Penguatan R&D
Dalam Upaya Pengembangan Industri Sawit

Tony Liwang

Lembaga Pendidikan Perkebunan
Jogjakarta, 17-18 Januari 2018
Background

**Yield Improvement - The facts at a glance**

‘Rice has been farmed in the same way for five or six thousand years’

“Oil Palm has been farmed in the same way for more than hundred years”

Source: Wageningen World, 2-2012
Sustainable Farming = Improving Yield + Reducing Cost
Initiated from selected seeds for long term investment
Potential Yield ± 18 t oil/ha/yr

Site Yield Potential ± 12 t oil/ha/yr

Actual Yield Potential ± 6 t oil/ha/yr

Genetic Factors
Elaeis guineensis, Elaeis oleifera Seeds, Clones

Environment Factors
(Limiting Factors)
Climate (Rainfall, Solar Radiation,...)
Soil Condition

Agronomic Mgmnt Factors
(Reducing Factors)
Mineral Nutrition Mgmnt
Pest and Disease Mgmnt
Mechanization Mgmnt
Social and Economic Mgmnt

Source: RHV Corley, 2006
Background

**Yield Improvement - Oil Palm Yield Potential**

<table>
<thead>
<tr>
<th>CPO Yield (ton/ha/year)</th>
<th>Improve through Tissue Culture?</th>
<th>Improve through Molecular Breeding?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesian (non-private)</td>
<td>3.3 **</td>
<td></td>
</tr>
<tr>
<td>Indonesian (private)</td>
<td>4.2 **</td>
<td></td>
</tr>
<tr>
<td>Best Experimental Plot</td>
<td>8.6 *</td>
<td>12.2 *</td>
</tr>
<tr>
<td>Selected Progeny</td>
<td>13.6 *</td>
<td>18.2 *</td>
</tr>
<tr>
<td>Individual Palm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Theoretical yield</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Rajinder Singh, MPOB, 2010 (*)
Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017 (**)
Background

An oil palm bunch with a weight of 79 kg from an Oil Palm Plantation in North Sumatera, in 1940’s

An oil palm bunch with a weight of 85 kg from an Oil Palm Plantation in Jambi, in 2017

New Record – MURI after 77 years

GAPKI
Yesterday at 17:58 ·

Rekor TBS Terberat baru saja terpecahkan di 85 Kg oleh Petani Sawit
Atas Nama : Sugiaro
Hp 51 (Mekar Mulya)
No Kav 1233.
KUD Subur Makmur
Desa Tidar Kuranji, JAMBI
Before 2005 it was suspected that one third of the oil palm plantation in Indonesia has been planted with un-certified seeds.

Source: Liwang et al. (2008).
the Impact

CPO Production (million ton)

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-Private</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>9.5</td>
<td>9.8</td>
</tr>
<tr>
<td>2010</td>
<td>10.3</td>
<td>11.6</td>
</tr>
<tr>
<td>2011</td>
<td>10.8</td>
<td>12.3</td>
</tr>
<tr>
<td>2012</td>
<td>11.3</td>
<td>14.7</td>
</tr>
<tr>
<td>2013</td>
<td>12.2</td>
<td>15.6</td>
</tr>
<tr>
<td>2014</td>
<td>12.4</td>
<td>16.8</td>
</tr>
<tr>
<td>2015</td>
<td>12.9</td>
<td>18.2</td>
</tr>
<tr>
<td>2016</td>
<td>13.3</td>
<td>19.9</td>
</tr>
<tr>
<td>2017</td>
<td>13.8</td>
<td>21.5</td>
</tr>
</tbody>
</table>

CPO Productivity (ton/ha/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-Private</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>2010</td>
<td>3.4</td>
<td>3.5</td>
</tr>
<tr>
<td>2011</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>2012</td>
<td>3.3</td>
<td>3.8</td>
</tr>
<tr>
<td>2013</td>
<td>3.3</td>
<td>3.8</td>
</tr>
<tr>
<td>2014</td>
<td>3.3</td>
<td>3.9</td>
</tr>
<tr>
<td>2015</td>
<td>3.2</td>
<td>3.9</td>
</tr>
<tr>
<td>2016</td>
<td>3.3</td>
<td>4.1</td>
</tr>
<tr>
<td>2017</td>
<td>3.3</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Average Annual Growth
Non Private = 6 %
Private = 15 %

Average Annual Growth
Non Private = x % (?)
Private = 5 %

Source: Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017
**PKO Production (million ton)**

- **Non-Private**
  - 2009: 1.9
  - 2010: 2.1
  - 2011: 2.2
  - 2012: 2.3
  - 2013: 2.4
  - 2014: 3.1
  - 2015: 3.4
  - 2016: 3.6
  - 2017: 4.0

- **Private**
  - 2009: 2.0
  - 2010: 2.3
  - 2011: 2.5
  - 2012: 2.9
  - 2013: 2.5
  - 2014: 2.6
  - 2015: 2.7
  - 2016: 2.8
  - 2017: 4.3

**PKO Productivity (ton/ha/year)**

- **Non-Private**
  - 2009: 0.7
  - 2010: 0.6
  - 2011: 0.7
  - 2012: 0.8
  - 2013: 0.8
  - 2014: 0.8
  - 2015: 0.8
  - 2016: 0.8
  - 2017: 0.8

- **Private**
  - 2009: 0.6
  - 2010: 0.7
  - 2011: 0.7
  - 2012: 0.8
  - 2013: 0.8
  - 2014: 0.8
  - 2015: 0.8
  - 2016: 0.8
  - 2017: 0.8

**Average Annual Growth**

- **Non Private** = 6%
- **Private** = 14%

**Average Annual Growth**

- **Non Private** = x% (to be determined)
- **Private** = 4%

*Source: Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017*
the Impact

Total Oil Yield (ton/ha/year)

Average Annual Growth

PKO = 4.2 %
CPO = 2.3 %
PKO + CPO = 2.6 %

Source: Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017
Yield Improvement
New Planted Area

Average Annual Growth
New Planted Area = 584,200 Ha
= 6.5%

Planting area
(000 ha)

Source: Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017
the Challenge …

CPO Productivity
Non Private = \(x\%\) (?)
Private = 5%

PKO Productivity
Non Private = \(x\%\) (?)
Private = 4%

New Planted Area = 6.5%

Average Annual Growth of Productivity < New Planted Area and contributed mainly by Private Company

An increment of minimum wage is about 8.72% for 2017-2018
Projection of Replanting Area in Indonesia

Area (x 1,000 Ha)

Simulated based on age of palm only, but it should be also based on yield performance

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-Private</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>49</td>
<td>107</td>
<td>156</td>
</tr>
<tr>
<td>2018</td>
<td>54</td>
<td>92</td>
<td>146</td>
</tr>
<tr>
<td>2019</td>
<td>76</td>
<td>115</td>
<td>191</td>
</tr>
<tr>
<td>2020</td>
<td>104</td>
<td>116</td>
<td>221</td>
</tr>
<tr>
<td>2021</td>
<td>102</td>
<td>122</td>
<td>225</td>
</tr>
<tr>
<td>2022</td>
<td>165</td>
<td>508</td>
<td>673</td>
</tr>
<tr>
<td>2023</td>
<td>117</td>
<td>521</td>
<td>638</td>
</tr>
<tr>
<td>2024</td>
<td>171</td>
<td>171</td>
<td>342</td>
</tr>
<tr>
<td>2025</td>
<td>137</td>
<td>119</td>
<td>256</td>
</tr>
<tr>
<td>2026</td>
<td>416</td>
<td>139</td>
<td>555</td>
</tr>
<tr>
<td>2027</td>
<td>269</td>
<td>85</td>
<td>354</td>
</tr>
<tr>
<td>2028</td>
<td>77</td>
<td>139</td>
<td>216</td>
</tr>
</tbody>
</table>

Source: Dir. Gen. of Estate of Min. Agric. of Indonesia, 2017
Duration of Breeding Approaches

Oil Palm
Conventional Phenotype Selection Breeding vs Genetic Selection (GS) Breeding

Traditional phenotype selection breeding schedule

40 years

GS steered breeding schedule

24 years

Cros et al. 2014
Duration of Breeding Approaches

**Conventional - Molecular Markers - Mutagenesis - GMO Dev.**

10 – 7 – 5.5 – 14 years

Source: Annual Report Vilmorin Clause & Cie 2004-2005 and USDA information
Objectives of Oil Palm Biotechnology

Main objectives to carry out research on oil palm biotechnology and micro propagation (tissue culture):

1. to validate the phenotypic advantages with the genotyping test and genomic information
2. to shorten the time required to develop elite palm with desired characters (biotic and abiotic tolerant, nutrient efficient, … ) compared to conventional breeding
3. to minimize the space and the cost required for field trials
4. to develop and produce the desired elite planting materials through tissue culture
5. to improve the interaction of genetic and environment through microbial agents
Molecular Assisted Selection

Oil Palm Genome consists of 16 pairs of chromosome, >1.71 giga base pairs
Molecular Breeding of Oil Palm
Main Desired Characters

- High Yield (FFB & OER)
- High Oil Quality (Oleate & Carotene)
- Long Peduncle
- Biotic Stress: Disease Resistance (Ganoderma sp.)
- Nutrient Uptake Efficiency
- Slow Stem Height Increment
- Drought Tolerance
- Pest Resistance
- High Photosynthesis Rate

- Molecular Breeding of Oil Palm
- \[
\begin{align*}
\text{Biotic Stress:} & \quad \text{Disease Resistance (Ganoderma sp.)} \\
\text{High Yield} & \quad \text{(FFB & OER)} \\
\text{High Oil Quality} & \quad \text{(Oleate & Carotene)} \\
\text{Long Peduncle} & \\
\text{Biotic Stress:} & \\
\text{Drought Tolerance} & \quad \text{Pest Resistance} \\
\text{High Photosynthesis Rate} & \quad \text{High Yield (FFB & OER)} \\
\text{High Oil Quality (Oleate & Carotene)} & \quad \text{Long Peduncle} \\
\text{Biotic Stress:} & \quad \text{Disease Resistance (Ganoderma sp.)} \\
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\end{align*}
\]
Terima Kasih