Breeding for Sustainable Palm Oil Production

Presented by Sharifah Shahrul Rabiah Syed Alwee
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Introduction to Felda Global Ventures
Felda Global Ventures Holdings Berhad (FGV) is a global, diversified and sustainable integrated agri-business leader, dynamically advancing to lead as a top 10 global player by 2020.

Incorporated in Malaysia in 2007, FGV progressed into a diverse agri-business company and rapidly established itself as Malaysia’s leading global agri-business player.

Today we are the world’s largest producer of crude palm oil (CPO), a leader in Malaysia’s sugar industry and a pioneer of cutting edge green technologies, anchored by a 18,000 strong workforce and a global integrated supply chain able to add value to every endeavour.
Global Footprint

FGV’s overseas footprint spans the globe, with operations in more than 10 nations.
Our Overall Value Chain

**Palm Upstream Cluster**
+ The world’s largest CPO producer
+ Forms the core of the company

**Palm Downstream Cluster**
+ Innovating new palm-based products
+ Processing of crude palm oil into refined oils & focuses on FMCG

**Rubber Cluster**
+ Top 5 global processed rubber player

**Sugar Cluster**
+ Malaysia’s leading refined sugar producer
+ Operated through MSM Malaysia Holdings Berhad, a listed company on Bursa Malaysia

**Trading, Marketing and Logistics Cluster**
+ Ensures FGV’s integrated supply-chain support
+ World’s largest bulking installation for vegetable oil
+ One of the global palm oil trading house

**R&D and Agri-Services Cluster**
+ Breeding disease-resistant, high-yielding oil palm
+ Improving the yield of selected agri-crops through breeding, tissue culture agronomy & crop protection
R&D and Agri-Services Cluster

Utilizing cutting-edge technologies across all facets of FGV

FGV’s world class R&D and Agri-Services Cluster is anchored on four decades of research and development. The Cluster’s key objective is to utilize cutting-edge agriculture technologies to enhance operational performance and commercial utilisation across all facets of FGV. The company’s award-winning Yangambi oil palm planting material, which has 42 percent market share in Malaysia, is just one of R&D’s innovative products.
Award-winning oil palm seeds

Seeds SOLD
24.1M

# No. 1 Market Share
42%

# Malaysia, 2014

DxP Yangambi ML 161 Germinated Seeds Capacity : 40.0 million p.a.

Ramet Clonal Seedlings Capacity : 2.5 million p.a.
ALL THE WORLD 336 Million Seeds

DxP Felda Yangambi 331 Million Seeds

DxP Felda 3 Way 5 Million Seeds

Honduras 0.74 mil
Gabon 0.26 mil
Ethiopia 0.14 mil
Thailand 0.03 mil
Kamboja 0.38 mil
Philippine 0.20 mil
Indonesia 2.22 mil
Papua NG 0.15 mil
OIL PALM BREEDING PROGRAMME

Existing Variety

Wild or Improved Collection

Phenotypic & statistical selection

Molecular breeding through marker selection

YIELD

- GANO. D. TOLERANT
- HIGH DENSITY
- DWARF
- DROUGHT TOLERANCE
- VIRESCENS
- FERTIZER UPTAKE EFF.
- HIGH IV, UNSATURATED
- HIGH CAROTENE
- LONG STALK
- LOW LIPASE
- DELAYED HARVESTING

Type of Production

<table>
<thead>
<tr>
<th></th>
<th>DxP Seed</th>
<th>Clonal Seed</th>
<th>Ramet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image" alt="DxP Seed" /></td>
<td><img src="image" alt="Clonal Seed" /></td>
<td><img src="image" alt="Ramet" /></td>
</tr>
</tbody>
</table>
# FGV OIL PALM PLANTING MATERIALS IMPROVEMENT PROGRESS

<table>
<thead>
<tr>
<th>YEAR RELEASE</th>
<th>MATERIALS</th>
<th>TRAIT OF INTEREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980s</td>
<td>La Me / AVROS / Yangambi</td>
<td>Yield</td>
</tr>
<tr>
<td>1990s</td>
<td>Yangambi</td>
<td>Yield</td>
</tr>
<tr>
<td>2000s</td>
<td>Yangambi (ML 161)</td>
<td>Yield</td>
</tr>
<tr>
<td>2010s</td>
<td>3 way-cross</td>
<td>Yield + High density</td>
</tr>
<tr>
<td>2016</td>
<td>GT1</td>
<td>Ganoderma tolerance</td>
</tr>
</tbody>
</table>

![Bar Chart](chart.png)

- **2016 Total Mature Oil Yield (T/HA)**: 6.31, 7.39, 7.86, 8.13
- **33% Increase**
A highly efficient crop (Oil World 2016)

Highest Yield

<table>
<thead>
<tr>
<th>Crop</th>
<th>Oil (tons) per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm</td>
<td>3.8</td>
</tr>
<tr>
<td>Rape</td>
<td>0.8</td>
</tr>
<tr>
<td>Sunflower</td>
<td>0.7</td>
</tr>
<tr>
<td>Soy</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Strategy to increase productivity per ha of land

1. Higher yield per hectare
2. Higher palm stand per hectare
3. Palms tolerant to common disease
4. Ability to plant in environmentally challenged areas – drought tolerance
5. Shorter palms for longer economic lifespan
DxP Felda 3 Way
Selection method (Modified RRS)

- **Dura selection**
  - Based on individual, family and progeny test performance
  - Cycle '0'
    - **D x D**
      - IRHO, Banting, Ulu Remis, Elmina & Kulai
      - Dura
      - Family: eg. CBP, ARK, EOD, FI, CDN
    - **T x P**
      - IRHO Yangambi
      - Family: ML
- **D x P** progeny test
- **D x P Yangambi** seed production

- **Pisifera selection**
  - Based on tenera sib and progeny test performance
  - Cycle '1'
    - **D x D**
      - IRHO, Banting, Ulu Remis, Elmina, Kulai and inter-cross Dura
      - Family: eg. HPH, HQN, GHN, JFM, DR11
    - **T x P**
      - IRHO Yangambi (Sib crossing ML)
      - Family: GMH, AB1, GNR
  - **D x P** progeny test
  - **D x P** Felda ML161 seed production

- **Tenera selection**
  - Based on individual, family
Assembling DxP Felda 3 way

**Group A**
Kulai Banting Dura
Early population

**Group B**
Nigerian Dura
Early population

**Intercrosses (1*)**
DxD
GCA - SCA

**Progeny Testing 1* Generation**
DxP/DxT

**Selfing & Sibmating (2*)**
DxD

**Selection**

**Progeny Testing 2* Generation**
DxP/DxT

**Group AB**
Improved population

**PISIFERA**
IRHO Yangambi
L718P, L322P, L519P, L238P

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

**T x P**
IRHO Yangambi (Sib crossing ML)
Family: GMH, AB1, GNR

**Tenera selection**
Based on tenera sib and progeny test performance

**Pisifera selection**
Based on individual, family

**DxP FELDA 3 WAY**
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 148 palms / ha to 160 palms/ha.
Placing Material testing at Sahabat 6
Rachis length data at 7 year after planting

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th></th>
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<tbody>
<tr>
<td>DxP Yangambi P1</td>
<td>5.66</td>
<td></td>
</tr>
<tr>
<td>3Way P1</td>
<td>4.86</td>
<td></td>
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</table>

Results of density trial conducted on Felda 3Way

<table>
<thead>
<tr>
<th>Trt</th>
<th>Density</th>
<th>BN</th>
<th>BW</th>
<th>ABW</th>
<th>T/ha</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2011 (2nd YAH)</td>
<td></td>
<td></td>
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<tr>
<td>T1</td>
<td>136</td>
<td>18.5</td>
<td>148.5</td>
<td>8</td>
<td>20.2</td>
</tr>
<tr>
<td>T2</td>
<td>148</td>
<td>23.6</td>
<td>198.3</td>
<td>8.4</td>
<td>29.4</td>
</tr>
<tr>
<td>T3</td>
<td>160</td>
<td>18.9</td>
<td>148.5</td>
<td>7.9</td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012 (3rd YAH)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>136</td>
<td>21.3</td>
<td>229.2</td>
<td>10.8</td>
<td>31.2</td>
</tr>
<tr>
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<td>26.5</td>
<td>251.9</td>
<td>9.6</td>
<td>37.3</td>
</tr>
<tr>
<td>T3</td>
<td>160</td>
<td>25.6</td>
<td>236.1</td>
<td>9.3</td>
<td>37.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013 (4th YAH)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>T1</td>
<td>136</td>
<td>24.8</td>
<td>299.6</td>
<td>12.1</td>
<td>40.7</td>
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<tr>
<td>T2</td>
<td>148</td>
<td>27</td>
<td>316.5</td>
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<td>46.8</td>
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<tr>
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<td>316.8</td>
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<td>50.7</td>
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<tr>
<td></td>
<td></td>
<td>2014 (5th YAH)</td>
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<td></td>
<td></td>
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<tr>
<td>T1</td>
<td>136</td>
<td>23.8</td>
<td>278.2</td>
<td>11.7</td>
<td>37.8</td>
</tr>
<tr>
<td>T2</td>
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<td>23.2</td>
<td>262.1</td>
<td>11.3</td>
<td>38.8</td>
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<tr>
<td>T3</td>
<td>160</td>
<td>22.2</td>
<td>249.2</td>
<td>11.3</td>
<td>39.9</td>
</tr>
</tbody>
</table>
Economic gain through higher density planting

<table>
<thead>
<tr>
<th>Palm stand /hectare</th>
<th>Mean fresh fruit bunch weight (tonne/hectare)</th>
<th>% gain over 136 palm/hectare planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>136</td>
<td>32.48</td>
<td>-</td>
</tr>
<tr>
<td>148</td>
<td>38.08</td>
<td>17.24</td>
</tr>
<tr>
<td>160</td>
<td>38.05</td>
<td>17.15</td>
</tr>
</tbody>
</table>

Additional USD 6,660/Ha in first 5 years of harvesting
Assumptions: OER: 25%; KER: 4.3%; CPO Price: USD 564/MT; Kernel Price: USD 496/MT
Oil Palm Improvement

**Dura lines**

- **D x D crosses = 100% D**
  - 20 – 30% planted for evaluation
  - Selected dura for seed production and/or progeny test

- 70 – 80% lost opportunities due to resource shortage

**Pisifera line**

- **T X T or T X P**
  - 1D : 2T : 1P
  - 1T : 1P
  - 30 – 40% planted for evaluation

- ???? Lost opportunity
**Breeding by Design: Marker-Assisted Selection in Pisifera improvement programme**

- **Marker screening**

**QTL enriched** Advanced pisifera source without duras (from nursery screening) -25% of original population for field screening

Field evaluation (FFB-5yrs, BA-3x/palm (teneras only), VM-1x/palm)

- **QTL enriched** Pisifera selection – for progeny testing, tenera selection for next generation pollen source

DxP progeny testing (FFB-5yrs, BA-3x/palm, VM-1x/palm)

- **TxC/P crosses for next cycle**

Commercial DxP seed production
MAB = Reduced Oil Palm Breeding Costs

Conventional breeding

- Crossing & nursery stages
  - RM 6,000.00
  - RM16,500.00

- Immature period
  - RM4,550.00

- Fruiting/ recording (field data to establish reliable phenotype for yield)
  - RM445,000.00

± 10 YEARS

MAS breeding

- Crossing
  - RM6,000.00

- Nursery (MAS I : BSA)
  - RM22,500.00

- Selected Crosses
  - RM4,550.00

- Immature period
  - RM86,000.00

- Fruiting
  - Records & Selects superior individual palm

± 7 YEARS

- 30 crosses, 100 plant/cross, RM200/cross (≈ 20 ha)
- RM5.5/seedling, RM6,000.00/ha (≈ 20 ha)
- ~ RM2,000/ha/yr (≈ 20 ha, 5 yrs)

RM472,050.00

- 30 crosses, 100 plant/cross, RM200/cross (≈ 10 ha)
- RM5.5/seedling, RM6,000.00/ha (≈ 10 ha)
- ~ RM2,000/ha/yr (≈ 5 ha, 3 yrs)

RM119,300.00
• Convergence of breeding, biotechnology and genomics compliments each other to arrive at a common goal of producing high performing value-added planting materials.

• New oil palm varieties are aimed at sustainable production of palm oil across various environmental demands

• These development are of immense importance to the 3P principals (people, planet, profit) for sustainable palm oil production.
THANK YOU