaruthathathum* (Malyalam) Directorate of Oil Palm Research, Pedavegi, A. P., p.12.
- Jeeva M.L., **Sunilkumar** K., Asha Devi , A. Kesavakumar H., Krishnakumar T. and P. Prakash.2023. Elephant Foot Yam **.** Technical Bulletin, ICAR-CTCRI. p38.

13.Consultancies offered

Title of consultancy offered	Client
Consultancy project on oil palm hybrid seed production at seed garden at Taraka (PI)	The Department of Horticulture, Govt. of Karnataka
Consultancy project on oil palm hybrid seed production (Co PI)	Navbharat Agro products Pvt Ltd, Andhra Pradesh
Consultancy project on oil palm hybrid seed production	Department of Agriculture, Govt. Of Mizoram

Consultancy project on oil palm hybrid seed production	Oil palm India Limited, JV of Govt of Kerala and Govt of India, Kottayam, Kerala

14. Technologies developed

1.Development of methodology for quality testing of oil palm pollen:

An effective method for determining pollen quality such as viability and germinability is a prerequisite for successful breeding programmes in oil palm. Previous reports in many crops established the differential response of pollen to media composition as well the staining method. Hence, study was taken up to standardize the method of pollen quality assessment in terms of viability and *in vitro* germination in oil palm. Screened five established dyes to assess the oil palm pollen viability Of the five dyes, 2, 5-diphenyl Tetrazolium bromide (MTT) performed better with high correlation of viability with *in vitro* germination. It did not stain dead or aborted pollen. For *in vitro* germination test, eight different media were tried. The media consisting of 2.5%-Sucrose;100ppm - H_3BO_3 and PEG-10% (Mw 10,000) produced the maximum of 97.941% germination with pollen tube length of 317.88µm and high correlation of germination with viability/staining values. Hence, this media was selected for oil palm pollen germinability testing. Thus, the methodology for quality testing in terms of viability and in vitro germination was standardized for oil palm pollen. Further, it is also recommended for using some type of control such as dead pollen to check the potential of the dye for pollen viability testing in oil palm.

2.Medium term storage of oil palm pollen:

As commercial variety is Tenera produced by pollinating Dura with Pisifera pollen and male and female flowers/infloresences are produced in different times, it has become necessary to collect and store pollen for any selfing or crossing programme. The oil palm pollen was subjected to four storage temperatures such as ambient /room temperature (RT=35± 2 oC), refrigerated storage (5oC), Freezer storage at -5 oC and Deep freezer storage at -20 oC. There was significant variation for viability and germination percentages among the different storage temperatures tried. At room temperature, viability of pollen was rapidly lost and at third month of storage , it reached below 60 percent. Similar was the case with pollen stored in refrigerated condition (5oC). In case of pollen stored in freezer of refrigerator (-5oC), it retained viability upto 9 months at satisfactory level of above 60 percent. In case of deep freezer (-20oC) stored pollen, the viability was retained above 80 % upto 12 months.

The result was confirmed by in vivo fruit set studies carried out using Pisifera pollen after storage. Bunch analysis data revealed that the mean maximum bunch weight (19.17 kg) was in pollen stored at -20 oC and the lowest in case of room temperature stored pollen (13.32kg). Weight of fruits (after removing stalk and spikelet rachis) was the maximum for -20 oC stored pollen (13.9kg) followed by 11.47 and 11.01 kg for -5 and 5 oC storage. The pollen from RT storage resulted in only 9.09 kg fruits. Percent sterile fruits was highest (30.89) in case of RT stored pollen indicating the loss in viability of the pollen. This was followed by 18.26 % in case 5 oC stored pollen, 18.611 % in case -5 oC stored pollen and 5.47 % in case of pollen stored at -20 oC , indicating the effectiveness of the last treatment for storing the Pisifera pollen. Thus, it was found with respect to storage

under varying temperatures, storage in deep freezer at -20 oC retained maximum viability as well as germination.

3.Storage of pollen in organic solvents

Storage of pollen for sufficiently long period without considerable loss of viability has been amajor cncern for oil palm. Reports suggested the scope of storing pollen grains of various plants in organic solvents. Hence, studies were conducted to find out the efficacy of organic solvents for pollen storage. Among five solvents tried for pollen storage, there was significant variation for viability and germination percentages. Viability was the maximum for pollen stored in Diethyl ether (90.45 %) as well as in n-Hexane (88.41%) at 200 days of storage against 99 % for fresh pollen. Viability of pollen stored in Chloroform and acetone were moderate and in case of Methyl alcohol, complete loss of viability was observed after initial 40 days. With respect to germination, similar trend was observed with the highest germination percent in pollen stored in Diethyl ether (78.98%) and n-Hexane (78.11%) against 94 % in case of fresh pollen. Same trend was observed for different intervals/period of storage. Pollen grains stored in non polar organic solvents (n-Hexane and Di ethyl ether) retained maximum viability where as those stored in polar solvents, lost viability and germination very fast. Extensive leaching of membrane phospholipids, sugars and amino acids into the solvents could be the primary reason for loss of viability in case of polar solvents as they are hydrophilic in nature. Non polar solvents cause very little leaching and hence did not affect viability or germination considerably.

The *in vivo* fruit set data obtained after pollination with stored pollen indicated the same trend as in case of *in vitro* viability and germination tests. Bunch weight, number and percentage of sterile fruits as well as fruit to bunch ratio showed that, pollen stored in Diethyl ether and n-Hexane were normal with about 20 kg bunch weight. The weight of bunch was reduced to 17.4 kg in case of Chloroform and 5.86 kg for Acetone. As observed in *in vitro* studies, bunches pollinated with pollen from Methyl alcohol showed bunch failure (no fruit set). Percent sterile fruits was 19.41 in Diethyl ether and 14.5 in n-Hexane. Where as in case of Chloroform and Acetone sterile fruits varied from 26.47 to 28.3%. In a case of fruit to bunch ratio, the highest being in Diethyl ether (67.5 %) followed by n-Heaxane (59.7%) and Chloroform (53.56%).Thus, present method indicated that it is feasible to store oil palm pollen in Diethyl ether or n-Hexane at -5^{o}C temperature beyond one year without considerable loss of viability or germination.

4.Development of Cryo preservation protocol for oil palm pollen

Conservation of valuable genetic resources in oil palm necessitated technology for long term storage of pollen grains. Reports suggested that in many crop plants preservation of plant material/pollen in liquid nitrogen at -196 ^{0}C was effective. Hence, further to development of short/medium term storage techniques, studies were conducted to develop protocol for cryopreservation of oil palm pollen. Pollen was collected from inflorescences of Dwarf Tenera (P-221), processed by following standard practices. Then the pollen was placed in 5 ml cryo vials and immersed in liquid nitrogen for 1 hour in a 10 litre cryocan and then taken out and thawed as per standard procedure. The viability and germination were estimated for fresh pollen before cryo treatment as well as after cryo exposure at -196^{0}C (liquid nitrogen). Both the viability and germination of cryo stored pollen were retained at 79 and 74 percentages after storage against the original 87 and 84percentages. There was no significant morphological changes observed before

and after cryo treatment under Light microscopy or scanning electron microscopy. The pollen grains were stored in liquid nitrogen for one year and when tested showed no significant decline in viability or germination. *In vivo* fruit set studies confirmed results. The study was repeated with different pollen sample and the results were in conformity with first study. Thus, standardised the method of cryopreservation of oil palm pollen.

5.First report of Differential Longevity of Dura and Pisifera pollen

Dura and Pisifera pollen were collected and processed following standard procedures and stored at different temperatures viz. Room Temperature (RT) of 35±3^{o}C, 5^{o}C, -5 ^{o}C and -20^{o}C for a period of 12 months. Observation on viability (MTT test) and *in vitro* germination were recorded at monthly interval for the entire period of storage for Dura as well as Pisifera pollen.

Dura pollen retained viability for one month where as Pisifera for two months at room temperature storage. At **5^{0}C** , Dura retained viability upto two months whereas Pisifera for three months. At **-4^{o}C** , Dura remained viable upto four months . But Pisifera retained viability upto nine months. When stored at **-20^{o}C** , both remained viable for 12 months, with pisifera retaining higher percentage of viability compared to Dura. The overall viability and germination decreased with increased storage period as well as with storage temperature. Temperature above 0^{o}C was not suitable even for storage of pollen from both fruit form types. The results of the study pointed that -20^{o}C was the best storage temperature for both the fruit forms viz. Dura and Pisifera upto one year. In general, Pisifera pollen retained viability for more time compared to Dura pollen. To the best of my knowledge, this is the first report on differential pollen longevity in case of oil palm Dura and Pisifera fruit types.The results were confirmed by *in vivo* fruit set studies where after storage pollination was carried out separately using Dura and Pisifera pollen and bunch analysis done.

Genetic Stocks – Oil Palm

1. **Development of dwarf oil palm:**
   In an effort to develop dwarf and compact oil palm, selfed progeny of the Dwarf Tenera -1 from Palode was evaluated. The mean height of progenies was 165.94 cm on 7th year. Out of 58 palms, 23 recorded a height increment less than 40 cm of which 4 palms recorded height increment less than 30 cm per annum. Palm no.31 recorded annual height increment of 19 cm and a bunch index of 0.43 against the standard value of 0.3 for normal DxP material.

   The canopy spread was analysed to find out the number of palms that could be accommodated per unit area. The mean canopy spread was 61.33 sq.m which allows is 23.76 percent extra land area as compared to currently followed spacing of 9mx9m. Hence, a modified spacing with 161 palms /Ha would be possible . Yield potential of the selected progeny is 33.01 MT/Ha which in turn is equivalent to 6.6 MT oil per ha. With 30 cm per annum as average height

increment of dwarf palms the plantation height could be around 9.0 meters (~ 27 ft) upon reaching 30 years. Therefore, with the present rate of height increment of dwarf tenera progenies, it would be possible to harvest palms well beyond thirty years and economic life of plantations could be extended considerably.

2. Identification of high yielding Dura mother palms

Increased yield of Fresh Fruit bUnches (FFB) and therby oil yield has been the most important objective in oil palm improvement programme. Yield data of elite Dura palms for use as mother palms in crossing programme were collected and analysed for selection of high yielding palms. The enhanced selection criteria of 200 kg FFB per palm per year was applied while selecting the Dura as mother palm. This inturn, is expected to ensure yield of >30 MT FFB and >6 MT palm oil per ha per year from the new hybrids that would be developed using these mother palms. Five year Fresh Fruit Bunch yield of ten DxD crosses in the second breeding cycle at oil palm seed garden Thodupuzha were collected. The data was then analysed for stability parameters in order to identify consistent performing crosses. By considering the stability parameter along with mean yield, ThD2 was the best genotype followed by ThD 5 and ThD1. From among the best families, individual palms with highest mean yield were selected for use in developing crosses. Similar exercise was carried out with Dura-II population at IIOPR-RC, Palode and selected high yielding palms. The details of mother palms are given below:

3.Promising interspecific hybrid palms Identified

The *E. oleifera*, otherwise known as American Oil Palm is under-utilized and considered to have dwarfness, tolerance to several biotic and abiotic stresses, high iodine value , high carotene content, high vitamin E content etc. Hence, inter-specific hybridization was taken up for introgression of desirable traits mainly dwarfness /compactness from *E. oleifera* into *E.guineensis* ,the cultivated species. In interspecific hybrids the refining efficiency is higher leading to more recovery of liquid oil compared to the traditional *E.guineensis* varieties. Two inter-specific hybrids ISH-1(360Egx13Eo) and ISH-2 (361Egx11Eo) developed with *E. guneensis* as female and *E.oleifera* as male parent are evaluated along with Dura x Pisifera (Tenera)

Subsequent upon variance and heritability analysis of various growth and bunch components, a selection index was constructed by considering the most important traits of height increment, FFB yield and oil yield. As result, eight palms were shortlisted; five from ISH-1 and three from ISH-2. Of the five promising palms from ISH-1, four were having annual height increment

between 30 and 33 cm. Number of leaves produced by interspecific hybrid is lower compared to *E. guineensis.* Palm number 28 recorded a bunch yield of 148.25 kg, height increment of 33.1 cm and had a bunch index of 0.29 which is on par with normal D x P. Though ranked low, palm numbers 2 and 3 were promising with respect to height increment and had moderate yield.

Palm 28 of ISH-1 showed potential of the maximum oil yield of 4.8 tonnes per ha resulting from the high mesocarp content and oil to bunch ratio. This was followed by 3.8 tonnes per ha in palm 25, also from ISH-1. Among promising palms from ISH-2, palm 34 recorded the highest oil yield of 3.4 tonnes per ha. The kernel size was the maximum for palm number 34, which in turn would be useful in the development of genotypes for high kernel oil.

4. Identified dwarf Dura palms having drought tolerance

Dura palms are important as the desirable trait identified in Dura could be directly used in breeding as well as commercial seed production. Four dwarf Dura palms having tolerance to abiotic stress (drought resistance) have been identified.

- **42CD**: dwarf Dura palm with 212cm after 14 years having annual height increment of 19.27 cm, fruit to bunch 52 %, shell to fruit 30, kernel to fruit 12.6 %, oil to bunch 11.26 % . The FFB yield is 117 kg/palm/year with average bunch weight of 14.6 kg.

- **43CD**: Dura palm having 220 cm height, 20 cm annual height increment, 68 % fruit to bunch, 26.4 % shell to fruit, high oil to bunch of 24.17%, big fruit size (16.13g), FFB yield of 172 kg/palm/year with average bunch size of 13.23 kg.
- **497CD**: Dura, extremely dwarf with 202 cm height, 18.36 cm annual height increment, 70 % fruit to bunch , 29.46 % shell to fruit, 20.9% oil to bunch, and average bunch weight of 13.6 kg.
- **465CD**: Dura palm, medium dwarf (232cm), having 21.09 cm annual height increment, fruit to bunch 72 %, shell to fruit 31.6 %, oil to bunch 13.62 %, FFB yield of 159 kg/palm /year with mean bunch weight of 22.7 kg

1. Development of DxD and TxT crosses for high yield

By utilizing the selected high yielding mother palms at three places viz. OPSG Thodupuzha , DOPR- RC Palode in Kerala and OPSG-Taraka, Mysore, Fifty crosses were made for high yield.

Fourty two crosses have been supplied as part of the research trial to be established at centre under UHS Bagalkot. Nursery established at to AICRP-Palms Gangavathy and nursery evaluation of the crosses is in progress. The details of the crosses along with parentage are presented in the following table.

Sl no	Cross ID	Sl no	Cross ID

1	IOP.TP.002D	22	IOP.PL.011D
2	IOP.TP.006D	23	IOP.PL.013D
3	IOP.TP.007D	24	IOP.PL.014D
4	IOP.TP.011D	25	IOP.PL.015D
5	IOP.TP.012D	26	IOP.MY.001T
6	IOP.TP.013D	27	IOP.MY.002T
7	IOP.TP.014D	28	IOP.MG.001T
8	IOP.TP.015D	29	IOP.TK.004D
9	IOP.TP.016D	30	IOP.TP.031D
10	IOP.TP.019D	31	IOP.TP.030D
11	IOP.TP020D	32	IOP .TP.017D
12	IOP.TP.021D	33	IOP .TP.008D
13	IOP.TP.022D	34	IOP .TP.009D
14	IOP.TP.023D	35	IOP .TP.005D
15	IOP.TP.024D	36	IOP .TP.032D
16	IOP.TP.025D	37	IOP .TK.001D
17	IOP.TP.028D	38	IOP .TP.033D
18	IOP.TP.029D	39	IOP .TP.004D
19	IOP.PL.001D	40	IOP .TK.005D
20	IOP.PL.002D	41	IOP .TP.018D
21	IOP.PL.007D	42	IOP .PL.017D

6. Development of DxP Oil Palm Hybrids

Commercial planting material in oil palm is DxP hybrid (Tenera) and hence development of new hybrids and evaluation are critical steps in improvement programme**.** Eleven DxP hybrids with dwarfness, high yield and tolerance to moisture stress were developed and the evaluation trial laid

out along with DxP control at Vijayrai Centre of AICRP on Palms under the Andhra Pradesh Horticultural University. The details of the hybrids and parentage is given below.

Sl no.	Parentage	Cross ID
1	328CDx76P	DOPR 41
2	166Cdx76P	DOPR 42
3	99CDx76P	DOPR 43
4	83CDx76P	DOPR 44
5	45Cdx76P	DOPR 45
6	193CDx110P	DOPR 46
7	45CDx110P	DOPR 47
8	487CDx110P	DOPR 48
9	250CDx110P	DOPR 49
10	438CDx110P	DOPR 50
11	240CDx110P	DOPR 51
12	97CDx76P	Control

7. Plant genetic resources developed :

In view of the stringent regulations in transfer of genetic resources by those countries having primary collections, it was decided to survey the existing plantations within the country for trait specific/country specific collection. As result of germplasm survey and collection activities 166 palms identified of which **52 accessions have received IC numbers** from NBPGR, New Delhi which are collected from commercial oil palm plantations having exotic genetic material various parts of the country.

Sl. No	Accession	Imp Traits/Remark	Sl. No	Accession	Imp Traits/Remark
1	IC-0610000	Planted by MACS during 1950s and Conserved in FGB at DOPR, Pedavegi	27	IC-0610026	Dura, thick shell, high yield under drought condition from ASD Costa Rica and Conserved in

					FGB at DOPR, Pedavegi
2	IC-0610001	Planted by MACS during 1950s and Conserved in FGB at DOPR, Pedavegi	28	IC-0610027	Tenera and Conserved in FGB at DOPR, Pedavegi
3	IC-0610002	Tenera, Malaysian Source and Conserved in FGB at DOPR, Pedavegi	29	IC-0610028	Tenera, thin shell, elongated bunch, PNG Source and Conserved in FGB at DOPR, Pedavegi
4	IC-0610003	Tenera, Malaysian Source and Conserved in FGB at DOPR, Pedavegi	30	IC-0610029	Tenera, big fruits, small kernel, PNG source and Conserved in FGB at DOPR, Pedavegi
5	IC-0610004	Tenera, Malaysian Source and Conserved in FGB at DOPR, Pedavegi	31	IC-0610030	Tenera, thin shell and Conserved in FGB at DOPR, Pedavegi
6	IC-0610005	Tenera, Malaysian Source and Conserved in FGB at DOPR, Pedavegi	32	IC-0610031	Tenera and Conserved in FGB at DOPR, Pedavegi
7	IC-0610006	Dura, Malaysian Source and Conserved in FGB at DOPR, Pedavegi	33	IC-0610032	Tenera, thick shell and Conserved in FGB at DOPR, Pedavegi
8	IC-0610007	Tenera, Virescen, Nigerian Source and Conserved in FGB at DOPR, Pedavegi	34	IC-0610033	Tenera and Conserved in FGB at DOPR, Pedavegi
9	IC-0610008	Tenera, dwarf, big kernel, Nigrescen, Nigerian Source and Conserved in FGB at DOPR, Pedavegi	35	IC-0610034	Tenera, dwarf, Ivory Coast and Conserved in FGB at DOPR, Pedavegi
10	IC-0610009	Tenera, dwarf and Conserved in FGB at DOPR, Pedavegi	36	IC-0610035	Dura, Ivory coast and Conserved in FGB at DOPR, Pedavegi
11	IC-0610010	Tenera, dwarf, Nigerian Source and Conserved in FGB at DOPR, Pedavegi	37	IC-0610036	Tenera and Conserved in FGB at DOPR, Pedavegi
12	IC-0610011	Tenera, High yield, more girth, Nigerian source and Conserved in FGB at DOPR, Pedavegi	38	IC-0610037	Tenera, more bunches, high yield under drought, ASD Costa Rica and Conserved in FGB at DOPR, Pedavegi
13	IC-0610012	Pisifera, Virescen, produce female inflorescences, Nigerian source and	39	IC-0610038	Tenera, dwarf, high yield under drought, ASD Costa Rica and Conserved in FGB at DOPR,

		Conserved in FGB at DOPR, Pedavegi			Pedavegi
14	IC-0610013	Dura, Unknown source and Conserved in FGB at DOPR, Pedavegi	40	IC-0610039	Tenera and Conserved in FGB at DOPR, Pedavegi
15	IC-0610014	Nigerian Dura and Conserved in FGB at DOPR, Pedavegi	41	IC-0610040	Tenera and Conserved in FGB at DOPR, Pedavegi
16	IC-0610015	Nigerian Tenera and Conserved in FGB at DOPR, Pedavegi	42	IC-0610041	Tenera and Conserved in FGB at DOPR, Pedavegi
17	IC-0610016	Nigerian Tenera and Conserved in FGB at DOPR, Pedavegi	43	IC-0610042	Dura, very thick shell, PNG source and Conserved in FGB at DOPR, Pedavegi
18	IC-0610017	Ivory coast Tenera and Conserved in FGB at DOPR, Pedavegi	44	IC-0610043	Dura, very thick shell, dwarf, PNG source and Conserved in FGB at DOPR, Pedavegi
19	IC-0610018	PNG Tenera and Conserved in FGB at DOPR, Pedavegi	45	IC-0610044	Pisifera, Virescence, produced female inflorescence from Nigerian source and Conserved in FGB at DOPR, Pedavegi
20	IC-0610019	Nigeria Dura and Conserved in FGB at DOPR, Pedavegi	46	IC-0610045	Tenera, dwarf and Conserved in FGB at DOPR, Pedavegi
21	IC-0610020	Virescen, Nigeria Dura and Conserved in FGB at DOPR, Pedavegi	47	IC-0610046	Tenera, dwarf and Conserved in FGB at DOPR, Pedavegi
22	IC-0610021	Republic of Zaire Tenera and Conserved in FGB at DOPR, Pedavegi	48	IC-0610047	Tenera, dwarf and Conserved in FGB at DOPR, Pedavegi
23	IC-0610022	PNG Dura and Conserved in FGB at DOPR, Pedavegi	49	IC-0610048	Tenera, dwarf and Conserved in FGB at DOPR, Pedavegi
24	IC-0610023	Republic of Zaire Dura and Conserved in FGB at DOPR, Pedavegi	50	IC-0610049	Dura, big fruit, small kernel from Costa Rica source and Conserved in FGB at DOPR, Pedavegi
25	IC-0610024	PNG Tenera and Conserved in FGB at DOPR, Pedavegi	51	IC-0610050	Dura, big fruit, thick shell, small kernel from Costa Rica source and Conserved in FGB at DOPR, Pedavegi

26	IC-0610025	Tenera, thin shell, high yield under drought condition from ASD Costa Rica and Conserved in FGB at DOPR, Pedavegi	52	IC-0610051	Dura, very thick shell, big kernel, big fruit from Costa Rica source and Conserved in FGB at DOPR, Pedavegi

8. Supplied parental palms to four new seed gardens

Seed garden established at Morumpudi, East Godavari, Andhra Pradesh and the following parental materials were developed and supplied.

S. No.	CROSS	CODE
1	206 D X 4D	11
2	232CD X 298NATP	2
3	36CD X 4D	24
4	207CD X 257 CD	21
5	124 CD X 198 CD	23
6	58 CD X 45CD	F1
7	4RJY1198 X 227DPED	5
8	2ARJY14D X PED4D	7
9	617D X4 D	8
10	1ARJY4D X PED56D	9
11	170D X 33D	HT

For the proposed seed garden in Mizoram, the following eight mother palms are developed and the sprouts are supplied.

S. No	**Cross ID**	**Parentage**	**Location**
1	**IOP.TP.012D**	2D 218 X 2D 105	Thodupuzha
2	**IOP.TP.034D**	2D 108x 2D 105	Thodupuzha

3	**IOP.TP.013D**	2D 36 X D-II 88	Thodupuzha
4	**IOP.TP.014D**	2D 205 X D-II 88	Thodupuzha
5	**IOP.TP.022D**	5D 36 X D-II 20	Thodupuzha
6	**IOP.TP.025D**	5D 102 X 2D 225	Thodupuzha
7	**IOP.TP.026D**	5D 207 X D-II 20	Thodupuzha
8	**IOP.TP.028D**	5D 173 X 2D 131	Thodupuzha

Further, Ten TxT and three DxD crosses were supplied to Mizoram for raising nursery for seed garden.

9.Commercialized Technology for oil palm hybrid seed production

The cultivated oil palm is a hybrid produced by crossing Dura (low oil yielding type) as mother palms and pisifera (generally female sterile but male fertile) as the male parent. It is a highly specialized procedure. Upon realization of oil palm cultivation as a profitable enterprise giving high returns per unit area by the farmers/ entrepreneurs, there is an increased demand for planting materials at the national level. . The techniques of hybrid seed production and seed germination have been standardized at IIOPR and seed sprouts are being produced and distributed to the developmental agencies and entrepreneurs involved in Oil Palm Development Programme. A technology package as given below has been developed and commercialized to three commercial seed producing centres.

Sl. No	Technology provided
1	Training of the personnel involved in advanced hybrid seed production techniques
2	Assessment of present hybrid seed production techniques
3	Recording biometrical observations
4	Bunch analysis
5	Selection of parent palms viz. dura and pisifera
6	Production of DxP hybrid seeds
7	Seed processing, sprout development, culling & packaging
8	Implementing improved Seed quality, germination and storage methods
9	Agronomic management of palms
10	Plant protection techniques
11	Planning and conducting of Progeny Testing trials
12	Overall monitoring of the project

10. Three oil palm hybrids released (CoPI):Three oil palm hybrids for high yield were identified and named as **Godavari Swarna**, **Godavari Ratna** and **Godavari Gold**. Godavari Swarna has 26.87t/ha/year fresh fruit bunch yield and 5.71 t/ha/year mesocarp oil yield and recommended for cultivation in Andhra Pradesh. Godavari ratna has 22.44 t/ha/year FFB yield, 18.31 kg bunch weight , mesocarp oil yield of 5.36t/ha/year and recommended for coastal region of Maharashtra and Goa. Godavari gold has27.3 t/ha/year yield with more number of bunches per palm (11.74), high mesocarp oil yield of 5.79t/ha/year and is recommended for coastal Tamilnadu under assured irrigation.

15.Patent : "A METHOD FOR IDENTIFICATION OF DWARF OIL PALM PLANT USING MICROSATELLITE MARKERS" (Co PI)

16. Any other:

- International assignment: *International Collaborative Research Project Involving exchange of Oil Palm Germplasm between India (ICAR- Indian Institute of Oil Palm Research) and Malaysia (Malaysian Palm Oil Board)-*
- **Scientist In- charge**, IIOPR- RC Palode till 22.08.19.