CHALLENGES TO THE PLANTATION DIVISION

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• Goh Kah Joo, AARSB
• Sharudin Bin Jaffar, BHB
Figure 1: Map showing the extent of oil palm cultivation in 43 oil palm producing countries in 2006 (FAO, 2007)
# Challenges to Plantation Division

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Current situation</th>
<th>Future solution</th>
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<tbody>
<tr>
<td><strong>1) Human Capital</strong></td>
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<tr>
<td>a) Middle management</td>
<td>Limited number of graduate applying for the job.</td>
<td>Continuous recruitment of Planter and Agronomist.</td>
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<td>executives, Agronomist,</td>
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<td>Researchers and Planting</td>
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<td>Advisors.</td>
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<td>These are the drivers who</td>
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<td>provides solution to</td>
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<td>problems faced by the</td>
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<td>Industries and set new</td>
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<td>directions</td>
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<td>b) General workers and</td>
<td>Dependence on foreign labour.</td>
<td>Increased mechanization in estates operations</td>
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<td>Harvesters</td>
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<td>The Division has 97000</td>
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<td>hectares and require 12,200</td>
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<td>workers.</td>
<td>Availibility is limited and approval is subject to the Authority</td>
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## Challenges to Plantation Division

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<thead>
<tr>
<th>2) Agronomic practices and Plantations operation</th>
<th>Are these practices effective and efficient. Yes &amp; No</th>
<th>Need to re look into overall operation using current technology. Eg satellite imaging</th>
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<tr>
<td><strong>a) Field upkeep</strong></td>
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<td>Weed control</td>
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<td><strong>b) Disease outbreak</strong></td>
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<td>Eg. <em>Ganoderma bonensis</em></td>
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<td><strong>c) Harvesting</strong></td>
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<td>Short to medium ht ( &lt;5 meters)</td>
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<td>Tall palm</td>
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<td>Sharpening stone</td>
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<td><strong>d)</strong></td>
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<td><strong>e)</strong></td>
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### 2) Agronomic practices and Plantations operation

#### a) Field upkeep
- Weed control
- Inorganic Fertilizer application
- Organic fertilizer application

#### b) Disease outbreak
- Eg. *Ganoderma bonensis*

#### c) Harvesting
- Short to medium ht ( <5 meters)
- Tall palm
- Sharpening stone

### Best management practices
- Many has been developed in late 60’s to early 90’s
- Are these practices effective and efficient. Yes & No

### Need to re look into overall operation
- Using current technology. Eg satellite imaging

### Field upkeep
- Control droplet applicator, ULV, VLV
- Fertiliser spreader
- Manual application

### Disease outbreak
- No know chemical can effectively control the disease.
- The best control is by sanitation

### Harvesting
- Motorised cutter (Cantas)
- Aluminium poles.
- Diamond sharpener

### To look into the biology, aetiology, life cycle and epidemiology
- Using Technology approaches
- Electric motor, light and durable pole (15m)
- Composite carbon fibre pole (15m)
Tall palm harvesting
Carbon fiber pole (L) vs Aluminium pole (R)
### d) Stagnating Yield

When GMO crops were introduced to other vegetable oil the oil yield /ha has improved compared to Palm oil.

Low FFB and Oil yield/Ha over the past three decades Oil yield/ha is in the ranges of 3.5-4.3 mt.
2011 – 3.37 mt/ha

Low productivity/worker

| **No break-through.** Most breeder confined their selection through crossing of hybrid vigour |
| Replanting with high FFB yield and high oil yield planting material at higher planting density/hectare. Clonal planting material 17% Compact planting material 1% |
| Improve breeding through biotechnology. On going? |
| Target FFB yield 35.0 mt/ha Oil yield 8.7 mt/ha |
| To improved the motorised cutter vibration effect, pole length and overall weight. |

### e) Limited arable land

Planting on steep land, marginal soils and peat land – 40%

| Resulted in low yield due to low soil fertility and logistic factors. |
| To look into planting materials that is tolerance to stress. |
Figure 2: The national trends of FFB yields and crude palm oil production between 1975 and 2011 in Malaysia
Figure 4: Comparison of the rates of yield growth of soybean, rapeseed and oil palm since 1970s
Figure 3: Some marginal to unsuitable tropical soils planted with oil palm
3) Legislation

<table>
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<tr>
<th><strong>a) Domestic</strong></th>
<th><strong>b) International</strong></th>
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<tr>
<td>Highly regulated under, Federal, State and regional legislation</td>
<td>Environmentalist NGO’s, People, Planet and Profit 3P’s concept, Sustainability (RSPO)</td>
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<td>Eg. Minimum Hosing Act</td>
<td>Trade barrier- competing with other vegetable oil</td>
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<td>Subject to numbers of Laws, Acts, Taxes and other Statutory Charges</td>
<td>MPOC and MPOB have initiated proactive measures to counter various claims through scientific studies.</td>
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<td>Ensure compliance</td>
<td>We have obtained RSPO accreditation for one of our business unit to produce certified sustainable palm oil (CSPO) and 90% of our Pam Oil Mill are accredited with ISO9000</td>
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<tr>
<td>Introduction of New legislation</td>
<td>To obtained MSPO certification once it became mandatory.</td>
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<tr>
<td>On going.</td>
<td>To attain high yield and economic viability without compromising with environmental issues</td>
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# Milling

### Milling efficiency

Group OER over the past decade ranges 19.8% to 20.7%.

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<tr>
<th>Year</th>
<th>Best Mill</th>
<th>Planting material oil to bunch ratio</th>
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<tr>
<td>2011</td>
<td>20.4%</td>
<td>26%-28%</td>
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<td>23%</td>
<td>30%-32%</td>
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### Pollution

Smoke, Sound and Palm Oil Mill Effluent

Compliance with the law and treating of POME by way aerobic and anaerobic treatment.

Eg Smoke emission concentration to be reduced from 0.4g/Nm$^3$ to 0.2g/Nm$^3$.

### Biomass/Bio-waste Utilization

Eg, EFB, Boiler ash, Mesocarp fiber, Decanter cake, Pome

EFB application, Composting

Improve oil extraction method through high-tech milling processes.

Target – 25%

Convert Bio-waste to Biogas, Solid fuel, Bio ethanol and product of high value from organic waste.

To look for total solution to utilize all bio-waste and biomass into Bio energy and high value phyto-nutrient.
Palm Oil Mill /CPO
Bio waste (POME/EFB)
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<th>5) Profitability</th>
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<tr>
<td><strong>Fluctuating CPO prices</strong></td>
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<tr>
<td>High Production cost</td>
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<td>Early 80’ FFB cost@RM80/mt</td>
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<td>CPO@RM400/mt.</td>
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<tr>
<td>Mainly due high overhead and cost of inorganic fertiliser which consist of up to 60% of the production cost</td>
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<tr>
<td>Palm Oil is a price taker and buyers dictate the pricing.</td>
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<tr>
<td>Nothing much a producer can do but improve efficiency and be prudent at all time.</td>
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<tr>
<td>Increase FFB and Oil yield /Ha to remain competitive</td>
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6) R & D Development on Oil Palm

- The main research thrusts are as follows:
  a) Crop improvement
  b) Crop production
  c) Management
  d) Sustainability
  e) Information
a) Crop Improvement

- Objective is to develop uniform planting materials that maximise the potential yield. Eg. planting material that maximises the conversion of solar radiation into crude palm oil and kernel.
a) Crop Improvement

2) secondary traits of current interest include

I. slow height increment for ease of harvesting and extending the economic life of oil palm (Figure 5)
II. small canopy sizes for high density planting
III. long stalk for better pollination and perhaps, ease of harvesting (Figure 6)
IV. Ganoderma tolerant palms to reduce disease incidence in the fields
V. High yielding palms which require low fertilizer inputs i.e. palms with high nutrient use efficiency (Figure 7)
VI. High carotene, tocotrienol etc for value added products
Figure 5: AAR Hybrida 1 which short compact canopy features and slow height increment compared with other commercial planting material.
Figure 6: Long stalk bunches of oil palm within AAR breeding materials
Figure 7: Differential oil yield responses of oil palm to K fertilizer input. Clone A112 has high K use efficiency and in fact, showed a declining oil yields with increasing K fertilizer rate due to large kernel size. The other two planting materials showed that K fertilizer improved their oil yields.
a) Crop Improvement

3) Selection for high oil palm yield involves the selection of better light interception \( f \), canopy efficiency \( e \) and harvest index \( h \). This is because the multiplication of \( f \times e \times h \) gives the economic products.

- Another approach to high yielding materials is to select for high light interception \( f \) and tolerance to competition for light (Bruere, 2003). Such palms should have small canopy sizes (compact palms) and high yielding.

5) Harvest index, \( h \), slow height increment associated with higher \( h \) with higher sex ratio i.e. a higher partitioning of flowers to female inflorescences. The downside could be poor pollination due to lack of male inflorescences and probably pollinating weevils.
a) Crop Improvement

- 6) Breeding scheme for perennial crops should be short-term, i.e. molecular plant breeding. Traditional oil palm breeding has a long gestation period. Soh (2012) reported that it takes at least 30 years to develop a reasonably uniform cultivar.
a) Crop Improvement

- 7) The availability of the physical genomic map of oil palm and its 2nd generation map can be made to improve the selection efficiency, selection of desirable genotypes and shortening the development time for new cultivars.

- The genetic variability and diversity of oil palm breeding and germplasm populations can be revealed using high throughput microarrays such as DArT (Figure 8).

- This information can be used to improve the planting materials by introgressing the genes or alleles of interest into the breeding population via conventional hybridisation.

- DArT markers can be utilized in genomewide selection method to enable early selection to be carried out before the palm mature and efficient selection of traits with low heritability e.g. FFB yield which are affected by the environment.
Figure 8: Dendrogram showing the overall relationships between the genotypes analysed with the Discovery Array technology. The dendrogram illustrated the wide variation in current oil palm planting materials.
• 7) Utilization of QTL, to improve the breeding of oil palm quantitative traits. Many traits of economic importance are probably controlled by many QTL e.g. yield, oil content, protein content and drought tolerance (Soh, 2012) and these may be exploited using marker-assisted recurrent selection (MARS) or genomewide marker-assisted recurrent selection (GMARS). These methods save time, space and effort by obviating certain intervening cycles of field testing (Soh, 2012).

• Although molecular plant breeding offers much promises, proof of concept for perennial crops such as oil palm is still essential before it can be fully exploited.
a) Crop Improvement

• 8) One of the main reasons for the poorer rate of improvement in oil palm materials compared with other oilseeds crops is the use of genetically modified (GM) plants in the latter.

• Herbicide and insect resistant cultivars are already grown worldwide while GM crops with new traits such as improved oil and starch contents, nutrient composition and drought tolerance will be available soon (Soh, 2012).

• Currently, there is no commercial GM oil palm but similar work must proceed in the event that they may be needed in the future. Moreover, we need to keep abreast of new technology to maintain our competitive edge.
a) Crop Improvement

- 9) Tissue culturing of the best palms within the best families.
- Field experiences with tissue cultured palms showed that, they have more than 10% better oil yield than DxP seedlings.
- Research work is on-going to exploit the best planting materials of the next generation of oil palm in order to extend the lead time of tissue culture palms over the DxP seedlings.
- 10) Apart from oil yield, tissue culture palms can have other desirable characteristics such as reduced palm height, more liquid oil and components of high economic values.
a) Crop Improvement

• 11) Tissue culturing processes have a number of problems. The major ones are

  a) low embryogenesis rate
  b) abnormality
  c) high labour requirement

• These critical problems, which emerged in the mid-1980s have remained unresolved till today and hindered the use of this technology to mass produce superior oil palm planting materials.
a) Crop Improvement

• 12) Although most ortets will produce embryos, the rate of embryogenesis (from callus to embryogenic culture) remains low at less than 4% and its variability and can range from 0 to over 30%.

• To date, we still cannot pin-point the dominant factors influencing the embryogenesis rate. Nevertheless, there were a number of promising markers to detect embryogenic cultures but further work is needed before they can be used commercially.

• It would also be useful to elucidate the biochemical processes involved in embryogenesis of oil palm culture.
a) Crop Improvement

13) Many tissue culture laboratories for oil palm still experience somaclonal variation resulting in abnormal flowering and partial or complete sterility of some clonal palms. The rate of abnormality varies between 2% to 30%. Just like embryogenesis rate, the abnormality rate is unpredictable since the controlling factors are still unknown.

14) The tissue culturing process of oil palm can be shortened and the number of ramets increased with liquid culture. However, only certain type of calluses can be propagated via liquid culture. Again, the reasons for this have eluded us since we published this method in the 1990s.
a) Crop Improvement

• 15) It should be clear from this discussion that crop improvement in oil palm should be developed at MPOB and the Universities and made available to the industry for further joint commercial exploitation.
•b) Crop production

1) Crop production projects are concerned with the site yield potential. Thus, Agronomic research programmes in AARS/Malaysia have the objectives of improving or creating the best growing environments for the oil palm from highly degraded tropical soils.
b) Crop production

2) The progress of crop production research on oil palm was impeded by incomplete or unavailable information to answer several basic questions as below:

– i) Production

• What are the dominant site-factors which cause high and low yield? When management is optimum, how can we modify site-factors which limit production and what kind of responses is possible?
• What are the effects of external stimuli (e.g. fertilizers, soils) on dry matter production and partitioning including root architecture and turnover, and bunch development? How is oil production affected?
• What are the real causes of poor fruit set in newly mature precocious palms?
b) Crop production

ii) Fertilization

• What is the influence of multi-nutrient (including micronutrients) interactions on the production of oil palms? Why do some clonal palms do not respond to P and K fertilizer inputs despite their high yields?

• How does an oil palm respond to seasonal FFB production in terms of allocation of energy, dry matter and nutrient?

• What is the inter-relationship between soil-fertilizer-plant in maintaining optimum palm nutrition?
b) Crop production

iii) Effectiveness and efficiency of external inputs

a) What are the efficiencies of external inputs (e.g. fertilizers, cut fronds) in different environments?
b) What are the residual values of our external inputs?
c) What factors influence the effectiveness, efficiencies and residual values of external inputs?

iv) Environment and soil quality

a) How important is soil organic matter and quality of organic matter on long-term sustainability of oil palm plantations?
b) How do palm organic residues (e.g. cut fronds, root turnover) and their utilization affect the C cycle and sequestration in oil palm plantations?
c) What are the roles of microbes in oil palm plantations and how do they influence the soil health?
b) Crop production

3) Biofertilizers in the market with many claims on their effectiveness in improving palm nutrition and disease control.
   - We need to establish the criteria for soil health in relation to palm nutrition and how the biofertilizers influence these criteria.
   - The need to fully understand the relationship between the native and introduced microbes and how to maintain the introduced microbes over the 25 economic years of oil palm.

4) High fertiliser cost- It is essential that we improve the efficiency of fertilizer use in the plantations. 4Rs of fertilization (i.e. right rate, right time, right method and right frequency), specialty fertilizers (e.g. controlled release fertilizer, vermiculite) and soil fertility.
b) Crop production

5) The major problems of nutrient loss are at replanting when the enormous palm biomass are recycled and the growth of palms and legumes are unable to absorb the large quantities of the nutrients released over a relatively short period. Various methods such as pulverisation of the biomass have been attempted to alleviate this problem but without much success. Perhaps, a practical field method of pyrolysis to convert the biomass into energy, biochar and bio-oil will provide the necessary solution.

6) Ganoderma disease (Figure 8b) is now prevalent and most debilitating disease of oil palm in Malaysia and Indonesia. Despite much research, the biology, aetiology, life cycle and epidemiology are still not well established particularly under field conditions. This information/knowledge is needed to develop proper control of the disease while awaiting the plant breeders to develop Ganoderma disease tolerant palms.
8b) Basal stem rot (Ganoderma sp)
c) Management practices

1) The main Management constrained is labour availability.
   • Thus, labour saving methods have been developed and implemented in the plantations
     e.g. mechanical fertilizer spreader and grabber for loading FFB.
   • Other plantation operations which require labour saving methods are pruning, harvesting and application of empty fruit bunches (EFB).

2) MPOB has developed the Cantas system of pruning the oil palm fronds and cutting the bunches using a motorised system (Figure 9). Although the system can improved worker productivity, further improvement to the following areas should be beneficial:
   • I. reduce the excessive vibration
   • II. extend the harvesting pole
   • III. reduce the weight and shape of harvesting knife
   • IV. improve the reliability of the motor
   • V. prevent excessive removal of fronds
Figure 9: A harvester using Cantas to harvest bunches on the palms
3) Development of a mechanised, calibrated EFB applicator will be useful to utilize this bulky but valuable by-product in the fields efficiently (Figure 10). The EFB should be applied fresh from the mill to reduce the leaching losses of nutrients.
Figure 10: Tractor drawn applicator to applied pressed EFB and immature compost in the field.
d) *Sustainability*

1) The primary concerns are usually over issues related to sustainability of the plantations due to potential degradation of land resources, loss of biodiversity and forests, greenhouse gas emission and C loss from land-use change. RSPO Principal and Criteria has addressed these issues in detail.

2) Biodiversity in existing oil palm plantations, the ecoservice functions in the plantations and how they compared with other agricultural crops should be the prime interest. However, reports on this aspect of biodiversity for oil palm is surprisingly scarce or superficial. Similarly, the impact of riparian zones and high conservation value areas in the plantations on their overall biodiversity index is still not well established. It will also be useful to relate biodiversity with other indices of sustainability of oil palm.
d) Sustainability

3) With the trapping of methane from the effluent pond becoming a common practice in palm oil mills, the C cycle and greenhouse gas (GHG) emission from the plantations on mineral soils should not be an issue. The C budget and GHG emission of oil palm on peat soils require further measurements before a firm conclusion can be made on its sustainability. More extensive field work is needed to ascertain whether oil palm plantations in different environments are C sink or source, and how they fare when compared with other agricultural crops.
e) **Information management**

1) Computer technology, have replaced the traditional way of recording with database and information management system. The two major challenges now are to capture the data or information on a large scale and to assimilate data from different spatio-temporal scales into useful information for quick decision making.

2) Remote sensing via satellites provides quick, accurate and large scale data capture. Combining the imageries from Radarsat and high resolution optical images might overcome the cloud interference while maintaining the resolution. Another method is to use unmanned aerial vehicle (Figure 11) to capture high resolution hyperspectral images below the cloud. However, much work is still needed to make this technology feasible and practical for oil palm plantations.
Figure 11: Assembling an unmanned aerial vehicle (helicopter) and an image of oil palm captured by it
e) Information management

– Our in-house development called BAARMIS which utilises a Samsung Galaxy tablet is shown below (Figure 12). The application allows the user to track to problem areas, retrieve agro-management information, capture images and much more.
Figure 12: An example of the in-house information management system, BAARMIS, in Samsung Galaxy Tablet
1) Private sector R&D has a good track record of economic successes and contributions to improvements in plantations (Chew et al., 1999). This must continue because oil palm plantations must achieve high crop production and efficiencies to be sustainable.

2) With new challenges in the oil palm industry, it is vital that the private sector researchers conduct collaborative R&D with the public research institutions and universities where expertise and equipment are available in order to complement their work and to generate new information to solve the various pressing problems.

3) It is also essential for the oil palm industry to develop a scheme to attract and retain competent scientists so that a critical mass of researchers could be maintained to enable it to remain competitive and sustainable (Chew et al., 1999).
Thank You