



Advances of Oil Palm Breeding for Crop Improvement

MPOB-SOPPOA Seminar on R&D Progress 2023

Green Hotel & Suits, Bintulu Sarawak

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PRESENTATION OUTLINES

01

Introduction

02

Genetic
Resources :
Germplasm
Collections

03

MPOB
Germplasm
Programme

04

Advancement
of Oil Palm:
Palm Series

05

Clonal Palm
Series

06

Conclusion

Introduction

- Oil Palm: Major crop in **South East Asia, Africa & South America**
- Economy of Malaysia & Indonesia: Palm oil used in food and non-food sectors
- 2 species of the genus *Elaeis*:
 - a. *Elaeis guineensis* (The African oil palm)
 - b. *Elaeis oleifera* (South and Centre America)

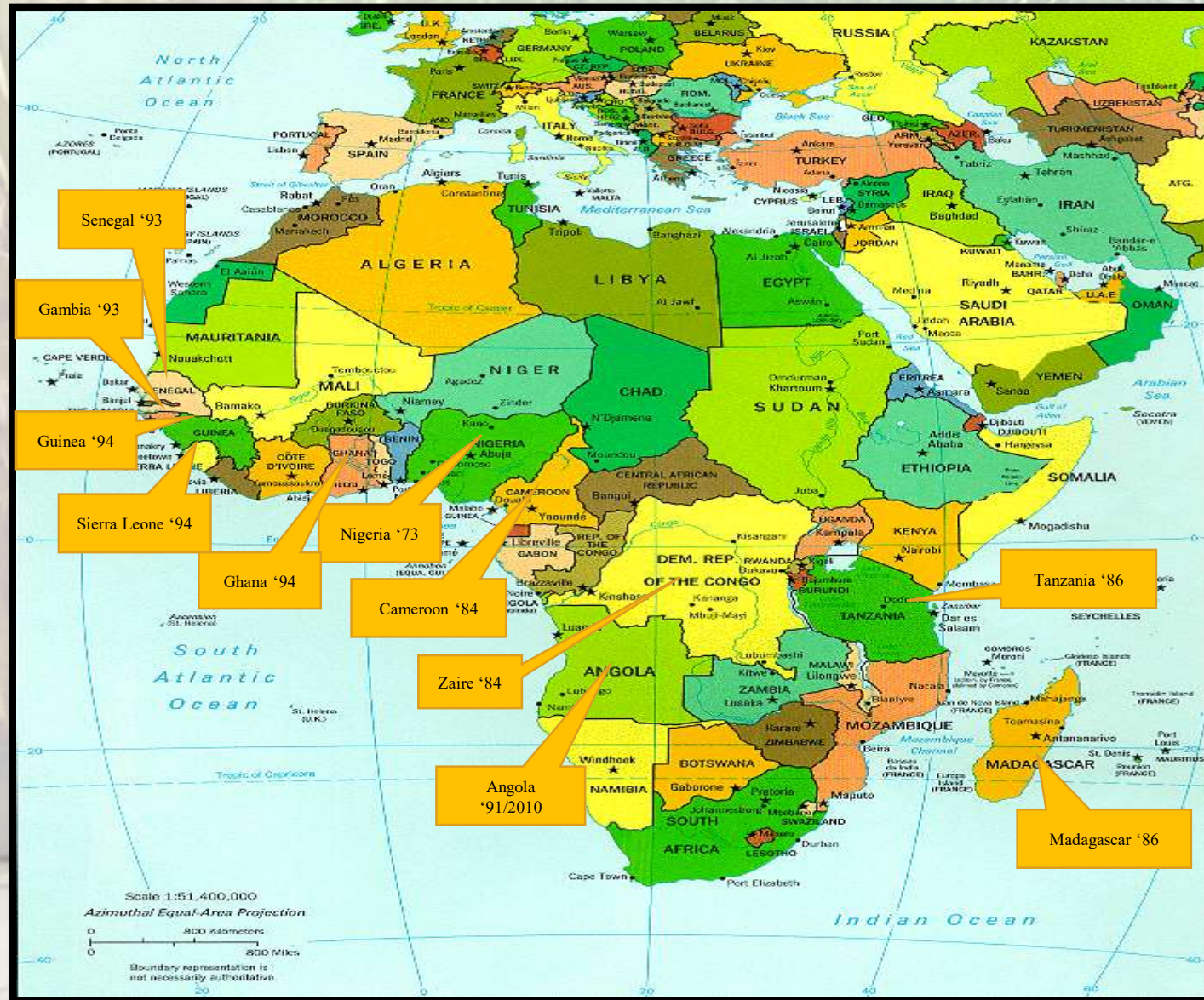


Elaeis guineensis



Elaeis oleifera

Genetic Resources: Germplasm Collection



Genetic Resources: Germplasm Collection



MPOB Germplasm Programme



COLLECTION

**STEP
01**

EVALUATION

**STEP
02**

UTILIZATION

**STEP
03**

CONSERVATION

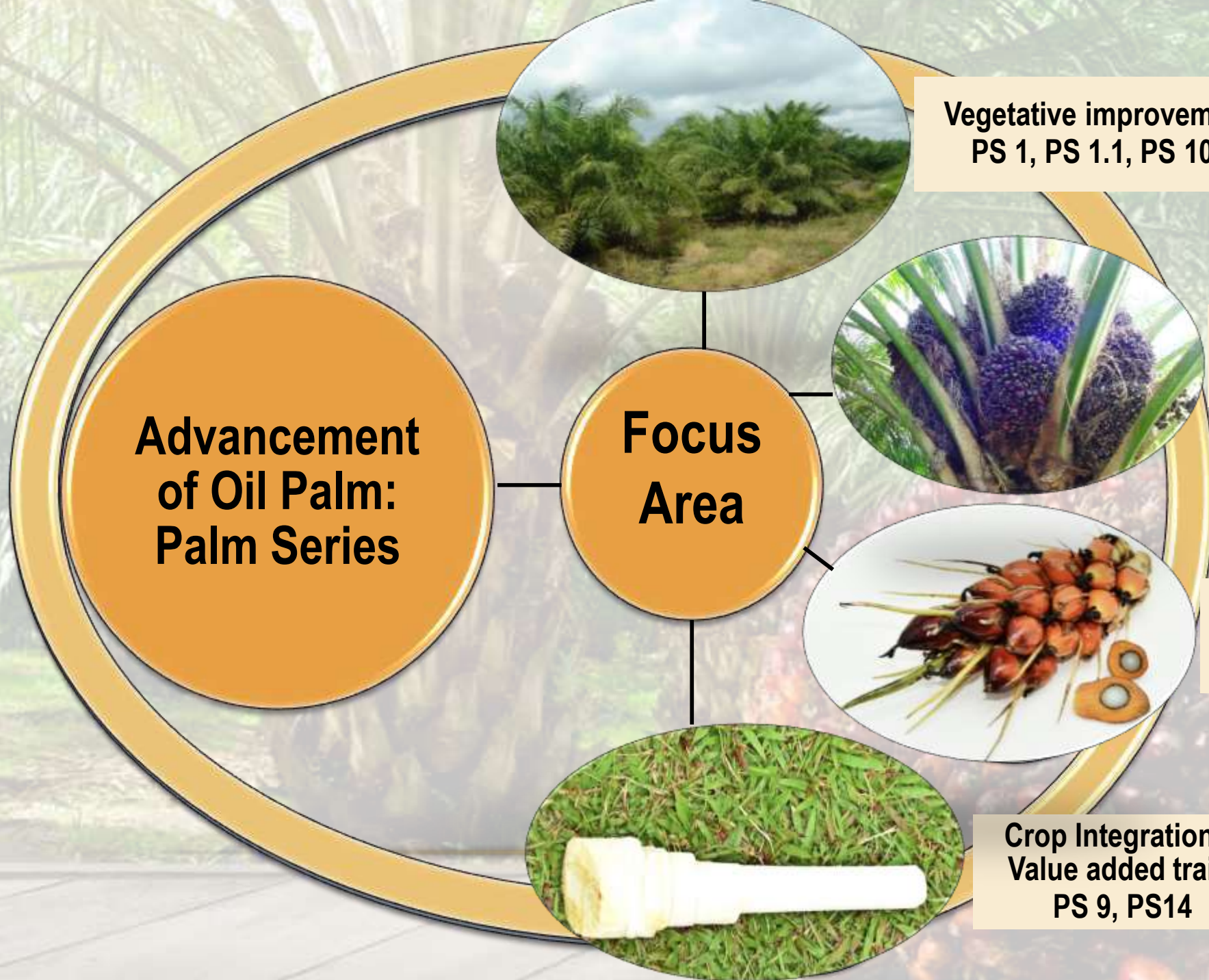
**STEP
04**

Evaluation for Over 50 years



PALM SERIES (PS1 – PS14)

- PS1 (dwarf) - 25 – 45 cm/yr, DxP- 45-75 cm,yr
- PS2 (high iodine)->60, DxP 50-53
- PS3 (high kernel)- >10%, DxP (5-7%)
- PS4 (high carotene E.O) -> 3000 ppm, DxP 500-700
- PS5 (thin shell) - < 7.4%, DxP 12%
- PS6 (big fruit) - > 24g, DxP 10g
- PS7 (high bunch index - >0.6, DxP 0.4
- PS8 (high vitamin E)- 1300-2500, DxP 1000ppm
- PS9 (Bactris gasipaes)
- PS10 (long stalk)- 20-36 cm, DxP 10-15cm
- PS11 (high carotene E.G) -> 2000 ppm, DxP 500-700
- PS12 (high oleic)-48-52%, DxP37-40%
- PS13 (low lipase)- <10%, DxP >23%
- PS14 (high protein kernel) - >20%, DxP 16%



**Advancement
of Oil Palm:
Palm Series**

**Focus
Area**



**Vegetative improvement:
PS 1, PS 1.1, PS 10**



**Yield:
PS5, PS 6, PS7**



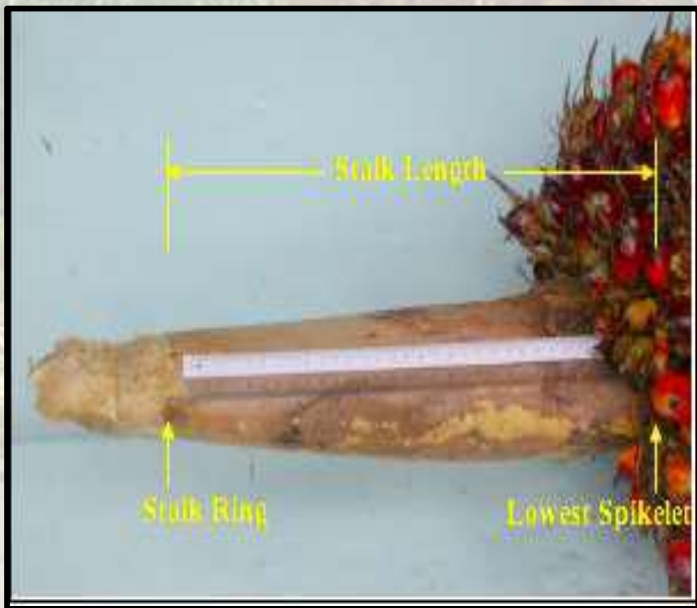
**Oil Improvement
PS 2, PS 3, PS4, PS 8,
PS 11, PS 12, PS 13**



**Crop Integration &
Value added traits
PS 9, PS14**



Vegetative Improvement



Palm Series 1: High Yielding Dwarf



Table:MPOB-Nigerian dura families selected for high yield and low height increment

Family	FFB		BNO (no/palm)	ABWT (kg/palm)	HI (cm/year)
	(kg/palm year)	(t/ha/year)			
NGA 26.04	204	30.3	20	20.08	16
NGA 18.02	217	32.2	17	13.63	14
NGA 16.11	226	33.5	13	17.64	19
NGA 17.04	207	30.7	19	11.94	15
NGA 16.27	211	31.3	17	12.28	18
NGA 20.02	225	33.4	22	10.46	18
NGA 36.07	218	32.3	23	9.92	19

Ease of Harvesting &
Prolong economic
lifespan

Dwarf Oil Palm Breeding Programme PS 1.1

SPECIAL CHARACTERISTICS OF PS1.1

- ❑ Slow height increment (25 – 45 cm/yr).
- ❑ High fresh fruit bunch (FFB) yield (30 – 40 t/ha/yr).
- ❑ High oil to bunch (O/B) ratio of about 30% (OER > 25%)

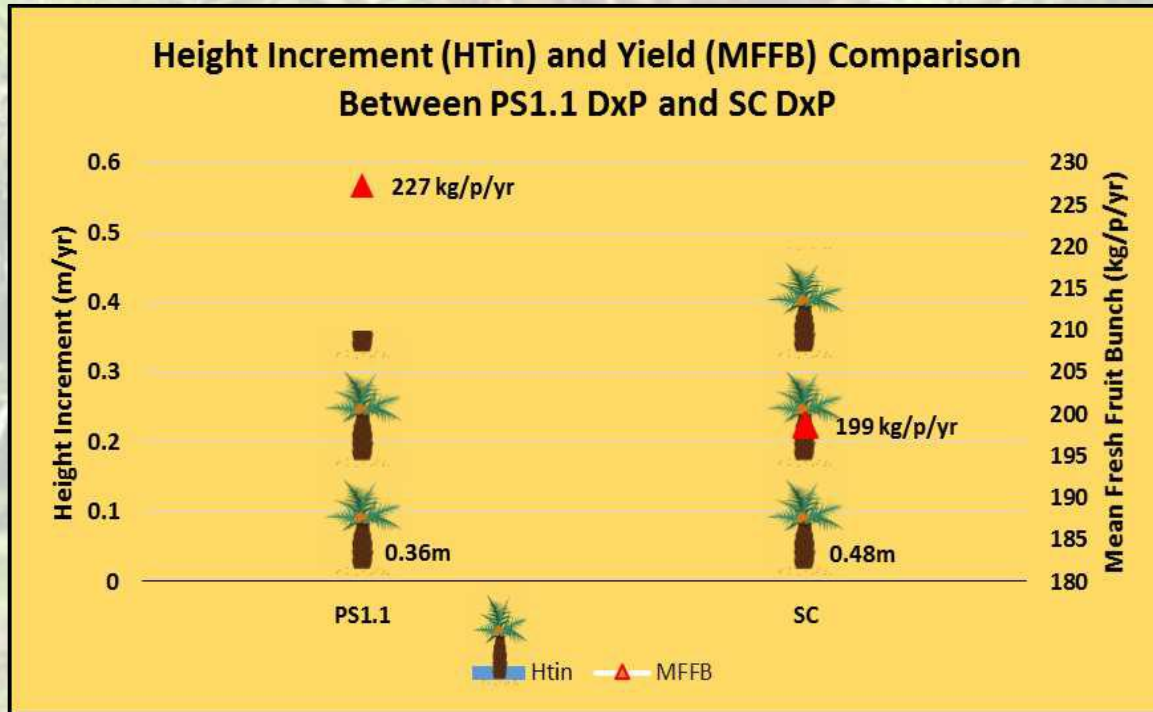


Figure 1. Yield Performance (a) and Height Comparison (b) of PS1.1 DxP with Standard Cross DxP (SC)

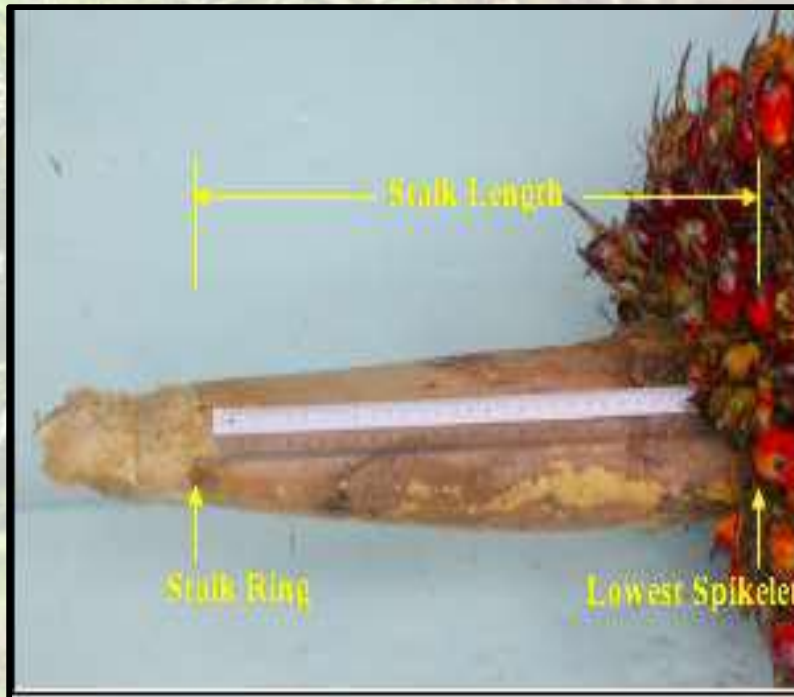


Figure 2.

Height Comparison between Deli Dura x MPOB-Nigerian Pisifera, PS1.1 (left) with Standard Cross Material, SC (right) at the same age (10 y.a.p)

Palm Series 10: Long Stalk

Table: Palms selected for long stalk (PS10)



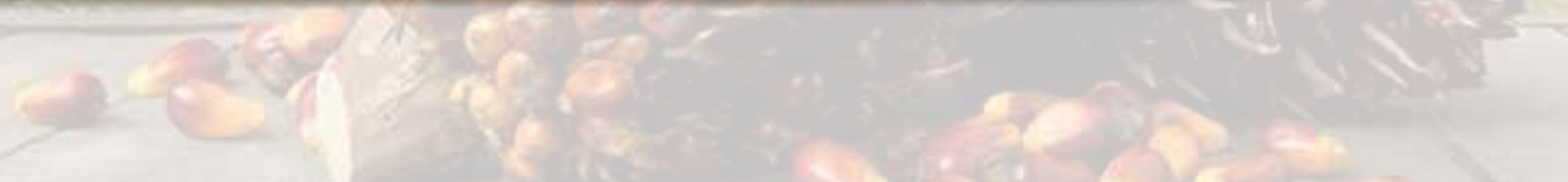
No	Palm No.	Fruit Type	Stalk Length (cm)	FFB (kg/palm/year)	BNO (no/palm)	ABWT (kg/palm)	MFW (g)	O/B (%)	K/B (%)	OY (kg/palm/year)	TEP (kg/palm/year)	HI (cm/year)
1	0.312/416	<i>Dura</i>	36.3	171.9	13.0	13.2	16.4	16.4	7.9	28.2	36.4	40.0
2	0.312/894	<i>Tenera</i>	35.5	205.8	18.3	11.3	11.3	21.9	6.9	45.1	53.7	53.3
3	0.312/1074	<i>Dura</i>	35.5	169.1	12.6	13.5	15.4	20.2	7.4	34.2	41.7	36.7
4	0.312/1263	<i>Tenera</i>	30.3	221.3	15.0	14.8	13.7	23.9	9.4	52.9	65.3	66.7
5	0.311/331	<i>Dura</i>	27.0	203.2	14.7	13.8	16.3	16.8	6.7	34.1	42.2	36.7
6	0.311/612	<i>Dura</i>	33.7	186.2	13.6	13.7	16.7	19.5	8.6	36.3	46.0	56.7
7	0.311/627	<i>Dura</i>	31.0	180.4	13.4	13.4	12.5	19.8	5.3	35.8	41.6	46.7
8	0.311/645	<i>Dura</i>	30.0	181.0	12.4	14.6	16.6	16.9	6.1	30.6	37.2	63.3
9	0.312/359	<i>Dura</i>	30.0	189.1	16.0	11.8	13.0	19.5	7.3	36.9	45.2	45.0
10	0.312/682	<i>Dura</i>	28.8	194.7	18.0	10.8	15.0	23.0	5.3	44.9	51.1	50.0

Source: Noh *et al.* (2005)

Ease of harvesting



Yield



Palm Series 5: Thin-Shell Tenera

Table: Characteristics of thin shell Teneras (PS5)



Palm No	FFB	BNO	ABWT	FB	MFW	M/F	S/F	K/F	O/DM	O/B	K/B	OY
	(kg/palm year)	(no/ palm)	(kg /palm)									(%)
0.256/2246	144.08	15.67	9.19	60.64	9.33	92.30	2.80	4.90	80.67	28.84	2.98	41.55
0.256/632	167.98	17.67	9.51	61.54	8.37	88.55	4.93	6.52	79.33	26.73	4.02	44.90
0.256/2204	169.08	17.50	9.66	64.98	10.09	83.16	7.13	9.71	80.61	29.84	6.32	49.84
0.256/902	103.38	7.50	13.78	57.34	13.78	87.24	7.23	5.52	81.70	86.53	3.37	27.43
0.256/270	144.67	18.33	7.89	59.79	10.45	86.30	7.40	6.30	81.60	28.58	3.83	41.35

Higher oil yield compared to the current planting material.

Palm Series 6: Large Fruit *Duras*

Table: Characteristics of large fruit duras (PS6)

Palm No	FFB	BNO	ABWT	FB	MFW	M/F	S/F	O/DM	O/B	K/B	OY
	(kg/pal m year)	(no/ palm)	(kg /palm)								(%)
0.311/124	58.14	10.40	5.59	65.28	33.97	51.83	39.22	77.10	16.53	5.84	9.61
0.311/892	125.98	11.60	10.86	76.60	33.82	49.93	41.74	79.10	19.61	6.38	24.70
0.311/775	167.72	13.40	12.50	65.36	30.44	51.20	40.57	78.13	16.16	5.37	27.10
0.311/269	119.48	10.80	11.06	69.08	30.10	51.94	38.43	79.40	17.86	6.66	21.34
0.312/1241	178.65	11.83	15.10	53.80	29.03	61.99	29.90	76.40	15.96	4.11	28.51
0.311/405	105.46	19.40	5.44	69.49	28.37	51.63	38.70	74.93	16.74	6.72	16.60
0.311/633	209.10	13.00	16.08	72.66	26.95	62.03	30.69	80.00	21.19	5.36	44.31



Higher oil yield & higher
Total Economic Product
(TEP).

Palm Series 7: High Bunch Index

Table: Characteristics of Palms with high bunch index (PS7)

Palm No	Fruit Type	Bunch Index	FFB		BNO (no/palm)	ABWT (kg/palm)	O/B (%)	OY	
			(kg/palm year)	(t/ha/year)				(kg/palm year)	(t/ha/year)
0.256/2058	Dura	0.68	184.1	27.2	23.2	7.9	21.6	39.7	5.9
0.256/2300	Dura	0.66	206.8	30.6	20.3	10.2	17.6	36.4	5.8
0.256/2125	Dura	0.65	187.3	27.7	23.0	8.1	16.1	30.2	4.7
0.150/500	Tenera	0.68	246.9	36.5	25.7	9.6	22.8	56.2	8.3
0.150/4280	Tenera	0.69	202.2	30.0	20.2	10.0	24.3	49.1	7.3
0.150/5974	Tenera	0.75	259.4	38.4	16.3	15.9	22.5	58.4	8.6



Higher Oil Yield



Oil Improvement

Palm Series 2: High Unsaturated Oil



Table: Iodine value of selected MPOB-Nigerian palms and their selfed progenies

Parental Palms		Progeny	
Palm No.	I.V.	Progeny Code	I.V.
0.151/814	61.4	PK 486	61.4
0.151/146	65.4	PK 488	60
0.151/1861	61.4	PK 591	61.9
0.151/305	61.4	PK 543	59
0.151/971	64.4	PK 549	60.8
0.151/48	61.4	PK 515	64.2
0.151/903	63.9	PK 533	59.5
0.151/1662	66.4	PK 597	58.8
0.151/618	61.2	PK 507	64.6
0.151/128	63.4	PK 540	61.6
		Progeny Men	61.2

Increase unsaturated
& liquid palm oil

Palm Series 3: High Kernel

Table: Characteristics of dura mother palms with high kernel content

Palm No.	FFB (kg/palm / year)	BNO (no/palm)	ABWT (kg/palm)	K/F (%)	K/B (%)	O/B (%)	OY (kg/palm / year)
0.149/7021	168.9	24	7.4	17.6	11.44	13.1	22.13
0.149/3077	171.2	19	10.1	19.3	12.56	14.3	24.48
0.149/14376	197.7	17	11.6	17.5	11.38	16.8	33.21
0.149/1094	162.2	8	22.8	16.2	10.53	13.5	21.90
0.149/3231	174.8	13	14.6	20.4	13.26	13.9	24.30
0.149/10702	167.1	17	11.0	17.0	11.05	13.5	22.56
0.149/10426	189.5	12	13.6	20.0	13.00	16.8	31.84



High lauric acid

Palm Series 4: High Carotene Content

Table: Selected high carotene *Elaeis oleifera* palms (PS4)



Palm No	Country of Origin	I.V.	Carotene (ppm)
0.211/142	Costa Rica	85.5	3021.1
0.211/143	Panama	87.6	3038.8
0.211/233	Panama	82.5	3042.5
0.211/991	Costa Rica	88.0	3083.5
0.211/1212	Panama	86.9	3106.2
0.211/1196	Panama	87.6	3110.0
0.211/1200	Panama	88.7	3115.6
0.211/1051	Costa Rica	88.9	3196.1
0.211/1151	Costa Rica	90.7	3208.9
0.211/1152	Costa Rica	92.3	3292.8
0.211/1144	Panama	88.9	3336.5
0.211/1131	Costa Rica	89.0	3377.0
	Commercial DxP	50-53	500-700

Carotene is used in
pharmaceutical
industries

Palm Series 8: High Vitamin E

Table: Palms selected for high vitamin E (PS8)

Palm No	α -	α -	γ - Tocopherol/ β - Tocotrienol	γ -	δ -	Total Vitamin E	OY	
	Tocopherol (ppm)	Tocotrienol (ppm)		Tocotrienol (ppm)	Tocotrienol (ppm)		(kg/pal m year)	(t/ha/yea r)
0.150/500	448.90	528.00	181.93	986.97	356.63	2496.57	56.25	8.33
0.225/441	571.80	227.90	31.20	593.20	259.40	1683.50	31.10	4.60
0.150/3752	294.20	389.70	37.80	535.30	152.20	1409.20	51.45	7.61
0.256/166	569.70	160.80	25.10	571.40	64.90	1391.20	45.41	6.71
0.311/84	495.90	224.30	27.80	484.00	136.80	1368.80	31.61	4.68
0.150/338	248.80	226.53	36.43	506.90	346.00	1364.67	74.41	11.01



Vitamin E as
a source of
antioxidant

Palm Series 11: High Carotene Content

Table: Selected High Carotene *Elaeis guineensis* Palms (PS 11)

Palm No	Fruit Type	Carotene (ppm)	I.V.	FFB (kg/palm year)	FFB 2 (t/ha/year)	BNO (no/palm)	ABWT (kg/palm)	O/B (%)	OY 1 (kg/palm year)	OY 2 (t/ha/year)	HI (cm/year)
0.256/718	Tenera	2279.8	53.0	226.5	33.5	24.3	9.3	20.4	46.3	6.8	35
0.256/271	Tenera	2177.3	55.0	192.7	28.5	19.2	10.1	17.0	32.8	4.8	16
0.256/803	Tenera	2058.8	55.8	185.0	27.4	14.2	13.1	17.3	32.0	4.7	35
0.256/327	Dura	2474.0	57.6	226.5	33.5	22.7	10.0	13.8	31.2	4.6	20
0.256/673	Dura	2257.4	56.3	195.3	28.9	15.8	12.3	14.5	28.3	4.2	20



Used in
pharmaceuticals

Palm Series 12: High Oleic Acid

Table: Breeding Population for High Oleic Acid (C18:1) (PS12)

Palm No.	Progeny	Parentage	Fruit Type	FFB (kg/palm / year)	OY (kg/palm / year)	KY (kg/palm / year)	C 16:0 (%)	C 18:0 (%)	C 18:1 (%)	C 18:2 (%)	C 18:3 (%)	LV.
0.290/252	PK 1177	0.150/2333 x 0.150/2333	<i>Dura</i>	182.5	28.1	13.7	37.1	3.4	50.2	8.4	0.2	58.3
0.290/1593	PK 1215	0.151/1662 x 0.151/146	<i>Dura</i>	174.6	29.2	13.3	34.5	4.0	50.3	10.2	0.3	61.7
0.290/2577	PK 1145	0.151/1276 x 0.150/5375	<i>Dura</i>	171.0	29.9	8.3	34.8	4.5	48.1	11.5	0.3	62.1
0.292/9	PK 1151	0.150/1969 x 0.150/1969	<i>Tenera</i>	176.5	37.5	8.4	32.0	5.1	51.5	10.2	0.3	62.9
0.292/10	PK 1151	0.150/1969 x 0.150/1969	<i>Tenera</i>	192.0	45.2	10.7	33.7	4.5	49.7	11.1	0.3	62.7
0.292/20	PK 1021	0.149/14388 x 0.149/12279	<i>Tenera</i>	229.4	52.4	10.3	37.0	4.1	48.9	8.9	0.3	58.2
0.292/818	PK 1105	0.149/11526 x 0.149/11526	<i>Tenera</i>	184.5	40.1	6.8	34.5	5.4	48.0	11.4	0.2	61.5
0.292/905	PK 1138	0.150/1837 x 0.150/1544	<i>Tenera</i>	140.8	30.7	10.1	34.5	5.4	49.3	10.0	0.1	60.1
0.292/1236	PK 1151	0.150/1969 x 0.150/1969	<i>Tenera</i>	142.2	34.8	9.6	31.9	6.2	52.5	8.5	0.3	60.7
0.306/319	PK 540	0.151/128 x 0.151/128	<i>Tenera</i>	145.8	24.7	6.8	34.2	5.2	48.9	11.2	0.2	61.8
0.337/172	PK 1254	0.150/5976 x 0.150/5978	<i>Tenera</i>	196.8	47.1	14.3	35.8	3.8	49.5	9.9	0.2	60.3
0.337/186	PK 1201	0.150/2360 x 0.150/1969	<i>Tenera</i>	273.5	65.1	11.2	33.6	7.1	48.4	10.1	0.2	59.6
0.337/249	PK 1254	0.150/5976 x 0.150/5978	<i>Tenera</i>	209.0	43.5	18.0	33.8	6.8	48.9	9.6	0.2	59.2
0.337/506	PK 1201	0.150/2360 x 0.150/1969	<i>Tenera</i>	218.0	53.2	14.8	34.0	5.0	48.8	11.2	0.2	62.1
0.337/1062	PK 1040	0.150/1714 x 0.150/1544	<i>Tenera</i>	179.0	40.0	11.6	35.1	5.7	48.4	9.9	0.3	59.7
Mean									49.4			60.7
Current Dx P									37-40			50.0

Source: Isa *et al.* (2006)

Increase unsaturated & liquid palm oil



Palm Series 13: Low Lipase

Table: FFA Levels of Selected Palms for Low Lipase

Palm No	Fruit Type	FFB (kg/palm/year)	BNO (no/palm)	ABWT (kg/palm)	O/B (%)	OY (kg/palm/year)	FFA at 5°C (%)
0.353/216	Tenera	199.23	16.00	12.45	24.26	48.33	1.05
0.256/2246	Tenera	144.08	15.67	9.19	28.84	41.55	9.90
0.219/833	Tenera	159.18	12.00	13.26	26.99	42.96	8.20
0.353/182	Tenera	189.27	21.83	8.67	21.88	41.41	1.52
0.256/2259	Dura	203.77	19.83	10.28	11.57	23.58	9.90
0.256/157	Dura	179.05	18.00	9.95	12.64	22.63	4.82
0.256/2243	Dura	179.07	15.67	11.43	18.06	32.34	2.04
0.353/188	Dura	176.23	23.17	7.61	15.91	28.04	3.60



Maintain oil quality even if there is a delay in harvesting and processing

**+ ADDED
VALUE** 



**Crop
Integration &
Value added trait**

Palm Series 9: Palm Heart

Bactris gasipaes: one of the exotic palms in the MPOB germplasm collection.



Palm Series 14: High Protein Kernel



Table: FFA Levels of Selected Palms for Low Lipase

No.	Palm number	Fruit type	Country of origin	Progeny code	Protein	FFB yield (2006-2009)	
					(%)	(kg palm ⁻¹ yr ⁻¹)	(t ha ⁻¹ yr ⁻¹)
1	0.397/27	<i>Tenera</i>	Ghana	GHA02.07	26.21	142.63	21.11
2	0.397/372	<i>Dura</i>	Ghana	GHA11.01	24.04	112.49	16.65
3	0.219/684	<i>Dura</i>	Cameroon	CMR20.02	23.77	110.40	16.34
4	0.219/519	<i>Dura</i>	Cameroon	CMR29.01	23.49	155.12	22.96
5	0.398/47	<i>Dura</i>	Gambia	GAM05.09	23.42	148.64	22.00
6	0.397/21	<i>Tenera</i>	Ghana	GHA02.07	23.37	185.46	27.45
7	0.398/69	<i>Dura</i>	Gambia	GAM03.07	23.04	104.19	15.42
8	0.352/22	<i>Dura</i>	Senegal	SEN04.03	22.93	127.25	18.83
9	0.256/115	<i>Dura</i>	Tanzania	TZA02.03	22.41	150.25	22.24
10	0.256/152	<i>Dura</i>	Tanzania	TZA06.02	22.39	144.00	21.31
11	0.397/1	<i>Dura</i>	Ghana	GHA02.03	22.29	154.42	22.85
12	0.221/1590	<i>Dura</i>	Congo*	ZRE27.05	22.06	113.13	16.74
13	0.397/300	<i>Dura</i>	Ghana	GHA09.02	22.00	150.92	22.34
14	0.397/28	<i>Tenera</i>	Ghana	GHA02.07	21.09	157.63	23.33
15	Commercial	DxP	-	-	16.67	145.30	21.50

Note: * Formerly known as Zaire.

Clonal Palm Series

Clonal Palm Series 1 (CPS 1)

Clonal Palm Series 2 (CPS 2)

Clonal Palm Series 3 (CPS 3)



Clonal Palm Series 1 (CPS1)



P456

Performance of CPS1 vs DxP

Clone	FFB (kg/palm/yr)	O/B (%)	OY (t/ha/yr)	Increment compared to DxP (%)			Location	
				FFB	O/B	OY		
1	CPS 1	180.50	28.41	51.28	32.7	14.1	51.1	MPOB Terengganu (2.3 ha)
	D x P	136.02	24.89	28.59				

Clonal Palm Series 2 (CPS2)



CLONAL PALM SERIES 2 (CPS2)
 SAMSUL KAMAL ROSLI; ZAMZURI ISHAK; FADILA AHMAD MALIKE; NOR AZWANI ABU BAKAR; MOHD NAQUIDDIN HUSRI; DALILAH ABU BAKAR and AHMAD TARMIZI HASHIM

MPOB INFORMATION SERIES • ISSN 1511-7871 • JULY 2018

MPOB TT No. 634

NOVELTY OF CPS2

1. Distinctive morphological traits:

- Thin petiole cross section (PCS) of 15.7 cm² vs. 39.3 cm² of DxP standard cross.
- Short rachis length (RL) of 4.5 m vs. 6.1 m of DxP standard cross.

N = 180 palms	4 yrs 2011	5 yr s 2012	6 yr s 2013	7 yrs 2014	8 yrs 2015
MFFB	97.1	134.2	169.9	177.4	163.22
MBNo	29.3	30.1	27.1	24.4	22.48
ABWt	3.34	4.44	6.26	7.25	7.19

Clonal Palm Series 3 (CPS3)



CPS3

DXP

CLONAL PALM SERIES 3 (CPS3)

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The national average crude palm oil (CPO) yielding of less than 4 t ha⁻¹ yr⁻¹ for the last three decades has been a long-term pain point for the industry. For instance, the recorded CPO yield in 2019 of 3.47 t ha⁻¹ yr⁻¹ (MPOB, 2020) was four folds below the genetic potential of the oil palm

clonal trials forged with various agencies. CPS3 originated from amongst DxPs planted at MPOB Research Station Hulu Paka, Terengganu. The outstanding yield performance of a particular individual with fresh fruit bunches (FFB) of 198.80 kg palm⁻¹ yr⁻¹ and oil to bunch (O/B) of 35.22% led to the cloning of this ortet in 2001. The resultant

FFB of 4-year old CPS3 and DXP (SC) planted at Sedenak Estate, Kulim (Malaysia) Berhad, Johor

MATERIAL	FFB (kg/p/yr)	O/B (%)	OY (t/ha/yr)
CPS3	221.7	37.5	11.3
DXP (SC)	206.0	30.8	8.6

Conclusion

- The main objective of oil palm germplasm collections: utilize the elite palms with interesting and desired traits.
- 14 Ps Series were released to the industry as breeding materials for improvement
- This Ps Series will be introgressed into current planting materials to create new and improved varieties
- High yielding planting materials such as PS1.1 and Clonal Palm Series plays a major role in the oil palm industry

An aerial photograph of a dense plantation of palm trees, likely coconut palms, with a prominent vertical trunk in the center. The trees are lush green, and the ground is visible between them. A yellow rectangular box is positioned at the bottom of the image, containing text.

**THANK
YOU**

In AGRICULTURE not everything is about the SEED (or Planting Material) but everything BEGINS with the SEED (or Planting Material)!