Discovering Future Planting Materials for the Betterment of Oil Palm Industry
FASSB Oil Palm Seminar 2017

Presented by
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FGV R&D Sdn Bhd
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Presentation Overview

- Oil Palm Breeding at FGV - History
- Premium Planting Materials
  - FGV Yangambi
  - FGV 3-way
  - FGV clone & clonal seeds
- Latest Planting Materials Launched
  - Yangambi GT1 (Ganoderma tolerant planting materials)
- Other Planting Materials In the Pipeline
FGV’s Premium Planting Materials
FGV’s overseas footprint spans the globe, with operations in more than 10 nations.
THE GENE POOL FOR FGV OIL PALM BREEDING: BASIC POPULATION AND ORIGIN

1972-1975
Collection from IRHO: Yangambi, La Mé, NIFOR, Deli Dabao

1975
Nigerian from MPOB

1985-1986
Cameroon & Zaire from MPOB

1987
Tanzanian from MPOB

2005 & 2013
Angolan from MPOB

Other collection:

<table>
<thead>
<tr>
<th>Year</th>
<th>Material</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>Fertile pisifera</td>
<td>FES Serdang</td>
</tr>
<tr>
<td>1968</td>
<td>Deli dura</td>
<td>Elmina, Ulu Remis, Banting</td>
</tr>
<tr>
<td>1974</td>
<td>Banting Dura</td>
<td>Banting</td>
</tr>
<tr>
<td>1976</td>
<td>AVROS sib crosses</td>
<td>DOA Serdang</td>
</tr>
<tr>
<td>1985-1990</td>
<td>Deli dura introgression / dumpy AVROS pisifera/ tenera introgression</td>
<td>HRU</td>
</tr>
</tbody>
</table>

(E. guineensis)
Africa
The route to Elite Planting Materials

(1) Wild Germplasm Prospection

(2) Selection for Improvement (Gen 1)

NCM1/NCM2

Yield Recording / Bunch Analysis

CRD/RCBD

(3) Selection for Improvement (Gen 2)

Repeat #2

(4) Gen 3

Note: Each Steps in the process require ~ 15 years before desirable traits can be achieved.
Characteristics of Yangambi PM

- Bunch size: 17 - 25
- Bunch no.: 9 - 15
- HI: 0.55 meter/year
- Fruitlet size: ~11g
- Frond length: ~6m
- PCS: ~37cm$^2$
What is Expected? Actual Yield Results 2001 - 2015

FFB Yield (Kg / Palm)
Yield per Ha (t/ha)

Harvesting Year (2001 - 2015)
What is Expected? Actual Yield Results 2001 - 2015

Average Bunch Number (ABO) and Average Bunch Weight (kg/bunch) over the harvesting years from 2001 to 2015.
DxP Yangambi Progenies
- FFB (25.77 t/ha/yr)
- 2% above SC3
- Oil Yield (6.96 t/ha)
- 4% above SC3

FELDA Deli x Yangambi ML161
- FFB (32.81 t/ha/yr)
- 30% above SC3
- Oil Yield (8.89 t/ha)
- 32% above SC3
- 5% above P164 Clone
FELDA Palm Industries (FPI) Mills giving OER > 22% in Peninsular Malaysia (Data: 2010 -2014)

<table>
<thead>
<tr>
<th>No.</th>
<th>Mill</th>
<th>OER (%)</th>
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<td>3</td>
<td>Jengka 21- Pahang</td>
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<td>4</td>
<td>Mempaga - Pahang</td>
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OER achievement (1994 -2014): Pre & Post Replanting (Kilang FPI Seroja)
OER achievement (1994 - 2014): Pre & Post Replanting (Kilang FPI Kota Gelanggi)
FELDA DxP PERFORMANCE – Sources For Future Planting Materials

- Broaden the genetic base (inbreeding selection pressure)
- Introgression of new germplasm to current OP breeding programme
- 3-way cross \{D (Deli-NPM) x P (Yangambi)\} – Compact & High Oil Yield
- Clonal Propagation - Top Individuals (ensure higher uniformity, FFB & OER)
- Trait specific planting materials (disease / drought & etc.)
FGV 3way cross
(Deli-NPM x Yangambi)
FGV’s Oil Palm Germplasm Collection

*Elaeis oleifera*  
(South America)

*Elaeis guineensis*  
(Africa)

1975  
Nigerian from MPOB
## Utilization of Nigerian-derived Dura in FGV

<table>
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<th>Year</th>
<th>Activity</th>
<th>Details</th>
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<tr>
<td>1980</td>
<td>NPM germplasm Elite <em>tenera</em> and <em>dura</em> palms from PORIM</td>
<td>Evaluation &amp; Selection by PORIM (now MPOB)</td>
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<td>1989-1992</td>
<td>DxT, TxT, DxD Testing</td>
<td>Exploitation of Nigerian materials in FELDA breeding programme</td>
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<td>1993-1997</td>
<td>Selection for best Dura palms &amp; Progeny test trial</td>
<td>Selection of best palms for further testing</td>
</tr>
<tr>
<td>2002-2007</td>
<td>Evaluation &amp; Selection of 2(^{nd}) cycle Dura Breeding Populations</td>
<td>Selection for 2(^{nd}) cycle planting materials from DxP test</td>
</tr>
<tr>
<td>Present</td>
<td>Evaluation the Breeding Populations with value added trait</td>
<td>Value addition focus to elite progenies (Gano tolerant, high density progeny)</td>
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</table>
Nigerian Prospected Materials (NPM) in FGV
(FFB yield – improvement process)

Suthashini et al., (2015); Fine tuning the Nigerian germplasm breeding programme at FGV for climate change in Malaysia. In Proceeding: ISOPB 2015
The newest DxP FGV variety, a result of long breeding scheme and was released in 2008

The variety comes from 3 breeding lines. The Dura line is a result of introgression of Dura Nigerian (MPOB) and Dura Deli Group. And the pisifera line comes from Yangambi ML 161 family.

The advantages of Nigerian Dura is the small bunches with high number of bunches per year. And the advantages of Pisifera Yangambi ML161 is the high yield (CPO and kernel)

High density interval planting $\approx 148$ palms / ha to 160 palms/ha
Assembling variety of Felda 3 way

**D x D**
Deli (Banting) x Nigerian (NPM)
Family: C2 & GKN

**T x P**
IRHO Yangambi
Family: ML

**D x D**
Deli (Banting) x Nigerian (NPM)
Family: ML

**T x P**
Felda 3Way seed production

**D x P progeny test**

**D x P Felda 3Way seed production**

**D x P Felda 3Way seed production**

**D x P progeny test**

Dura selection
Based on individual, family and progeny test performance

**CYCLE ‘0’**

**CYCLE ‘1’**
3 Way Cross Palm: Background

*(Deli-Banting x Nigerian)*

Dura

x

*(Yangambi)* Pisifera

Characteristics:

- High Fresh Fruit Bunch
- High Oil Yield
- Compact palm

Potential Planting Material for **HIGH DENSITY** planting.
Characteristics of 3 way

- Bunch size: 8 - 17
- Bunch no.: 14 - 23
- HI: <0.55 meter/year
- Fruitlet size: ~11.75g
- Frond length: 5.57 m – 5.86 m
- PCS: ~27cm²
Trial 14 (T162) Kota Gelanggi 6, Pahang, Planted June 1999
(25 DxP Crosses Planted)

DQ 34(Deli_NPMxYangambi)
3 Way Cross Palm Performance

Yield Profile for Selected Deli-Nigerian x Yangambi Progenies

OER = 27.1%

3 Way Cross Palm Performance

Yield Profile for Selected Deli-Nigerian x Yangambi Progenies

OER = 26.79%

FGV OIL PALM
PLANTING MATERIALS PROGRESS

MEAN MATURE YIELD (T/HA)

1980s
La Me / AVROS / Yangambi

1990s
Yangambi

2000s
Yangambi (ML 161)

2010s
3 way-cross

TOTAL MATURE OIL YIELD (T/HA)

1980s
27.18

1990s
29.66

2000s
29.83

2010s
30.12

Mean Mature Yield (T/HA)

1980s
22.2

1990s
24.9

2000s
26.3

2010s
27.1

OER*

1980s

1990s

2000s

2010s

33%

OER*
Vegetative traits of Yangambi 3-way materials
Comparison of the rachis length (RL) of NPM derived DxP progenies, generally gives:

- Shorter RL when NPM introgression is in the female (Deli) dura parent.

- Whereas if the NPM is introgressed into the pisifera (Yangambi) parent the RL is on the average 102.6% of SCs’ (Deli x Ybi & Deli x Lame) and has a smaller range from 545.5-595.9cm.
Yangambi 3 way have shorter rachis length by up to 22% as compared to Yangambi material.

<table>
<thead>
<tr>
<th>Planting Material</th>
<th>Progeny</th>
<th>Rachis Length at Year 8</th>
<th>Ratio of 3-Way over Yangambi</th>
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<tr>
<td></td>
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<td>Trial’s Yangambi</td>
<td>3-Way Progeny</td>
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<tr>
<td>3-Way</td>
<td>EL 3</td>
<td>652.94</td>
<td>546.88</td>
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<tr>
<td>3-Way</td>
<td>EL 14</td>
<td>652.94</td>
<td>510.16</td>
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<td>2-Way</td>
<td>DQ 6*</td>
<td>582.99</td>
<td>540.19</td>
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* DQ6 – GGN/14D x GMH/43P, one of the high yielding NPM materials
### 3-Way Density Trial in Sahabat 6: Vegetative Measurements

#### Rachis Length

<table>
<thead>
<tr>
<th>Months After Planting</th>
<th>T1(136)p/ha</th>
<th>T2(148)p/ha</th>
<th>T3(160)p/ha</th>
<th>DxP(136)p/ha</th>
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<tr>
<td>12MAP</td>
<td>141.1</td>
<td>129.7</td>
<td>133.1</td>
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<td>24MAP</td>
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<td>366.5</td>
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<td>48MAP</td>
<td>430.5</td>
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<td>401.4</td>
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<td>491.5</td>
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<td>496.0</td>
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<tr>
<td>72MAP</td>
<td>509.8</td>
<td>519.7</td>
<td>501.0</td>
<td>541.0</td>
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</table>

3-Way is 6% shorter than DxP
Planting Material testing at Sahabat 6 Rachis length data at 7 year after planting

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<tr>
<th>Trt</th>
<th>Density</th>
<th>BN</th>
<th>BW</th>
<th>ABW</th>
<th>T/ha</th>
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<td>8.4</td>
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<td>229.2</td>
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<td>31.2</td>
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<td>2013</td>
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<td>T3</td>
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<td>22.2</td>
<td>249.2</td>
<td>11.3</td>
<td>39.9</td>
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</tbody>
</table>

Results of density trial conducted on Felda 3Way
Felda 3 Way
Commercial Performances
### DxF FELDA 3Way Commercial Performances at FGVPM Kechau

<table>
<thead>
<tr>
<th>Planting Materials</th>
<th>Elite Clone DxF</th>
<th>DxF FELDA 3 way</th>
<th>DxF Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average FFB (Kg/palm/Yr)</td>
<td>125.6</td>
<td>116.5</td>
<td>96.9</td>
</tr>
<tr>
<td>Year Planted</td>
<td>2008</td>
<td>2008</td>
<td>2008</td>
</tr>
<tr>
<td>Planting Density</td>
<td>30ft</td>
<td>29ft</td>
<td>30ft</td>
</tr>
<tr>
<td>Hectare Planted</td>
<td>125.6</td>
<td>116.5</td>
<td>96.9</td>
</tr>
</tbody>
</table>
Commercial Estate Coastal Land (Perak)

Commercial Yield of Felda 3way materials at Bukit Asa Perak River Estate Planted Oct 2007
What are clonal seeds?

By definition:
Clonal seeds are the product of crossing of one clonal *dura* to a sexual *pisifera* (semi-clone) OR crossing of both clonal parent (bicline)

\[
\begin{align*}
D_{\text{Normal}} & \times P_{\text{Normal}} &= DP_{\text{Conventional}} \\
D_{\text{Clone}} & \times P_{\text{Normal}} &= DP_{\text{Semi-Clonal}} \\
D_{\text{Clone}} & \times P_{\text{Clone}} &= DP_{\text{Bi-Clonal}}
\end{align*}
\]
Pictorial explanation: Semi-clonal seeds via clonal *duras*
Production of Clonal Seeds in Felda

- Felda’s entrance into the clonal seed market takes into account the following essential conditions:
  - Superior yields from higher bunch oil content over the current Felda DxP;
  - More uniform palms; and
  - Low abnormalities
# Dura Ortet* Progeny test result

<table>
<thead>
<tr>
<th>Dura Clone</th>
<th>Dura Ortet’s DxP Progeny Test Result</th>
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<tbody>
<tr>
<td><strong>Ortet</strong></td>
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<td>GHI 25</td>
<td>FC2554</td>
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<td>ELP 1</td>
<td>FC2721</td>
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<td>EMG 40</td>
<td>FC2720</td>
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<tr>
<td>EOE 17</td>
<td>FC2743</td>
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</table>

**Notes:**

*Dura Ortet = The elite Dura individual cloned for seed production*

*Progeny testing trial conducted at Kota Gelanggi & Tekam, Pahang*
Clonal Seeds

- Clonal seeds combines advantages of both cloning and conventional seed multiplication.

- Seeds are produced from top performing mother palm and crosses without compromising on the yield performance. The uniformity of the seeds is improved through utilization of limited but high yielding crosses.

- The utilization of tissue culture technology in breeding programmes leading to the production of clonal seeds is expected to drive the planting material improvement programme faster.

Proven Planting materials are not the only factor boosting yield performance

Sustainable & Good Agricultural Practices are prerequisites for maximizing yield potential
Yangambi GT1
Ganoderma Nursery Screening

Dedicated 8.40 hectare nursery located at Ulu Belitung (Johor)

A = 6,000 palms
B = 2,800 palms
C = 3,000 palms
D = 8,000 palms
E = 10,000 palms
F = 8,000 palms
G = 7,000 palms
Total = 44,750 palms
High Throughput *Ganoderma* Nursery Trials

- Screening capacity for planting materials (35 + 6 control crosses)
- Conventional strategies to identify resistant / partial resistant PM
- Platform to validate the *Ganoderma* tolerant marker (GTM) – genomics
Ganoderma Nursery Trial
Symptoms of BSR disease (A) white mycelia produced on oil palm stem base at 5 month after inoculation (B) mature fruiting body on dead oil palm stem base (C) mature fruiting body on living oil palm stem base at 9 month after inoculation (D) necrotic lesion in stem bulb (E) severe decay in stem bulb at 9 month after inoculation.
External Scoring

– Monthly intervals
– 2 components:
  1. Dessicated leave status
  2. *Ganoderma* infection
Internal scoring

- Recorded at end of trial
- Also known as destructive sampling
- 2 components:
  1. Stem decay
  2. Root infection
High Tolerance Palms

Susceptible Palms
## Phenotypic Assessment
(Nursery)

<table>
<thead>
<tr>
<th>Progeny</th>
<th>Production of Leaves (Ranking)</th>
<th>Severity of Foliar Symptom (Ranking)</th>
<th>Total number of Roots (Ranking)</th>
<th>Primary Root Infection (Ranking)</th>
<th>Stem Decay (Ranking)</th>
<th>Total Ranking</th>
<th>% over Control Crosses</th>
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Mean Tolerant for *Ganoderma* control crosses (100%)

**Relative Tolerance against Control crosses**

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**138% - 168%**  **114% - 131%**
Partnership with FGV

• Priority to purchase our PalmaGro and PalmaShield product with some loyalty discounts
• *Ganoderma* census and survey for the area that YangambiGT1 will be planted.
• Follow up census and recommendations
• Early access to improved version of YangambiGT1 *Ganoderma* tolerant materials in the future
• Your contribution towards R&D activities in your area will be duly acknowledged in all our publications
Development of Virescens Planting Materials

Development of Long Stalk Planting Materials

Development of Ganoderma tolerant Planting Materials

Wild or Improved Collection

Phenotypic & statistical selection

Molecular breeding through marker selection

YIELD

GANO. D. TOLERANCE

HIGH DENSITY

DWARF

DRAUGHT TOLERANCE

VIRESCELS

FERTIZER UPTAKE E.

HIGH IV, UNSATURATED

HIGH CAROTENE

*BUD ROT D. TOLERANCE

LOW LIPASE

DELAY HARVESTING

LONG STALK

Type of Production

DxP Seed

Cional Seed

Ramet

Elite Variety
THANK YOU