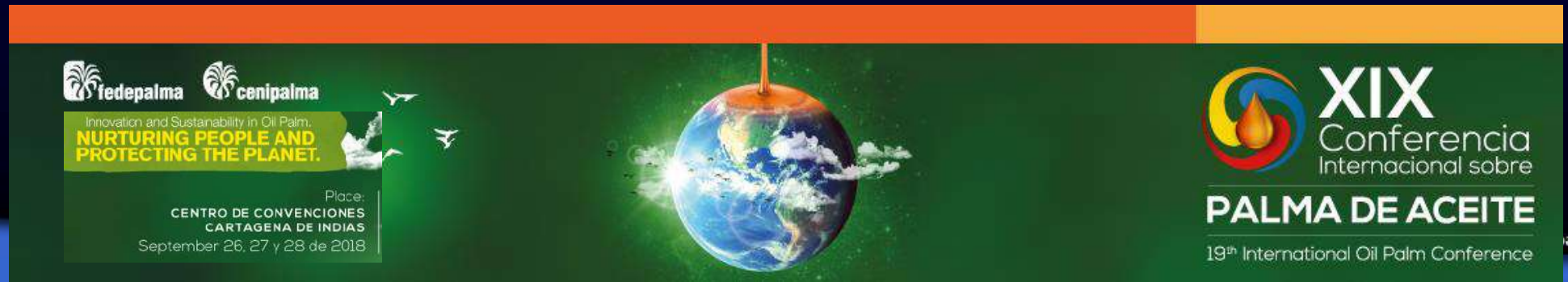
Development of New Oil Palm Cultivars in Malaysia with Special Reference to Protocols in Developing and Releasing a New Cultivar

A. KUSHAIRI and A. MOHD DIN

Malaysian Palm Oil Board (MPOB)

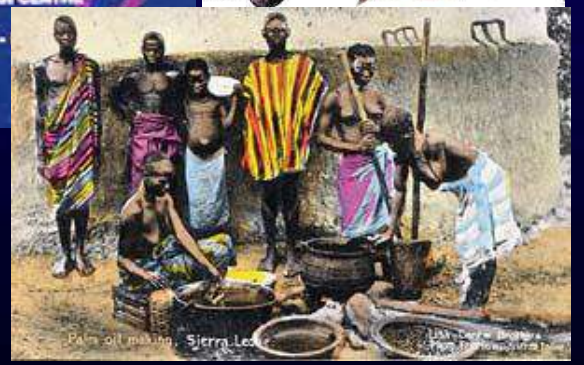


Oil Palm Centres of Origin

7. West African Centre: *Elaeis guineensis*
9. North-South American Centre: *E. oleifera*

N.I. Vavilov
1887 – 1943

http://www.heritage-history.com/



Palm oil making, Sierra Leone

http://www.sierra-leone.org/HistoricPostcards/historic2.html

kushairi@mpob.gov.my

Initial Planting Materials

Early commercial plantings utilized the thick-shell, thin-mesocarp ***dura*** planting materials

Single Gene Inheritance

Experiment of
Beirnaert & Vanderweyen (1941)
– The single gene inheritance


Tenera

X

Tenera


Dura


Tenera


Tenera


Pisifera

Shell	Shell	Shell	No shell

Phenotypic ratio 3:1

Sh+Sh+	*Sh+Sh-*	*Sh+Sh-*	*Sh+Sh-*

Genotypic ratio 1:2:1

Current planting materials

Dura
Sh+ Sh+
Shell: present
S/F: 30%
K/F: 10%
M/F: 60%
O/B: 18%
Fibre ring: absent

X

Pisifera
Sh- Sh-
Shell: absent
S/F: 0%
K/F: 5%
M/F: 95%
O/B: 0%
Fibre ring: present


100%

Tenera
Sh+ Sh-
Shell: present
S/F: 10%
K/F: 5%
M/F: 85%
O/B: 20%
Fibre ring: present

kushairi@mpob.gov.my

Deli *Dura* Breeding Population

- 1848: Four *dura* seedlings introduced to Bogor Botanical Garden
- 1870s: Seeds from Bogor were planted along avenues long bungalows in Deli, Sumatra for decorative purposes
- Superior materials unconsciously mass selected for several generations for more avenue plantings
- 1920s: Formal breeding and selections carried out in Indonesia (Marihat Baris) and Malaysia (Elmina & Serdang)
- The population became known as **Deli *dura*** population with uniform performance, big bunches and good fruit traits with high mesocarp


Deli dura

- Deli dura sub-populations in Malaysia (Serdang Avenue, Elmina, Dumpy E206, Ulu Remis and Johore Labis) are considered Breeding Populations of Restricted Origin (BPRO)

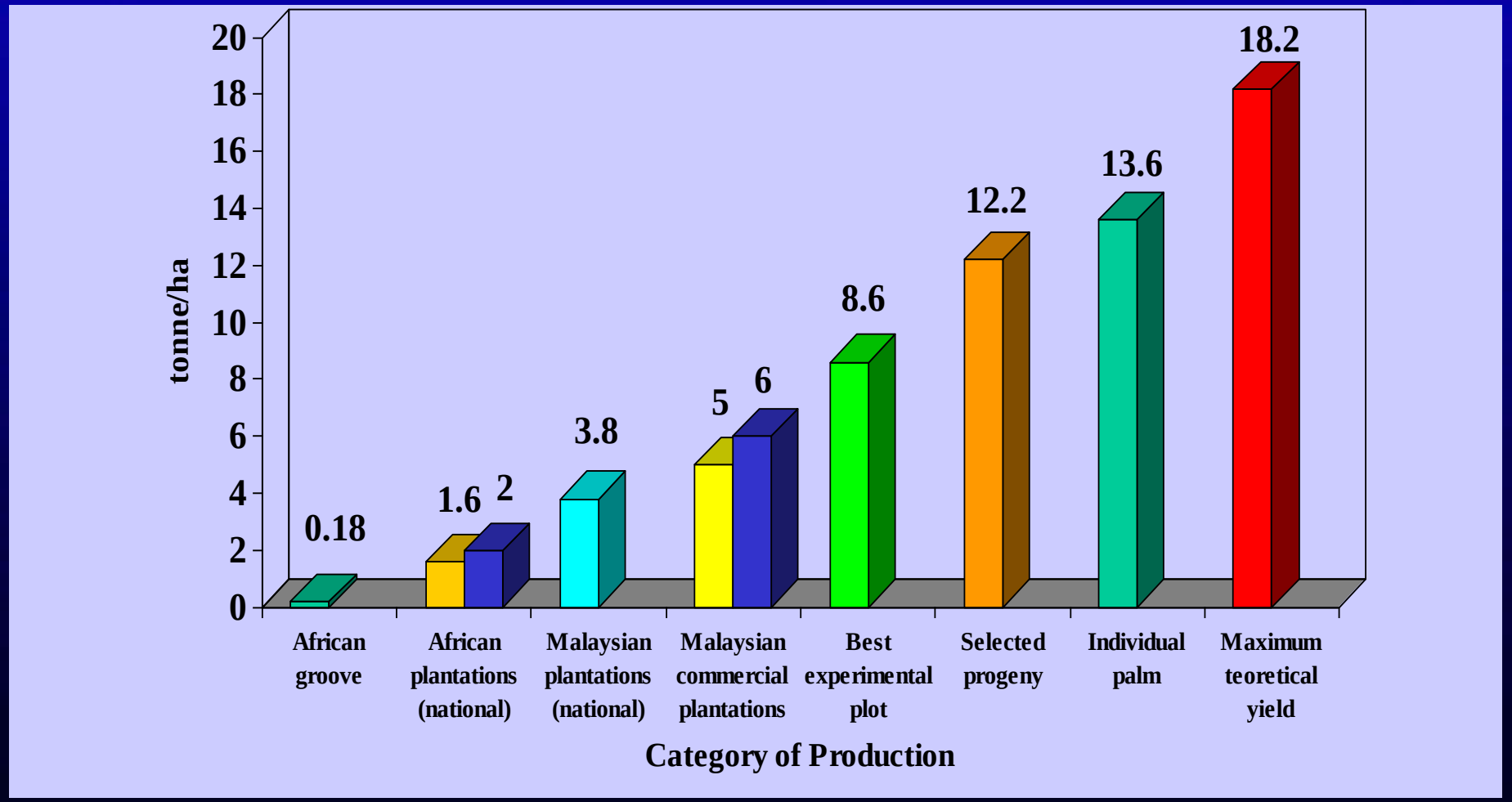
Tenera/*Pisifera* Breeding Populations

- *Pisiferas* generated from
  - *Tenera* x *Tenera* (TxT) = 1D:2T:1P
  - *Tenera* x *Pisifera* (TxP) = 1T:1P
  - *Pisifera* x *Pisifera* (PxP) = 1P
- Some common *pisiferas*
  - Yangambi, AVROS, Serdang 27B, NIFOR, La Me, Derived *Pisifera*
- **Culti**vated **Var**iety (**Cultivar**)
  Common DxP planting material
  - Deli *dura* x AVROS *pisifera*

AVROS *pisifera* palm, MPOB Kluang, Malaysia

kushairi@mpob.gov.my

Oil yield potential of oil palm



Oil Palm Breeding Objectives

To increase oil yield

To increase oil quality

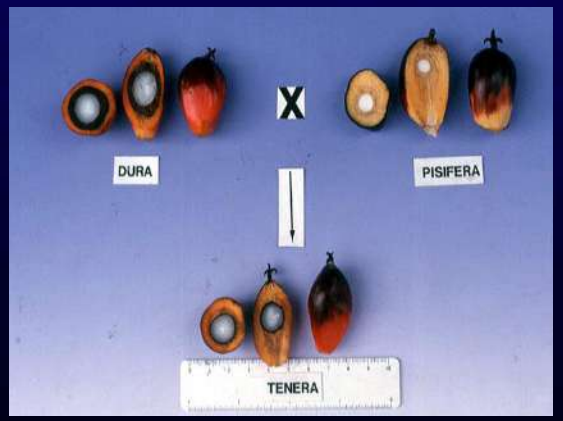
To reduce palm height

Tolerance to pests and diseases

Oil Palm Genetic Base

- The oil palm has a narrow genetic base
  - **4 Bogor Palm (1848)**
    - → **Deli *dura***

- **Limited Sources of *Pisiferas* (AVROS, La Me, Yangambi)**
  - **Commercial DxP seeds**
    - **Deli x AVROS**

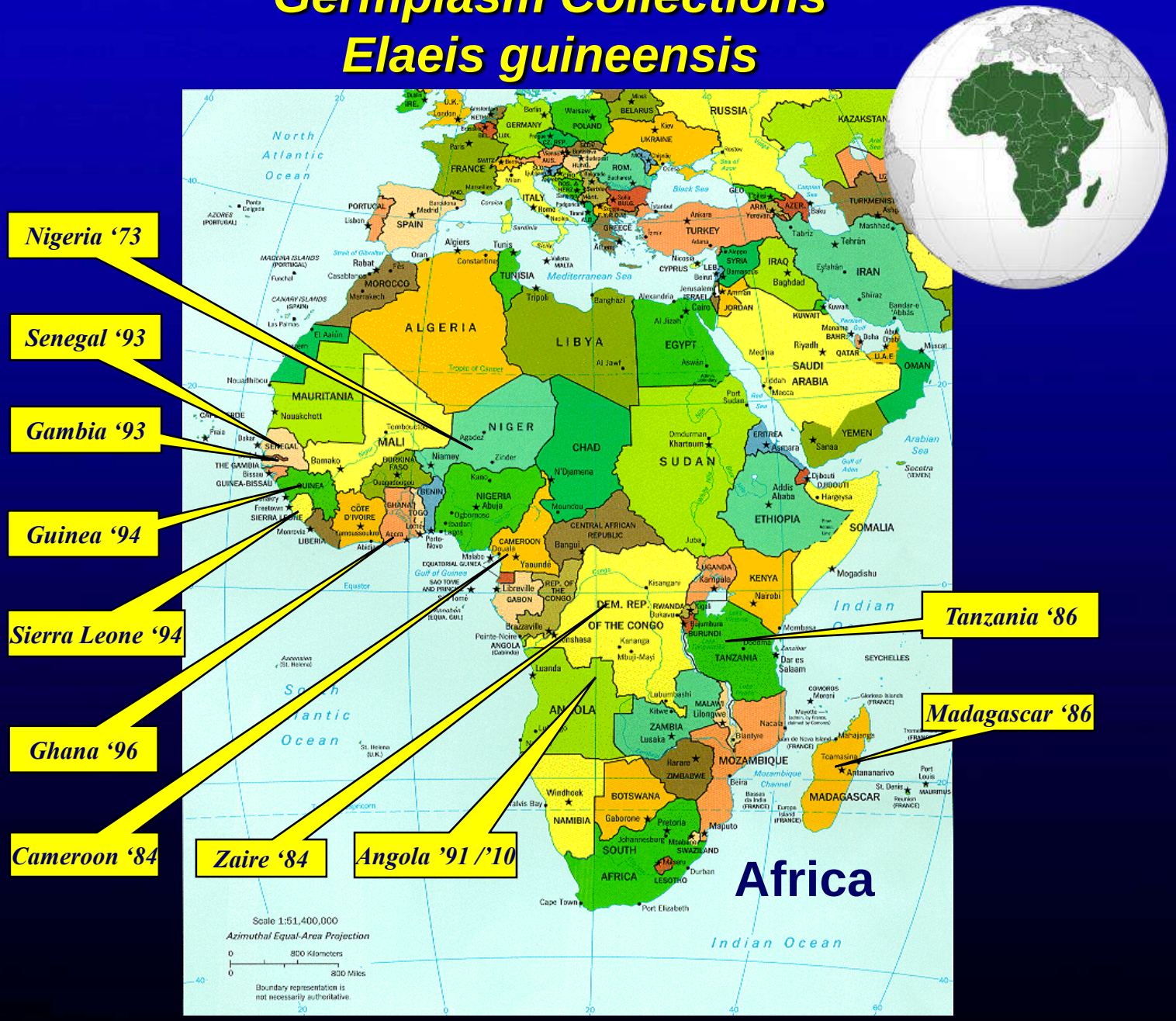


Selection

Activities of MPOB Oil Palm Genebank

- Collections at centres of diversity
- Establishment, evaluation and selection of elite materials
- Progeny testing of elite materials
- Distribution of elite materials to the industry
- Screening germplasm for genetic variability (quantitative, molecular, biochemical)

Germplasm Collections
Elaeis guineensis



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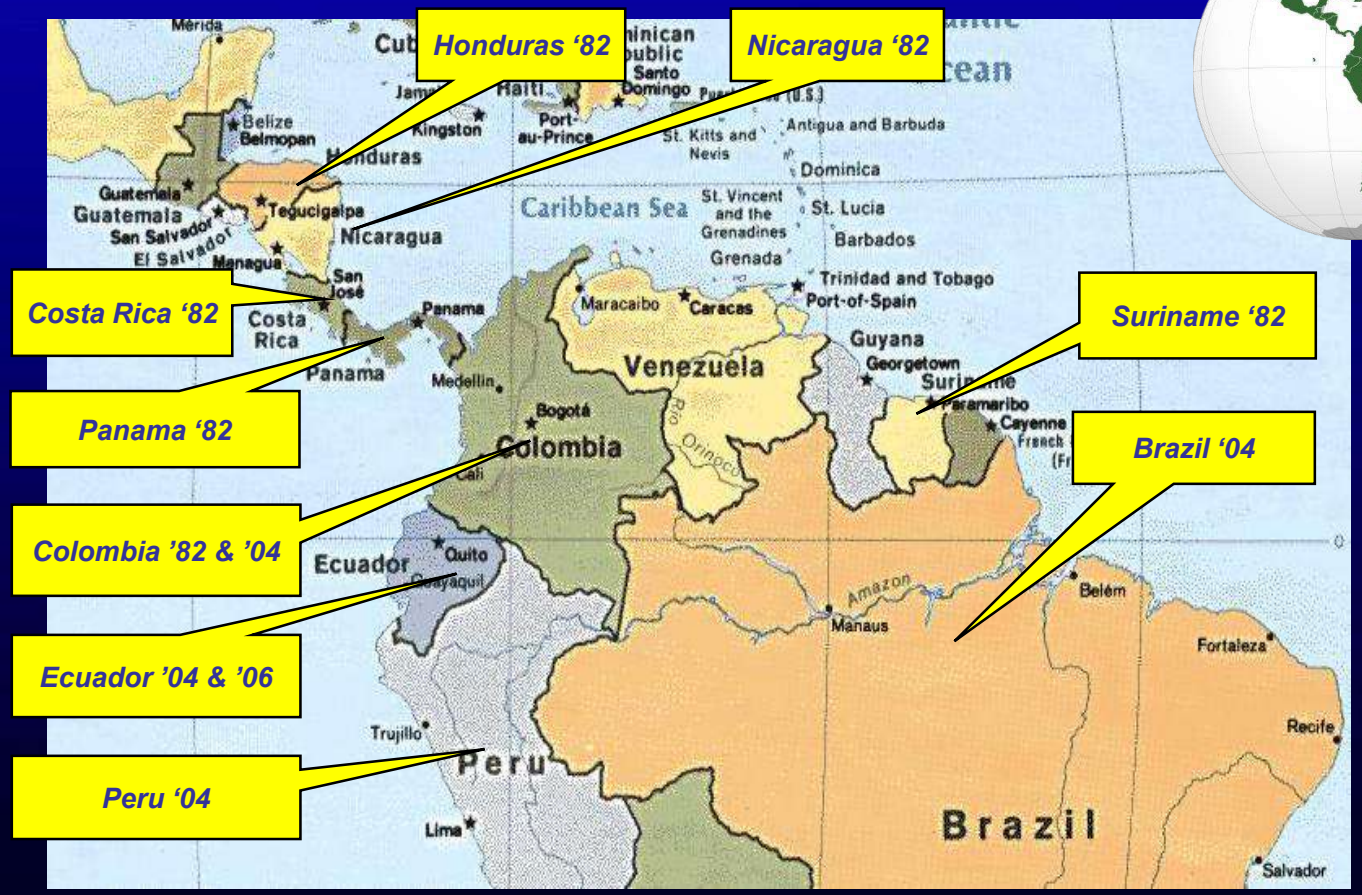
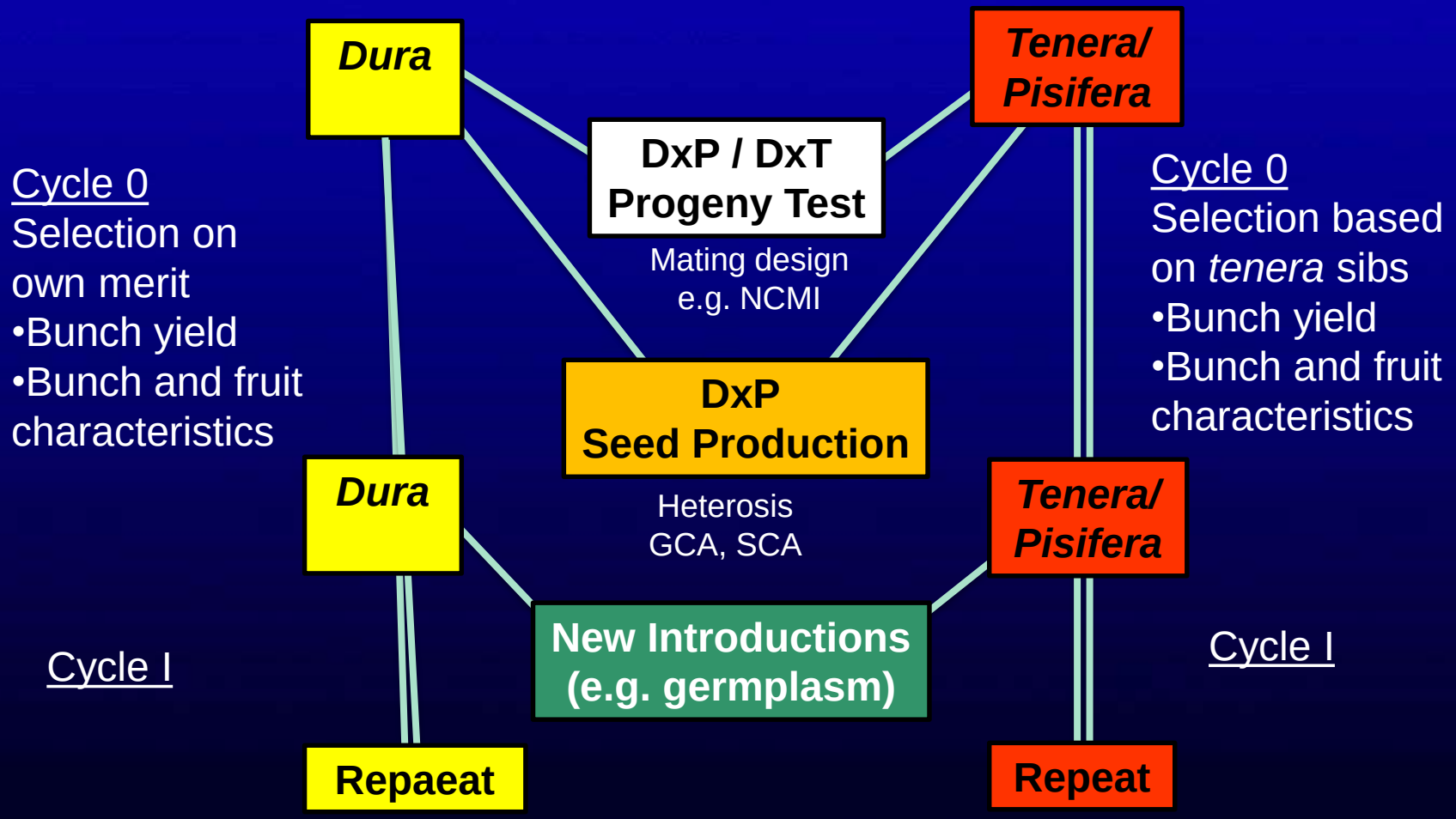
Germplasm Collections
Elaeis oleifera



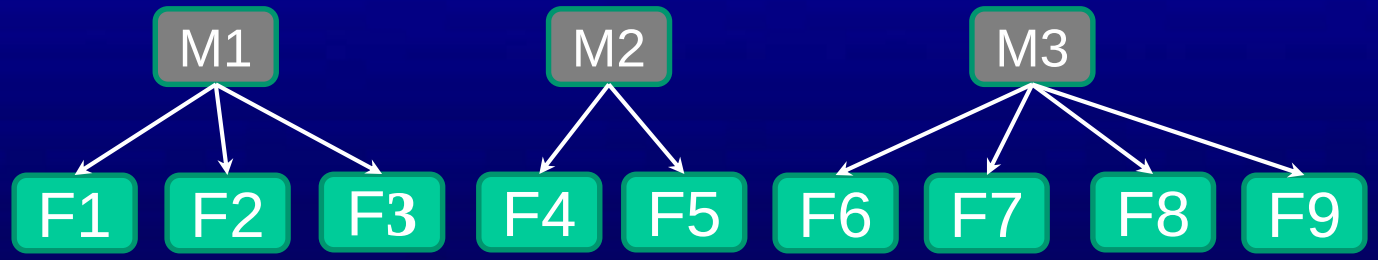
Improvement Programmes



Modified Reciprocal Recurrent Selection (MRS) in Oil Palm Improvement Programme in Malaysia

North Carolina Model I (NCM I) Breeding Design

- Females / within Males (nested)

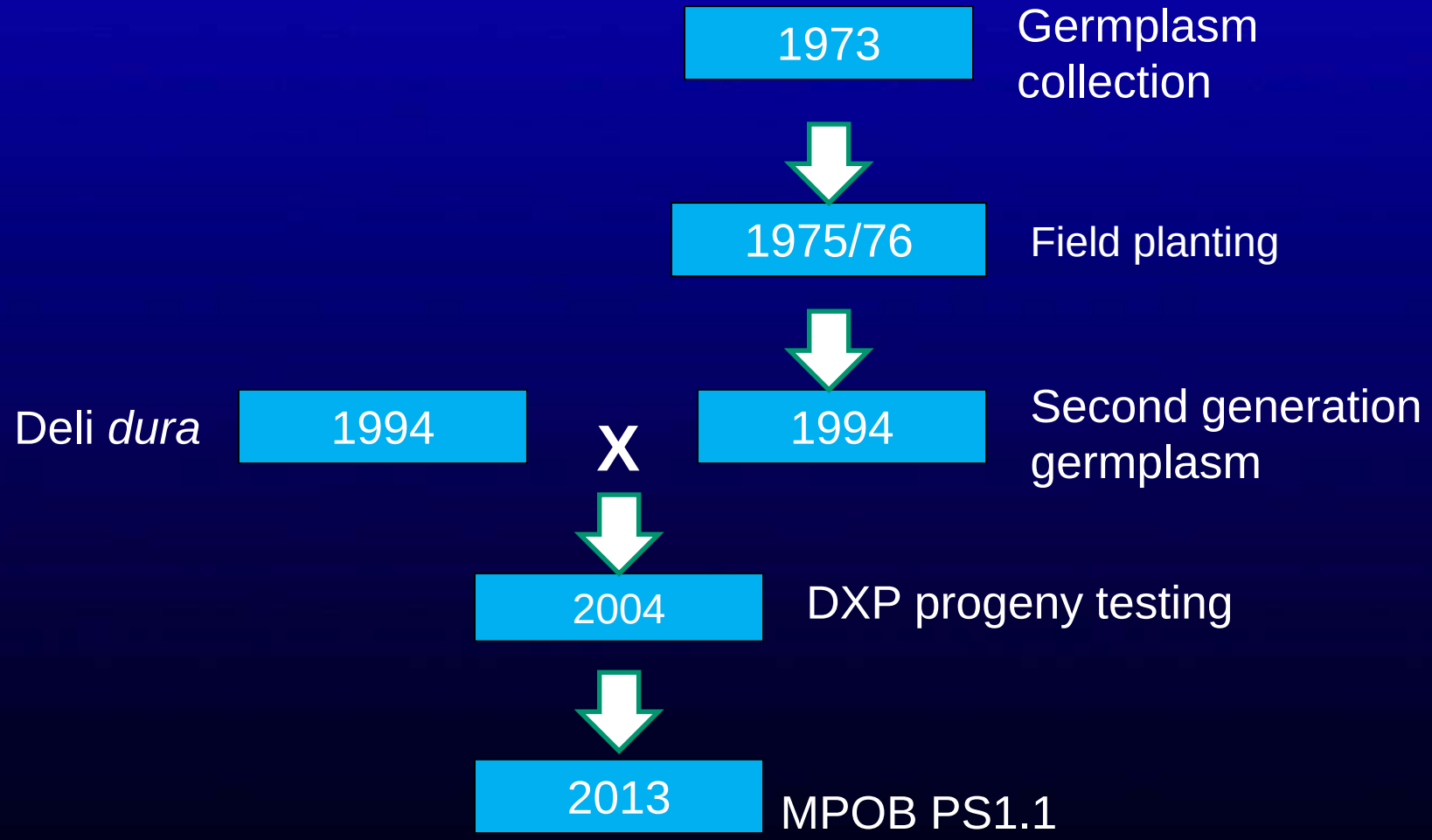


Key
F : Female (Dura)
M : Male (Pisifera)

North Carolina Model I.

The progenies include both full-sibs and half-sibs. Each set of families with the same father in common constitutes a half sib family group and a set of families with both parents in common constitutes a full-sib family

Timeframe to Develop MPOB PS1.1 DxP Cultivar (high yield, short palm)



Improvement Programmes

Oil Palm Breeding Objectives

To increase oil yield

To increase oil quality

To reduce palm height

Tolerance to pests and diseases

Breeding for specialty traits

PS Series
PS1 – slow height increment
PS2 – high iodine value
PS3 – high kernel
PS4 – high carotene *Elaeis oleifera*
PS5 – thin shell *tenera*
PS6 – large fruit *dura*
PS7 – high bunch index
PS8 – high vitamin E
PS10 – long stalk
PS11 – high carotene *E. guineensis*
PS12 – high oleic
PS13 – low lipase

Selection

Breeding Populations	Specialty Traits	PS	Current DxP
• PS1 • PS1.1	Dwarf palm (height increments)	40cm/yr	50 – 75cm/yr
• PS2	High Iodine value	56	52
• PS3	Large kernel (K/F)	10-15%	5-7%
• PS4	High carotene *E. oleifera*	> 3,000ppm	500 – 700ppm
• PS5	Thin shell *tenera* (S/F)	2.80 – 7.40%	>10%
• PS6	Large fruit *dura* (weight)	24g – 34g	10g
• PS7	High bunch index	0.6	0.3
• PS8	High vitamin E	1,300 – 2,500ppm	600 – 1000ppm
• PS9	*Bactris gasipaes*	Not oil palm	
• PS10	Long stalk	20 – 30cm	10-15cm
• PS11	High carotene *E. guineensis*	2000 – 2474ppm	500 – 700ppm
• PS12	High oleic	48 – 52.5%	37 – 40%
• PS13	Low lipase (FFA cold activation)	1 – 10%	22 – 73%

Selection

PS1.1 Dwarf palm

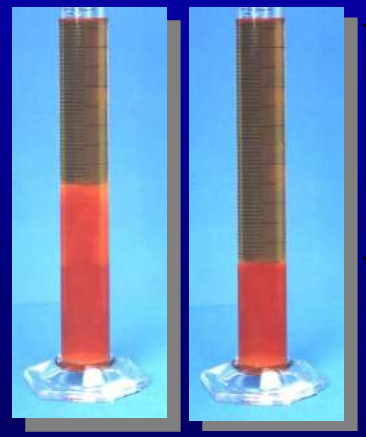
PS1.1 palm

Control (normal DxP)

kushairi@mpob.gov.my

Selection

PS1 and PS1.1 Dwarf palm



PS2 High Iodine value

PS3 Large kernel

Carotene extract

Carotene capsules

PS4 dan PS11 High carotene

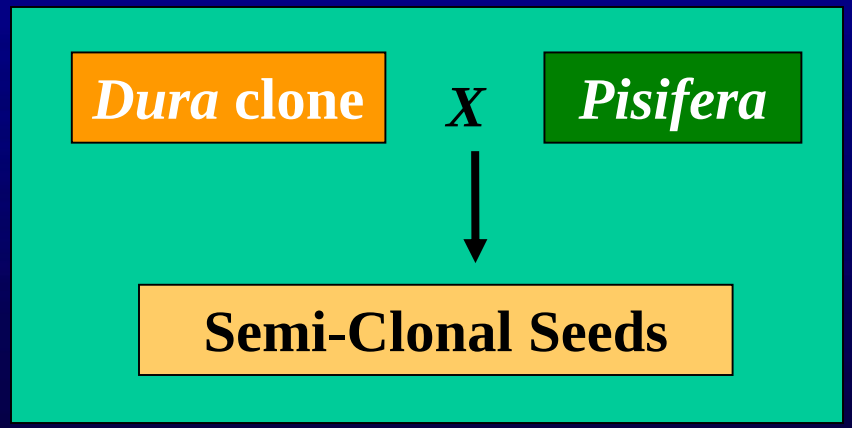
PS5 Thin shell *tenera*

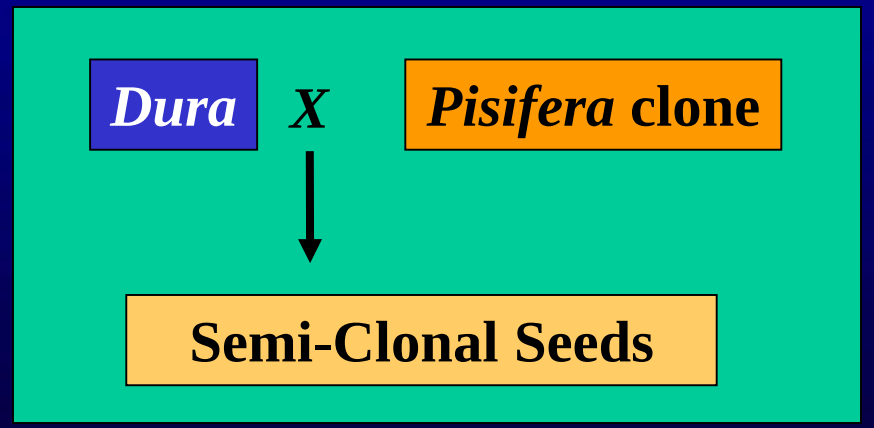
PS6 Large fruit *dura*

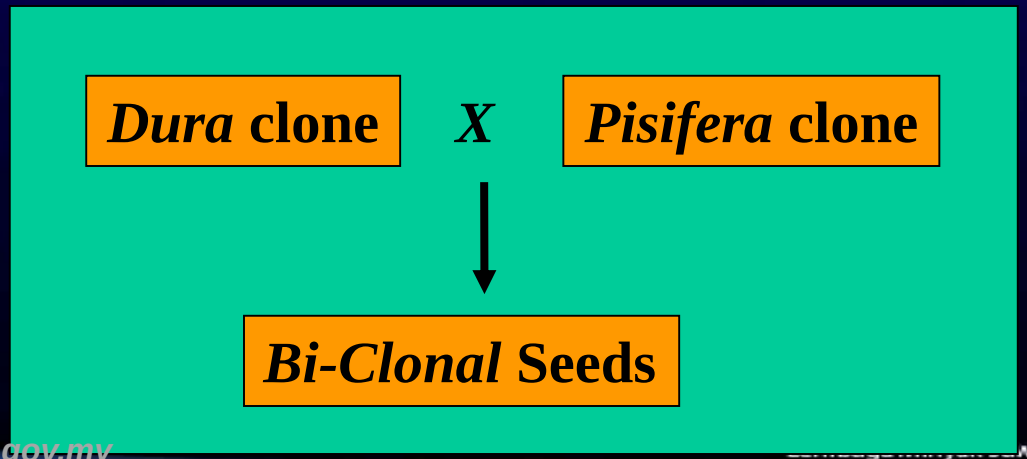
PS10 Long stalk

Clonal Seeds

- An alternative to clones
- Parents with good Specific Combining Ability (SCA)







Planting Materials

Breeding Programmes

1. DxP seeds
   - General Combining Ability (GCA)
2. Clonal DxP seeds
   - Specific Combining Ability (SCA)
3. Clones
   - Individual palms

Duration from field to nursery
- DxP: 9 months
- Clone : 2 – 5 yrs

DxP Seeds

Pollination

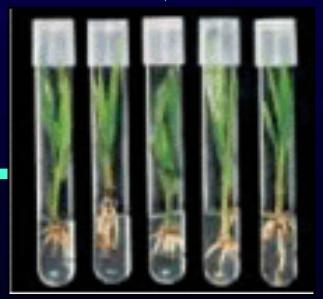
Seeds

Nursery

Clone

Ex-plant

Polyembroid



Rooting

kushairi@mpob.gov.my

Cloning of Palms with Special Traits

Palms with special traits were cloned, examples:

- High bunch index
- High vitamin E
- High carotene
- Long stalk
- Low height increment

High-bunch index 0.68 *dura*

High bunch index (0.58) *tenera*

High vitamin E *dura* (1551ppm) & *tenera* (1392ppm)

Long stalk tenera (35.5cm)

High carotene (4000ppm) *E.oleifera* ramets

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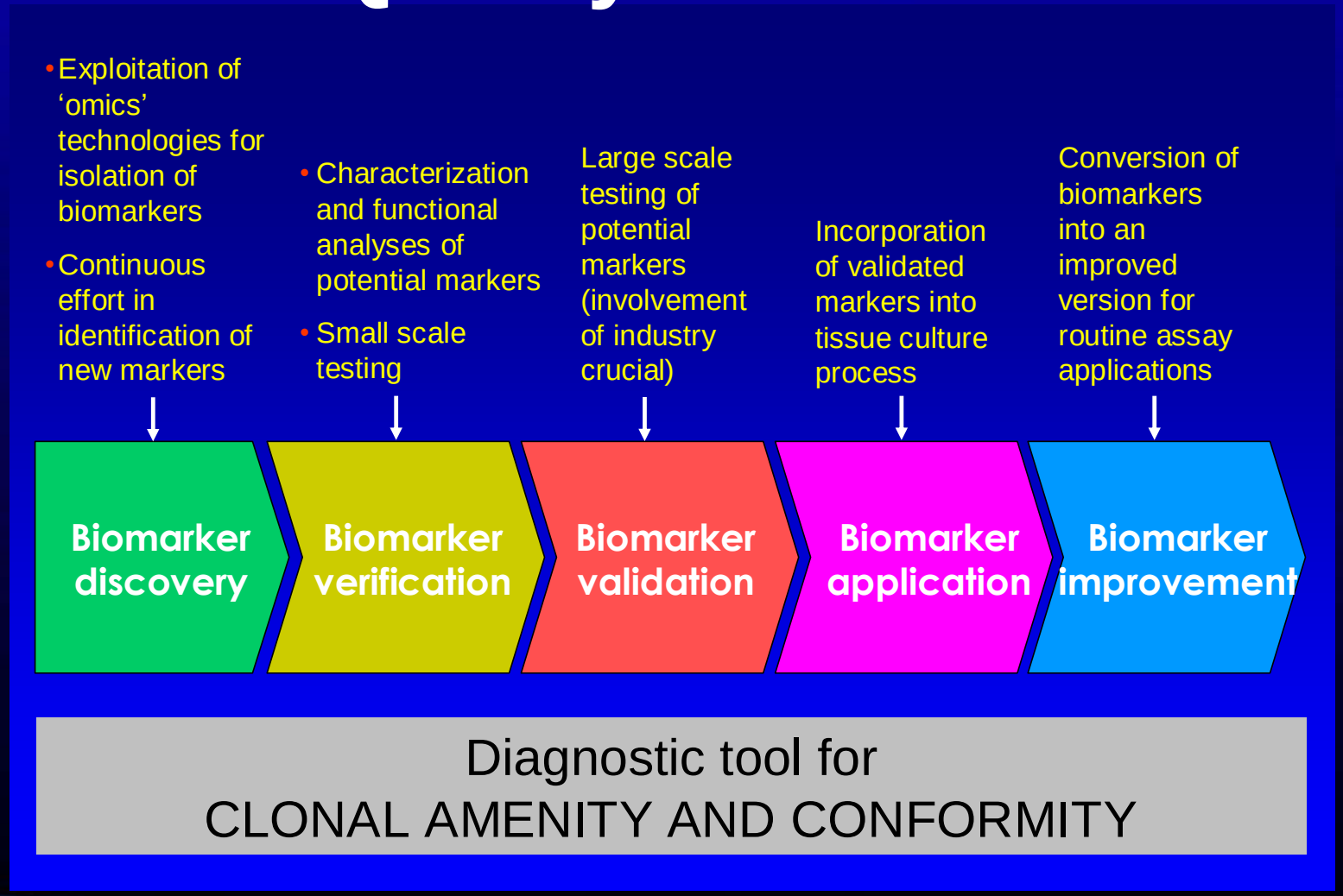
Molecular Markers for Quality Control



Genomics-guided Breeding

Classical Breeding

- 10 – 12 year selection cycle
- Large land requirement
- High cost in conducting breeding trials

Genomics-guided Breeding

MARKER APPLICATION

- Genomics guided decisions
- Short breeding cycle
- Reduced cost of trials
- Tools for QC & selection of traits

TYPES OF MARKERS

- Simple Sequence Repeats (SSRs)
- Single Nucleotide Polymorphisms (SNPs)

Improved Planting Material

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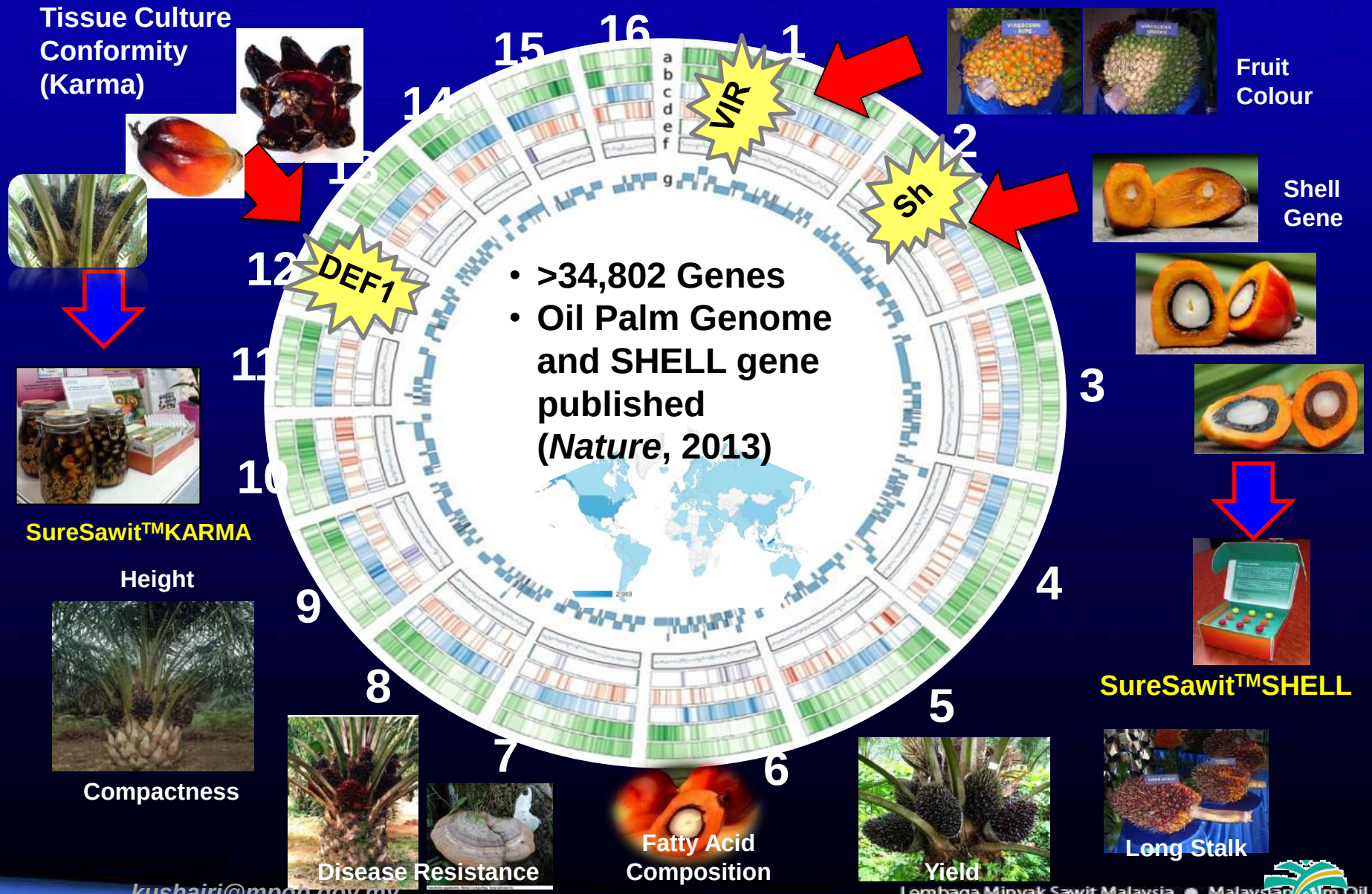
Oil Palm Genome Programme

PRECISION selection for High Yielding Varieties, Special Traits



kushairi@mpob.gov.my

Convention on Biological Diversity (CBD)

- CBD is a UN treaty formally adopted in Rio de Janeiro, Brazil in 1992
- CBD recognizes biological resources as sovereign rights of nations
- Malaysia, being a party to CBD deposits equal portion of oil palm germplasm collection in the host country

Plant Breeders Right (BPR)

Test Guidelines for New, Distinct, Uniform and Stable (DUS)

New plant varieties are registered based on the International Union for the Protection of New Varieties of Plants (UPOV)

Oil palm DUS test guidelines (TG) developed under the purview of the Department of Agriculture, Malaysia

Harmonized DUS TG of oil palm involved Malaysia (chair), Indonesia & Thailand under the East Asia Plant Variety Protection Forum (EAPVPF), Japan

CRITERIA FOR PROTECTING A PLANT VARIETY

The plant variety must be:

- Distinct: A variety should be clearly distinguishable by at least one essential characteristic from existing or commonly known varieties in any country at the time of filing of the application.
- Uniform: A Variety must be sufficiently uniform in its essential characteristics.
- Stable: Essential characteristics of a variety must be stable after repeated propagation or in the case of a particular cycle of propagation at the end of each cycle.

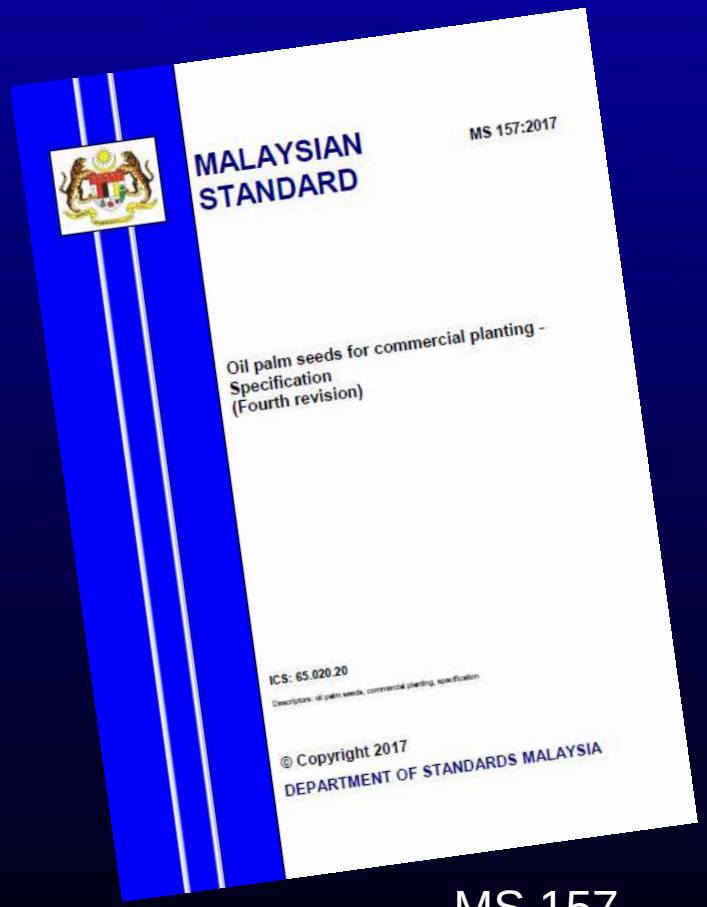
kushairi@mpob.gov.my

MALAYSIAN STANDARD

- The Department of Standards Malaysia (STANDARDS MALAYSIA) is the national standardisation and accreditation body.
- Malaysian Standards are developed through consensus by committees which comprise of balanced representation of producers, users, consumers and others with relevant interests.
- To the greatest extent possible, Malaysian Standards are aligned to or are adoption of international standards.
- Approval of a standard as a Malaysian Standard is governed by the Standards of Malaysia Act 1996 (Act 549).
- Malaysian Standards are reviewed periodically.
- The use of Malaysian Standards is **VOLUNTARY** except in so far as they are made mandatory by regulatory authorities by means of regulations, local by-laws or any other similar ways.

MALAYSIAN STANDARD

MS 157 Oil Palm Seeds for Commercial Planting: Specification
MS 2099 Oil palm Clones for Commercial Planting. Specification for Ortet Selection



MS 157

MS 2099

Malaysian Standard MS157

Oil Palm Seeds for Commercial Planting

- **B1. Materials of both known pedigree and performance**
  - B1.1 minimum requirements for the *tenera* in the progeny test.
  - B1.2 minimum requirements for the *dura* parent palms.
- **B2. Materials of unknown pedigree but known performance**
  - B2.1 minimum requirements for the *tenera* in the progeny test.
  - B2.2 minimum requirements required for the *dura* parent palms.
- **B3. Materials of known pedigree but unknown performance**
  - B3.1 minimum requirements for *tenera* in the progeny test
  - B3.2 minimum requirements for the *dura* parent palms.
- **B4. Materials of both unknown pedigree and performance**
  - Materials of both unknown pedigree and performance shall not be used for commercial *D*×*P* seed production.

Selection requirements of parental palms for commercial DxP seed production MS157:2005

Traits	*Dura*	*Tenera*
Fresh fruit bunch (kg/p/yr), min.	150	170
Mesocarp to fruit (%), min.	55	-
Shell to fruit (%), max.	35	-
Kernel to bunch (%), min.	-	3
Oil to dry mesocarp (%), min.	75	-
Oil to bunch (%), min.	18	25

Yield records: Mean of four consecutive years,
Bunch analysis: Minimum of three bunches/palm

kushairi@mpob.gov.my

Legal Requirements

- Producers of oil palm planting materials must obtain license to produce, store and move the planting materials
- Producers must be a registered company, financially sound and has a competent breeder.
- Seeds, clones and seedlings for commercial sale must fulfill the requirements of Malaysian Standard MS157 (seeds) or MS2099 (clones).
- The seeds and clones shall in all aspects comply with the requirements of the legislations currently in force in Malaysia

License for Oil Palm Seeds and Clones for Commercial Planting

Related Legislation:

- Malaysian Standards are voluntary according to the Department of Standards Malaysia (STANDARDS MALAYSIA)
- However, MS 157 (seeds) and MS 2099 (clones) are **MANDATORY** standards imposed by MPOB on producers regulated under the Malaysian Palm Oil Board (Licensing) Regulations 2005
- The industry in general is very well regulated and any revisions to improve the standards will immediately be imposed on producers

Conclusion

- Development of new oil palm cultivars owes a great deal to the work and dedication initiated by early breeders
- Science, laws and regulations facilitate development and release of new cultivar and healthy growth of the industry

Genetic Materials

Introduction of germplasm
Genetic diversity

Breeding & Selection

Breeding objectives
Yields, specialty traits

Malaysian Standard

MS 157 (seeds)
MS 2099 (clones)

Plant Breeders Right (optional)

Register for protection

Legal Requirements (mandatory)

Malaysian laws
MPOB licence

Commercial Sale & Planting

Oil palm area in Malaysia 5.84 mil ha (June 2018)

kushairi@mpob.gov.my

Thank You

Datuk Dr. Ahmad Kushairi Din
e-mail: kushairi@mpob.gov.my
Website: www.mpob.gov.my

Malaysian Palm Oil Board (MPOB)
No. 6, Persiaran Institusi,
Bandar Baru Bangi,
43000 Kajang, Selangor
MALAYSIA