Future prospects for palm oil in the 21st century:
Biological and other challenges

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Introduction

- In 2006, palm oil supplanted soybean oil as the major globally traded vegetable oil.

- Despite breeding advances, plantation yields have only shown modest improvements in established centres of cultivation, but worldwide production of palm oil has continued its steady increase.

- This is largely due to the conversion of additional land to plantations in countries as far apart as Papua New Guinea, Indonesia and Columbia.
Introduction

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• This is largely due to the conversion of additional land to plantations in countries as far apart as Papua New Guinea, Indonesia and Columbia.

• Thanks to its year-round harvestability and multi-decade productive lifetime, the oil palm cropping system has unique advantages over annual oil crops such as soybeans, rapeseed or sunflower.

• Oil palm has only just begun to benefit from modern high-tech breeding and selection techniques.
Global trends

• Economic downturn:

• Biofuels:

• Population growth:

• Climate change:

• Environment:

• Petrochemicals:
Global trends

- Economic downturn: R&D -ve  foods +ve
- Biofuels:  foods -ve  transient distraction
- Population growth:  foods ++ve
- Climate change:  pests & diseases -ve  unpredictable
- Environment:  expansion -ve  efficiency & sustainability
- Petrochemicals:  no future  oleochemicals ++ve
Continuing buoyant production in crop oils sector

![Graph showing global oil production from 2003/04 to 2007/08 with MT/yr on the y-axis and years on the x-axis.]
Oil palm as the global leader
Biological challenges

- Yield enhancement:
- Manipulation of fatty acid quality for different downstream applications:
- Pest and disease control:
- Addressing sustainability agenda:
- Bio-environmental audits and action plans:
Biological challenges

• Yield enhancement: currently <4 T/ha, future max >18 T/ha?

• Manipulation of fatty acid quality for different downstream applications: currently 16:0/18:1, future 60-80% 18:1 etc

• Pest and disease control: focus on surveillance & non-chemical methods

• Addressing sustainability agenda: minimise inputs

• Bio-environmental audits and action plans: eg peatlands
Biotechnological tools

Advanced breeding technologies

- Transgenesis (genetic engineering or GM)
- Mass clonal propagation
- Hybrid creation
- DNA marker assisted selection
- Genomics
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These technologies have created unprecedented opportunities for radical steps forward in redesigning the architecture and biological performance of the oil palm plant
Segmentation

• *Per capita* consumption of vegetable oils is still increasing across the world, with increasing uses for food and biofuels.

• These factors are leading to an increased *segmentation* in the marketplace for vegetable oil production and utilisation.
Segmentation

• *Per capita* consumption of vegetable oils is increasing across the world, with increasing levels of affluence, and a greater awareness of the nutritional benefits of plant-based oils

• These factors are leading to an increased *segmentation* in the marketplace for vegetable oil production and utilisation

• On the one hand, there is a slowing demand for cheap, edible *commodity oils*, such as soybean or palm, from the emerging economies of Eastern Asia

• On the other hand, in developed economies, there is a slowing demand for *biodiesel*, which is mainly sourced from food-grade palm and rapeseed oils

• *Is high oleic palm oil the answer?*
High oleic - low PUFA

- the multi-purpose oil crops of the future
High oleic oils

- Cheap but ‘healthy’ commodity oils
- High monounsaturate content (olive oil, Mediterranean diet etc)
- Do not require hydrogenation (*low trans*)
- Suitable for *non-food* use, eg lubricants (low oxidation)
GM High-oleic oils

- Very high oleate (65-90%+), v low PUFA (<5%)
- Several transgenic (GM) lines have been developed but not commercialised:
  - These line are based on antisense or RNAi technologies
  - Rapeseed/canola (89%)
  - Indian mustard (73%)
  - Soybean (90%)
  - Cottonseed (78%)
Non-GM High-oleic oils

- Very high oleate (65-90%+), v low PUFA (<5%)

- Many non-GM commercial lines already developed:
  - Rapeseed/canola (75%) - [LN 3%]
  - Soybean (83%) - [LN 3%]
  - Sunflower (80-90%) - [LN <1%]
  - Safflower (75%) - [LN <1%]
  - Olive (75%) - [LN <1%]
  - (Palm (55-60%) - [LN <15%] )
Some commercial High oleic oils

- **NuSun™** sunflower (65%) used by P&G for Pringles chips (200k T)
- **Vistive™** soybeans (80%) from Monsanto
- **Natreon™** canola (75%) from Dow
- **Nutrium™** sunflower (75%) sunflower from DuPont/Pioneer/Bunge
Strategies for oil modification

• Both GM and non-GM strategies are viable and can be cost-effective for many oil modifications

• Most (but not all) companies currently chose the non-GM route due to adverse market signals for GM
GM oil palm – some like it HOT
(high oleic transgenic)

• **HOT** is currently under development in Malaysia


• **BUT** - non-GM palm oil varieties @ 55%+ oleic could also be available in the near future

• **Both strategies** should be pursued vigorously
**High oleic palm oil**

<table>
<thead>
<tr>
<th>Fatty Acid Composition</th>
<th>E. Guineensis</th>
<th>E. Oleifera</th>
<th>O. G. Hybrids</th>
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<tr>
<td>14:0</td>
<td>1.1</td>
<td>0.1</td>
<td>0.3</td>
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<tr>
<td>16:0</td>
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<td>18.0</td>
<td>30.0</td>
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<td>18:0</td>
<td>4.5</td>
<td>0.5</td>
<td>1.9</td>
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<tr>
<td>18:1</td>
<td>39.2</td>
<td>62.8</td>
<td>53.9</td>
</tr>
<tr>
<td>18:2</td>
<td>10.1</td>
<td>16.8</td>
<td>13.6</td>
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<tr>
<td>Iodine Value</td>
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<td>71.5</td>
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<td>Tocopherols (ppm)</td>
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<td>1300</td>
<td>1000</td>
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<tr>
<td>Tocotrienols (ppm)</td>
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<tr>
<td>Carotene (ppm)</td>
<td>600</td>
<td>2036</td>
<td>1100</td>
</tr>
</tbody>
</table>
The environment

• Bio-environmental audits and action plans

• Environmental context of oil palm cultivation encompasses numerous complex areas of science and policy making

• Encouraging plantation biodiversity in a way that is consistent with maintaining sustainable levels of production

• Management of the conversion of tropical peatlands and other sensitive habitats to plantations while minimising avoidable release of greenhouse gases or other adverse environmental impacts.
Challenges for oil palm

• Developers
• Environmentalists
• Sluggish innovation
• Biodiesel
Challenges for oil palm

- Developers
- Environmentalists
- Sluggish innovation
- Biodiesel
Crop management

• Translation of biological improvements into reality on all plantations (commercial & smallholder)

• Management of plantations – disseminating best practice, improving extension services, re-skilling labour force

• Implementation of best practice in propagation, husbandry, harvesting, and processing of the crop

• Underperformance in this area is shown by the relative stagnation of average plantation yields at well under 4 t/ha over the past 15 years

• This is despite the development of much higher-yielding genotypes and their effective cultivation by some of the more exemplary growers.
Soybean/Canola/Sunflower: 1 T/ha

Oil palm: 3 to 10 T/ha potentially < 20 T/ha
Oil palm - an emerging giant

- 3 to 10-fold higher yield than temperate oilseeds
- Year-round cropping
- Plantations last 25+ years (no annual sowing)
- Low labour costs
- Emerging mechanisation
- Considerable unexplored genetic potential
- Room for improved management systems
- Good prognosis for future yield gains and potential for product diversification
Some challenges for oil palm

- Environmental concerns
- Sluggish innovation (e.g. yield)
- Biodiesel
- Slow pace of genetic oil modification whether via GM and non-GM methods
Some take-home messages

• We are moving into an increasingly uncertain period

• Economic dislocation and climatic changes are translating into:

  • unpredictable shifts in public policy (e.g. biofuels)

  • rapid shifts in global demand for (and hence prices of) commodities such as crops

• Therefore it will be crucial for the oil palm sector to maintain an efficient R&D operation in biology and other sectors so that this uniquely versatile crop can maintain, and possibly extend, its global pre-eminence in the future.
Healthy vegetable oils
Palm oil - the healthy vegetable oil
Thank you for your attention