1. Minutes of 36th Plenary Session
2. Matters Arising out of Minutes of 36th Plenary Session
3. Combined Reports:
   3.1. Biology Sub-Committee
   3.2. Food Nutrition & Quality Sub-Committee
   3.3. Oleochemical Sub-Committee
   3.4. Processing & Engineering Sub-Committee
   3.5. Technical Promotion & Market Development Sub-Committee
   3.6. Techno-Economics Sub-Committee
   3.7. Cross-Cutting Issues Session on Sustainability Sub-Committee
PROGRAMME ADVISORY COMMITTEE MEETING
36TH MEETING: 15 APRIL 2016

MINUTES OF PLENARY SESSION

Date: 15 April 2016, Friday
Time: 2.45 pm
Venue: Grand Ballroom, Putrajaya Marriott Hotel, Putrajaya

Present:
YB Dato’ Ar Wan Mohammad Khair-al Anuar Wan Ahmad, Chairman MPOB
Y Bhg Datuk Dr Choo Yuen May, Director General MPOB

Biology Sub-Committee (Bio SC):
- Prof Denis J Murphy, University of South Wales, UK (Chairman)
- Y Bhg Datuk Dr Abd Shukor Abd. Rahman, Arief Efektif Sdn Bhd., Malaysia
- Prof Dr Richard Martin Cooper, University of Bath, UK
- Prof Dr John L Harwood, Cardiff University, UK
- Prof Dr Mohd Zamri Saad, Universiti Putra Malaysia, Malaysia
- Prof Dr Jeremy Roberts, University of Nottingham, UK
- Prof Dr Monique Leclerc, University of Georgia, USA
- Prof Dr John Crawford, Rothemstead Research UK
- Dr Trevor Anthony Jackson, Ag Research Ltd, NZ
- Dr Xaviar Arulando, United Plantations Bhd, Malaysia
- Dr Paramanathan Selliah, Param Agricultural Soil Surveys (M) Sdn Bhd, M’sia
- Dr David Marshall, James Hutton Institute, UK.
- Dr Tristan Durand-Gasselin, PalmElit, France
- Mr Mahbob Abdullah, IPC Services Sdn Bhd, Malaysia
- Tn Hj Ir Izhar Mahmood, Malaysia

Food, Nutrition and Quality Sub-Committee (FNQ SC)
- Y Bhg Academician Tan Sri Emeritius Prof Datuk Dr Augustine Ong Soon Hock, MOSTA, Malaysia (Chairman)
- Y Bhg Datuk Er Kok Leong, Malaysia
- Prof Dr Eckhard Floter, Technical University of Berlin, Germany
- Prof Dr Tom Sander, King’s College London, UK
- Prof Dr Md Fauzi Abdullah, Universiti Kebangsaan Malaysia, Malaysia
- Dr V Raghavan, Malaysia
- Dr Aishah A Latif, Toxicology and Multipurpose Labs, Qatar
- Dr Pramod Khosla, Wayne State University, USA
- Dr Kaushik Banerjee, National Referral Lab, India

Oleochemical Sub-Committee (Oleo SC)
- Dr Wolfgang Rupilius, Germany (chairman)
- Y Bhg Datuk Hong Ngit Ming, Teck Guan Group, Malaysia
- Prof Dr Chong-Su Cho, Seoul National University, South Korea
- Prof Dr Douglas G Hayes, University of Tennesse, USA
- Prof Gianni Carvoli, University of Milan, Italy
• Prof. Dr Howard A Barnes, The Chester University, UK
• Dr Vahid Sendijarevic, Troy Polymers Inc, USA
• Dr Toshio Kakui, Lion Corporation, Japan
• Dr Burghard Gruning, Germany

Processing and Engineering Sub-Committee (PE SC)
• Prof Dr Stanislav Miertus, International Centre for Applied Research and Sustainable Technologies, Slovakia (Chairman)
• Prof Dr Ing Volker Thole, Eberwalde University of Sustainable Development (HNEE), Germany
• Prof Dr Stephen M Shaler, University of Maine, USA
• Dr Gee Ping Tou, Palm Nutraceuticals Sdn Bhd, Malaysia
• Dr Tong Soo Loong, Oiltek Nova Bioenergy Sdn Bhd, Malaysia
• Mr Lee Hock Leang, Kretam Holdings Berhad, Malaysia
• Mr Lee Keong Hoe, IHMS Sdn Bhd, Malaysia
• Tn Hj Shawaluddin Tahiruddin, Sime Darby Research Sdn Bhd, Malaysia
• Tn Hj Ismail Hassan, Malaysia

Technical Promotion and Market Development Sub-Committee (TPMD SC)
• Y Bhg Datuk Franki Anthony Dass, Sime Darby Plantations Sdn Bhd, Malaysia
• Mr K.T. Chin, Erapoly Global Sdn Bhd, Malaysia
• Mr U.R. Unnithan, Carotino Sdn Bhd, Malaysia

Techno-Economics Sub-Committee (TE SC)
• Y Bhg Tan Sri Dato’ Dr Mohd Noor ismail, Malaysia
• Y Bhg Tan Sri Datuk Dr Yusof Basiron, Malaysian Palm Oil Council, Malaysia
• Dr Abdul Hamid Jaafar, Universiti Kebangsaan Malaysia, Malaysia
• Dr James Fry, LMC International, UK
• Dr Khalid Abdul Rahim, Universiti Putra Malaysia, Malaysia

Cross-Cutting Issues Session on Sustainability Sub-Committee (CCI SC)
• Y Bhg Dato’ Carl Bek-Nielsen, United Plantation Berhad, Malaysia (Chairman), TM&MD, Sub-Committee
• Prof Dr Tom Sanders, FNQ Sub-Committee
• Prof Dr Md Pauzi Abdullah, FNQ SC
• Y Bhg Datuk Hong Ngit Ming, Oleo SC
• Prof Dr Stanislaw Miertus, PE SC
• Prof Dr Matthias Finkbeiner, PE SC
• Prof Dr Ing Martin Kaltschmitt, PE SC
• Y Bhg Datuk Franki Anthony Dass, TP&MD SC
• Dr Sushil Goenka, TPMD SC
• Mr UR Unnithan, TPMD SC
• Mr Chin Kok Tian, TPMD SC
• Y Bhg Tan Sri Datuk Dr Yusof Basiron, TE SC
Absent with apology:

- Prof. Madya Dr. Hj. Ismi Arif Ismail, Biology SC
- Prof. Dr. Matthias Finkbeiner, PE SC
- Prof. Dr. Ing Martin Kaltschmitt, PE SC
- Dr. Trevor Tomkins, FNQ SC
- Prof. Yang Yuexin, FNQ SC
- YBhg. Dato’ Carl Bek-Nielsen, TPMD SC
- Mr. Sushil Goenka TPMD SC
- YBhg. Datuk Dr. Mohd. Emir Mavani Abdullah, M’sia
- Mr. Thomas Mielke, TPMD SC

In Attendance:

- Dr Ahmad Kushairi Din, DDG (R&D)
- Hj Mohamad Nor Abd. Rahman, DDG (S)
- Dr Burhanuddin Abd. Salam, DITCS, Secretary of Plenary Session
- En Mohd Saufi Kassim, DFM, Secretary of PAC
- Dr Norman Hj Kamaruddin, DB
  - Dr Siti Ramlah Ahmad Ali
  - Dr Mohd Haniff Harun
  - Dr Hj Idris Abu Seman
  - Hj Abd Rahim Shuib
  - Dr Zulkifli Hashim
- Dr Hj Ahmad Parveez Hj Ghulam Kadir, Dir ABBC
  - Dr Rajinder Singh
  - Dr Meilina Ong Abdullah
  - Dr Leslie Low Eng Ti
  - Dr Umi Salamah Ramli
  - Dr Rajanaidu a/l Nookiah
- Hj Wahid Omar, DIRED
  - Hj Hamdan Abd Baklar
  - Hj Zulkifli Abd Manaf
  - YM Raja Zulkifli Raja Omar
  - Hj Rosli Johan
- Dr Lim Weng Soon, DE&P
  - Dr Hj Zulkifli Ab. Rahman
  - Dr Loh Soh Kheang
  - Dr Astimar Abd Aziz

- Cik Rosidah Radzian, DPDAS
  - Dr Hj Miskandar Mat Sahri
  - Dr Halimah Mohamad
  - Dr Kang Rani Selvaduray
  - Pn Fauziah Arshad
  - Dr N Kalanithi Nesaratnam
  - Dr N Nagendran Balasundram
  - Dr Ooi Cheng Keat
  - Mr Mohamad Fairus Mohd Hidzir
  - Mr Johari Minal
  - Hj Isa Mansor
  - Ms Juanita Lourdes Nanthan
  - Hj Hishamuddin Mohamad Aspar
  - En Mohd Salleh Mohd Kassim
• En Balu a/l Nambiappan, DEID
  o En Azman Ismail
• Dr Hazimah Abu Hassan, DAOTD
  o Dr Yeong Shoot Kian
  o Pn Razmah Ghazali
  o Dr Zainab Idris
  o En Zafarizal Bin Azizul Hassan
  o Pn Rosnah Ismail
• Sustainability, Conservation and Certification Unit
  o Dr Tan Yew Ai
  o Nik Aznizan Nik Ibrahim
  o Dr Puah Chiew Wei
  o Dr Ainie Kuntom
  o Dr Ramadasan Krishnan
• En Mohd Saufi Awang, HOU CC
• En Norizam Ahmad, CICU
1.0 Opening Remarks
The chairperson YB Dato’ Ar. Wan Mohammad Khair-il Anuar Wan Ahmad, Chairman of MPOB welcomes all attendees to the PAC Plenary Session.

2.0 Confirmation of Minutes
Minutes of the Plenary Session PAC 2015 was confirmed unanimously without amendments.

3.0 Matters arising
All matters arising from the Plenary Session PAC 2015 were resolved at the various Sub-Committee meetings.

4.0 Reports by Sub-Committees (SC)
4.1 Biology Sub-Committee (Presented by SC Chairman Prof. Dr Denis Murphy)

4.1.1. The report was divided into: (A) New project proposals (B) review of current projects (C) International Advisory Panel (IAP) on Ganoderma & IAP on Peat (D) Specific recommendations and (E) Additional remarks

4.1.2. Fourteen (14) New Project Proposals were assessed:
- Six (6) projects were rated as priority A (approved with minor comments);
- Four (4) projects were rated as priority B (approved with major comments/amendments)
- Four (4) projects were rated as priority C (not approved or subject to very substantial revision & reassessment)
- Some of the category C projects were on Ganoderma research, which were recommended to undergo a strategic realignment by the International Advisory Panel. Therefore, PAC suggested that relevant officers need to propose new projects that are align with the priority areas within the next 6 months.

4.1.3. Review of Current Projects
The Biology Sub-Committee reviewed the work of three Divisions (Biology, ABBC and IRED) with very diverse project areas. This year numerous breakout meetings between small groups of PAC members and MPOB researchers held on Tuesday until Friday, more than in previous years. The Sub-Committee felt that these sessions were valuable to MPOB staff. However, this resulted in lack of time for formal report writing and the Sub-Committee may consider amending the format in future to have shorter research progress reports, increased time for breakout meetings, and maybe a less detailed final report that focuses more on future recommendations.
4.1.4. Genomics breakthrough
The Biology Sub-Committee were pleased to commend MPOB on the impressive achievement in discovering and publishing the identity of the mantling gene, which was on the front cover of the premier high impact scientific journal, *Nature*. This was an example of world leading research from MPOB and the Sub-Committee congratulated the team of researchers involved and MPOB management for their leadership. This and other genomics work is opening new avenues for commercial exploitation and wealth creation in Malaysia and the Sub-Committee urged MPOB to seize such opportunities and capitalise on them.

4.1.5. International Advisory Panel on Ganoderma Disease Research.

a) The Advisory Panel comprised of Dr Richard M. Cooper from University of Bath, UK (Chairperson), Dr Xavier Arulandoo from United Plantations, Dr Tristan Durand-Gasselin from PalmElit, France, Prof Matthew Dickinson from University of Nottingham, UK and Prof Jan Stenlid from Dept. Forest Mycology and Plant Pathology, Sweden.

b) The Panel recommended that:
   - Future progress be reviewed after 2 and 5 years.
   - GanoDROP Unit structure and remit should be revised

c) The Sub-Committee suggested the following new groups:
   i) **Ganoderma Biology and Pathogenicity (GBP) Group**
      - Aims: to acquire fundamental knowledge on Ganoderma in terms of: Epidemiology, Biology; Pathology, Collection & Genetics
   
   ii) **Ganoderma Control Group**
      - Aims: disease control and mitigation; sustainable control through integration of knowledge.

   iii) **Emerging and Exotic Diseases and Biosecurity**
      - Aims: Awareness and monitoring of major perceived threats. Preparation of diagnostic tools. Greater ongoing contact with DOA Quarantine Dept.

In order to achieve this restructuring, it was recommended that weed and herbicide research be discontinued and staff transferred to the GBP Group.
4.1.6. International Advisory Panel on Peat

a) The Panel includes Dr. Paramanathan Selliah from Param Agricultural Soil Surveys (M) Sdn Bhd, Prof. Susan Page from University of Leicester, United Kingdom, Prof. Takashi Hirano from University of Hokkaido and Dr Fahmuddin Agus from Indonesian Soil Research Institute.

b) The Sub-Committee was concerned about the level of resourcing for the peat work in Sarawak. Inadequate levels of resource were impacting on provision of adequate lab facilities, availability of personnel to do the work and ensure timely publication, overreliance on goodwill of collaborating partners and a generally unsatisfactory intellectual environment. The consequences pose a risk to satisfactory progress of the work.

4.1.7. Key Recommendations

a) Improve the structure & impact of *Ganoderma* research. Ganodrop has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, the Biology Sub-Committee has considered that the structure and research strategy was imbalanced and that was not creating sufficient progress where it is needed, in particular on *Ganoderma* stem rots. The recommendations were based on: lack of progress on *Ganoderma* in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from Ganoderma; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding *Ganoderma* epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR.

(This will require some reorganisation of the structure and strategy of *Ganoderma* research at MPOB as detailed previously)

b) Improve the structure and impact of MPOB research on tropical peat systems. This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. There is an urgent need for increased personnel and provision of the necessary equipment and infrastructure to carry out this vital project. The PAC welcomes the newly formed International Advisory Committee supporting this research and considers it essential that they provide regular input into the project over the coming years. The Sub-Committee recommended that regular meetings of this advisor grouping should commence within the next few months.
c) Facilitate, coordinate and publicise examples of environmental management and conservation on oil palm plantations. Palm oil is frequently under attack for rainforest habitat destruction with consequent loss of iconic wildlife, yet many in the industry are actively promoting and implementing habitat preservation, restoration and wildlife conservation in and around oil palm estates. MPOB should take a positive leadership role in coordinating these efforts. It can develop “best practice” for conservation planning, riparian planting and wildlife monitoring. It can also promote wildlife conservation among industry workers and it can coordinate presentation and publicity for positive efforts in the conservation arena.

d) Improve the use of existing expertise in PAC, MPOB, industry and other stakeholders in addressing public concerns about oil palm. Unfortunately, many inaccurate and misleading stories about oil palm have been widely disseminated which contributes to negative public reactions to oil palm, especially in Europe. It was recommended that MPOB should take advantage of the considerable expertise among the independent experts on PAC, plus other credible experts, to address topics where inaccurate reporting of science-related issues related to oil palm has occurred and to achieve this MPOB could also work with other stakeholders such as MPOA and MPOC. Possibilities include more extensive engagement with media and other outlets in disseminating ‘good news’ stories and also in the rapid response to inaccurate or misleading stories. In addition to scholarly articles, some PAC members could write more accessible (to non-specialists) articles in magazines or popular journals (as in example article by Prof Dennis Murphy)

e) Improve communication and results sharing within and outside MPOB by promoting such interactions and incentivising cross-disciplinary research. While there are numerous examples of good collaboration on relevant research both inside and outside MPOB, there are also too many examples of a ‘silo’ mentality. This hampers progress and can mean that opportunities are missed and even that some work is duplicated. This issue has been raised in previous PAC reports but this year it was again raised in several Subcommittees and especially in the Crosscutting Subcommittee. There are still a lack of awareness of highly relevant international developments among many officers and more senior scientists at MPOB. Researchers should make better use of citation alerts and the availability of most published research as open access. In those cases where an article is not fully available online, a request for a pdf from the author(s) was normally successful.
f) MPOB should work more effectively and urgently with all relevant stakeholders to address the increasingly urgent need for mechanisation of plantation operations. Recent developments in Malaysia, especially restrictions on foreign labour have highlighted the importance of addressing the need for increased mechanisation of many planation operations from input applications to harvesting. Several projects proposals on mechanisation were presented to the Subcommittee but it was felt that these tended to be ‘more of the same’ in terms of projects that have already been pursued for many years without achieving a true breakthrough in terms of widespread utility on plantations. The launch of a US$1 million prize competition was a welcome development but this may not result in the right sort of projects. There are many experienced agricultural machinery suppliers who are already developing and manufacturing devices for automated or semi-automated crop management. Some of these use GIS technology linked to satellite or low-cost UAV (drone) systems while others include crop harvesting and processing as a single multi-step operation. Examples include the deployment in Europe of harvesters for the extraction and shelling of peas where many hectares can be harvested, processed and taken to supermarkets within a few hours with minimal use of labour; self-propelled tomato harvesters and citrus tree harvesters.

4.1.8. Additional remarks
The Sub-Committee fully supports the efforts by MPOB to revise relevant legislation in order to enable commercial opportunities from R&D to be better exploited for the benefit of future work by MPOB. (Case study: Orion Biosains genotyping systems). It may be useful to more fully engage with DOA in order to adjust the current (overly) stringent phytosanitary regulations where these are directly hampering crop research and breeding. This mainly applies to movement of OP germplasm which could possibly be done under more stringent quarantine conditions similar to some medical/animal samples.

The Sub-Committee thanked to MPOB for its fine support of the PAC activities, also supportive of MPOB’s great work but needs to continually adapt and improve in order to keep up with rapidly moving international developments.
4.2 **Food, Nutrition and Quality Sub-Committee** (Presented by SC Chairman, Academician Tan Sri Emeritus Prof. Datuk Dr. Augustine Ong Soon Hock)

4.2.1 **New Project Proposals**
- Thirteen (13) new project proposals were evaluated:
- Six (6) projects were rated A (approved with minor comments);
- Six (6) projects were rated B (approved with major comments/amendments);
- One (1) project was rated C (not approved or subject to very substantial revision & reassessment).

4.2.2 **Review of Current Projects**
A total of 46 projects were reviewed and presented in poster forms.

4.2.3 **Protocol in layman language**
- a) To produce good quality CPO with FFA < 3%
- b) To reduce organochlorine by washing oil palm fruits
- c) To reduce Cl⁻ by washing at mills
- d) To bleach with low arsenic neutral bleaching earth
- e) To deodorise at low temperature (ca. 210°C) and good vacuum (P< 2 Torr)
- f) To aim for production of RBD Palm Oil with 3-MCPD / GE < 1ppm

4.3 **Oleo-chemical Sub-Committee** (Presented by SC Chairman, Dr Wolfgang Rupilius)

4.3.1 **New Project Proposals**
- Eleven (11) new project proposals were evaluated:
- Six (6) projects were rated A (approved with minor comments);
- Two (2) projects were rated B (approved with major comments/amendments);
- Three (3) project were rated C

4.3.2 **Review of Current Projects**
A total of 43 projects were reviewed, covering the following areas/programs:
- Polyols and polyurethanes
- Lubricants
- Surfactants
- Fine chemicals
- Technology
- Cosmetics
- Agrochemicals
- Environment
  (involving laboratory synthesis, formulations, product development, method establishment, major equipment/instruments and pilot plants)
4.3.3 Key Recommendations

- Scientifically high-risk R&D projects should be adopted e.g. (i) Metathesis of palm oil products (olefins, dicarboxylic acids, polyols etc).
- (ii) Production of ether-type compounds (lubricants, cosmetics).
- Non-successful projects should be terminated early.
- Focus on fewer projects.
- Improve collaboration between divisions, and between PAC sub-committees.

4.4 Processing and Engineering Sub-Committee (Presented by SC Chairman, Prof. Dr. Stanislav Miertus)

4.4.1 New Project Proposals

Five new projects proposals were evaluated. Two project were rated A (approved minor comments); Three projects were rated B (approved major comments).

4.4.2 The Sub-Committee had brain storming sessions on the following subjects and the recommendations are as follows:

4.4.2.1 Recommendation on the issue of MPOB to become World Class and strengthening the integrated strategy of MPOB research programme:

(i) Sub-Committee members are highly appreciated the effort of Processing & Engineering Division, MPOB in streamlining of individual projects into more integrated research programme and obviously this effort should be continued.

(ii) Bearing in mind that MPOB has been actively involved in the elaboration and implementation of National Key Economic Areas (NKEA) and the 10 R&D strategic focus areas, it is recommended to start the preparation of the vision “Sustainable Palm Oil & Productivity 2025”. It should take into consideration changing frame conditions in Malaysia as well as on global level.

(iii) To continue exploring possible involvement of MPOB into international R&D programs such as HORIZON 2020, USDA, bilateral programs and industrial programs.
4.4.2.2 Recommendation on new research projects/ ideas to be further developed:
(i) To streamline development of the integrated bio-refinery concept within palm oil utilization (bio-energy - biofuel – bio-based products and materials) taking into account cascade approach and including also sustainability assessment.
(ii) To consider complex utilization of waste (EFB, POME, etc.) as well as of by-products (especially glycerol) to value-added products, phytonutrients, fine chemicals, biodegradable plastics (PLA), etc.
(iii) To develop new palm bio based materials.
(iv) To look further on sustainability issues.

4.4.2.3 Recommendation on further increase of MPOB impact on palm oil industry milling efficiency and sustainability. The proposals are focused mainly on:
(i) Oil Extractions Rates (OER) on Fresh Fruit Bunches (FFB)
(ii) Environmental Quality (Crude Palm Oil Mill) Regulations Review
(iii) Biogas (Anaerobic Treatment) Capture & Avoidance
(iv) Minimizing Crude Oil Quality Degradation in Milling Process

4.4.2.4 Recommendation on further improvement of performance of MPOB researchers and strengthening of interaction with PAC members.

4.4.2.5 Recommendation on further improvement of research projects proposals.

4.5 Technical Promotion and Market Development Sub-Committee (Presented by SC Member, Mr. UR Unnithan on behalf of SC Chairman, Dato’ Carl Bek-Nielsen)

4.5.1 The objectives of the Technical Advisory Services (TAS) Unit of MPOB are creating new markets, promoting technical awareness and engaging with oils and fats industry members, local authorities, NGOs and local associations to address regional issues and develop market for palm oil.

4.5.2 Key issues in 2015/2016:
(i) Anti-palm oil campaign: Health and Nutrition, Sustainability and Environment
(ii) Changing Market Dynamics
(iii) Tariff and Non-Tariff Barriers
4.5.3 Highlights of TAS activities: Enhancing with policy makers and government officials:
(i) high-level dinner at European Parliament
(ii) cooperation with the Chinese Government to facilitate the export of Malaysian palm oil to China
(iii) Malaysian delegation visit led by Chairman of MPOB to USDOL,
(iv) working visit to Iran Food and Drug Authority
(v) briefed Prime Minister of Djibouti on palm oil uses by Regional Manager Africa
(vi) Familiarization Program for Thailand’s Department of Agricultural officers

4.5.4 Enhancing market demand for Malaysian palm oil products:
(i) Commercialization of 5 palm-based food products in China through PORTSIM
(ii) Palm-based shortening in Iran
(iii) Palm-based soap in Ethiopia

4.5.5 Enhancing Malaysian Palm Oil Brand:
(i) Launching of Pioneer – a Malaysian PKC brand in Pakistan
(ii) Launching of Olera Gold (Sime Darby) – low colour shortening from Malaysia at Palm Oil Seminar in Washington DC
(iii) TAS market penetration efforts for Carotino red palm oil in Tanzania
(iv) Launching of Altin Palm Cooking Oil (Altin Foods) in Pakistan

4.5.6 International outreach programs:
(i) Milano Expo 2015, Milan, Italy
(ii) IFT Annual Meeting & Food Expo
(iii) 3rd Palm Oil Health And Nutrition Forum, Chongqing, China
(iv) POTS Cairo
(v) National Conference on Vegetable Oils and Fats India
(vi) MTecS Iran

4.5.7 Collaboration with International Institutes:
(i) National Institute of Nutrition (NIN), Hyderabad, India
(ii) Indian Institute of Chemical Technology (IICT), Hyderabad, India
(iii) Institute of Chemical Technology (ICT), Mumbai, India
(iv) China Agricultural University, Beijing, China
(v) Chinese Center for Diseases Control and Prevention (CDC), China
(vi) Southeast University, China
(vii) Lanzhou University, China
(viii) Jiangnan University, China
(ix) Agricultural University of Hebei, China
(x) Xihua University, Chengdu, China
4.5.8 General recommendations

(i) Nutrition and Food Safety Issues:
   (a) MPOB to engage top universities such as Cambridge/Harvard to conduct Epidemiological Studies related to palm oil consumption.
   (b) MPOB to collate data on 3-MCPD and Glycidyl Esters in palm oil fractions from the refining sector to establish baseline values.

(ii) Sustainability and Environmental Issues
   (a) The Malaysian Government to come up with a clear policy which would highlight forest cover, land allocated for palm oil plantations as well as overall green cover for Malaysia.
   (b) MPOB to commission an independent study on life cycle assessment comparing palm oil vs. soybean and rice cultivation.
   (c) MSPO certification for smallholders to ensure responsible development and environmental protection.

(iii) Communication
   (a) Intensify continuous engagement with Health Authorities in Malaysia and Overseas.
   (b) Engagement with national and international schools in Malaysia and Singapore.
   (c) Consumer friendly promotional materials to be made available
   (d) Intensify translation of technical and promotional materials into more regional languages in key markets.
   (e) To establish a ‘War Room’ to expeditiously respond to any attack against palm oil.

(iv) Acute Issue of Labour Shortage
   (a) MPIC to URGENTLY engage with the relevant ministries to overcome the current freeze on foreign workers.
(v) More Focus on Value-added Products
   (a) To increase value share instead of just market share.

(vi) Continuous Enhancement of Palm Oil Acceptance Worldwide
   (a) Continue to promote the goodness of palm oil through technical seminars and exhibitions.

(vii) Compressing the PAC Program:
   (a) Monday - Seminar with presentations by PAC members & invited industry speakers.
       - Cross Cutting Forum
   (b) Tuesday - Opening Ceremony
       - Presentation in the respective Sub-Committees
   (c) Wednesday - Presentations in the respective Sub-Committees & report writing.
       - PAC Dinner
   (d) Thursday - Finalization of report
       - Plenary Session

4.5.9 Specific Recommendation
(i) Europe
   (a) To follow-up closely on the issue of endocrine disruptors including a comprehensive sampling of CPO.
   (b) To follow-up on developments related to 3-MCPD & glycidyl esters legislation in the EU.
   (c) MPOB & MPOC to continue the lobbying and promotion of sustainable palm oil vigorously.

(ii) Americas Region
   (a) MPOB to convey to the Malaysian Government the need to resolve the alleged forced/child labour issue before the Trans-Pacific Partnership Agreement (TPP) is enforced.
   (b) MPOB to request through MPIC for the Malaysian Government to amend related laws to fully comply and adhere with the International Labour Organization (ILO) standards.

(iii) Oceania
    To create new demand for higher price realisation by;
    (a) Opening new markets for PKE in addition to New Zealand, e.g. Australia.
    (b) Exploring further potential use of PKE as a substitute for other meals.

(iv) China & Far Eastern Region
(a) To further enhance tripartite R&D and commercialization projects.
(b) To proactively engage with local authorities.
(c) MPOC to intensify promotional efforts through social media.
(d) Extend animal feed trials to include triglyceride based fat powders.

(v) South Asia
(a) To replicate PORTSIM China’s model in India.
(b) To explore opportunities of blending palm olein with olive oil as well as regionally preferred oils.
(c) To explore application of palm oil products in snack food industry both as frying medium using palm olein and as a colorant and functional food using red palm olein.
(d) To explore potential of palm biodiesel and oleochemicals markets in India.
(e) To promote PKC in India.
(f) To focus more on promotion activities in southern and eastern parts of India (in collaboration with MPOC).

(vi) West Asian & Central Asian Region
(a) To follow-up on status of convenient banking channels for export to Iran.

(vii) Africa
(a) To obtain statistics on growth trend of middle class across African countries to estimate potential growth in demand.
(b) To consider setting up two offices in the African region to tap the huge African market.

(viii) ASEAN
(a) To assess the domestic consumption of coconut oil for food and evaluate the feasibility to blend palm olein with coconut oil in the Philippines.
(b) To translate technical and scientific data related to palm oil into local languages within ASEAN.

4.6 Techno-Economics Sub-Committee (Presented by SC Chairman, Y Bhg Tan Sri Dato’ Dr Mohd Noor Ismail)

4.6.1 The Techno-Economics (TE) Sub-committee continued to offer advice and guidance to the TE Unit of the Economics and Industry Development Division (EID) and Integrated Research and Extension Division (IRED).

4.6.2 New Project Proposals:
(a) Seven new projects proposals from TE-EID were presented and evaluated.
All the seven new project were rated A (approved with minor comments).

(b) Two new project proposals from CLI-IRED were presented and evaluated.
    All two new projects were rated A (approved with minor comments).

4.6.3 Nine on-going Techno-economic projects were deliberated at the SC meeting. The Sub-Committee was satisfied with the progress of all the TE on-going projects and all projects will be viva this year.

4.6.4 Five on-going CLI-IRED projects were deliberated at the SC meeting. Out of the five on-going projects, four will be viva this year and one project will be viva in progression in-line with these three phases of research.

4.6.5 The Sub-Committee would also like to recommend to IRED the following:
    (i) Improvement of the TUNAS activities capacity and develop or create module for adoption by ISH.
    (ii) Consider the smallholder’s status (full time / part time) as a measure to decide on the assistance to be provided.
    (iii) To consider the provision of full package assistance for better impact of the project.
    (iv) Create cluster or group among the ISH to provide more effective extension services in general.
    (v) Use different techniques of teaching and training for different categories of smallholders.
    (vi) Provide better access of essential agricultural inputs for the ISH.
    (vii) Fertilization and sanitation are areas of great emphasis to be addressed.

4.6.6 In response to MPOB Chairman and Director General's Speech, the Sub-Committee discussed and gave some inputs and guidance for future activities towards achieving MPOB’s vision and mission. They are:
    (i) To strengthen further the Implementation of Replanting Programme
        (a) The replanting program especially for smallholders needs close monitoring, supervision and follow up operations to achieve its target.
        (b) Newly develop high yielding planting material should be made available to the smallholders.
        (c) Intensify extension services to the smallholders
(ii) To provide accurate and timely economic and industry information to the government.

(iii) New recruitment should focus on strong applied economics analytical tools.

4.6.7 The Sub-Committee recommended the TE officers to present valuable preliminary results relating to current issues faced by the industry. Such results provide important inputs for use by the government relating to their implementation of GST, export tax, labour, mechanisation strategies and etc. To continue also generating the industry by providing timely research results to improve industry’s competitiveness in the market.

4.6.8 The Sub-Committee would like to recommend that the EID continue to build up all relevant databases based on their studies and research works with a view to provide our government and the industry with a timely, accurate and useful information.

4.7 Cross Cutting Session on Sustainability Sub-Committee (Presented by Mr. UR Unnithan on behalf of SC Chairman, Dato’Carl Bek-Nielsen)

4.7.1 The Sub-Committee acknowledged four papers presented at the meeting:

- Paper 1: A Perspective of MPOB’s Sustainability Endeavors by Dr. Tan Yew Ai
- Paper 2: An Analysis of National Oil Palm Yield Trends for the Past 20 years by Mr. N. Balu
- Paper 3: The Sime Darby High Carbon Stock Study and its Implications by Dr. Kho Lip Khoon
- Paper 4: An Update on Peat Research by Dr. Mohd Haniff Harun

4.7.2 Recommendations were made based on key issues includes labor shortage, stagnating yield, development on high carbon stock areas and quality).

4.7.2.1 Key Recommendations on NGOs
(i) Engagement with NGOs has to be with personnel who are actually feeding information to the general public.

4.7.2.2 Key Recommendations on MSPO
(i) To continue with efforts to link the MSPO certification scheme more towards a “fair-trade” set up often used for smallholders.
(ii) More efforts should be directed at getting more smallholders being certified.

4.7.2.3 Key Recommendations on GHG Emissions
(i) To expedite and complete the LCA study on peat emission with special emphasis on the state of decomposition of the peat *i.e.* sapric, hemic and fibric peat swamps in oil palm plantings.
(ii) The international Steering Committee should meet and monitor peat studies more frequently.
(iii) MPOB to continue on the study on carbon emissions and combine it with UPCS to hopefully come up with a range of emissions specific for sapric, fibric and hemic.

4.7.2.4 Key Recommendations on Nutrition
(i) Intensify efforts to translate scientific information into consumer friendly messages.
(ii) MPOB and MPOC should work hand in hand in this endeavour.

4.7.2.5 Key Recommendations on Insecticide
(i) MPOB should look into the matter of making dimehypo commercially available to the oil palm plantation industry.
(ii) Top priority must be given for MPOB, together with experts, to identify effective alternatives for Class 1A and Class 1B insecticides as there is a possibility that monochrotophos could be banned.

4.7.2.6 Key Recommendations on Cost of Production
(i) MPOB is to make available the information on the general cost of production in a booklet to be circulated to the PAC members one week before the next PAC Meeting.
(ii) The Sub-Committee requested a presentation on cost of production at the next PAC Meeting.

4.7.2.7 Key Recommendations on Stagnating Yield
(i) MPOB to continue updating yield trends with a view to improve yield.

4.7.2.8 Key Recommendations on Mechanisation
(i) Step up efforts to find solutions to overcome problems associated with tall palm harvesting, loose fruit collection and evacuation of harvested stacks.
(ii) MPOB to engage reputed agricultural machinery companies to implement mechanization.
4.7.2.9 Key Recommendations on Labour Shortage
   (i) Recommended to MPOB to urgently appeal to the Government to lift the freeze on the intake of foreign labor for the plantation sector on the ground that oil palm is a perishable crop.

4.7.2.10 Other Recommendation
   (i) A 10-year masterplan to be developed for the oil palm industry by a Task Force consisting of selected PAC members, MPOB Officers and members of the private sector. Who will brainstorm to identify targets and common goals in the areas of 3-MCPD, nutrition and yields.
   (ii) MPOB to take a more proactive role in improving the sustainability of the overall oil palm industry.

5.0 Other matters

5.1 Tan Sri Mohd Noor raised the issue on RSPO, and the needs of compliance by smallholders. MPOB has also developed MSPO and it is a standard and certification that MPOB should use. It was urged that plantations and stallholders should comply with MSPO standard.

5.2 It was highlighted that the establishment of ‘War Room’ to expeditiously respond to any attack against palm oil. There is a need to engage with consultants especially strategists to respond to the issue. MPOB and MPOC should work together.

5.3 It was noted that the quantity of publication by MPOB officers is not an issue but we must come up with credible information and data i.e. best practices, promotion, wild-life promotion etc. We should also publish in social media or internet and not just focus in high impact factor journals.

5.4 On the suggestion to reduce the PAC meeting from five to four days, the meeting decided to retain the numbers of days. However, the PAC Seminar could be brought forward to the first day as suggested.

6.0 Date of Next PAC Meeting
The 37th PAC Meeting is scheduled 3 – 7 April 2017.
7.0 Closing Remarks

YB Chairman of MPOB thanked all PAC members for their tremendous contribution. MPOB appreciates all your guidance, comments and suggestions which help MPOB and the oil palm industry address the challenges ahead. As a Member of Parliament, I view this as a beneficial platform to leverage your expertise to provide options and scenarios so that our leaders can formulate better policies and informed decision making.

Many issues were raised and deliberated during the past few days. We will take-up recommendations of the PAC. Please continue to communicate with us, either in person or through the various communication media on relevant matters.

I made to understand that this is your last 3 year PAC term. Most of you will be re-appointed for 2017-2019 term. I would like to thank all of you for your contributions.

We look forward to seeing you again in 2017. Have a safe journey home. I now adjourned this meeting, thank you.
MATTERS ARISING OUT OF MINUTES OF PLENARY SESSION
**Key Recommendations**

### 4.0 Reports by Sub-Committees (SC)

#### 4.1.1. The report was divided into:
- (A) New project proposals
- (B) review of current projects
- (C) International Advisory Panel (IAP) on *Ganoderma* & IAP on Peat
- (D) Specific recommendations
- (E) Additional remarks

#### 4.1.2. Fourteen (14) New Project Proposals were assessed:
- Six (6) projects were rated as priority A (approved with minor comments);
- Four (4) projects were rated as priority B (approved with major comments/amendments);
- Four (4) projects were rated as priority C (not approved or subject to very substantial revision & reassessment)

Some of the category C projects were on *Ganoderma* research, which were recommended to undergo a strategic realignment by the International Advisory Panel. Therefore, PAC suggested that relevant officers need to propose new projects that are align with the priority areas within the next 6 months.

#### 4.1.3. Review of Current Projects

The Biology Sub-Committee reviewed the work of three Divisions (Biology, ABBC and IRED) with very diverse project areas. This year numerous breakout meetings between small groups of PAC members and MPOB researchers held on Tuesday until Friday, more than in previous years. The Sub-Committee felt that these sessions were valuable to MPOB staff. However, this resulted in lack of time for formal report writing and the Sub-Committee may consider amending the format in future to have shorter research progress reports, increased time for breakout meetings, and maybe a less detailed final report that focuses more on future recommendations.

### Response

Proposal drafts are being submitted by the end of Oct. 2016.

<table>
<thead>
<tr>
<th>Key Recommendations</th>
<th>Response</th>
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<tr>
<td>4.0 Reports by Sub-Committees (SC)</td>
<td>Proposal drafts are being submitted by the end of Oct. 2016.</td>
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</table>
### Key Recommendations

<table>
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<tr>
<th><strong>4.1.5. International Advisory Panel on Ganoderma Disease Research.</strong></th>
<th><strong>Response</strong></th>
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<tbody>
<tr>
<td>a) The Advisory Panel comprised of Dr Richard M. Cooper from University of Bath, UK (Chairperson), Dr Xavier Arulandoo from United Plantations, Dr Tristan Durand-Gasselin from PalmElit, France, Prof Matthew Dickinson from University of Nottingham, UK and Prof Jan Stenlid from Dept. Forest Mycology and Plant Pathology, Sweden.</td>
<td>MPOB management have decided to restructure the Unit according to the recommendation by IAPGD. Three groups are formed as below:</td>
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| b) The Panel recommended that :  
  • Future progress be reviewed after 2 and 5 years.  
  • GanoDROP Unit structure and remit should be revised | 1. *Ganoderma* Biology and Pathogenicity (GBP) Group |
| c) The Sub-Committee suggested the following new groups:  
  i) *Ganoderma* Biology and Pathogenicity (GBP) Group  
  • Aims: to acquire fundamental knowledge on *Ganoderma* in terms of: Epidemiology, Biology; Pathology, Collection & Genetics | 2. *Ganoderma* Control (GC) Group |
| ii) *Ganoderma* Control Group  
  • Aims: disease control and mitigation; sustainable control through integration of knowledge. | 3. Emerging and Exotic Diseases and Biosecurity (EEDB) Group |
| iii) Emerging and Exotic Diseases and Biosecurity  
  • Aims: Awareness and monitoring of major perceived threats. Preparation of diagnostic tools. Greater ongoing contact with DOA Quarantine Dept. | |
| In order to achieve this restructuring, it was recommended that weed and herbicide research be discontinued and staff transferred to the GBP Group | |

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<tr>
<th><strong>4.1.6. International Advisory Panel on Peat</strong></th>
<th><strong>Response</strong></th>
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<tr>
<td>a) The Panel includes Dr. Paramanathan Selliah from Param Agricultural Soil Surveys (M) Sdn Bhd, Prof. Susan Page from University of Leicester, United Kingdom, Prof. Takashi Hirano from University of Hokkaido and Dr Fahmuddin Agus from Indonesian Soil Research Institute.</td>
<td>Lab facilities is improving with the assistance of plantation company.</td>
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<td>b) The Sub-Committee was concerned about the level of resourcing for the peat work in Sarawak. Inadequate levels of resource were impacting on provision of adequate lab facilities, availability of personnel to do the work and ensure timely publication, overreliance on goodwill of collaborating partners and a generally unsatisfactory intellectual environment. The</td>
<td>Interviews to be held in August to recruit assistants.</td>
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<td>All collaborating partners including TROPI have specific role and expertise</td>
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Page 2 : PAC 2016 – Matters Arising out of Minutes of Plenary Session
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<th>Response</th>
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<tr>
<td>consequences pose a risk to satisfactory progress of the work.</td>
<td>to ensure timely completion of task. Hence, every partner work together and do not rely on each other. Communication and partnership enhanced with the establishment of IAP to continuously follow up.</td>
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**KEY RECOMMENDATIONS**

a) Improve the structure & impact of *Ganoderma* research. GanoDROP has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, the Biology Sub-Committee has considered that the structure and research strategy was imbalanced and that was not creating sufficient progress where it is needed, in particular on *Ganoderma* stem rots. The recommendations were based on: lack of progress on *Ganoderma* in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from Ganoderma; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding *Ganoderma* epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR.

(This will require some reorganisation of the structure and strategy of *Ganoderma* research at MPOB as detailed previously)

b) Improve the structure and impact of MPOB research on tropical peat systems. This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. There is an urgent need for increased personnel and provision of the necessary equipment and infrastructure to carry out this vital project. The PAC welcomes the newly formed International Advisory Committee supporting this research and considers it essential that they provide regular input into the project over the coming years. The Sub-Committee recommended that regular meetings of this advisor grouping should commence within the next few months.

Personnel, equipment and infrastructures have been managed.

Second meeting/ review held 15 August 2016 at Kuching, Sarawak.
### Key Recommendations

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<tr>
<th>c) Facilitate, coordinate and publicise examples of environmental management and conservation on oil palm plantations. Palm oil is frequently under attack for rainforest habitat destruction with consequent loss of iconic wildlife, yet many in the industry are actively promoting and implementing habitat preservation, restoration and wildlife conservation in and around oil palm estates. MPOB should take a positive leadership role in coordinating these efforts. It can develop “best practice” for conservation planning, riparian planting and wildlife monitoring. It can also promote wildlife conservation among industry workers and it can coordinate presentation and publicity for positive efforts in the conservation arena.</th>
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<tr>
<td><strong>SUSTAINABILITY/TROPI</strong></td>
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<tr>
<td>Sustainability unit to coordinate (together with TROPI) the programme which gathers all the industry which has implementing the conservation efforts in order to combine all the ideas to come out with SOP or best practice in enhancing the biodiversity in oil palm plantation.</td>
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<tr>
<td>BMP for oil palm on peat to incorporate conservation planning. Collaboration with Wetlands.</td>
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<td>d) Improve the use of existing expertise in PAC, MPOB, industry and other stakeholders in addressing public concerns about oil palm. Unfortunately, many inaccurate and misleading stories about oil palm have been widely disseminated which contributes to negative public reactions to oil palm, especially in Europe. It was recommended that MPOB should take advantage of the considerable expertise among the independent experts on PAC, plus other credible experts, to address topics where inaccurate reporting of science-related issues related to oil palm has occurred and to achieve this MPOB could also work with other stakeholders such as MPOA and MPOC. Possibilities include more extensive engagement with media and other outlets in disseminating ‘good news’ stories and also in the rapid response to inaccurate or misleading stories. In addition to scholarly articles, some PAC members could write more accessible (to non-specialists) articles in magazines or popular journals (as in example article by Prof Dennis Murphy)</td>
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<td>To suggest PAC members to write an article in newspaper/magazine concerning the negative issues highlighted by the NGOs are usually taken out of context and incorrect.</td>
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<tr>
<td>e) Improve communication and results sharing within and outside MPOB by promoting such interactions and incentivizing cross-disciplinary research. While there are numerous examples of good collaboration on relevant research both inside and outside MPOB, there are also too many examples of a ‘siloh mentality. This hampers progress and can mean that opportunities are missed and even that some work is duplicated. This issue has been raised in previous PAC reports but this year it was again raised in several Subcommittees and the SMBFG Group - The importance of an advanced international collaboration has been stated in the final report of the International Review Panel on Soil Microbial Biodiversity which was held in 2014. However this matter was due for 2 years because of the appointment of a new Group Leader for SMBFG. An agreement with Prof. Brajesh Singh from University of Western</td>
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Key Recommendations

especially in the Crosscutting Subcommittee. There are still a lack of awareness of highly relevant international developments among many officers and more senior scientists at MPOB. Researchers should make better use of citation alerts and the availability of most published research as open access. In those cases where an article is not fully available online, a request for a pdf from the author(s) was normally successful.

Response

Sydney, Australia will be arranged to provide training and advice to SMBFG in applied soil microbial biodiversity research. Prof. Brajesh is scheduled to visit MPOB on the second week of November (07 to 11 Nov 2016).

Insect Biopesticide Research Group – Research collaboration with oil palm associations such as MPOB, SOPPOA on important issues such as on reduction of fruit set and pollinating weevil has been carried out. This work is also cross divisional involving MPOB experts from Agronomy, Entomology, Breeding and Research Stations.

Efforts are being made to work with PAC experts on management of rhinoceros beetle especially on detection and control of incursion new biotype of rhinoceros beetle into Malaysia. With this team, the collaborative work on management of rhinoceros beetle using Oryctes nudivirus was also continued.

f) MPOB should work more effectively and urgently with all relevant stakeholders to address the increasingly urgent need for mechanisation of plantation operations. Recent developments in Malaysia, especially restrictions on foreign labour have highlighted the importance of addressing the need for increased mechanisation of many plantation operations from input applications to harvesting.

Several projects proposals on mechanisation were presented to the Subcommittee but it was felt that these tended to be ‘more of the same’ in terms of projects that have already been pursued for many years without achieving a true breakthrough in terms of widespread utility on plantations. The launch of a US$1 million prize competition was a welcome development but this may not result in the right sort of projects. There are many experienced agricultural machinery suppliers who are already developing and manufacturing devices for automated or semi-automated crop management. Some of these use GIS technology linked to satellite or low-cost UAV (drone) systems while others include crop harvesting and processing as a single multi-step operation. Examples include the deployment in Europe of harvesters for the extraction and shelling of peas where many hectares can be harvested, processed

Interaction with relevant stakeholders to address the increasingly urgent need for mechanization of plantation operations is an on-going process. Representative from industry are participating yearly meeting through MPOB industry forum. Organizations such as MEOA, SOPPOA, and MPOA are constantly being engaged/consulted during these forums. They have given enough opportunity to air their views for MPOB to take in their proposal that later will be translated to proposal being tabled to PAC.

Comparing grain harvester to harvest annual crop such as wheat and barley with oil palm may be not applicable as these grain harvester, harvest all crop in one go. Grain harvester, harvests all crop in one go which contribute to high productivity whereas in oil palm the person who do the harvesting need inspect tree by in order to look for ripe bunches. Even with machine, the same method apply. This is contributing to slowness in operation.
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<td>and taken to supermarkets within a few hours with minimal use of labour; self-propelled tomato harvesters and citrus tree harvesters.</td>
<td>Invitation to public to showcase their ideas through competition failed to scout a brilliant idea for tall palm harvesting. Old concept of harvesting machine such as by bring up the worker on platform to palm crown to enable him to cut the bunches from close proximity are being re-proposed.</td>
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**FOOD, NUTRITION AND QUALITY SUB-COMMITTEE**

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<th>No.</th>
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<tr>
<td>4.2</td>
<td><strong>NEW PROJECT PROPOSALS</strong></td>
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<tr>
<td>4.2.1</td>
<td><strong>PD211/16 - Mitigation measures for 3-MCPD ester: Identification of sources of chloride at plantations and palm oil mills.</strong></td>
<td>The effect of MOP and chloride-free fertilizer will be studied. EFSA had published a report on risks for human health related to 2- and 3-MCPD and their esters and GE in food in May 2016. The report derived a TDI of 0.8 µg/kg bw per day for 3-MCPD which will be proposed to the relevant authority for implementation. Collaboration project with FGV has started. Crude and refined palm oil samples and water samples have been collected from a mill and refinery located in the southern part of the Peninsula. The crude oil will be analysed for FFA, Dobi, Cl, phosphorus, TAG and DAG content while the refined oil will be analysed similar to crude except DOBI. The water samples will be analysed for Cl.</td>
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<td>4.2.1</td>
<td><strong>PD207/16 - Study on the development of 3-MCPD Esters and Glycidol Esters During Frying</strong></td>
<td>The SC emphasized that degradation of 3-MCPD is due to the polarity of oil upon frying. The SC suggested to also identify oxidation or degradation products in the</td>
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<td>oil during frying by using non-targeted method such as by LCMS/MS or LCQTOF. This is to broaden the scope of the research. To this end the chemistry of frying should be looked into in detail.</td>
<td>The oxidation / degradation products in the oil during frying will be analysed using LC-MS/MS method.</td>
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<td>In order to have a better reference that monitors the generation of MCPDE and GE in the oil it is suggested to additionally use a wet neutral carrier material as standardized frying material. This is so because hydrolysis is necessary to create the partial glycerides. Possible neutral frying material are for example cotton balls containing predetermined levels of moisture (recommended to check the literature for other options).</td>
<td>Cotton balls will be used as neutral carrier material, in addition, heating of oil without food product will be part of control experiment.</td>
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<td>The SC proposed to utilize 2 different palm oleins, one with lower 3 MCPDE and GE content and one with relatively high levels as frying media. It is recommended to also use high oleic sunflower oil as a reference oil because there is a study claiming its superiority in frying with respect to MCPDE formation.</td>
<td>High oleic sunflower oil will be used as one of the frying oil. 3-MCPDE and GE content will be determined in the fresh oil prior to the frying process.</td>
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<td>The SC suggested to identify whether the decrease in the 3-MCPDE and GE level in frying oil is due to the migration onto the product surface or chemical reactions.</td>
<td>This proposal will be looked into in details.</td>
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<td>Another recommendation is to explicitly add chlorine (salt) to the fried food as additional experimental parameter to stimulate MCPD/GE formation. This could as well be done with the model frying materials by wetting the material (cotton) with salt water.</td>
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<td>The SC is further concerned with the possible adsorption of the contaminants to the food matrix. This sheds doubt on the reliability of assessing the MCPD levels by soxhlet extraction. The determined contaminant levels might not reflect the level in the food. This needs to be checked/validated. (Priority A)</td>
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<td>Possible adsorption of these contaminants in the food will be looked into in details.</td>
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<td>3.</td>
<td>PD212/16 - Influence of polyglycerol fatty acid ester on the thermal properties of palm olein under extended frying conditions.</td>
<td>Effect of PGE on the cold stability of different grades of palm olein (IV 58, IV 60 and IV 64) has been studied and reported by Basker (2015). The oil samples were added with different dosages of PGE (0.05% to 0.4%) and stored at 15, 18 and 20 °C. Inclusion of PGE significantly improved the clarity of palm olein over storage times. By taking 15°C as the study case, palm oleins of IV 58, IV 60 and IV 64 remained clear for up to 15 days, 39 days and 99 days, respectively when compared to samples without PGE (1.2 h, 2.9 h and 2 days, respectively). With regards to DAG content, Siew (2011) reported that the diacylglycerols (DAG) were insignificantly higher when the IV increases. The mean values of DAG content in palm olein of IV &gt;60, IV 60-64 and IV 65-67 were 5.3%, 6.4% and 7.1%, respectively. Correlation between colour changes and other quality indices including DAG content will be identified after all frying experiments have been carried out. The PGE is mainly added to palm olein – hereafter referred to as cooking oil – with the aim to delay crystallisation due to storage at chilled temperatures. Since cooking oil is widely used for frying applications, it is therefore essential to investigate the effect PGE inclusion in palm olein upon extended frying.</td>
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<tr>
<td>4.</td>
<td>PD208/16 - Development of multiresidue analytical method for the determination of triazole fungicides in palm oil matrices</td>
<td>The project will be focus on using LC-MS/MS only for determination of triazole residues in palm oil matrices. QuEChERS matrix enhancement method has been studied and will be tried in</td>
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<td>The SC suggested the use of QuEChERS matrix enhancement removal method specific for oil to reduce effect of matrix enhancement in palm oil matrix.</td>
<td>sample cleaning-up process before quantification</td>
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<td>The SC suggested to refer to the Q-oil developed by EU reference lab methods. Although this is not specific for palm oil, it may just need a slight modification, which has been suggested.</td>
<td>Q-oil method will be referred. Carbon 13 modified standard are currently being sourced and will be used as internal standard in method development</td>
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<td>The analysis using LC/MS/MS requires 1-2 internal standards (depending on where it elutes in the chromatogram); deuterated or a carbon-13 standards of any of the 7 triazole fungicides may need to be acquired for this purpose.</td>
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<td>The method using LC/MS/MS should be elaborated with regards to acquisition mode (MRM of fullscan MS/MS), which column will be used as well as the mobile phase that will be used. The type of instrument used will influence the extraction protocol that needs to be developed.</td>
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<td>Seeing that the project is on the fungicide residues in palm oil, it is sufficient to analyse these in palm oil matrices; it is not necessary to analyse other oils (olive, sunflower, corn, etc) as the matrices are similar. Method development and analysis in palm oil is the focus of this proposal and comparison with other oils is not necessary.</td>
<td>(Priority A)</td>
</tr>
<tr>
<td>5.</td>
<td>PD214/16 - Nutritive values of treated oil palm frond and empty fruit bunch as the potential feedstuff for ruminant.</td>
<td>The expected cost of analysis for mixtures and treatments of OPF and EFB is about RM450 per sample per treatment. The percentage of combined mixture for the inclusion into animal feed database / formulation will be determined after the analyses complete.</td>
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<td>The SC suggested to check the cost of mixtures and treatments on the samples to be used in this study because the expected expenditure reported is quite low. Cost of analysis should be included in the proposed budget.</td>
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<td>The SC also suggested to run the project by reviewing the percentage of the combined mixture of the treatment</td>
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<td>groups instead of running all the treatments simultaneously.</td>
<td>(Priority A)</td>
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<td>6.</td>
<td>PD215/16 - The efficacy of crude palm oil in broiler feed ration and comparison with other palm fats available in the market.</td>
<td>Soybean oil has been added in broiler starter and grower feed formulation at 3.5% and 4.0%, respectively. The researcher will look into the possibility to use the interesterified palm olein in broiler ration as suggested by the SC.</td>
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<td>The SC suggested to add other oils such as soybean oil and rice bran oil for comparison with other palm fats used in this study as they are of importance to importing countries.</td>
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<td>The SC informed that there is a study conducted by Dr Neo from Soon Soon Oil Mills on the usage of interesterified palm olein which provides a higher metabolizable energy than palm olein and found that the interesterified palm olein is suitable for animal feed.</td>
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<td>(Priority A)</td>
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<td>7.</td>
<td>PD213/16 - Crystallisation behaviour of palm olein with the addition of a legume seed oil.</td>
<td>Based on PAC comments and a discussion with one of the co-researchers of the project, it was decided that the focus of this project will be to improve the cold stability of palm olein through dilution and crystal retardation with the addition of WBSO. This is due to the fact that the effect of seeding and seeding material on fractionation of palm olein has already been studied by another researcher. Hence, the new project title will be “Crystallisation behaviour of palm olein for cold stability improvement with the addition of legume seed oil”. The objectives of the study is to help in enhancing crystallization in very minute crystal and stop further secondary crystallization. It also will help industry to overcome oil separation during transportation to cold countries.</td>
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<td>The SC suggests after having assessed the properties of winged bean seed oil (WBSO) - triacylglycerol (TAG) and diacylglycerols (DAG) - to reformulate the project outline. It is recommended not to study WBSO for the purpose of improving the olein fractionation. Properties of WBSO give little support for a hypothesis that this is actually beneficial.</td>
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<td>Alternatively the SC recommends to study in detail the different options for improvement of the fractionation for the production of superolein. Different means to improve fractionation have been studied primarily for palm oil fractionation. Basic options are:</td>
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<td>a) dissolution of higher melting material. It is not clear what the best composition of this material is; FA composition of tri-, or di-saturated TAG’s.</td>
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<td>b)</td>
<td>Seeding performed in powder form. c) use of emulsifiers influencing the crystallization process. It is recommended to evaluate the existing literature thoroughly and design an experimental program accordingly. Consequently the project title has to be adjusted. (Priority B)</td>
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<td>8.</td>
<td>PD216/16 - Effect of Empty Fruit Bunch (EFB) oil on the bleachability and fractionation of palm oil</td>
<td>To meet the targeted oil extraction rate (OER) of 23.0% by the year 2020, palm oil mills are encouraged to install screw press facility to extract oil from empty fruit bunch (EFB). The suggestion is highlighted in the entry point project 4 (EPP 4 - Increasing the Oil Extraction Rate). The extract, which is also known as EFB liquor, contains mostly water and some oil. The liquor is normally added to the CPO extraction system at the clarification stage where the water from the liquor can be used for dilution while the oil can increase the OER of mills. Addition of the EFB liquor into the CPO extraction system has become a common practice in some mills. However, the effect of the EFB liquor on CPO is unknown. Therefore, the aim of the project is to study the effect of EFB oil on the bleachability and refining of CPO and also to study its effect on the fractionation of the resulted refined oil. It is never the intention of the project to propose the blending of EFB oil with CPO to the industry as it has already become a common practice nowadays.</td>
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The PAC SC suggested to include 3-MCPDE and GE analyses. Nevertheless, the SC was informed that the effect of EFB oil / liquor on the formation of 3-MCPDE and GE is already covered in another new project i.e.; mitigation measures for 3-MCPD ester: Identification of sources of chloride at plantations and palm oil mills.

It was noted that the quality parameters of the EFB oil indicate that it is not advisable to mix it with good quality CPO. Therefore, the SC recommended to use this oil for biodiesel / oleochemical applications.

The SC emphasized that the presence of Cl not only triggers the formation of 3-MCPD E, but also initiates the development of other contaminants such as furans and dioxins.

The committee emphasized that adding poor quality oil into the processing stream (cycle) will result in inferior end products.

Furthermore, incorporation of EFB liquor would also increase the amount of 3-MCPDE in the refined oil. It is recommended to search for other options to increase OER without affecting oil quality.

The SC was informed that this research would provide guidance to the industry that adding EFB liquor into the system is not recommended. Thus the objective is
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<td>certainly not the formulation of safe blending rules but rather the documentation of the risks and consequences of adding an oil of really low quality to good quality CPO.</td>
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<td>(Priority B)</td>
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<td>9.</td>
<td><strong>PD217 /16 - Chewable tablets fortified with palm vitamin E.</strong></td>
<td><strong>i.</strong> The term “palm tocotrienols or TRF” be used instead of palm vitamin E. To consider changing the title to “Chewable tablets fortified with palm tocotrienols”.</td>
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<td>The SC commented that single supplementation is not preferable and suggested a multi-supplement chewable tablets instead. The SC was informed that the chewable tablets could also be fortified with vitamin C and vitamin A(carotene). The SC also suggested that:- i. The term “palm tocotrienols or TRF” be used instead of palm vitamin E. ii. Other analyses i.e., dermatology, radioprotection and neuroprotection should be looked into. iii. The bioavailability protocol should be fine-tuned. (Priority B)</td>
<td><strong>ii.</strong> Other analyses i.e., dermatology, radioprotection and neuroprotection should be looked into. To be considered as New Project once the current project completed.</td>
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<td>10.</td>
<td><strong>PD218/16 - Nutrition bars fortified with palm vitamin E.</strong></td>
<td><strong>iii.</strong> The bioavailability protocol should be fine-tuned. To consider changing the bioavailability protocol. To discuss with PAC member.</td>
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<td>The SC requested that more information on other nutrients e.g., protein, fibre, vitamins and calories be provided. It also suggested that free sugar content be declared and the term “palm TRF or tocotrienols” be used instead of “palm vitamin E”.</td>
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<td>The SC questions the bioavailability in this food format. (Priority B)</td>
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<td>To consider changing the bioavailability protocol. To discuss with MPOB PAC member.</td>
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| 11. | PD219/16 The Effect Of Biscuits Containing Red Palm Oil On School Children With Vitamin A Deficiency In East And West Malaysia. | The SC informed that the vitamin A deficiency is more prevalent in children less than 5 years old.  
The SC commented that if the study is not a randomised controlled trial with a control group to compare to; it will be more difficult to publish.  
The SC commented that the children will be susceptible to gastro-intestinal infection which will affect the absorption of vitamin A.  
The SC suggested conducting sample size calculation based on prevalence of low serum retinol concentration among the Orang Asli children or from the recently completed China study.  
The SC suggests to study a smaller group, possibly within the population on plantations. Further details  
• Need for a randomized control trial.  
• Clustered trails at different locations.  
• Materials ordinary PO/Refined PO and Carotino. Make sure appearance equal.  
• Dosage biscuits administering possibly 3 times a week at high dosage  
• Attendance in school to be normalized (asked)  
• Overall design needs to be simplified to reduce work and costs.  
The primary and secondary outcome need to be defined.  
(Priority B) | A randomised controlled trial will be undertaken and a control group will be added.  
The comment is noted and the children will be closely monitored by doctors in the study.  
A sample size calculation will be conducted based on the recently completed China study and study by Al-Mekhlafi et al., 2010 as advised by PAC members.  
No publication or documentation is available on the prevalence of low retinol levels among the children in plantations, hence the recent study by Poh, Ng et al. 2013 will be used to identify the under-privileged population/school with low retinol levels.  
• A randomized controlled trial will be undertaken.  
• Clustered trials at different schools will be done.  
• All commented have been noted and the protocol will be revised accordingly with defined primary and secondary outcomes. |
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<td>12.</td>
<td>PD220/16 - Effect of Palm Carotene Mix on Molecular Targets Implicated in Human Disease: A High Throughput Screening Approach.</td>
<td>The SC enquired on the delivery of carotene mix to the cells and was informed that carotene mix will be dissolved in tetrahydrofuran for cell culture. The SC queried on the composition of carotene mix and has been informed that the carotene mix is mainly composed of 56% β-carotene, 32% α-carotene and others. The SC enquired on the aim of this study and was informed that this study will serve as a basis to guide future animal and clinical trials of carotenoids. The SC commented that the lack of breakdown product, metabolites and binding proteins in cell studies will affect the translation to clinical trial. This will be looked in detail in future in vivo and clinical studies.</td>
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<td>13.</td>
<td>PD221/16 - Assessment of 3-MCPD fatty esters (3MCPDE), Glycidyl Esters (GE), 3-MCPD and Glycidol after feeding with prolonged frying palm olein in animal model</td>
<td>The PAC SC suggested using other oils for comparison, e.g: corn oil. The PAC SC commented that lower level of 3-MCPDE and GE across frying time could be due to their migration to the fried product. The SC was informed that this study will monitor the bioavailability of the two esters. In order to conduct proper toxicology study, the PAC SC emphasized that the expected cost would be 10 times higher than the proposed expenditure. The SC enquired on how to differentiate the effects of other compounds that are toxic other than 3-MCPD in this study. (Priority C)</td>
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<td>4.2.2</td>
<td>On-Going Projects</td>
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<tr>
<td>1. QUALITY DEVELOPMENT &amp; ANALYTICAL UNIT Programme: Life Cycle Assessment</td>
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<tr>
<td>1.1.1 PD175/14 – Method Development for Determination of Metsulfuron Methyl in Palm Fruit Oil and Palm-Based fatty Acids</td>
<td>Project completed, viva report under preparation.</td>
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<td>The SC members are generally satisfied with the progress of the project and agree to close the project.</td>
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<td>1.1.2 PD176/14 - Development of a Method for the Analysis of Dimehypo Residue in Palm Oil</td>
<td>Based on recent discussion with Biology Division, it was informed that the potential company to bring in this new insecticide has withdrawn from the project. Therefore, it was decided not to continue with this project. Project will be closed once the method for the determination of nereistoxin has been developed.</td>
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<td>The SC suggested to study the conversion rate of dimehypo to its metabolite, nereistoxin during sample preparation and injection.</td>
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<td>1.1.3 PD177/14 – Method Development for the Determination of 2,4-Dichlorophenoxy Acetic acid in Palm fruit Oil and Palm Based fatty Acids</td>
<td>All standards required in this project have been received. Project will be continued by other researcher in the team. Principal researcher for this project is expected to give be on maternity leave starting on September 2016.</td>
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<td>The SC recommended to verify the method developed using esterified 2,4-D standard and modify the method if necessary.</td>
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<td>It is also important to study the possibility of finding of 2,4-D in its esterified form, and the method of analysis may be developed accordingly.</td>
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<td>The researchers are requesting a time extension of this project due to new recommendations by PAC members.</td>
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<td>1.1.4 PD178/14 – A Survey on Quality of Crude Palm Oil in Malaysia</td>
<td>Majority of samples received have been analysed. Data analysis is in progress.</td>
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<td>The SC commented that adding of QC data to the table is useful when</td>
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<td>presenting results of MCPD levels for quality purpose. This will illustrate method efficiency and extraction recovery. It is possible to use LOD as QC level</td>
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<td>1.1.5</td>
<td><strong>PD193/15 - Development of phytonutrient-rich bread incorporated with oil palm leaves</strong></td>
<td>It was decided to maintain the mobile phase composition. However, a new gradient system is being optimized so that the peaks of catechin and epicatechin are better separated. Other compounds present in the extract are also being identified.</td>
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<td>The PAC-SC commented that this work has illustrated a number of components within the OPL. The LC peaks appeared to be concentrated within 0.5 minutes. In that regard it is recommended to change mobile phase composition and gradient conditions to spread the peaks across 3-5 minutes instead of 0.5 minutes.</td>
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<td>1.1.6</td>
<td><strong>PD194/15 - Development of Multi-residue Method for the Determination of Pesticides and Chemical Contaminants in Palm-Based Fatty Acids</strong></td>
<td>LC method optimization for better peaks separation is currently being carried out. New column and LC solvents profile are the two main subjects in this optimization.</td>
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<td>The SC commented that the peaks appeared to have some tailing even with pure standards. Care of columns should be practiced to preserve the C18 column. The mobile phase composition and gradient should be optimized to improve peak shapes.</td>
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<td>The extraction method with QuEChERS needs to be revised as there is a lot of ion suppression in the analysis.</td>
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<td>Researchers need to include the actual method so that optimization can be suggested.</td>
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<td>It may be useful to look at other QuEChERS products with enhanced matrix removal (EMR).</td>
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<td><strong>Programme: Food Safety</strong></td>
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<td>1.1.7</td>
<td><strong>PD130/09 – Assessment of Mycofloral and Mycotoxins In Palm Kernel Cake/Meal Produced In Malaysia</strong></td>
<td>No comments</td>
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<td><strong>1.1.8</strong></td>
<td>PD149/10 - Determination of Na, Mg, Al, S, K, Ca, Ni, Zn, Sb and Hg in Palm Oil by ICPMS</td>
<td>Calibration curve for the 10 elements were established and optimized to obtain good linearity of more than 0.9990. Calibration standards were prepared in mix elements solution at 5 different concentrations which were 0.5 ppb, 1 ppb, 5 ppb, 10 ppb and 20 ppb.</td>
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The SC commented that the calibration curve used for all 10 elements may not be appropriate as a few like Hg would be expected to be at very low levels. So a calibration solution from 0.5-10ppb may be more appropriate. Researcher should refer to past analysis of palm oil.

| **1.1.9** | PD168/13 - A reliable and Sensitive Method for Determination of Paraquat in Oil Matrix and Investigation of Its Residue in Palm Oil Products | The mobile phase condition has been changed to gradient separation. |

It is proposed that the points for the calibration curve be revised, have a blank sample as zero concentration and have one point below the cut-off unit, for example 0, 0.05, 0.1, 0.2, 0.4, 1.0 and 2.0ppb.

The condition for LC needs to be changed so that the peak does not elute at the solvent front. Perhaps changes in the mobile phase condition or use of a gradient instead of isocratic separation will improve the analysis.

The analysis is ready for validation; one matrix is sufficient for full validation with 3 QC levels at LOQ, mid point and upper limit. For other matrices, a verification (one-day) is sufficient with 2 QC levels.

The calibration curve is already established at the concentration level of 0, 0.05, 0.1, 0.2, 0.4, 1.0 ppb.

| **1.1.10** | PD180/14 – Study of 3-MCPD esters and Glycidol Esters in Vegetable Oils | New recovery table will be prepared with RSD. |

The SC suggested that a table with RSDs, etc. would be beneficial.

The SC commented about the good accuracy and agreement of the results with Eurofins and SGS. It may be nice to know which method is adopted by these two labs.

It was also suggested that this method to be used for monitoring of refined oils from industry to evaluate compliance with the 1ppm limit.

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<td>This method will be used for monitoring of 3-MCPDE and GE contents refined oils.</td>
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**Programme: Crystallization**

1.1.11 **PD169/13 – Development of a Composite Post hardening Index of Palm-Based Blends for Palm-Based Low saturated Fat Margarine**

The SC commented that there are 2 factors / causes of the margarine/product failure:
1. Formulation and processing
2. Storage and handling

These 2 factors could contribute to the different crystallization phenomena. Therefore, this project could be used to identify or predict the product failure. Consequently hardness changes in a homogeneous structure and the formation of grains (inhomogenieties) have to be described separately and respective rules for their occurrence formulated.

The products from manufacturer were treated with 2 different methods before storage study at 15, 20 and 25°C was carried out:-

a. Method 1 – samples received after process (without temperature treatments).

b. Method 2 - simulated the handling process (temperature treatments).

The result indicated that treated samples with method 1 had shown an insignificant increase in hardness (Fi) and solid fat content (%SFC) at 15 and 20°C after day 3 to week 5 of storage. The samples also stabilised in a mixture of (β΄+β) polymorph with β΄ dominating to form homogeneous structured samples.

Samples treated with method 2, some of the crystals obviously melted and reduced in their SFC and hardness. However, upon storage at 20°C, SFC and Fi of the samples were drastically increased from day 1 to week 5.

In addition, the transformation of the polymorphic form from β΄ to β also occurred during storage. These phenomena might cause the post-hardening due to the recrystallization process and polymorphic transformation during storage at 20°C.

All the stored samples at 25°C became softer and lost their plasticity throughout the storage time. Thus, unable to retain the original structure and caused the samples to be crystallised in a mixture of small and bigger crystals (19nhomogeneity) as also indicated in melting thermograms of differential scanning calorimetry (DSC).
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<td>1.1.12</td>
<td>PD179/14 – Characterization and Evaluation of Palm-Based Organogel</td>
<td>The SC suggested trying of different parameters on preparation of organogels. He also suggested the researcher to concentrate more on polyglycerol behenic acid esters (PBA) for this project since little is known on this system. Waxes and monoglycerides in contrast are already reasonably studied. The effect of palm olein compared to other seed oils on the gels should be studied with focus on the question of the type of interaction. Is there a) just an additional independent effect from POP crystals and other crystals, or b) formation of mixed crystals, c) effects on nucleation and growth, d) simple effects of viscosity. The effect of day of preparation on organogels properties has been studied as a new parameter. Optimum temperature and day of preparation will be obtained. The effect of the percentage of palm olein in different blends of oil will be studied after optimization of condition is obtained.</td>
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<td>1.1.13</td>
<td>PD195/15 – Development of Palm Based Edible Coating for Prolonging the Quality and Post-Harvest Life of Guava (Psidium guajava L.) and Star Fruit (Averrhoa carambola L.)</td>
<td>No comments and proceed with preferred formulations. Good results were obtained as recorded in Research Note Book (PD195/15) and presented during PAC Meeting 2016. therefore can be proceed for Phase 3 of project -Verification and optimisation of the best formulated palm-based edible coating based on weigh loss of coated fruits. Weight loss is chosen as a main factor due to its role as a direct indicator in evaluating the effectiveness of developed palm-based edible coating.</td>
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<td>2.</td>
<td>PROTEIN &amp; FOOD TECHNOLOGY UNIT</td>
<td>Programme: Oil and Fats Technology Centre (OFTEC)</td>
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<td>2.1.1</td>
<td>PD184/14 – Characterization of Commercial Available Palm Oil Based Solid Fraction For Food Formulations</td>
<td>The SC was informed that this work was carried out to evaluate the various palm solid fractions which were produced by the local companies. The solid fractions were categorized by its TAG composition. The VIVA report has been submitted for review and comments.</td>
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<td>2.1.2</td>
<td>PD185/14 – Determination of The Oil Binding Capacity of Palm Stearin Fractions (iodine value 30 and below)</td>
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<td>The SC was satisfied with the progress of the research project and advised the researcher to proceed with publication.</td>
<td>The stability of blends of palm olein with palm oil solid fractions with IV 30, IV 20, IV 12 and IV 10 were determined. The blends with more than 7.5 percentage of IV 20, IV 12 and IV 10 with palm olein IV 60 were able to give minimal oil released, hence giving stability readings of above 95%.</td>
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2.1.3 PD186/14 – Formulation of Trans Free Margarine That is Stable From Temperature of 15°C to 30°C  
The SC was informed that the project was in the stage of identifying the suitable formulations as the market survey has been completed.  
The stability and solid fat content, slip melting point were evaluated to determine the acceptability of the blends for the formulation of trans free margarine that is stable from temperature of 15°C to 30°C. Some blends have potential to fulfill the objective of the study. The addition of palm oil solid fractions with IV 20, IV 12 and IV 10 seem to increase the slip melting points of the formulations this indicated the strength of the formulation to resist melting at the higher range of application. |

2.1.4 PD187/14 – Structured fat from Interesterification of soft  
The SC commented that interesterification of soft PMF will add cost to the PMF which is already expensive. Researcher informed that the soft PMF is the by-product of palm olein (IV56) fractionation and is available in abundance in few countries such as Middle East countries and China. Interesterification of PMF may improve the physical properties of the PMF and make it more suitable for food formulation.  
Soft PMF is the by-product of palm olein (IV56) fractionation and is available in abundance in few countries such as Middle East countries and China. Interesterification of PMF may improve the physical properties of the PMF and make it more suitable for food formulation. |
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<td>2.1.5</td>
<td>PD196/15 – Effect of palm based fat on texture and mouth feel perception of ice-cream</td>
<td>The subset blend which is closed to commercial reference has been identified for ice cream production and organoleptic properties of commercial ice cream have been carried out. 10 commercial samples from local and imported ice cream were evaluated for sensory attributes such as appearance, aroma, taste, body and texture, melting and overall acceptability. One of the local ice cream samples was most preferable by the panelist in terms of overall acceptability.</td>
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|     | PD197/15 – Utilization of Soft Stearin As Confectionery Fat                         | Blending and modification will be carried out as suggested by SC.  
Blending and modification will be carried out as suggested by SC.  
The raw materials are available and will start soon with the help on Pn Noor Lida IE of soybean oil and palm oil are in progress. Mixture design of the fat, IE PO, IE SBO and POS will be created when the samples are ready.
|     | PD198/15 – Physicochemical Properties of Various Bakery Using Palm-Based Fluid Shortening | Palm olein will be included as the control in this study. Currently, the study on one of the bakery products (biscuits) has been completed. |

The SC was informed that the different blends with solid fat content (SFC) profiles close to commercial reference products have been identified. The SFC (40°C) in palm oil has to be reduced through blending. It is recommended to study only a subset of the blends presented and add a few blends with different SFC profiles. This is to establish how the SFC translates into perceivable product properties such as stand up and organoleptic properties.

It was commented that it is very difficult to produce a chocolate like coating when levels of only approximately 40% of Sat-O-Sat triglycerides are present. Improved blends with higher SFC values have to be looked for. Option such as limited addition of POs or alternatively blend with shea stearin and enzymatically interesterified mixes of soft stearin with shea stearin could be studied. These 3 fats should not be used exclusively but mixed such that best structures are achieved.

The SC suggested to additionally include palm olein as one of the ingredients to make the bakery products to compare with the other fats. Currently differences between structured products 20% palm stearin/80% PO and 100% PO are very limited. Inclusion of palm olein as third fat would extend the viscosity range to verify the robustness of certain applications.
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<td>2.1.8</td>
<td>PD199/15 – Synthesis of Hydrocolloid From Palm Kernel Meal</td>
<td>Referring to similar research of published papers on how to maximize yield in the protein esterification process. The researcher managed to find a patent (WO 2009025543 A2) which described successful esterification of palm kernel cake using enzymatic process. No paper on chemical process was found. The researcher has yet to start the esterification using enzyme. A protease enzyme was just procured.</td>
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Programme: **Innovative Product Group (IPG)**

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<tr>
<th>2.1.9</th>
<th>PD161/12 – Enzymatic Degumming of Crude Palm Oil</th>
<th>Chloride-free CPO will be refined with acid degumming and chloride-free bleaching earth, and the refined oil will be analysed for 2- and 3-MCPD esters and GE.</th>
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<td>PAC SC commented the effort to look for an alternative degumming method in addressing the 3-MCPDE issue since acid degumming has been proven to have a positive effect. However, the study would provide a better understanding of the mechanism for the formation of the ester if it also covers the effect of acid degumming in the absence of CI. If the esters are still formed, then this could be due to other factors or precursors.</td>
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<tr>
<th>2.1.10</th>
<th>PD171/13 – Post-Frying Vacuum Application As A Route To Minimise Oil Degradation And Oil Uptake In Fried Product</th>
<th>Progress on the issuance of safety and health certification from JKKP is being monitored on the weekly basis.</th>
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<tr>
<td>The integrated frying system has been designed and fabricated. Nevertheless, the system is yet to be delivered and commissioned in MPOB due to the application process of safety and health certification which consumed significant amount of time; the system complexity contribute to the delay in the certification process. Suspension of experimental work involving the integrated frying system has been highlighted during the last PAC Meeting. Considering that the</td>
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<tr>
<td>2.1.11</td>
<td>PD172/13 – Comparative Studies Between Intermittent And Continuous Frying of Extruded Product</td>
<td>Project PD 172/13 has underwent for VIVA on 7 July 2016</td>
</tr>
<tr>
<td>2.1.12</td>
<td>PD181/14 – Palm Kernel Reference Materials For The Determination of Iodine Value And Slip Melting Point</td>
<td>The stability monitoring on palm kernel oil, palm kernel olein and palm kernel stearin reference materials are on-going and are scheduled for completion in the first quarter of 2017, which is within the extension time granted.</td>
</tr>
<tr>
<td>2.1.13</td>
<td>PD91/06 – Growth performance of tilapia fed with diets formulated with MPOB-HIE and CPO</td>
<td>This project has been presented in Viva Meeting on 16 August 2016.</td>
</tr>
<tr>
<td>2.1.14</td>
<td>PD133/09 – Quality of Floating Fish Feed Formulated With Different Levels of MPOB-HIE</td>
<td>The project has been presented in Viva Meeting on 16 August 2016.</td>
</tr>
<tr>
<td>2.1.15</td>
<td>PD134/09 – Quality of Broiler Finisher Pellet Formulated With Different Level of MPOB-HIE</td>
<td>The researcher will continue with fatty acid analysis and amino acid composition of the broiler feed pellets.</td>
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<td>Key Recommendation</td>
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<tr>
<td>2.1.16</td>
<td>PD158/11 – Development of β-Mannanase Enzyme Derived from PKC as Microbes Carbon Sources and Its Effects in Broiler</td>
<td>The SC suggested to carry on with the future programme as suggested. The project will be carried out as per schedule until it is completed.</td>
</tr>
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</table>

3. NUTRITION UNIT

3.1.1 | PD162/12-Molecular Mechanism of Palm Tocotrienol on Wound Healing | No comments |

3.1.2 | PD164/12 - Red Palm Olein and Cardiovascular Health. | No comments. |

3.1.3 | PD165/12-GEMM – Gamma Delta Tocotrienol as a potential maintenance treatment in women with metastatic breast cancer. Phase 1a: A randomized, 2-period cross-over study to compare the bioavailability of Gamma-Delta Tocotrienol (GDT) with that of tocotrienol rich fraction (TRF) in twelve healthy subjects. | No comments. |

3.1.4 | PD167/12 - Elucidating the effects of Gamma-Tocotrienol (γ-T3) supplementation on the ratio of T-helper: T-regulatory cells in a syngeneic mouse model of breast cancer. | No comments. |

3.1.5 | PD174/13- Chronic effects of natural palm-margarine, interesterified palm-margarine and modified soy-based margarine on cardiovascular diseases risk, inflammation, insulin resistance and obesity in Malaysian adults. | No comments. |
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<tr>
<td>3.1.6</td>
<td>PD188/14-The Effects of Tocotrienol Adjuvanted Dendritic Cell in Established Mammary Tumour in BALB/C Mouse Model.</td>
<td>No comments.</td>
</tr>
<tr>
<td>3.1.7</td>
<td>PD189/14 - Gene Expression profiling of combination therapy using tocotrienols (gamma- and delta-) with leukemic drugs in acute myeloid leukemic cells.</td>
<td>No comments.</td>
</tr>
<tr>
<td>3.1.8</td>
<td>PD190/14- Effects of Positional Distribution of Stearic Acid on Triacylglycerol backbone on lipid, lipoproteins and Atherosclerosis.</td>
<td>The subcommittee suggested that liver lipid levels be looked into.</td>
</tr>
<tr>
<td>3.1.9</td>
<td>PD191/14- Study on the effect of palm tocotrienol fraction supplementation on collagen-induced arthritis in rat Model.</td>
<td>No comments.</td>
</tr>
<tr>
<td>3.1.10</td>
<td>PD192/14- To study the effect of triacylglycerol (TAG) structure on lipid profile using hamster model.</td>
<td>A SC member commented that the data shows that the sn-2 fatty acid is not impacting lipid levels in this study. The comment has been noted and the project to be closed.</td>
</tr>
<tr>
<td>3.1.11</td>
<td>PD200/15 - Clinical study on the effect of tocotrienol rich fraction (TRF) supplementation in patients with primary osteoarthritis (OA) of knee joints.</td>
<td>No comments.</td>
</tr>
<tr>
<td>3.1.12</td>
<td>PD201/15 - Effect of palm tocotrienol rich fraction (TRF) and palm carotenes on asthmatic Inflammation.</td>
<td>No comment.</td>
</tr>
<tr>
<td>3.1.14</td>
<td>PD202/15 - Biodistribution, pharmacokinetics and targeting efficacy of tumour-targeted</td>
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<td>tocotrienol nano-formulations in mice model.</td>
<td>No comment.</td>
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<tr>
<td>3.1.15</td>
<td>PD203/15 - Development of nano-carrier delivery systems of tocotrienols for oral, subcutaneous and topical administration.</td>
<td>No comment.</td>
</tr>
<tr>
<td>3.1.16</td>
<td>PD204/15 - Study of the effect of the positional fatty acids on triacylglycerol backbones on cardiovascular risk markers and fat deposition in mice.</td>
<td>No comment.</td>
</tr>
<tr>
<td>3.1.17</td>
<td>PD205/15 - (Project 1a) Multicentre studies on the effects of positional distribution of fatty acids at triglyceride backbone on serum lipids, lipoprotein (a) and LDL-subclasses in healthy Malaysian volunteers.</td>
<td>The SC commented that the sample size might be under powered. The SC commented that only minor changes may be expected as the study was done among normal individuals and the fat energy exchange is only 30%. The SC enquired on compliance issues and was informed that the compliance was good with more than 95% attendance. The SC enquired on the cholesterol levels among groups so far and was informed that the cholesterol readings have not been stratified according to groups and would only be done at the end of the feeding intervention. The committee was informed that the sample size was calculated applying Lehr’s formula and since it is a crossover design the sample size per group is 36.</td>
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<td>3.1.18</td>
<td>PD205/15 (b) - Multicentre studies on the effect of positional distribution of fatty acids at the triglyceride backbone of vegetable oils on fat deposition and health outcome measures-Malaysia.</td>
<td>The fecal analysis protocol will be obtained from King’s College London. Bomb calorimeter analysis will be carried out for the fecal samples.</td>
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<td>The SC suggested obtaining protocol for fecal analysis from King’s College, London.</td>
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<td></td>
<td>The SC also suggested that the fecal samples be subjected to bomb calorimeter analysis.</td>
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<tr>
<td>3.1.19</td>
<td>PD206/16 – Effect of dietary fatty acids on human breast cancer cell growth: in vivo studies.</td>
<td>Study by Clement et al has been referred to. Labels on corn oil has been corrected. Timeline is in accordance with what has been proposed during last PAC.</td>
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<td>The SC suggested that the study from clement Ip et al. in the 1980s/1990s be referred to.</td>
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<td>The SC suggested that the labels on the diagram for corn oil be corrected.</td>
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<td>The SC advised that the timeline for the project be adhered to, in order to obtain the result on time.</td>
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### Key Recommendations

**4.3.** Oleo-chemical Sub-Committee  
(Presented by SC Chairman, Dr Wolfgang Rupilius)

| 4.3.1. | New Project Proposals  
Eleven (11) new project proposals were evaluated:  
Six (6) projects were rated A (approved with minor comments);  
Two (2) projects were rated B (approved with major comments/amendments);  
Three (3) projects were rated C |
| --- | --- |
| **Response** | All projects rated A and B are currently in progress.  
Projects rated C are not being implemented. A thorough literature review on the subject matter is to be drafted by the officers who plan to present a new project proposal. |

| 4.3.2. | Review of Current Projects  
A total of 43 projects were reviewed, covering the following areas/programs:  
- Polyols and polyurethanes  
- Lubricants  
- Surfactants  
- Fine chemicals  
- Technology  
- Cosmetics  
- Agrochemicals  
- Environment (involving laboratory synthesis, formulations, product development, method establishment, major equipment/instruments and pilot plants) |
| **Response** | Out of the 43 projects reviewed during the 36th PAC Oleo-Subcommittee meeting:  
3 projects were successfully closed/viva in 2016.  
25 projects are being proposed to go through Viva in 2017.  
However, there were additional 4 projects which were not reported during the 36th PAC Oleo-subcommittee but have successfully gone through Viva 2016. |
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<th>Key Recommendations</th>
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<td>4.3.3. Key Recommendations</td>
<td>A metathesis project is currently being carried out as a PhD program a GSAS student in AOTD.</td>
</tr>
<tr>
<td>• Scientifically high-impact R&amp;D projects should be adopted e.g. (i) Metathesis of palm oil products (olefins, dicarboxylic acids, polyols etc). (ii) Production of ether-type compounds (lubricants, cosmetics).</td>
<td>• Non-successful projects were advised to be terminated. However, these projects need to be presented at VIVA first.</td>
</tr>
<tr>
<td>• Non-successful projects should be terminated early.</td>
<td>• Projects to be proposed are first surveyed through collaborations with private industries under a Non-Disclosure Agreement (NDA). The proposed project must be in line with MPOB R&amp;D strategies. These projects are not reported as PAC projects as those are projects carried out under an agreement signed between MPOB and the company.</td>
</tr>
<tr>
<td>• Focus on fewer projects.</td>
<td>• Examples of collaboration R&amp;D projects proposed as PAC projects:</td>
</tr>
<tr>
<td>• Improve collaboration between divisions, and between PAC sub-committees.</td>
<td>• Esterification technology: Esters of PFAD for Oil &amp; Gas Industry (AOTD 098/2016)</td>
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<td>• Ethoxylation technology collaboration with one of the PAC members.</td>
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PROGRAMME ADVISORY COMMITTEE MEETING
36th MEETING: 11 - 15 APRIL 2016

MATTERS ARISING OUT OF MINUTES OF PLENARY MEETING:
15 APRIL 2016

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<th>Key Recommendations</th>
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<tr>
<td><strong>PROCESSING AND ENGINEERING SUB-COMMITTEE</strong></td>
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<tr>
<td>1. To strengthen the integrated strategy of R&amp;D programme</td>
<td>1. All R&amp;D programmes are already in line with 10 strategic research areas.</td>
</tr>
<tr>
<td>i) To explore the recommendation on the vision “Sustainable Palm Oil Production 2025”.</td>
<td>i) The vision, mission and corporate strategy of MPOB / palm oil industry is being reviewed by MPOB management.</td>
</tr>
<tr>
<td>ii) To continue exploring possible involvement of MPOB in international R&amp;D programs such as HORIZON 2020, USDA, bilateral programs (JICA), industrial programs, etc.</td>
<td>ii) To continue to explore when the opportunity arises.</td>
</tr>
<tr>
<td>2. Recommendation on new projects/ideas to be further developed.</td>
<td>2. Person-in Charge – The Director / HOUs</td>
</tr>
<tr>
<td>(i) To streamline development of the integrated bio-refinery concept within palm oil utilization.</td>
<td>i) The proposed integrated cluster research on establishment of a palm oil mill-based biorefinery will be tabled in the PAC 2017 for discussion.</td>
</tr>
<tr>
<td>(ii) To explore New Palm based bio-composite (Bio-based Materials)</td>
<td>ii) Two new projects will be tabled in PAC 2017, on PKS powder reinforced bio-composite and Nano-cellulose for bio-composite.</td>
</tr>
<tr>
<td>(iii) To explore on Material Flow Cost Accounting (MFCA) in the future.</td>
<td>iii) A project on MFCA for palm oil mills is being explored for 2018.</td>
</tr>
<tr>
<td>3. Recommendation on further increase of MPOB impact on palm oil milling efficiency and sustainability:</td>
<td>3. Person-in Charge – The Director / HOUs</td>
</tr>
<tr>
<td>• Oil Extraction Rates (OER) on Fresh Fruit Bunches (FFB)</td>
<td>• To continue monitoring and improving mill performance under NKEA EPP4 (Improvement in</td>
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<td>Key Recommendations</td>
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<tr>
<td>• Environmental Quality (Crude Palm Oil Mill) Regulations Review</td>
<td>OER) together with Licensing &amp; Enforcement Division</td>
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<td>• Biogas (Anaerobic Treatment) Capture &amp; Avoidance</td>
<td>• Working closely with DOE, technology providers and industry on issues and challenges.</td>
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<td>• Pursued under NKEA-EPP5</td>
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1. **GENERAL RECOMMENDATION**

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<th>MATTERS TO BE FOLLOWED UP</th>
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| 1  | The Sub-Committee also discussed on the need to expand the engagement with the schools in Malaysia to include the private international schools and international universities as well. | A series of discussion have been conducted with the relevant organizations as follows:

  i. Division of Co-Curricular and Arts, Ministry of Education Malaysia (MOE).
  ii. St. John School of Bukit Nenas, Kuala Lumpur
  iii. Institute of Teacher Education Malaysia (IPGM)

  From the engagement with the Division of Co-Curricular and Arts, MOE, MPOB has been invited to participate in a national-level programme, organized by the Division of Co-Curricular and Arts, MOE called *Program Kembara Kokurikulum Peringkat Kebangsaan 2016 (Co-Curriculum Expedition at National level 2016)* on 17-21 October 2016. Awareness to school children on the benefits of palm oil will be focused during this programme.

  A visit by the School Children of St. John’s School of Bukit Nenas Kuala Lumpur to MPOB was held on 10 August 2016 during which an interactive talks and visit to MPOB Gallery and margarine Pilot Plant was conducted.

  In addition, MPOB has also proposed programmes to be conducted in schools and this has been officially communicated to the Ministry of Education. The implementation of these programmes will be done upon approval from the MOE. |
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<td>Communications have been made to liaise with few private universities including International Medical University and University Kuala Lumpur Malaysia France Institute (UniKL MFI) to co-organize the MPOB Technical Seminar (MTecS U) by end of this year or early next year in view that we would like to focus first on the programmes with the public schools and Universities in 2016.</td>
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<td>Communications with the Sustainability, Conservation and Certification Unit has been done for this purpose.</td>
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<td>MPOB has identified several companies that we could collaborate in these programmes.</td>
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<td>MPOB has conveyed the recommendation of the PAC with regards to the importance of the social media to MPOC for their action.</td>
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<tr>
<td></td>
<td>MPOB has responded that social media has and will continue to be an important tool in marketing, educating and addressing issues. The education process has long been started where we have established an edupalm website which is used specially to educate students on palm oil. This complements the work books developed and distributed in stages to schools in Malaysia.</td>
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<td>Consumer friendly competitions are organized using social media as a way to get consumers to learn about palm oil. A number of food videos have been produced to entice Malaysians to better appreciate palm oil. International chefs who feature in the videos speak about their favourite oil. These videos have been well received.</td>
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In this regard, the Sub-Committee also proposed that promotional materials be made available which would also include messages to convey the correct information on sustainability and the environment to the relevant institutions. This would also involve the likelihood of the private sector being invited along to participate in such educational activities. The Sub-Committee also noted that the importance of the social media in influencing the general public and agreed for MPOC to take the lead in the promotion in the social media. In this respect, it was requested that emphasis be given on using much of the available information from various scientific and reputable institutions including science based NGOs, e.g. World Resource Institute, to help distribute positive information and counter the allegations made against Malaysian palm oil. The Sub-Committee also recommended for this initiative to be extended to the private and international schools and universities in Singapore.
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<td>2</td>
<td>The Sub-Committee ...</td>
<td>Several activities have been carried out with Ministry of Health Malaysia. On 20&lt;sup&gt;th&lt;/sup&gt; July 2016 MPOB was invited to present a lecture at Ministry of Health Auditorium to a group of doctors, nurses, dieticians and medical staff from various hospitals. The lecture was successfully carried out with a good interaction between the audience and the speaker (Dr. Kanga Rani). A meeting with the Ministry of Health Singapore will be arranged upon completion of other activities such as MTech Seminar and POTS.</td>
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<td>The Sub-Committee ...</td>
<td>A proposal has been received from Cambridge and is currently under review.</td>
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<td></td>
<td>The Sub-Committee ...</td>
<td>MPOB has conveyed the recommendation of the PAC with regards to the importance of the social media to MPOC for their action. MPOC has responded that social media has and will continue to be an important tool in marketing, educating and addressing issues. The education process has long started where we have established an edupalm website which is used specially to educate students on palm oil. This complements the work books developed and distributed in stages to schools in Malaysia. Consumer friendly competitions are organized using social media as a way to get consumers to learn about palm oil. A number of food videos have been produced to entice Malaysians to better appreciate palm oil. International chefs who feature in the videos speak about their favourite oil. These videos have been well received. PORTSIM Shanghai disseminates information on palm oil in layman through its WeChat Public Account. To-date (from July 2015 till August 2016), PORTSIM Shanghai...</td>
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<td>The Sub-Committee also recommended to intensify the translation of promotional materials into other languages such as in the Hindi, Tamil and Telegu for the expanding Indian market in addition to the other languages that are already proposed by the various Regional Managers.</td>
<td>With the assistance of Mr Goenka’s office, a Hyderabad-based company (Hyderabad Translation Bureau-HTB)) had been identified to undertake the translation work. The translations in Tamil, Hindi and Telegu has been completed and is now ready for printing. Translation of the Palm Oil Health Facts to French language has been completed and is being printed. Discussion with Confederation of Iranian Food Industry Association (IFIF) was held in June 2016 for translation of Palm Oil Health Facts to Persian language. Discussion with MUMSAD of Turkey was also held for the collaboration to translate the Health Facts into Turkish. This will be undertaken when the latest version of the Pocketbook of Palm Oil Uses is made available. PORTSIM Shanghai has translated the following papers into Mandarin and distributed, together with other papers translated earlier, at 5th Palm Oil Health and Nutrition Forum in Tianjin, China on 10th August 2016. 1. Lucci et. al. (2016). Palm oil and cardiovascular disease: a randomized trial of the effects of hybrid palm oil supplementation on human plasma lipid patterns. <em>Food Function</em>, 2016, 7, 34. Teh et. al. (2016). Effects of Fatty Acids at Different Positions in the Triglycerides on Cholesterol Levels. JOPR Vol. 28 June 2016 p. 211-221</td>
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<td>5</td>
<td>The Sub-Committee...</td>
<td>The basic formulation has been tested. Inclusion of suitable palm oil fractions and stability during storage will be determined.</td>
</tr>
<tr>
<td>6</td>
<td>The Sub-Committee...</td>
<td>From 1\textsuperscript{st} January 2015 to 30\textsuperscript{th} June 2016, 9 groups of smallholders (5,341.34 ha) have been certified under MSPO.</td>
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|   | the MSPO certification be directed towards the smallholder segment thereby be able to fulfill the UN recommendations on improving the livelihood of the poor and simultaneously ensuring that responsible development can go hand in hand with protecting the environment. The Sub-Committee was of the opinion that the MSPO certification would be able to fill the void which currently exists with the RSPO certification, particularly amongst the smallholders who either did not have the resources or finances to proceed with sustainable farming. 15 Sustainable Palm Oil Clusters (SPOC) have been identified to be certified with MSPO for 2016. As of 25 July 2016, 8 SPOC had gone through Stage 1 MSPO auditing.  
- To spearhead the implementation of MSPO for smallholders, a fund of RM 53 M has been allocated for that purpose.  
- MPOB and Solidaridad Asia had signed a Memorandum of Understanding to formalize a very important strategic partnership towards achieving high returns from sustainably-cultivated oil palm on smallholdings and promotion of Malaysian Sustainable Palm Oil or MSPO-certified sustainable palm oil in international markets. |
| 7  | The Sub-Committee... | West Asia  
Zade of Turkey had purchased Malaysian red olein for a trial distribution of red olein capsule in Turkey.  
South Asia  
In South Asia, particularly India, efforts are made towards promoting higher value-added products, despite domestic challenges.  
Africa  
For the African region, MPOB Cairo has intensified the TAS efforts on market expansion for palm based finished products which have more value addition as compared with the export of palm oil in bulk. Exports of Malaysian palm based finished products to Africa for January-July 2016 was 42,477 tonnes, an increase of 35.4%. For January-July 2016, TAS efforts were conducted mostly in the Eastern African region. |
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<td>8</td>
<td>Whilst the Sub-Committee appreciated the work done on 3-MCPD and its mitigation by the MPOB, it nevertheless recommended that more work needs to be done in order to prepare the industry for a potential backlash which very well could be just around the corner. The question posed by the Sub-Committee are we ready to address issues in the international media relating to 3-MCPD in an affirmative manner? In other words, the Sub-Committee wished for the MPOB to pre-empt such an outcome.</td>
<td>RBD samples (PO, POo and POS) have been collected from several refineries from all over Malaysia by MPOB’s enforcement officers and are being analysed for 2-, 3-MCPD esters and GE.</td>
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</table>
| 9  | The Sub-Committee recommended that the regional offices interact with their counterparts at the Indonesian Embassies (and any other palm oil producing countries) with regard to the sustainable development of palm oil. | Europe
RM for Europe meets regularly with the counterparts of the palm oil producing countries included Indonesian Embassy in Brussels to discuss various issues on palm oil, sharing of latest development and thoughts. |
<p>| 10 | The Sub-Committee recommended for all the RMs and TAS Officers to fully understand the issues affecting palm oil across the globe and to be consistent in the dissemination of messages in the various regions. A standard fact sheet comprising all the necessary information to be used by TAS RMs and officers. This standard fact sheet (environmental All the RMs and TAS officers are using the information from the Palm Oil Health Facts, Pocketbook of Palm Oil Uses, Palm Oil Fact Sheets, and statistics on environmental eg on forest cover, production of certified palm oil under RSPO, MSPO and other MPOB statistics in the various regions in the dissemination of technical information in the various regions. |</p>
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<td>11</td>
<td>The Sub-Committee also recommended the MPOB to commission an independent study on life cycle assessment comparing palm oil vs soybean and rice cultivation and to compare the results between these three primary agricultural crops and to assess the differences in each of these crops’ GHG emissions - carbon footprint expressed in kgCO₂eq product produced, i.e. per tonne of oil and per tonne of rice.</td>
<td>Discussion is being held with local universities to undertake an independent study on LCA for palm oil, soybean oil and rice. Desktop research is also being conducted to review the existing data/results.</td>
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<td>12</td>
<td>The Sub-Committee recommended that the contract of Dr. Ooi Cheng Keat and Dr Kalanithi Nesaretnam to be extended to assist in the technical promotional activities in the Far East and Europe regions.</td>
<td>The contract of Dr Ooi Cheng Keat has been renewed for another year. The HR Unit is currently looking into the contract of Dr Kalanithi.</td>
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<td>13</td>
<td>The Sub-Committee recommended that MPOB together with the Ministry of Natural Resources (NRE) and MPIC to formulate a strategic master plan providing a clear policy on the targeted area that would be permanently set aside under protected forest and what would be used for agriculture specifying plantation crops. The intention of the aforementioned is to create a landscape use master plan for Malaysia, which can be used for promoting the country’s Green Agenda.</td>
<td>A meeting with the Palm Oil and Sago Industry Development Division (BISS), MPIC is scheduled in mid September 2016 to discuss on this matter.</td>
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| 14 | The Sub-Committee recommended that the MPOB & MPOC to form a ‘War Room’ to formulate strategic communications/rebuttals as expeditiously as possible when serious allegation arise. In this connection, it was specified that the MPOB should take the lead on allegations surrounding health-science related issues and that the MPOC should take the lead on MPOB (PDAS and the Corporate Communication Unit) is scheduled to meet and discuss with the Corporate Communication of Sime Darby Bhd to learn from the experience of the private company on the mechanism to establish this 'War Room'. | }
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<td>environmental and social issues. The Sub-Committee advocated that the culture of readiness to pre-empt any such problems.</td>
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<td>15</td>
<td>The Sub-Committee expressed their strong concern with the acute labour shortages currently experienced in the Malaysian palm oil industry, considered to be the worst in the last 10 years arising from the freeze on recruiting foreign labour. The Sub-Committee specifically mentioned the urgent need for the MPOB (ideally the Chairman’s personal intervention) to engage with the relevant ministries to overcome the current freeze on foreign workers as this would inevitably become a liability for Malaysia in terms of lower tax revenues arising from lower yields, higher loses and a smaller production and export volume of palm oil during 2016.</td>
<td>This issue has been resolved as the Cabinet has lifted the freeze on foreign labor in the plantation sector in May 2016 due to shortage of man power.</td>
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<td>16</td>
<td>The Sub-Committee recommended that future presentations to give an overview of total oils and fats export, overall palm oil export before focusing on Malaysian export data.</td>
<td>Americas All RMs have taken note of this recommendation and will apply it in future presentations to the PAC Sub-Committee.</td>
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<td>17</td>
<td>The Sub-Committee also appealed to the MPOB top management to consider compressing the PAC meeting schedules from 5 days to 3 days in view of the fact that many representatives found it difficult to justify being away from their other responsibilities for more than 3 days. The proposal will be as follows:</td>
<td>This matter is subject to the decision of MPOB’s Management</td>
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<td></td>
<td>Monday</td>
<td>Seminar with presentations by PAC members and invited speakers (addressing current issues which can be taken up in the sub-committee discussion later) &amp; Cross Cutting Forum</td>
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<td>Tuesday</td>
<td>Opening plus presentations in the respective Sub-Committees</td>
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<td></td>
<td>Wednesday</td>
<td>Presentations in the respective Sub-Committees and report writing &amp; Dinner</td>
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<td>Thursday</td>
<td>Morning: Finalisation of recommendations and conclusions of the Sub-Committee Afternoon: Plenary</td>
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<td><strong>GENERAL RECOMMENDATION BROUGHT FORWARD TO 2016 IN VIEW OF ITS ON-GOING ACTIVITIES</strong></td>
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<td>The Sub-Committee also recommended that findings from the meta-analysis which highlights that saturated fat is not bad for health published by researchers from the Cambridge University should be translated into consumer-friendly messages and communicated extensively particularly through social media.</td>
<td>MPOB has printed the booklet Palm Oil Health Facts in July 2015 and had presented to the International Advisory Panel on Nutrition (IAPN) in October 2015. It was agreed that the booklet be updated on a yearly basis and new findings will be incorporated when the revision is due. MPOB will also work with MPOC in disseminating these information in the social media.</td>
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<td>In view of the fact that the information in the technical material would be dynamic, the Sub-Committee recommended that the information be revised annually based on new research findings and to update the</td>
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|    | members of the PAC Sub-Committee on 1st March every year. | Americas  
MPOB have been active in participating in major exhibitions and conferences, i.e., World Ag Expo, Natural Product Expo West, NIOP Annual Convention 2016, 107th AOCS Annual Conference and Expo 2016, NYCC Suppliers’ Day, Tortilla Industry Association (TIA) Annual Convention, International Dairy Deli Bakery Association Show (IDDBA), Summer Fancy Food Show - Specialty Food Association as of June 2016. |
| 3  | The Sub-Committee recommended for MPOB and MPOC to intensify efforts and to continue to participate actively in the relevant trade seminars, food and feed exhibitions to promote Malaysian value added palm based products. The Sub-Committee recommended that either MPOB or MPOC or both should be represented at each of these events. | South Asia  
MPOB India has constant interactions with MPOC to discuss the nature of participation in these activities.  
- In 2016, MPOB India had attended AAHAR New Delhi in March, Global Grains, Foods and Feeds Conference (G2F2) in Pune in June 2016 as well as Food Ingredients India in New Delhi in August 2016.  
MPOB India shall also attend:-  
- CLFMA National Symposium, Calcutta, Sept 2016  
- AAHAR Chennai, Sept 2016  
- Globoils India, Goa, Sept 2016  
Europe  
The followings are the identified and planned palm oil seminars and meetings in Europe:  
**September**  
Euro Fed Lipid 2016  
**September/October**  
Seminar on MSPO, 3 MCPD and GE in Brussels and Paris. Working Visit to Alba, Italy.  
**November 2016**  
Technical Palm Oil Seminar, Berlin Germany  
**March 2017**  
MEPs Familiarzation Programme 2017. |
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<td>Oceania</td>
<td>Identification of events-</td>
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<td>• Australian Dairy Conference, Feb 2017</td>
<td>Africa</td>
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<td>• Australia National Field Days (20-22 Oct), NSW</td>
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<td>• Australian International Dairy Week (15-19 Jan 2017), Melbourne</td>
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<td>• 2nd International Conference on Livestock Nutrition (21-22 Jul 2016), Brisbane</td>
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<td>• Good Food &amp; Wine Show (June, July, Aug, Oct 2016)</td>
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<td>• Fine Food Australia (12-15 Sept 2016), Melbourne</td>
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<td>• Malaysia Fest (27 Sept 2016), Sydney.</td>
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<td>Far East</td>
<td>PORTSIM Shanghai has participated and presented paper at:</td>
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<td>• 9th Annual Meeting of China Oleochemical Industry in Yangzhou, China on 15th to 17th July 2016</td>
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<td>• 8th China International Cereals and Oils Industry Summit in Chengdu, Sichuan Province, China from 14th to 15th July 2016.</td>
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<td>In addition, PORTSIM Shanghai also participated at the Asia Energy Cooperation Forum in Chongqing, China on 27th and 28th June 2016, one of the highest level forums on energy in China organized by the Ministry of Foreign Affairs, China and officiated by the Vice Chairman of the Chinese People’s Political Consultative Conference (CPPCC) National Committee.</td>
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<td>Far East. PORTSIM has translated Palm Oil Health Facts, Project Brochures, Palm Oil Pocket Books, Published Palm Oil Nutrition Papers into Chinese for distribution.</td>
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<td>Americas Some brands do not exclusively use Malaysian palm oil except those imported directly from Malaysia for industrial use such as Olera Gold Shortening etc. Companies like ISF and Felda has shown interest to participate in major exhibitions to promote their brands by using MPOB/MPOC booth.</td>
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<td>South Asia MPOB India has introduced certain leading Malaysian companies to potential importers in India to create brand loyalty for palm products in both food and feed applications.</td>
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<td>Africa MPOB Cairo continues the efforts in trade and technical promotional activities to encourage the usage of Malaysian Carotino Red Palm Oil and Tocotrienols products especially in Egypt, Ethiopia and Djibouti. TAS efforts were also carried out in promoting palm kernel cake for poultry feed and ruminant feed in Egypt. This also includes the advisory services on the usage of high value palm based products. Effort is also carried out on the use of palm based medium-chain triglycerides (MCT) in Egypt.</td>
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<td>Far East: The efforts of promoting the high value palm products have been implemented in the R&amp;D activities as well as engagement with the Chinese industry players.</td>
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<td>The Sub-Committee noted that there was a decline in the Malaysian export for two consecutive years, which is partly a result of declining yield and production for which weather factors cannot be blamed alone. The reasons for the decline should be carefully analysed. In this regard, the Sub-Committee requested for information on the pattern on the total planted area, areas under replanting (small holders and private estates) and the age profile based on the following breakdown: 3-10 years, 10 - 15 years, 15 – 20 years and &gt;20 years to know the trend for the last five years (2011-2015) which has an impact on the oil yield and palm oil production. Nevertheless, there are also other factors to be analyzed.</td>
<td>It was found that the decline in palm oil export in 2014 and 2015 did not have any direct correlation with FFB yield, pattern on the planted area, areas under replanting and the age profile of oil palm. <strong>Declining yield</strong> There is no direct correlation between declining yield and PO exports. CPO Production in 2013 was at 19.22 Mn T and increased to 19.67 Mn T in 2014 whilst simultaneously, PO export declined to 17.31 Mn T in 2014 from 18.15 Mn T in 2013. <strong>Age profile</strong> As at December 2015, 8.2% of oil palm trees are below 3 years of age, 20.7% are young palms between 3 to 6 years old and 54.6% are palms in the peak production age of 7 years to 20 years. <strong>Other factors</strong> <strong>PO exports increase when SBO price increase</strong> The analysis show that the major factor contributing to the decline in Malaysian PO export in 2014 was due to the significant decline in SBO prices as compared to CPO prices. This scenario contributes to the narrower price discount of CPO against SBO. The price discount of CPO against SBO registered at US$200/tonne in 2013 and significantly declined to US$88/tonne in 2014. Therefore, an increase in CPO production in 2014 was not able to increase palm oil export due to the greater fundamental impact of price discount on PO export. PO and SBO are close substitute products in the world vegetable oils market. Therefore, when SBO price increase, demand for PO increases, especially when the price discount between both products widen. PO export increased to 3.2% from 17.58 Mn T in 2012 to 18.15 Mn T in 2013 and in the same period, SBO price declined by 13.8% to US$1,057 per tonne in 2013 as compared to US$1,226 per tonne in 2012. <strong>PO exports has a positive correlation with CPO Prices</strong> It was found that there is a moderate</td>
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<td>relationship between PO exports and CPO prices in 2011-2015. PO export declined by 2.3% from 17.99 Mn T in 2011 to 17.58 Mn T in 2012 and in the same period, CPO price declined by 14.1% to RM2,764 per tonne in 2012 as compared to RM3,219 per tonne in 2011. <strong>Loss of market share</strong> It was also found that the decline in palm oil exports in the last two years is not due to palm oil production or declining yield, but rather increasing imports of soybean as well as higher intake of Indonesian palm oil by major Malaysian palm oil export markets. Palm oil exports on the other hand, declined from 18.15 million tonnes in 2013 to 17.31 million tonnes in 2014 and 17.45 million tonnes in 2015. The decline in palm oil export for the last two years were mainly due to poor export performance to major markets such as China P.R, Pakistan, USA, Iran, Bangladesh and Egypt. Increased imports of soybean by China P.R, Iran and Pakistan, combined with higher intake of Indonesian palm oil by China P.R, Egypt, Pakistan, USA, Bangladesh and Myanmar had contributed to the decline in Malaysian palm oil export performance in 2014 and 2015.</td>
<td>MPOB has had discussions with the Ministry of Foreign Affairs, Malaysia with regards to the opening of the satellite office in Croatia for the CEE countries. A Board Paper has been prepared for Board’s approval in its next meeting scheduled in September 2016. The MPOB Board in its meeting in April 2016 has approved to re-activate the MPOB Regional Office in Tehran as well as the liaison officer on contract basis based on CFS.</td>
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<td>7</td>
<td>The Sub-Committee also recommended that locally recruited staff (LRS) be recruited to facilitate and assist with the market development activity in the respective regions.</td>
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### 3. SPECIFIC RECOMMENDATION - EUROPEAN REGION

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<td>1</td>
<td>The Sub-Committee...</td>
<td>RM for Europe...</td>
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<td>The Sub-Committee...</td>
<td>13 CPO samples...</td>
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<td>The Sub-Committee...</td>
<td>3 MCPD Esters &amp; Glycidyl Esters (GE)...</td>
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<td>3</td>
<td>The Sub-Committee...</td>
<td>RM for Europe...</td>
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1. The Sub-Committee recommended that the issues surrounding endocrine disruptors be thoroughly followed and that mitigative measures be taken in Malaysia to pre-empt the likelihood of the thresholds for various pesticides used in the industry being lower than 0.01 ppm. This would include a comprehensive sampling of CPO of all Malaysian states.

2. The Sub-Committee recommended that the issues surrounding 3-MCPD & glycidyl esters be thoroughly followed and monitored and that mitigative measures be taken in Malaysia to keep 3-MCPD levels below 1 ppm at the point of export.

3. The Sub-Committee noted that Europe remains an important region, the Sub-Committee recommends that MPOB & MPOC continue to enhance the lobbying and promotion of sustainable palm oil vigorously.

RM for Europe meets regularly with several Missions in Brussels to share of information and newest development on endocrine disruptors (EDs), thoughts, action plans proposals and convey back to MPOB on the outcome of the meetings.

13 CPO samples (12 real samples and 1 blank sample fortified with 4 ED compounds registered in Malaysia at 0.015 ppm) collected from various mills and refineries were submitted to Eurofins Lab for endocrine disruptor residues determination.

3 MCPD Esters & Glycidyl Esters (GE) seminars will be held in Brussels on 5 September 2016 to talk about the steps Malaysia would be taking to mitigate and lower levels for 3-MCPD and GE. 

Recommended mitigation measures:

1. Screen the total chloride content and pH of bleaching clay prior to usage. Only use bleaching clay with the lowest total chloride content that is available, while the pH should be almost neutral to alkaline.
2. Reduce deodorization temperature from 260 °C to 230 °C
3. Rinse CPO prior to refining

RM for Europe maintains good relationship with European authorities both in Brussels and France especially with MEPs, Commissioner Offices, French Senate and European Alliances to enhance the smooth communication flow to the parties involved.

A MSPO seminar will be held on 5th September 2016 in Brussels.

A meeting with members of the Sustainability Criteria Commission will also be arranged in France.
## 4. SPECIFIC RECOMMENDATION - AMERICAS REGION

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<td>1</td>
<td>The Sub-Committee was displeased with the slow progress to resolve the alleged forced/child labour issue and strongly urged MPOB to convey to the Malaysian Government the acute need to resolve the issue before the Trans-Pacific Partnership Agreement (TPP) is enforced. The Sub-Committee stressed that the alleged forced/child labour issue could be very damaging to the image of Malaysian palm oil.</td>
<td>MPOB had conveyed this matter during the meeting between MPOB Management, RMs and TAS officers with the late KSU of MPIC on 20 April 2016 after the PAC meeting. MPIC also organized a briefing to the Malaysian Oil Palm Industries by the Ministry of Human Resources on 23 August 2016 which informed that the Ministry of Human Resources will amend relevant Acts and Regulations related to labour laws which will include laws to eliminate forced/child labour. On 22 April, 2016, MPIC organised a discussion with representatives of the Embassy of the United States on the issue of forced /child labour in sub-sectors of oil. To create awareness about forced and child labour, MPOB organised seminar on labour situation in oil palm plantations on 22^nd^ February and 26^th^ April 2016 in Bangi, Selangor and Sandakan, Sabah respectively. It is proposed to appoint a lobbying firm once some improvements have been made and new data have been obtained. These lobbying companies have been identified but the cost is a major hurdle. Communicating directly with USDOL has limited success as the issue has a political dimension which can only be addressed through top-down approach via lobbyist services.</td>
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<td>The Sub-Committee also recommended for MPOB to request through MPIC that the Malaysian Government to amend related laws for fully compliance and adherence with the International Labour (ILO) standard.</td>
<td>Since Malaysia has agreed to join TPPA, certain labour laws related need to be amended in order to fulfill the International Labour (ILO) standard. This will be done by the Ministry of Human Resource. It was informed during the briefing at MPIC that the Ministry of Human Resource is currently amending their laws related to labour to be in compliance with the ILO standard.</td>
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5. **SPECIFIC RECOMMENDATION - AUSTRALASIA/OCEANIA REGION**

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| 1  | The Sub-Committee recommended that technical promotion to focus on expanding the market share of palm kernel cake in Australia and New Zealand. | • Propose to participate in events such as Australian International Dairy Week (15-19 Jan 2017), Melbourne.  
• Meet with PKE users in Australia & NZ during TAS Visit. |
| 2  | The Sub-Committee recommended that to explore further potential use of palm kernel expeller (PKE) and to conduct analysis on the current use of PKE vis-à-vis use of other oilseed meals in animal feed especially during the time when the milk price is declining. The Sub-Committee also recommended to come up with ways for a higher price realisation to reduce the price gap between palm based animal feed against other oilseed meals. | The imports PKE and other oilmeals to NZ has been collected. Potential further use of PKE to be analysed. |
### 6. SPECIFIC RECOMMENDATION - CHINA AND FAR EASTERN REGION

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| 1  | The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in China led by the Director General of MPOB, through tripartite R&D and commercialization and engagements with local authorities, and recommended that these efforts be intensified. | i. YBM Meeting with Tianjin Mayor on 10 August 2016.  
ii. Three Projects Completed.  
1. PORTSIM 030/2013 - Application of Palm Based Piglet Feed Meal  
2. PORTSIM 031/2013 - Application of Palm Based in Jinhua Pastry  
3. PORTSIM 033/2014 Studies on characteristics of blends of red palm oil and other indigenous oils. |
| 2  | The Sub-Committee noted promotional efforts of MPOB and MPOC to disseminate information on palm oil through social media and recommended that this effort be intensified to broaden reach of Malaysian palm oil to users of palm oil and consumers in China. | Regular postings of palm oil health and nutrition information in PORTSIM WECHAT Social media. |
| 3  | The Sub-Committee recommended that the presentations at Palm Oil Health and Nutrition Forums in China be uploaded and shared to the public in MPOB Official Website in China. | 1. 4th Palm Oil Nutrition and Health Forum Papers are uploaded on PORTSIM Website. |
| 4  | The Sub-Committee noted the importance of promoting palm oil in animal feed industry in China and recommended intensified R&D works be extended on animal feed be conducted by PORTSIM and to extend animal feed trials to include triglyceride based fat powders. | New Projects on animal feed to be proposed in the next RAC meeting in November 2016. |
### 7. SPECIFIC RECOMMENDATION - INDIA AND SOUTH ASIAN REGION

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| 1  | The Chairman and the Sub Committee noted that they were very pleased with the current initiatives, progress and efforts by the MPOB India Branch Office. They recommended that MPOB India Branch office replicate the effective research activities conducted in PORTSIM China to enhance palm oil utilization in India. | NIN MPOB India has liaised with NIN to finalize the research proposal. However, direct discussions between Nutrition Unit and NIN are still needed to fine-tune the proposal on palm oil nutrition studies (lipid metabolism/fat deposition and red palm oil in vitamin A intervention) as the study designs need to be carefully set. **IICT** Proposals from IICT on blended oils and palm-based solid fats have been received. Comments have been sought from PFT Unit to fine-tune the proposals. Further discussions with IICT to be pursued after review by PFT is completed. **ICT** Two proposals from Dr Jyotsna Whagmare of ICT had been received: -  
  a. Development of palm oil-based micro- and nano emulsion for wide range of application in food applications  
  b. Development of red palm oil-based micro-encapsulation for wide application in food products  
After internal review by TAS and PFT, the above proposals were not found to be viable. Further discussions with ICT will be pursued, specifically with focus on palm olein and snack foods studies.  
An MoU between MPOB-ICT has been prepared and to be finalized by the both parties. |
<p>| 2  | The Sub Committee commented that MPOB India should take a pro-active approach to chart strategies to overcome any nutrition or sustainability issues which are currently affecting the developed countries. | MPOB India has had discussions with several major palm oil importers in India to constantly gauge the issues related to nutrition and sustainability in India. |
| 3  | The Sub-Committee recommended that MPOB India engage or lobby policy makers, health authorities and various government agencies to improve the perception of palm. One of the suggestions is to establish strong networking with Dr. RBN Prasad, former of the IICT. A meeting with Dr. Prasad and his IICT colleagues was held in July 2016 to discuss the projects and other collaborations with IICT. | MPOB India is in constant touch with Dr. RBN Prasad of the IICT. MPOB India has created networking with |</p>
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<td>Chief Scientist &amp; Head Centre for Lipid Research, Indian Institute of Chemical Technology who is currently the Chairman of the Oils &amp; Fats scientific panel under the Food Safety and Standards Authority (FSSA) of India.</td>
<td>Association of Food Scientists and Technologists (AFST) and is currently drafting an MoU between MPOB and IFST. IFST could be a strategic ally for MPOB as they have over 3500 members spread in over 29 chapters (city/regional-bases) in India.</td>
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<td>The Sub-Committee recommended that MPOB India explore the possibilities of blending palm oil with olive oil in the blending projects that will focus on blending of palm olein with indigenous oils to cater to the preference in the different regions of India and enter the premium market through health benefit of the blended oil.</td>
<td>The blending of palm olein/olive oil would be incorporated into the scope of the blending project with the IICT. Other oils to be blended with palm olein are sunflower, soybean, rice bran, sesame and mustard oils.</td>
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<td>The Sub-Committee recommended that Malaysian Palm Industry take the opportunities from the initiative taken by the Central government of India which allows 100% Foreign Direct Investment (FDI) in oil palm plantations. The Sub-Committee however noted that this will need efforts and initiatives from the Malaysian palm oil industry.</td>
<td>Discussions with Malaysian palm oil industry are still required, as this would be a business decision.</td>
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<td>6</td>
<td>A Sub-Committee member (Mr Unnithan) expressed his keenness to assist MPOB India in the snack food project proposed between MPOB and ICT as India’s snack food market is expanding rapidly. MPOB should explore the application of palm oil products in snack food industry both as frying medium using palm olein and as a colorant and functional food using red palm olein.</td>
<td>MPOB India has had several discussions with Mr Unnithan on this proposal. Further deliberations are still required.</td>
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<td>7</td>
<td>The Sub-Committee recommended that MPOB India explore the potential of palm biodiesel market and value added products in oleochemicals/chemical industry in India.</td>
<td>Exploratory meeting with Godrej Industries, a major player in Indian oleochemical and personal care products had been held in July 2016.</td>
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<td>8</td>
<td>The Sub-Committee recommended that MPOB should assist the Malaysian industry to take advantage of the existing potential of export of palm kernel cake in India and present the findings to the Sub-Committee next year. Emphasis should be given to the cattle feed industry in India where PKC can be utilized as feed.</td>
<td>MPOB India has recommended to a leading Malaysian exporter of PKC, several potential importers of PKC in India. In addition, MPOB India has approached a leading Indian dairy player (Amul Dairy of Gujarat) and suggested that they import palm-based bypass fat for their dairy cattle. Amul Dairy has requested for sample of the bypass fat, which will be provided by the</td>
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### MATTERS TO BE FOLLOWED UP | ACTIONS TAKEN
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9 | The Sub-Committee recommended that MPOB and MPOC focus more on promoting palm oil to the southern and eastern part of India. MPOB India has discussed this recommendation with MPOC Mumbai. Discussions have also been held with Sime Darby Chennai. Palm Oil Seminar is planned for Chennai, Hyderabad and Kolkata in November 2016 (after the monsoon and religious-festive holidays). A Malaysia-India Palm Oil Seminar was held in Hyderabad on 19 May 2016.

### 8. SPECIFIC RECOMMENDATION - WEST ASIAN AND CENTRAL ASIAN REGION

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<tr>
<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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| 1 | The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in Pakistan and the Middle East, through technical collaboration efforts such as development of palm based formulation, introducing Malaysian palm oil brand and engagements with local authorities, and recommended that these efforts be intensified. | • Palm olein by the brand name ‘Minyak’ is being widely promoted in Pakistan.  
• In addition, MPOB’s Formulations for palm based solid fats have also been promoted to be incorporated in their products formulation. |
| 2 | The Sub-Committee recommended for MPOB West Asia to follow up the status of convenient banking channels for export to Iran. | • RM for West Asia has sought advice from several major importers in Iran on the convenient payment method for export to Iran. The banks in Iran are in the process of putting in place systems to receive payments from other international banks. |

### 9. SPECIFIC RECOMMENDATION - AFRICAN REGION

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<tr>
<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
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| 1 | The Sub-Committee recommended that MPOB Africa to obtain on growth trend of middle class across African countries to estimate potential growth in demand. This is because the emergence of the middle class citizen will contribute to an increase in the calories consumed per person per day. | The efforts have started in Egypt and a meeting was held in May 2016 with Egypt's Agency on Population Growth and Income Status (CAPMAS). Data is still being gathered as it involves a wide coverage of the target group. MPOB Cairo has also planned to gather the information in the major palm oil markets in which the future efforts will be in Kenya (August/September 2016), Nigeria (September 2016), Tanzania (September/October 2016) and Algeria or

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Page 53 : PAC 2016 – Matters Arising out of Minutes of Plenary Session
<table>
<thead>
<tr>
<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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<tr>
<td>2</td>
<td>The Sub-Committee recommended the MPOB to consider setting up two offices in the African region to tap the huge African market.</td>
<td>Morocco (February 2017).</td>
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### 10. SPECIFIC RECOMMENDATION - ASEAN REGION

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
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<tr>
<td>1</td>
<td>The Sub-Committee recommended that MPOB assess the domestic consumption of coconut oil for food and to evaluate the feasibility to blend palm olein with coconut oil in the Philippines.</td>
<td>Discussion was held with Head of PFT Unit. PFT will conduct the study and TAS will provide samples when needed.</td>
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<tr>
<td>2</td>
<td>The PAC Sub-Committee recommended technical and scientific data related to palm oil be translated in local languages within the ASEAN countries. This is to ensure that the technical promotion and the message of the nutritional benefit are well conveyed to the consumers in the ASEAN region. The translated documents are recommended to be in hard copy as well as in electronic version.</td>
<td>Draft of The Palm Oil Health Facts in Vietnamese language has been received from IOOP and is being reviewed.</td>
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<td>Key Recommendations</td>
<td>Response</td>
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<tr>
<td>4.6. Techno-Economics Sub-Committee (Presented by SC Chairman, Y Bhg Tan Sri Dato' Dr Mohd Noor Ismail)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.6.1. The Techno-Economics (TE) Sub-committee continued to offer advice and guidance to the TE Unit of the Economics and Industry Development Division (EID) and Integrated Research and Extension Division (IRED).</td>
<td>-</td>
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<td>4.6.2. New Project Proposals: (a) Seven new projects proposals from TE-EID were presented and evaluated. All the seven new project were rated A (approved with minor comments). (b) Two new projects proposals from CLI-IRED were presented and evaluated. All two new projects were rated A (approved with minor comments).</td>
<td>• Action taken. Improvements have been done on the proposals, in line with the comments given by the Sub-Committee.</td>
<td></td>
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<tr>
<td>4.6.3. Nine on-going Techno-economic projects were deliberated at the SC meeting. The Sub-Committee was satisfied with the progress of all the TE on-going projects and all projects will be viva this year.</td>
<td>• Eight TE on-going projects were vivaed in 2016 (one was not deliberated during the 2016 PAC) while the remaining two (2) projects are scheduled for viva in 2017.</td>
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<tr>
<td>4.6.4. Five on-going CLI-IRED projects were deliberated at the SC meeting. Out of the five on-going projects, four will be viva this year and one project will be viva in progression in-</td>
<td>• Project on the Acceptance Level of Extension Service Activities by Pusat TUNAS among Independent Oil Palm Smallholders has been vivaed on 8 November 2016:</td>
<td></td>
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### Key Recommendations

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<th>Line with these three phases of research.</th>
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<th>Response</th>
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- The other three projects will be vivaed in 2017. The projects are:
  
i. Factors Affecting FFB Production Among Independent Smallholders’ In Sabah
  
ii. A Preliminary Study on the Economic Stimulus Package II Incentive Scheme (PRE2) on FFB Yield and Income of Smallholders in Peninsular Malaysia
  
iii. Factors Affecting FFB Production among Participants of Quality Oil Palm Seedlings Assistance Scheme (SBABB)

- Project ‘on Knowledge Assessment of Fertilizer Management among Oil Palm Smallholders in Malaysia’ is in the second phase of collecting data.

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<th>4.6.5. The Sub-Committee would also like to recommend to IRED the following:</th>
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- Improvement of the TUNAS activities capacity and develop or create module for adoption by ISH.

- Consider the smallholder’s status (full time / part time) as a measure to decide on the assistance to be provided.

- To consider the provision of full package assistance for better impact of the project.

- Create cluster or group among the ISH to provide more effective extension services in general.

- Use different techniques of teaching and training for different categories of smallholders.

- Provide better access of essential agricultural inputs for the ISH.

| TUNAS activity capacity has been improved and several extension modules have been developed. The extension activities carry out are technical lecture, farm visit, sustainable certification, demonstration plot, hand-on practical training and campaign on good agricultural practices (GAP) and government assistances. |

- Results of the survey indicated that 60% of the independent smallholders (ISH) are fulltime farmers and the rest are part-time. All the government assistances available have been tailored to suit all the smallholder categories.

- The current assistances for the ISH such as oil palm replanting, new planting and sustainable oil palm grower cooperative (KPSM) are full package assistance.

- The ISH have been clustered into small groups call Sustainable Palm Oil Cluster (SPOC). Up to June 2016, 32 SPOC had been established all over the country.

- The TUNAS officers are encouraged to attend Train the Trainers Training so that they can
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<th>Key Recommendations</th>
<th>Response</th>
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| (vii) Fertilization and sanitation are areas of great emphasis to be addressed. | adjust the ISH training according to their categories. |• All the 33 KPSM that have been established are encouraged to carry out the agriculture inputs selling. By doing this, members and also the other ISH can have better access to the agriculture inputs at reasonable prices.  
• The GAP trainings given to the ISH will encourage them to give better emphasis on their oil palm fertilization and farm sanitation. |

4.6.6. In response to MPOB Chairman and Director General’s Speech, the Sub-Committee discussed and gave some inputs and guidance for future activities towards achieving MPOB’s vision and mission. They are:

(i) To strengthen further the Implementation of Replanting Programme:  
(a) The replanting program especially for smallholders needs close monitoring, supervision and follow up operations to achieve its target.  
(b) Newly develop high yielding planting material should be made available to the smallholders.  
(c) Intensify extension services to the smallholders  

(ii) To provide accurate and timely economic and industry information to the government.  

(iii) New recruitment should focus on strong applied economics analytical tools.  

• Up to November 2016, total areas of replanting and new planting been implemented were 48,345 ha and 61,896 ha respectively. Regular replanting and new planting committee meeting and the establishment of expectorate committee will strengthen the monitoring of the replanting programme. Continuous extension services given to the replanting and new planting applicants will help in achieving the objectives of the replanting programme.  

• High yielding oil palm planting materials are already available. To ensure that the ISH getting the right planting materials, they have to obtain their planting materials only from the Code of Good Nursery Practice for Oil Palm Nurseries (CoPN) certified oil palm nurseries.  

• Action taken. Two (2) new TE officers with economics analytical background have been recruited.
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<th>Key Recommendations</th>
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<tr>
<td>4.6.7. The Sub-Committee recommended the TE officers to present valuable preliminary results relating to current issues faced by the industry. Such results provide important inputs for use by the government relating to their implementation of GST, export tax, labour, mechanisation strategies and etc. To continue also generating the industry by providing timely research results to improve industry’s competitiveness in the market.</td>
<td>TE unit will continue to present valuable preliminary results relating to current issues faced by the industry and to provide timely research results in order to improve industry’s competitiveness in the market.</td>
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</table>
### Matters Arising from 2015 Cross-Cutting Session (further opinions and recommendations)

#### Items 2 and 13

- To continue with efforts to link the MSPO certification scheme more towards a “fair-trade” set up often used for small-holders as this could then be viewed globally as being a holistic certification scheme that gave due consideration to the small holders who would not be able to afford to go through e.g. an RSPO certification.

- More efforts should be directed at getting more smallholders being certified.

*(Action by: Dr. Ainie Kuntom & DIRED)*

- The Government has allocated RM20 million under RMKe-11 and RM50 million under the Malaysian Sustainable Palm Oil (MSPO) Fund to assist and accelerate the smallholders’ sustainable certification. For year 2016, four Sustainable Palm Oil Clusters (SPOC) had been certified under MSPO involving 338 smallholders with a total area of 1,150.05 ha. On the other hand, 970.67 ha involving 221 smallholders had been certified with the Roundtable Sustainable Palm Oil (RSPO).

- MPOB and Solidaridad are working together to enhance the effectiveness of MSPO initiative.
  - To execute three (3) pilot projects on implementation of MSPO and create models for landscape/ regional approach of smallholders’ certification.
  - To design initiatives to promote awareness amongst buyers and civil society in Asia on MSPO.
  - To offer support to Malaysian palm oil companies in identifying and addressing sustainability risks associated to palm oil across their supply chain and provide risk mitigation techniques using different tools.
  - To develop impact studies and business cases for sustainable palm oil production.
  - To support each other’s sustainability communication on palm oil.

A consultant has been identified to assist MPOB in the implementation of MSPO requirements for smallholders in Sarawak. This will help to accelerate the MSPO implementation amongst the smallholders.

#### Item 4

MPOB was requested to expedite and complete the LCA study on peat emission with special emphasis on the state of decomposition of the peat *i.e.* sapric, hemic and fibric peat swamps in oil palm plantings.

*(Action by: DB)*

At this point, Dr Kho is collecting data on CO$_2$ emission from different stages of peat decomposition at Sebaju and Sebungan in Sarawak based on the soil chamber analysis. He is also in the process of analysing the data based on the three different stages of peat decomposition.
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<th>Key Recommendations</th>
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<td><strong>Item 7</strong>&lt;br&gt;Prof. Dr. Denis Murphy suggested that the international Steering Committee to be recommended may meet and monitor peat studies as frequently as every four months. This was supported by the PAC members.</td>
<td>Meeting with IAP members was held on 15 August 2016 at Kuching, Sarawak. The next meeting of IAP is tentatively scheduled in mid-January 2017. &lt;br&gt;&lt;br&gt;(Action by: DB)</td>
</tr>
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<td><strong>Item 9</strong>&lt;br&gt;The Sub-Committee recommended that MPOB make full use of scientific literature citing the beneficial nutritional properties of palm oil (e.g. Chowdhury of Cambridge’s paper entitled “Association of Dietary, Circulating, and Supplement Fatty Acids with Coronary Risk: A Systematic Review and Meta-analysis”) by translating the scientific information into simple language which consumers and end users of palm oil could understand and thereby appreciate. MPOB and MPOC should work hand in hand in this endeavour.</td>
<td>MPOB has printed the booklet <em>Palm Oil Health Facts</em> in July 2015 and had presented to the International Advisory Panel on Nutrition (IAPN) in October 2015. It was agreed that the booklet will be updated on a yearly basis and new findings will also be incorporated when it is due for revision. MPOB will also work with MPOC in disseminating these information in the social media. &lt;br&gt;&lt;br&gt;(Action by: DPDAS)</td>
</tr>
<tr>
<td><strong>Item 10</strong>&lt;br&gt;&lt;ul&gt;&lt;li&gt;The Chairman of the Sub-Committee recommended that MPOB should look into the matter of making dimehypo commercially available to the oil palm plantation industry.&lt;/li&gt;&lt;li&gt;Top priority must be given for MPOB, together with experts, to identify worthy alternatives for Class 1A and Class 1B insecticides as there is a possibility that monochrotophos could be banned.&lt;/li&gt;&lt;/ul&gt;</td>
<td>&lt;ul&gt;&lt;li&gt;The analyses required for dimehypo proprietary registration are costing approximately RM 23 million. Any exemption on the analyses is not possible. The data required for the registration especially on the toxicological part needs to be carried mostly by overseas GLP labs. This matter has been discussed with the Pesticides Control Division of Department of Agriculture Malaysia, MPOA and also several representatives from the industry.&lt;/li&gt;&lt;li&gt;A new formulation of Acephate, known as Acephate 97% SG (soluble granule) will be available soon. Acephate 97% SG is very soluble in water as compared to the existing Acephate 75% WP available in the market. Acephate 97% SG is a worthy alternative for Class 1A and Class 1B insecticides since it is categorized as a Class III insecticide. A field trial will be carried out soon to confirm its efficacy in controlling bagworms via trunk injection. A new chemical has been identified as a possible alternative for monochrotophos and metamidophos.&lt;/li&gt;&lt;/ul&gt;</td>
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<tr>
<td>Key Recommendations</td>
<td>Response/Action</td>
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| **Item 20**  
- MPOB is to make available the information on the Malaysian palm oil industry's cost of production trend within the segment of smallholders, private estates, listed companies *etc.* on a yearly basis. The sub-committee stated that this was an incredibly important factor as it would help to shed more light on the considerable rise on the cost of production which was important from an economic viability point of view.  
- **MPOB** is to make available the information on the general cost of production in a booklet to be circulated to the PAC members one week before the next PAC Meeting.  
- The Sub-Committee requested a presentation on cost of production at the next PAC Meeting.  
  * *(Action by: DEID)*  | - MPOB has collected information on Cost of Production only for estates sector (excluding Smallholders). However, the information is highly confidential and it is for restricted circulation only.  
- This Cost of Production information will be provided only to the Chairman of the Sub-Committee on Cross Cutting Issues on Sustainability since the information is deemed to be **highly confidential and for restricted circulation.**  
- MPOB is of the opinion that the information on the Cost of Production should not be presented openly since the information is **strictly confidential.** |

### Matters Arising from 2016 Cross-Cutting Session (Recommendations by the Sub-Committee)

1. The Sub-Committee suggested that engagement with NGOs has to be with the people who are actually feeding the information to the general public.  
  * *(Action by: SCC)*  

2. MPOB is to take an even greater and more active role in trying to enforce the importance of sustainability throughout the Malaysian palm oil industry, so that it is viewed as being more proactive in mitigating issues revolving around sustainability.  
  * *(Action by: SCC)*  

MoUs on collaboration to promote palm oil sustainability and MSPO have been signed with the Malaysian Nature Society (MNS), Solidaridad and Tropical Rainforest Conservation and Research Centre (TRTRC)  

More proactive action is being carried out by MPOB through Codes of Practice (COP) and MSPO Certification with particular emphasis on smallholdings. Apart from sustainability aspects, transfer of the latest technologies from MPOB R&D will also be given due attention.
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<th>Key Recommendations</th>
<th>Response/Action</th>
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<tr>
<td>3. MPOB is to give an update on the yield trends through a presentation by Mr Balu next year so that we can monitor the trend. <strong>(Action by: DEID)</strong></td>
<td>EID Division will collate and present in power point slides on FFB yield and OER performance from 1996 – 2016.</td>
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<tr>
<td>4. MPOB to appeal to the Government to lift the freeze on the intake of foreign labour particularly for the plantation sector because we are dealing with a perishable crop. <strong>(Action by: DEID)</strong></td>
<td>Effective February 2016, the Malaysian government had decided to suspend the recruitment of all foreign workers including those from Bangladesh (G to G). Due to severe labour shortage in several sectors, the government has lifted the freeze on hiring foreign workers for four sectors namely manufacturing, plantation, construction and furniture-making industries in May 2016. However, the recruitment of foreign workers from Bangladesh (G to G) is still suspended.</td>
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<tr>
<td>5. Step up efforts to find solutions to overcome problems associated with tall palm harvesting, loose fruit collection and evacuation of harvested stacks. <strong>(Action by: DB)</strong></td>
<td>Apart from on-going projects undertaken by the Farm Mechanisation Unit of MPOB, several innovations submitted for the International Competition on Oil Palm Mechanisation (ICOPM) can also be considered to be proposed for the coming PAC meeting. The issue on patent will be resolved with the respective inventors prior to submission of the proposal to PAC.</td>
</tr>
<tr>
<td>6. MPOB to try to engage with some foreign agriculturally reputable companies who have had a string and proven track record with mechanizing labour intensive agricultural tasks in order to hopefully arrive with a solution as to how to overcome what is probably the industry’s No 1 main problem, namely the harvesting of tall palms. <strong>(Action by: DB)</strong></td>
<td>MPOB has been working with a well-established international company with an objective to arrive at a proper solution for tall palm harvesting. In previous project, MPOB had worked with Kobelco Company from Japan in producing oil palm harvesting machine and later with a company from China, Sunward Intelligent Company. Both companies are well known manufacturers for earth moving equipment. For the last two years, MPOB has been working with a Korean company to produce harvesting machine. We are now at an advanced stage of producing machine for tall palm harvesting.</td>
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<tr>
<td>7. MPOB to continue on the study on carbon emissions and combine it with UPCS to hopefully come up with a range of emissions specific for sapric, fibric and hemic. <strong>(Action by: DB)</strong></td>
<td>Field work for Tinbarap Estate, Beluru will commence in Jan/ Feb 2017. Data analysis will include data from Pelitanah 2, Sibu.</td>
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<tr>
<td>8. A 10-year masterplan to be developed for the oil palm industry by a Task Force consisting of selected PAC members, <strong>Work is in progress</strong></td>
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Key Recommendations | Response/Action
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MPOB Officers and four to five members from the private sector. The selected members could spend a couple of days brainstorming to identify targets and common goals such as those for 3-MCPD, nutrition and yield.
*(Action by: DPDAS, DB & DEID)*

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<tr>
<th>9. With regards to the request by the Chairman of MPOB for advice and inputs on how to effectively tackle issues/sentiments against palm oil in Europe especially in France, it is recommended that a ‘war room’ could be set up to respond to issues within 24 hours. This is a recommendation made by the Technical Promotion and Market Development Sub-Committee. <em>(Action by: DPDAS)</em></th>
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</table>
A meeting between MPOB and Corporate Communication Group of Sime Darby was held on 21 October 2016 to learn from the experience of the private company on the mechanism to establish this ‘War Room’. During the discussion, Sime Darby shared with MPOB their experiences on how they handle crisis situations.

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<tr>
<th>10. With regards to the proposal to restructure the PAC programme, it is noted that this recommendation has been brought up at the Technical Promotion and Market Development Sub-Committee. <em>(Action by: DPDAS)</em></th>
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</table>
This matter is subject to the decision of MPOB’s Management.
MATTERS ARISING OUT OF MINUTES & REPORTS OF 36TH MEETING
## Key Recommendations

<table>
<thead>
<tr>
<th>Recommendation 1: Improve the structure and impact of MPOB research on <em>Ganoderma</em></th>
<th>Response</th>
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<td>Clearly some work within GanoDROP has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, we consider the structure and research strategy is imbalanced and that it is not creating sufficient progress where it is needed, in particular on <em>Ganoderma</em> stem rots, so we suggest considerable changes. Our recommendations are based on: lack of progress on <em>Ganoderma</em> in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from <em>Ganoderma</em>; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding <em>Ganoderma</em> epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR. These levels of basic understanding are a prerequisite in other crop plant diseases. <strong>More specific details on the exact recommendations are itemised below in Part 3, the report of the International Advisory Panel on <em>Ganoderma and Diseases</em> (IAPGD).</strong></td>
<td>As suggested by the IAPGD, restructure of the three groups under GanoDROP unit have been formed, they are: 1. <em>Ganoderma Biology and Pathology</em> (GBP) Group. 2. <em>Ganoderma Detection and Control</em> (GDC) Group. 3. <em>Emerging &amp; Exotic Diseases and Crop Biosecurity</em> (EEDCB) Group.</td>
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<tr>
<th>Recommendation 2: Increase support for MPOB research on tropical peat systems</th>
<th>Extension and additional funding for the next three years granted to continue the project in Sebungan/ Sabaju</th>
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<tr>
<td>This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. There is an urgent need for increased personnel and provision of the necessary equipment and infrastructure to carry out this vital project. The PAC welcomes the newly formed International Advisory Committee supporting this research and considers it essential that they provide regular input into the project over the coming years. We recommend that regular meetings of this advisor grouping should commence within the next few months.</td>
<td>Tower construction recently approved and will begin construction immediately Next IAP meeting/ data workshop in August</td>
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<tr>
<th>Recommendation 3: MPOB should facilitate, coordinate and publicise examples of environmental management and conservation on Oil Palm plantations</th>
<th>Sustainability unit to coordinate (together with TROPI) the programme which gathers</th>
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<td>Palm oil is frequently under attack for rainforest habitat destruction with consequent loss of iconic</td>
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wildlife, yet many in the industry are actively promoting and implementing habitat preservation, restoration and wildlife conservation in and around the oil palm estates. MPOB should take a positive leadership role in coordinating these efforts. It can develop "best practice" for conservation planning, riparian planting and wildlife monitoring. It can promote wildlife conservation among industry workers. It can coordinate presentation and publicity for positive efforts in the conservation arena.

MPOB should:
- take a positive leadership role in promotion of wildlife conservation in and around oil palm plantations.
- appoint an appropriate conservation specialist to PAC
- hold a stakeholder meeting to review oil palm impacts and the potential to enhance wildlife conservation
- establish a pilot programme in key areas for endangered wildlife in Sabah
- use positive results from wildlife conservation to improve the image of palm oil

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<tr>
<th>Recommendation 4: MPOB should improve the utilisation of existing expertise in PAC, MPOB, industry and other stakeholders in addressing public concerns about oil palm.</th>
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<tr>
<td>Media stories and other publications related to oil palm are appearing with increasing frequency. While some of these articles are accurate and balanced, many are not. Unfortunately, many inaccurate and misleading stories about oil palm have been widely disseminated and have contributed to negative public reactions to oil palm, especially in Europe. It is recommended that MPOB take advantage of the considerable expertise among the independent experts on PAC, plus other credible experts, in order to address topics where inaccurate reporting of science-related issues related to oil palm has occurred. To achieve this MPOB could also work with other stakeholders such as MPOA and MPOC. Possibilities include more extensive engagement with media and other outlets in disseminating ‘good news’ stories and also in the rapid response to inaccurate or misleading stories. In addition to scholarly articles, some PAC members could write more accessible (to non-specialists) articles in magazines or popular journals. One example of this is the article by Denis Murphy, Chair of the Biology Subcommittee, which was published in World Agriculture late in 2015. Copies of this article have been circulated to participants at the Plenary Session of PAC 2016.</td>
</tr>
<tr>
<td>To suggest PAC members to write an article in newspaper/magazine concerning the negative issues highlighted by the NGOs are usually taken out of context and incorrect. ABBC is working closely with the PAC and industry members while carrying out their research. There are a number of collaborative-research projects carried out by ABBC involves PAC members or industry members. One good example is the breakthrough in the discovery of mantled “gene” was carried out with collaboration of three oil palm industry tissue culture laboratories. Even though it’s not directly addressing public concern, but it helps salving one of the major oil palm industry’s problem.</td>
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all the industry which has implementing the conservation efforts in order to combine all the ideas to come out with SOP or best practice in enhancing the biodiversity in oil palm plantation.

BMP for oil palm on peat to incorporate conservation planning. Collaboration with Wetlands.
Recommendation 5:
Improve communication and results sharing both within and outside MPOB by proactively promoting such interactions and incentivising cross-disciplinary research.

While there are numerous examples of good collaboration on relevant research both inside and outside MPOB, there are also too many examples of a ‘silo’ mentality. This hampers progress and can mean that opportunities are missed and even that some work is duplicated. This issue has been raised in previous PAC reports but this year it was again raised in several Subcommittees and especially in the Crosscutting Subcommittee. We still see a lack of awareness of highly relevant international developments among many officers and more senior scientists at MPOB. Researchers should make better use of citation alerts and the availability of most published research as open access. In those cases where an article is not fully available online, a request for a pdf from the author(s) is normally successful.

Comments noted.
ABBC has collaboration with many local and international organizations on most of its research areas. Similarly many cross-divisional research activities are ongoing such as in the area of oil palm disease and nutrition. Work on implementation of SureSawit Kit on independent nurseries also involved few research and non-research divisions. However, ABBC still encourages its researchers to collaborate with other national or international organizations when there is a need and it’s essential to move forward the research.

Recommendation 6:
MPOB should work more effectively and urgently with all relevant stakeholders to address the increasingly urgent need for mechanisation of plantation operations

Recent developments in Malaysia, especially restrictions on foreign labour, have highlighted the importance of addressing the need for increased mechanisation of many plantation operations from input applications to harvesting. Several projects proposals on mechanisation were presented to the Subcommittee but it was felt that these tended to be ‘more of the same’ in terms of projects that have already been pursued for many years without achieving a true breakthrough in terms of widespread utility on plantations. The launch of a $1 million prize competition is a welcome development but this may not result in the right sort of projects. There are many experienced agricultural machinery suppliers who are already developing and manufacturing devices for automated or semi-automated crop management. Some of these use GIS technology linked to satellite or low-cost UAV (drone) systems while others include crop harvesting and processing as a single multi-step operation. Examples include the deployment in Europe of harvesters for the extraction and shelling of peas where many hectares can be harvested, processed and taken to supermarkets within a few hours with minimal use of labour; self-propelled tomato harvesters and citrus tree harvesters (see below).

We recommend that should engage in wider ‘out of the box’ discussions with potential equipment manufacturers and developers. In order to give

Suggestions from committee will be looked into to jointly develop the appropriate mechanised harvesting tools in collaboration with machine manufacturers as well as plantation companies.
confidence to such companies, MPOB should work with the plantation industry to develop models for the likely demand and cost limitations for purchasing such equipment. They should run scenarios of future decreases in the labour supply (and therefore cost) from a modest 10% up to as much as 90-95% in the next decade. MPOB should also seek government support for a mechanisation programme as part of their evident programme of reducing levels of foreign migrant labour in the country.

### RECOMMENDATIONS TO GANODERMA AND DISEASE RESEARCH OF OIL PALM (GanoDROP)

**Major recommendations:**
- It is recommended that future progress be reviewed after 2 and 5 years.
- Revising the GanoDROP Unit structure and remit

Clearly some work within GanoDROP has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, we consider the structure and research strategy is imbalanced and that it is not creating sufficient progress where it is needed, in particular on *Ganoderma* stem rots, so we suggest considerable changes.

Our recommendations are based on: lack of progress on *Ganoderma* in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from *Ganoderma*; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding *Ganoderma* epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR. These levels of basic understanding are a prerequisite in other crop plant diseases

**Unit structure:**

We suggest the following new groups:

**Ganoderma Biology and Pathogenicity Group**
*Aims: to acquire fundamental knowledge on Ganoderma in terms of:*

- Epidemiology (spread, survival); Biology; Pathology (infection; aggressiveness; virulence factors);
- Collection, characterization and maintenance of *Ganoderma* cultures representing geography and aggressiveness.; Role of basidiospores (infection; role in *Ganoderma* variation; role in dispersal);
- Genetics (species identification; phylogeny;

As suggested by the IAPGD, restructure of three groups under GanoDROP unit have been formed, they are:

1. Ganoderma Biology and Pathology (GBP) Group.

The progress of the project on *Ganoderma*, emerging, exotic diseases and biosecurity plan is proposed to be reviewed in 2019 (3 years).

The first group is *Ganoderma* Biology and Pathology (GBP) which covers biology, epidemiology, pathology, basidiospores, and genetics of *Ganoderma*. 
population structure and di-mon mating as another source of genetic variation).
Genome (eventually of pathogenic and non-pathogenic spp; transcriptome).

*ABBC related projects:
*Ganoderma proteome; metabolomics should include Ganoderma in vitro (see later comments); Genome; Ganoderma transformation

**Ganoderma Control Group**
Aims: disease control and mitigation; sustainable control through integration of knowledge.

Monitoring/disease census; Early detection; Modelling of disease progress; Chemical control; Biological control; Cultural control
Early resistance screening: development of methods optimized for industry: application and correlation to field results
Industrial liaison/coordination/collaboration/dissemination

*ABBC related projects:
Resistance mechanisms (gene and protein expression); RNA silencing

**Emerging and Exotic Diseases and Biosecurity**
Aims: Awareness and monitoring of major perceived threats. Preparation of diagnostic tools. Greater ongoing contact with DOA Quarantine Dept.

Merger of the two existing groups EEDG and CBBG would create a logical combination of activities.

In order to achieve this restructuring, we recommend removal of weed and herbicide research. This is not perceived by industry as an issue currently worthy of R&D, especially where staff time could be better allocated to BSR research. Two ROs currently allocated to this group have or soon will have, UK PhDs in plant pathology. They are clearly better placed in Group 1.

**Personnel implications:**

(1) **Ganoderma** research. An expert pathologist/mycologist, familiar with *Ganoderma* and related basidiomycetes and up to date with current plant-pathogen interactions is required (This person may need to be sourced internationally if such expertise does not exist in Malaysia). Ideally the researcher would function freely between GanoDROP and ABBC, as both require frequent and specific scientific and technical inputs. Panel members (RMC, JS, MD) might be able to assist by sourcing from European labs.

(2) Early screening/optimization. Dependent on scale this operation is likely to require several RAs.

The second group is *Ganoderma Detection and Control (GDC)* which is covered early detection and control and management of *Ganoderma* disease.

The third group is *Emerging & Exotic Diseases and Crop Biosecurity (EEDCB)* which is covered emerging and exotic diseases and also biosecurity.

Any progress research on weeds will be reported under the biosecurity plan.

New members of PAC 2017 proposed are:
Prof. Jan Stenlid, Sweden, Prof. Matthew Dickinson, U.K. and Dr. Julie Flood, CABI-EURO, U.K. Among them, Dr. Julie Flood was selected as a new PAC member for 2017.

The screening project required an extensive labour for rubber wood block preparation and also for artificial inoculation on at least
Integral to this operation along with ABBC/Breeding and BSR modelling a statistically orientated person is required.

Overall the balance of the three proposed groups could be respectively: 35, 45, 20 %

**Management and communication**

- The level of scientific rigour and awareness of up to date progress elsewhere both need to be enhanced. This can be achieved in several ways.
- Obtain and make readily available a full and up to date literature set on your key research topics, e.g. *Ganoderma* genetics, pathogenicity, taxonomy and of related basidiomycetes. We realize some journal papers cannot be readily accessed from MPOB, so request papers from MPOB library service, paper authors or colleagues or PAC members covering key topics.
- Attend relevant courses. For example a very detailed course on plant-pathogen interactions with clear implications for *Ganoderma* was given at MPOB by one of us (RMC) in February 2015.
- Hold journal clubs. Get staff and students to present results from one or two related papers.
- Have regular research meetings to critically discuss your findings.

These comments apply of course also to related work between GanoDROP and ABBC. The need to work as a team was repeatedly emphasized in order to make real progress.

**SPECIFIC RECOMMENDATIONS**

**Recommendation 1:**

**Early detection of BSR and of disease resistance**

This work is being attempted both by GanoDROP and by ABBC.

We question at this stage cost, speed and applicability to the field of induced defence-related genes, of proteomics and of metabolomics. Genes, proteins or metabolites would need to be shown to be truly linked to *Ganoderma* and not just to abiotic stress or to other pathogens.

Remote sensing of *Ganoderma* (aerial/spectral, or VOCs) may be valuable but only once correlated to 5000 seedlings per experiment. Therefore, it is estimated 10 RAs or daily workers are required for this project. ABBC acknowledged needing of such “statistically orientated person” in their research activities, however, it’s not easily available. Currently collaborating with university lecturer or outsourcing the research components may be more practical if available.

All papers published on *Ganoderma* and other diseases in oil palm are being compiled with regular updating. In 2016, the GanoDROP Unit has produced 35 publications (12 journal papers and 23 conference papers), 6 theses completed (3 PhD and 3 MSc), 2 MPOB viva, 1 TOT, 2 MoA and 1 patent.

Currently there is an interdivisional committee on *Ganoderma* research involving ABBC, Biology and IRED. This committee meets twice a year and is good platform to coordinate research activities between divisions.

We are aware of this and appreciate the comments and suggestions made by the reviewers during the review. ABBC encourages ROs to communicate with PAC /Reviewers whenever they need any guidance to move forward their research.

New project proposal entitled ‘Development of Integrated Airborne Hyperspectral and
disease incidence.

DNA-based diagnostics especially using LAMP, should be investigated as a means of early detection. It could also be applied to the route of infection (petioles/roots?), and the presence of inoculum in the soil/linked to pathogen survival.

**Recommendation 2: Fungicides**

It is hoped that these will eventually not be required as resistance/tolerance comes into use. Use should be carefully limited in view of environmental contamination and RSPO criteria. In the meantime understanding route of infection might change strategy, e.g. preventative rather than curative.

**Recommendation 3: Biocontrol**

Several products have been developed by GanoDROP with substantial levels of claimed disease control. It is crucial to obtain verification mid to long term by growers using these products. Industry commented that it is bombarded mid to long term by growers using these products. Industry commented that it has become very sceptical.

Establishing the route of *Ganoderma* infection could guide the site of delivery of antagonistic biocontrol agents such as *Trichoderma*, currently used at root level. Spore infection via frond bases for example could be controlled by BCA application during pruning of frond bases, analogous to treatment of tree stumps as described by one of us (JS) for Heterobasidion control.

**Recommendation 4: Resistance screening**

Here comparisons of inoculated seeds, 4 month and 12 month seedlings are compared. This is useful, but industry is asking for a standardised, repeatable method. Therefore criteria also to be included are: pathogen isolate(s)-high and medium aggressiveness (?); inoculum size; contact or not between inoculum and root; standard host lines as internal controls; growth medium/nutrition; shading. Level of repeatability and therefore replication based on sound disease assessments and statistical analysis is essential to evaluate.

This very important study will require good coordination between GanoDROP and ABBC/Breeding.

The method will serve as a tool for breeders, geneticists and pathologists comparing isolate aggressiveness and palm resistance responses.

<table>
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<tr>
<th>3D Tomography Remote Sensing Technology for Detection of <em>Ganoderma</em> Disease in Oil Palm was approved by PAC 2016. Remote sensing data will be correlated with BSR disease incidence.</th>
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<tr>
<td>Study on molecular RT-LAMP assay for detection of <em>Ganoderma</em> in oil palm was initiated in collaboration with Prof. Dr. Matthew Dickinson, University of Nottingham, UK. Identification of specific primers for RT-LAMP to detect <em>Ganoderma</em> is on-going.</td>
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<tr>
<td>Some products on biological control and fertilizer formulation are being developed as preventive treatment of <em>Ganoderma</em> disease to be applied in <em>coll</em> oil palm plantations.</td>
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<tr>
<td>More field trials on the use of biological control products will be conducted in collaboration with oil palm industry.</td>
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<td>Pathology related proposals will be proposed for PAC 2017 and preliminary literature search and experimentation addressing the research is currently on-going.</td>
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<tr>
<td>MPOB always consults GanoDROP Unit as well as used the techniques recommended by GanoDROP unit in carrying out the screening. The GanoDROP unit will continue to optimize the screening methods based on discussion with plant pathology experts from SOFINDO, Indonesia and CIRAD, France.</td>
</tr>
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</table>
**Recommendation 5: Biosecurity and comments on diagnostics**

Studies should continue with the main threats, including *Fusarium*, orange spotting, *Phytophthora*, but with effort being reduced according to actual damage or threat.

We suggest inclusion of a study of spear rots. What are the associated microorganisms? Compare with the situation of spear/bud rots in Colombia.

Update biosecurity list.

Be prepared for exotic pathogens with diagnostic kits as well as just disease images/keys. You should be able to go to a grower and identify the cause and determine whether it is a quarantine issue.

In order to be able as function as a responsible partner to the Board of Agriculture for biosecurity work, GanoDROP should consider building capacity for diagnostics of quarantine species. Suggestions for improved lab protocols to avoid contamination were detailed.

**Recommendation 6: Ganoderma reference isolate culture collection**

We offer suggestions for long term, reliable storage and the need to train at least two RAs for annual or biennial transfers. One panel member (JS) has experience with a closely related pathogen.

**Recommendation 7: Modelling**

We would like to see more constructive use of data collected in disease census/monitoring. There is a large potential in modelling of disease development based on the data collected empirically from small holders and companies. Questions on e.g. the feasibility of mounding, the influence of soil type, plantation age, original planting density, and any trends in disease incidence over time etc. can be addressed this way. It is likely that this requires a statistically oriented person to develop the model.

**Recommendation 8: Spores**

In view of the enormous genetic diversity of *Ganoderma* in plantations, there is a clear need to conduct spore inoculations under field conditions to determine infectivity and route of infection(s). This will require extensive replication, long term sampling because infection could be infrequent and slow and

The possibility of detecting CCCVd variant via LAMP-PCR is currently on-going. Different primers (4-6 primers) are designed using the new OptiGene machine.

*Phytophthora* research in Malaysia has been completed and submitted for viva on 8 November 2016.

The threat of Fusarium disease in Malaysia will be monitored based on reports and assessments carried out by the oil palm industry members. Kits for key pathogens such as *Fusarium oxysporum* f.sp. *elaeidis*, *Phytophthora palmivora* and orange spotting disease have been developed. Collaboration with other institutes such Department of Agriculture and University of Nottingham, UK are also being pursued as these institutes have the diagnostic tools to detect several exotic pathogens.

Currently no new RAs are recruited since new employment in MPOB has been seized temporarily. The maintaining of culture is carried out by rotation between the officers.

New RO for modelling is on-hold due to employment freeze in MPOB. However Cik Maizatul will be going through training on modelling. Possibility of training with Dr John Crawford in Rothamsted Research in the UK.

A new research proposal is proposed for PAC 2017 addressing the epidemiology research on *Ganoderma* and will include research on spore. The title proposed is “Study on the epidemiology and ethology of *Ganoderma*.”
sensitive but robust detection methods. One of us (MD) suggested use of LAMP.

**Recommendation 9:**
**ABBC research on Ganoderma and the need for collaboration**

Research on Ganoderma was described based on sophisticated analyses at the levels of genes, proteins and metabolites. This well-equipped and technically able team can offer huge potential if the approaches are targeted and based on the long-term knowledge of how plant pathogens function.

However, some of the work has limited validity because of a lack of understanding/guidance with regard to pathogen virulence. For example, growth on rich media is highly unlikely to reveal genes, proteins or metabolites involved in disease. Also, with necrotrophic fungi, extracellular secreted proteins are much more likely to be valid than intracellular ones. *Ganoderma* metabolites should be investigated.

Years have been lost awaiting the completed genome because of insufficient knowledge/communication at that time.

All of this makes clear to us that so much potential progress is being severely limited and delayed because of the need for collaboration and need for in-depth advice by an expert in-house on pathogen–pathogen interactions. It is hoped that our recommendation is taken up.

In addition, it must also be stressed that insufficient analysis of relevant literature remains an issue to all *Ganoderma* research here.

We appreciate that the structure of MPOB divisions and funding by specific programmes can discourage cross-cutting and teamwork as is suggested above, but we implore management to seek ways around this, or yours will not be the establishment that makes the long overdue breakthrough with *Ganoderma* pathogenicity and resistance.

As suggested, molecular RT-LAMP will be used in understanding the mode of Ganoderma spread in oil palm plantations.

We have set up “The Inter Divisional Research Committee on Ganoderma” between ABBC, Biology and IRED Divisions. To date, a total of 5 meetings have been held with the last one before PAC 2016. The meeting has described the progress of Ganoderma researches including on-going and future projects. Issues on the screening methods, planting materials, targeted products and overall research strategies are amongst the main agenda discussed.
**RECOMMENDATIONS TO TROPICAL PEAT RESEARCH UNIT (TROPI)**

**Recommendations**

The PAC was concerned about the apparent level of resourcing for the peat work in Sarawak. Inadequate levels of resource were impacting on provision of adequate lab facilities, availability of personnel to do the work and ensure timely publication, overreliance on goodwill of collaborating partners and a generally unsatisfactory intellectual environment. The consequences pose a serious risk to satisfactory progress of the work.

**SUMMARY OF MAIN COMMENTS AND RECOMMENDATIONS FROM THE IAP**

The IAP were extremely impressed by all aspects of the study, in particular:

- The support of SOPB local managers and staff; their willingness to support the studies and their understanding of best plantation management was very clear. Both plantations were seen to have managers who were committed to the study and their plantations were well maintained, with support for the field plot activities. It is also commendable that one of the SOPB staff, Mr Sii (agronomist), has recently started a PhD at the University of Aberdeen on aspects of the nitrogen cycle in peatland plantations which will provide important knowledge on fertiliser management, with the aim of minimising fertiliser applications and thereby mitigating greenhouse gas emissions. This type of cross collaboration between a private company, MPOB and academia is strongly supported as it is likely to provide an effective pathway for dissemination of research results within the broader objective of delivering more responsible peatland management.

- During the field visit, IAP members were able to observe that the set up for the TROPI plots is extremely well conceived and the field research is generating meaningful, novel data within a relatively short time period. These data address the controls on peat carbon losses and greenhouse gas emissions from plantations on peat soils, thus providing, for the first time, reliable information on the environmental impact of land use change on peatland in Sarawak.

- Dr Kho is to be congratulated on his management of the research facilities to date. He has an excellent experimental set up, ably supported by a strong team of researchers and assistants. Once the EC towers are installed.

| Additional resources/ funds recently approved to continue the project in Sebungan. |
| Assistant Research Officers and General Worker recruited. |
| Overreliance on goodwill of collaborating partners may not apply here as collaboration as agreements are in place with specific deliverables and milestones. |
| Noted. Collaboration will continue. |
| PhD student supervised by MPOB officer. |
| Noted. Data being analysed extensively for publication. |
| EC tower completed and inspection was conducted on 24 January 2017. |
and fully operational, they will provide an unparalleled opportunity to integrate the plot-based flux measurements with landscape-scale tower measurements. This scalar approach to flux measurement is state of the art and is to be highly commended.

- Dr Kho is providing considerable logistical and technical support to the PhD students. Some students are using quite complex measurement and analysis methods in association with their research (e.g. eddy covariance) and they would benefit greatly from additional support from those with strong expertise in this measurement technique since they are now at a stage where they are starting to analyse their data and consider the wider implications of their data for the scale of greenhouse gas emissions from peatland plantations. Given that these data are likely to set a benchmark for future studies while also having wider implications for policy decisions, it is essential that the data are subject to an appropriate level of scrutiny prior to PhD completion and the production of journal papers. External, expert advice and support for these students is strongly recommended.

- The IAP recommend that TROPI researchers take measures to ensure that adequate environmental information is collected to describe present and previous site conditions (e.g. previous site use, time since drainage, previous use of forested sites, history of fire etc.).

- Researchers should ensure that measurements of peat properties use an appropriate range of complementary novel and established methodologies:
  - e.g. use of instruments for measurement of soil moisture content should be validated using a direct measurement method, i.e. gravimetric method for soil moisture content, to ensure consistency of results and comparability with other studies.
  - e.g. subsidence studies should ensure that the measurement interval is appropriate and that complementary measurement of peat bulk density and carbon content are in line with established methodologies (see also below).

- IAP believes that monitoring of subsidence using subsidence poles along with annual monitoring of carbon stock is a simple and effective approach to addressing a better estimate of oxidation/subsidence ratio. The TROPI Bintulu site provides a range of plantation levels from forest, newly cleared area, and plantation areas that promises good research results on this subject. It is advisable that the initial condition characterization of peat carbon stock (peat bulk density and C content) and peat maturity from the surface to the

External expert advice and support has always been priority and are in place. IAP members are also providing support.

Data and information collected and available.

This has been validated and continuously updated.

Subsidence is monitored monthly across all research plots in Sebungan/ Sabaju.

Bulk density and carbon content study completed across all research plots in Sabaju/ Sebungan.
The mineral soil layer at the bottom be conducted. This is to be followed by subsequent monthly subsidence monitoring along with annual monitoring of carbon stock from 0-150 cm depth; where the 150 cm is the initial depth at the time of subsidence pole installation. The sampling for BD measurement of 0-10 and 10-20 cm may be conducted using either soil cores or galvanized iron, open-ended boxes and for the surface to 150 cm depths may be done using a peat auger at 50 cm increments.

- IAP strongly encourages all researchers to start moving towards the preparation of papers for submission to international journals in order to ensure that their data are made available to the wider scientific community. We have every confidence that the TROPI study outputs will be accepted for publication and will receive wide recognition.
- IAP members are willing to offer their support in providing advice and inputs on manuscripts at the drafting stage in order to support the TROPI team in delivering their results to the wider scientific community.

Papers are being drafted and at advance stages for submission.

Noted.
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<th>New PAC Ideas</th>
<th>Response</th>
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<td>1 The Chairman raised the issues of genome editing technologies and recommended that ABBC should investigate their potential application for OP research. Such applications might include applied research such as the transgenic programme, but also for proof of concept work in other areas of MPOB research.</td>
<td>The Group is currently working on the proposal for collaboration or attachment of an officer at Wageningen University/Iowa State University.</td>
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<th>PAC Comments / Recommendations</th>
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<tr>
<td>1 During PAC a Breeding Roadmap for Oil Palm was provided that identified a number of trait priorities and a time line for their delivery into elite commercial material. This approach is to be welcomed but it will be important that both the predicted trait achievements, and time frames for their implementation, are realistic. Many of these goals will be realised by collaborating with industry and it would be useful to develop the roadmap further after discussions with a range of plantation companies who have active research programmes.</td>
<td>A draft of the Breeding Roadmap was presented during the discussion session with PAC members (TDG, XA and DM). The roadmap needs further fine tuning and this was further discussed during TDG visit in July. We also hope to strengthen the roadmap through discussions with industry and the Breeders and Tissue Culturists’ Meeting is a good platform for this purpose.</td>
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<td>2 ABBC is now actively engaged in research on many fronts both in terms of the technologies that are being applied and the nature of the problems that are being addressed. Key to co-ordinating research activities and generating synergism between groups is the establishment of regular communication both at a PI and research officer level and this should be fostered by encouraging attendance at research seminars and the establishments of journal clubs that span the application of technologies and the focus of disciplines.</td>
<td>Several groups in ABBC are already conducting their own internal journal clubs in addition to the ongoing ABBC seminar series. Group meetings are also now tailored towards technical discussions rather than operational as the latter is taken up in general lab meetings.</td>
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<td>3 For many years PAC has promoted engagement between scientists at MPOB with members of research groups working at other institutions both nationally and internationally. There is clear evidence that this is taking place effectively within some groups within ABBC but engagement is uneven and one approach that might promote this is the encouragement of some research officers to undertake PhD programmes both at local Universities and at institutions abroad. The cost of sponsoring an MPOB staff member to study for a PhD abroad is often considerable higher than at a University in Malaysia and their maybe domestic challenges for the individual concerned, however, the benefits that can be gained are often substantial. Data provided during the presentation by Datuk Dr Choo Yuen May, D-G MPOB, indicates that</td>
<td>With regards to the cost of a PhD programme abroad as opposed to local, MPOB has been in negotiations with locally based international universities for reduced fees to encourage MPOB staff to sign up for postgraduate studies at these universities.</td>
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less than 25% of permanent staff have a PhD and it would be useful to know what target MPOB has in terms of the proportion of scientific staff who they would wish to have such a qualification by 2025 and the progress that is being made to achieve this goal.

The summary produced this year of progress across the Division was once again extremely useful and provided a way of rapidly identifying research highlights. However, Gantt charts relating to the progress of individual projects were not included and without these it is not possible to identify what progress has been made against agreed objectives. Projects routinely have a value for percentage completed but this value has little credibility unless deliverables can be mapped against original timescales. It would also be useful to identify the publications that have originated from individuals projects and other outputs such as seminar/poster presentations that have been delivered over the 12 month reporting period.

For future reporting, Gantt charts relating to progress of individual projects will be provided to aid in monitoring progress made against promised objectives. In addition, reporting will also include publications and other outputs originating from these projects within the reporting duration.

### A. FUNCTIONAL BIOTECHNOLOGY UNIT

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<th>PAC Comments / Recommendations</th>
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<td><strong>1  Gene Function Group</strong></td>
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<td><strong>Gene expression profiles of <em>Ganoderma</em> infected palms BD388-2002(A) and (B)</strong></td>
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| Reported progress on these projects over the last 12 months seems to be slow and it is not clear how transcript profiles will be generated after application of the direct root-inoculum attachment technique. Previously SSH was used but techniques such as RNA-seq would now be more appropriate and would provide information on both coding and non-coding RNAs. Identification of some genes that show a differential expression pattern is described in the text but no data are presented to substantiate this claim.  

*Comments from the Ganoderma review panel:*  
If this study is to investigate palm responses to *Ganoderma* then palm lines with clear differences in susceptibility and resistances are required. Note that several papers/reviews from Malaysia have already emerged on this topic. If these genes are to be used for early detection of *Ganoderma*, we question the likelihood of success and applicability. Defence-related genes are a |
| As reported in the PAC Research Progress Report 2016, SSH was used for the previous batch (sitting technique) to identify the DEGs. As for the later batch (direct root-inoculum attachment technique), the text described only the physical observations during sampling as results on further analyses for genes profiling are not yet ready. Suggestion to use RNA-seq technique has been taken into consideration as well.  

Identification of the PR genes that show differential expression patterns was described in text as analysis was still on-going at that moment. However the data was presented in during the presentation session. |
general response to many pathogens and sometimes to abiotic stresses. Even if one was found specific to Ganoderma, how applicable would it be under field conditions with respect to cost and time? Studies on abiotic stresses are also being conducted to avoid confusion of the DEGs obtained. All suggestions and ideas have been taken into consideration.

**2 Regulation of oil palm fruit ripening**

This study has used the oil palm genome sequence to identify putative orthologues of lipases and ethylene receptor genes based on conserved amino acid domains from a range of plant species. The expression of specific family members has then been determined in a range of oil palm tissues and in fruit mesocarp at different stages of ripening. The profile of expression of individual ethylene receptors during ripening and abscission is interesting and could provide the foundation for a valuable programme to explore how the manipulation of responses to ethylene might provide a strategy to optimise oil palm yield.

Gene expression profile of the lipase class 3 genes associated with oil bodies is on-going. In addition, the expression pattern of the splice variants from the ethylene receptor genes are also being tested in various oil palm tissues especially in the mesocarp. This information will help further in understand the process of oil palm fruit development and ripening.

**3 Strategies to regulate the height of the oil palm tree BD393-2010**

The project has already provided convincing evidence, using the gibberellin (GA) biosynthesis inhibitor paclobutrazol, that by manipulating GA levels in oil palm it is possible to generate plants with reduced height. Studies over the last 12 months on naturally occurring dwarf material have revealed that some of the plants exhibiting attenuated growth have reduced levels of active GAs and that this is correlated with a reduction in expression of GA20oxidase1. These data provide an excellent foundation for further studies to characterise the genotypic basis for the dwarf phenotypes and by monitoring the performance of this material in the field it should be possible to identify novel breeding material that can be exploited by the industry over the coming years.

Characterisation of the oil palm dwarf materials are being carried out. In this study, morphological characterisations of the vegetative and reproduction organs are being determined. Gene expression profile of GA related genes are also being performed on each individual palms.

**Transgenic Technology Group**

**1 Optimization of parameters affecting stable integration of oil palm using biolistic method BD343-1999 C & D**

Progress on the development of an efficient transformation strategy to deliver stable integration of DNA constructs into oil palm tissues using biolistic continues to be slow. The work is arduous and requires a precise approach to the making of small changes to protocols to deliver success. The development of an effective transformation system must be a priority for MPOB over the next few years as it is the key to approaches such as gene editing that may provide a ‘non GM’ strategy to

The Group takes note of the comments. The focus of the Group has been on the improvement of transformation efficiency. In the effort to improve oil palm transformation efficiency, small changes in protocol such as using calli at different stages as starting material and use of different media composition for selection have been carried out.
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<td>attenuate crop yield or modify valuable commodities such as oils or fine chemicals.</td>
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<td></td>
<td>Putative transformants were able to regenerate using this protocol and some of the samples were shown positive for bar gene by PCR. The Group is also in the process of forming collaboration with Wageningen University/Iowa State University on the genome editing.</td>
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| 2 | **Transformation of oil palm via Agrobacterium tumefaciens carrying useful genes BD341-1999 B & C**

Although some success seems to have been achieved in transforming embryogenic calli with *Agrobacterium* as identified by the expression of the reporter gene GFP in some cells of the embryogenic tissues it has not proved possible to regenerate transgenic plantlets using hygromycin as the selectable marker. Hopefully the group will be encouraged by the initial observation and will fine tune the system over the coming year to achieve success.

The Group takes note of the comments. The work to establish the efficient protocol will be continued.

| 3 | **Development of oil palm resistant to Ganoderma boninense via RNA silencing BS384-2009 B & C**

These related projects are very ambitious and use putative pathogenicity genes from Ganoderma and are the reliant on an effective transformation system for oil palm and for Ganoderma.

**Comments from the Ganoderma Review panel:**

In practice we know almost nothing about Ganoderma pathogenicity. Therefore the choice of these genes is a shot in the dark. This stresses the urgency for the completed genome of *Ganoderma boninense* monokaryon, the transcriptome and associated projects on its proteome and metabolome. Do not study expression of pathogenicity genes in a rich growth medium (PDB) as they are very unlikely to be expressed.

The comment is noted. The Group will use the more potential target genes once they are made available.

| 4 | **Identification, isolation and functional characterization of mesocarp/root specific promoters BD359-2002 (B) & (C)**

Encouraging progress is being made in the quest to identify tissue specific and constitutive promoters in oil palm. The use of RNA-seq transcript analysis is helping to source genes with specific patterns of expression and these data might be supplemented using analyses in other species to help focus on gene functions that might exhibit appropriate attributes such as transporter proteins in roots. Whilst tissue specific promoters may be ideal to drive expression of transgenes in a precise way it may be more appropriate in some instances to use

The Group takes note of the comment. Effort will be made to identify genes/promoters that have greater strength in targeted tissues but less discrete site of expression. The Group also works with Bioinformatics Unit to identify the candidates’ genes.
promoters that have greater strength in tissues of interest but have a less discrete site of expression.

### B. BREEDING AND TISSUE CULTURE UNIT

#### General comments

In addition to presentations to the Biology sub-committee, 3 members of the PAC were able to hold a specific meeting with staff from the Breeding & Tissue culture unit. The main aim of this meeting was to follow up last year report and to discuss a road map for the unit.

The road map which has been provided to PAC members aims to report the work done up to now on the 10th priority which was discussed with the industry in 2002.

The PAC recommended last year that this work should be prioritized. This has been discussed with the PAC and will need further discussions with industry during the breeding and tissue culture committee.

In addition connections with other research units, in particular Ganodrop, were specifically discussed.

As mentioned in the earlier section, the draft roadmap needs further fine tuning and the details will be discussed with members of industry using the Breeders and Tissue Culturists’ Meeting as the platform.

<table>
<thead>
<tr>
<th>I) Breeding and Quantitative Genetics</th>
<th>I) Molecular Breeding Group</th>
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<tbody>
<tr>
<td>PAC makes the following recommendations:</td>
<td>The road maps will be discussed and drafted.</td>
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</table>

**Road Map(s)**

There is a huge need for a long term plan of action for the breeding section. This can take the form of a road map that can be divided into four different fields:

- Collection
- Evaluation and pre-breeding
- Breeding for advance material
- Early screening for Ganoderma resistance.

The PAC strongly suggests that it is made clear how the resources will be allocated to the different fields.

**Priorities**

As a main or general guide line priorities have to be re-evaluated. From last year 10 priorities the team has reported 5 general traits. The PAC recommends to be even more stringent and to put emphasis on Ganoderma resistance as the first trait of interest followed by oil yield and architecture traits (height and compactness).

The Group takes note of this and will put Ganoderma resistance as Priority One followed by oil yield and architecture traits.
### Collection

A report on the germplasm collection status was made to the PAC 2015. This report might exist but has not been presented. Work is in progress to secure the collection in different ways: field, cryopreservation, DNA bank. The road map should help to clarify what has still to be done in line with the available facilities.

### Evaluation and pre-breeding

Most of the collections have been already evaluated for the classical traits (FFB, OER, growth rate, bulkiness, oil characteristics, etc.). The road map should help to identify the work which is completed and the populations that are available for the industry. The remaining work to do has to be clearly highlighted including the precision level that one wants to achieve in terms of population, family, and palms.

The main challenge is to systematically evaluate this material for its (partial) resistance to Ganoderma. Four important trials (under project BD2-PT2) were planted on “hot spot” for Ganoderma. Unfortunately the genetic design is a “bi-parental” one that has lacked the appropriate genetic design. Neither the less, PAC recommend to the unit to have a detailed look at the protocol in order to identify a possible subset of this trial which may follow a genetic design such as a small factorial design. If some work has to be conducted in connection with the molecular group on those trials, it is urgent to decide with them the list of leaf/DNA samples that have to be collected before the palm infected by Ganoderma dies. Given the limited resources, the PAC strongly recommends concentrating the efforts on projects that will be done properly and not to dilute them.

To fulfill the field evaluation, the PAC still recommends launching collaborations with the industry on the bases of bilateral agreements.

Some interesting characteristics are present within the collections. The strategy which has been followed until now, i.e. to separate the different trait of interest in different populations has to be re-evaluated. The long term aim of breeders is to gather all traits into one ideal palm and the road map should specify the pre-breeding work that can be launched to combine the different traits into the most interesting material that can then be passed to the breeding program for advance material.

The road map for evaluation and pre-breeding will draft the long term strategy that could be presented to the next PAC meeting.

---

### A road map on germplasm has already been prepared and will be presented.

### The precision level to be achieved will be addressed from the road map that has been prepared.

### Crosses based on the NCM1 genetic design has been prepared for study on partial resistance to Ganoderma. Germinated seeds have been sent to Lahad Datu. The Group takes note of suggestion on work with the molecular group.

### The Group has collaborated on bilateral basis with the industry for traits such as long stalk, high carotene and height.

### The Group will consider re-evaluating the strategy to gather all traits into one ideal palm as suggested. This will be presented in the next PAC meeting.
<table>
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<tr>
<th>Breeding</th>
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<tr>
<td>This part of the work has not been discussed in details. Last year recommendations to define the long term strategy will be part of the road map. Last year, given the limited land resources, PAC recommended trying to find collaborations with the industry this has to be part of the road map. It is an acknowledgeable success for MPOB to have launched a new variety based on Nigeria PS1 blood. (As part of the Project DB2-PT1 “High oil yield”). The committee strongly recommends adding some work on tenera palms. The strategy which aims at testing only pisifera palms is not sufficient.</td>
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<tr>
<td>The road maps should clearly identify the breeding choices (in line with priorities) that may lead to strong changes in breeders practices: breeding for resistance to Ganoderma, reevaluate the role of Avros material within the breeding program, work on interspecific hybrids and Back crosses. The road map should keep as a final objective the future oil palm “ideotype”. The road map may include Ganoderma assessment of existing planting material from the industry.</td>
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<th>Early screening for Ganoderma resistance</th>
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<td>This work could be integrated into the previous points as a “transversal” tool. The PAC think that this has to be identified, at least for the following 3 to 5 years as a specific objective with its own road map, as it is new and of tremendous importance for the unit (and for the industry).</td>
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<tr>
<td>The road map should differentiate different aims:</td>
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<tr>
<td>1. The launching of a standardized early screening test. This activity has to be conducted hand in hand with the Ganodrop unit which will have the responsibility to define the procedure. Nevertheless the breeding unit has to be part of the work, taking in charge the definition of a range of standard crosses that will be made available in the long term. A study of the statistical performances of the test, i.e. precision &amp; reputability, is needed; the group has to follow very closely that work. Studies on interactions between isolate and planting material will need to be planned and breeders should be part of this strategy.</td>
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<td>2. As part of the early screening test, knowledge of the breeding parameters has to be evaluated. This will help to define a strategy for the routine testing of the</td>
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| A crossing programme for Ganoderma screening had been initiated in Dec. 2014. The crosses involved pisiferas (AVROS, Nigeria, Yangambi, La Me, Ekona and Calabar) and duras (Johor Labis, Banting, Ulu Remis and Serdang) from advanced breeding populations. |
| The Group takes note on importance of studies on interactions between isolate and planting material for incorporation into the strategy. |
| The Group will also put focus on tenera palms in addition to the current strategy of testing only pisifera palms. |
| The Group takes note of the suggestions in moving towards getting the future oil palm “ideotype”. |
planting material, such as the use and definition of testers.

3. Routine tests. Depending on the resources allocated to the breeding group, a program has to be launched and priorities will have to be defined.

4. The breeding unit will have to produce material for the other research groups, such as Ganodrop but also for the ABBC molecular group. We encourage the unit to anticipate the needs that might be useful and to discuss the aims of each team, in order to propose and provide appropriate material, and to produce the seeds on time (it may take up to 2 years).

The Group has been providing materials to Ganodrop (for nursery inoculation studies) and also to other groups within ABBC for PAC projects, PhD research projects etc. The Group acknowledges the importance of discussion and the aims of each team in order to provide appropriate materials.

| 1) Clonal Propagation Group  
2) Biomarker Discovery Group | Tissue culture process |
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<tr>
<td>The development of tissue culture processes to clonally multiply oil palm is split into two projects:</td>
<td>The development of tissue culture processes to clonally multiply oil palm is split into two projects:</td>
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<tr>
<td>- BD5-1.4(92) Production of oil palm clones for various studies</td>
<td>- BD 353-1999 Establishment and improvement of oil palm liquid culture for clonal propagation</td>
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<tr>
<td>- BD 353-1999 Establishment and improvement of oil palm liquid culture for clonal propagation</td>
<td>It seems that MPOB has reached a good expertise in tissue culture. The Moto vessel for liquid suspension is an interesting improvement of the technique. The PAC recommends that the group closely collaborate with the ABBC molecular group in order to determine the most appropriate material to work with in order to make use of the MANTLED gene. During the PAC week, several PAC members were able to visit Orion Biosains Sdn Bhd, which has the exclusive licence for commercialisation of the marker technology originating from the Shell, Virescens, and Mantled genes. This company has created some high skilled jobs in a very high-tech sector in Malaysia and is a good example of a spinoff from MPOB R&amp;D that has led directly to significant wealth creation in Malaysia. We are aware that further expansion of the genotyping work that has originated from MPOB discoveries may in the future be hampered by ongoing issues regarding the import of samples from other countries. While we fully support the appropriate enforcement of phyto-sanitary regulations in Malaysia, it would be a pity if too strict an interpretation of these rules led to the loss of this kind of high-tech business to the Malaysian economy.</td>
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As part of an ongoing MANTLED assay development exercise, various stages of tissue culture derived ramets are being sampled and tagged using barcodes generated by Orion Biosains Sdn Bhd. This will help determine the best earliest stage for MANTLED assay application in future.

With regards to transporting leaf punches from Sabah and Sarawak, MPOB is currently in discussions with the phytosanitary section of DOA. The most efficient and cost effective way to transport these materials will greatly enhance the value of the test.
### Use of Tissue Culture tools for breeding purposes

At the moment the breeding group uses it for three different projects:
- To develop commercial planting material: outstanding clones.
- To multiply parents in order to produce mono or bi-clonal seeds.
- To secure outstanding palms which were found in MPOB collections.

Last year the PAC recommended clones were prepared that will, in the future, be used as testers (breeding, Ganoderma assessment, etc.) or standard crosses (breeding, Ganoderma, etc.). The use of clonal material and the needs for that material by the breeder should be clearly included in the road maps (as clones in the field (testers), mono or bi clonal seeds, etc.).

The tissue culture group takes note of the recommendations by PAC and will consult the breeding group on future testers to be cloned. The tissue culture related components will be included in the Breeding Roadmap.

### Search for molecular markers of mantled abnormally

The PAC acknowledges the very important work done to understand the role of the MANTLED gene. The main challenge will be to develop a method to assess the quality of the culture.

The team is working closely with Orion Biosains Sdn Bhd in developing a reliable assay to assess the quality of the cultures. The assay so far has been effective in distinguishing Normal and Mantled clones (known phenotype). The test in now being extended to younger materials whereby their state is not yet known. Currently a probe based assay seemed to be the most cost effective and efficient in providing a prediction of clonal conformity on all clones. In addition, clones of different genotype background are being sourced from various industries namely UP, AAR and FELDA for this purpose.

### C. GENOMICS AND BIOINFORMATICS UNIT

1. The release of the oil palm sequence and the supporting web site is a valuable step forward. However I think that some progress could be made in terms of improving the interface and usability. In all likelihood the main entry point for users will be via blast followed by retrieval of the sequences underlying one or more of the best hits either protein or nucleotide. This could be made easier with some tuning and development of the web interface. I have only directly experienced the external site which is limited in its capability but it would be good to be re-assured that MPOB users and collaborators have access to something like a simple page bring together all the information that a gene model database called PalmXplore has been incorporated into the Genomsawit portal. Users can now use the search engines in the PalmXplore system as well as in the MYPalmViewer genome browser. The results from the PalmXplore system and Blast analysis is directly linked to the MYPalmViewer system. We have also developed a standardize nomenclature for the naming of locus and gene models, which is available in the PalmXplore system.
is available for an individual gene sequence. A good model for this is the NSF rice site at MSU run by Robin Buell which summarises gene models, expression data, orthologies etc. and provides links to the GBrowse view of the rice genome. It would be particularly valuable to have some idea of the relative chromosome position either where on the genetic map it belongs (where known) or on the pseudochromosome when available. Do the Genomics and Bioinformatics units have a naming strategy for the genes in the pseudochromosome release? I would strongly endorse the Arabidopsis/Rice model which has proved robust and adaptable.

2 The Genomics and Bioinformatics groups are currently experiencing the standard problem that many genome projects face, namely the tension between the sequencing and annotation to a high degree and the need to have the sequence and supporting information made fully available at least internally. This may be helped by having a more formal release schedule based on a fixed data freeze in conjunction a release specific naming strategy and with cross linking between releases. The new genome builds and improved annotations are released over time and shared internally within MPOB. For internal use, there is a Bioinfo portal where all the in-house bioinformatics systems are available for use. We work closely with the other Units that use the information to coordinate the version of data to use. We take PAC’s recommendation and will look at coming up with a more formal schedule on release of new builds, improved annotations and other relevant information. However, availability of funds will strongly dictate improving the sequence and annotations further.

3 I welcome the commitment to placing the data within the context of Plant Ensemble it will increase interest in the sequence and attract experts in particular gene families and pathways to incorporate the data in their analyses. I would encourage MPOB to, if possible, work with the team involved in the data palm sequence. The annotation for this has been done by Klaus Meyer’s group at MIPS who have been extensively involved in plant genome sequence annotation. Linking with them will help ensure that a breadth of experience is brought to bear on the MPOB oil palm sequence. A discussion with Dan Dolser from EBI took place last year and we have plans to attach a researcher at EBI for 3 months. We will look into linking with Klaus Meyer’s group once we have sorted out the attachment with EBI.

4 There are a number of targets of comparative sequence and genome analysis that might be identified as being of value to oil palm production. Work has clearly started on a number of these including gibberellin production and response, RGA resistance genes and those involved lipid biosynthesis. However it might be sensible to develop this work in the context of a longer term strategy. It is clear from that there is much to be gained from work in other monocots, especially the cereals.

- Potential targets might include the following:
  - Inflorescence infrastructure

Comparative genomics studies with other monocots and related crops is being undertaken but at a very specific stage at this level. Comparisons are being made to identify specific genes related to height, fatty acid biosynthesis, and disease resistance among others. This was carried out via ortholog and domain analysis. Focus has also been to look at the diversity within oil palm germplasm collection. Extending the work as recommended
|   | Nutrient uptake, including N and P transporters.  
|   | Cell wall related genes including the cellulose synthase superfamily and genes in the lignin biosynthesis pathway.  
|   | Work on these is well advanced in many cereal species supported by functional genomics and extending this to the oil palm and date genomes (and perhaps Musa and even Yam) through comparative genomics has the potential to provide valuable landmarks on the oil palm genome and generate good quality publications. This approach could be considerably enhanced by the design and utilisation of an exome capture array to enable a significant number of the genes to be sequenced across a wide range of oil palm germplasm this would serve as a valuable informatics resource to be mined for allelic variation as important genes for oil palm are identified either directly in oil palm or in other monocot species. At the very least it should be linked to comparative sequence from the skim sequencing project. A comparative study between palm and other key monocot groups together (inflorescence infrastructure, Nutrient uptake etc.) is being considered and will be explored with more intensity once the initial goals of the oil palm genome programme are achieved.  
|   | Carrying out extensive comparative genomics via exome capture arrays will also be dictated by Funds requested in Phase 5 of the oil palm genome programme.  
|   | We are currently using transcriptome data from date palm and coconut to help in the annotation of the oil palm genome. The work in EBI, which will focus on comparative genomics will hopefully help connect the vast information available from other crops to oil palm.  

5 The work on the karma character in relationship to oil palm flower mantling represents a significant breakthrough in oil palm clonal production. There are clearly a number of interesting ways in which this work might be further developed. For example if the expression of the deleterious character is due to the hypo-methylation of a line transposon, one interesting approach might be develop primers to survey the germplasm collection of both species to identify if a variant exists that lack this transposon insertion. Such a variant might be resistant to mantling. A comparative study of the relatively highly conserved orthologues of EgDEF1 in other related monocot species may provide a useful starting point. There is a highly homologous date palm sequence.  

The team takes note of the interesting approach recommended and will investigate further if there are indeed variants lacking the transposon insertion. The orthologues of EgDEF1 in other monocots will also be looked into.  

6 With the improvement to the reference genome sequence there is an interesting opportunity to more systematically study comparative genomics with:  
|   | Palms  
|   | Rice and other cereals.  
|   | Other related monocots such as Musa and Yam  
In the latter case identifying evolutionary related chromosome regions may help provide a syntenic focus for the support of identifying likely candidate orthologous genes. The occurrence in a syntenic position increases the likelihood of true orthologies.  

Looking at synthetinic regions will definitely be a goal in Phase 5 of the oil palm genome programme. In order to carry this out effectively, the focus now in Phase 4 has been to get the best possible genome build for the palms that are being sequenced at the “reference scale” and the work as presented at PAC is progressing well. The research at EBI will provide the key to looking into this.  

7 It is not completely clear what MPOB strategy is for exploitation of marker technology within the breeding programs. There is clearly an available high density illumina array which is being used to anchor/order the latest genome builds. There is developing high density illumina array was an expensive exercise and the initial focus was to genotype a high density mapping family to aid in the anchoring/ordering of the latest
also a program of association and QTL mapping projects. However the utilisation of these technologies directly within the breeding programme is not completely clear. It appears there is a commitment save tissue and DNA preps for at least a subset of the breeding/rebreeding lines but consideration should be given to fully genotyping a subset of ideally linked crosses as opposed to partial genotyping of a wide range of material. It would appear that a genotyping plan which indicates what will be genotyped and by what deadline would be of value to many groups within MPOB.

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<th>8</th>
<th>The introduction by the head of ABBC referred to both association analysis and genomics selection but there was no real evidence presented that indicated that MPOB might be operating GS within their programmes any time soon. However it would be of value to have a formal assessment of the likely role of GS and related prediction approaches might have within the MPOB program. This would be helped by an economic assessment of the components of the program and the resources available and how they can be optimally combined to maximise the rate of breeding gain. For example a first round filter through genomic prediction of performance based on marker data alone may enable a much more efficient use of the available trialling resource that is available to MPOB.</th>
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<td>9</td>
<td>It is clear that a significant amount of RNA-seq data exists and that further experiment work is likely. As this is an area of technological and software development it would be valuable to have a broader strategy in place within the context of which expression analysis can be done. For example there are considerable issues of experimental design relevant to RNA-seq experiments including tissue collection to avoid or block of circadian complications. Blocking of libraries within flow cells to enable multiple round of sequencing without confounding sequence run effects. Current analysis strategies have identified that appropriate choices of normalisation and analysis method can significantly affect the power of the analysis and MPOB should ensure that they are currently following best practice. If it is not already underway co-expression and network analysis of the mesocarp development data set should be undertaken and the position of oil biosynthesis enzymes within such a network analysis undertaken. Collection time of fruit bunches for the sampling of mesocarp and endosperm tissues were synchronized. The bunches were harvested in the morning. Efforts are being carried out to look into the co-expression and network analysis of the mesocarp development data set.</td>
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### D. METABOLICS UNIT

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<th>1</th>
<th><strong>Proteomics And Metabolomics (PROMET) Group</strong></th>
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<tr>
<td><strong>Establishment of a comparative protein and metabolite profiles of elite oil palm varieties (baseline data for oil palm) and genetically-modified (GM) oil palm (BD370-2007)</strong></td>
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<tr>
<td>Project well on-time for completion during the allocated period. Will dovetail with data from the Orbitrop system. Interesting to note the distribution of identified proteins with a high proportion for carbohydrate rather than lipid metabolism.</td>
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<td>The proteomics analysis for mesocarp tissue was established using complementary approaches i.e. gel-based, combination of gel and liquid chromatography as well as shotgun approach. The use of Orbitrap MS as high performance LC-MS and MSn system would intensify the identification and quantification of proteins, peptides, lipids, glycans and small molecules. Most of the identified proteins are associated to carbohydrate/primary metabolism (glycolysis pathway and TCA cycle) could be significant drivers to various metabolic pathways notably lipid for example pyruvate dehydrogenase, enolase, fructose 1,6-bisphosphate aldolase and triosephosphate isomerase.</td>
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<th>2</th>
<th><strong>Development of oil palm metabolome database (ABBC4-2013)</strong></th>
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<td>A demonstration of the on-line portal was given which looked useful and functional. The project is unlikely to be completed within the allotted time-frame but that was pointed out last year. However, the project is obviously very important.</td>
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<tr>
<td>The development of OPMDB and its web portal has been completed and the system is ready for mass spectrometry metabolome data deposit. Further improvement and expansion of the system will be addressed using feedbacks and opinions from OPMDB users. The project was closed with a final report submission and a viva voce presentation, followed by continuous metabolome data entry from MPOB research projects.</td>
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<th>3</th>
<th><strong>Metabolomics analysis of parental palms and progenies tolerant and susceptible to <em>Ganoderma boninense</em> for improved understanding of basal stem rot disease (BD399-2011)</strong></th>
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<tr>
<td>PAC members raised a number of important points for consideration in 2015. It is not clear how many have been taken on board. Nevertheless, quite a lot of work has been done. An additional issue about how to define ‘tolerant’ and ‘susceptible’ lines is very difficult. Since so-called tolerant palms were reported from Sumatra, it was a little surprising that these did not appear to have been examined.</td>
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<tr>
<td>The team has initiated the discussion with the Breeding &amp; Quantitative Genetics Group, MPOB on the selection of isogenic lines. Dura palms generated from several rounds of selfing (inbred line derived from Deli Dura selfs) were selected, which consists of intermediate and susceptible oil palm to <em>Ganoderma</em> as reported by the GanoDROP Unit (Biology) from their nursery screenings. The leaf and root samples will be collected from MPOB Kluang and MPOB Keratong stations in the middle of February 2017.</td>
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**Comments from the Ganoderma review panel:**
Comparing palm lines of very different genotypes is likely to reveal differences which may be unrelated to resistance. You require isogenic lines or a study of many lines in order to make any valid link to disease susceptibility/resistance. The literature will tell you that chemical differences within a species as related to resistance are an extremely rare event. It certainly can happen between species.

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<th>4</th>
<th>Functional characterization of oleate desaturase (e.g.FAD2) gene in model plant (Arabidosis thaliana) (ABBC1-2012)</th>
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<tr>
<td>Agrobacterium-mediated transformation and over-expression by PCR carried out. T2 putative transgenic plants produced with growth changes but unfortunately further analysis prevented by fungal infection.</td>
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Antifungal studies (96-well microtitre plate-based assay) were conducted using oil palm root fractions collected by Semi-Prep HPLC to see potential antifungal from oil palm root.

A serial concentration of palmitic acid, jasmonic acid and ganoderic acid were prepared from 0 µg/mL to 50 µg/mL in potato dextrose agar (PDA) and inoculated with 7 days old G. boninense mycelium. Following incubation at 27±2°C for 11 days, minimum inhibitory concentration (MIC) was observed. The MIC values of palmitic acid and ganoderic acid were at 40 µg/mL, while the MIC value of jasmonic acid was 50 µg/mL.

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<th>5</th>
<th>Biochemical studies of oil palm artificially inoculated with Ganoderma boninense, the causal agent of stem rot (BD387-2003)</th>
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<td>The proteomics part is very much on-going with few proteins identified. Many of these were stress proteins. Again, progress is limited with a large number of sample (6 replicates) and 0-to-48-weeks after inoculation for ‘susceptible’ (Elmina X Elmina) and ‘tolerant’ (Zaire X Cameroon) progenies. For metabolomics, chelidonic acid was again highlighted. Although this compound reduced G. boninense growth it did so only at high concentration unlikely to be of in vivo relevance. In fact, it stimulated growth at lower concentrations.</td>
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Comments from the Ganoderma review panel:

Toxicity at >2 mg/mL is not very impressive in physiological terms. The literature will tell you that compounds linked to defences are usually in the low ug/mL range. Always relate such toxicity to actual amounts in relevant tissue (where Ganoderma invades). A better approach arguably would be to use what others successfully employed over decades, by testing directly for anti-fungal activity from various solvent extracts (you use

Due to insufficient sample to perform various analyses, an integrated extraction procedure was developed for the oil palm root tissue based on Weckwerth et al., 2004, with a slight modification. The metabolites were extracted using a mixture of methanol and chloroform. The metabolite compounds will be analysed using a GC-TOF. Protein extraction buffer was further added to the pellet to extract out proteins via a phenol-based extraction method. One and two dimensional SDS-PAGE were performed to determine the number of protein spots when using the integrated method. A total of 652 protein spots were obtained. The protein fractions will be further used for gel- and non-gel based platforms. Meanwhile the aqueous phase was collected to extract out the DNA using acetic acid and ethanol.
correctly five) then identify those compounds. This applies to preformed compounds-phytoanticipins and to infection-induced compounds-phytoalexins. Strong encouragement was given to extend this work to study metabolites from Ganoderma in vitro as part of revealing potential pathogenicity factors.

A spectrum of metabolites from crude extracts of healthy and natural Ganoderma-infected palm leaves has been used for antifungal test against G. boninense inoculum. A 96 well microlitre plate-based bioassay method using these metabolite fractions collected by Semi-Prep HPLC has been carried out.

| 6 | Regulation and specificities of FatA and FatB thioesterases in the oil palm (BD371-2001) |
|   | Work with the FatB seems to be making progress with some characterization of the fusion protein in E.coli. It was able to hydrolyase medium-and long-chain acyl-CoAs. However, acyl-ACPs will be the natural substrate and no details were given as whether the saturated and unsaturated fatty acyl groups were substrates. The FatA-type gene is currently under amplification testing and little (or no) progress as this part of the 10-year project has been made since 2015. |
|   | A few sets of new degenerate primers will be designed based on conserved regions of FatA thioesterase genes from *Elaeis guineensis* and other plants. Total RNA extractions have been carried out using *E. guineensis* mesocarps at different stages of development i.e. 10-, 12-, 1-, 15-, 17-, 18- and 20-WAA. Intact bands of 18S and 28S ribosomal RNAs (rRNA) were observed for the total RNA samples which showed good quality of RNAs |

| 7 | Comparative proteomics of pathogenic and non-pathogenic Ganoderma Species (ABBC11-2014) |
|   | This new project (June 2014) has only given preliminary data so far. A key aspect is purity of samples to be analysed as was pointed out last year. It is most important that this issue is addressed fully, in cooperation with the GanoDROP group and external advice should prove useful. |
|   | Extracted proteins from *Ganoderma boninense* are concurrently being analyzed using both approaches gel- and non-gel based. Besides, the preparation of the starvation media has also been initiated in order to get secretome proteins but it needs further optimization due to some contaminations. |
|   | Comments from Ganoderma review panel: |
|   | Fungal proteins linked to necrotrophic pathogenicity are usually extracellular, not intracellular as is being attempted here. Therefore focus on culture fluids. Do not use rich culture media, but starvation conditions, having first established the mycelium. This comment also applies to metabolite production in culture. |

| 1 | Phenolics Group |
|   | Dose exploration trial of oil palm phenolics (OPP) supplementation in humans (ABBC11-2014) |
|   | Some differences were reported for liquid or spray-dried phenolic formulations but these were not significant. Standard errors and n values were not included in the Figures presented so it is difficult for |
|   | In the current trial, only one dose of OPP supplementation were investigated (900 mg GAE/d). Based on our observations, the 1800 mg |

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PAC members to comment. Also, although the title indicated a dose study, the data presented concerned three different OPP preparations all at the same dose.

| 2 | **OPP on glucose uptake by in vitro preparations (ABBC12-2015)** | GAE/d dose is not suitable for human consumptions, due to its taste and product characteristics. Supplementation with 900 mg GAE/d dose did not significantly improve the glucose and insulin profiles although there was a difference between treatment and control group. Therefore, it can be concluded that, there will be no significant effects by acute OPP supplementation dose less than 900 mg GAE/d (i.e. 450 mg GAE/d). The project is completed and will be presented in MPOB Viva Committee in 2017. |

The experiments concerned human colonic Caco-2 cells which were grown as monolayers. Following advice from last year, it is intended to expand the study with intestinal everted used but ethical approval is waiting for this. The Caco-2 cell system has been set up and preliminary data obtained to show that certain abundant phenolics in the OPP samples reduced glucose uptake into cells. Suggestions for delineating this reduction in terms of the glucose transport system were made.

**Summary**

Overall, this has been a productive year for the Group with significant progress on most individual projects. Perhaps the biggest concerns are with the supply of pure, well-characterised samples of *Ganoderma* for analysis.

The ethical approval to carry out glucose uptake assays on everted intestinal sacs has been granted by the Universiti Kebangsaan Malaysia Animal Ethics Committee (UKMAEC) on the 23rd of March 2016. Following this, preparative steps to obtain mouse everted intestinal sacs have been carried out using ICR mice. *Ex vivo* experiments will be initiated to complement the *in vitro* Caco-2 cell culture experiments. Some of the parameters to be tested in the glucose uptake assays include the presence/absence of sodium, the types of OPP fractions, as well as their concentrations and exposure time.
## 2. BIOLOGY DIVISION

### PAC Comments/Recommendations

<table>
<thead>
<tr>
<th>Soil and Nutrient Management Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Soil Erosion and Nutrient Losses from slopes under Oil Palm</strong></td>
<td>To reanalyse the experiment as well as to provide detail soil texture, rainfall frequency and intensity in next year report.</td>
</tr>
<tr>
<td>Besides reporting a total soil loss to be within USDA tolerance of 2 t ha-1yr-1. Actual figures from the experiment were not available. The experiment should be reassessed to see if the location of study has been suitable along the lines of the objectives of the study. Texture of soil and slope (%) are prerequisite considerations. Rainfall frequency and intensity should also be provided.</td>
<td></td>
</tr>
<tr>
<td><strong>II. Density x Progeny x N Fertilizer Trial on Alluvium Soils.</strong></td>
<td>To critically evaluate the year to year response to nutrient as well as soil fertility level.</td>
</tr>
<tr>
<td>It is surprising that nitrogen does not give a significant response to yield. The soil fertility level should be elucidated to support the finding. A more careful evaluation of the year to year response to nutrient is required. It is very well established that nitrogen is the most important element for yield increases in oil palm.</td>
<td></td>
</tr>
<tr>
<td><strong>III. Long Term Impact of Fertilizer Inputs on Soil Fertility Changes, Oil Palm Productions and Environment</strong></td>
<td>It was clearly stated that MOP rate of 2-3 kg/palm as normally practiced does not contributed to high level of Cl. The higher rate of MOP, however does contribute to high level of Cl in palm oil.</td>
</tr>
<tr>
<td>Whilst it has been shown that high levels of MOP application of more than 4 kg MOP per palm increases significantly the Cl level in oil, it must also be verified that the optimum rates generally recommended 2-3 kg MOP p-1 does not or does also contribute to high levels of Cl. The threshold of Cl in oil should also be given. Do not create an alarm of high Cl in palm oil due to fertilizer application. Further verification is required to elucidate the role of MOP towards Cl content of palm oil and its relationship to 3-MCPD ester level in palm oil.</td>
<td></td>
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<tr>
<td>Data on nutrient use efficiency and on soil fertility status over the years is yet to be provided.</td>
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<tr>
<td><strong>IV. Nitrogen Fertilizer Requirement in Relation to Ground Cover Management for Oil Palm Planted on Peat</strong></td>
<td></td>
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<tr>
<td>Trial results should be carefully evaluated to derived</td>
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</tbody>
</table>
suitable recommendations with respects to use of nitrogen fertilizer in the presence of leguminous cover crop. It should also take into cognizance that in the fields it is difficult to establish a uniform cover crop coverage over large areas. Hence the variability of nitrogen contribution from cover crop should be carefully considered.

V. Assessment of Nutrients and Carbon Stock from Different Cover Vegetation and their Effect on Oil Palm Performance on Peat in Sarawak.

An important variable influencing the results would be how well the cover crop has been established. It is reported that cover crop did not grow well and this could be related to land preparation activities and other management practices. The results should be carefully evaluated as some of the treatment effects related to cover crop may not be useful.

VI. Assessing Micronutrient Status In Oil Palm Plantations

Though some results were provided, further elucidation is necessary to identify proportion of estates with below optimal levels of micronutrients. Some of the findings appear to conflict with what is seen in the field with respect to micronutrient deficiency.

VII. Changes in Soil Pore Morphology and Hydraulic Properties Due to Heavy Machinery Under Palm Planted on Inland Soil

The variations in the measured soil parameters should also be reported rather than just means. Additionally, water retention under various pressures should also be determined via suction pressures in the laboratory so as to get an understanding of water retention/availability of water under various pressures (pF curves) for the different treatment studied in the field.

VIII. Oil Palm Nutrient Management For High Yielding Materials

The long term trial at Keratong is only in its third year and two other potential sites have been identified.

The researchers should characterize the trial locations at all the three sites and report it at the next 2017.

IX. The Potential Use of Biochar on Soil and Oil Palm Agronomic Benefits

The trial is encountering multiple nutrient to come up with suitable recommendation taking into account the difficulty of establishing a uniform cover crop over large areas

Treatment with Legumes Cover Crop (LCC) showed poor growth while Mucuna B. and natural fern grow well in early development and decreased with palm age. To reanalyse the results

Detail elucidation in identifying proportion of estates with below optimal levels of micronutrients is being looked into. The findings of micronutrients status in oil palm planted on peat over 25 years at Teluk Intan reported showing some conflicted of what was shown in micronutrient status on mineral soils.

Determination of water retention under various pressures were done routinely twice a year for all treatments and the results will be presented in the next report.

Plot mapping and soil sampling for initial soil characteristic for all the sites are being conducted and the data will be reported in the next PAC meeting.
deficiencies of potassium, magnesium and Boron. These deficiencies have to be corrected in a timely manner so as to have minimal disruption. It may be prudent to correct the deficiencies by using more frequent applications of straight fertilizer rather than a blended compound.

### X. Role of Boron in Pollination and Fruit Set Formation of Oil Palm on Peat

At all planting densities evaluated, fruit set was low, <50%. Not much progress reported since commencement of the study in 2014. A more detailed progress report of the effects of boron and planting density should be provided in PAC 2017.

### XI. Investigation on Premature Frond Desiccation in Oil Palm Planted on Peat Soil in Sarawak.

This is an important study as the problem is intensifying in most peat areas. There is an urgent need for management practices to alleviate the malady. The likely causes should be identified as soon as possible with recommendation for mitigation measures.

PAC recommends that a background survey be conducted to categorise the severity of the malady into severe, moderate, mild and normal and should be tracked over time to understand the recovery with management practices that will be studied.

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**Geospatial Technology Group**

#### I. Establishment of Oil Palm Resource Information System (OPRIS)

Remarkable progress has been made. The project is basically complete. PAC suggest that it be released to the industry as one achievement of MPOB during the TOT after refinements. Target it for 2017.

#### II. Remote Sensing for Oil Palm Plantation Management (Sub-Project: Management of the outbreak of bagworms and leaf eating pests by GIS and Remote Sensing).

The project is almost completed but objective of prediction of pest outbreak as an early warning system is not achievable. However PAC suggests that the data gathered could be analysed to see if there are some regular patterns of outbreaks in the bagworm prone areas e.g. Perak Besout region, Lower Perak region so as to alert the estates and to ensure that ground census are carried during specific months of the year.

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To re-evaluate and correct the nutrient deficiencies as suggested

To report a more detail progress in next year’s PAC report

The survey to categorise the severity of the incidence was conducted and will continue to monitor every 3 months.

OPRIS refinement will be transferred to the industry in next year TOT.

Survey to estates in Lower Perak region will be carried out. To date, K’lapa Bali Estate, Sungei Chinoh Estate and Norborough Estate has been visited. From the survey, it was found that they had carried out ground census and chemical treatment.
### III. Modeling of Oil Palm Biomass for Carbon Stock SAR (Synthetic Aperture Radar).

HV filtered data used with allometric equation of Syarinudin (2005) provided the best correlation for biomass and the polynomial function was better than the linear. The project is nearing completion and a publication should be produced upon completion.

A paper will be published upon completion.

### IV. Oil Palm Crown Detection Using Remote Sensing Technology as a Tool for Plantation Management.

The methodology is not well explained. PAC requires a further clarification of the methodology.

Detail methodology will be reported.

### V. Precision Oil Palm Plantation

The project has been completed. A comprehensive report should be produced. Report should be evaluated to see the suitability of adoption by the industry particularly on the evidence of VRT fertilizer application and yield improvements.

To produce comprehensive report as required

#### Recommendations

1. Due to the impending labour shortages, the industry has to move towards mechanization as soon as possible. The Farm Mechanization Unit is within the Biology Sub-Committee. It is recommended that a local panel be established to evaluate if it should be upgraded to a Mechanization Sub-committee with more competency to drive research on mechanization.

2. The Agronomy unit should develop a study on the relationship of some of the GAPs in relation to *Ganoderma* incidence. e.g. cover crop, trunk injection, EFB application, windrowing of biomass after felling and chipping.

To put forward as a new project proposal

### FARM MECHANISATION UNIT (FMU)

#### On-going projects

A special discussion was held between PAC Members namely Ir Izhar Mahmood and Mr Mahbob Abdullah with the MPOB team on mechanization led by Hj Abd Rahim Shuib to deliberate on the status of the works done on the existing projects. These included enhancement of various aspects of the previous model of the Cantas, namely improvement on the durability of the cutting head, reduction in

|
vibration and weights with lighter and higher pole reach up to 7 metres palm height. Also the 4-wheeled mini FFB transporter/grabber for difficult ground conditions and portable sideway mounted conveyor to assist in FFB loadings. Other ongoing works that have been carried out include the possibility of using electromagnetic power and laser for FFB harvesting. The latter is being carried out through collaboration with UPM Engineering faculty. It is recommended that the team to updates periodically to the members on the progress of the on-going projects for their comments and/or inputs.

In order to ensure the continuity and sustainability of the technology introduced to the industry, it is recommended that MPOB to maintain updated database on the machines including its performance, productivity, costs and issues for future reference and improvements. It is also recommended that MPOB to forge and strengthen relationship with the industry and vendors to improve on the P&M technical backup services in order to maintain the market confidence with regard to the machines reliability and thereby avoid bad publicity due unfounded accusations by irresponsible users due to their own poor management rather on the machinery itself.

**PAC Members Remarks**

To continue with the ongoing projects with the necessary improvements as per comments

**Other matters**

Fertiliser Applicators. Besides focus given to works to produce good planting material, P&D, FFB harvesting, it is equally important that the MPOB mechanization team look into another very important aspect of the plantation operation that affects the industry enormously on the Company bottom line, i.e. effective fertilizer applicators. This is very important whereby about 30-40 % of the estate COP is on manuring and the present method of fertilizer applications has led to very high nutrient losses namely through leaching and evaporation. The industry badly needs an efficient mechanize subsoil fertilizer applicator to ensure minimum losses and sufficient nutrient are given to the palms to produce higher yields. In this respect, the member suggested that the MPOB mechanization team to search and develop effective and efficient subsoil fertilizer applicators as the next very important project to save the industry billions of Ringgit from importation of fertilizers. Similar smart partnership arrangements can be made with relevant group involving MPOB, plantation, manufacturers and fertilizer producers to ensure the project can be carried out effectively, speedily and at affordable costs.

The data base for the performances products will be updated from time to time and some of these data has been reported in the published paper and brochure.

The technology takers are responsible to ensure that service and parts of products that have sold to end users (estate or smallholders) should be easily accessible to them. On the positive note, some of these companies even provide schedule visits to area where the populations of machine is high to meet the users.

A proposal will be table in PAC meeting April 2017 on the possibility of developing fertilizer discharge machine/implement.
Project operation. In order to ensure the effective execution of the proposed projects by the team, members propose immediate action by the management on the followings:

- **Identification of site suitability**

  MPOB team to establish crucial database on suitability of sites with the proposed technology for it to meet the intended purposes. Factors to be considered includes the ground conditions, terrains, accessibility, mobility, productivity etc. This will facilitate logistics, operations, saving on costs, manpower and improve productivity.

- **Improvements on Projects Team & Management**

  In view of the pressing needs by the industry following lower palm prices, steep increase in the production cost and acute labour shortage it is crucial now for MPOB to review their present manpower strength and to draw comprehensive roadmap for the mechanization department to meet the present and future challenges and remain relevant for the industry.

- **Product Promotion Team**

  In view of the importance of good marketing plans required to promote commercially viable plant and machineries developed by the mechanization unit, it is important and timely for MPOB to consider the establishment of its own trained market personnel’s with good technical background and communication skills to promote to the industry users all machines and equipment successful developed by the Unit for commercial use.

The Unit have produced a booklet outlining the available technology that is invented by the Unit. In this booklet the basic information ground condition, economic analyses of particular machines are made available.

At the moment recruitment of new staff a bit tight and the Unit will keep propose to the management on need to have extra manpower to take up the future challenges and remain relevant for the industry.

That could be done with additional manpower, will propose to management for consideration when the time right.

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**APPLIED ENTOMOLOGY AND MICROBIOLOGY UNIT (AEM)**

Progress reports on seventeen projects of the AEM group were presented by Dr Siti Ramlah on behalf of the three working groups. The core work of the AEM group covers key entomological and microbiological topics; the pollinating weevil, bagworm, rhinoceros beetle and soil microbiology. PAC responses are grouped in these theme areas. It is good to see that a candidate for the Group Leader, Soil Microbial Biodiversity and Function, has been appointed and will start work with MPOB in May. Some of the projects have been running for many years with a monitoring role for the key insects. It will be good to revise these projects and, where appropriate, combine them into renovated projects for these key theme areas.
1. *Elaeidobius kamerunicus*

**Projects:**

BD6-1.1.1. (82) A study on the biology and population dynamics of *Elaeidobius kamerunicus*


These two long running projects have provided useful information about populations of *E. kamerunicus* on reference sites in Malaysia. The study has shown that *E. kamerunicus* is abundant in the reference oil palm plantations, leading to satisfactory fruit set, in most parts of the country. The exception was Sarawak, where the three monitored locations had poor fruit set and relatively low weevil numbers. However, industry have noted the problem of poor fruit set and due to their concern about the weevil a Steering Committee of MPOB, Government agencies, universities and industry was convened in January to address the problem of “Fruit Set and Pollinating Weevil”. Minutes have been circulated and a permanent Steering Committee and a Task force to evaluate and resolve the problem have been established.

PAC agree with the Terms of Reference for the Steering Committee;

a) To identify reasons and issues related to low weevil populations, low fruit set and oil extraction

b) To obtain general consensus on how to resolve issues related to low weevil population and fruit set

c) To identify possible collaborative research work among the members and compliment MPOB on leading this multi-agency initiative to resolve a problem raised by industry.

In carrying out the project it is important to focus on the fruit set and identify problem areas before trying to evaluate the role of the pollinating weevil. It is also important to evaluate the role of the two parasitic nematodes that were introduced with the weevil and, if further introductions of different weevil species are contemplated, to ensure that these are free from parasites and pathogens.

The current long term projects should be closed and combined into a single project focusing on the problem areas for fruit set guided by the targets of the Task Force and presented to PAC as a new project in 2017.

The current weevil projects will be closed soon. A new project proposal will be presented in 2017 covering the problem areas, parasitic nematodes, low weevil populations and low fruit set in collaboration with Agronomy & Geospatial Unit.
2. Bagworm

Projects:

BD6 – 1.3.2. (88). Beneficial plants for sustenance of parasitoids and predators for control of bagworm

BD360-2006. Identification of the sex pheromone of bagworms

BD390-2009. Development of mass rearing system for predator Sycanus dichotomus

BD390-2009. Potentials of insectivorous birds on bagworm control in oil palm plantations

The reported projects describe fragmented work around the bagworm problem and it is difficult to see how they are contributing to building an effective IPM strategy. The census for parasitoids at Teluk Intan seems to have taken place in an area with low bagworm numbers and it is hard to interpret parasite numbers. Conversely high numbers of bagworm were evident at the Pahang site where the pheromone traps were tested but these dropped to relatively low levels during the period of the experiment. As suggested previously, replicates of treated and untreated populations should be monitored to provide statistically valid results. Mass rearing of the predator Sycanus dichotomus appears now to be more successful but assessment of its effect in cages and/or field is necessary before too much effort is allocated to mass rearing. The response of insectivorous birds to bagworms is interesting and suggests there is potential to obtain some control of bagworms through encouragement of birds in the plantations.


BD 417-2013. Development of an automated counter for bagworm census

It is good to see a range of activities being carried out against the bagworm outbreak around Teluk Intan and affected smallholder blocks. Application of Ecobac-1 to 18,189 ha is a major effort but this does not appear to have been assessed in a way that measures impact in relation to trends in untreated control blocks. Pre and post application assessments of bagworm numbers are provided and, while reductions are recorded following most treatments, the residual populations appear to be very high and well above the Economic Threshold Level (ETL) of 10 bagworms/leaf (P 49). The extensive effort of pheromone trapping also appears

Pre and post treatment census will be conducted at chemical treated plot and untreated neighbouring estate and smallholder to monitor significant effect to the bagworm populations.

The census of parasitoids will be conducted in another place with high infestation of bagworm, Metisa plana in Chaah, Johor. The selected areas with beneficial plants planted were identified.

The pheromone trap site has been initiated in a few location in Johor as replicates.

The predators were conducted in experimental cages. The results revealed there were differences in attack rate and handling time. Field assessment will be initiated soon.

On the study of potential of insectivorous birds for controlling bagworms, the effect of Bacillus thuringiensis on the bird in oil palm areas have been conducted.

To conduct a follow-up aerial spray from early larval stage to fourth larval stage for Metisa plana to reduce bagworm population to below Economic Threshold Level (ETL). The aerial spraying will be conducted continuously through two to three consecutive rounds of spray per generation by applying machine-gun concept to bring down the population in one generation of the bagworm.

Follow-up aerial spray will be conducted depends on availability of Bt-products and
to have been made without an experimental design including replicates and controls. As a result it is not possible to assess the effectiveness of the trapping and bagworm numbers appear to have been unacceptably high for much of the monitored period.

The MPOB team have been working on bagworm control measures for several years and it is now time to show that these measures can be incorporated into an effective IPM programme for control of the pest. It is premature to promote an IPM bagworm control programme until this can be validated in plantations and approved to control the pest to acceptable levels by the farmers. This needs a large scale experiment carried out with replication and controls for proper evaluation.

The current bagworm control programmes are operated by two teams within AEM and another programme on bagworm detection is carried out by the Geospatial Technology Unit. These projects should be managed in a coordinated manner under a designated leader for bagworm research. The role of trunk injections should also be assessed.

A new, modified IPM project should be planned (with input from a statistician) and implemented with progress measured against established targets. Progress should be regularly reported to MPOB leadership. The cost effectiveness of the programme and satisfaction of the farmers should be recorded.

The results should be reported to PAC 2017. If the bagworm outbreak is still not controlled it may be necessary to form a Task Force to develop and implement controls for this difficult pest.

<table>
<thead>
<tr>
<th>Projects</th>
<th>Previous and current data during field trial under IPM program at any estates will be collected and reported in MPOB report to monitor the effectiveness of IPM program in controlling bagworm populations. The thorough observation of large scale IPM control program will be made by AEM with co-operation from plantations who keen to join the program.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD 3668-2001. Population studies of termites in peat</td>
<td>Pre and post treatment census will be conducted after trunk injection treatment at neighbouring smallholder to monitor the bagworm populations. For estate, census data will be collected from estate management.</td>
</tr>
<tr>
<td>BD402-2011. Biopesticides for termites</td>
<td>To carry out survey on farmers’ satisfaction and to monitor closely costing of modified IPM project through proper budget planning under expert supervision.</td>
</tr>
<tr>
<td>B65-84/2011 Bunch moth infestation on peat soil.</td>
<td>The progress and corrective actions of bagworm control operation will be reported in 2017.</td>
</tr>
</tbody>
</table>

3. Pests of oil palm in Sarawak

Projects:


BD402-2011. Biopesticides for termites

B65-84/2011 Bunch moth infestation on peat soil.

It appears that Fipronil is still the best control option for termites on peat soil but care must be taken with this toxic chemical and training in pesticide application by MPOB has been appropriate. Research should continue to look for less toxic alternatives including evaluation of the entomopathogenic fungi. An effective formulation will be necessary for successful use of fungi. Use

| The group consider finding alternatives for less toxic chemicals, especially the use of fungal pathogens. The group are correctly evaluating the entomopathogenic fungi to control termite in the field (Beauveria bassiana and Metarhizium anisopliae). Baiting technique with fungal spores will be evaluated in the field. |
of insecticides and biologicals against bunch moth is giving promising results but the need for four rounds of application seems excessive. This work should be continued to find an effective, practical and economic option for control.

4. Rhinoceros beetle

Projects:

BD 304-96-877. Use of Metarhizium anisopliae to control rhinoceros beetles

BD 391-2009. Development of integrated bio-management systems for rhinoceros beetle

BD434 -2015. Genetic diversity, virulence and population dynamics of Oryctes nudivirus

Rhinoceros beetle remains a significant problem for oil palm especially as renovation of old plantations provides trunks for breeding sites. It is good to see that Metarhizium is an effective control and the isolation of the insect pathogenic Paecilomyces amoeneroseus is an interesting and useful discovery. The MPOB team have successfully established the black beetle cell line in the laboratory and are using it for production of pure strains of virus which have been tested and found effective against beetles. This is not a simple matter and the team are to be complimented for progress in this area. They have initiated the new project looking at genetic diversity of the Oryctes nudivirus which is urgent to counter the threat of the new Oryctes rhinoceros Guam strain which is spreading from the Pacific into the Asia region.

5. Soil Microbial Biodiversity

Projects:

R009711000. Microbial study on Deep Peat Sarawak

Q0012005001. Underground microbial biodiversity, Belaga, Sarawak

The team report the welcome news that the new Group Leader, Soil Microbial Biodiversity and Function has been appointed to lead the soil microbiology biodiversity research area and will start work with the MPOB in May. It is important that the new GL work with a top international team in soil microbial ecology (recommended Brajesh Singh, UNSW) who will provide training and mentoring to the MPOB soil microbial biodiversity team. The work in this area should be revised together with the new GL and the international expert to look at functional

Dr. Mohamed Mazmira has been appointed as the new GL for Soil Microbial Biodiversity and Function.
biodiversity within the oil palm environment.

### 6. Biofertiliser

Work with microbial biofertilisers was presented but no details are given of the microbiology of the biofertiliser, its chemical content and possible costs of production. A field trial has been carried out but more details will be needed to assess the value. There is no indication that the project staff carried out the field testing in collaboration with the soils/fertilizer group and GanoDROP as suggested by PAC in 2014 and 2015.

The details of the nursery & field trials is being documented for patent. Collaboration with MPOB soil fertilizer member & agronomists from the plantation involved, is still on-going.

### GANODERMA AND DISEASE RESEARCH FOR OIL PALM UNIT (GANODROP)

Note that the IAPGD (International Advisory Panel on GanoDROP) 2016 report comments in detail on a number of these projects and offers recommendations. These will only be referred to briefly here. For further detail the reader should access that report.

Efforts of the GanoDROP group (other than key remaining issues such as biosecurity and exotics) should be absolutely directed to understanding and control of BSR/USR which continues to increase in prevalence.

**Ganoderma Research Group (GRG)**

Studies on biology, epidemiology and ethology of *Ganoderma* pathogenic to oil palm.

R0094110001 (BD6-2.2.1)

This project involves a continuing survey of the degree of BSR incidence in oil palm smallholders and is conducted in collaboration with IRED Division.

By June 2015 >14,000 smallholders had been visited representing >5700 ha in Peninsular, Sabah and Sarawak. 17% reported the presence of BSR. 14% incidence is reported, surprisingly, the same as presented for PAC 2015.

IAPGD: The questionnaire was presented to us and it appears comprehensive.

Clearly disease modelling would be advantageous using this and other data (especially from industry from as presented for UPB by Dr Arulandoo). This could incorporate, palm age, soil type, treatments etc.

Suggestions are noted. The survey forms have been submitted to the oil palm estates in December 2016.
The project title is misleading as no studies are being conducted on biology or epidemiology.

| Early detection of *Ganoderma*.  
R009411000-2 (BD6-2-2-2) |
<table>
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<td><strong>Sub project 1: Hyperspectral remote sensing.</strong></td>
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</table>
| Clearly large scale evaluation of BSR incidence would be advantageous to industry and to understanding of BSR epidemiology.  
Spectral indices are suggested as suitable for *Ganoderma* detection. The influence of palm genotypes and other forms of biotic and abiotic stress must be very carefully evaluated before this method is validated.  
Refinements are ongoing and are described in a new project proposal (see elsewhere).  
IAPGD: The method must be carefully linked to actual BSR incidence on the ground.  
The spectral analysis could be linked to other agronomic/physiological traits and pests and relevant agronomists or entomologists should then be included. |
| Suggestions are noted. |

| **Sub project 2: Molecular techniques.** |
| No data are presented in the report.  
IAPGD: We were generally critical of the approach of using defence-related (AKA pathogenicity-related) genes as a means of specific detection of *Ganoderma* infection. These are a general response to most pathogens and to various abiotic stresses. This comment applies equally to ABBC using this approach. The cost and practicality of use in a field situation is questioned. |
| Any molecular detection methods developed for *Ganoderma* disease will be field tested and validated. The cost and practicality of the method developed will be discussed with the oil palm industry. |

| **Sub project 3: VOCs.** |
| Comments/data are not included after the method failed last year to discriminate between infected and healthy palms.  
However our comment from PAC 2015: “There seems little progress from 2014, when we questioned the origin of VOCs as palm or *Ganoderma* and gave suggestions as to how to distinguish the latter”.  
IAPGD: Again we strongly recommend a simple technique to obtain *Ganoderma* VOCs by growing it in vitro on sterilized palm wood blocks, taking the head space and testing for those volatiles in the field. |
| As suggested, identifying *Ganoderma* VOCs by growing it *in vitro* on sterilized palm wood blocks is being conducted in collaboration with ABBC Division, MPOB and local university. |
### Investigation of fungicides to control Ganoderma.
R009411000-3 (BD6-2.2.3)

Comments from 2015 still apply. “Clearly there is benefit in some situations to using tetraconazole. It is hoped that in time this large volume application will not be required for economic and environmental reasons. This continues to emphasize the need to find effective resistance to prevent the establishment and spread of the disease in the first instance”.

IAPGD: Progress on optimizing the method for disease resistance screening.

Establish the ways that Ganoderma infects. Spores are likely to contribute and, for example, might enter via cut frond bases. If so, this could influence targeted application of chemical or biocontrol.

### Biological control of Ganoderma.
R009411000-5 (BD6-2.2.5)
R009411000-7 (BD6-2.2.7)

Treatments and new data are presented for Endophytic fungi-GanoeF fertilizer and endophytic bacteria-EMBIO actinoPLUS. With seedlings, increased growth parameters are claimed but what level of fertilisation was given to control seedlings? This information must be provided or the experiment is invalid. Under field conditions bait seedlings is arguably the best method. Dramatic disease control (>83%) is claimed for GanoEF and 6.6 vs 75% death for EMBIO treatment.

### Organic fertilizer

Seedling trials gave a claimed 77.8% reduced BSR incidence. Field trials gave <5% death in treated bait seedlings cf >83% untreated.

IAPGD: these data suggest the products give substantial control, but must be validated mid and long term by growers using them. Note that industry members advocate MPOB to test without prejudice commercial bio-products. However, as you are producing such products there would seem to be a conflict of interest. The result with the organic fertilizer lacking any biological antagonist is quite remarkable and contrasts with control of other plant diseases. The claimed key factor is silicon. Evidence for the role of this element in resistance is very limited. Here it is

| Large oil palm nursery for screening of oil palm resistance to Ganoderma is being constructed in MPOB Research Station Keratong, Pahang and expected to be completed in June 2017. |
| New research proposals addressing the role of spores will incorporate the suggestions and will be proposed in PAC 2017. |
| Two field trials on the effects of EMBIO actinoPLUS in controlling Ganoderma disease through seedling baiting technique were carried out in Teluk Intan and Seberang Perak, Perak. Seedlings were treated with EMBIO actinoPLUS in nursery and planting hole and untreated seedlings as control. All seedlings were applied with NPK blue (12:12:17:2). Both trials were completed. Large field trials with oil palm industry and smallholders are on-going and BSR disease incidence in replanted oil palms will be reported. |
| More field trials on the use of organic fertilizer and commercial bio-products to control Ganoderma at replanting will be carried out in collaboration with oil palm industry. Study of Si nutrition in oil palm roots using TEM (EDAX and ESEM) will be explored. |
claimed that oil palm cell walls are thicker. This is based merely on SEM (scanning electron microscopy) and is not a rigorous technique in view of how samples are prepared and which tissues are being compared. This same comment was made last year. A rigorous scientific study of Si nutrition, soils, amounts in palm roots and use of elemental analysis under SEM or TEM (EDAX or ESEM) would reveal if it is contributing and if so, makes the basis for an important paper in an international refereed journal.

**Endophytic bacteria**

Nursery trials with two isolates gave some disease suppression of DSI 25% cf 75% untreated. Field trials initiated in 2013 so far show no infection.

IAPGD: Academic study of siderophores and putative antifungal compounds will not assist in the application of this work, yet it is understood that as part of PhD training is valuable. These comments apply also to work on *Trichoderma* (see below). They should not however be allowed to detract from the main thrust.

**Screening of oil palm for resistance to Ganoderma.**

R009411000-6 (BD6-2.2.6)

Fifteen progenies were screened using three inoculation techniques: germinated seed, 4 month, 12 month seedlings.

Significant differences between lines were obtained with 4 and 12 month seedlings.

IAPGD: As an addition to the useful study above, we strongly recommend optimisation of a technique for screening for disease resistance that can be recommended for industry. This also comes at their request. We list the many criteria that should be evaluated.

Disease resistance must be the long term solution and this basic technique underpins that progress.

MPOB have a very extensive collection or world sourced oil palms. Using the optimised inoculation protocol it seems clear that representatives of this diversity should be screened for resistance. If extreme resistance exists it gives hope and possible breeding route for a resistant genotype longer term. Strong resistance to many major crops such as tomato, potato, cereals was derived from wild relatives from the centre(s) of diversity. See also comments in the Breeding and Tissue Culture Report.

A screening technique developed by SOFINDO Indonesia is being explored at MPOB. Seedlings have been inoculated with *G. boninense* and disease assessments are being recorded. The SOFINDO screening technique will also be used to screen MPOB oil palm planting materials for resistance to *Ganoderma*.
## Emerging and Exotic Disease Group (EEDG)

**Development of *Trichoderma* as biofungicide for *Ganoderma* basal stem rot infection in the field.**

BD415/2013

Two potential isolates of *Trichoderma* from soil (of five initially selected) are being field tested by incorporation into the planting holes.

Five treatments are described and compared with chemical treatments. Thus far no infection by *Ganoderma* has been detected.

The rest of the report concerns identification of metabolites. A patent has been filed for phenylethyl alcohol although it has been reported in papers before and has not been tested against *Ganoderma*, so we are surprised at the reason behind this filing.

IAPGD: See comments above about academic study. Comments from last year question the likely value of any metabolite in disease control as fungi are the best delivery vehicles: “Extracts active against *Ganoderma* were obtained and some identified. There is at this stage no data on individual toxicities. It is not clear how these compounds might be used in disease control. Are they likely to be more effective than applying *Trichoderma* itself, which has an invasive capability?”

GFP as a marker for *Trichoderma* in roots as an endophyte could be useful.

IAPGD. GFP transformation of *Ganoderma* would be even more useful in order to follow its infection route(s).

The work on compounds is an academic approach in deciphering *Trichoderma* mechanism as potential biocontrol agent.

To date the transformation of *Trichoderma* is unsuccessful. Efforts are continued with modification on the original protocol.

New project proposal addressing Pathology of *Ganoderma* will be including the GFP transformation on *Ganoderma*.

## Biology, epidemiology, economic impact of orange spotting-coconut cadang-cadang viroid (OS-CCCVD) variant in oil palm.

BD414/2013

Extraction protocols, detection (including RT-PCR, qRT-PCR and LATE-PCR), prevalence based on the 2013 survey are described. A pictorial guide on orange spotting will be released in 2016

IAPGD: We are still unclear as to the significance of this disorder and how it relates to palm genotypes and locations (see questions from last year). We are aware of regional and quarantine implications, but the time given to this study should be in proportion to its actual importance with regard to yield loss, if any. Lab diagnostics set up is likely to require revision to

Yield record of OS-CCCVD palms are compared with healthy palms and will be reported in PAC 2017.
avoid contamination.

**Pathogenicity study on oil palm with Malaysian Phytophthora palmivora isolates.**
BD414/2013

In summary: inoculations of oil palms at MPOB and at University of Nottingham suggest that Pp is unlikely to be the primary agent behind so called spear/bud rots in Latin America.

ITS sequencing revealed Colombian and Malaysian isolates are not closely related.

IAPGD: This is an important study in terms of biosecurity. MPOB should maintain a watching brief because Phytophthora species are notorious for adaptation.

Clearly the situation in Latin America requires international investigation. Should MPOB become involved in view of the level of devastation caused there?

We make a suggestion that spear rots in this region be investigated for associated pathogens and compared to those reported from Latin America.

Biosecurity plan has listed Phytophthora palmivora as causal agent of bud rot and has included it as a high risk pathogen.

Incidences of spear rot in Malaysia is not common but suggestion to investigate on associated pathogens is noted.

**Crop Biosecurity And Biodiversity Group (CBBG)**

**Influence of herbicides on BSR**
BD400-2011

This study continues to confuse us. Comments from last year: “Is this study on Ganoderma based on confirmed field observations or more on anecdotal evidence? Where is this information presented? What is still omitted is the likely level of exposure Ganoderma might encounter in the field. This is fundamental information.” The same questions were posed in 2014 and 2015.

The objectives are to investigate the effects of herbicides on physiological and biochemical reaction in oil palm seedlings. Previous studies showed some of the herbicides can caused phytotoxicity injuries to oil palm seedlings and reduces the production plant hormones that involve in defence mechanism such as abscisic acid, auxin, cytokinin and gibberellin. These factors could have a direct impact in Ganoderma development. Therefore, a study is conducted to investigate effect of several common herbicides on oil palm seedlings inoculated with Ganoderma.

**Development of bioherbicides for controlling noxious weeds in plantations**
BD368-2007

A powder formulation of Phoma is described which results in 90% death of Eleusine indica after 28 days.

Currently, one MSc student is pursuing on the development of bioherbicide for controlling noxious weed Eleusine indica. The project will be not considered priority in the GanoDROP Unit.
IAPGD: Comments from industry suggested that they have weed control as routine and that it should not be part of R&D of MPOB.

Also note that the RO involved in this work obtained an overseas PhD in plant pathology and in view of the importance of BSR, his time and expertise should be directed to that major issue.

**Biosecurity plan for Malaysian oil palm industry**

**R000941000**

Final reports on the Biosecurity plan were submitted by CABI in November 2015. This describes 691 pests, diseases and weeds associated with Palmae in 44 oil palm producing countries. 224 of this list are absent from Malaysia.

Spread and threat potentials are provided along with fact sheets.

IAPGD: We recommend you prepare by obtaining diagnostic kits where possible for the main threats, not just relying on images/keys. Ensure you are well familiar with the main threats (morphology, biology, symptoms, as appropriate. See comments about lab set-up to avoid contamination during diagnostics).

Collaboration with other institutes such Department of Agriculture (DOA) and University of Nottingham, U.K are also being pursued as they have the diagnostic tools to detect several exotic pathogens.

**TROPICAL PEAT RESEARCH INSTITUTE (TROPI) UNIT**

**TROPI Presentation and Progress Review**

The TROPI team presented progress for all 10 projects across the Crop Physiology, Peat Research, and Biodiversity Groups during a formal presentation of progress in the research programme. This was followed up at an informal roundtable discussion the following day. The panel was pleased to see that good progress had been made in most of the projects, and that many of the recommendations from PAC2015 had been taken on board. In particular, the panel was delighted that the MPOB had appointed an International Advisory Panel for the Peat Soil research programme, and were impressed by the calibre of the individuals on that Panel. The Panel made a formal report of its activities to the sub-committee, along with the project progress reviews. During the Q&A session for that report, it transpired that the Panel did not have terms of reference which was a little surprising since the PAC2015 report recommended terms of reference for the Panel. We were also pleased to see the appointment of an RO to support the critical flux measurements of Dr. Kho’s team and that appropriate training had been provided.
**Crop Physiology Group**

Following on from a previous successful project on water use efficiency, this new project aimed to develop and validate the use of carbon stable isotope discrimination as a tool for use in screening for improved water use. The initial results suggest that the delta-C values correlate well ($r^2 = 0.69$) with the WUE. The panel noted that the positive correlation was at odds with other findings where WUE decreased with increase in delta-C, and that the team would investigate effects of age and season to probe this discrepancy.

The continued work on CO$_2$ enrichment studies sees this project nearing an end stage. A robust correlation between standing biomass and ambient CO$_2$ concentration has been established. The panel noted that for many other metrics, trends were being claimed where there was no statistically significant difference in the data. This reflected a wider pattern of quoted results being at odds with their statistical significance. Recommendation 6 of PAC2015 was to appoint a cross-divisional expert in biometrics and experimental design, and PAC noted that this appointment had not been made, and that an informal arrangement to 'work with' statisticians on a project basis was in place. PAC cannot state strongly enough that robust analysis and interpretation of data is a critical core capability and must not be left to chance. **PAC again recommends that a full-time appointment of a statistician is made to support staff across Divisions.** As reported last year, PAC were of the view that there was a consensus that the method employing enclosed chambers would introduce artefacts that are difficult to correct for. As the project was coming to a close, PAC recommended discontinuing the use of the method and considering the use of Free Air CO$_2$ Enrichment (FACE) in the future.

The Belaga study of carbon stocks and flows continues to produce fascinating results. The measured net primary productivity of the primary forest in Sarawak is similar to that calculated for the Amazon. The standing carbon stocks in primary forest are significantly higher than in the plantation, as expected. However the values for plantation and degraded secondary forest are similar. Moreover, there is significant variation in carbon stocks between different study plots in the same secondary forest. PAC noted that, in light of likely HCS Approach Steering Group recommendations, it is important to understand the consequences of this variability in setting carbon stock thresholds. **Proper characterization of spatial variation and optimal (adaptive) sampling methodologies are required.** In addition to this, PAC strongly recommends that

| Visited Free air CO2 enrichment (FACE) facility at UKM in April 2016. A proposal on FACE experiment at MPOB Kluang was drafted. |  |
mapping of peat in areas relevant to Palm Oil production is undertaken with urgency to ensure that the best information on spatial variability of peat is obtained. Not only is this important for assessment of GHG emissions and carbon stocks, but it is also likely to be critical to future better management of peat soil plantations to increase yields.

**Peat Research Group**

The PAC were pleased to see that an International Advisory Panel (IAP) for palm oil in peat soil had been established, chaired by Dr. Param. One of the international members of the Group, Dr. Susan Page, attended the meeting and presented a report of the Panel’s activities, which is summarized in Appendix 1.

Good estimates of carbon loss from peat soil are critically important for assessing the sustainability of palm oil grown on peat, and results were presented using a range of different measurement methodologies. The methodologies compared were eddy covariance, portable soil respiration chambers, and peat subsidence. The highest values (64 t ha⁻¹ yr⁻¹) were recorded using the Eddy flux tower, while the other methods produced 45 t ha⁻¹ yr⁻¹ and between 27 and 37 t ha⁻¹ yr⁻¹, respectively for the other methods. The reasons for the comparatively high Eddy flux measurement is not clear, though the team proposed this was due to the additional contributions of decomposing woody materials on the soil surface that are cleared before the chamber measurement. The low value for peat may be due to the fact that samples to calculate bulk density and carbon content were taken from 5 cm depth, and this may not be representative of peat at different depths. It is obviously critically important to understand the discrepancy in the values between the different measurement methodologies if the data is to be interpreted correctly.

An update on the project to study the effect of water table height on subsidence and carbon emissions was provided. CO₂ efflux was not correlated with water table height. However, the range in water table height was small, ranging from 30 cm to 32 cm. There was significant difference in yield, with lower water table correlating with higher yield. However, PAC remarked on the very low yields being achieved on the peat soil plantations.

As well as water table height, agronomic practices can have an important effect on carbon fluxes. A study of different cover crops did not show any significant effect on fluxes. Interestingly, though, the eddy covariance data showed that the plantation was both a net source and a net sink of carbon during the year depending on the whether the

Spatial variation characterization will be adopted following a collaborative paper recently submitted to Global Change Biology. The paper highlights some similar work and applying useful or similar analysis and methodologies.

Mapping of peat in areas relevant to current project has been established. This is specifically for the project related to Sebungan/ Sabaju. Efforts and initiative has also been explored to work on mapping using Google Earth Engine.

The reasons for different emissions values obtained from different methods were suspected/identified. The eddy covariance method yielded high value compare to other methods were due to a large footprint other than decomposing woody materials factor. This might also due to an unique condition of the site which surrounded by oil palm trees that leads to adjacent effects. Other factors are still being investigated.

Different peat types in the study plots and plantation management might contributed to low yield recorded.
season was wet or dry. This is important data and the PAC were keen to see it published. In the discussion that followed, the IAP noted that the results were almost ready for publication. The IAP wanted to first assure itself of the appropriateness of the flux tower setup and that the proper cross-checks had been undertaken. The PAC noted that these results have been available for more than a year and strongly recommended that this data be published as soon as quality assurance was complete and that this was given priority.

As carbon is not the only, or even the most important, greenhouse gas, the team are also undertaking measurements of nitrogen and methane fluxes. This work, comparing fluxes from a 7 years old plantation on peat with fluxes from a secondary swamp forest is now in its second year. CO₂ flux showed significant differences across different peat types and the PAC agreed that this was a very significant finding that reinforced the importance of peat classification. Root biomass distribution was a significant predictor of soil respiration. There was a very significant dependence of respiration rate on distance from palm trees. This dependence was significant close to the tree (< 1m), but the correlation coefficient fell to 0.13 at distances > 1m. Analysis showed that heterotrophic respiration dominated the flux at distances >1m from the palm by a factor of about 2. This stressed the importance of incorporating spatial heterogeneity in flux measurements in forests. Biochar application was reported to have a surprisingly large effect on N₂O emissions after only 3 days of application. However the results were not statistically significant due to the lack of sufficient replication. This reinforces earlier comments on the need for more statistical input to experimental design. The loss of carbon in the form of DOC was significantly higher in these tropical peatland systems compared with losses in temperate peat soils. Most fluvial carbon is in this form. The losses in plantation and degraded secondary forest seem similar. PAC were impressed by these findings and hoped the results could be confirmed and published as soon as possible. These results, together with those reported above on yield effects, provide further evidence of how different tropical peat systems are from temperate peat systems. It is therefore going to be important to account for the differential effects of different peat types.

**Biodiversity Group**

Results from the biodiversity impacts of peat cultivation were presented by the biodiversity group in two projects that are at an advanced stage of completion.
A biodiversity assessment of three different levels of swamp forest disturbance was undertaken: primary peat swamp forest, secondary peat swamp forest, and disturbed primary swamp forest. This was compared to the same measures in a nearby peat soil plantation. There was a biodiversity gradient from primary to secondary, to disturbed swamp forest as one might expect. Species number is more or less halved between primary and disturbed swamp forest.

The impacts of peat cultivation on water quality and aquatic fauna is important and samples are being collected quarterly in the same locations as the other biodiversity studies. A similar gradient in species richness was observed as above with fish species declining from 32 to 18 species. However macroinvertebrates seem to follow the opposite trend. Results on water quality indicate differences between the different peat systems, except for pH.

The PAC congratulated the biodiversity team on the thoroughness of their work. The Committee reinforced previous comments on the need to create a synthesis of these results and to analyse the data in terms of functional groups that will allow the consequences for ecosystem services to be understood. Furthermore, PAC recommended a new emphasis on biodiversity that not only examined impacts of production on biodiversity, but also created a new synthesis with the benefits of biodiversity on production (IPM) and most importantly of all, to understand how production systems and adjacent non-agricultural land may be managed to optimize production and boost the quantity and resilience of biodiversity.

Summary

In summary, PAC we extremely pleased to see that last year’s recommendation to establish an International Advisory Panel (IAP) had been adopted and welcomed the high caliber panel members. This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. In light of this urgency, PAC support the recommendation of the IAP that additional personnel are transferred to the project to ensure that outputs are accelerated. However the Committee was disappointed that an inordinate delay has occurred between the time of requesting funds to be released for the construction of a flux tower, and the release of the funds by the finance department. We expect that MPOB will regard this as unacceptable given the importance of the work. We were also disappointed that a previous high-level recommendation to make available senior

All the recommendations on biodiversity study were noted.
statistical input to the Biology Division has not been supported, as much of the work of TROPI would benefit from more sophisticated input in sampling design and data analysis. PAC support the view of the IAP, that the publication of high quality and high impact papers is a priority for the group. The PAC noted the significant progress that the biodiversity group had made and the hard work of the team. We urge that this work will see renewed support and, along with the emissions work, start to position itself towards mitigation strategies in the near future.

**Summary of recommendations**

To recap, the PAC recommends that:

1. The PAC welcomed the formation of the International Advisory Panel (IAP) for palm oil in peat. We were surprised to learn that the international members were not aware of the terms of reference for the Group, and urge the MPOB to ensure that these are drafted and agreed by the Group before any further activity is undertaken.

2. PAC supports the recommendation that more human resource is made available to the measurement of stocks and flows in peat soil systems to accelerate outputs, given the urgency with which quality data is required.

3. The TROPI group should make full use of the IAP to ensure the rapid publication of results from the peat soil GHG and carbon stock measurements, and that nothing impedes this progress.

4. In light of recommendation 3, PAC was astonished to find that money allocated for the establishment of the flux tower in Sarawak had not yet been released despite prompt requests having been submitted to finance in response to our Recommendation 1 in the PAC2015 report. PAC requests that the highest-level mechanisms in the organization are used to ensure that the Finance Dept releases these funds without further delay.

5. PAC recommends that TROPI seeks high level statistical input to help in the design of sampling regimes and in the interpretation of measurements. This is in line with recommendations relating to other programmes where input from experts in statistics is required. It is particularly important here, because of the exceptional spatial and temporal variability across all scales. There must be full characterization of spatial variation and this information used...
to design optimal (adaptive) sampling methodologies to improve the statistical power of the sampling.

6. PAC strongly recommends that mapping of peat in areas relevant to Palm Oil production in Sarawak is completed with urgency to ensure that the best information on spatial variability of peat is obtained, both for the purpose of improved measurement of GHG stocks and flows, and to inform better management of peat to increase the unacceptably low yields on peat soil.

7. The PAC noted that results on source-sink relationships for carbon fluxes have been available for more than a year and strongly recommended that this data be published as soon as quality assurance was complete and that this was given priority.

8. PAC recommended a new emphasis on biodiversity that not only examined impacts of production on biodiversity, but also created a new synthesis of this work with work on the benefits of biodiversity on production (IPM) and most importantly of all, to understand how production systems and adjacent non-agricultural land may be managed to optimize production and boost the quantity and resilience of biodiversity in the landscape.

New PAC idea from Dr Trevor Jackson

In 2015, after reviewing extensive data on sightings of the Sumatran rhinoceros, scientists concluded “It is safe to consider the species extinct in the wild in Malaysia” (Oryx 50(2) 2015). The demise of this species has been attributed to human impact and habitat loss and, whatever the direct cause, the extinction of such iconic species is a tragedy for Malaysia and the world. Oil palm is perceived to be the cause of such extinctions through conversion of rainforest to plantation and is a target for criticism from many in the palm oil consuming countries. While the Oil Palm industry has taken a positive and conservationist approach through adoption of the MSPO and RSPO criteria for sustainability and positive conservation initiatives have been developed by individual companies, the perception of palm oil is often tainted by the environmental downside of production.

Last week I was fortunate to see some of the positive initiatives for wildlife conservation from the oil palm industry for wildlife conservation in Sabah. The MPOB team at Lahad Datu and Sime Derby were able to arrange visits to the conservation
programme of the Sabahmas (Wilmar) plantation and the reforestation programme supported by Sime Derby at Ulu Segama. These projects are impressive in their vision and are beginning to have an impact. They show that Malaysia can have both successful palm oil production and a positive wildlife conservation impact.

Where is the role for MPOB in wildlife conservation? MPOB can coordinate efforts for wildlife conservation on and around the oil palm estates. It can develop “best practice” for conservation planning, riparian planting, wildlife monitoring, etc. It can promote wildlife conservation among industry workers. It can coordinate presentation and publicity for positive efforts in the conservation arena.

**Recommendations:** MPOB should;

- take a positive leadership role in promotion of wildlife conservation in and around oil palm plantations.
- appoint an appropriate conservation specialist to PAC
- hold a stakeholder meeting to review oil palm impacts and the potential to enhance wildlife conservation
- establish a pilot programme in key areas for endangered wildlife in Sabah
- use positive results from wildlife conservation to improve the image of palm oil

Some collaborations with NGOs i.e. Wetlands International, Malaysian Nature Society (MNS) and Tropical Rainforest (TRCRC) is ongoing to discuss and initiate projects on these issues.
## INTEGRATION RESEARCH AND EXTENSION DIVISION

### CROP AND LIVESTOCK INTEGRATION UNIT

<table>
<thead>
<tr>
<th>PAC Comments / Recommendations</th>
<th>Response / Actions</th>
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<tbody>
<tr>
<td><strong>1.</strong> Smallholders will have to be persuaded to plant on double avenue system for many of these integration practices, so they can earn more income. Therefore, persuading them to do so will be one of the big tasks to be addressed.</td>
<td>Agreed. Continue to promote double avenue for smallholders through several approaches.</td>
</tr>
<tr>
<td><strong>2.</strong> The research trials must get the benefit of advice from specialists from outside MPOB such as veterinary services, and managers with long experience on specific crops and livestock.</td>
<td>Agreed. This has been practiced and will be continuously persuaded in the future.</td>
</tr>
<tr>
<td><strong>3.</strong> Selected PAC members should be invited to visit the sites and see the trials, and discuss the figures on yield, costs and financial feasibility.</td>
<td>Noted.</td>
</tr>
<tr>
<td><strong>4.</strong> MPOB can be invited to approach PAC members for advice, through email or phone in advance of next year’s presentation on proposed projects.</td>
<td>Noted. This has been practiced for the past several years.</td>
</tr>
<tr>
<td><strong>5.</strong> Some of the papers could have been edited more carefully to reduce errors such as in spelling and grammar, befitting a major research centre.</td>
<td>Agreed and noted.</td>
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### EXTENSION SERVICE UNIT

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<tr>
<th>PAC Comments / Recommendations</th>
<th>Response / Actions</th>
</tr>
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<tbody>
<tr>
<td><strong>1.</strong> Prioritization of extension activities to the smallholders</td>
<td>Several extension service activities was done under Pusat TUNAS to disseminate new technology to the smallholders such as:</td>
</tr>
<tr>
<td>AC is of the opinion that extension activities and support services need to further enhance considering the huge number of smallholders which are spread all over the country.</td>
<td>- Technical lecture</td>
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<td></td>
<td>- Individual Field visits</td>
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<td></td>
<td>- MPOB GAP Certification Field Visit</td>
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<td></td>
<td>- Scheme Assistance Field Visit</td>
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<td></td>
<td>- Evaluation Field Visit</td>
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<td></td>
<td>- Demonstration Plot</td>
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<tr>
<td></td>
<td>- Etc.</td>
</tr>
<tr>
<td><strong>2.</strong> Accessibility of smallholders to ICT facilities</td>
<td>Smallholders can have quick access to the new technology and latest information on oil palm by</td>
</tr>
<tr>
<td>In view of the advance in information and communication technology, PAC is of the opinion</td>
<td></td>
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</table>
that the smallholders should have quick access to information.

- browsing MPOB Website,
- using Sawit SMS info,
- official MPOB Facebook,
- Twitter,
- Youtube,
- MPOB TV,
- Radio,
- Warta Sawit,
- Pamphlet,
- brochure,
- etc.

3. Visits to model farm

PAC commended that more programmed visits for smallholders should be made to model farm to encourage them to adopt modern technology and GAP.

Visits programme and model farms had been include in Tunas Officer's KPI to encourage smallholders to adopt modern technology and GAP.

4. Consistency of 30 tonner club member to sustain high productivity

PAC is concerned about the consistency of the 30 tonner club members to sustain high productivity of their farms

- Continuously monitor 30 tonner club member's FFB yield by TUNAS officer
- 4 seminars have been conducted which involved 30 tonner club members to delivered new technologies about oil palm.

**PROJECT IMPLEMENTATION UNIT**

<table>
<thead>
<tr>
<th>PAC Comments / Recommendations</th>
<th>Response / Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cantas Discount's Schemes (SKIDIC)</td>
<td>Harvesting productivity research is conducted by Farm Mechanization Unit (FMU). However, adoption rate of Cantas usage among smallholders has been carried out by IRED and the result was presented at sub-biology sub-committee in PAC 2016.</td>
</tr>
<tr>
<td>PAC recommends that harvest productivity be monitored and feedback as to breakdowns and problems related to services of machines be recorded with the necessary guidance to overcome their problems so that the adoption of innovative practices are sustained</td>
<td></td>
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<tr>
<td>2. Oil Palm New Planting Schemes</td>
<td>Main cause - smallholder not able to get suitable contractor on time</td>
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<tr>
<td>The causes for the low rate of approved applicants not planting should be identified and addressed. Further, extension services should be provided to monitor and ensure good agricultural practices are adopted in the new plantings.</td>
<td></td>
</tr>
<tr>
<td>3. Farm Roads to Smallholders</td>
<td>To supervise the project together with the implementer agency at the same time to look any issue thoroughly and solve the problems.</td>
</tr>
<tr>
<td>MPOB officers should endeavour to have regular meetings with the implementation group to speed up the implementation of the road projects especially in areas where planting has been completed</td>
<td></td>
</tr>
<tr>
<td>4. Oil Palm Smallholders Fertilizer Aid Scheme</td>
<td>5. Factors affecting FFB production among participants of Quality Oil Palm Seedlings Assistance Scheme (SBABB).</td>
</tr>
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<tr>
<td>a) MPOB should carefully monitor the fertiliser assistance programme and also should recommend judicious rates to ensure optimal yields are achieved. Timely application of fertilizers should also be monitored.</td>
<td>The project has been confined to Sarawak and Sabah. As the study involves a lot of data collection and subsequent analysis, it is best to discuss with the statistical analysis would be reliable for a meaningful interpretation and inferences.</td>
</tr>
<tr>
<td></td>
<td>A committee for fertilizer determination has been established and functioning to recommend judicious rates to ensure optimal yields are achieved well as timely application can be monitored.</td>
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<td>Discussion regarding statistical analysis has been done within co-authors. We also decided to do separate analysis for both state and continue with comparison study.</td>
</tr>
<tr>
<td>NEW PROJECT PROPOSALS</td>
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<tr>
<td><strong>PAC Comments / Recommendations (NPP)</strong></td>
<td><strong>Response / Actions</strong></td>
</tr>
<tr>
<td><strong>1</strong> Mesocarp-specific promoter for genetic engineering of oil palm</td>
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<tr>
<td>This project seeks to isolate and characterise a mesocarp specific promoter from oil palm that could be used to manipulate gene expression in a fruit specific manner in transgenic plants. Tissue specific promoters are a challenge to identify and there may be opportunities to broaden the study to target genes that are particularly highly expressed, rather than solely expressed, in fruit tissues as an alternative strategy. Generalising the target of the work to identifying promoters with strong mesocarp expression at a range of stages of mesocarp expression may be more appropriate. It would also be appropriate to classify the genes that these promoters come from into the sets of co-expressed genes that they are expressed in across a range of tissues and developmental stages. This may help by providing a sequence resource for comparative promoter analysis which in turn may identify key motifs that underpin mesocarp expression. The Subcommittee recognised the potential merits of this project but felt that not all elements of the work were of equal value. In particular, whilst the expression study in tomato was of scientific interest the Subcommittee felt that it would be difficult to draw any definitive conclusions from this part of the programme about the specificity of the promoter in monocot oil palm using this model dicot system and as a consequence it should be omitted. This work package should be replaced by further data mining from the replicated RNA-seq experiments that have been undertaken at different stages of fruit maturation and ripening to explore the identification of a suite of promoters exhibiting some mesocarp specificity at different stages of fruit development.</td>
<td>Effort will be made to identify genes/promoters that have greater strength in targeted tissues but less discrete site of expression. Promoter analysis will be carried out to identify key motifs that underspin mesocarp expression. The Group take note of the comments. Transformation of tomato will be excluded from this study. Data-mining from the RNA-seq experiment still on-going.</td>
</tr>
</tbody>
</table>

**RECOMMENDATION: Grade A FUNDING APPROVED subject to some restructuring of the work packages relating to the project.**
Annotation and development of species-specific markers for Ganoderma

This proposal is linked closely to another from Dr Sundram in GanoDROP. It aims to annotate genes in the four key Ganoderma species (three pathogenic, one non-pathogenic), to develop markers from the four genomes, then validate these markers across samples to be collected from Malaysian estates. The outcome should enable molecular identification across Malaysia of oil palm-related Ganoderma isolates and confirm identity of isolates in the new culture collection. Also, although not given emphasis here, to track infections following artificial inoculations. Microsatellites and SNPs on targeted genes would be identified.

We are supportive partly because in line with the IAPGD review, this work focuses on the key issue of Ganoderma and is collaborative with GanoDROP.

Other comments:
There will be a likely delay in availability of newly collected isolates, which must be identified and microbiologically homogeneous, free from contamination. Therefore hyphal tip procedure must be first conducted. Thought must be given to the start time of this project that runs for just 2 years, whereas the collection and characterisation is planned to run to 4 years.

The time frame needs amending because Phase 1 has already been done but appears in 2018.
The much needed monokaryotic genome is ongoing and availability of this within the time will be important.

RECOMMENDATION: Grade A

The project is being implemented. Isolates from 3 sites have already been collected and some preliminary classifications using ITS had been carried out. These isolates will be used to test the primers.
<table>
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<th>3</th>
<th><strong>Investing the regulation of high-value fatty acid production in oil palm using shotgun proteomics</strong></th>
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</table>
| | The PAC members considered this a worthwhile project and, in general, approved the overall thrust of the work. Clearly, an understanding of the basic biochemistry behind fatty acid biosynthesis is fundamental to MPOB’s work. Successful results from this project would provide useful background information that would aid in the future production of different quality palm oils. The choice of germplasm should be carefully reassessed. It is certainly of interest to compare a set of high and low oleic acid germplasm. However, rather than choosing a relatively arbitrary set of palms it would be worthwhile, assessing whether there is a set of progenies derived from a low x high cross. If this is the case if the progeny have been typed for oleic acid levels then it would be possible at the very least to randomise the effect of background genotype. It might also be possible to use the data to create two phenotype pools to underpin a bulk segregant analysis (BSA). This approach has the potential with appropriate genotype data to extend the study to map potential transcription factors or other factors regulating the process. Though this has primarily been conceived as a proteomics study it is important that tissue sample are preserved to allow for RNA-seq analysis using all the strict sampling required to avoid effects such as confounding the effects of germplasm with diurnal patterns of gene and protein expression. In addition it is important to consider this an open proteomics study without preconceptions of likely target proteins.
| | As a consequence of these comments from PAC members it is suggested that some modification to the work packages take place:
| | • The proteomics should include as many proteins relevant to fatty acid formation as possible.
| | • Samples should be retained to allow parallel metabolomics (and, if necessary, genomics) analysis.
| | Tagging and harvesting of *E. guineensis* fruits (from high oleic breeding populations) are underway. However, some of the selected palms for this study are either being used in other ongoing crossing programs, or the female inflorescences are not available. Hence the sampling progress has been slow. Tagging of *E. oleifera* fruits has not been started.
| | Concurrently, we are looking at the feasibility of SWATH MS approach in profiling the differential expression of fatty acid biosynthetic proteins. SWATH MS eliminates the need of isobaric tags, and thus, may offer a more cost effective solution in a long run. The analysis will be carried out at SCIEX Singapore as a system demonstration due to the inavailability of the MS system (Triple TOF 6600) required to perform the SWATH MS analysis in MPOB. Samples are being prepared for the analysis.
| | In another works regarding the sample preparation procedure, we are also looking at the possibility of finding alternative/replacement to the urea and thiourea components of oil palm protein extraction buffer. The evaluated reagent is more compatible with the downstream MS analyses. Results to date are promising and will be validated further through MS approach. As the high resolution MS system is not available at MPOB, all analyses will be outsourced. |
- Samples to be used should be considered carefully. For example, segregating progeny that have been well characterised in terms of oleate production, would allow the generation of more robust data (not just use of high or low oleate species)
- Although the project is focussed around oleate, other useful fatty acid products could be considered for the future. Thus, palmitoleate which is an useful renewable chemical for industry should be relatively easy to produce given that palm oil is already enriched in palmitate.

**RECOMMENDATION:** Grade A  
**FUNDING APPROVED** subject to some restructuring of the work packages relating to the project as indicated above.
### NEW PROJECT PROPOSALS

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<tr>
<th>PAC Comments / Recommendations</th>
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<tr>
<td><strong>BIOLOGY DIVISION</strong></td>
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<tr>
<td>1 Loose Fruit Collector (B)</td>
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<td><strong>RECOMMENDATION: Grade B</strong></td>
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<tr>
<td>The need for efficient and robust loose fruit collecting machine by the industry has long been proposed but yet to be realised. The portable prototype model proposed by the team need to be reviewed to ensure its durability and effectiveness in separating the LF from the debris mainly decayed organic matter, sands and laterite. It is recommended that the team to evaluate the performance of similar machines previously tested and to carry out the necessary improvements especially with regards to the working mechanisms and the high cost of the proposed LF collector to before project implementation. This is to save on costs and time.</td>
<td>Suggestions are noted.</td>
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<tr>
<td>PAC Members Remarks: To carry on with the project on LF collector but with the necessary change in the project executions as per above.</td>
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<tr>
<td></td>
<td>Mechanical Harvester powered by Electro Magnet</td>
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<td></td>
<td><strong>RECOMMENDATION: Grade B</strong></td>
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|   | The efforts to search for more efficient and cost effective harvesting method is very critical in view of the escalating cost of production and the acute labour shortage encountered by the oil palm plantation owners. The situation is further aggravated with the uncertainties by the policy change imposed by our government on foreign workers recruitments. The new type of FFB harvester proposed is expected to be more costs effective, cheaper and the machine is expected to address problem on the tall palm harvesting. The new harvesting machine will be a hybrid powered with electro magnet compared previously using fuel and hydraulic transmissions and will use lighter and stronger composite material. In view of the difficult working environments in the plantation with undulating steep terrain and soft soggy ground conditions, it is crucial that the team develop and adopt proven technology. Preferably those that are already in the market but not necessarily those that were used in the plantation industry. For example automation and robotics systems that are used in the automobile assembly plant etc. In view of the urgent need by the industry for efficient, cost effective and robust harvesting machine, it is strongly recommended that team to establish collaborations with other experienced bodies through smart partnership, namely the manufacturers and fabricators both locally and overseas and fabricators for the transfer technologies. This may be done through appropriate MOU between MPOB with the respective players including the manufacturers/fabricators, plantation owners and higher learning research institutes. Such an arrangements will facilitate technology transfer and fast track the proposed projects urgently needed in the plantation industry through the usual “Win Win” tripartite business arrangements. Remarks by PAC Members: Project to carry on with the necessary improvements as mentioned above.

Comments by committee were noted and to cater for challenging ground such as peat and soft area, the use available technology will be looked into so that prototype that will be developed should be able to traverse on various ground conditions.
<table>
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<th>3</th>
<th>Development of molecular diagnostic tools for detection of BSR in oil palm</th>
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<tr>
<td>Madiah Ahmad Zairun et al</td>
<td>Project duration 3 years. Cost 326,000RM</td>
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<tr>
<td>This proposal describes the use of defence-related genes expression to detect BSR infection, using qRT-PCR and RT-LAMP.</td>
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<tr>
<td>The IAPGD review has already expressed significant concerns about this approach. The genes are expressed generally to many pathogens and sometimes to abiotic stresses. The chances of any gene expressed specifically to <em>Ganoderma</em> are slim, and cost and applicability under field conditions are questioned.</td>
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<tr>
<td>We do realise the potential of LAMP detection in the field but only after discriminatory genes have been identified.</td>
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<tr>
<td>The presentation provided extra information to the written version in terms of soil detection for <em>Ganoderma</em>, and the testing of stressed plants.</td>
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<tr>
<td>Looking ahead, development of LAMP targeting the pathogen itself might be worth exploring for use with natural infections and with artificial inoculations to track route of infection and rate of colonization. Also the late inclusion of soil detection could be valuable.</td>
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<tr>
<td>Grading C</td>
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<tr>
<td>Collaboration research project defense-related genes expression to detect <em>Ganoderma</em> disease in oil palm will be carried with ABBC Division, MPOB.</td>
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</table>
4  Suppression of *Fusarium* wilt of oil palm by non-pathogenic *Fusarium oxysporum* species and other microorganisms recovered from a disease suppressive soil.

Mohd Hefni Rusli et al  
Duration 3 years. Cost 250,000 RM  
*Fusarium* wilt remains a threat to Malaysia, yet has never appeared here in spite of myriad seed being planted before quarantine was enforced in the 1970s. This proposal asks the interesting question as to whether the absence reflects *Fusarium*-suppressive soils (which are known elsewhere). The study cannot be conducted in Malaysia, so Cameroon is suggested as the host location and laboratory.

This is a potentially highly complex study involving analysis of soil, rhizosphere and root (endophytic) microflora. Some methods for microbial profiling were questioned along with practicality of soil transportation and facilities of the Cameroon lab(s).

Overall this remains a potentially interesting study, but especially in light of the IAPGD recommended focus on *Ganoderma*, it is not supported at this stage  
Grade C  

Noted.

5  Development of integrated airborne hyperspectral and 3D tomography for detection of *Ganoderma* disease in oil palm  

RECOMMENDATION: Grade A  

Mohd Izzuddin bin Anuar  
4 years cost 1.1 million RM  
Benefits to industry and epidemiologists of widespread disease detection are clear. This detailed and well researched and presented proposal offers some hope for successful detection of BSR. It is robust in terms of linking aerial survey with disease assessment at ground level as symptoms and extent using 3D tomography.

The approach is in line with recommendations made in the IAPGD Review with regard to detection and modelling the disease.  

Noted.
|   | Dual efficacy of hymenomycetes in degrading oil palm generated wastes and controlling BSR caused by *Ganoderma*  
R. Yuvarani Naidu et al  
3 years. Cost 250,000 RM  
Removal of diseased stumps of oil palm is often a major issue, especially on difficult terrain or for large companies. Rapid degradation of the chipped wood should reduce the problem and possibly eliminate residual *Ganoderma* inoculum.  
This proposal describes use of several hymenomycetes. The proposal includes a significant academic component (e.g. lignase production, secondary metabolites) that would be linked to the proposer’s PhD training experiences.  
The disturbing aspect is that a closely related funded project was performed within the last few years by the Biology Division Applied Microbiology group. Yet no mention is made of this. That study has not been put into practice, so is the approach flawed or did it need further development?  
We cannot be supportive of projects that fail to build on previous ones or show no apparent awareness of their existence.  
The approach might be a valid one, but it needs to be joined up and convincing to obtain support. Perhaps a future proposal might be more discerning. IAPDG recommendations include the need to understand where and for how long *Ganoderma* inoculum survives in the field.  
Grade C | A new proposal to study the epidemiology and aetiology of *Ganoderma* pathogenic to oil palm is being drafted to be presented at the next PAC 2017. |
| 7 | **Investigation of UVC radiation on induced disease resistance in oil palm against major oil palm diseases**  
Shariffah Muzaimah Syed Aripin et al  
4 years. Cost 760,000 RM  
This proposal offers an interesting concept that is being trialed in other species. The work would be primarily performed at University of Nottingham with associated costs.  
Overall we consider this to be an academic study that is best confirmed first with other more tractable plant-disease models. Certainly *Ganoderma* does not offer a model system.  
Suggestions of influencing soil microflora appear to be a digression from the main theme of induced resistance. Note that inclusion of *Phytophthora* is probably no longer valid because of failure to obtain disease symptoms.  
Grade C | Noted. |
**Updating the systematics of diversity of *Ganoderma* based on morpho-taxonomy, ultrastructural, biochemical and molecular techniques**

**RECOMMENDATION: Grade A**

Shamala Sundram et al  
4 years. Cost 450,000 RM  
There is a long overdue requirement for GanoDROP to obtain and maintain a reference culture collection of the key *Ganoderma* species. This need was highlighted in the IAPGD Review.

The utility of such a collection will be to test then provide isolates with degrees of aggressiveness for [1] screening for disease resistance/tolerance [2] understanding pathogenicity. Also in conjunction with proposed work on molecular characterization by Dr Low in ABBC, confirmation of the identity, location and frequency of the 4 (or more?) species will be possible. This collaboration between divisions is also underlined by IAPGD as crucial for progress with *Ganoderma*.

Arguably the collection should focus on the key species, which most agree is *G. boninense*.

It will be crucial to ensure that isolates to be subjected to ‘omics are microbiologically pure. The equivalent of a single spore culture (not possible with *Ganoderma*) is hyphal tip isolation. Culture and storage conditions must quickly be optimised for long term survival and at least two staff trained in re-isolation and periodic transfers. Evaluation of aggressiveness of isolates will be a long job and here, focus on optimisation of the screening technique (see IAPGD report) will be crucial. Your proposal cites the germinating seed technique, yet that did not yield significant results in contrast to 4 and 12 month seedlings; please amend.

The ABBC molecular analysis of the four species will require cultures in the near future.

Note that the last half of the proposal cites references that are not listed in the bibliography. Please amend this as reviewers cannot access those references to check methods etc.

The section on spores seems completely out of place here and should be removed. The role of spores (see IAPGD report) warrants a separate proposal and this study should be made in the very near future.
| 9 | **Potential Impact of Climate Change and Related Factors on Oil Palm Growth and Productivity.**  

RECOMMENDATION: Grade A  

This project aims to use a model-based approach to create yield gap maps to help identify areas where palm yield is significantly below the potential water-limited yield, and therefore to prioritise extension effort to improve profitability, particularly relevant to smallholder plantations. The approach will also be used to predict likely impact of climate change on future production levels.

This project is well designed and the Committee are pleased to see that this project builds on a previous recommendation by PAC to develop the modelling capacity and capability in MPOB. We are particularly pleased to see that more than one modelling approach will be used from the outset for evaluation purposes. There are many advantages to using an ensemble of models to help improve prediction and estimation of uncertainty. The co-researchers have some experience in the use of models, however the Committee felt that maximum benefit to the project and to the MPOB would come from using this project to begin to build an international network of collaborators in modelling. We therefore recommend that links are made to the crop modelling group at Rothamsted Research in the UK where similar work has been undertaken targeting arable crops, and through them to experts the Universities of Reading and Bristol where additional expertise in the models proposed for this study reside. PAC member Crawford will facilitate these links and will offer support to the team as required for this work.

For Grade C projects in the Ganoderma area, we suggest that relevant officers propose new projects that are aligned with the recommendations of the International Review Panel within the next 6 months.

Comments are noted and action will be taken along the lines recommended.

From the email communication with Prof. Dr. John Crawford on 15 April 2016 notes that he is happy to offer the services of the Rothamsted crop modelling team as required to help with progress. He is also happy to host a visit of MPOB scientists at Rothamsted when appropriate, as well as to facilitate visits to other labs including that of Dr Hensen and those at the University of Reading where Rothamsted already has close formal links.

Noted.
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<th>NEW PROJECT PROPOSALS</th>
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<td><strong>PAC Comments / Recommendations</strong></td>
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## PROGRAMME ADVISORY COMMITTEE MEETING
### 36TH MEETING: 15 APRIL 2016

#### MATTERS ARISING OUT MINUTES AND REPORTS OF 36TH MEETING

**FOOD, NUTRITION AND QUALITY SUB-COMMITTEE**

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<tr>
<td></td>
<td><strong>General Comments</strong></td>
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</tr>
<tr>
<td>i.</td>
<td><strong>i. GCMS/MS Triple Quadrupole</strong></td>
<td>Due to financial constraint and the urgency of other project requirements, purchase of GCMS/MS in ARG has been put on hold temporarily.</td>
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<td>The SC enquired on why the process of acquiring GCMS/MS took almost one year (from last PAC meeting in 2015).</td>
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<td>The SC was informed that the tendering process is on-going. The acquiring process took longer time due to sourcing of fund. The tender has been opened on 4 April and will be closed on 21 April 2016.</td>
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<td>ii.</td>
<td><strong>3-MCPD esters</strong></td>
<td>There is no information so far on any estates that is applying chloride-free fertilizer. A further discussion with planters, had noted that all estates still apply MOP since the price of chloride-free fertilizer is 3 times higher than MOP.</td>
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<td>The SC commented that the muriate of potash (MOP), a common fertilizer used in estate, is the source for chloride. Some estates have started to apply chloride-free fertilizer e.g. potassium sulphate</td>
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<td>iii.</td>
<td><strong>Analysis of MCPD and glycidol esters</strong></td>
<td>Additional manpower was acquired and proposing to purchase a back-up instrument is in progress.</td>
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<td>There are a number of new and ongoing projects that require the analysis of MCPD and glycidol esters. It appears that the samples that will be generated</td>
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<td>for this analysis will increase continuously in the near future. As the issue with MCPD esters is</td>
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<td>regarded as a priority area, MPOB should consider upgrading the resources to serve this need. The</td>
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<td>following may be considered:</td>
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<td>- Additional manpower that can be trained to provide the analytical service to researchers on a</td>
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<td>routine manner.</td>
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<td>- Back-up equipment that can ensure continuity of analysis and no downtime.</td>
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<td>iv.</td>
<td>Communication</td>
<td>The information was disseminated during the Interaction with Industry: Forum on 3-MCPD and Glycidyl Ester, which was held on 1st July 2016.</td>
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<td>It is proposed to disseminate information to the industry on the good practices to reduce 3-MCPDE and GE</td>
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<td>levels during processing.</td>
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<td>v.</td>
<td>Centralized Lab</td>
<td>Two (2) quotations were obtained from overseas core facilities control software vendors. The cost for setting up of such system to control</td>
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<td>The SC would like to commend on the organization of the PDAS Virtual Centralized Lab; this will serve</td>
<td>about 20 instruments is more than RM100,000 per year.</td>
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<td>to provide efficient response to requests for various analysis. With the LIMS in place, the SC</td>
<td>Currently booking of equipment is being done on manual basis due to financial constraint.</td>
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<td>looks forward to receive a progress report on the management of laboratory workflows.</td>
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| vi. | Feedback on poster session  
- Generally good set up allowing for detailed discussions  
- The feedback should be in a different format instead of 'post its'  
- Some posters are not of sufficient quality, the information on the poster is sometimes incomplete. | No action required. |

**Acknowledgement**

The Chairman and the SC members would like to thank the Director-General, Senior Management Staff, Research Officers and Administrative Staff for their co-operation and support during the tenure of the SC (2014 – 2016).

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**APPENDIX I**

**Food, Nutrition and Quality Sub-Committee**

**NEW PROJECTS**

1. PD211/16 - Mitigation measures for 3-MCPD ester: Identification of sources of chloride at plantations and palm oil mills.

In light of possible external pressure it is recommended that the project focusses on MCPD and is fast tracked. Attempts to execute the project within 6 months

The effect of MOP and chloride-free fertilizer will be studied. EFSA had published a report on risks for human health related to 2- and 3-MCPD and their esters and GE in food in May 2016. The
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<td></td>
<td>with focus on chlorine and its organic sources are encouraged.</td>
<td>Report derived a TDI of 0.8 µg/kg bw per day for 3-MCPD which will be proposed to the relevant authority for implementation.</td>
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<td></td>
<td>The SC commented that overripe palm fruitlets contribute to high level of organochlorine content, which is more reactive for the formation of 3-MCPDE.</td>
<td>Collaboration project with FGV has started. Crude and refined palm oil samples and water samples have been collected from a mill and refinery located in the southern part of the Peninsula. The crude oil will be analysed for FFA, Dobi, Cl, phosphorus, TAG and DAG content while the refined oil will be analysed similar to crude except DOBI. The water samples will be analysed for Cl.</td>
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<td>The SC suggested to look into chlorine-free fertilizers such as potassium sulfate for comparison.</td>
<td>(Priority A)</td>
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<td></td>
<td>The SC informed that EU is going to implement the limit for 3-MCPDE and GE, contents most probably by mid 2016. Nevertheless, the methods for quantification of 3-MCPDE and GE need to be harmonized before implementing the limit.</td>
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2. **PD207/16 - Study on the development of 3-MCPD Esters and Glycidol Esters During Frying**

The SC emphasized that degradation of 3-MCPD is due to the polarity of oil upon frying.

The SC suggested to also identify oxidation or degradation products in the oil during frying by using non-targeted method such as by LCMS/MS or LCQTOF. This is to broaden the scope of the oxidation / degradation products in the oil during frying will be analysed using LC-MS/MS method in the later part of this study.
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<td>of the research. To this end the chemistry of frying should be looked into in detail.</td>
<td>Heating of oil without food product was carried out as part of control experiment.</td>
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<td></td>
<td>In order to have a better reference that monitors the generation of MCPDE and GE in the oil it is suggested to additionally use a wet neutral carrier material as standardized frying material. This is so because hydrolysis is necessary to create the partial glycerides. Possible neutral frying material are for example cotton balls containing predetermined levels of moisture (recommended to check the literature for other options).</td>
<td>Fresh cooking oil was analysed for 3-MCPDE and GE content prior to the frying process. There were four different types of cooking oils used in this study: Palm olein, Sunflower oil, Soybean oil and Canola oil, with initial values of 3-MCPD esters were 2.68, 0.01, 0.05 and 0.01 ppm, respectively. Preliminary data indicated that both 3-MCPD esters and Glycidol esters compounds were found to be reduced after frying process.</td>
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<td>The SC proposed to utilize 2 different palm oleins, one with lower 3 MCPDE and GE content and one with relatively high levels as frying media. It is recommended to also use high oleic sunflower oil as a reference oil because there is a study claiming its superiority in frying with respect to MCPDE formation.</td>
<td>The 3-MCPDE and GE contents were analysed in both frying oils and extracted oil from the food product. Analyses in progress.</td>
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<td>The SC suggested to identify whether the decrease in the 3-MCPDE and GE level in frying oil is due to the migration</td>
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<td>onto the product surface or chemical reactions. Another recommendation is to explicitly add chlorine (salt) to the fried food as additional experimental parameter to stimulate MCPD/GE formation. This could as well be done with the model frying materials by wetting the material (cotton) with salt water. The SC is further concerned with the possible adsorption of the contaminants to the food matrix. This sheds doubt on the reliability of assessing the MCPD levels by soxhlet extraction. The determined contaminant levels might not reflect the level in the food. This needs to be checked/validated. <strong>(Priority A)</strong></td>
<td>The recommendation to add chlorine to the fried food with model frying materials will be looked into details. At this moment, the aim of this study is on the effect of frying different type of cooking oil and food product on the formation of 3-MCPD esters and Glycidol esters. Possible adsorption of these contaminants in the food will be looked into details. Preliminary data on the levels of 3-MCPD esters in food matrix such as margarine and shortening is within the range of 0.01 – 2.2 ppm. As for this study, extracted oils from French fries is being analysed for 3-MCPD esters and Glycidol esters content.</td>
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3. PD212/16 - Influence of polyglycerol fatty acid ester on the thermal properties of palm olein under extended frying conditions. The SC suggested to study different grades of palm olein produced by different companies, *i.e.*, melting point, cloud point, iodine value. The need to use PGE to suppress crystal formation and hence cloudiness in cold stored oil might correlate with the level of DAG’s. Effect of PGE on the cold stability of different grades of palm olein (IV 58, IV 60 and IV 64) has been studied and reported by Basker (2015). The oil samples were added with different dosages of PGE (0.05% to 0.4%) and stored at 15, 18 and 20 °C. Inclusion of PGE significantly improved the clarity of palm olein over
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<td>The SC suggested to study the cause of reduced color formation for palm olein with PGE added when subjected to frying. It is unclear if this is due to the presence of diglycerides or other partial glycerides, chemical reaction or just physical phenomena (emulsification/concentration). The SC agrees with the necessity to understand what the consequences of PGE addition to palm olein are during frying applications. (Priority A)</td>
<td>storage times. By taking 15°C as the study case, palm oleins of IV 58, IV 60 and IV 64 remained clear for up to 15 days, 39 days and 99 days, respectively when compared to samples without PGE (1.2 h, 2.9 h and 2 days, respectively). With regards to DAG content, Siew (2011) reported that the diacylglycerols (DAG) were insignificantly higher when the IV increases. The mean values of DAG content in palm olein of IV &gt;60, IV 60-64 and IV 65-67 were 5.3%, 6.4% and 7.1%, respectively. Correlation between colour changes and other quality indices including DAG content will be identified after all frying experiments have been carried out. The PGE is mainly added to palm olein – hereafter referred to as cooking oil – with the aim to delay crystallisation due to storage at chilled temperatures. Since cooking oil is widely used for frying applications, it is therefore essential to investigate the effect PGE inclusion in palm olein upon extended frying.</td>
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<td>4.</td>
<td>PD208/16 - Development of multiresidue analytical method for the determination of triazole fungicides in palm oil matrices</td>
<td>The project used only LC-MS/MS for determination of triazole residues in palm oil matrices.</td>
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<td>The SC suggested the researchers focus on using LC-MS/MS alone for the project, this is because the use of GC-μECD requires a further confirmation step in compound determination.</td>
<td>QυEChERS matrix enhanced matrix (EMR) removal kit has been studied. After discussion with the application chemist, it was found that the kit may not be suitable for sample with fatty content &gt;70%.</td>
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<td>The SC suggested the use of QuEChERS matrix enhancement removal method specific for oil to reduce effect of matrix enhancement in palm oil matrix.</td>
<td>Q-oil method has been referred and tested. Nevertheless, further optimization still required to obtain accurate results.</td>
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<td>The SC suggested to refer to the Q-oil developed by EU reference lab methods. Although this is not specific for palm oil, it may just need a slight modification, which has been suggested.</td>
<td>Carbon 13 modified standard are currently being sourced and will be used as internal standards in method development.</td>
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<td>The analysis using LC/MS/MS requires 1-2 internal standards (depending on where it elutes in the chromatogram); deuterated or a carbon-13 standards of any of the 7 triazole fungicides may need to be acquired for this purpose.</td>
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<td>The method using LC/MS/MS should be elaborated with regards to acquisition</td>
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<td>mode (MRM of fullscan MS/MS), which column will be used as well as the mobile phase that will be used. The type of instrument used will influence the extraction protocol that needs to be developed. Seeing that the project is on the fungicide residues in palm oil, it is sufficient to analyse these in palm oil matrices; it is not necessary to analyse other oils (olive, sunflower, corn, etc) as the matrices are similar. Method development and analysis in palm oil is the focus of this proposal and comparison with other oils is not necessary. (Priority A)</td>
<td>Optimization of LC and MS/MS parameters has been completed and it is currently being used for analysis. Method development and analysis of triazole residues will focus only in palm oil matrices.</td>
</tr>
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<td>5.</td>
<td>PD214/16 - Nutritive values of treated oil palm frond and empty fruit bunch as the potential feedstuff for ruminant. The SC suggested to check the cost of mixtures and treatments on the samples to be used in this study because the expected expenditure reported is quite low. Cost of analysis should be included in the proposed budget.</td>
<td>The expected cost of analysis for mixtures and treatments of OPF and EFB is about RM450 per sample per treatment. The percentage of combined mixture for the inclusion into animal feed database / formulation will be determined after the analyses complete.</td>
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<td>The SC also suggested to run the project by reviewing the percentage of the combined mixture of the treatment groups instead of running all the treatments simultaneously.</td>
<td>(Priority A)</td>
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</table>
| 6.  | **PD215/16 - The efficacy of crude palm oil in broiler feed ration and comparison with other palm fats available in the market.**                                                                                                                                                                                                                             | Soybean oil has been added in broiler starter and grower feed formulation at 3.5% and 4.0%, respectively. The researcher will look into the possibility to use the interesterified palm olein in broiler ration as suggested by the SC.  

The SC suggested to add other oils such as soybean oil and rice bran oil for comparison with other palm fats used in this study as they are of importance to importing countries.  

The SC informed that there is a study conducted by Dr Neo from Soon Soon Oil Mills on the usage of interesterified palm olein which provides a higher metabolizable energy than palm olein and found that the interesterified palm olein is suitable for animal feed.  

( Priority A)
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<td>7.</td>
<td>PD213/16 - Crystallisation behaviour of palm olein for cold stability improvement with the addition of a legume seed oil.</td>
<td>Based on PAC comments and a discussion with one of the co-researchers of the project, it was decided that the focus of this project will be to improve the cold stability of palm olein through dilution and crystal retardation with the addition of WBSO. This is due to the fact that the effect of seeding and seeding material on fractionation of palm olein has already been studied by another researcher. Hence, the new project title will be “Crystallisation behaviour of palm olein for cold stability improvement with the addition of legume seed oil”. The objectives of the study is to help in enhancing crystallization in very minute crystal and stop further secondary crystallization. It also will help industry to overcome oil separation during transportation to cold countries.</td>
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The SC suggests after having assessed the properties of winged bean seed oil (WBSO) - triacylglycerol (TAG) and diacylglycerols (DAG) - to reformulate the project outline. It is recommended not to study WBSO for the purpose of improving the olein fractionation. Properties of WBSO give little support for a hypothesis that this is actually beneficial.

Alternatively the SC recommends to study in detail the different options for improvement of the fractionation for the production of superolein. Different means to improve fractionation have been studied primarily for palm oil fractionation. Basic options are:

- a) dissolution of higher melting material. It is not clear what the best composition of this material is; FA composition of tri-, or di-saturated TAG’s.
- b) Seeding performed in powder form.
- c) use of emulsifiers influencing the crystallization process.
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<td>It is recommended to evaluate the existing literature thoroughly and design an experimental program accordingly. Consequently the project title has to be adjusted.</td>
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<td>(Priority B)</td>
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<td>8.</td>
<td>PD216/16 - Effect of Empty Fruit Bunch (EFB) oil on the bleachability and fractionation of palm oil</td>
<td>To meet the targeted oil extraction rate (OER) of 23.0% by the year 2020, palm oil mills are encouraged to install screw press facility to extract oil from empty fruit bunch (EFB). The suggestion is highlighted in the entry point project 4 (EPP 4 - Increasing the Oil Extraction Rate). The extract, which is also known as EFB liquor, contains mostly water and some oil. The liquor is normally added to the CPO extraction system at the clarification stage where the water from the liquor can be used for dilution while the oil can increase the OER of mills. Addition of the EFB liquor into the CPO extraction system has become a common practice in some mills. However, the effect of the EFB liquor on CPO is unknown. Therefore, the aim of the project is to study the effect of EFB oil on the bleachability and refining of CPO and also to study its effect on the fractionation of the resulted refined oil. It is never the</td>
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<td>The committee emphasized that adding poor quality oil into the processing stream (cycle) will result in inferior end products.</td>
<td>intention of the project to propose the blending of EFB oil with CPO to the industry as it has already become a common practice nowadays.</td>
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<td>Furthermore, incorporation of EFB liquor would also increase the amount of 3-MCPDE in the refined oil. It is recommended to search for other options to increase OER without affecting oil quality.</td>
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<td>The SC was informed that this research would provide guidance to the industry that adding EFB liquor into the system is not recommended. Thus the objective is certainly not the formulation of safe blending rules but rather the documentation of the risks and consequences of adding an oil of really low quality to good quality CPO.</td>
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<td><strong>(Priority B)</strong></td>
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<td>9.</td>
<td><strong>PD217 /16 - Chewable tablets fortified with palm vitamin E.</strong></td>
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<td>The SC commented that single supplementation is not preferable and suggested a multi-supplement chewable tablets instead. The SC was informed that the chewable tablets could also be fortified with vitamin C and vitamin A(carotene).</td>
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|     | The SC also suggested that:-  
|     | i. The term “palm tocotrienols or TRF” be used instead of palm vitamin E.  
|     | ii. Other analyses *i.e.*, dermatology, radioprotection and neuroprotection should be looked into.  
|     | iii. The bioavailability protocol should be fine-tuned.  
|     | (Priority B) | i. The title has been changed to “Chewable tablets fortified with palm TRF”.  
|     |  
|     | i. The title has been changed to “Nutritious granola bar fortified with palm TRF”.  
|     | ii. The protein, fibre, vitamins and calorie content of the bar will be determined. |
| 10. | **PD218/16 - Nutrition bars fortified with palm vitamin E.** |  
|     | The SC requested that more information on other nutrients *e.g.*, protein, fibre, vitamins and calories be provided. It also suggested that free sugar content be declared and the term “palm TRF or
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<td>tocotrienols” be used instead of “palm vitamin E”.</td>
<td>iii. The free sugar content will be declared. The bioavailability protocol will be revised.</td>
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<td>The SC questions the bioavailability in this food format. (Priority B)</td>
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<td>11.</td>
<td>PD219/16 The Effect Of Biscuits Containing Red Palm Oil On School Children With Vitamin A Deficiency In East And West Malaysia.</td>
<td>A randomised controlled trial will be undertaken and a control group will be added.</td>
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<td>The SC informed that the vitamin A deficiency is more prevalent in children less than 5 years old.</td>
<td>The comment is noted and the children will be closely monitored by doctors in the study.</td>
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<td>The SC commented that if the study is not a randomised controlled trial with a control group to compare to; it will be more difficult to publish.</td>
<td>A sample size calculation will be conducted based on the recently completed China study and study by Al-Mekhlafi et al., 2010 as advised by PAC members.</td>
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<td>The SC commented that the children will be susceptible to gastro-intestinal infection which will affect the absorption of vitamin A.</td>
<td>No publication or documentation is available on the prevalence of low retinol levels among the children in plantations, hence the recent study by Poh, Ng et al. 2013 will be used to identify the under-</td>
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| 1   | The SC suggests to study a smaller group, possibly within the population on plantations. Further details  
• Need for a randomized control trial.  
• Clustered trails at different locations.  
• Materials ordinary PO/Refined PO and Carotino. Make sure appearance equal.  
• Dosage biscuits administering possibly 3 times a week at high dosage  
• Attendance in school to be normalized (asked)  
• Overall design needs to be simplified to reduce work and costs.  
The primary and secondary outcome need to be defined.  
(Priority B) | privileged population/school with low retinol levels.  
• A randomized controlled trial will be undertaken.  
• Clustered trials at different schools will be done.  
• All commented have been noted and the protocol will be revised accordingly with defined primary and secondary outcomes. |
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| 12. | **PD220/16 - Effect of Palm Carotene Mix on Molecular Targets Implicated in Human Disease: A High Throughput Screening Approach.**                                                                                  | The SC enquired on the delivery of carotene mix to the cells and was informed that carotene mix will be dissolved in tetrahydrofuran for cell culture.  
    The SC queried on the composition of carotene mix and has been informed that the carotene mix is mainly composed of 56% β-carotene, 32% α-carotene and others.  
    The SC enquired on the aim of this study and was informed that this study will serve as a basis to guide future animal and clinical trials of carotenes. The SC commented that the lack of breakdown product, metabolites and binding proteins in cell studies will affect the translation to clinical trial.  
    This will be looked in detail in future *in vivo* and clinical studies.                                                   |
| 13. | **PD221/16 - Assessment of 3-MCPD fatty esters (3MCPDE), Glycidyl Esters (GE), 3-MCPD and Glycidol after feeding with prolonged frying palm olein in animal model**                                             | The PAC SC suggested using other oils for comparison, e.g: corn oil.  
    This is project has been discontinued.                                                                               |
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|     | The PAC SC commented that lower level of 3-MCPDE and GE across frying time could be due to their migration to the fried product.  
The SC was informed that this study will monitor the bioavailability of the two esters. In order to conduct proper toxicology study, the PAC SC emphasized that the expected cost would be 10 times higher than the proposed expenditure.  
The SC enquired on how to differentiate the effects of other compounds that are toxic other than 3-MCPD in this study. | (Priority C) |

**APPENDIX II**

**On-Going Projects**

1. **ANALYTICAL & QUALITY DEVELOPMENT UNIT**
   
   **Programme: Life Cycle Assessment**

1.1.1 **PD175/14 – Method Development for Determination of Metsulfuron Methyl in Palm Fruit Oil and Palm-Based fatty Acids**
   
   The SC members are generally satisfied with the progress of the project and agree to close the project.

   Project completed, viva report under preparation.
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<td>1.1.2</td>
<td>PD176/14 - Development of a Method for the Analysis of Dimehypo Residue in Palm Oil</td>
<td>Based on recent discussion with Biology Division, it was informed that the potential company to bring in this new insecticide has withdrawn from the project. Therefore, it was decided not to continue with this project. Project will be closed once the method for the determination of nereistoxin has been developed. Project was put on hold due to the unavailability of time slot for LCMSMS-QQQ usage. Discussion with PIC of LCMSMS-QQQ was done to sort out the schedule for the instrument.</td>
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<td>1.1.3</td>
<td>PD177/14 – Method Development for the Determination of 2,4-Dichlorophenoxy Acetic acid in Palm fruit Oil and Palm Based fatty Acids</td>
<td>All standards required in this project have been received. Project will be continued by other researcher in the team. Principal researcher for this project is expected to give be on maternity leave starting on September 2016. Standard of 2,4-D in esterified form has been purchased and the method is being developed at the moment.</td>
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The SC suggested to study the conversion rate of dimehypo to its metabolite, nereistoxin during sample preparation and injection.

The SC recommended to verify the method developed using esterified 2,4-D standard and modify the method if necessary.

It is also important to study the possibility of finding of 2,4-D in its esterified form, and the method of analysis may be developed accordingly.
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<td>1.1.4</td>
<td>PD178/14 – A Survey on Quality of Crude Palm Oil in Malaysia</td>
<td>Majority of samples received have been analysed. Data analysis is in progress.</td>
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<td>The SC commented that adding of QC data to the table is useful when presenting results of MCPD levels for quality purpose. This will illustrate method efficiency and extraction recovery. It is possible to use LOD as QC level</td>
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<td>1.1.5</td>
<td>PD193/15 - Development of phytonutrient-rich bread incorporated with oil palm leaves</td>
<td>It was decided to maintain the mobile phase composition. However, a new gradient system is being optimized so that the peaks of catechin and epicatechin are better separated. Other compounds present in the extract are also being identified.</td>
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<td>The PAC-SC commented that this work has illustrated a number of components within the OPL. The LC peaks appeared to be concentrated within 0.5 minutes. In that regard it is recommended to change mobile phase composition and gradient conditions to spread the peaks across 3-5 minutes instead of 0.5 minutes.</td>
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| 1.1.6 | PD194/15 - Development of Multi-residue Method for the Determination of Pesticides and Chemical Contaminants in Palm-Based Fatty Acids | The SC commented that the peaks appeared to have some tailing even with pure standards. Care of columns should be practiced to preserve the C18 column. The mobile phase composition and gradient should be optimized to improve peak shapes.  
LC method optimization for better peaks separation is currently being carried out. New column and LC solvents profile are the two main subjects in this optimization.  
Several methods of extraction will be tested to avoid ion suppression in the analysis.  
QuEChERS products with enhanced matrix removal (EMR) will be purchased and tested. |
<p>|       |                                                                                     | Researchers need to include the actual method so that optimization can be suggested.                                                                 |
|       |                                                                                     | It may be useful to look at other QuEChERS products with enhanced matrix removal (EMR).                                                                                                      |
| 1.1.7 | PD130/09 – Assessment of Mycofloral and Mycotoxins In Palm Kernel Cake/Meal Produced In Malaysia | No comments from PAC                                                                                                                                                                             |
|       |                                                                                     | Programme: Food Safety                                                                                                                                                                           |</p>
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<td>1.1.8</td>
<td>PD149/10 - Determination of Na, Mg, Al, S, K, Ca, Ni, Zn, Sb and Hg in Palm Oil by ICPMS</td>
<td>Calibration curve for the 10 elements were established and optimized to obtain good linearity of more than 0.9990. Calibration standards were prepared in mix elements solution at 5 different concentrations which were 0.5 ppb, 1 ppb, 5 ppb, 10 ppb and 20 ppb.</td>
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<td>The SC commented that the calibration curve used for all 10 elements may not be appropriate as a few like Hg would be expected to be at very low levels. So a calibration solution from 0.5-10ppb may be more appropriate. Researcher should refer to past analysis of palm oil.</td>
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<td>1.1.9</td>
<td>PD168/13 - A reliable and Sensitive Method for Determination of Paraquat in Oil Matrix and Investigation of Its Residue in Palm Oil Products</td>
<td>The validation of the developed method is in progress using crude palm oil (CPO) as the matrix. 3 QC levels have been</td>
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<td>It is proposed that the points for the calibration curve be revised, have a blank sample as zero concentration and have one point below the cut-off unit, for example 0, 0.05, 0.1, 0.2, 0.4, 1.0 and 2.0ppb.</td>
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<td>The condition for LC needs to be changed so that the peak does not elute at the solvent front. Perhaps changes in the mobile phase condition or use of a gradient instead of isocratic separation will improve the analysis.</td>
<td>The mobile phase condition has been changed to gradient separation.</td>
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<td>The analysis is ready for validation; one matrix is sufficient for full validation with 3 QC levels at LOQ, mid point and upper</td>
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<td>limit. For other matrices, a verification (one-day) is sufficient with 2 QC levels.</td>
<td>selected at LOQ, mid point and upper limit.</td>
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<td>1.1.10</td>
<td><strong>PD180/14 – Study of 3-MCPD esters and Glycidol Esters in Vegetable Oils</strong></td>
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<td>The SC suggested that a table with RSDs, etc. would be beneficial.</td>
<td>New recovery table was prepared with RSD.</td>
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<td>The SC commented about the good accuracy and agreement of the results with Eurofins and SGS. It may be nice to know which method is adopted by these two labs.</td>
<td>SGS adopted AOCS Method Cd 29b-13; whilst Eurofins adopted AOCS Method Cd 29c-13.</td>
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<td>It was also suggested that this method to be used for monitoring of refined oils from industry to evaluate compliance with the 1ppm limit.</td>
<td>This method is being used for monitoring of 3-MCPDE and GE contents refined oils.</td>
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<td><strong>Programme: Crystallization</strong></td>
<td>This project was completed and closed with Viva presentation on the 9th January 2017 (Viva No. 791/2017 (02)).</td>
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<tr>
<td>1.1.11</td>
<td><strong>PD169/13 – Development of a Composite Post hardening Index of Palm-Based Blends for Palm-Based Low saturated Fat Margarine</strong></td>
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<td>The SC commented that there are 2 factors / causes of the margarine / product failure: 1. Formulation and processing 2. Storage and handling</td>
<td>Further verification of the PHI mathematical model was carried out to indicate the post-hardening phenomena of shortening and dough fat obtained from food manufacturer. The slight change in storage modulus $G'$, SFC, firmness, polymorphism and PHI of the shortening and dough fat crystal networks at 20°C indicated the minimum occurrence of the post-hardening phenomena during</td>
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<td>These 2 factors could contribute to the different crystallization phenomena. Therefore, this project could be used to identify or predict the product failure. Consequently hardness changes in a homogeneous structure and the formation of grains (inhomogenieties) have to be described separately and respective rules for their occurrence formulated.</td>
<td>storage. Hence, it is recommended that the shortening should be stored at 20°C before being used for applications. Rheological measurement showed that all the stored samples at 25°C became softer and lost their plasticity throughout the storage time. Thus, unable to retain the original structure and caused the samples to be recrystallised in a mixture of small and bigger crystals (inhomogeneity) as were also indicated in melting thermograms of differential scanning calorimetry (DSC) and microscopy observation.</td>
</tr>
<tr>
<td>1.1.12</td>
<td>PD179/14 – Characterization and Evaluation of Palm-Based Organogel</td>
<td>The effect of day of preparation on organogels properties has been studied as a new parameter. Optimum temperature and day of preparation will be obtained. The effect of the percentage of palm olein in different blends of oil will be studied after optimization of condition is obtained.</td>
</tr>
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</table>

The SC suggested trying of different parameters on preparation of organogels. He also suggested the researcher to concentrate more on polyglycerol behenic acid esters (PBA) for this project since little is known on this system. Waxes and monoglycerides in contrast are already reasonably studied.

The effect of palm olein compared to other seed oils on the gels should be studied with focus on the question of the type of interaction. Is there a) just an additional independent effect from POP crystals and other crystals, or b)
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<tr>
<td>1.1.13</td>
<td>PD195/15 – Development of Palm Based Edible Coating for Prolonging the Quality and Post-Harvest Life of Guava (<em>Psidium guajava</em> L.) and Star Fruit (<em>Averrhoa carambola</em> L.)</td>
<td>No comments from PAC and recommended to proceed with preferred formulations.</td>
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<td>2.</td>
<td><strong>PROTEIN &amp; FOOD TECHNOLOGY UNIT</strong></td>
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<td>Programme: Oil and Fats Technology Centre (OFTEC)</td>
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<tr>
<td>2.1.1</td>
<td>PD184/14 – Characterization of Commercial Available Palm Oil Based Solid Fraction For Food Formulations</td>
<td>The VIVA report has been submitted for review and comments.</td>
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<td>The SC was informed that this work was carried out to evaluate the various palm solid fractions which were produced by the local companies. The solid fractions were categorized by its TAG composition.</td>
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<td>2.1.2</td>
<td>PD185/14 – Determination of The Oil Binding Capacity of Palm Stearin Fractions (iodine value 30 and below)</td>
<td>The project is completed and VIVA report writing is in progress.</td>
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<td>2.1.3</td>
<td>PD186/14 – Formulation of Trans Free Margarine That is Stable From Temperature of 15°C to 30°C</td>
<td>The project is completed and VIVA report writing is in progress.</td>
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<td>The SC was informed that the project was in the stage of identifying the suitable formulations as the market survey has been completed.</td>
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<td>2.1.4</td>
<td>PD187/14 – Structured fat from Interesterification of soft</td>
<td>Soft PMF is the by-product of palm olein (IV56) fractionation (or “polishing”) to produce super palm olein, and is available in abundance in countries such as Middle East countries, India and China. Interesterification of PMF improved the solid content and crystallization rate of PMF, thus make it suitable soldi fat product formulations.</td>
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<td>The SC commented that interesterification of soft PMF will add cost to the PMF which is already expensive. Researcher informed that the soft PMF is the by-product of palm olein (IV56) fractionation and is available in abundance in few countries such as Middle East countries and China. Interesterification of PMF may improve the physical properties of the PMF and make it more suitable for food formulation.</td>
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<td>2.1.5</td>
<td>PD196/15 – Effect of palm based fat on texture and mouth feel perception of ice-cream</td>
<td>The subset blend of PO/PMF and PO/PKO were studied. SFC of the blends reduced at the target higher temperatures. Indicating the possible</td>
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<td>(40°C) in palm oil has to be reduced through blending. It is recommended to study only a subset of the blends presented and add a few blends with different SFC profiles. This is to establish how the SFC translates into perceivable product properties such as stand up and organoleptic properties.</td>
<td>ability to improve the organoleptic properties of ice cream.</td>
</tr>
<tr>
<td>2.1.6</td>
<td>PD197/15 – Utilization of Soft Stearin As Confectionery Fat</td>
<td>Ternary blending of soft stearin, shea stearin and IE palm oil were analysed. The blends that contained higher amount of solid fat at 30°C were selected. However they also contained high amount of trisaturated and low melting glycerides. Therefore the next process is to fractionate the fats with the objective to reduce both types of glycerides.</td>
</tr>
<tr>
<td>2.1.7</td>
<td>PD198/15 – Physicochemical Properties of Various Bakery Using Palm-Based Fluid Shortening</td>
<td>The analysis of the performance of fluid shortening on biscuits has been completed. It is concluded that fluid...</td>
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<td>to compare with the other fats. Currently differences between structured products 20% palm stearin/80% PO and 100% PO are very limited. Inclusion of palm olein as third fat would extend the viscosity range to verify the robustness of certain applications.</td>
<td>shortening is comparable to the solid shortening in making biscuits. The performance of fluid shortening in bread are entering the last phase where the sensory analysis will be done. Meanwhile, the report is currently being prepared to close this project.</td>
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<tr>
<td>2.1.8</td>
<td>PD199/15 – Synthesis of Hydrocolloid From Palm Kernel Meal</td>
<td>There was no comment from the SC</td>
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<td>Programme: Innovative Product Group (IPG)</td>
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<td>2.1.9</td>
<td>PD161/12 – Enzymatic Degumming of Crude Palm Oil</td>
<td>CPO was extracted from an experimental plot that has not been applied with any fertilizer for 9 years but it still contained 5 ppm Cl. Search for Cl-free CPO will continue.</td>
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PAC SC commented the effort to look for an alternative degumming method in addressing the 3-MCPDE issue since acid degumming has been proven to have a positive effect. However, the study would provide a better understanding of the mechanism for the formation of the ester if it also covers the effect of acid degumming in the absence of Cl. If the esters are still formed, then this could be due to other factors or precursors.
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<td>2.1.10</td>
<td><strong>PD171/13</strong> – Post-Frying Vacuum Application As A Route To Minimise Oil Degradation And Oil Uptake In Fried Product</td>
<td>The integrated frying system has been designed and fabricated. Nevertheless, the system is yet to be delivered and commissioned in MPOB due to the application process of safety and health certification which consumed significant amount of time; the system complexity contribute to the delay in the certification process. Progress on the issuance of safety and health certification from JKKP is being monitored on the weekly basis.</td>
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<td>Suspension of experimental work involving the integrated frying system has been highlighted during the last PAC Meeting. Considering that the certification process is still in progress, it is proposed by the PAC SC to allow more time to ensure the certificate to be issued and hence commissioning of the system, since the extension does actually not increase the project’s costs.</td>
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<tr>
<td>2.1.11</td>
<td><strong>PD172/13</strong> – Comparative Studies Between Intermittent And Continuous Frying of Extruded Product</td>
<td>There was no comment from the SC. Project PD 172/13 was presented for VIVA on 7 July 2016 and agreed to be closed.</td>
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<td>2.1.12</td>
<td>PD181/14 – Palm Kernel Reference Materials For The Determination of Iodine Value And Slip Melting Point</td>
<td>The SC recommended for extension of the project for at least another 9 months to allow completion of the on-going stability monitoring programme on the reference materials. The stability monitoring study on palm kernel olein and palm kernel stearin reference materials are on-going and are scheduled for completion in the first quarter of 2017, which is within the extension time granted.</td>
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<td><strong>Programme: Animal Nutrition</strong></td>
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<td>2.1.13</td>
<td>PD91/06 – Growth performance of tilapia fed with diets formulated with MPOB-HIE and CPO</td>
<td>This project has been presented in Viva Meeting on 16 August 2016 and agreed to be closed.</td>
</tr>
<tr>
<td>2.1.14</td>
<td>PD133/09 – Quality of Floating Fish Feed Formulated With Different Levels of MPOB-HIE</td>
<td>The project has been presented in Viva Meeting on 16 August 2016 and agreed to be closed.</td>
</tr>
<tr>
<td>2.1.15</td>
<td>PD134/09 – Quality of Broiler Finisher Pellet Formulated With Different Level of MPOB-HIE</td>
<td>The Project has been completed and viva report under preparation.</td>
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<td>2.1.16</td>
<td>PD158/11 – Development of β-Mannanase Enzyme Derived from PKC as Microbes Carbon Sources and Its Effects in Broiler</td>
<td>The SC suggested to carry on with the future programme as suggested.</td>
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<td>β-Mannanase enzyme reaction will be upscaled in a 13-L bioreactor and will be</td>
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<td>applied into broiler feed.</td>
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<td>3.</td>
<td>NUTRITION UNIT</td>
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<tr>
<td>3.1.1</td>
<td>PD162/12-Molecular Mechanism of Palm Tocotrienol on Wound Healing</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
</tr>
<tr>
<td>3.1.2</td>
<td>PD164/12 - Red Palm Olein and Cardiovascular Health.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
</tr>
<tr>
<td>3.1.3</td>
<td>PD165/12-GEMM – Gamma Delta Tocotrienol as a potential maintenance treatment in women with metastatic breast cancer Phase 1a: A randomized, 2-period cross-over study to compare the bioavailability of Gamma-Delta Tocotrienol (GDT) with that of tocotrienol rich fraction (TRF) in twelve healthy subjects.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<td>3.1.4</td>
<td>PD167/12 - Elucidating the effects of Gamma-Tocotrienol (γ-T3) supplementation on the ratio of T-helper: T-regulatory cells in a syngeneic mouse model of breast cancer.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<td>3.1.5</td>
<td>PD174/13- Chronic effects of natural palm-margarine, interesterified palm-margarine and modified soy-based margarine on cardiovascular diseases risk, inflammation, insulin resistance and obesity in Malaysian adults.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.6</td>
<td>PD188/14-The Effects of Tocotrienol Adjuvanted Dendritic Cell in Established Mammary Tumour in BALB/C Mouse Model.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.7</td>
<td>PD189/14 - Gene Expression profiling of combination therapy using tocotrienols (gamma- and delta-) with leukemic drugs in acute myeloid leukemic cells.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.8</td>
<td>PD190/14- Effects of Positional Distribution of Stearic Acid on Triacylglycerol backbone on lipid, lipoproteins and Atherosclerosis.</td>
<td>The liver total cholesterol, free cholesterol and cholesteryl esters are being analyzed using cholesterol assay colorimetric kit.</td>
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<td>The subcommittee suggested that liver lipid levels be looked into.</td>
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<td>3.1.9</td>
<td>PD191/14- Study on the effect of palm tocotrienol fraction supplementation on collagen-induced arthritis in rat Model.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.10</td>
<td>PD192/14- To study the effect of triacylglycerol (TAG) structure on lipid profile using hamster model.</td>
<td>A SC member commented that the data shows that the sn-2 fatty acid is not impacting lipid levels in this study. The project is closed.</td>
</tr>
<tr>
<td>3.1.11</td>
<td>PD200/15 - Clinical study on the effect of tocotrienol rich fraction (TRF) supplementation in patients with primary osteoarthritis (OA) of knee joints.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.12</td>
<td>PD201/15 - Effect of palm tocotrienol rich fraction (TRF) and palm carotenes on asthmatic inflammation.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.14</td>
<td>PD202/15 - Biodistribution, pharmacokinetics and targeting efficacy of tumour-targeted tocotrienol nano-formulations in mice model.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.15</td>
<td>PD203/15 - Development of nano-carrier delivery systems of tocotrienols for oral, subcutaneous and topical administration.</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<tr>
<td>3.1.16</td>
<td>PD204/15 - Study of the effect of the positional fatty acids on triacylglycerol backbones on</td>
<td>No comment from PAC. All issues were addressed during the presentation.</td>
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<td>cardiovascular risk markers and fat deposition in mice.</td>
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<td>3.1.17</td>
<td>PD205/15 - (Project 1a) Multicentre studies on the effects of positional distribution of fatty acids at triglyceride backbone on serum lipids, lipoprotein (a) and LDL-subclasses in healthy Malaysian volunteers. The SC commented that the sample size might be under powered. The SC commented that only minor changes may be expected as the study was done among normal individuals and the fat energy exchange is only 30%. The SC enquired on compliance issues and was informed that the compliance was good with more than 95% attendance. The SC enquired on the cholesterol levels among groups so far and was informed that the cholesterol readings have not been stratified according to groups and would only be done at the end of the feeding intervention.</td>
<td>The committee was informed that the sample size was calculated applying Lehr’s formula and since it is a crossover design the sample size per group is 36.</td>
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<td>3.1.18</td>
<td>PD205/15 (b) - Multicentre studies on the effect of positional distribution of fatty acids at the triglyceride backbone of vegetable oils on fat deposition and health outcome measures-Malaysia.</td>
<td>The fecal analysis protocol has been obtained from King’s College London. Bomb calorimeter analysis will be carried out for the fecal samples.</td>
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<td>The SC suggested obtaining protocol for fecal analysis from King’s College, London.</td>
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<td>The SC also suggested that the fecal samples be subjected to bomb calorimeter analysis.</td>
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<td>3.1.19</td>
<td>PD206/16 – Effect of dietary fatty acids on human breast cancer cell growth: in vivo studies.</td>
<td>Study by Clement et al. has been referred to. Labels on corn oil has been corrected. Timeline is in accordance with what has been proposed during last PAC.</td>
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<td>The SC suggested that the study from clement Ip et al. in the 1980s/1990s be referred to.</td>
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<td>The SC suggested that the labels on the diagram for corn oil be corrected.</td>
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<td>The SC advised that the timeline for the project be adhered to, in order to obtain the result on time.</td>
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<td>New Project Proposal</td>
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| 1.1 | AOTD 096/2016 – Development of oil in water emulsion (EW)-based insecticides for AEDES control | • The Sub-Committee asked whether the non-ionic surfactant used is of palm-based origin or others.  
• The Sub-Committee enquired whether the high shear homogenizer pilot plant equipment is sourced locally.  
• The Sub-Committee enquired whether the size of microemulsion is smaller than nanoemulsion.  
• The Sub-Committee enquired on the advantages of nanoemulsion over emulsion concentrate (EC). | • The non-ionic surfactants used are of vegetable-oil derived surfactants obtained from local distributors.  
• The high shear homogenizer pilot plant equipment is fabricated by S.I.T Schiffs-& Industrie Technik (M) Sdn Bhd, a local company which has a licence from S.I.T Germany.  
• The researcher explained that in colloid science, ‘microemulsion’ is defined as an emulsion system with very small droplets size (< 100nm) and thermodynamically stable. A ‘Nanoemulsion’ is defined as an emulsion system with droplets size ranged between 200-500 nm, and it is thermodynamically unstable.  
• The researcher highlighted that oil-in-water nanoemulsion uses palm-based |
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<td>materials with low concentration of petroleum-based solvent. On the other hand, EC-insecticide conventionally uses ~90% petroleum-based solvents hence, is not environmentally friendly.</td>
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<td>The solubility of selected pyrethroids as active ingredient in methyl ester has been conducted which will be applied as a solvent phase in the oil-in-water nanoemulsion-insecticide. The bioefficacy test will be conducted at the Institute for Medical Research (IMR), Kuala Lumpur.</td>
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<td>The data from prototype / commercial products and system for mosquitoes control have been collected &amp; will be applied as bench-marks for the study. The Researcher has also received two types of emulsifiers: TEGO Care CG 90 and TEGO Break Thru EM V 20 supplied by Evonik through their Distributor in K.L, Malaysia. These two surfactants will also be included in this study.</td>
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- The Sub-Committee enquired whether a high amount of pyrethroid can be dissolved in the nanoemulsion in view of the fact that pyrethroid must be free from nanoemulsion monolayer to be bio-available and effective. The Sub-Committee asked if there are data on bioefficacy.

- The Sub-Committee commented on the need to start collecting proof of concept data on bioactivity much earlier in the project timeline. The Sub-Committee also commented on obtaining a prototype system by 6 months and to test the prototype system vs controls on Aedes mosquitoes. The Sub-Committee was also informed that there are two types of emulsifiers which can be used that have the required HLB value. An oleic acid based ethoxylated emulsifier and APG with stearyl alcohol, otherwise known as Evonik Tegocare.
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<td>• The Sub-Committee asked if the researcher intended to go directly into pilot plant scale to which the researcher said he will perform benchtop trials before conducting the pilot plant trials. The bioefficacy test will be compared with standard EW-insecticides, which are commercially available.</td>
<td>• A lab-scale experiment has been conducted in order to get optimum condition for suitable mixed surfactants, their HLB values and concentrations. The optimum formulations which have been produced in the laboratory will then be scaled up with the pilot plant equipment. The bioefficacy test will be compared with the standard or commercial EW-insecticide products.</td>
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<td>AOTD 098/2016 – Esterification of PFAD for drilling mud application</td>
<td>• The Sub-Committee stated that most of the ingredients used in drilling mud are not cheap, and therefore enquired how this project would help in producing cheap drilling mud. The Sub-Committee was then informed that the esters of PFAD could be potentially cheap and could replace the mineral oils used in the drilling mud formulation. The Sub-Committee was informed that the field testing will be carried out together with a collaborator, where it will involve the utilization of facilities that will mimic the actual drilling mud application. The Sub-Committee was also informed that the 25 kg pilot plant can be used to produce sufficient quantity of PFAD esters for field testing. The Sub-Committee informed that for drilling mud application, auto catalytic reaction of palmitic acid with 2-ethylhexanol at different molar ratio has been conducted as benchmark reaction. The ratio of palmitic acid: 2-ethylhexanol was varied from 1:1, 1:2, 1:3, 1:4 and 1:5.</td>
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<td>CPO cannot be directly used as ingredient in drilling mud because of its high kinematic viscosity.</td>
<td>• For information</td>
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<td>• The source of the PFAD was also enquired about and it was informed that the PFAD will be provided by the industrial collaborator.</td>
<td>• For information</td>
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<td>• The Sub-Committee recommended that the esterification should first be carried out without the presence of catalyst. The incorporation of ester during the initial stage of esterification would also help the reaction go to completion.</td>
<td>• At the end of the esterification process, two-phase reaction mixture was observed. First layer is the entraining agent phase which contains virtually all the catalyst used and virtually all the water of reaction formed during the esterification and also the free part of the monoalcohol still present in the reaction mixture. The second layer is triglycerides since it is immiscible with the entraining agent. The oil phase layer was further used for trans esterification reaction.</td>
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<td>• The Sub-Committee commented that the replacement of mineral oil with the bio-based-esters should not compromise the performance of the drilling mud.</td>
<td>• For information</td>
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<td>• The Sub-Committee also recommended that the researcher study a patent on the same subject where glycerol is added to the PFAD as a water entrainer in the esterification.</td>
<td>• For information</td>
</tr>
<tr>
<td>1.3</td>
<td>AOTD 099/2016 – Separation modeling of crude glyceryl carbonate via reactive distillation</td>
<td>• The Sub-Committee was informed that the crude glycerol carbonate to be used in this new project is produced from the reaction of glycerol and ethylene carbonate. The crude glycerol carbonate consists of glycerol carbonate and ethylene glycol.</td>
<td>• For information</td>
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<td>• The Sub-Committee reminded the researcher not to be disturbed by the high price of</td>
<td>• For information</td>
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<td>pure glycerol carbonate. The researcher should just target the price of the industrial grade.</td>
<td>• The Sub-Committee was informed that the development of vapor-liquid equilibrium (VLE) for the four components is time-consuming. The researcher intends to proceed with reactive distillation experimental work.</td>
<td>• For information</td>
</tr>
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<td></td>
<td>• The Sub-Committee commented that the Aspen Plus software is expensive and suggested a collaboration with a university or business firm that has a software license. The researcher informed the Sub-Committee that there are two possible ways to have access to the software. Collaboration with a university is possible but their license is restricted for academic purposes. The researcher is currently looking at the possibility of collaborating with a suitable business firm.</td>
<td>• The Sub-Committee commented that glycidol is dangerous. Therefore thermal decomposition of glycerol carbonate to glycidol should be prevented</td>
<td>• Currently have limited access. Technical visit by AspenTech in November 2016.</td>
</tr>
<tr>
<td>1.4</td>
<td>AOTD 100/2016 – Environmental life cycle assessment (LCA) on the production of glycerol from oleochemical processes</td>
<td>• The Sub-Committee pointed out that it would be beneficial to see the impact of glycerine production from fatty acid and methyl ester routes with respect to the energy consumption used for both routes.</td>
<td>• Amount of glycidol is negligible. Process is controlled to suppress formation of glycidol.</td>
</tr>
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<td></td>
<td>• The Sub-Committee was informed that the proposed</td>
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<td>• Currently, the researcher is drafting an NDA between glycerine producer and MPOB.</td>
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<td>• For information</td>
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| 1.5 | AOTD 101/2016 – Determination of ecotoxicological behavior of poorly water-soluble surfactants | • The Sub-Committee enquired about the number of ethoxylates with a range of EO to be used and was informed that the commercial alcohol ethoxylates (AEO) will be used in this project which includes AEO with 2, 3, 5 and 9 ethoxylate numbers.  

• The Sub-Committee enquired on the positive and negative controls to be used in the test and they were informed that 3,5-Dichlorophenol will be used as a reference control in ecotoxicity studies, while aniline will be used as a positive control in the biodegradation study as stipulated in the standard methods.  

• The Sub-Committee also enquired on the source of microorganisms used for the MITI (301C) test, as the microorganisms must be taken from various sites. It was informed that the microorganisms will be sourced from 10 different sites in Selangor. | • Currently, the researcher focuses on optimizing some parameters involved in OECD 209 test method, e.g. pH of mineral medium, temperature and method on BOD measurement. The researcher had contacted KC Chemical for AEO samples.  

• The microorganisms was sampled from 10 sites i.e, Palm Mill Seri Langat, Pantai Morib, Pantai Bagan Lalang, sungai Semenyih, Tasik Idaman Dengkil, Indah Water Konsortium (IWK) UKM, Tasik Cempaka, Sungai Langat, IWK Putrajaya, IWK Taman Tun Dr Ismail and Taman Wetland. |
<p>| 1.6 | AOTD 102/2016 – Polyhydroxy estolides | • The Sub-Committee commented that the reaction between oleic acid and | • Experiments are being conducted to optimize the synthesis of |</p>
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<td></td>
<td>derivatives</td>
<td>hydrogen peroxide could also yield polyol, instead of just polyhydroxy estolides. The researcher stated that an initial study to synthesize the polyhydroxy estolides at laboratory scale has been carried out. Results from NMR and MALDI-TOF analyses showed that the formation of polyhydroxy estolide was successful. • The Sub-Committee enquired how the researcher could prevent transesterification from occurring during the derivatization of polyhydroxy estolide with glycerol. The researcher stated that the optimum reaction temperature and catalyst would be determined, whereby transesterification is at the minimum. Previous publications also suggested that ester bonds of polyhydroxy estolides are very stable towards transesterification and hyrolysis. • The Sub-Committee was informed that the global market size of Group IV and Group V base lubricant was projected to be about 830,000 metric tonnes by the year 2020, based on a report by Radiant Insight in January 2016. • The Sub-Committee commented that the molecular weight of polyhydroxy estolide is important in determining its application and enquired about polyhydroxy estolides on larger scale (500g). The prepared polyhydroxy estolides will be used for further derivatization.</td>
<td>For Information</td>
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|     |                     | the molecular weights of the prepared polyhydroxy estolides. The researcher told The Sub-Committee that the molecular weight of prepared polyhydroxy estolides were ~ 1200 Da.  
• The researcher informed the Sub-Committee that one of the targeted applications of polyhydroxy estolides derivatives is lubricant base oil with a better pour point and cloud point characteristics. |                      |
| 1.7 | AOTD 104/2016 – Corrosion inhibition properties of some fatty acid derivatives | • No comment. | • Chemicals used for this project is being purchased. |
| 1.8 | AOTD 106/2016 – Palm-based polyurethane binder for rebond foams | • The Sub-Committee suggested that PolyFAME polyol also be incorporated in this study. The Sub-Committee highlighted that some of the test methods listed may not be applicable for this study.  
• The Sub-Committee was informed that MDI is better than TDI because of its low volatility and no special safety equipment is required. | • PolyFAME EG has been used in this study. PolyFAME EG has a unique structure with pendant secondary hydroxyl groups attached to the backbone of hydrocarbon chain and pendant primary hydroxyl group attached via oxygen to the hydrocarbon backbone. Therefore, PolyFAME-EG polyol should promote better binding property with various substrates.  
• In this study, MDI such as Demodur 3133 will be used. |
## MATTERS ARISING OUT OF MINUTES & REPORT OF 36th PAC MEETING 2016
ON ON-GOING PROJECTS
ADVANCED OLEOCHEMICAL TECHNOLOGY DIVISION (AOTD)

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<tr>
<td>1</td>
<td>POLYOLS</td>
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</table>
| 1.1 | AOTD 052/2009 – Catalysis study on the production of polyol | • The Sub-Committee enquired about the high hydroxyl value that was obtained for one of the polyols in the presentation. The Sub-committee was informed that the alcoholysis reaction was carried out with ethylene glycol.  
• The Sub-committee was also informed that the epoxidized palm olein (EPOo) used was from the same batch. The Sub-committee pointed out that the different unsaturation values (IV) in palm-based polyols might be an indication of an elimination reaction that could have occurred during the alcoholysis process for the reaction with methanol. The Sub-Committee was informed that the reaction was conducted under reflux at 60°C. | • This polyol contained high hydroxyl value because it was prepared using ethylene glycol (diol). Meanwhile, other polyols were prepared using monoalcohol.  
• For information |
<p>| 1.2 | AOTD 080/2012 – Synthesis of azelaic ester polyol | • The Sub-Committee suggested using lipase enzyme for the esterification reaction at low temperature (60°C - 70°C) could improve the colour of the product. The Sub-Committee also pointed out that applying vacuum during the reaction at a lower | • Esterification of azelaic acid with diethylene glycol and 1,3-propanediol have been conducted and water was removed through vacuum. Enzymatic synthesis of polyester polyol based on azelaic acid is not the objective of this study, it could be proposed as a new project. |</p>
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<td>temperature could also improve the colour of the products.</td>
<td>The process to prepare dimethyl azelate of high purity will increase the cost of the project. The researcher is in progress conducting the transesterification of dimethyl azelate (80% purity) with 1,3-propanediol.</td>
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<tr>
<td></td>
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<td>• The Sub-Committee suggested conducting the transesterification of dimethyl azelate with 1,4-butanediol instead of esterification of azelaic acid with 1,4-butanediol.</td>
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<td>• The Sub-Committee also suggested carrying out the esterification of azelaic acid with methanol to produce dimethyl azelate of high purity, for the transesterification reaction.</td>
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<td>2</td>
<td>POLYURETHANES</td>
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<tr>
<td>2.1</td>
<td>AOTD 038/2008 – Palm-based rigid polyurethane foam for insulation material</td>
<td>No comment.</td>
<td>To close the project</td>
</tr>
<tr>
<td>2.2</td>
<td>AOTD 049/2009 – Polyurethane elastomer made from palm oil polyol</td>
<td>The Sub-Committee pointed out that the purpose of using polyFAME was not highlighted in the presentation.</td>
<td>Noted PolyFAME EG has been used as a chain extender in elastomer preparation. The prepared elastomer was soft compared with other palm olein-based polyols. It shows that the soft elastomer obtained can be potentially formulated for applications such as sealants and compression sensitive adhesives.</td>
</tr>
<tr>
<td>2.3</td>
<td>AOTD 091/2015 – One component palm-based</td>
<td>The Sub-Committee commented that the adhesive currently</td>
<td>Preparation of quasi prepolymer by using ratio between isocyanate and</td>
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<td>polyurethane (PU)</td>
<td>prepared is more like a 2K rather than 1K because a</td>
<td>polyol of 6 to 1 is being conducted. The free isocyanate content of the quasi prepolymer about 16%.</td>
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<td></td>
<td>wood adhesives</td>
<td>gelling catalyst was used. The Sub-Committee suggested preparing quasi-polymer with a high excess of isocyanate.</td>
<td>The researcher is in-progress to determine the lap shear strength of PU wood adhesives.</td>
</tr>
<tr>
<td>2.4</td>
<td>AOTD 071/2011 –</td>
<td>The Sub-Committee reported that there are new regulations imposed on Enovate-3000 as a blowing agent and requested that the researcher study the new requirements.</td>
<td>New regulations imposed on Enovate-3000 have been studied. The U.S Environmental Protection Agencies have given Significant New Alternatives Policies (SNAP) approval for the use of Enovate as a replacement in all foam applications.</td>
</tr>
<tr>
<td></td>
<td>Development of low density rigid PU foams based on palm oil polyols</td>
<td>The Sub-Committee also informed on the availability of a new commercial blowing agent in the market.</td>
<td>For information</td>
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<td>The Sub-Committee suggested varying the amount of catalyst used to increase the density of the foam. In addition, the researcher should measure the average cell size of the foam because there is a direct effect between density, cell size and thermal conductivity.</td>
<td>The researcher is currently conducting a new batch of experiments to study the effect of amount of catalyst on the density and cell sizes.</td>
</tr>
<tr>
<td>2.5</td>
<td>AOTD 092/2015 –</td>
<td>The Sub-Committee recommended changing the type of surfactant when 35% PolyFAME E-185 was incorporated at a isocyanate index of 75% in the foam formulation in order to improve the cell structure of the foam.</td>
<td>The researcher is currently searching for a supplier that can supply the new surfactant for viscoelastic foam.</td>
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<td></td>
<td>Evaluation of palm-based polyols on viscoelastic foam</td>
<td></td>
<td>Currently the researcher still searching the suitable</td>
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<td>• The Sub-Committee suggested that the average cell size of the viscoelastic foams be measured as it directly affects the morphology of the viscoelastic foams.</td>
<td>microscope that could be used to evaluate the average cell size of viscoelastic foam</td>
</tr>
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<td>• The Sub-Committee also suggested that the tensile strength of the viscoelastic foams be determined. It was then informed that the tensile strength was planned to be measured later.</td>
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<td>3</td>
<td><strong>SURFACTANT</strong></td>
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<tr>
<td>3.1</td>
<td>AOTD 055/2009 – Production of palm-based rhamnolipid biosurfactant</td>
<td>• The Sub-Committee enquired about the advantages of using palm oil as a feedstock over other vegetable oils. The Sub-Committee was informed that the balanced composition of saturated and non-saturated fatty acids contributed to the unique properties of the biosurfactant.</td>
<td>• Study of rhamnolipid produced from sludge palm oil (SPO) in the bioremediation of arsenic contaminated soil was carried out and the results were presented at ITEX 2016.</td>
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<td>• Palm oil as a feedstock would lower the cost of biosurfactant production. Furthermore, waste effluent from the palm oil mill can also be used to produce rhamnolipid.</td>
<td>• For information</td>
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<td>• The Sub-Committee also enquired as to what would be the major product (mono or dirhamnolipid) using palm oil as feedstock. The Sub-</td>
<td>• For information</td>
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<td>Committee was informed that the production of biosurfactant, whether mono or dirhamnolipid, is determined by the medium conditions.</td>
<td>• The researcher may propose this study as new project proposal</td>
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<td>• The Sub-Committee suggested using PKO as the feedstock to produce biosurfactant as it has never been tried in this study.</td>
<td>• For information</td>
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<td></td>
<td>• The Sub-Committee enquired about the difference in foaming properties between rhamnolipid and sophorolipid. The Sub-Committee was informed that some foams were observed during the production process of both sophorolipid and rhamnolipid. The Sub-Committee was informed that sophorolipids are commercially used as the surfactant in low foam detergents for automatic dish washing machines</td>
<td></td>
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<tr>
<td>3.2</td>
<td>AOTD 086/2013 – Commercial scale production of palm-based sophorolipid biosurfactant</td>
<td>• The Sub-Committee commented that one should increase the yield of sophorolipid to be commercially viable and was informed that the production of sorphorolipid with a high yield of about 300g/L has been reported.</td>
<td>• For information</td>
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<td>• The Sub-Committee enquired whether the carbon source chain length would affect the</td>
<td>• Glycerol as carbon feedstock will be studied extensively as a separate PAC project because it will</td>
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<td>biosurfactant properties. The use of glycerol as a feedstock to produce biosurfactants was suggested. • The Sub-Committee suggested collaboration with Saraya Corporation which is producing sophorolipids in Japan.</td>
<td>require separate small scale shake flask optimization studies and progress towards semi-large scale mini pilot plant production. • Requested Dr Toshio Kakui to assist in establishing collaboration with Saraya Corporation.</td>
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<tr>
<td>3.3</td>
<td>AOTD 061/2010 – Enzymatic synthesis of palm-based sucrose esters in green solvent</td>
<td>• The Sub-Committee enquired whether the reaction was carried out in an open vessel setup. The Researcher confirmed that the reactions were carried out in an open beaker on a hotplate. • The Sub-Committee suggested that fresh sugar be introduced in stages to the reaction mixture. The researcher stated that it had been done as suggested. However, due to the multiple filtration steps throughout the reaction, most of the fatty acid was lost through the processes. • The Sub-Committee commented that as this is a solid liquid phase reaction, the size distribution of the sucrose powder is important as it can affect the rate of reaction.</td>
<td>• For information • The researcher is carrying out experiments using tert-butanol in order to increase the solubility of sucrose in oleic acid and increase product yield. The acid value of the current experiment (with tert-butanol) reduced approximately 68.5% compared with the previous experiment (no tert-butanol), 53%.</td>
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<td>3.4</td>
<td>AOTD 074/2012 – Synthesis of cationic gemini</td>
<td>• No comment.</td>
<td>• Methyl iodide is used to react with N,N-dimethyl palmityl hydrazide in order</td>
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<td>surfactant from fatty hydrazides</td>
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<td>to examine reactivity of the reaction.</td>
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<td>4 LUBRICANTS</td>
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<tr>
<td>4.1 AOTD 058/2010 – Synthesis of dimerate ester as lubricant base stock</td>
<td>• The Sub-Committee enquired whether the stability of the synthesized dimerate ester was affected by the presence of ester linkage and the Sub-Committee was informed that with reference to petroleum-based lubricants, dimerate ester would be less stable. An oxidative stability study will be carried out to investigate the stability of the products. &lt;br&gt;• The Sub-Committee was informed that the price of the dimerate ester lubricant could be quite high because the price of dimer acid itself is also high. &lt;br&gt;• The Sub-Committee suggested the use of a catalyst such as an ion exchange resin for the reaction with 2-propanol so that the reaction could be carried out at a lower temperature (maximum 120°C).</td>
<td>• The oxidative stability studies on the dimerate esters synthesized are currently being carried out according to the official ASTM method D6186 – 98 using PDSC model DSC Q20P. For short chain alcohol with low boiling point, esterification can be carried out using sulfuric acid as catalyst.</td>
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<td>4.2 AOTD 063/2010 – Palm-based lithium complex grease</td>
<td>• The Sub-Committee was informed that the high amount of soap in grease would be disadvantage in terms of cost. However, from the study, it was found that a lower amount of soap did not give products that meet the</td>
<td>• The research is optimizing the amount of soap to balance the cost and performance of grease. However, the plant was found to be not functioning. Contacted supplier to repair.</td>
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<td>5.1</td>
<td>AOTD 043/2008 – Enzyme-catalysed acyl transfer reaction of dimethyl azelate and amino acid ethyl esters</td>
<td>• No comment.</td>
<td>• Reaction of palmitoyl hydroxyproline with palmitoyl anhydride using papain as catalyst did not show any amidation reaction. On the other hand, the reverse reaction seems to happen.</td>
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<tr>
<td>5.2</td>
<td>AOTD 044/2008 – Fatty esteramine derivatives from various palm-based methyl ester feedstocks</td>
<td>• The Sub-Committee suggested that future work should be focused on the synthesis of gemini surfactant, vis-à-vis addition of a spacer on the amine derivatives.</td>
<td>• Optimization process for transesterification between methyl diethanol amine and methyl laurate has been carried out at various ratios of methyl laurate and DMEA.</td>
</tr>
<tr>
<td>5.3</td>
<td>AOTD 081/2012 – Derivatization of glycerol with levulinic acid</td>
<td>• The Sub-Committee was informed that Novozyme 435 enzyme was used for this study. Based on reports in the literature, the Sub-Committee suggested using an ionic liquid which can act as a good solublizer and catalyst. • The Sub-Committee also suggested that the reaction be conducted between 70°C to 90°C using an ion exchange resin as the catalyst. • The Sub-Committee was informed the glycerol layer and levulinic acid layer can be completely homogenised on heating and stirring.</td>
<td>• For information</td>
</tr>
<tr>
<td>5.4</td>
<td>AOTD 084/2013 – Silane functionalized palm oil</td>
<td>• The Sub-Committee recommended that the prepared silane products, which are transparent and</td>
<td>• Silane products that are transparent and tacky are being prepared on larger scale for development of</td>
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<tr>
<td>No.</td>
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<tr>
<td>derivatives</td>
<td>tacky, be used in development of pressure-sensitive adhesives.</td>
<td>pressure-sensitive adhesives</td>
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<tr>
<td>5.5</td>
<td>AOTD 093/2015 – Synthesis of glyceryl polyalkylether</td>
<td>• No comment.</td>
<td>• Prior to transformation of the hydroxyl group into good leaving group (Tosylate), hydroxyl at 1,3-position is protected using 2,2-dimethylpropane in the presence of (±)-camphorsulfonic acid.</td>
</tr>
<tr>
<td>5.6</td>
<td>AOTD 095/2015 – Preparation of epoxidised sucrose ester of oleic acid</td>
<td>• The Sub-Committee commented that epoxidised trimethylolpropane ester is not suitable to be used as a cosmetic ingredient. The researcher agreed and suggested that the trimethylolpropane ester is to be used in grease and lubricants.</td>
<td>• The epoxidised trimethylolpropane ester has been prepared and a ring-opening reaction was done with acrylic acid. The rate of the reaction was monitored by the oxirane oxygen content.</td>
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<td>6</td>
<td>ENVIRONMENT</td>
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<td>6.1</td>
<td>AOTD 069/2011 – Physico-chemical properties of palm-based 9, 10-dihydroxystearic acid (DHSA) and Alpha-Sulphonated Methyl Ester (SME/MES) for EU REACH requirement</td>
<td>• No comment.</td>
<td>• For information</td>
</tr>
<tr>
<td>6.2</td>
<td>AOTD 078/2012 – Determination of ethylene oxide (EO) distribution in palm-based alcoxylated products</td>
<td>• No comment.</td>
<td>• The HPLC and GC methods have been optimized.</td>
</tr>
<tr>
<td>6.3</td>
<td>AOTD 073/2011 – Method</td>
<td>• No comment.</td>
<td>• For information</td>
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<td>No.</td>
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<td>development and analysis of volatile organic compounds emitted from palm-based polyurethane products</td>
<td>• The Sub-Committee was informed that $^3$H standard solution was used only for instrumental self-normalization and calibration. However, $^3$H standard solution was not used for the quantitation of bio-based content.</td>
<td>• The Liquid Scintillation Counter and the Sample Oxidizer are having technical breakdowns. The supplier has been contacted to repair the instrument.</td>
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<td>6.4</td>
<td>AOTD 077/2012 – Determination of bio-based content in polyols and polyurethanes</td>
<td>• The Sub-Committee suggested applying the method developed for the cationic gemini surfactant which had used dimethyl sulphate. The Sub-Committee was informed that the method might not be suitable for Gemini surfactant because it is a different matrix. The sample preparation method might not be suitable for the cationic gemini surfactant developed for methyl ester sulphonate. • The Sub-Committee expressed concern about the method being developed for analysing of IPTS in the final product, e.g., cosmetic but instead suggested that the method should</td>
<td>• For information</td>
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<td>6.5</td>
<td>AOTD 076/2012 – Determination of by-products in methyl ester sulphonate and cosmetic products containing palm-based esters</td>
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|     | Malaysia            | assumptions were made in this study to obtain a narrow range of inventory data.  
- The Sub-Committee was informed that the project is a collaborative project with the Malaysian Oleochemical Manufacturers Group (MOMG). The data on the production of fatty acids were obtained from MOMG. Plant visits were also conducted to verify the validity of the data. Progress reports of the study were also submitted regularly to the MOMG. | columns involved and steps or processes involved will be taken into account in this analysis. These parameters are expected to contribute an effect on the energy and utilities consumed. Another verification session will be carried out soon with the respective producers to revise their inventory data. |

### 7 TECHNOLOGY

#### 7.1 AOTD 001/2005 – Ethoxylation of palm based derivatives (DHSA, Methyl Ester and Polyol)
- The Sub-Committee stated that the stability of sorbitol monooleate is dependant on the reaction parameters and it might decompose at extreme ethoxylation temperatures.  
- The researcher informed the Sub-Committee that the production of ethoxylated sorbitol monooleate is the know-how process of the technology provider, i.e., Inventa Technologies.  
- For information

#### 7.2 AOTD 055/2007 – Improvement on the polyol pilot plant production
- The Sub-Committee was informed that the wastewater treatment system is located in the vicinity of the 1 tonne polyol pilot plant.  
- For information
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<td>7.3</td>
<td>AOTD 064/2010 – Synthesis and characterization of catalyst system for methyl ester ethoxylates</td>
<td>• The Sub-Committee was informed that the treated waste originated from the polyol process only. &lt;br&gt; • The Sub-Committee was informed that the ethoxylation reaction was conducted at Lion Corporation Laboratory in Japan using a stirred batch reactor. &lt;br&gt; • The Sub-Committee asked whether there will be any effect of using a solid catalyst in the loop reactor. &lt;br&gt; • The Sub-Committee was informed that MPOB will work closely with Lion Corporation on the ethoxylation of ME with solid catalyst using loop reactor.</td>
<td>• For information</td>
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<td>7.4</td>
<td>AOTD 072/2011 – Determination of non-catalytic esterification protocol</td>
<td>• The Sub-Committee informed that the quality of DEG ester will not be significantly affected by the moisture content present in the final product. After all, the DEG ester will be used as a pearlizing or opacifying agent. The Sub-Committee also informed that the “non-catalytic” terminology should be replaced with “auto-catalytic” because the esterification reactions are being catalyzed by the carboxylic acid used as</td>
<td>• The word 'non-catalytic' has been revised to 'autocatalytic'.</td>
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the reactant in the esterification reactions.

- The Sub-Committee enquired about the need for vacuum at the beginning of the esterification reaction. The Sub-Committee was informed that the protocol was set to conduct the experiment at high temperature with no vacuum and no catalyst. The Sub-Committee recommended running the reaction by purging N₂ gas and to use excess of glycols so that reaction can be run at lower temperature.

- The Sub-Committee was informed that in previous experimental work, the esterification reactions were conducted at a temperature of 120°C using amberlyst A46 catalyst. However the conversion rate was not high. Attempts at using tin oxalate at 230°C for production of DEG ester successfully produced high diester after reaction duration of 13 hours.

- The Sub-Committee mentioned that the commercial product used was based on stearic acid from tallow. Tin oxalate was used as a benchmark catalyst. The Sub-Committee

- The researcher had performed the esterification in the presence of catalyst to produce higher yield of DEG ester and excess amount of diol in the experiment
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<td>recommended the use of excess glycol in the reaction and the removal of unreacted DEG can be conducted at the final stage of reaction.</td>
<td>• The project will be closed and as such new recommendation will be proposed in another project</td>
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<td>7.5</td>
<td>AOTD 082/2012 – Production of fatty amides from triglycerides via microwave technology</td>
<td>• The Sub-Committee commented that there is a possibility of the formation of nitrile from dehydration of amide because the reaction was conducted at high temperature. Consequently, the Sub-Committee requested that the presence of nitrile in the reaction mixture be analysed. The Sub-Committee also recommended the use of column chromatography for purification of the product.</td>
<td>• The project will be closed and as such new recommendation will be proposed in another project</td>
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<td>AGROCHEMICAL</td>
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<td>8.1</td>
<td>AOTD 066/2010 – Palm-Based aerosol insecticides for public health importance</td>
<td>• The Sub-Committee enquired what are the differences between this on-going project and the new project proposal (AOTD096/2016</td>
<td>• The researcher explained that the new project proposal is focused on the development of nanoemulsion as a fogging agent to control mosquitos in public areas. However, this on-going project is focused on the production of microemulsion as an aerosol insecticide for household use only.</td>
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<td>• The Sub-Committee was informed that the size of the aerosol spray mist will also be determined in a collaborative study with a local university.</td>
<td>• The Sub-Committee</td>
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Page 126 : PAC 2016 – Matters Arising out of Minutes & Reports of 36th Meeting
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<td>emphasized that the mist droplets should not be less than 5µm to reduce the chance of entering the body through respiratory tract.</td>
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| 8.2 | AOTD 094/2015 – Water in biodiesel microemulsion for fuels | • The Sub-Committee was informed that the research is currently in progress and the economic study including cost analysis will be calculated at the final stage of the research work.  
• The Sub-Committee enquired if companies such as Petronas are interested in adopting the technology.  
• microemulsion-diesel fuels. | • The researcher informed that the cost of microemulsion-fuels should be cheaper or comparable to conventional diesel due to the high water content that can be incorporated in the microemulsion-fuels.  
• The Sub-Committee was informed that a local company has expressed interest on the project. However, the researcher will also approach Petronas.  
• The Sub-Committee was informed that the water content ranges between 5% to 20% (w/w) in commercial |
| 9   | COSMETICS           |                  |              |
| 9.1 | AOTD 047/2009 – Preparation, characterization and applications of palm based lipid nanoparticles | • The Sub-Committee enquired about the stability of solid lipid nanoparticles (SLN). The Sub-Committee was informed that the formulated SLN is quite stable based on the particle size and polydispersity index (PDI) values obtained after one month storage at 25°C and 45°C.  
• The Sub-Committee enquired about the negative value obtained for the zeta potential. The Sub-Committee was informed that the negative | • For information  
• For information |

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<td>value of zeta potential was influenced by the type of lipid used in the SLN formulation which would provide for the stability of SLN.</td>
<td>• The Sub-Committee mentioned that nanoparticles has a bad reputation in the market. The Sub-Committee was informed that the use of different term for &quot;nanoparticles&quot; in this study will be considered. The Sub-Committee was also informed that griseofulvan was used in the study because it was poorly soluble in water.</td>
<td>• For information</td>
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<td>9.2</td>
<td>AOTD 068/2011 – Palm phenolics as active ingredient for topical application</td>
<td>• The Sub-Committee was informed that oil palm phenolics (OPP) were obtained from palm oil mill effluent (POME) and it is already produced at a pilot plant located in MPOB Experimental Mill at Labu, Negeri Sembilan. • The Sub-Committee was informed that OPP used in this study contains phenolic compounds such as p-hydroxybenzoic acid and shikimic acid with total phenolic content of 1500 ppm gallic acid equivalent. • The Sub-Committee was informed that the process to produce OPP has been established and</td>
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<td>standardized to control the product composition. The Sub-Committee highlighted that kojic acid is no longer used in Europe as it may induce skin irritation and allergic reactions.</td>
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<td>9.3</td>
<td>AOTD 085/2013 – Evaluation of in vitro ocular irritation for palm oleochemicals through Bovine Corneal Opacity &amp; Permeability (BCOP) test</td>
<td>• No comment.</td>
<td>• The prediction of eye irritation of palm-based methyl ester sulphonates (MES C12, C14, C16, C16:18) have been carried out through BCOP test and SkinEthic Human Corneal Epithelium (HCE) model. MES were classified as irritants.</td>
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<td>9.4</td>
<td>AOTD 075/2012 – Potential application of proteins derived from PKC for cosmetic products</td>
<td>• The Sub-Committee pointed out that the low protein yield may be due to the high temperature used during protein extraction and may cause changes in the protein conformation. The researcher informed that the extraction parameters had been optimized and used by the co-researcher for protein extraction. • The researcher planned to carry out the application of PKC protein on hair care products once the protein extraction process is</td>
<td>• Discussion has been done with Malaysia Genome Institute to explore the possibility to analyze the secondary structure of PKC protein. It was informed that the protein sample must be of pure compound in order to be analyzed using circular dichroism spectroscopy. The researcher is exploring methods to purify the PKC protein. In the meantime, the extraction process is also being studied by controlling the extraction temperature so that it does not exceed 60°C. Previously, the extraction temperature was around 60°C to 70°C. • The researcher has conducted the protein extraction for many times in order to get enough amount of PKC protein for product</td>
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<td>optimized. The Sub-Committee was informed that the</td>
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<td>formulations. Currently, a hair care product is being developed.</td>
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<td>protein was hydrolyzed with sulphuric acid and</td>
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<td>• A new project will be proposed once this project is closed. The new project will be on derivatization of PKC protein to produce peptides.</td>
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<td></td>
<td>PKC protein to cationic surfactant (or other products)</td>
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<td></td>
<td>will be proposed.</td>
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<tr>
<td>9.5</td>
<td>AOTD 067/2011 – Efficacy of palm-based tocotrienol</td>
<td>• No comment.</td>
<td>• Application of palm tocotrienol nanoemulsion on the skin increases the skin elasticity parameters. However, the increase was not significant.</td>
</tr>
<tr>
<td></td>
<td>nanoemulsion</td>
<td></td>
<td>• Final completed project report is being prepared for viva examination.</td>
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<tr>
<td>9.6</td>
<td>AOTD 090/2014 – Establishment of bacterial reverse</td>
<td>• No comment</td>
<td>• The bacterial reverse mutation assay showed that C14 palm-based MES has no potential mutagenic properties against all the five strains in the absence of S9 metabolic activation. In addition to that, the test validation of the bacterial reverse mutation assay in the presence of S9 metabolic activation is on-going.</td>
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<tr>
<td></td>
<td>mutation assay for assessment of genotoxicity of</td>
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<tr>
<td></td>
<td>methyl ester sulphonate</td>
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<td>Key Recommendation</td>
<td>Response</td>
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<tr>
<td><strong>PROGRAMME : BIOENERGY</strong></td>
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</table>
| 1. **EP 113/2009 - Novel Microorganisms for Industrial Catalytic Solutions: Glycerol Utilization for the Production of 1,3-Propanediol (1,3-PDO)**  
  - SC proposed to explore other routes of transformation of glycerol into value-added products such as lactic acid and other relevant compounds.  
  - This project could also be integrated/clustered in the future with other related projects focused on transformation of glycerol and its use e.g. EP 175/2015, EP 168/2014. |  
  - The project has been completed.  
  - VIVA is scheduled in August 2017.  
  - New research on the transformation of glycerol into other valuable and relevant compounds will be explored. |
| 2. **EP 115/2009 - Bioenergy Production from Algae**  
  - SC highlighted large variations was observed on the maximum growth rate of microalgae.  
  - SC noticed a large difference in the fatty acid composition between the microalgal oil and the biodiesel obtained from in situ transesterification of the same microalgal oil. SC commented that these values should be similar. |  
  - The growth rate of microalgae can be different depending on the type of microalgae used and the culture medium.  
  - The FAC was rerun and the data rectified.  
  - The project will be closed with VIVA presentation in 2017. |
  - SC commented that the distortion of the ILCD LCIA was actually from uncertain normalization data and normalization references  
  - SC encouraged the researcher to publish the results. |  
  - Noted.  
  - Will publish when there is sufficient data. |

- SC advised that future efforts need to be specific with indication of appropriate timeframe.

- SC queried on the selection of EFB rather than other oil palm biomass *i.e.* shell, frond and trunk; as shell seems to be a suitable material because of its homogeneity and in ready form.

- SC suggested to include the error bars on the data presented for EFB, frond and trunk.

- SC suggested to compare the energy value of the torrefied pellet produced with that produced by a simple moisture reduction. The researchers also need to study the economic and market accessibility of the torrefied pellet.

- **Noted.**

- For the first parameter study, EFB, trunk, frond and palm kernel shell (PKS) were used to investigate the effect of torrefaction on different type of oil palm biomass. The results indicated that the optimum torrefied yield was obtained using EFB. Based on the first parameter results, EFB was chosen as the feedstock rather than other biomass.

- **Noted and included.**

- The comparison of energy value of the torrefied pellet produced with that produced by a simple moisture reduction will be presented during PAC 2017. The study of economic and market accessibility of the torrefied pellets is still in progress.

5. **EP 175/2015 - Glycerolysis of Palm Fatty Acid Distillate as Biodiesel Feedstock using Heterogeneous Catalyst**

- SC suggested using commercial CaO which is cheaper and readily available in the market. In addition, calcinated eggshell caused an undesirable darker colour in the final product.

- SC also suggested to look into the possibility of integration of glycerol project with that in the production of lactic acid, 1,3-propanediol, etc.

- **Noted and will be integrated in future research endeavours.**
<table>
<thead>
<tr>
<th></th>
<th>EP 158/2013 - Water Footprint of the Production of Crude Palm Kernel Oil and Palm Kernel Expeller</th>
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<tbody>
<tr>
<td></td>
<td>• SC suggested to use the UNEP-SETAC consensus method (WULCA) to compare the water footprint.</td>
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<td></td>
<td>• SC suggested to include the uncertainty in the inventory data, and to conduct sensitivity analysis</td>
</tr>
<tr>
<td></td>
<td>• The current method used for water footprint is already listed under the WULCA list of methods.</td>
</tr>
<tr>
<td></td>
<td>• The standard deviation is being carried out for the data and decision will be made on what parameter to conduct the sensitivity analysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>EP 159/2013 - Consequential Life Cycle Assessment of the Production of Palm Kernel Expeller (PKE) Specifically used as Animal Feed</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>• SC commented that the displacement of feed just based on protein may not be good enough as not all the protein in PKE are absorbed. Efficiency of absorption should be considered.</td>
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<td></td>
<td>• SC commented that the IPCC calculation of biogas based on chemical oxygen demand may not be suitable for the actual scenario because different anaerobic treatment systems have different digestion efficiency. The anaerobic digestion efficiency has to be considered.</td>
</tr>
<tr>
<td></td>
<td>• SC commented that the GHG emissions of the vegetable oil varies, the displacement calculations must also be carried out using the sensitivity analysis approach.</td>
</tr>
<tr>
<td></td>
<td>• SC commented that the European data may not be applicable for tropical conditions. SC cautioned that one has to be careful when using the data from literature.</td>
</tr>
<tr>
<td></td>
<td>• In LCA some assumptions have to be carried out. Since weight displacement cannot be carried out for PKC just as in other studies protein content is the best estimate.</td>
</tr>
<tr>
<td></td>
<td>• The explanation behind the IPCC formula is not based on efficiency but it just calculates the amount of COD or BOD that is digested that can produce biogas. Data is being collected before and after the anaerobic ponds and biodigestors to make these calculations which will be presented during PAC 2017.</td>
</tr>
<tr>
<td></td>
<td>• A different approach is being carried out for this project where a proposal to just do system boundary expansion for all the by-products and not go ahead and calculate the displacement of products. This new approach will also be presented during PAC 2017 for comments. This is due to the the very high uncertainties of feed GHG emissions as well as vegetable oils GHG emissions.</td>
</tr>
</tbody>
</table>
|   | • The displacement of GHG emissions is based on the consequential approach where the vegetable oil is
displaced in Europe or USA or other parts of the world. And so using the CLCA approach the GHG of those specific European or US or Global data have to be used. However now with change of scope this may not be an issue.

| 8. | **EP 166/2014 - Bioflocculant Production from Palm Oil Mill Effluent (POME)** |
|    | • SC suggested to look into using bioflocculant for raw water treatment as there is a ready market for this application. |
|    | • SC also suggested to look into the possibility of integrating this project with other relevant projects or any other potential upcoming new projects as a follow-up from the conclusion of this project |
|    | • The project has been completed with Viva (Viva No. 775/2016 (33), MPOB 215, Viva Committee Meeting, 8 September 2016). New project on its application (for raw water treatment) using bioflocculant can be potentially proposed in the future. |
|    | • The project can be possibly integrated into the long-term biorefinery cluster research program targeting zero discharge i.e. transformation of POME into various value–added products. |

|    | • SC requested the researchers to include a detailed report on sampling procedure and sources of EFB contributing to increased ash content of the pellet produced. Characteristics of the ash should also be determined. |
|    | • The high ash content was probably caused by the contamination of soil and dirt due to poor handling of the raw material either during transportation to the production plants or material handling/storage at the production plant. |
|    | • A preliminary study of ashes obtained from combustion of EFB was analyzed using a scanning electron microscopy –energy dispersive X-ray spectroscopy (SEM-EDX). Samples of fly ash and bottom ash generated from EFB-based biomass power plant were used. The study showed that main elemental content of EFB bottom ash were K (20.96±8.3%) and Si (10.92±2.15%) and Cl (19.22±5.53) and...
• SC advised to consider a sensitivity analysis for EFB as a product. In that case, the LCA study starting from zero burden should be compared with EFB having allocated some burden from upstream.

K (36.02±2.24) were two main elements found in EFB fly ash.

• This will be considered in the final report.

<table>
<thead>
<tr>
<th>10</th>
<th>EP 172/2015 - Investigation on the Practice of Disposing Treated POME into Plantation and its Impact on Adjacent River Quality</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• SC commented that the revised methodology was very site specific; thus the data transferability is questionable. It may be difficult to generalize the results obtained for meaningful plantation operations on land application.</td>
</tr>
<tr>
<td></td>
<td>• SC commented that potential saving of fertilizer can be achieved by the proper POME utilization. It has been well-established that application with biosolids from POME can increase FFB yield without using inorganic fertilizers and also beneficial in alleviating water stress, if the project can be conducted in a proper manner. The current project can only relief water stress but without any nutrient value.</td>
</tr>
<tr>
<td></td>
<td>• Apart from the proposed experimental land irrigation site, recorded data from nearby actual land irrigation site is currently being collected. Arrangement of percolated tube well to be installed in these locations is also on-going to collect ground water samples for similar analysis.</td>
</tr>
<tr>
<td></td>
<td>• With the proposed experimental land irrigation site, the project now has the capability of testing the dumping of effluent with higher organic loading in the site thus proper analysis of its benefit as well as environmental implication can be conducted.</td>
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<tr>
<td></td>
<td>• SC suggested a particle size analysis be performed on the sample.</td>
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<td>• SC commented that the high moisture content from the TGA analysis could be due to water of crystallization in the</td>
</tr>
<tr>
<td></td>
<td>• Particle size analysis and other relevant characterization analysis is being performed.</td>
</tr>
<tr>
<td></td>
<td>• Noted and moisture content analysis will be repeated.</td>
</tr>
</tbody>
</table>
compounds.

- SC commented that the project should decide whether the objective is to avoid clogging due to crystal formation in the pipeline or to utilize the crystal as fertilizer. The methodology involved in these two objectives are different. SC suggested that avoidance in accumulation of the crystal is a better approach.

- SC commented that this project was contradicting with EP 172/2015 as the latter was deemed to be more cost-effective due to its direct application to the plantation.

- The project is currently focusing on the avoidance and accumulation of the crystals.

### PROGRAMME : MILLING TECHNOLOGIES

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<td>Nil</td>
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<tr>
<th></th>
<th>13. EP 151/2012 - Potential Air Control Technologies for Particulate Reduction from Palm Oil Mill Palm Waste</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Nil</td>
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</tbody>
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<tr>
<th></th>
<th>14. EP 152/2012 - Study on the Applications of Ionic Liquid in Oil Palm Processing</th>
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<tbody>
<tr>
<td></td>
<td>SC inquired on the possible reasons for the low content of carotene in the raffinate. SC suggested that the researcher check the pH of the ionic liquid as carotene is easily degraded in acidic condition.</td>
</tr>
</tbody>
</table>

|   | The comments from the SC are well noted. However, the laboratory work with regard to the original scope of the study has been completed. The work so far has take into account the previous comments and suggestions from the SC before coming up with the current findings and conclusion. Most of the findings have been published in refereed journal (ISI-index). To date, a full thesis |
dissertation containing all the findings from the study has been submitted to the University of Malaya for evaluation by the internal/external panel. Nevertheless, the suggestion from the SC (to check the pH) can be included in future work but must be well-planned considering many other parameters and scope of study that was not covered in this present study.

<table>
<thead>
<tr>
<th>15.</th>
<th>EP 157/2013 - Value Addition of Palm-pressed Fibre Oil (PPFO)</th>
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<tbody>
<tr>
<td></td>
<td>SC requested the researchers to check the data as inconsistency was observed.</td>
</tr>
<tr>
<td></td>
<td>SC also suggested to check on oxidized carotenes.</td>
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<tr>
<td></td>
<td>Replication of experiments for solvent fractionation process has been carried out for data consistency check.</td>
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<td></td>
<td>The progress and findings will be presented during PAC 2017.</td>
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<thead>
<tr>
<th>16.</th>
<th>EP 163/2014 - Production of Feed Quality Palm Kernel Expeller (PKE) for Poultry Industry</th>
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<tbody>
<tr>
<td></td>
<td>Once the installation is completed, the crude fibre in the feed could be reduced to a minimum level comparable to the commercial feed. Therefore, the feed intake per bird will be lower. SC advised the researchers to look into wastage of feed.</td>
</tr>
<tr>
<td></td>
<td>The installation has been completed and it was found that there is a reduction of crude fibre in the PKC. This resulted in lower feed intake per bird and no wastage.</td>
</tr>
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<table>
<thead>
<tr>
<th>17.</th>
<th>EP 170/2015 - Trash Removing System (Trash-RID) for Palm Oil Mill</th>
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<tbody>
<tr>
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<td>Nil</td>
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**PROGRAMME: PHYTONUTRIENTS**

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<tbody>
<tr>
<td></td>
<td>Nil</td>
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<tr>
<td></td>
<td>The study is already in the final stage. The results on the squalene extraction will be reported in the next PAC meeting.</td>
</tr>
</tbody>
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<tr>
<th>19.</th>
<th>EP 155/2012 - Potential Value-Added Chemicals from Pyrolysis Oil (Bio-oil)</th>
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<tbody>
<tr>
<td></td>
<td>SC commented to provide further</td>
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</table>

<table>
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<tr>
<th>19.</th>
<th>EP 155/2012 - Potential Value-Added Chemicals from Pyrolysis Oil (Bio-oil)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SC commented to provide further</td>
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</table>
Details on the research programme in 2016 *i.e.* to include the overall outlook and the possible next step to be taken e.g. publication or transfer of technology. This is also applicable to other researchers.

- SC suggested to explore efficient methods for extraction of fine chemicals from bio-oil as well as to characterize and identify the extracted fine chemicals.
- SC queried on the progress of the economic analysis (phase 5) of the project. SC was informed that it is necessary to establish the extraction method prior to economic evaluation.
- SC encouraged researchers to present results including difficulties encountered and abnormal observations.

<table>
<thead>
<tr>
<th>20. EP 171/2015 - Process Development for the Production of Intermediate Palm Tocotrienols Products for Food and Beverages Applications</th>
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<tbody>
<tr>
<td>• SC suggested that nitrogen blanketing could be considered to prevent degradation of tocotrienols. SC also suggested the researchers to look into the pH of the emulsion.</td>
</tr>
<tr>
<td>• SC requested the researcher to speed up the project as the progress for 2015 was only 35%.</td>
</tr>
<tr>
<td>• Nitrogen blanketing was carried out in preparation of emulsion using different pH.</td>
</tr>
<tr>
<td>• There was problem encountered in releasing 100% of vitamin E (emulsion form) into hexane during vitamin E analysis. Replication of tocotrienols determination has been done using multiple volumes.</td>
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**PROGRAMME : BIOMASS PRODUCTS**

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<tbody>
<tr>
<td>SC suggested to look into other applications of furfural once this project is completed (e.g. as platform chemicals)</td>
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<tr>
<td>• The suggestion is noted.</td>
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next report.

- SC was informed that the inconsistent results in Table 1 may be due to heterogeneity of the samples since samples were taken from different points in the furnace.
- SC commented on the title of the project. The title should be more specific on the use of PKS rather than oil palm biomass for the activated carbon production.

**PROGRAMME : GREEN PRODUCTS**

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<tr>
<td>- SC requested to include the economic evaluation of the study even though the project has not been completed yet. The parallel analysis would enable the researcher to take any necessary actions to move towards the optimization of the process.</td>
<td>- The economic evaluation will be presented in the next PAC meeting.</td>
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<tbody>
<tr>
<td>- SC requested to check on the differences in the initial results of oil content of the materials. The researchers may need to repeat or recalculate the results.</td>
<td>- The results have been recalculated and will be presented in the next PAC meeting. This project has been completed.</td>
</tr>
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<tbody>
<tr>
<td>- SC requested to include the error bars in the data obtained. The measurements need to be replicated,</td>
<td>- Noted.</td>
</tr>
<tr>
<td></td>
<td>- SEM magnification has been re-</td>
</tr>
</tbody>
</table>
| • SC suggested to use other methods on identifying the unknown compound, such as LCMS, NMR or GPLC.  
| • Identification of the unknown compounds in palm-based lubricant samples using GC-MS has been carried out.  
| | 30. **EP 177/2015 - Diversifying the Palm Based Sodium Carboxy Methyl Cellulose Characteristics for Different Applications**  
| • SC acknowledged the progress but commented on the different format of the written report as compared to the slides in the presentation  
| • The comment was noted. |
**MATTERS ARISING OUT OF MINUTES & REPORTS OF 36TH MEETING**

**ENGINEERING AND PROCESSING RESEARCH DIVISION**

**ON NEW PROJECT PROPOSAL**

<table>
<thead>
<tr>
<th>Key Recommendation</th>
<th>Response</th>
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<tr>
<td><strong>PROGRAMME : PHYTONUTRIENTS</strong></td>
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<tr>
<td>• The Sub-Committee (SC) urged that a proper plan on experimental design and analyses be conducted considering the constraints on man-power, resources and facilities available.</td>
<td>• Experimental design for the project is conducted according to statistical approach. The analyses of selected parameters are carried out at least in duplication.</td>
</tr>
<tr>
<td>• SC suggested to use up-to-date advanced instrumentation for sample analyses. SC suggested NIR for IV, replacing the time-consuming titration method; UPC2 for simultaneous vitamin E, carotene and other phytonutrients analyses. Method development is needed and can be rapidly carried out. SC requested RM600,000 budget allocation for the two additional instruments. These two instruments are to be shared with other MPOB projects.</td>
<td>• For NIR, currently an officer from another research group is in the process of purchasing the instrument. The facility will be shared once it is available. For UPC2, SC’s recommendation to purchase the instrument will be looked into.</td>
</tr>
<tr>
<td>• SC also requested details in the purpose of using nanofiltration technology. It should clearly state that nanofiltration is to be used for molecular separation of phytonutrients from the triglycerides based on differences in molecular weight</td>
<td>• Using a suitable pore size of nanofiltration (NF) membrane and based on molecular weight differences, it is expected that the permeate obtained will be riched in phytonutrients such as vitamin E and carotenes. The retentate will have higher content of phospholipids. NF technology is a physical separation process that can be operated at mild operating conditions which can reduce the energy consumption and be able to retain components that are sensitive to high temperatures.</td>
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**PROGRAMME: ENVIRONMENT & SUSTAINABILITY**

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<tr>
<td>• SC was informed that this project was formulated to address the request from DOE on the proposed odour regulatory compliance i.e. at 12,000 OU/m³.</td>
<td>Meeting has been conducted to discuss the sampling matter with MPOB statistician and the experiment methodology has been duly designed</td>
</tr>
<tr>
<td>• SC requested to conduct detail analysis on odour-causing chemical components including identification of the odour sources.</td>
<td></td>
</tr>
<tr>
<td>• SC highlighted the importance of representative sampling. If the samples are non-representative, the results obtained are meaningless and can even be misleading.</td>
<td></td>
</tr>
<tr>
<td>• SC recommended that the project should proceed only if proper sampling procedure is established. The sampling procedure is unique in this case because of the unique topography, different treatment systems, environmental changes, etc.</td>
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<tbody>
<tr>
<td>• SC suggested the inclusion of an additional stakeholder group since the oil palm industry is a very important industry for Malaysia as a whole.</td>
<td>The stakeholder group of the nation will be included in the study.</td>
</tr>
<tr>
<td>• SC suggested attention be paid to the questionnaire format in order to avoid biasness. It was informed that respondents may be alarmed by very difficult questions. The best way to gather data is to have a face to face interview with the respondents.</td>
<td>Data is being collected via direct discussion and not through questionnaires.</td>
</tr>
<tr>
<td>• SC suggested increasing the budget, especially for travelling and training since this is a new emerging field.</td>
<td>The budget for this project will be obtained from the environment group annual budget.</td>
</tr>
<tr>
<td>• SC highlighted that there may be a vast difference between the RSPO-certified and the non-RSPO-certified companies on social impact.</td>
<td>This will be looked into.</td>
</tr>
<tr>
<td>Programme: Biomass Products</td>
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<tr>
<td>SC suggested that the lignin fraction be recognized in addition to the cellulose and hemicellulose fractions of the EFB.</td>
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<tr>
<td>SC suggested to start writing report and publication during the experimental phases.</td>
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</tr>
<tr>
<td>SC proposed to consider the possibility on the use of other types of adhesive, besides PVA. SC doubted that PVA is suitable for the purpose.</td>
<td></td>
</tr>
<tr>
<td>SC suggested that emphasis should be given on research to improve the quality oil palm veneer prior to product making.</td>
<td></td>
</tr>
<tr>
<td>SC suggested that consideration of preservative treatment after manufacture of the structural composite lumber be considered as an alternative to treatment of the veneers.</td>
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</table>
1. **GENERAL RECOMMENDATION**

<table>
<thead>
<tr>
<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
</tr>
</thead>
</table>
| 1  | The Sub-Committee also discussed on the need to expand the engagement with the schools in Malaysia to include the private international schools and international universities as well. | MPOB has initiated an engagement with the Co-Curricular and Arts Division (BKK) of the Ministry of Education (MoE) to convey our intention on organizing educational programmes in schools. The main objective of this engagement is to educate and create awareness amongst students and teachers on the importance of Malaysian oil palm industry and the nutritional attributes of palm oil and its applications. A list of programmes which have been successfully organized is as follows:  
  i. Program *Kembara Kokurikulum Peringkat Kebangsaan 2016* (Co-Curriculum Expedition at National Level) on 17 - 21 October 2016. In collaboration with BKK, MoE.  
  ii. School Visit to MPOB from St. John’s School, Bukit Nanas Kuala Lumpur on 10 August 2016.  
  iii. Carnival Day of St. John’s School, Bukit Nanas Kuala Lumpur on 6 November 2016.  
  A paperwork on ‘Educational Programmes via School Co-curricular Activities’ had been submitted and approved by MoE. The first stage of implementation will involve public schools in Kuala Lumpur, Selangor and Putrajaya. MPOB has been channeling its efforts towards organizing palm oil awareness related programmes in public schools and universities in 2016. Engagements with international/private schools and universities are to be enhanced in the near future. A list of successful MPOB Technical Seminar (MTecS) conducted last year in collaboration with universities is as follows:  
  i. MTecS at Universiti Teknologi Malaysia on 10 October 2016. In collaboration with Institute of Bioproduct Development, Universiti Teknologi Malaysia.  
  ii. MTecS at University of Malaya on 14 November 2016. In collaboration with Faculty of Science, University of Malaya. |
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<td>iii. MTecS at Universiti Kebangsaan Malaysia on 25 November 2016. In collaboration with School of Chemical Sciences &amp; Food Technology, Universiti Kebangsaan Malaysia.</td>
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<td>In this regard, the Sub-Committee also proposed that promotional materials be made available which would also include messages to convey the correct information on sustainability and the environment to the relevant institutions.</td>
<td>Communications with the Sustainability, Conservation and Certification Unit has been done for this purpose.</td>
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<td>This would also involve the likelihood of the private sector being invited along to participate in such educational activities.</td>
<td>MPOB has identified a potential collaborator namely Yayasan Sime Darby (YSD) to jointly organize educational programmes. An initial meeting with an YSD representative was held on 21 October 2016 to discuss on potential collaborations between MPOB and YSD in organizing educational programmes for schools. A very encouraging feedback was received from YSD.</td>
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<td>The Sub-Committee also noted that the importance of the social media in influencing the general public and agreed for MPOC to take the lead in the promotion in the social media. In this respect, it was requested that emphasis be given on using much of the available information from various scientific and reputable institutions including science based NGOs, e.g. World Resource Institute, to help distribute positive information and counter the allegations made against Malaysian palm oil. The Sub-Committee also recommended for this initiative to be extended to the private and international schools and universities in Singapore.</td>
<td>MPOB has conveyed the recommendation of the PAC regarding the importance of the social media to MPOC for their action. MPOC has responded that social media has and will continue to be an important tool in marketing, educating and addressing issues. MPOC has established an Edupalm website (can be viewed at this link <a href="http://edupalm.org.my/web/">http://edupalm.org.my/web/</a> which is used specially to educate secondary school students on palm oil. This complements the books developed and distributed in stages to schools in Malaysia. Consumer friendly competitions are organized using social media as a way to get consumers to learn about palm oil. A number of food videos have been produced to entice Malaysians to better appreciate palm oil. International chefs who feature in the videos speak about their favorite oil. These videos have been well received.</td>
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<td>The Sub-Committee recommended that the MPOB to continue their engagement with the Ministry of Health in Malaysia as well as in Singapore involving MPOC to jointly help clarify some of the misunderstandings circulating on palm oil and its health attributes in order to arrive at a more balanced approach. The Sub-Committee recommended that a minimum of two meetings be held with the Singaporean authorities over the next 12 months.</td>
<td>Several activities have been carried out with the Ministry of Health Malaysia. On 20 July 2016, MPOB was invited to give a lecture at the Ministry of Health to a group of doctors, nurses, dieticians and medical staff from various hospitals. The lecture was successfully carried out with a good interaction between the audience and MPOB Nutritionist, Dr. Kanga Rani. A meeting with the Ministry of Health Singapore will be arranged upon completion of other activities such as MTech Seminar and POTS.</td>
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<td>In this connection, the Sub-Committee urged the MPOB to speed up or to accelerate nutrition studies on the aspect of palm oil for these to be used for promotional purposes. In this respect, the Sub-Committee specifically recommended that Cambridge/Harvard University be contacted to undertake this study.</td>
<td>A proposal has been received from Cambridge and is currently under review.</td>
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<td>3</td>
<td>The Sub-Committee discussed the increasing importance of the social media. The Sub-Committee agrees that MPOC to take the lead in the promotion in the social media and encouraged MPOC to enhance their promotional efforts in this area and for MPOC to enhance the palatability of the contents to create more interest amongst the young and old people and to reach out to a wider coverage.</td>
<td>MPOB has conveyed the recommendation of the PAC regarding the importance of the social media to MPOC for their action. MPOC has responded that social media has and will continue to be an important tool in marketing, educating and addressing issues. MPOC has established an Edupalm website (can be viewed at this link <a href="http://edupalm.org.my/web/">http://edupalm.org.my/web/</a>) which is used specially to educate secondary school students on palm oil. This complements the books developed and distributed in stages to schools in Malaysia. Consumer friendly competitions are organized using social media as a way to get consumers to learn about palm oil. A number of food videos have been produced to entice Malaysians to better appreciate palm oil.</td>
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<td>International chefs who feature in the videos speak about their favorite oil. These videos have been well received. PORTSIMP Shanghai disseminates information on palm oil in layman term through its WeChat Public Account. To-date (from July 2015 till August 2016), PORTSIMP Shanghai has posted 40 short articles on palm oil in Mandarin and these articles have been shared widely in WeChat.</td>
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<td>4</td>
<td>The Sub-Committee also recommended to intensify the translation of promotional materials into other languages such as in the Hindi, Tamil and Telugu for the expanding Indian market in addition to the other languages that are already proposed by the various Regional Managers.</td>
<td>With the assistance of Mr Goenka’s Office, a Hyderabad-based company, Hyderabad Translation Bureau (HTB) had been identified to undertake the translation work. The translations in Tamil, Hindi and Telugu have been completed. Translation of the Palm Oil Health Facts to French language has been completed and is being printed. Palm Oil Health Facts has been translated into Persian language. The translated book was launched during POTS Iran 2017 by YB Minister of MPIC on 6 February 2017. The latest version of the Pocketbook of Palm Oil Uses has been printed.</td>
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<td>MUMSAD is yet to provide cost estimation cost of translation and printing. Regional Manager had started to look for alternative collaborator in Turkey including University of Selcuk. PORTSIM Shanghai had translated the following papers into Mandarin and distributed together with other papers translated earlier, at 5th Palm Oil Health and Nutrition Forum in Tianjin, China on 10 August 2016. i. Lucci et. al. (2016). Palm oil and cardiovascular disease: a randomized trial of the effects of hybrid palm oil supplementation on human plasma lipid patterns. <em>Food Function</em>, 2016, 7,34. ii. Teh et. al. (2016). Effects of Fatty Acids at Different Positions in the Triglycerides on Cholesterol Levels. <em>JOPR</em> Vol. 28 June 2016 p. 211-221</td>
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<td>5</td>
<td>The Sub-Committee recommended that MPOB develop a peanut butter flavoured formulation by using palm oil based fractions. This will eliminate the risk of aflatoxin contamination in peanut butter especially in the African region.</td>
<td>The basic formulation has been tested. Inclusion of suitable palm oil fractions and stability during storage are being determined.</td>
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<td>The Sub-Committee recommended that the MSPO certification be directed towards the smallholder segment thereby be able to fulfill the UN recommendations on improving the livelihood of the poor and simultaneously ensuring that responsible development can go hand in hand with protecting the environment. The Sub-Committee was of the opinion that the MSPO certification would be able to fill the void which currently exists with the RSPO certification, particularly amongst the smallholders who either did not have the resources or</td>
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<td>From 1 January 2014 to 5 January 2017, 13 groups of smallholders including 9 Sustainable Palm Oil Clusters (SPOC) with a total area of 6,798.55 ha had been certified under MSPO. Under RMKe-11 Project (<em>Program Pemerkasaan Pekebun Kecil</em>) Government has allocated fund to finance the smallholders' MSPO certification. To spearhead the implementation of MSPO for smallholders, a fund of RM 53 million has been allocated for that purpose. MPOB and Solidaridad Asia had signed a Memorandum of Understanding to formalize a very important strategic partnership towards achieving high returns from sustainably-cultivated oil palm on smallholdings and promotion of Malaysian Sustainable Palm Oil or MSPO-certified sustainable</td>
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<td>finances to proceed with sustainable farming.</td>
<td>palm oil in international markets.</td>
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7. The Sub-Committee recommended that there should be less focus on protecting market share but on increasing the sales of higher value-added products.

### West Asia
Zade of Turkey had purchased Malaysian red olein for a trial distribution of red olein capsule in Turkey.

### South Asia
In South Asia, particularly India, efforts are made towards promoting higher value-added products, despite domestic challenges. The major challenge is price consideration among importers.

### Africa
For the African region, MPOB Cairo has intensified the TAS efforts on market expansion for palm based finished products which have more value addition as compared with the export of palm oil in bulk. Exports of Malaysian palm based finished products to Africa for January-October 2016 were 54,262 tonnes, an increase of 17.1%. For January-November 2016, TAS efforts were conducted in the eastern African region especially in Egypt, Djibouti, Kenya and west Africa i.e. Nigeria. Egypt has become the biggest Malaysian palm based finished products market in Africa for January-October 2016 with finished products import stood at 14,575 tonnes, an increase of slightly more than four folds. Djibouti has imported 1,730 tonnes of palm based finished products from Malaysia in January-October 2016, an increase of slight more than two folds as compared with the corresponding period in 2015. Nigeria import of finished products remained stable at 3,301 tonnes for January–October 2016. This served as a good indication on the successful efforts done by MPOB Africa and Malaysian palm oil industry in promoting high value added palm based products in these countries.

### Far East:
PORTSIM Shanghai has initiated a study on effects of red palm oil on chicken egg yolks in order to open new market for value-added red palm oil in poultry feed. The red-yolk eggs are sold at double price of normal eggs in China.

In addition, this strategy has been incorporated into the newly approved projects by PORTSIM Research Advisory Committee (RAC) on 2 December 2016.

8. Whilst the Sub-Committee appreciated the work done on 3-RBD samples (PO, P0o and POS) have been collected from several refineries from all over
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<td>MCPD and its mitigation by the MPOB, it nevertheless recommended that more work needs to be done in order to prepare the industry for a potential backlash which very well could be just around the corner. The question posed by the Sub-Committee-are we ready to address issues in the international media relating to 3-MCPD in an affirmative manner? In other words, the Sub-Committee wished for the MPOB to pre-empt such an outcome.</td>
<td>Malaysia by MPOB’s enforcement officers and are being analysed for 2-, 3-MCPD esters and GE.</td>
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| 9  | The Sub-Committee recommended that the regional offices interact with their counterparts at the Indonesian Embassies (and any other palm oil producing countries) with regard to the sustainable development of palm oil. | Europe
RM for Europe meets regularly with counterparts of the Indonesian Embassy in various meetings to discuss latest issues on palm oil.
Indonesian Ambassador to Italy was invited and attended the MPOB palm oil seminar in Rome on 29 Nov 2016. The First Secretary of the Indonesian Embassy to Belgium also attended the 3-MCPD Ester seminar organized by MPOB Brussels during MPIC Mission to Europe on 5 September 2016. |
<p>| 10 | The Sub-Committee recommended for all the RMs and TAS Officers to fully understand the issues affecting palm oil across the globe and to be consistent in the dissemination of messages in the various regions. A standard fact sheet comprising all the necessary information to be used by TAS RMs and officers. This standard fact sheet (environmental and oil palm facts &amp; figures) should be in every MPOB publications. These should be data from unbiased parties (e.g. MPOB Statistics, Oil World, FAO, etc…). | All the RMs and TAS officers are using the information from the Palm Oil Health Facts, Pocketbook of Palm Oil Uses, Palm Oil Fact Sheets, and statistics on environmental eg on forest cover, production of certified palm oil under RSPO, MSPO and other MPOB statistics in the various regions in the dissemination of technical information in the various regions. |</p>
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<td>The Sub-Committee also recommended the MPOB to commission an independent study on life cycle assessment comparing palm oil vs soybean and rice cultivation and to compare the results between these three primary agricultural crops and to assess the differences in each of these crops’ GHG emissions- carbon footprint expressed in kgCO-2eq product produced, i.e. per tonne of oil and per tonne of rice.</td>
<td>Discussion is being held with local universities to undertake an independent study on LCA for palm oil, soybean oil and rice. Desktop research is also being conducted to review the existing data/results.</td>
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<td>science related issues and that the MPOC should take the lead on environmental and social issues. The Sub-Committee advocated that the culture of readiness to pre-empt any such problems.</td>
<td>This issue has been resolved as the Cabinet has lifted the freeze on foreign labor in the plantation sector in May 2016 due to shortage of man power.</td>
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<td>The Sub-Committee expressed their strong concern with the acute labour shortages currently experienced in the Malaysian palm oil industry, considered to be the worst in the last 10 years arising from the freeze on recruiting foreign labour. The Sub-Committee specifically mentioned the urgent need for the MPOB (ideally the Chairman's personal intervention) to engage with the relevant ministries to overcome the current freeze on foreign workers as this would inevitably become a liability for Malaysia in terms of lower tax revenues arising from lower yields, higher loses and a smaller production and export volume of palm oil during 2016.</td>
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<td>The Sub-Committee recommended that future presentations to give an overview of total oils and fats export, overall palm oil export before focusing on Malaysian export data.</td>
<td>All RMs have taken note of this recommendation and will apply it in future presentations to the PAC Sub-Committee.</td>
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<td>The Sub-Committee also appealed to the MPOB top management to consider compressing the PAC meeting schedules from 5 days to 3 days in view of the fact that many representatives found it difficult to justify being away from their other responsibilities for more than 3 days. The proposal will be as follows: Monday</td>
<td>This subject was discussed and not agreed upon during the PAC Plenary Session.</td>
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<td>The Sub-Committee also recommended that findings from the meta-analysis which highlights that saturated fat is not bad for health published by researchers from the Cambridge University should be translated into consumer-friendly messages and communicated extensively particularly through social media.</td>
<td>MPOB has printed the booklet Palm Oil Health Facts in July 2015 and had presented to the International Advisory Panel on Nutrition (IAPN) in October 2015. New findings will be incorporated when the revision is due. MPOB will also work with MPOC in disseminating these information in the social media.</td>
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<td>2</td>
<td>The Sub-Committee recommended</td>
<td>Americas</td>
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2. GENERAL RECOMMENDATION BROUGHT FORWARD TO 2016 IN VIEW OF ITS ON-GOING ACTIVITIES
for MPOB and MPOC to intensify efforts and to continue to participate actively in the relevant trade seminars, food and feed exhibitions to promote Malaysian value added palm based products. The Sub-Committee recommended that either MPOB or MPOC or both should be represented at each of these events.

**Matters To Be Followed Up**

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<td>MPOB have been active in participating in major exhibitions and conferences, i.e., World Ag Expo, Natural Product Expo West, NIOP Annual Convention 2016, 107th AOCS Annual Conference and Expo 2016, NYCC Suppliers’ Day, Tortilla Industry Association (TIA) Annual Convention, International Dairy Deli Bakery Association Show (IDDBA), Summer Fancy Food Show - Specialty Food Association as of June 2016.</td>
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<td>South Asia</td>
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<td>MPOB India has constant interactions with MPOC to discuss the nature of participation in these activities.</td>
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<td>Key contacts were made at these conferences and these have been shared with Malaysian palm oil industry for further exploration of export opportunities.</td>
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<td>Europe</td>
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<td>Relevant events which could be participated by TAS</td>
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<td>had been identified:</td>
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<td>• Australian Dairy Conference, Feb 2017</td>
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<td>• Australia National Field Days (20-22 Oct), NSW</td>
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<td>• Australian International Dairy Week (15-19 Jan 2017), Melbourne</td>
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<td>• 2nd International Conference on Livestock Nutrition (21-22 Jul 2016), Brisbane</td>
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<td>• Good Food &amp; Wine Show (June, July, Aug, Oct 2016)</td>
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<td>• Fine Food Australia (12-15 Sept 2016), Melbourne</td>
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<td>• Malaysia Fest (27 Sept 2016), Sydney.</td>
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|   | Far East: |                           |
|   | PORTSIM Shanghai had participated and presented paper at: |                           |
|   | • 9th Annual Meeting of China Oleochemical Industry in Yangzhou, China on 15 to 17 July 2016 |                           |
|   | • 8th China International Cereals and Oils Industry Summit in Chengdu, Sichuan Province, China from 14 to 15 July 2016 |                           |
|   | In addition, PORTSIM Shanghai also participated in the Asia Energy Cooperation Forum that was held in Chongqing, China on 27 and 28 June 2016, one of the highest level forums on energy in China organized by the Ministry of Foreign Affairs, China and officiated by the Vice Chairman of the Chinese People’s Political Consultative Conference (CPPCC) National Committee. |                           |

|   | 3 | Americas |
|   | The Sub-Committee recommended that technical promotional materials be translated into the local language particularly in those importing countries where language is a barrier. | Plan to translate the new pocketbook into Spanish and the Palm Oil Nutrition fact into Spanish is underway. The translator had been identified. |

<p>|   | Africa |                           |
|   | MPOB Cairo had initiated efforts to translate the Palm Oil Health Facts into Arabic language. The translator and publisher had already been identified. |                           |</p>
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| 4  | The Sub-Committee also highlighted on the importance to build brands which incorporate Malaysian palm based products as a way to build loyalty and realise a higher value for palm products including both food and feed and recommended for the MPOB TAS Regional Managers to assist in the promotion of these Malaysian Brands. | **Far East:** PORTSIM had translated Palm Oil Health Facts, Project Brochures, Palm Oil Pocket Books, Palm Oil Nutrition Papers in Chinese were published for distribution.  
**Americas** Some brands do not exclusively use Malaysian palm oil except those imported directly from Malaysia for industrial use such as Olera Gold Shortening etc. Companies like ISF and Felda has shown interest to participate in major exhibitions to promote their brands by using MPOB/MPOC booth.  
**South Asia** MPOB India has introduced several leading Malaysian companies to potential importers in India to create brand loyalty for palm products in both food and feed applications. Constant follow-ups have been made with the Indian importers to assure them of MPOB’s support and assistance.  
**Africa** MPOB Cairo continues the efforts in trade and technical promotional activities to encourage the usage of Malaysian Carotino Red Palm Oil and Tocotrienols products especially in Egypt, Ethiopia and Djibouti. TAS efforts were also carried out in promoting palm kernel cake for poultry feed and ruminant feed in Egypt. This also includes the advisory services on the usage of high value palm based products. Effort is also carried out on the use of palm based medium-chain triglycerides (MCT) in Egypt.  
**Far East:** The efforts of promoting the high value palm products have been implemented in the R&D activities as well as engagement with the Chinese industry players. |
| 5  | The Sub-Committee noted that there was a decline in the Malaysian export for two consecutive years, which is partly a result of declining yield and production for which weather | It was found that the decline in palm oil export in 2014 and 2015 did not have any direct correlation with FFB yield, pattern on the planted area, areas under replanting and the age profile of oil palm.  
**Declining yield** There is no direct correlation between declining yield... |
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<td>factors cannot be blamed alone. The reasons for the decline should be carefully analysed. In this regard, the Sub-Committee requested for information on the pattern on the total planted area, areas under replanting (small holders and private estates) and the age profile based on the following breakdown: 3-10 years, 10 - 15 years, 15 – 20 years and &gt;20 years to know the trend for the last five years (2011-2015) which has an impact on the oil yield and palm oil production. Nevertheless, there are also other factors to be analyzed.</td>
<td>and PO exports. CPO Production in 2013 was at 19.22 Mn T and increased to 19.67 Mn T in 2014 whilst simultaneously, PO export declined to 17.31 Mn T in 2014 from 18.15 Mn T in 2013. <strong>Age profile</strong> As at December 2015, 8.2% of oil palm trees were below 3 years of age, 20.7% were young palms between 3 to 6 years old and 54.6% were palms in the peak production age of 7 years to 20 years. <strong>Other factors</strong> <strong>PO exports increase when SBO price increase</strong> The analysis shows that the major factor contributing to the decline in Malaysian PO export in 2014 was due to the significant decline in SBO prices as compared to CPO prices. This scenario contributed to the narrower price discount of CPO against SBO. The price discount of CPO against SBO registered at US$200/tonne in 2013 and significantly declined to US$88/tonne in 2014. Therefore, an increase in CPO production in 2014 was not able to increase palm oil export due to the greater fundamental impact of price discount on PO export. PO and SBO are close substitute products in the world vegetable oils market. Therefore, when SBO price increases, demand for PO increases, especially when the price discount between both products widen. PO export increased to 3.2% from 17.58 Mn T in 2012 to 18.15 Mn T in 2013 and in the same period, SBO price declined by 13.8% to US$1,057 per tonne in 2013 as compared to US$1,226 per tonne in 2012. <strong>PO exports has a positive correlation with CPO Prices</strong> It was found that there is a moderate relationship between PO exports and CPO prices in 2011-2015. PO export declined by 2.3% from 17.99 Mn T in 2011 to 17.58 Mn T in 2012 and in the same period, CPO price declined by 14.1% to RM2,764 per tonne in 2012 as compared to RM3,219 per tonne in 2011. <strong>Loss of market share</strong> It was also found that the decline in palm oil exports in the last two years was not due to palm oil production or declining yield, but rather increasing imports of soybean as well as higher intake of Indonesian palm oil by major Malaysian palm oil export markets. Palm oil exports on the other hand, declined from 18.15 million tonnes in 2013 to 17.31 million tonnes</td>
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| | | in 2014 and 17.45 million tonnes in 2015. The decline in palm oil export for the last two years was mainly due to poor export performance to major markets such as China P.R, Pakistan, USA, Iran, Bangladesh and Egypt. Increased imports of soybean by China P.R, Iran and Pakistan, combined with higher intake of Indonesian palm oil by China P.R, Egypt, Pakistan, USA, Bangladesh and Myanmar had contributed to the decline in Malaysian palm oil export performance in 2014 and 2015.
6 | The Sub-Committee also recommended that locally recruited staff (LRS) be recruited to facilitate and assist with the market development activity in the respective regions. | MPIC had advised that the opening of the TAS Office in Croatia for the CEE countries should be put on hold first. MPIC is also of the view that the location for the new office should be in Moscow, Russia rather than in Zagreb, Croatia.

The MPOB Board in its meeting in April 2016 had approved to re-activate the MPOB Regional Office in Tehran as well as the liaison officer on contract basis based on CFS.

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3. **SPECIFIC RECOMMENDATION - EUROPEAN REGION**

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<td>The Sub-Committee ...</td>
<td>RM for Europe meets regularly with several Missions in Brussels to discuss issues on Endocrine Disruptors (EDs). Latest information on ED development, action plan, proposals and outcome of the meetings are conveyed immediately to MPOB HQ.</td>
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<td></td>
<td>The issues surrounding endocrine disruptors be thoroughly followed and that mitigative measures be taken in Malaysia to pre-empt the likelihood of the thresholds for various pesticides used in the industry being lower than 0.01 ppm. This would include a comprehensive sampling of CPO of all Malaysian states.</td>
<td>13 CPO samples (12 real samples and 1 blank sample fortified with 4 ED compounds registered in Malaysia at 0.015 μg/g level) collected from various mills and refineries were submitted to Eurofins Lab for endocrine disruptor residues determination.</td>
</tr>
<tr>
<td>2</td>
<td>The Sub-Committee ...</td>
<td>3 MCPD Esters &amp; Glycidyl Esters (GE) seminar was successfully held in Brussels on 5 September 2016 and discussed steps taken by Malaysia to mitigate and lower levels for 3-MCPD and GE. Currently, the European Commission is awaiting EFSA decision see if they will re-evaluate the TDI for 3-MCPD Esters as there is a discrepancy in the values between JECFA and EFSA.</td>
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<td></td>
<td>The issues surrounding 3-MCPD &amp; glycidyl esters be thoroughly followed and monitored and that mitigative measures be taken in Malaysia to keep 3-MCPD levels below 1 ppm at the point of export.</td>
<td>Recommended mitigation measures: 1. Screen the total chloride content and pH of bleaching clay prior to usage. Only use bleaching clay with the lowest total chloride content that is available, while the pH should be almost neutral to alkaline. 2. Reduce deodorization temperature from 260 °C to 230 °C 3. Rinse CPO prior to refining</td>
</tr>
<tr>
<td>3</td>
<td>The Sub-Committee ...</td>
<td>RM for Europe maintains good relationship with European authorities in Brussels and France. Especially with MEPs, Commission Offices, French Senate and the various European palm oil alliances to enhance the smooth communication to all parties involved.</td>
</tr>
<tr>
<td></td>
<td>Europe remains an ...</td>
<td>Various meetings were organised in Paris during Dato’ Carl Bek-Nielsen’s visit to Paris. There was also a Public Talk in Strasbourg at the European</td>
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<td>No</td>
<td>MATTERS TO BE FOLLOWED UP</td>
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<td>Parliament.</td>
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4. **SPECIFIC RECOMMENDATION - AMERICAS REGION**

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
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<tbody>
<tr>
<td>1</td>
<td>The Sub-Committee was displeased with the slow progress to resolve the alleged forced/child labour issue and strongly urged MPOB to convey to the Malaysian Government the acute need to resolve the issue before the Trans-Pacific Partnership Agreement (TPP) is enforced. The Sub-Committee stressed that the alleged forced/child labour issue could be very damaging to the image of Malaysian palm oil.</td>
<td>MPOB had conveyed this matter during the meeting between MPOB Management, RMs and TAS officers with the late KSU of MPIC on 20 April 2016 after the PAC meeting. MPIC also organized a briefing to the Malaysian Oil Palm Industries by the Ministry of Human Resources on 23 August 2016 which informed that the Ministry of Human Resources will amend relevant Acts and Regulations related to labour laws which will include laws to eliminate forced/child labour. On 22 April, 2016, MPIC organised a discussion with representatives of the Embassy of the United States on the issue of forced /child labor in sub-sectors of oil. To create awareness about forced and child labour, MPOB organised seminar on labour situation in oil palm plantations on 22nd February and 26th April 2016 in Bangi, Selangor and Sandakan, Sabah respectively. It is proposed to appoint a lobbying firm once some improvements have been made and new data have been obtained. These lobbying companies have been identified but the cost is a major hurdle. Communicating directly with USDOL has limited success as the issue has a political dimension which can only be addressed through top-down approach via lobbyist services.</td>
</tr>
<tr>
<td>2</td>
<td>The Sub-Committee also recommended for MPOB to request through MPIC that the Malaysian Government to amend related laws</td>
<td>Since Malaysia has agreed to join TPPA, certain labour laws related need to be amended in order to fulfill the International Labour (ILO) standard. This will be done by the Ministry of Human Resource. It</td>
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### 5. SPECIFIC RECOMMENDATION - AUSTRALASIA/OCEANIA REGION

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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| 1  | The Sub-Committee recommended that technical promotion to focus on expanding the market share of palm kernel cake in Australia and New Zealand. | • Propose to participate in events such as Australian International Dairy Week (15-19 Jan 2017), Melbourne  
• Meet with PKE users in Australia & NZ during TAS Visit |
| 2  | The Sub-Committee recommended that to explore further potential use of palm kernel expeller (PKE) and to conduct analysis on the current use of PKE vis-à-vis use of other oilseed meals in animal feed especially during the time when the milk price is declining. The Sub-Committee also recommended to come up with ways for a higher price realisation to reduce the price gap between palm based animal feed against other oilseed meals. | The imports PKE and other oilmeals to NZ has been collected. Potential further use of PKE to be analysed. |

### 6. SPECIFIC RECOMMENDATION - CHINA AND FAR EASTERN REGION

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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| 1  | The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in China led by the Director General of MPOB, through tripartite R&D and commercialization and engagements with local authorities, and recommended that these efforts be intensified. | The following meetings had been carried out to reach the higher levels in China and to enhance rapport with them:  
i. YBM Meeting with Vice Mayor of Tianjin on 10 August 2016.  
ii. Meeting between Ambassador of Malaysia in China and Vice Governor of Gansu on 27 September 2016  
iii. Meeting between Ambassador of Malaysia in China and Vice Mayor of Tianjin on 10 October 2016  
iv. Delegation Meeting between YAB PM and Premier of China on 1 November 2016  
v. Meeting between DG MPOB and DG of |
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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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<tr>
<td>1</td>
<td>The Chairman and the Sub Committee noted that they were NIN</td>
<td></td>
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</table>
| 2  | Five projects have been completed in 2016:  
  i. PORTSIM 032/2014 - Development of palm oil based bakery release agent  
  ii. PORTSIM 033/2014 - Studies on characteristics of blends of red palm oil and other indigenous oils  
  iii. PORTSIM 035/2014 - Study on the PM2.5 emission from kitchen cooking oils  
  iv. PORTSIM 036/2015 - Study on livestock growth benefits using palm based animal feed products in China  
  v. PORTSIM 043/2015 - Application of palm oil used in vegetable protein drinks | Shanghai CIQ on 1 December 2016  
  Regular postings of palm oil health and nutrition information in PORTSIM WECHAT Social media  
  Papers presented at 4th, 5th and 6th Palm Oil Nutrition and Health Forum were uploaded on PORTSIM Website  
  Project to study effects of feeding different palm powder fats on the production performance of dairy cattle had been approved by RAC at its 10th meeting held on 2 December 2016.  
  The animal feed study will be carried out in 2017. |

7. **SPECIFIC RECOMMENDATION - INDIA AND SOUTH ASIAN REGION**
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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
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<td>1</td>
<td>very pleased with the current initiatives, progress and efforts by the MPOB India Branch Office. They recommended that MPOB India Branch office replicate the effective research activities conducted in PORTSIM China to enhance palm oil utilization in India.</td>
<td>MPOB India continuously has been liaising with the NIN to pursue the finalization of the research proposal. The current priority is to focus on the red palm oil study.</td>
</tr>
<tr>
<td>2</td>
<td>The Sub Committee commented that MPOB India should take a pro-active approach to chart strategies to overcome any nutrition or sustainability issues which are currently affecting the developed countries.</td>
<td>MPOB India has had discussions with several major palm oil importers in India to constantly gauge the issues related to nutrition and sustainability in India. Thus far, there is not much concern expressed on the nutritional or sustainability issues, but the overall concern is the ‘cheap’ image of palm olein due to its 4-decades of association with the Public Distribution System.</td>
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<td>3</td>
<td>The Sub-Committee recommended that MPOB India engage or lobby policy makers, health authorities and various government agencies to improve the perception of palm.</td>
<td>MPOB India is in constant touch with Dr. RBN Prasad of the IICT. Meeting with Dr. Prasad and his IICT colleagues was held in July and September 2016 to discuss the projects and other collaborations with IICT.</td>
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<td>No</td>
<td>MATTERS TO BE FOLLOWED UP</td>
<td>ACTIONS TAKEN</td>
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<td>4</td>
<td>The Sub-Committee recommended that MPOB India explore the possibilities of blending palm oil with olive oil in the blending projects that will focus on blending of palm olein with indigenous oils to cater to the preference in the different regions of India and enter the premium market through health benefit of the blended oil.</td>
<td>MPOB India has created networking with Association of Food Scientists and Technologists (AFST) and has currently drafted an MoU between MPOB and IFST. The MoU is now under review of MPOB HQ. IFST could be a strategic ally for MPOB as they have over 3500 members spread in over 29 chapters (city/regional-bases) in India. The blending of palm olein/olive oil had been incorporated into the scope of the blending project with the IICT. Other oils to be blended with palm olein are sunflower, soybean, rice bran, sesame and mustard oils.</td>
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<td>5</td>
<td>The Sub-Committee recommended that Malaysian Palm Industry take the opportunities from the initiative taken by the Central government of India which allows 100% Foreign Direct Investment (FDI) in oil palm plantations. The Sub-Committee however noted that this will need efforts and initiatives from the Malaysian palm oil industry.</td>
<td>Discussions with Malaysian palm oil industry are still required, as this would be a business decision. The current land ownership regulations and climatic conditions are major limitations. However, with Karnataka recently declaring oil palm as a plantation crop, and other states (e.g. Himachal Prades) set to follow Karnataka’s move, there may be some amount of liberalization on land ownerships.</td>
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<td>6</td>
<td>A Sub-Committee member (Mr Unnithan) expressed his keenness to assist MPOB India in the snack food project proposed between MPOB and ICT as India’s snack food market is expanding rapidly. MPOB should explore the application of palm oil products in snack food industry both as frying medium using palm olein and as a colorant and functional food using red palm olein.</td>
<td>MPOB India has had several discussions with Mr Unnithan on this proposal. Further deliberations are still required. This project has been suggested to the ICT, and discussions are underway to get ICT to submit a research proposal.</td>
</tr>
<tr>
<td>7</td>
<td>The Sub-Committee recommended that MPOB India explore the possibility of blending palm oil with olive oil in the blending projects that will focus on blending of palm olein with indigenous oils to cater to the preference in the different regions of India and enter the premium market through health benefit of the blended oil.</td>
<td>Discussions with Godrej Industries, a major player in Indian oleochemical and personal care products</td>
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Page 165 : PAC 2016 – Matters Arising out of Minutes & Reports of 36th Meeting
<table>
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<tr>
<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
<th>ACTIONS TAKEN</th>
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<td></td>
<td>potential of palm biodiesel market and value added products in oleochemicals/chemical industry in India.</td>
<td>had been held. MPOB India had joined the visit to Hyderabad to meet the Andra Pradesh Economic Development Board (APEDB) with President of MBA and PEMANDU in September. However, follow up action on the part of APEDB has been rather slow. PEMANDU has been directly engaged in follow up actions with the Andhra Pradesh Chief Minister’s office. MPOB India had discussions with MITI New Delhi on actions to be taken jointly with PEMANDU on this matter.</td>
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<td>8</td>
<td>The Sub-Committee recommended that MPOB should assist the Malaysian industry to take advantage of the existing potential of export of palm kernel cake in India and present the findings to the Sub-Committee next year. Emphasis should be given to the cattle feed industry in India where PKC can be utilized as feed.</td>
<td>MPOB India has recommended to some leading Malaysian exporter of PKC, several potential importers of PKC in India, but these companies did not express any interest in the Indian market as they said their priority was EU, New Zealand and South Korea. In addition, MPOB India has approached a leading Indian dairy player (Amul Dairy of Gujarat) and suggested that they import palm-based bypass fat for their dairy cattle. Amul Dairy has requested for sample of the bypass fat, which will be provided by the Malaysian supplier. MPOB India had assisted the Malaysian supplier to send samples to Amul Dairy. Amul Dairy was happy with their initial evaluations on the sample. However, Amul Dairy did not proceed with imports as their expectation was that of a low price (below that of raw material) was not economically feasible for the Malaysian exporters.</td>
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<td>9</td>
<td>The Sub-Committee recommended that MPOB and MPOC focus more on promoting palm oil to the southern and eastern part of India.</td>
<td>MPOB India has discussed this recommendation with MPOC Mumbai. Seminar was planned for Chennai, Hyderabad and Kolkata to be held towards the end of the year but had to be deferred to early 2017. A Malaysia-India Palm Oil Seminar) was held in Hyderabad on 19 May 2016.</td>
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### 8. SPECIFIC RECOMMENDATION - WEST ASIAN AND CENTRAL ASIAN REGION

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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| 1  | The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in Pakistan and the Middle East, through technical collaboration efforts such as development of palm based formulation, introducing Malaysian palm oil brand and engagements with local authorities, and recommended that these efforts be intensified. | • Promotion of ‘Minyak’ palm olein in Pakistan is on-going and has received positive feedback from distributors and consumers.  
• MPOB’s Formulation for palm based solid fats is used by Abu Dhabi Vegetable Oil Company (ADVOC) of UAE. |
| 2  | The Sub-Committee recommended for MPOB West Asia to follow up the status of convenient banking channels for export to Iran. | This issue had been highlighted during the visit of YBM MITI to Iran in October 2016. MITI and Bank Negara are discussing on the banking channels with Iranian counterparts. Financial transaction between Iran and Malaysia is expected to recommence in first half of 2017. |

### 9. SPECIFIC RECOMMENDATION - AFRICAN REGION

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<th>No</th>
<th>MATTERS TO BE FOLLOWED UP</th>
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<td>1</td>
<td>The Sub-Committee recommended that MPOB Africa to obtain on growth trend of middle class across African countries to estimate potential growth in demand. This is because the emergence of the middle class citizen will contribute to an increase in the calories consumed per person per day.</td>
<td>The efforts have started in Egypt and a meeting was held in May 2016 with Egypt’s Agency on Population Growth and Income Status (CAPMAS). Data is still being gathered as it involves a wide coverage of the target group. MPOB Cairo had also planned to gather the information in the major palm oil markets in which the future efforts would be in Kenya (August/September 2016), Nigeria (September 2016), Tanzania (September/October 2016) and Algeria or Morocco (February 2017).</td>
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<td>2</td>
<td>The Sub-Committee recommended the MPOB to consider setting up two offices in the African region to tap the huge African market.</td>
<td>MPOB Cairo is considering two countries which are Nigeria and Kenya of which both are the biggest importers of Malaysian palm oil and palm products. Information gathering will be conducted during TAS visits were held to Kenya on 28 August 2016 until 6 September 2016 and Nigeria on 14 - 23 September 2016.</td>
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## 10. SPECIFIC RECOMMENDATION - ASEAN REGION

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<th>MATTERS TO BE FOLLOWED UP</th>
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<td>1</td>
<td>The Sub-Committee recommended that MPOB assess the domestic consumption of coconut oil for food and to evaluate the feasibility to blend palm olein with coconut oil in the Philippines.</td>
<td>A meeting with Dr Azmil from Protein &amp; Food Technology Unit had been held to discuss the PAC recommendation on evaluation the feasibility to blend palm olein with coconut oil in the Philippines.</td>
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<td>2</td>
<td>The PAC Sub-Committee recommended technical and scientific data related to palm oil be translated in local languages within the ASEAN countries. This is to ensure that the technical promotion and the message of the nutritional benefit are well conveyed to the consumers in the ASEAN region. The translated documents are recommended to be in hard copy as well as in electronic version.</td>
<td>Draft of the Palm Oil Health Facts in Vietnamese had been reviewed.</td>
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### RESEARCH PROJECTS

<table>
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<tr>
<th>No</th>
<th>Key Recommendations</th>
<th>Response</th>
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</table>
| 1. | Labour Requirement in the Oil Palm Independent Smallholders Sector in Sabah and Sarawak (Azman Ismail) | The Sub-Committee suggested that ethnicity group such as Bajau, Kadazan, Murut, Bidayuh should be included in the questionnaire. The Sub-Committee also suggested that the researcher includes qualitative measures in the study. Level of mechanization (if any) also should be studied since mechanization can reduce labour utilization.  

As suggested by the TE Sub-Committee, ethnicity groups such as Bajau, Kadazan, Murut and Bidayuh, as well as the level of mechanization were included in the questionnaire. Face to face interviews with identified respondents have been conducted in both Sabah and Sarawak.  

For Sabah, a total of 395 independent smallholders from various districts were interviewed, whereas for Sarawak, a total of 367 respondents have been interviewed. The study is expected to be completed in March, 2017 and to be vivaed in July 2017. |
| 2. | The Impact of Currency Fluctuation on Malaysian Palm Oil Export (Nur Nadia bt. Kamil) | The Sub-Committee commented that CPO & PPO should be separated in the study. Besides the US Dollar, the study should also  

The Researcher has separated the analysis between CPO and PPO prices as suggested by the Sub-Committee. |
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<th>No</th>
<th>Key Recommendations</th>
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<td>focus on the impact of Indonesian Rupiah against RM (i.e. comparing local delivered</td>
<td>Committee. Upon discussion with one of the PAC Members, Dr James Fry, it has been agreed that there were some amendments in the direction of this study. Throughout the discussion, Dr. Fry suggested that the title of the project needs to be reviewed because he believes that the currency does not really affect the behaviour of palm oil buyers. In his opinion, although Malaysia is the second largest palm oil producer in the world, the price of crude palm oil in the marketplace is not set by Malaysia. He believes that it is more valuable if the study focuses on currency fluctuations and its risk to the palm oil exporters. He also requested that the study examine how exporters manage their foreign exchange rate.</td>
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<td>CPO and FOB Belawan CPO). The Sub-Committee informed that the exchange rate gives</td>
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<td>more impact to the downstream sector such as refined products, oleochemical and</td>
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<td>biodiesel. The Sub-Committee suggested that the researcher consults the industry</td>
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<td>players on how important exchange rate is to their businesses (e.g. hedging activity).</td>
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<td>The study should also make comparison between the impact of exchange rate to other</td>
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<td>vegetable oils like soyabeans, rapeseed oil and others.</td>
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<td>He also commented on the methodology of the study. Besides using an econometric model, he proposed to undertake a survey of Malaysian palm oil exporters. This is to see how fluctuations in exchange rates affect their decision to buy and sell crude palm oil in the marketplace. In addition, he proposed the study to include the impact of export taxes on palm oil prices. He believes that this is one of the factors that attract buyers to buy palm oil from Malaysia or not. Overall, he proposed that the objective of the study should be changed.</td>
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<td>No</td>
<td>Key Recommendations</td>
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<td>• In response to the discussion, the title of the study has been changed to “Exchange Rate Risk: Practice of Malaysian Palm Products Exporters”. The objective and the methodology of the study also has been restated. To date, a set of questionnaire has been drafted. This questionnaire will be sent to 261 Malaysia palm products exporters. For the purpose of pilot test, the survey were sent to twenty selected companies which were listed in the Directory of Malaysian Exporters of Palm Products published by MPOB. The selection of twenty companies were done randomly. Five companies responded and only two companies were found involved in the export of palm products. Another three companies just selling their product locally. The two companies that were involved in the export of palm oil did hedge their position in Bursa Malaysia Derivative. However, the ratio of the hedging is small.</td>
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<td>• Final report of this study is expected to be completed in June 2017 and to be vivaed in July 2017.</td>
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3. **An Empirical Analysis of Malaysian Palm Oil Export to TPPA Member Countries (Nur Nadia bt. Kamil)**

The Sub-Committee suggested that the study should also make comparisons between FTA, TPPA, Bilateral agreements and analyse the impact on the Malaysian palm oil export to these selected countries. The study also should disaggregate between CPO & PPO in the study. The Sub-Committee suggested that the researcher apply WITS (online model) in order to analyse global perspective for trade agreement and for the purpose to make comparison between the 2 models. Besides that, proxy variables are also suggested to be used instead of dummy variables in the model.

- All suggestions made by the TE Sub-Committee had been incorporated into the study.
- The project was completed and presented to the MPOB Viva Committee on 9th January 2017. The study found that participation of Malaysia in TPPA does indeed help to uplift the performance of Malaysian palm oil. The reduction and/or elimination of trade barriers allows palm oil to enlarge its market share among the other major oils and fats consumed globally. With respect to the US, one of the major consumers of Malaysian palm oil, the TPPA does help to open up the market for the palm-based downstream products.

Note: The US has officially withdrawn itself from the TPPA in January 2017

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<tr>
<td>The Sub-Committee commented that the researcher should make a comparison in terms of economic analysis between the existing technology (POMEDfree) and other alternatives technologies for producing energy. Therefore, the duration of the study</td>
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- Economic analysis between the existing technology (POMEDfree) and other alternatives technologies for producing energy such as methane trapping via lagoon and digester tank as well as
should be extended to 1 year instead of 6 months. The Sub-Committee suggested the follow-up action as suggested to DEID in the Divisional Highlights.

other technologies will be conducted as suggested by the TE Sub-Committee.

- Discussion with Officers from the Milling Unit of MPOB (E & P Division) was done. So far only one (1) mill i.e. Genting Jambongan in Sabah has been fully operational, which utilized the zero waste technology. Few other companies have shown interest to adopt the technology, but they are still in discussion process for the transfer of technology.

- In addition, economic analysis will be carried out jointly with inputs on costing provided by Nexus Technology.

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<tr>
<th>5. The Total Contribution of Oil Palm Industry to the Malaysian Economy (Kamalrudin Mohd. Salleh)</th>
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The Sub-Committee commented that this is a good project and will benefit the palm oil industry. However, The Sub-Committee suggested that the duration of the study should be shortened to 6 months.

- The project is almost complete and plan to be vivaed in August 2017.

- Based on the assumption that the export of palm oil and palm kernel oil for 2016 amounted RM49 billion and the local consumption worth RM23 billion, the contribution of the palm oil processing industry to the national income (GDP) is expected to be RM58.4 billion, higher by 7.7% as compared to that of 2015 at RM54.2 billion (as reported in the MPIC Annual Report 2015).

[Note: Sectoral Contribution to the National Economy based on Department]
<table>
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<tr>
<th></th>
<th><strong>The Impact of Indonesian Export Duty Structure and Levy on the Malaysian Palm Oil Export Competitiveness (Kamalrudin Mohd. Salleh)</strong></th>
<th><strong>The study is now focusing on CPO and RBD Palm olein export as these two products represent the major component of Malaysian PO export (24% and 44% of respectively in 2016), with the Indonesian PO export duty restructure directly affecting the export duty on the two products. Oleochemical is not included in the Indonesian palm oil export duty restructure.</strong></th>
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</table>
|   | The Sub-Committee commented that the study should focus more on the downstream sector. In addition, a distinction between refined product and oleochemical is suggested to be made in this study. For data analysis, the Sub-Committee commented that the methodology needs to be simplified and easier for the industry to interpret. The Sub-Committee also commented that a comparison between MPOB local delivered price and FOB Belawan price to be included in the analysis of the study. | • The methodology of this study has been simplified, leaving only the simulation analysis in order for the industry to easily interpret.  

• Both MPOB local delivered price and FOB Belawan price has been included in the analysis for comparison of the Malaysian and Indonesian PO export duty structure. |
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<td>7.</td>
<td>The Sub-Committee suggested to the researcher to reconcile trade data with that of domestic consumption data. In addition, the researcher has been also requested to calculate the growth in domestic consumption of CPKO.</td>
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<td>8.</td>
<td>An Economic Study on Mechanization in Oil Palm Plantations in Malaysia (Azman Ismail)</td>
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<td></td>
<td>The Sub-Committee suggested to the researcher to include an analysis on marginal product on labour against marginal product on mechanization since the analysis can give better explanation on the benefit of using mechanization as against manual. The findings of the study should be shared with the oil palm plantation sector so that the level of mechanization can be increased.</td>
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<td></td>
<td>▪ Based on discussion with a few estate managers, they were interested to know the comparison in terms of productivity between manual and machines. Therefore in this study, productivity analysis between manual and selected machines has been done.</td>
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<td></td>
<td>▪ The advantages using machines as against manual has also been included in this study. This study was completed and presented to the MPOB Viva Committee in July 2016.</td>
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<tr>
<td>9.</td>
<td>Consumers’ Perceptions on the Implementation of Biodiesel in the Malaysian Transportation Sector (Kamalrudin Mohamed Salleh)</td>
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<td></td>
<td>▪ The study will analyze demand for PKO and CPKO, covering export and domestic consumption data.</td>
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<td></td>
<td>▪ The study will also calculate the growth in domestic consumption of CPKO as suggested by the TE Sub-Committee.</td>
</tr>
</tbody>
</table>
The Sub-Committee also requested the researcher to clarify on the suitability of petrol users as the respondents for the project. For the data analysis, the Sub-Committee suggested that the researcher carry out cross-tabulation analysis from the survey results. The Sub-Committee also suggested that the researcher should identify a proper method to enhance awareness on biodiesel programme and the method should be included in the final report. The Sub-Committee also suggested that a further study on biodiesel programme in terms of engine manufacturer’s perspective for further policy recommendation.

- This study not only focused on the perceptions of the diesel user on the Implementation of the biodiesel programme in the Malaysian transportation sector, but also studied the perception of the non-users (petrol user). The reason is that it helped to portray the perception of Malaysian fuel consumers, as the biodiesel programme was subsidised by the Government (or indirectly the tax payers). The perception of consumers is important in ensuring that the (subsidised) biodiesel programme is supported not only by the diesel users, but also included all consumers in Malaysia (tax payers). The study has also included the cross-tabulation analysis and proposed methods to enhance awareness of the biodiesel programme.

- The binary logistic model employed in the study suggested that consumers’ willingness to accept the forthcoming B10 programme is much attributed by how positive that they were in anticipating the good quality of biodiesel B10 as compared to petroleum diesel, as well as their awareness of biodiesel and the income level of respondents (which will influence their usage of B10).

- The project was completed and presented to the MPOB Viva Committee on 17th May 2016.
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Details</th>
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<tbody>
<tr>
<td>10.</td>
<td>Labour Requirement in the Oil Palm Independent Smallholders Sector in Peninsular Malaysia (Azman Ismail)</td>
<td>The Sub-Committee requested that the researcher includes age of palm, especially for independent smallholders who hire workers for harvesting and FFB collection. The Sub-Committee informed that the findings of the study are very important to the oil palm independent smallholders sector. Therefore, the study should be given priority to be completed due to urgency of the findings to be given to the Government for policy recommendations. ▪ As suggested by the TE Sub-Committee, information on the age of palms has been included in the questionnaire. This project was completed and is scheduled to be vivaed in May 2017</td>
</tr>
<tr>
<td>11.</td>
<td>A Study on Market Behaviour and Buying Pattern of Edible Oils in India and China (Kamalrudin Mohd. Salleh)</td>
<td>The Sub-Committee further suggested that the researcher should include and mention the changing pattern of demand in China such as changing preference for noodles. ▪ The suggestion by the TE Sub-Committee has been included in the study. The project was completed and presented to the MPOB Viva Committee on 8th November 2016.</td>
</tr>
<tr>
<td>12.</td>
<td>Goods and Services Tax (GST): Impact on the Malaysian Oil Palm Industry and Potential Earnings to the Government (M. Ayatollah Khomeini b. Ab. Rahman)</td>
<td>The Sub-Committee raised the question about the total tax paid by the oil palm industry to the Government and was subsequently informed that there is no tax collected by the State Government in Peninsular Malaysia. However for Sabah and Sarawak, the State ▪ The project was completed and presented to the MPOB Viva Committee on 17 May 2016.</td>
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</table>
Governments imposed sales tax on the Industry.

- This study only focused on the potential GST collected by the Govt. from the OP industry players.

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<tbody>
<tr>
<td>There were no further comments or suggestions by the Sub-Committee on this project.</td>
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</table>

- The project was completed and presented to the MPOB Viva Committee on 28 June 2016

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<tr>
<td>The Sub-Committee suggested for the researcher to include the type of soil as one of the variables. It was also suggested that the most efficient and inefficient district in Sabah should be identified from the survey results. For Sarawak, the Sub-Committee requested the researcher to include the background of the study as part of the research design.</td>
<td></td>
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</tbody>
</table>

- The project was completed and presented to Viva Committee on 7 June 2016.

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There were no further comments or suggestions by the Sub-Committee on this project.

<table>
<thead>
<tr>
<th>16.</th>
<th><strong>Labour Productivity among Harvesters and FFB Collectors by Country of Origins: A Case Study in Peninsular Malaysia (Siti Mashani Ahmad)</strong></th>
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<tbody>
<tr>
<td></td>
<td>The Sub-Committee commented that incentives given by the estates to the workers, especially harvesters and FFB collectors needs to be studied since incentives have been identified as one of the factors that influences productivity.</td>
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<tr>
<td></td>
<td>As suggested by the TE Sub-Committee, the incentive factor has been studied and the study found that incentives can indeed influence productivity. This study was completed and presented to the MPOB Viva Committee on 27 September 2016.</td>
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</table>
MATTERS ARISING OUT OF MINUTES & REPORTS OF THE 36TH PAC MEETING:
SUB-COMMITTEE OF CROSS-CUTTING ISSUES ON SUSTAINABILITY

<table>
<thead>
<tr>
<th>Key Recommendations</th>
<th>Response/Action</th>
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<tr>
<td><strong>Matters Arising from 2015 Cross-Cutting Session (further opinions and recommendations)</strong></td>
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<tr>
<td><strong>Items 2 and 13</strong></td>
<td><strong>The Government has allocated RM20 million under RMKe-11 and RM50 million under the Malaysian Sustainable Palm Oil (MSPO) Fund to assist and accelerate the smallholders’ sustainable certification. For year 2016, four Sustainable Palm Oil Clusters (SPOC) had been certified under MSPO involving 338 smallholders with a total area of 1,150.05 ha. On the other hand, 970.67 ha involving 221 smallholders had been certified with the Roundtable Sustainable Palm Oil (RSPO).</strong></td>
</tr>
<tr>
<td>• To continue with efforts to link the MSPO certification scheme more towards a “fair-trade” set up often used for small-holders as this could then be viewed globally as being a holistic certification scheme that gave due consideration to the small holders who would not be able to afford to go through e.g. an RSPO certification.</td>
<td>• MPOB and Solidaridad are working together to enhance the effectiveness of MSPO initiative.</td>
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<tr>
<td>• More efforts should be directed at getting more smallholders being certified.</td>
<td>i. To execute three (3) pilot projects on implementation of MSPO and create models for landscape/ regional approach of smallholders’ certification. This would increase the number of smallholders certified.</td>
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<td></td>
<td>ii. To design initiatives to promote awareness amongst buyers and civil society in Asia on MSPO.</td>
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<td></td>
<td>iii. To offer support to Malaysian palm oil companies in identifying and addressing sustainability risks associated to palm oil across their supply chain and provide risk mitigation techniques using different tools.</td>
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<td>iv. To develop impact studies and business cases for sustainable palm oil production.</td>
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<td></td>
<td>v. To support each other’s sustainability communication on palm oil.</td>
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<tr>
<td>Because of issues on Native Customary Rights (NCR) and other issues which have slowed down the certification, a consultant has been identified to assist MPOB in the implementation of MSPO requirements for smallholders in Sarawak. This will help to accelerate the MSPO implementation amongst the smallholders.</td>
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<td>Key Recommendations</td>
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<td><strong>Item 4</strong></td>
<td>MPOB was requested to expedite and complete the LCA study on peat emission with special emphasis on the state of decomposition of the peat i.e. sapric, hemic and fibric peat swamps in oil palm plantings. At this point, MPOB is collecting data on CO$_2$ emission from different stages of peat decomposition at Sebaju and Sebungan in Sarawak based on the soil chamber analysis. MPOB is also in the process of analysing the data based on the three different stages of peat decomposition.</td>
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<tr>
<td><strong>Item 7</strong></td>
<td>Prof. Dr. Denis Murphy suggested that the international Steering Committee to be recommended may meet and monitor peat studies as frequently as every four months. This was supported by the PAC members. Meeting with IAP members was held on 15 August 2016 at Kuching, Sarawak. The next meeting of IAP is tentatively scheduled before PAC 2017.</td>
</tr>
<tr>
<td><strong>Item 9</strong></td>
<td>The Sub-Committee recommended that MPOB make full use of scientific literature citing the beneficial nutritional properties of palm oil (e.g. Chowdhury of Cambridge’s paper entitled &quot;Association of Dietary, Circulating, and Supplement Fatty Acids with Coronary Risk: A Systematic Review and Meta-analysis&quot;) by translating the scientific information into simple language which consumers and end users of palm oil could understand and thereby appreciate. MPOB and MPOC should work hand in hand in this endeavour. MPOB has printed the booklet <em>Palm Oil Health Facts</em> in July 2015 and had presented to the International Advisory Panel on Nutrition (IAPN) in October 2015. It was agreed that the booklet will be updated on a regular basis and new findings will also be incorporated when it is due for revision. MPOB will also work with MPOC in disseminating these information in the social media.</td>
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<tr>
<td><strong>Item 10</strong></td>
<td>• The Chairman of the Sub-Committee recommended that MPOB should look into the matter of making dimehypo commercially available to the oil palm plantation industry.</td>
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<tr>
<td>• Top priority must be given for MPOB, together with experts, to identify worthy alternatives for Class 1A and Class 1B insecticides</td>
<td>• The analyses required for dimehypo proprietary registration are costing approximately RM 23 million. Any exemption on the analyses is not possible. The data required for the registration especially on the toxicological part needs to be carried mostly by overseas GLP labs. This matter has been discussed with the Pesticides Control Division of Department of Agriculture Malaysia, MPOA and also several representatives from the industry.</td>
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<td>• A new formulation of Acephate, known as Acephate 97% SG (soluble granule) will be available soon. Acephate 97% SG is very</td>
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<td>Response/Action</td>
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<td>as there is a possibility that monochrotophos could be banned.</td>
<td>soluble in water as compared to the existing Acephate 75% WP available in the market. Acephate 97% SG is a worthy alternative for Class 1A and Class 1B insecticides since it is categorized as a Class III insecticide. A field trial will be carried out soon to confirm its efficacy in controlling bagworms via trunk injection. A new chemical has been identified as a possible alternative for monocrotophos and metamidophos. Representative from Bayer Monsanto has approached MPOB for a more detailed discussion on this matter soon.</td>
</tr>
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</table>

**Item 20**

- MPOB is to make available the information on the Malaysian palm oil industry’s cost of production trend within the segment of smallholders, private estates, listed companies etc. on a yearly basis. The sub-committee stated that this was an incredibly important factor as it would help to shed more light on the considerable rise on the cost of production which was important from an economic viability point of view.

- MPOB is to make available the information on the general cost of production in a booklet to be circulated to the PAC members one week before the next PAC Meeting.

- The Sub-Committee requested a presentation on cost of production at the next PAC Meeting.

- MPOB has collected information on Cost of Production only for estates sector (excluding Smallholders). However, the information is highly confidential and it is for restricted circulation only.

**Matters Arising from 2016 Cross-Cutting Session (Recommendations by the Sub-Committee)**

1. The Sub-Committee suggested that engagement with NGOs has to be with the people who are actually feeding the information to the general public. MPOB is collaborating with the following NGOs, Malaysian Nature Society (MNS), Solidaridad and Tropical Rainforest Conservation and Research Centre (TRCRC) to disseminate information to the public.
<table>
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<tr>
<td>2. MPOB is to give an update on the yield trends through a presentation by Mr. Balu next year so that we can monitor the trend.</td>
<td>EID Division will collate and present in power point slides on FFB yield and OER performance from 1996 – 2016.</td>
</tr>
<tr>
<td>3. MPOB to appeal to the Government to lift the freeze on the intake of foreign labour particularly for the plantation sector because we are dealing with a perishable crop.</td>
<td>Effective February 2016, the Malaysian government had decided to suspend the recruitment of all foreign workers including those from Bangladesh (G to G). Due to severe labour shortage in several sectors, the government has lifted the freeze on hiring foreign workers for four sectors namely manufacturing, plantation, construction and furniture-making industries in May 2016. However, the recruitment of foreign workers from Bangladesh (G to G) is still suspended.</td>
</tr>
<tr>
<td>4. Step up efforts to find solutions to overcome problems associated with tall palm harvesting, loose fruit collection and evacuation of harvested stacks.</td>
<td>Apart from on-going projects undertaken by the Farm Mechanisation Unit of MPOB, several innovations submitted for the International Competition on Oil Palm Mechanisation (ICOPM) can also be considered to be proposed for the coming PAC meeting. The issue on patent will be resolved with the respective inventors prior to submission of the proposal to PAC.</td>
</tr>
<tr>
<td>5. MPOB to try to engage with some foreign agriculturally reputable companies who have had a string and proven track record with mechanizing labour intensive agricultural tasks in order to hopefully arrive with a solution as to how to overcome what is probably the industry’s No 1 main problem, namely the harvesting of tall palms.</td>
<td>MPOB has been working with a well-established international company with an objective to arrive at a proper solution for tall palm harvesting. In previous project, MPOB had worked with Kobelco Company from Japan in producing oil palm harvesting machine and later with a company from China, Sunward Intelligent Company. Both companies are well known manufacturers for earth moving equipment. For the last two years, MPOB has been working with a Korean company to produce harvesting machine. We are now at an advanced stage of producing machine for tall palm harvesting.</td>
</tr>
<tr>
<td>6. MPOB to continue on the study on carbon emissions and combine it with UPCS to hopefully come up with a range of emissions specific for sapric, fibric and hemic.</td>
<td>MPOB has continued the study on carbon emissions and combined it with UPCS since mid-2016. The estates involved are Sebau, Tinbarap Estate, Beluru and Pelitanah 2, Sibu.</td>
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<td>Key Recommendations</td>
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<td>7. A 10-year masterplan to be developed for the oil palm industry by a Task Force consisting of selected PAC members, MPOB Officers and four to five members from the private sector. The selected members could spend a couple of days brainstorming to identify targets and common goals such as those for 3-MCPD, nutrition and yield.</td>
<td>MPOB is in the process of finalising the master plan and roadmap for MPOB and the industry in line with the Transformasi Nasional 2050 (TN50). These covered the common goals such as those for 3-MCPD, nutrition and yield.</td>
</tr>
<tr>
<td>8. With regards to the request by the Chairman of MPOB for advice and inputs on how to effectively tackle issues/sentiments against palm oil in Europe especially in France, it is recommended that a ‘war room’ could be set up to respond to issues within 24 hours. This is a recommendation made by the Technical Promotion and Market Development Sub-Committee.</td>
<td>On pertinent issues, MPOB has been practicing the concept of War Room to address matters expeditiously.</td>
</tr>
<tr>
<td>9. With regards to the proposal to restructure the PAC programme, it is noted that this recommendation has been brought up at the Technical Promotion and Market Development Sub-Committee.</td>
<td>The matter was discussed and disagreed upon during the Plenary session.</td>
</tr>
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PAC

PROGRAMME ADVISORY COMMITTEE
36TH MEETING : 11TH – 15TH APRIL 2016

COMBINED REPORT
BIOLOGY SUB-COMMITTEE

Plenary Session
Date: 15th April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
Malaysian Palm Oil Board (MPOB)
Programme Advisory Committee Meeting
36th Meeting: 11th - 15th April 2016

Biology Sub – Committee

Venue: Board Room, Level 2, Admin Building
MPOB Head Office, Bandar Baru Bangi, Selangor

Present:
1. Prof Dr Denis J. Murphy - University of Glamorgan, Chairman
2. Dr. Trevor Anthony Jackson - Agresearch Limited
3. Dr. Xaviar Arulando - United Plantations Berhad
4. Prof. Dr. Mohd. Zamri Saad - Universiti Putra Malaysia
6. Prof. Dr. John Harwood - Cardiff University
7. Prof. Dr. Richard Martin Cooper - University of Bath
8. Prof. Dr. Jeremy Roberts - University of Nottingham
9. Prof. John W. Crawford - Rothamsted Research
10. Prof. Dr. Monique Leclerc – University of Georgia
11. Dr. David F. Marshall – The James Hutton Institute
14. Dr. Tristan Durand-Gasselin - PalmElit SAS

In Attendance:
1. YBhg Datuk Dr. Choo Yuen May - Director General MPOB
2. Dr. Ahmad Kushairi Din - Deputy Director General (R&D)
3. Dr. Ahmad Parveez Ghulam Kadir – Director of Advanced Biotechnology and Breeding Centre
4. Dr. Norman Kamarudin - Director of Biological Research
5. Hj Wahid Omar - Director of Integration Research and Extension
6. Dr. Rajanaidu Nookiah - Senior Research Fellow
7. Dr. Siti Ramlah Ahmad Ali - HOU Applied Entomology and Microbiology
8. Dr. Mohd Haniff Harun – HOU Tropical Peat Research Institute
9. Dr Idris Abu Seman – HOU Ganoderma Disease Research for Oil Palm (GanoDROP)
10. Tn Hj Ir Abd Rahim Shuib – HOU Farm Mechanisation
11. Dr. Zulkifli Hashim – HOU Agronomy and Geospatial Technology Unit
12. Dr. Mohamad Arif Abd Manaf – HOU Functional Biotechnology
13. Dr. Rajinder Singh – HOU Genomics
14. Dr. Umi Salamah Raml – HOU Metabolics
15. Dr. Leslie Low Eng Ti – HOU Bioinformatics
16. Dr. Meilina Ong Abdullah – HOU Breeding and Tissue Culture
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<th>Number</th>
<th>Name</th>
<th>Position/Group</th>
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<td>Tn. Hj Hamdan Abu Bakar</td>
<td>HOU Extension and Services</td>
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<td>18</td>
<td>Tn. Hj Zulkifli Manaf</td>
<td>HOU Project Implementation</td>
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<tr>
<td>19</td>
<td>YM Raja Zulkifli Raja Omar</td>
<td>HOU Crop and Livestock</td>
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<td>20</td>
<td>Hj Abd. Razak Jelani</td>
<td>GL Harvesting Technology and Quality Testing</td>
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<td>21</td>
<td>En Mohd Ramdhan Khalid</td>
<td>GL FFB Evacuation &amp; Loose Fruit Collecting Technology</td>
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<td>Pn Salmah Jahis</td>
<td>GL Crop Care and Field Maintenance</td>
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<td>En Mohd Solah Deraman</td>
<td>GL Mechanisation Skills Development Group</td>
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<td>En Hasnol Othman</td>
<td>GL Agronomy Advisory And Laboratory Services Group</td>
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<td>En Ahmad Afandi Murdi</td>
<td>GL Soil and Nutrient Management</td>
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<td>26</td>
<td>Pn Nordiana Abd Aziz</td>
<td>GL Geospatial Technology</td>
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<td>Dr Ramle Moslim</td>
<td>GL Insect Biopesticides Research</td>
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<td>Dr Mohamed Mazmira Mohd Masri</td>
<td>GL Microbial Bioprospecting &amp; Bioprocessing</td>
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<td>Pn Siti Nurulhidayah Ahmad</td>
<td>GL Entomology &amp; Ecological Research</td>
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<td>Dr Shamala Sundram</td>
<td>GL Emerging and Exotic Disease</td>
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<td>GL Peat Research</td>
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<td>Dr Ahmad Tarmizi Hashim</td>
<td>GL Clonal Propagation</td>
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<td>GL Breeding and Genetic Quantitative</td>
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<td>Dr Zulkifli Yaakub</td>
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<td>Dr Omar Abd Rasid</td>
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<td>GL Genetics &amp; Fine Mapping</td>
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<td>En Norkaspi Khasim</td>
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<td>Dr Kamil Azmi Tohiran</td>
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<td>Dr Khalid Haron</td>
<td>Station Head MPOB Kluang</td>
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<td>Benjamin Lau Yii Chung (Dr)</td>
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<td>Fadila Ahmad Malike</td>
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<td>Farawahida Mohamad Darus</td>
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<td>Fazliza Mohd Ali</td>
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<td>Hashim Otar (Hj)</td>
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<td>Hasimah Mos</td>
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<td>62</td>
<td>Hasliza Hassan</td>
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<td>63</td>
<td>Hasmiza Desa</td>
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<td>64</td>
<td>Humairah Mat Taib</td>
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65. Intan Ernieza Farhana Nizam
66. Intan Nur Ainni Mohamed Azni
67. James Chula ak Hollis
68. Jayanthi Nagappan
69. K. Ramadasan (Dr)
70. Katialisa Kamaruddin
71. Kok Sau Yee
72. Latip Bundan
73. Law Mei Ching
74. Lee Pei Lee Angel
75. Leow Soon Sen (Dr)
76. Leslie Ooi Cheng Li
77. Lim Fook Hwa
78. Madiahah Ahmad Zairun
79. Maizan Ismail
80. Marhalil Marjuni
81. Md Zainal Rasyidi Mat Rodi (Dr)
82. Mohamad Rosman Sulaiman
83. Mohd Al AkmarulFizree Md Piji
84. Mohd Amin Ab. Halim
85. Mohd Arfan Johari
86. Mohd Azwan Mohd Bakri
87. Mohd Haidhar Abd. Hamid
88. Mohd Hefni Rusli (Dr)
89. Mohd Ikmal Hafizi Azaman
90. Mohd Izzuddin Anuar
91. Mohd Khairul Anuar Isnin
92. Mohd Mustakim Mohamad
93. Mohd Najib Ahmad
94. Mohd Naqiuddin Husni
95. Mohd Noor Izuddin Zanal Bidin
96. Mohd Ridzuan Sohimi
97. Mohd Rizal Ahmad
98. Muhammad Azwan Zulkifli
99. Muhammad Nurul Yaqin Syarif
100. Nadzirah Amiruddin
101. Nazirah Che Jaafar
102. Nik Shazana Nik Sanusi
103. Noor Idayu Mhd Tahir
104. Noorhazwani Kamarudin
105. Nor Azizah Kusai
106. Nor Azwani Abu Bakar
107. Nor Diana Hanim Mohd Nor
108. Nor Fakhrana Iskandar
109. Nor Hanin Ayub
110. Norashikin Sarpan
111. Norazah Azizi
112. Norazah Raziyan Azimi
113. Nordiana Hanim Mohd Nor
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PART 1. INTRODUCTION

The Biology Subcommittee is pleased to submit this report for consideration by MPOB. Firstly, the Subcommittee wishes to compliment the MPOB Chairman, Dato’ Ahmad and MPOB Director General, Datuk Dr Choo on the informative presentations given on Monday 11 April. These presentations highlighted the importance of the work covered by the Biology Subcommittee in addressing many of the most important targets of MPOB and of the broader Malaysian National Plan. Further issues relevant to the Biology Subcommittee were raised and discussed at the Crosscutting Subcommittee meeting on 13 April.

We thank also Drs Norman, Omar, and Parveez, the respective heads of the Biology, Integration & Extension, and ABBC Research Divisions for presenting detailed overviews of the recent work of their respective Divisions. These overviews were useful in putting into a broader context the more detailed and technical topics that were presented in the progress reports and new research proposals. This year we had three reports from international groups that were commissioned by MPOB to review the work on Ganoderma, peat, and proteomics and to recommend future directions.

Major challenges of concern to the Subcommittee include tackling ongoing problems of crop yield and quality in the field as well as existing and newly emerging diseases. Other high priority areas include mechanisation, use of peatlands and other sustainability related topics. These areas will be reflected in our discussions and the major review recommendations below for the Ganoderma and tropical peat programmes. The achievements of the ABBC Division were also mentioned by the DG, and our attention was especially drawn to the world leading studies on the oil palm genome with particular mention of the significant achievement in the discovery of the mantled gene and publication of this work in *Nature*. We are pleased to see the prospect of practical applications of this technology in industry as discussed in more detail below.

As ever, we are grateful to all the officers and support staff at MPOB for their many efforts in facilitating our work. The following report begins in Part 2 with a series of key recommendations, which will also be highlighted in the Plenary Session of PAC for further action. This is followed by a discussion in Part 3 of the findings of the review on Ganoderma research and in Part 4 of the findings of the review on Sarawak peat
research. In Part 5 we present a concise review of the detailed technical reports presented by the various research groups. Finally, in Part 6 we have assessed and graded the 13 project proposals that were submitted for consideration by the Subcommittee using the recommended A, B, C scale.

The level of expertise seems to be gradually rising every year across the board and MPOB should feel some pride in this success. As a general comment, we have found that the PAC website provides a good record of the reports from previous meetings and allows information on project updates and proposals to be accessed without the need for paper copies. Loading of the group presentations onto the website during the meeting is particularly useful and this might be considered as good practice for all groups and Subcommittees.

It would be helpful to have a copy of the powerpoint presentation BEFORE the presentations so we can review the precious additional information, graphs and figures that did not appear in the material provided weeks ahead of time. As presented, the figures and graphs were sometimes flashed in a hurry with the audience not having quite enough time to read the figures on the slides. The summary reports provided to us ahead of time is typically short on details and methodology and analysis. Remedying this situation would help PAC in studying the material ahead of time, in a more thorough way, leading to enhanced feedback to the PI of the project.

A list of references at the end of each project material would also be helpful ahead of the PAC meeting with the PIs. The background of the applicant or a two-page bio might be helpful to ensure that the proposed project is a match for the applicant and ensures the highest quality. There is some overlap between several projects, past and present and proposed. While some of this is unavoidable, this could be turned into the PI's advantage: s/he could take advantage of either current or recently acquired resources and knowledge within MPOB by 1. Bringing in either the past project personnel as a resource, formally or otherwise 2. Providing to new projects an examination of complementary strengths already available in house and make use of any apparent overlap and experience from other programs/units within MPOB. Applicants could look into a databank with the title, name of PIs and the detailed proposals and reports for past and current projects. It might make sense to make this a systematic modus operandi so that any new project proposal looks at previous projects and seek the input of officers responsible for it as well as any final report and papers.
It is suggested that, to raise the overall the likelihood of success and subsequent peer-review publication(s), a more in-depth, more extensive proposal be prepared by applicants of any new project. Examples (for inspiration) include European Research Council type of proposals, National Science Foundation proposals, NASA. That full proposal could then be shared with the PAC ahead of time. Some projects appear to be ‘great and sound idea’ until we hit the implementation stage. The suitability and scientific appropriateness of the background seem to be assessed by the applicant’s immediate supervisor and possibly by PAC. PAC at the moment does not have any bio info on the PIs of the projects submitted for funding recommendation.

Special attention could be given to setting up a grouping to look at ‘Management practices on yield’. According to experienced planters, ‘many problems in the oil palm plantations come from self-inflicted wounds’. Thus, this important group should be composed of large and small-scale plantation holders. This would decrease the overlap between several groups and should be done whether a reorganization of the current units is done or not. This (management practices) lies at the core mission of MPOB.

The creation of an ‘Elite Club’ within MPOB might also be an idea that would encourage and stimulate the generation of transformative and ground breaking ideas.
PART 2. KEY RECOMMENDATIONS

We list below several key recommendations that are specific to the remit of the Biology Subcommittee plus additional recommendations that are more crosscutting and of wider relevance to other PAC Subcommittees.

**Recommendation 1:**

_Improve the structure and impact of MPOB research on Ganoderma_

Clearly some work within Ganodrop has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, we consider the structure and research strategy is imbalanced and that it is not creating sufficient progress where it is needed, in particular on Ganoderma stem rots, so we suggest considerable changes.

Our recommendations are based on: lack of progress on Ganoderma in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from Ganoderma; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding Ganoderma epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR. These levels of basic understanding are a prerequisite in other crop plant diseases.

**More specific details on the exact recommendations are itemised below in Part 3, the report of the International Advisory Panel on Ganoderma.**

**Recommendation 2:**

_Increase support for MPOB research on tropical peat systems_

This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. There is an urgent need for increased personnel and provision of the necessary equipment and infrastructure to carry out this vital project. The PAC welcomes the newly formed International Advisory Committee supporting this research and considers it essential that they provide regular input into the project over the coming years. We recommend that regular meetings of this advisor grouping should commence within the next few months.
Recommendation 3:
MPOB should facilitate, coordinate and publicise examples of environmental management and conservation on Oil Palm plantations

Palm oil is frequently under attack for rainforest habitat destruction with consequent loss of iconic wildlife, yet many in the industry are actively promoting and implementing habitat preservation, restoration and wildlife conservation in and around the oil palm estates. MPOB should take a positive leadership role in coordinating these efforts. It can develop “best practice” for conservation planning, riparian planting and wildlife monitoring. It can promote wildlife conservation among industry workers. It can coordinate presentation and publicity for positive efforts in the conservation arena.

MPOB should;
• take a positive leadership role in promotion of wildlife conservation in and around oil palm plantations.
• appoint an appropriate conservation specialist to PAC
• hold a stakeholder meeting to review oil palm impacts and the potential to enhance wildlife conservation
• establish a pilot programme in key areas for endangered wildlife in Sabah
• use positive results from wildlife conservation to improve the image of palm oil

The Subcommittee has the following crosscutting recommendations:

Recommendation 4:
MPOB should improve the utilisation of existing expertise in PAC, MPOB, industry and other stakeholders in addressing public concerns about oil palm.

Media stories and other publications related to oil palm are appearing with increasing frequency. While some of these articles are accurate and balanced, many are not. Unfortunately, many inaccurate and misleading stories about oil palm have been widely disseminated and have contributed to negative public reactions to oil palm, especially in Europe. It is recommended that MPOB take advantage of the considerable expertise among the independent experts on PAC, plus other credible experts, in order to address topics where inaccurate reporting of science-related issues related to oil palm has occurred. To achieve this MPOB could also work with other stakeholders such as MPOA and MPOC. Possibilities include more extensive engagement with media and other outlets in disseminating ‘good news’ stories and
also in the rapid response to inaccurate or misleading stories. In addition to scholarly articles, some PAC members could write more accessible (to non-specialists) articles in magazines or popular journals. One example of this is the article by Denis Murphy, Chair of the Biology Subcommittee, which was published in World Agriculture late in 2015. Copies of this article have been circulated to participants at the Plenary Session of PAC 2016.

Recommendation 5:
**Improve communication and results sharing both within and outside MPOB by proactively promoting such interactions and incentivising cross-disciplinary research.**

While there are numerous examples of good collaboration on relevant research both inside and outside MPOB, there are also too many examples of a ‘silo’ mentality. This hampers progress and can mean that opportunities are missed and even that some work is duplicated. This issue has been raised in previous PAC reports but this year it was again raised in several Subcommittees and especially in the Crosscutting Subcommittee. We still see a lack of awareness of highly relevant international developments among many officers and more senior scientists at MPOB. Researchers should make better use of citation alerts and the availability of most published research as open access. In those cases where an article is not fully available online, a request for a pdf from the author(s) is normally successful.

Recommendation 6:
**MPOB should work more effectively and urgently with all relevant stakeholders to address the increasingly urgent need for mechanisation of plantation operations**

Recent developments in Malaysia, especially restrictions on foreign labour, have highlighted the importance of addressing the need for increased mechanisation of many planation operations from input applications to harvesting. Several projects proposals on mechanisation were presented to the Subcommittee but it was felt that these tended to be ‘more of the same’ in terms of projects that have already been pursued for many years without achieving a true breakthrough in terms of widespread utility on plantations. The launch of a $1 million prize competition is a welcome development but this may not result in the right sort of projects. There are many experienced agricultural machinery suppliers who are already developing and manufacturing devices for automated or semi-automated crop management. Some of these use GIS technology linked to satellite or low-cost UAV (drone) systems while
others include crop harvesting and processing as a single multi-step operation. Examples include the deployment in Europe of harvesters for the extraction and shelling of peas where many hectares can be harvested, processed and taken to supermarkets within a few hours with minimal use of labour; self-propelled tomato harvesters and citrus tree harvesters (see below).

![Image of self-propelled Johnson Mechanical Tomato Harvester]

We recommend that should engage in wider ‘out of the box’ discussions with potential equipment manufacturers and developers. In order to give confidence to such companies, MPOB should work with the plantation industry to develop models for the likely demand and cost limitations for purchasing such equipment. They should run scenarios of future decreases in the labour supply (and therefore cost) from a modest 10% up to as much as 90-95% in the next decade. MPOB should also seek government support for a mechanisation programme as part of their evident programme of reducing levels of foreign migrant labour in the country.

**Cross-cutting comments for TROPI TPRL**
The development of critical thinking skills should be encouraged with an emphasis on pro-actively interpreting data, graphs, charts and tables: this would remedy cases
where inter-comparisons of data collected for contrasting treatments, repetitions, or measurement sites are often of marginal differences and when combined their existing standard errors, make for data that is difficult to interpret. Another cross-cutting comment for TROPI-TPRL is the need to develop a greater mastery over the techniques and the resulting interpretation. Sometimes (often), this can be helped in concentrating efforts on fewer projects.

Hiring at the highest possible level field personnel and having a program of ‘continuing education and/or retooling can also augment the in-house capacity. The in-house continuing education could include weekly guest speakers and refresher courses in statistics. It could also include skill building such as technical writing and oral skills. Traveling to international conferences and participation in more advanced training are also possibilities.
PART 3. REPORT BY INTERNATIONAL ADVISORY PANEL ON GANODERMA
DISEASE RESEARCH, 6-8 April, 2016

The Advisory Panel comprised:

Dr Richard M. Cooper, University of Bath, UK (Chairperson)
Dr Xavier Arulandoo, United Plantations, Malaysia
Dr Tristan Durand-Gasselin, PalmElit, France
Prof Matthew Dickinson, University of Nottingham, UK
Prof Jan Stenlid, Dept Forest Mycology and Plant Pathology, Sweden.

The review comprised:

Day 1. Overview of the group’s research programme by Dr Idris AS.
Presentation of the industry perspective by Dr Xaviar Arulandoo.
Overview of the ABBC research programme by Dr Arif MA.
The labs of Ganodrop and ABBC were visited and Ganodrop projects were then discussed.

Day 2. Comprised discussions on inter-divisional projects, then new project proposals from Ganodrop and ABBC were commented upon.

Day 3. Panel members presented seminars to a large audience including many representatives from industry. The key recommendations were discussed at the time with Drs Norman, Idris, Sundram and Rusli, then with the whole group the following week.

Comments are also made below on Ganoderma research conducted by ABBC because that work should be intimately linked to the overall understanding of how Ganoderma functions as a pathogen.

Major recommendations:

- It is recommended that future progress be reviewed after 2 and 5 years.
- Revising the GanoDROP Unit structure and remit

Clearly some work within Ganodrop has made or continues to make important contributions to oil palm diseases in Malaysia, in particular to limiting the problem of BSR in Malaysia. However, we consider the structure and research strategy is imbalanced and that it is not creating sufficient progress where it is needed, in particular on Ganoderma stem rots, so we suggest considerable changes.
Our recommendations are based on: lack of progress on Ganoderma in contrast to the level of knowledge for all other major plant pathogens; infection/yield data resulting from Ganoderma; many comments passed on by managers and researchers in the industry in Malaysia. The main thrust needs to be on understanding Ganoderma epidemiology, biology, infection, pathogenicity and genetics; this then will lead on to devising sustainable control of BSR and USR. These levels of basic understanding are a prerequisite in other crop plant diseases

**Unit structure:**

We suggest the following new groups:

**Ganoderma Biology and Pathogenicity Group**

Aims: to acquire fundamental knowledge on Ganoderma in terms of:

- Epidemiology (spread, survival);
- Biology;
- Pathology (infection; aggressiveness; virulence factors);
- Collection, characterization and maintenance of Ganoderma cultures representing geography and aggressiveness;
- Role of basidiospores (infection; role in Ganoderma variation; role in dispersal);
- Genetics (species identification; phylogeny; population structure and di-mo mating as another source of genetic variation).
- Genome (eventually of pathogenic and non-pathogenic spp; transcriptome).

*ABBC related projects:

Ganoderma proteome; metabolomics should include Ganoderma in vitro (see later comments); Genome; Ganoderma transformation

**Ganoderma Control Group**

Aims: disease control and mitigation; sustainable control through integration of knowledge.

- Monitoring/disease census;
- Early detection;
- Modelling of disease progress;
- Chemical control;
- Biological control;
- Cultural control

Early resistance screening: development of methods optimized for industry: application and correlation to field results

Industrial liaison/coordination/collaboration/dissemination

*ABBC related projects:

Resistance mechanisms (gene and protein expression); RNA silencing
**Emerging and Exotic Diseases and Biosecurity**

Aims: Awareness and monitoring of major perceived threats. Preparation of diagnostic tools. Greater ongoing contact with DOA Quarantine Dept.

Merger of the two existing groups EEDG and CBBG would create a logical combination of activities.

In order to achieve this restructuring, we recommend removal of weed and herbicide research. This is not perceived by industry as an issue currently worthy of R&D, especially where staff time could be better allocated to BSR research. Two ROs currently allocated to this group have or soon will have, UK PhDs in plant pathology. They are clearly better placed in Group 1.

**Personnel implications:**

(1) Ganoderma research. An expert pathologist/mycologist, familiar with Ganoderma and related basidiomycetes and up to date with current plant-pathogen interactions is required (This person may need to be sourced internationally if such expertise does not exist in Malaysia). Ideally the researcher would function freely between GanoDROP and ABBC, as both require frequent and specific scientific and technical inputs. Panel members (RMC, JS, MD) might be able to assist by sourcing from European labs.

(2) Early screening/optimization. Dependent on scale this operation is likely to require several RAs.

(3) Integral to this operation along with ABBC/Breeding and BSR modelling a statistically orientated person is required.

**Overall the balance of the three proposed groups could be respectively: 35, 45, 20 %**

**Management and communication**

The level of scientific rigour and awareness of up to date progress elsewhere both need to be enhanced. This can be achieved in several ways.

Obtain and make readily available a full and up to date literature set on your key research topics, e.g. Ganoderma genetics, pathogenicity, taxonomy and of related basidiomycetes. We realize some journal papers cannot be readily accessed from
MPOB, so request papers from MPOB library service, paper authors or colleagues or PAC members covering key topics.

Attend relevant courses. For example a very detailed course on plant-pathogen interactions with clear implications for Ganoderma was given at MPOB by one of us (RMC) in February 2015.

Hold journal clubs. Get staff and students to present results from one or two related papers.

Have regular research meetings to critically discuss your findings. These comments apply of course also to related work between GanoDROP and ABBC. The need to work as a team was repeatedly emphasized in order to make real progress.

**Specific Recommendations**

**Early detection of BSR and of disease resistance**

This work is being attempted both by GanoDROP and by ABBC. We question at this stage cost, speed and applicability to the field of induced defence-related genes, of proteomics and of metabolomics. Genes, proteins or metabolites would need to be shown to be truly linked to Ganoderma and not just to abiotic stress or to other pathogens.

Remote sensing of Ganoderma (aerial/spectral, or VOCs) may be valuable but only once correlated to disease incidence.

DNA-based diagnostics especially using LAMP, should be investigated as a means of early detection. It could also be applied to the route of infection (petioles/roots?), and the presence of inoculum in the soil/linked to pathogen survival.

**Fungicides**

It is hoped that these will eventually not be required as resistance/tolerance comes into use. Use should be carefully limited in view of environmental contamination and RSPO criteria. In the meantime understanding route of infection might change strategy, e.g. preventative rather than curative.
Biocontrol
Several products have been developed by GanoDROP with substantial levels of claimed disease control. It is crucial to obtain verification mid to long term by growers using these products. Industry commented that it is bombarded by bio-products and has become very skeptical.

Establishing the route of Ganoderma infection could guide the site of delivery of antagonistic biocontrol agents such as Trichoderma, currently used at root level. Spore infection via frond bases for example could be controlled by BCA application during pruning of frond bases, analogous to treatment of tree stumps as described by one of us (JS) for Heterobasidion control.

Resistance screening
Here comparisons of inoculated seeds, 4 month and 12 month seedlings are compared. This is useful, but industry is asking for a standardised, repeatable method. Therefore criteria also to be included are: pathogen isolate(s)-high and medium aggressiveness (?); inoculum size; contact or not between inoculum and root; standard host lines as internal controls; growth medium/nutrition; shading.

Level of repeatability and therefore replication based on sound disease assessments and statistical analysis is essential to evaluate.

This very important study will require good coordination between GanoDROP and ABBC/Breeding.

The method will serve as a tool for breeders, geneticists and pathologists comparing isolate aggressiveness and palm resistance responses.

Biosecurity and comments on diagnostics

Studies should continue with the main threats, including Fusarium, orange spotting, Phytophthora, but with effort being reduced according to actual damage or threat.

We suggest inclusion of a study of spear rots. What are the associated microorganisms? Compare with the situation of spear/bud rots in Colombia.

Update biosecurity list.
Be prepared for exotic pathogens with diagnostic kits as well as just disease images/keys. You should be able to go to a grower and identify the cause and determine whether it is a quarantine issue. In order to be able as function as a responsible partner to the Board of Agriculture for biosecurity work, Ganodrop should consider building capacity for diagnostics of quarantine species. Suggestions for improved lab protocols to avoid contamination were detailed.

**Ganoderma reference isolate culture collection.**
We offer suggestions for long term, reliable storage and the need to train at least two RAs for annual or biennial transfers. One panel member (JS) has experience with a closely related pathogen.

**Modelling**
We would like to see more constructive use of data collected in disease census/monitoring. There is a large potential in modelling of disease development based on the data collected empirically from small holders and companies. Questions on e.g. the feasibility of mounding, the influence of soil type, plantation age, original planting density, any trends in disease incidence over time etc can be addressed this way. It is likely that this requires a statistically oriented person to develop the model.

**Spores**
In view of the enormous genetic diversity of Ganoderma in plantations, there is a clear need to conduct spore inoculations under field conditions to determine infectivity and route of infection(s). This will require extensive replication, long term sampling because infection could be infrequent and slow and sensitive but robust detection methods. One of us (MD) suggested use of LAMP.

**ABBC research on Ganoderma and the need for collaboration**
Research on Ganoderma was described based on sophisticated analyses at the levels of genes, proteins and metabolites. This well-equipped and technically able team can offer huge potential if the approaches are targeted and based on the long term knowledge of how plant pathogens function.

However some of the work has limited validity because of a lack of understanding/guidance with regard to pathogen virulence. For example growth on rich media is highly unlikely to reveal genes, proteins or metabolites involved in disease.
Also with necrotrophic fungi, extracellular secreted proteins are much more likely to be valid than intracellular ones. Ganoderma metabolites should be investigated. Years have been lost awaiting the completed genome because of insufficient knowledge/communication at that time.

All of this makes clear to us that so much potential progress is being severely limited and delayed because of the need for collaboration and need for in depth advice by an expert in house on plant-pathogen interactions. It is hoped that our recommendation is taken up.

In addition it must also be stressed that insufficient analysis of relevant literature remains an issue to all Ganoderma research here.

We appreciate that the structure of MPOB divisions and funding by specific programmes can discourage cross-cutting and teamwork as is suggested above, but we implore management to seek ways around this or yours will not be the establishment that makes the long overdue breakthrough with Ganoderma pathogenicity and resistance.

PART 4. REPORT BY INTERNATIONAL ADVISORY PANEL FOR PEAT RESEARCH

Recommendations
The PAC was concerned about the apparent level of resourcing for the peat work in Sarawak. Inadequate levels of resource were impacting on provision of adequate lab facilities, availability of personnel to do the work and ensure timely publication, overreliance on goodwill of collaborating partners and a generally unsatisfactory intellectual environment. The consequences pose a serious risk to satisfactory progress of the work.
INTRODUCTION

The TROPI study is a joint activity between the MPOB, University of Aberdeen and University of St Andrews, with additional inputs by a team from the University of Leicester/the Open University/Centre for Ecology & Hydrology. The aims of TROPI include:

(i) establishing an excellent R & D centre for tropical peat ecosystems in Malaysia;
(ii) facilitating research to investigate GHG emissions and biodiversity of peatland ecosystems and the measurement of carbon stocks and fluxes from peatland under different land covers and uses, including plantation management;
(iii) the generation and dissemination of knowledge and information;
(iv) establishing TROPI as a centre of excellence and the world’s reference point on tropical peat.

TROPI has established a number of locations for field studies that cover the full range of peat land covers from intact peat swamp forest (e.g. Maludam National Park), through secondary and degraded peat swamp forest, to recently cleared PSF and oil palm plantations of various ages. These study locations are in Peninsular Malaysia (Teluk Intan, Perak) and Sarawak (e.g. Bintulu, Sessang, etc).

The research undertaken by TROPI is assessed on an annual basis by an International Advisory Panel. The first assessment took place in April 2015 and this report provides the second assessment during early April 2016. Reports by the IAP are received by the MPOB Programme Advisory Committee (PAC) at their annual meeting.

PROGRAMME

During April 2016 the IAP undertook their second annual assessment. They had the opportunity to spend two days receiving presentations from students and staff undertaking various research projects as part of the TROPI programme as well as one full day at the TROPI field study site on the Sarawak Oil Palms Berhad (SOPB) Sebungan and Sabaju oil palm plantation estates, inland from Bintulu, Sarawak. The field visit provided an opportunity for presentations from PhD students who are carrying out their studies at this field location.

The detailed programme for the IAP assessment is provided in Appendix 1.
COMMENTS BY IAP ON CURRENT TROPIC PROJECTS

DAY ONE (7th April 2016) - MPOB HQ

Ms Nur Maisarah, Teluk Intan Peat Station – influence of agronomic practices on peatland carbon flux

- This project aims to establish peat GHG (CO₂ & CH₄) emissions from peatland under oil palm using a combination of methods including the eddy covariance (EC) technique.
- Data collection has been completed and the student is now at the data analysis stage. Given the complexity of EC data analysis, it is essential that Ms Maisarah is given full support in terms of data quality review, analysis and interpretation. The IAP understand that this support is being provided by Prof Monique Leclerc, Georgia State University, and we hope that this support can be continued during the critical phases of PhD completion.
- Ensuring data quality is particularly critical since the data that this student is collecting will likely be the first robust information on the ecosystem carbon balance of tropical peatland under oil palm, not only for Malaysia but internationally.
- In order to ensure the quality and wider application of the data, it is important that the student obtains as much information as possible on the original site conditions (e.g. original forest cover, peat depth, etc.) since this, along with robust data quality control and analysis, will improve the likelihood of the data being accepted and cited by the international scientific community.
- We would encourage completion of the thesis as soon as feasible, with submission of at least one paper to a high impact international journal.
- IAP members are willing to provide an internal review of draft manuscripts prior to journal submission.

Ms Law Mei Ching, Teluk Intan Peat Station – (a) dynamics of recalcitrant and labile soil carbon pools in oil palm plantation and forest on peatland; (b) influence of agronomic practice on peatland carbon flux

- The IAP supports the project on peat carbon pools with the aim of developing a Carbon Management Index and we look forward to hearing more about this at our next IAP review meeting. Ms Law may like to consider what methods she can use to assess the peat carbon pool condition prior to plantation establishment, e.g. by analysing peat cores with the assumption that conditions below the lowest current water table will reflect those that previously pertained near to the peat surface prior to forest removal and peat drainage.
- For the second component of the study, one EC tower has been established in an OP plantation and there is a plan to establish a second tower in peat swamp forest within the same peat dome.
- IAP is concerned to ensure that the two towers are located in and thereby comparing comparable sites, e.g. in terms of peat depth and peat type. In addition, the footprints for both towers need to be fully characterised (to take account of wind direction etc.). For footprint modelling, the student is advised to use on site
meteorological measurements, in addition to data available from the more distant Kuantan weather station.

- The IAP looks forward to monitoring progress on this research project during next year’s assessment, but with EC tower sitting in mind, the IAP will suggest that they visit this research location as part of a mid-term review (see information on suggested IAP 2016/17 programme below).

DAY 2 – VISIT TO SEBAJU AND SEBUNGAN PLANTATIONS

Dr Kho LK, Eddy covariance study, SPOB Sabaju 07 plot (SBU7)

- The IAP members were disappointed that the two EC towers that were planned for plantation and forest locations in the SOPB plantation estate had not been constructed but they were encouraged to learn that Dr Kho has used the intervening time period extremely profitably to collect the ground measurements that will support the interpretation of the EC tower measurement data once these become available.

- We understand that preparations are now well advanced for getting the EC tower constructed in the plantation plot and we would urge MPOB to support this installation and its finalisation as soon as possible.

- The construction of the second EC tower at the forested site should then follow soon after at a location that has been identified within the same peat dome.

- There are a number of additional studies that are being undertaken by PhD students as part of Dr Kho’s wider research programme at this site. The IAP members received on-site presentations from the students and our comments are provided below.

- Frances Manning, University of Aberdeen - study on spatial soil respiration
  - The IAP wished to commend this student for applying a mix of established and novel methodologies to investigate both peat soil surface and tree stem respiration.
  - This is quite an ambitious project given that it also attempts to address the scale of fluvial fluxes of CH4.
  - The IAP were interested to learn about innovative approaches to separating autotrophic and heterotrophic emissions and were pleased to see some promising initial results which indicated that, in this plot, the total soil respiration appeared to be more or less equally divided between autotrophic and heterotrophic emissions.
  - The IAP were also shown newly established stem chambers that have been established on palm trunks in order to measure fluxes of CO2 and CH4 and we look forward to hearing more about the results of this study in due course.
  - The IAP understands that this student will be completing her field work within the next 2 to 3 months and then returning to the UK to commence data analysis and thesis write up.

- Norliyana Zin Zawawi, University of Aberdeen - study on nitrous oxide emissions
  - Unfortunately this student has suffered some instrumentation problems which have delayed final data collection and data analysis.
The IAP are hopeful that the repaired instrument will be returned soon so that data collection can be completed.

The results of the biochar experiment are not yet available and the IAP look forward to hearing more about these results and their implications for plantation management operations in due course.

In common with the research described above, this is an innovative study that will provide new insights into the role of fertilisation on GHG emissions in plantations.

- Mr Sii Long Win, University of Aberdeen - reducing N fertiliser use in plantations on peat: a study of N mineralisation, nitrification and denitrification
  - This project makes a valuable contribution to the TROPI programme and is a logical follow on from the work being undertaken by Ms Norliyana.
  - The IAP understands that this project is in its early stages. We wish the student well with his studies and look forward to hearing more about the work and receiving some initial results during the next IAP visit.

- Ms Sarah Cook, University of Leicester - fluvial carbon losses
  - The IAP noted that investigation of fluvial carbon loss from plantation landscapes on peat was a long overdue study that is welcomed as part of the TROPI programme as it complements the other studies being undertaken at the study site, none of which (with the exception of subsidence studies) take account of fluvial carbon loss (i.e. EC and closed chamber measurement approaches do not account for leaching of carbon into water courses).
  - The IAP look forward to seeing the results of the study in due course.

- Ms Elisa Rumpang - in-situ root imaging
  - Preliminary data are being collected within the footprint of the proposed forest EC tower: these include data on root distribution and DOC flux (Sarah Cook).
  - Root imaging is a novel approach never before tried in peat soil. It may be challenging to apply this approach in peat and the researcher is encouraged to optimise the method for these specific conditions.

**DAY 3 – UPM, BINTULU CAMPUS**

- Dr Koh LK - Proposals for continuation of TROPI study
  - Dr Koh outlined his intention to extend the TROPI study into the very recently cleared plantation estate in Sabaju 5. This area includes a mixture of peat and mineral soils. The estate has been very recently cleared (within last few months), and initial drainage has been established. The site therefore presents an important opportunity to measure the carbon loss associated with the initial stages of forest conversion to oil palm plantation.
  - The IAP recommend that subsidence poles be installed as soon as possible in Sabaju 5 using a transect approach that includes the adjacent plantation and forest within the contiguous peat landscape in order to capture the change in carbon stock during the plantation conversion process. The IAP recommend that peat depth, peat bulk density and peat carbon content measures are carried out in conjunction with the subsidence monitoring in order to establish the carbon stock change over time. The IAP are mindful that the
location is not ideal in that the peat basin is interspersed with mineral hills. It will therefore be important that the topography and peat depth are taken into account in the design of the transect study. These factors may also mean that this is not an ideal location for an EC tower, although if there is further delay in construction of the proposed EC tower in the forested plot, Sabaju 5 could present an opportunity to establish a short tower for a limited time period to assess carbon flux during plantation establishment. Ideally, the IAP suggests that both the forest and an additional tower in Sabaju 5 are established and wonder whether MPOB could deploy one of their other towers to this location for a time limited period.

- For subsidence monitoring both here and at other TROP study sites it is essential that monitoring is carried out on a monthly basis as there can be short-term fluctuations in the height of the peat surface in response to changes in precipitation, and that on an annual basis there is down core (to a minimum depth of 1.5m) collection of peat samples for bulk density and carbon analysis to validate subsidence measures of carbon stock change.

- Ms Hasimah Mos – carbon flux studies at Ladang Pelitanah, Tradewinds estate, Sibu
  - The IAP recommends that the student undertakes a thorough data review and that MPOB provides appropriate support to this student for quality checking and analysis of EC data.
  - It is recommended that the student breaks her data down into smaller components and considers each measure of carbon loss separately.
  - For the subsidence data, IAP recommend that there is no need to apply the Wösten formula; the conversion of subsidence rate to carbon loss can be performed directly using the available data on change in bulk density and peat carbon content.
  - IAP recommends that the student considers whether her data indicate inter-annual variability that may be driven, for example, by seasonal changes in rainfall, water table depth etc.
  - If possible, the student is strongly encouraged to characterise the previous site conditions at her study location, i.e. site conditions prior to land conversion (e.g. had some peat compaction occurred during previous drainage and forest logging operations, is there evidence of the use of fire during land conversion etc). This will provide the baseline for interpretation of subsequent changes in carbon stocks and carbon flux. She should consider methods to establish the original peat bulk density prior to conversion (e.g. by using down core peat bulk density and carbon measurements to depths beyond the current range of water table variation).
  - In addition, all bulk density measurements on site should be taken down core to a depth of at least 1.5 m – rather than relying on single near surface measurements. This would bring the approach in line with published methodologies.
  - The IAP commend this student for carrying out a much needed study on an aspect of the peatland conversion process that is currently poorly quantified in terms of carbon loss during the early phase of forest to plantation conversion.
• Ms Bettycopa Amit and Mrs Ella Michael – comparisons of terrestrial and aquatic fauna between peat swamp forest and oil palm plantation.
  o These students have submitted their MSc theses with both studies providing very useful new data that are complementary to the studies of carbon and nitrogen dynamics. Both studies provide useful benchmarks on the effects of conversion.
  o For future biodiversity studies, in addition to extending the range of species under investigation, the emphasis should be on ways that land managers can improve biodiversity in existing plantations.
  o It would also be interesting to investigate the role of plantation biodiversity in bio-control of plantation pests and diseases.

SUMMARY OF MAIN COMMENTS AND RECOMMENDATIONS FROM THE IAP

The IAP were extremely impressed by all aspects of the study, in particular:

• The support of SOPB local managers and staff; their willingness to support the studies and their understanding of best plantation management was very clear. Both plantations were seen to have managers who were committed to the study and their plantations were well maintained, with support for the field plot activities. It is also commendable that one of the SOPB staff, Mr Sii (agronomist), has recently started a PhD at the University of Aberdeen on aspects of the nitrogen cycle in peatland plantations which will provide important knowledge on fertiliser management, with the aim of minimising fertiliser applications and thereby mitigating greenhouse gas emissions. This type of cross collaboration between a private company, MPOB and academia is strongly supported as it is likely to provide an effective pathway for dissemination of research results within the broader objective of delivering more responsible peatland management.

• During the field visit, IAP members were able to observe that the set up for the TROPI plots is extremely well conceived and the field research is generating meaningful, novel data within a relatively short time period. These data address the controls on peat carbon losses and greenhouse gas emissions from plantations on peat soils, thus providing, for the first time, reliable information on the environmental impact of land use change on peatland in Sarawak.

• Dr Kho is to be congratulated on his management of the research facilities to date. He has an excellent experimental set up, ably supported by a strong team of researchers and assistants. Once the EC towers are installed and fully operational, they will provide an unparalleled opportunity to integrate the plot-based flux measurements with landscape-scale tower measurements. This scalar approach to flux measurement is state of the art and is to be highly commended.

• Dr Kho is providing considerable logistical and technical support to the PhD students. Some students are using quite complex measurement and analysis methods in association with their research (e.g. eddy covariance) and they would benefit greatly from additional support from those with strong expertise in this measurement technique since they are now at a stage where they are starting to analyse their data and consider the wider implications of their data for the scale of greenhouse gas emissions from peatland plantations. Given that these data are likely to set a
benchmark for future studies while also having wider implications for policy decisions. It is essential that the data are subject to an appropriate level of scrutiny prior to PhD completion and the production of journal papers. External, expert advice and support for these students is strongly recommended.

- The IAP recommends that TROPI researchers take measures to ensure that adequate environmental information is collected to describe present and previous site conditions (e.g., previous site use, time since drainage, previous use of forested sites, history of fire, etc).

- Researchers should ensure that measurements of peat properties use an appropriate range of complementary novel and established methodologies:
  - e.g., use of instruments for measurement of soil moisture content should be validated using a direct measurement method, i.e., gravimetric method for soil moisture content, to ensure consistency of results and comparability with other studies.
  - e.g., subsidence studies should ensure that the measurement interval is appropriate and that complementary measurement of peat bulk density and carbon content are in line with established methodologies (see also below).

- IAP believes that monitoring of subsidence using subsidence poles along with annual monitoring of carbon stock is a simple and effective approach to addressing a better estimate of oxidation/subsidence ratio. The TROPI Bintulu site provides a range of plantation levels from forest, newly cleared area, and plantation areas that promises good research results on this subject. It is advisable that the initial condition characterization of peat carbon stock (peat bulk density and C content) and peat maturity from the surface to the mineral soil layer at the bottom be conducted. This is to be followed by subsequent monthly subsidence monitoring along with annual monitoring of carbon stock from 0-150 cm depth; where the 150 cm is the initial depth at the time of subsidence pole installation. The sampling for BD measurement of 0-10 and 10-20 cm may be conducted using either soil cores or galvanized iron, open-ended boxes and for the surface to 150 cm depths may be done using a peat auger at 50 cm increments.

- IAP strongly encourages all researchers to start moving towards the preparation of papers for submission to international journals in order to ensure that their data are made available to the wider scientific community. We have every confidence that the TROPI study outputs will be accepted for publication and will receive wide recognition.

- IAP members are willing to offer their support in providing advice and inputs on manuscripts at the drafting stage in order to support the TROPI team in delivering their results to the wider scientific community.

THE WIDER CONTEXT FOR THE TROPI STUDIES AND THEIR IMPORTANCE

There are various reasons why the TROPI study is both important and extremely timely.

(i) There are knowledge deficiencies on the scale of emissions arising (a) from the conversion of peat swamp forest to plantation agriculture and (b) the ongoing emissions occurring during plantation management. There have been very few studies that have addressed (a) and only a limited number of scientifically robust
PART 5. REVIEW OF PROGRESS REPORTS FROM THE VARIOUS RESEARCH DIVISIONS

This section is divided into the reports from ABBC, Biology and IRED.

5.1 ADVANCED BIOTECHNOLOGY & BREEDING CENTRE (ABBC) DIVISION

New PAC ideas

During the ‘new PAC ideas’ session, the Chair raised the issues of genome editing technologies and recommended that ABBC should investigate their potential application for OP research. Such applications might include applied research such as the transgenic programme, but also for proof of concept work in other areas of MPOB research.

To quote from an article in press:

“Since the mid-2010s several new and potentially revolutionary forms of plant and animal (including human) GM technologies, collectively known as ‘gene editing’ have been developed. Probably the most powerful of these is the CRISPR (Clustered, Regularly Interspaced, Short Palindromic Repeats) system (Bhaya et al., 2011, Hsu et al., Mao et al., 2013). In 2015, the CRISPR/Cas9 system was described in a Nature article as ‘the biggest game changer to hit biology since PCR’ (Ledford, 2015). Applying this method to crop improvement has opened up many new possibilities for radical genome modifications (Belhaj et al., 2015; Zhang et al., 2014). Gene editing will greatly accelerate crop and livestock breeding by precise and predictable genetic modifications directly in elite individuals and will also enable simultaneous modification of multiple traits.

In terms of crop breeding, this means that it will soon be possible to advance from the random insertion of single or small numbers of genes into a genome (as in traditional GM) to the highly precise insertion into a defined location of large numbers of genes, chromosome segments or pseudo-segments encoding entire metabolic pathways into virtually any plant species. Methods such as TALEN (Transcription Activator-Like Effector Nucleases) and CRISPR/Cas9 can be used for gene knockouts, e.g., to eliminate unwanted genes that adversely affect food quality or confer susceptibility to pathogens or that divert metabolism away from valuable end products (Davis, 2015). An example reported in 2014 was the use of both TALEN and CRISPR/Cas9 to target the genes of the mildew-resistance locus in wheat. This resulted in the production of plants resistant to powdery mildew disease, which is a serious crop disease (Wang et al., 2014).
Precise nucleotide exchanges using oligonucleotide donor sequences can also be used to modify the regulatory sequences upstream of genes that determine agricultural performance leading to improved crop yields. In some cases it will be possible to re-programme genes so that they are expressed in different organs at much higher rates. For example, seed-specific genes regulating storage lipid accumulation could be re-programmed to function in leaves or roots in order to generate high levels of oil in such vegetative tissues (Murphy, 2014a; Vanhercke et al., 2013). The oil could be used for food or fodder, as a source of renewable oleochemicals for industry, or even for biofuels. Within the next decade, it is likely that entire metabolic pathways will be transferred to the plant and tissue of choice so that some crops could become low-cost production systems for industrial green chemicals including high-value specialty chemicals (Murphy, 2014a), nutraceuticals such as omega-3 oils (Napier et al., 2015) and pharmaceuticals such as vaccines, antibodies and drugs (Murphy, 2007c). “

References and full text of original article available from Prof Murphy

Research progress of ABBC Units
ABBC should be congratulated for their achievements during 2015-16 and notably their identification and characterization of the elusive MANTLED gene that has been responsible for the mantling phenotype in oil palm (Ong-Abdullah et al., Nature 525, 533-537). The quest to unravel the scientific basis for this highly detrimental characteristic, that is particularly associated with clonal propagation, has been ongoing for over 30 years and its resolution has been a top priority for the oil palm industry. The identification of the epigenetic mechanism responsible for this phenomenon can now be exploited to develop a purpose built test that will enable growers to identify mantled material at the plantlet stage and when this is available, later on in 2016, it should save the industry many millions of Rm.

The last 12 months has also seen the retirement of Dr Ravi Sambanthamurthi from MPOB and her replacement, as Director of ABBC, by Dr Ahmad Parveez H.J. Ghulum Kadir. Ravi’s contributions to MPOB, and to ABBC in particular, have been immense. She has been the driving force behind the sequencing of the oil palm genome and her scientific vision led directly to the identification and characterization of the SHELL and VIRESCENS genes and most recently the resolution of the mantling phenomenon described above. Change is always a challenge but it also brings opportunities and it may now be an appropriate time for ABBC to reflect on their organisation and their direction of travel for both the medium and long term. During
PAC a Breeding Roadmap for Oil Palm was provided that identified a number of trait priorities and a time line for their delivery into elite commercial material. This approach is to be welcomed but it will be important that both the predicted trait achievements, and time frames for their implementation, are realistic. Many of these goals will be realised by collaborating with industry and it would be useful to develop the roadmap further after discussions with a range of plantation companies who have active research programmes.

ABBC is now actively engaged in research on many fronts both in terms of the technologies that are being applied and the nature of the problems that are being addressed. Key to co-ordinating research activities and generating synergism between groups is the establishment of regular communication both at a PI and research officer level and this should be fostered by encouraging attendance at research seminars and the establishments of journal clubs that span the application of technologies and the focus of disciplines. For many years PAC has promoted engagement between scientists at MPOB with members of research groups working at other institutions both nationally and internationally. There is clear evidence that this is taking place effectively within some groups within ABBC but engagement is uneven and one approach that might promote this is the encouragement of some research officers to undertake PhD programmes both at local Universities and at institutions abroad. The cost of sponsoring an MPOB staff member to study for a PhD abroad is often considerable higher than at a University in Malaysia and their maybe domestic challenges for the individual concerned, however, the benefits that can be gained are often substantial. Data provided during the presentation by Datuk Dr Choo Yuen May, D-G MPOB, indicates that less than 25% of permanent staff have a PhD and it would be useful to know what target MPOB has in terms of the proportion of scientific staff who they would wish to have such a qualification by 2025 and the progress that is being made to achieve this goal.

The summary produced this year of progress across the Division was once again extremely useful and provided a way of rapidly identifying research highlights. However, Gantt charts relating to the progress of individual projects were not included and without these it is not possible to identify what progress has been made against agreed objectives, Projects routinely have a value for percentage completed but this value has little credibility unless deliverables can be mapped against original timescales. It would also be useful to identify the publications that have originated from
individuals projects and other outputs such as seminar/poster presentations that have been delivered over the 12 month reporting period.

**FUNCTIONAL BIOTECHNOLOGY UNIT**

**Gene Function Group**

**Gene expression profiles of *Ganoderma* infected palms BD388-2002(A) and (B)**

Reported progress on these projects over the last 12 months seems to be slow and it is not clear how transcript profiles will be generated after application of the direct root-inoculum attachment technique. Previously SSH was used but techniques such as RNA-seq would now be more appropriate and would provide information on both coding and non-coding RNAs. Identification of some genes that show a differential expression pattern is described in the text but no data are presented to substantiate this claim.

**Comments from the Ganoderma review panel:**

If this study is to investigate palm responses to Ganoderma then palm lines with clear differences in susceptibility and resistances are required. Note that several papers/reviews from Malaysia have already emerged on this topic.

If these genes are to be used for early detection of Ganoderma, we question the likelihood of success and applicability. Defence-related genes are a general response to many pathogens and sometimes to abiotic stresses. Even if one was found specific to Ganoderma, how applicable would it be under field conditions with respect to cost and time?

**Regulation of oil palm fruit ripening**

This study has used the oil palm genome sequence to identify putative orthologues of lipases and ethylene receptor genes based on conserved amino acid domains from a range of plant species. The expression of specific family members has then been determined in a range of oil palm tissues and in fruit mesocarp at different stages of ripening. The profile of expression of individual ethylene receptors during ripening and abscission is interesting and could provide the foundation for a valuable programme to explore how the manipulation of responses to ethylene might provide a strategy to optimise oil palm yield.

**Strategies to regulate the height of the oil palm tree BD393-2010**

The project has already provided convincing evidence, using the gibberellin (GA) biosynthesis inhibitor paclobutrazol, that by manipulating GA levels in oil palm it is
possible to generate plants with reduced height. Studies over the last 12 months on naturally occurring dwarf material have revealed that some of the plants exhibiting attenuated growth have reduced levels of active GAs and that this is correlated with a reduction in expression of GA20oxidase1. These data provide an excellent foundation for further studies to characterise the genotypic basis for the dwarf phenotypes and by monitoring the performance of this material in the field it should be possible to identify novel breeding material that can be exploited by the industry over the coming years.

**Transgenic technology group**

**Optimization of parameters affecting stable integration of oil palm using biolistics method BD343-1999C & D**

Progress on the development of an efficient transformation strategy to deliver stable integration of DNA constructs into oil palm tissues using biolistics continues to be slow. The work is arduous and requires a precise approach to the making of small changes to protocols to deliver success. The development of an effective transformation system must be a priority for MPOB over the next few years as it is the key to approaches such as gene editing that may provide a ‘non GM’ strategy to attenuate crop yield or modify valuable commodities such as oils or fine chemicals.

**Transformation of oil palm via Agrobacterium tumefaciens carrying useful genes BD341-1999B & C**

Although some success seems to have been achieved in transforming embryogenic calli with *Agrobacterium* as identified by the expression of the reporter gene GFP in some cells of the embryogenic tissues it has not proved possible to regenerate transgenic plantlets using hygromycin as the selectable marker. Hopefully the group will be encouraged by the initial observation and will fine tune the system over the coming year to achieve success.

**Development of oil palm resistant to Ganoderma boninense via RNA silencing BS384-2009 B & C**

These related projects are very ambitious and use putative pathogenicity genes from Ganoderma and are reliant on an effective transformation system for oil palm and for Ganoderma.
Comments from the Ganoderma Review panel:

In practice we know almost nothing about Ganoderma pathogenicity. Therefore the choice of these genes is a shot in the dark. This stresses the urgency for the completed genome of *Ganoderma boninense* monokaryon, the transcriptome and associated projects on its proteome and metabolome.

Do not study expression of pathogenicity genes in a rich growth medium (PDB) as they are very unlikely to be expressed.

Identification, isolation and functional characterization of mesocarp/root specific promoters BD359-2002 (B) & (C)

Encouraging progress is being made in the quest to identify tissue specific and constitutive promoters in oil palm. The use of RNA-seq transcript analysis is helping to source genes with specific patterns of expression and these data might be supplemented using analyses in other species to help focus on gene functions that might exhibit appropriate attributes such as transporter proteins in roots. Whilst tissue specific promoters may be ideal to drive expression of transgenes in a precise way it may be more appropriate in some instances to use promoters that have greater strength in tissues of interest but have a less discrete site of expression.

BREEDING & TISSUE CULTURE UNIT

General comments

In addition to presentations to the Biology sub-committee, 3 members of the PAC were able to hold a specific meeting with staff from the Breeding & Tissue culture unit. The main aim of this meeting was to follow up last year report and to discuss a road map for the unit.

The road map which has been provided to PAC members aims to report the work done up to now on the 10th priority which was discussed with the industry in 2002.

The PAC recommended last year that this work should be prioritized. This has been discussed with the PAC and will need further discussions with industry during the breeding and tissue culture committee.

In addition connections with other research units, in particular Ganodrop, were specifically discussed.
Establishment and evaluation of germplasm collection (BD2-1)

A set of four projects, all under code project BD 2.1, were reported, namely:

1. Establishment and Evaluation of Germplasm collection: breeding material for compactness.
2. Establishment And Evaluation Of Germplasm Collection - Angola Germplasm Collection 2010
3. Establishment and Evaluation Of Germplasm Collection - MPOB Sierra Leone
4. Regeneration and Consolidation of Current Oil Palm Germplasm Collections

Under code BD358 the following project was reported:

1. Genetic Resources- Screening of oil palm for high protein kernel.

Those projects were discussed with regards to the road map.

General state:

- MPOB has gathered together one of the most important oil palm (E. guineensis and E. oleifera) collections in the world. To gather new collections does not seem to be a priority. The present collections have been evaluated as a routine, the most recent collections being still under evaluation (Angola Germplasm Collection 2010; Sierra Leone).
- Most of the collections were acquired a few decades ago: they are getting old and the work to secure the Germplasm has been launched recently.
- Real success was achieved with the Nigerian collection as a new commercial variety is proposed to the industry.
- Breeding priorities traits were re-evaluated and from 10 traits, 5 were considered as general the other being “niche” or secondary traits.

PAC makes the following recommendations:

Road Map(s)

There is a huge need for a long term plan of action for the breeding section. This can take the form of a road map that can be divided into four different fields:

- Collection
- Evaluation and pre-breeding
- Breeding for advance material
- Early screening for Ganoderma resistance.
The PAC strongly suggests that it is made clear how the resources will be allocated to the different fields.

Priorities
As a main or general guide line priorities have to be re-evaluated. From last year 10 priorities the team has reported 5 general traits. The PAC recommends to be even more stringent and to put emphasis on Ganoderma resistance as the first trait of interest followed by oil yield and architecture traits (height and compactness).

Collection
A report on the germplasm collection status was made to the PAC 2015. This report might exist but has not been presented. Work is in progress to secure the collection in different ways: field, cryopreservation, DNA bank. The road map should help to clarify what has still to be done in line with the available facilities.

Evaluation and pre-breeding
Most of the collections have been already evaluated for the classical traits (FFB, OER, growth rate, bulkiness, oil characteristics, etc.). The road map should help to identify the work which is completed and the populations that are available for the industry. The remaining work to do has to be clearly highlighted including the precision level that one wants to achieve in terms of population, family, and palms.

The main challenge is to systematically evaluate this material for its (partial) resistance to Ganoderma. Four important trials (under project BD2-PT2) were planted on “hot spot” for Ganoderma. Unfortunately the genetic design is a “bi-parental” one that has lacked the appropriate genetic design. Neither the less, PAC recommend to the unit to have a detailed look at the protocol in order to identify a possible subset of this trial which may follow a genetic design such as a small factorial design. If some work has to be conducted in connection with the molecular group on those trials, it is urgent to decide with them the list of leaf/DNA samples that have to be collected before the palm infected by Ganoderma dies. Given the limited resources, the PAC strongly recommends concentrating the efforts on projects that will be done properly and not to dilute them.

To fulfill the field evaluation, the PAC still recommends launching collaborations with the industry on the bases of bilateral agreements.
Some interesting characteristics are present within the collections. The strategy which has been followed until now, i.e. to separate the different trait of interest in different populations has to be re-evaluated. The long term aim of breeders is to gather all traits into one ideal palm and the road map should specify the pre-breeding work that can be launched to combine the different traits into the most interesting material that can then be passed to the breeding program for advance material. The road map for evaluation and pre-breeding will draft the long term strategy that could be presented to the next PAC meeting.

**Breeding**

This part of the work has not been discussed in details. Last year recommendations to define the long term strategy will be part of the road map. Last year, given the limited land resources, PAC recommended trying to find collaborations with the industry this has to be part of the road map. It is an acknowledgeable success for MPOB to have launched a new variety based on Nigeria PS1 blood. (As part of the Project DB2-PT1 “High oil yield”). The committee strongly recommends adding some work on tenera palms. The strategy which aims at testing only pisifera palms is not sufficient. The road maps should clearly identify the breeding choices (in line with priorities) that may lead to strong changes in breeders practices: breeding for resistance to Ganoderma, reevaluate the role of Avros material within the breeding program, work on interspecific hybrids and Back crosses.

The road map should keep as a final objective the future oil palm “ideotype”.

The road map may include Ganoderma assessment of existing planting material from the industry.

**Early screening for Ganoderma resistance**

This work could be integrated into the previous points as a “transversal” tool. The PAC think that this has to be identified, at least for the following 3 to 5 years as a specific objective with its own road map, as it is new and of tremendous importance for the unit (and for the industry).

The road map should differentiate different aims:

1. The launching of a standardized early screening test. This activity has to be conducted hand in hand with the Ganodrop unit which will have the responsibility to define the procedure. Nevertheless the breeding unit has to be part of the work, taking in charge the definition of a range of standard crosses that will be made available in the long term. A study of the statistical performances of the test, i.e. precision & reputability, is needed; the group has
to follow very closely that work. Studies on interactions between isolate and planting material will need to be planned and breeders should be part of this strategy.

2. As part of the early screening test, knowledge of the breeding parameters has to be evaluated. This will help to define a strategy for the routine testing of the planting material, such as the use and definition of testers.

3. Routine tests. Depending on the resources allocated to the breeding group, a program has to be launched and priorities will have to be defined.

4. The breeding unit will have to produce material for the other research groups, such as Ganodrop but also for the ABBC molecular group. We encourage the unit to anticipate the needs that might be useful and to discuss the aims of each team, in order to propose and provide appropriate material, and to produce the seeds on time (it may take up to 2 years).

**Tissue culture**

*Tissue culture process*

The development of tissue culture processes to clonally multiply oil palm is split into two projects:

- BD5-1.4(92) Production of oil palm clones for various studies
- BD 353-1999 Establishment and improvement of oil palm liquid culture for clonal propagation

It seems that MPOB has reached a good expertise in tissue culture. The Moto vessel for liquid suspension is an interesting improvement of the technique.

The PAC recommends that the group closely collaborate with the ABBC molecular group in order to determine the most appropriate material to work with in order to make use of the *MANTLED* gene. During the PAC week, several PAC members were able to visit Orion Biosains Sde Bhd, which has the exclusive licence for commercialisation of the marker technology originating from the *Shell*, *Virescens*, and *Mantled* genes. This company has created some high skilled jobs in a very high-tech sector in Malaysia and is a good example of a spinoff from MPOB R&D that has led directly to significant wealth creation in Malaysia. We are aware that further expansion of the genotyping work that has originated from MPOB discoveries may in the future be hampered by ongoing issues regarding the import of samples from other countries. While we fully support the appropriate enforcement of phyto-sanitary regulations in Malaysia, it would be a pity if too strict an interpretation of these rules led to the loss of this kind of high-tech business to the Malaysian economy.
Use of Tissue Culture as a tool for breeding purposes

At the moment the breeding group uses it for three different projects:

- To develop commercial planting material: outstanding clones.
- To multiply parents in order to produce mono or bi-clonal seeds.
- To secure outstanding palms which were found in MPOB collections.

Last year the PAC recommended clones were prepared that will, in the future, be used as testers (breeding, Ganoderma assessment, etc.) or standard crosses (breeding, Ganoderma, etc.). The use of clonal material and the needs for that material by the breeder should be clearly included in the road maps (as clones in the field (testers), mono or bi clonal seeds, etc.).

Search for molecular markers of mantled abnormally

The PAC acknowledges the very important work done to understand the role of the MANTLED gene. The main challenge will be to develop a method to assess the quality of the culture.

GENOMICS AND BIOINFORMATICS UNIT

Though it is good to see the progress in the development of the Oil Palm sequence there are a number of areas that require thought and development as a more comprehensive planning framework.

The release of the oil palm sequence and the supporting web site is a valuable step forward. However I think that some progress could be made in terms of improving the interface and usability. In all likelihood the main entry point for users will be via blast followed by retrieval of the sequences underlying one or more of the best hits either protein or nucleotide. This could be made easier with some tuning and development of the web interface. I have only directly experienced the external site which is limited in its capability but it would be good to be re-assured that MPOB users and collaborators have access to something like a simple page bring together all the information that is available for an individual gene sequence. A good model for this is the NSF rice site at MSU run by Robin Buell which summarises gene models, expression data, orthologies etc and provides links to the GBrowse view of the rice genome. It would be particularly valuable to have some idea of the relative chromosome position either where on the genetic map it belongs (where known) or on the pseudochromosome when available. Do the Genomics and Bioinformatics units have a naming strategy for the genes in the pseudochromosome release? I would strongly endorse the Arabidopsis/Rice model which has proved robust and adaptable.
The Genomics and Bioinformatics groups are currently experiencing the standard problem that many genome projects face, namely the tension between the sequencing and annotation to a high degree and the need to have the sequence and supporting information made fully available at least internally. This may be helped by having a more formal release schedule based on a fixed data freeze in conjunction a release specific naming strategy and with cross linking between releases.

I welcome the commitment to placing the data within the context of Plant Ensembl it will increase interest in the sequence and attract experts in particular gene families and pathways to incorporate the data in their analyses. I would encourage MPOB to, if possible, work with the team involved in the data palm sequence. The annotation for this has been done by Klaus Meyer’s group at MIPS who have been extensively involved in plant genome sequence annotation. Linking with them will help ensure that a breadth of experience is brought to bear on the MPOB oil palm sequence.

There are a number of targets of comparative sequence and genome analysis that might be identified as being of value to oil palm production. Work has clearly started on a number of these including gibberellin production and response, RGA resistance genes and those involved lipid biosynthesis. However it might be sensible to develop this work in the context of a longer term strategy. It is clear from that there is much to be gained from work in other monocots, especially the cereals.

- Potential targets might include the following:
  - Inflorescence infrastructure
  - Nutrient uptake, including N and P transporters.
  - Cell wall related genes including the cellulose synthase superfamily and genes in the lignin biosynthesis pathway.

Work on these is well advanced in many cereal species supported by functional genomics and extending this to the oil palm and date genomes ( and perhaps Musa and even Yam) through comparative genomics has the potential to provide valuable landmarks on the oil palm genome and generate good quality publications. This approach could be considerably enhanced by the design and utilisation of an exome capture array to enable a significant number of the genes to be sequenced across a wide range of oil palm germplasm this would serve as a valuable informatics resource to be mined for allelic variation as important genes for oil palm are identified either directly in oil palm or in other monocot species. At the very least it should be linked to comparative sequence from the skim sequencing project. A comparative study between palm and other key monocot groups together
The work on the karma character in relationship to oil palm flower mantling represents a significant breakthrough in oil palm clonal production. There are clearly a number of interesting ways in which this work might be further developed. For example if the expression of the deleterious character is due to the hypo-methylation of a line transposon, one interesting approach might be develop primers to survey the germplasm collection of both species to identify if a variant exists that lack this transposon insertion. Such a variant might be resistant to mantling. A comparative study of the relatively highly conserved orthologues of EgDEF1 in other related monocot species may provide a useful starting point. There is a highly homologous date palm sequence.

With the improvement to the reference genome sequence there is an interesting opportunity to more systematically study comparative genomics with:

- Palms
- Rice and other cereals.
- Other related monocots such as Musa and or Yam

In the latter case identifying evolutionary related chromosome regions may help provide a syntenic focus for the support of identifying likely candidate orthologous genes. The occurrence in a syntenic position increases the likelihood of true orthologies.

It is not completely clear what MPOB strategy is for exploitation of marker technology within the breeding programs. There is clearly an available high density Illumina array which is being used to anchor/order the latest genome builds. There is also a program of association and QTL mapping projects. However the utilisation of these technologies directly within the breeding programme is not completely clear. It appears there is a commitment save tissue and DNA preps for at least a subset of the breeding/rebreeding lines but consideration should be given to fully genotyping a subset of ideally linked crosses as opposed to partial genotyping of a wide range of material. It would appear that a genotyping plan which indicates what will be genotyped and by what deadline would be of value to many groups within MPOB.

The introduction by the head of ABBC referred to both association analysis and genomics section but there was no real evidence presented that indicated that MPB might be operating GS within their programmes any time soon. However it would be of value to have a formal assessment of the likely role of GS and related prediction
approaches might have within the MPOB program. This would be helped by an economic assessment of the components of the program and the resources available and how they can be optimally combined to maximise the rate of breeding gain. For example a first round filter through genomic prediction of performance based on marker data alone may enable a much more efficient use of the available trialling resource that is available to MPOB.

It is clear that a significant amount of RNA-seq data exists and that further experiment work is likely. As this is an area of technological and software development it would be valuable to have a broader strategy in place within the context of which expression analysis can be done. For example there are considerable issues of experimental design relevant to RNA-seq experiments including tissue collection to avoid or block of circadian complications. Blocking of libraries within flow cells to enable multiple round of sequencing without confounding sequence run effects. Current analysis strategies have identified that appropriate choices of normalisation and analysis method can significantly affect the power of the analysis and MPOB should ensure that they are currently following best practice. If it is not already underway co-expression and network analysis of the mesocarp development data set should be undertaken and the position of oil biosynthesis enzymes within such a network analysis undertaken.

METABOLOMICS UNIT

The Biology subcommittee would like to thank Dr Aishah Latiff and her colleagues for undertaking a review of the PROMET Unit. The conclusion of the review was that the unit was making good progress and recommended the purchase of additional analytical equipment to facilitate shotgun proteomic analysis.

The progress report presented orally by the Leader of the PROMET summarized the main progress of the Unit together with some future plans and PAC felt that it was impressive. Further details on progress were given in the Research Progress Report and extended information provided and discussed at the PAC meeting in 2015. A key event will be the arrival of the Orbitrap MS System, scheduled for April 2016.

In terms of the individual projects:
PROMET group

Establishment of a comparative protein and metabolite profiles of elite oil palm varieties (baseline data for oil palm) and genetically-modified (GM) oil palm (BD370-2007)

Project well on-time for completion during the allocated period. Will dovetail with data from the Orbitrop system. Interesting to note the distribution of identified proteins with a high proportion for carbohydrate rather than lipid metabolism.

Development of oil palm metabolome database (ABBC4-2013)

A demonstration of the on-line portal was given which looked useful and functional. The project is unlikely to be completed within the allotted time-frame but that was pointed out last year. However, the project is obviously very important.

Metabolomics analysis of parental palms and progenies tolerant and susceptible to Ganoderma boninense for improved understanding of basal stem rot disease (BD399-2011)

PAC members raised a number of important points for consideration in 2015. It is not clear how many have been taken on board. Nevertheless, quite a lot of work has been done. An additional issue about how to define ‘tolerant’ and ‘susceptible’ lines is very difficult. Since so-called tolerant palms were reported from Sumatra, it was a little surprising that these did not appear to have been examined.

Comments from the Ganoderma review panel:

Comparing palm lines of very different genotypes is likely to reveal differences which may be unrelated to resistance. You require isogenic lines or a study of many lines in order to make any valid link to disease susceptibility/resistance. The literature will tell you that chemical differences within a species as related to resistance are an extremely rare event. It certainly can happen between species.

Functional characterization of oleate desaturase (e.g. FAD2) gene in model plant (Arabidosis thaliana) (ABBC1-2012)

Agrobacterium-mediated transformation and over-expression by PCR carried out. T2 putative transgenic plants produced with growth changes but unfortunately further analysis prevented by fungal infection.
Biochemical studies of oil palm artificially inoculated with *Ganoderma boninense*, the causal agent of stem rot (BD387-2003)

The proteomics part is very much on-going with few proteins identified. Many of these were stress proteins. Again, progress is limited with a large number of sample (6 replicates) and 0-to-48-weeks after inoculation for ‘susceptible’ (Elmina X Elmina) and ‘tolerant’ (Zaire X Cameroon) progenies. For metabolomics, chelidonic acid was again highlighted. Although this compound reduced *G. boninense* growth it did so only at high concentration unlikely to be of in vivo relevance. In fact, it stimulated growth at lower concentrations.

*Comments from the Ganoderma review panel:*
Toxicity at >2 mg/mL is not very impressive in physiological terms. The literature will tell you that compounds linked to defences are usually in the low ug/mL range. Always relate such toxicity to actual amounts in relevant tissue (where Ganoderma invades). A better approach arguably would be to use what others successfully employed over decades, by testing directly for anti-fungal activity from various solvent extracts (you use correctly five) then identify those compounds. This applies to preformed compounds-phytoanticipins and to infection-induced compounds-phytoalexins. Strong encouragement was given to extend this work to study metabolites from Ganoderma in vitro as part of revealing potential pathogenicity factors.

Regulation and specificities of FatA and FatB thioesterases in the oil palm (BD371-2001)

Work with the FatB seems to be making progress with some characterization of the fusion protein in E.coli. It was able to hydrolyase medium-and long-chain acyl-CoAs. However, acyl-ACPs will be the natural substrate and no details were given as to whether saturated and unsaturated fatty acyl groups were substrates.

The FatA-type gene is currently under amplification testing and little (or no ) progress as this part of the 10-year project has been made since 2015.

Comparative proteomics of pathogenic and non-pathogenic Ganoderma Species (ABBC11-2014)

This new project (June 2014) has only given preliminary data so far. A key aspect is purity of samples to be analysed as was pointed out last year. It is most important that this issue is addressed fully, in cooperation with the GanoDROP group and external advice should prove useful.
Comments from Ganoderma review panel:
Fungal proteins linked to necrotrophic pathogenicity are usually extracellular, not intracellular as is being attempted here. Therefore focus on culture fluids. Do not use rich culture media, but starvation conditions, having first established the mycelium. This comment also applies to metabolite production in culture.

Phenolics Group
Dose exploration trial of oil palm phenolics (OPP) supplementation in humans (ABBC11-2014)
Some differences were reported for liquid or spray-dried phenolic formulations but these were not significant. Standard errors and n values were not included in the Figures presented so it is difficult for PAC members to comment. Also, although the title indicated a dose study, the data presented concerned three different OPP preparations all at the same dose.

OPP on glucose uptake by in vitro preparations (ABBC12-2015)
The experiments concerned human colonic Caco-2 cells which were grown as monolayers. Following advice from last year, it is intended to expand the study with intestinal everted used but ethical approval is waiting for this. The Caco-2 cell system has been set up and preliminary data obtained to show that certain abundant phenolics in the OPP samples reduced glucose uptake into cells. Suggestions for delineating this reduction in terms of the glucose transport system were made.

Summary
Overall, this has been a productive year for the Group with significant progress on most individual projects. Perhaps the biggest concerns are with the supply of pure, well-characterised samples of Ganoderma for analysis.
5.2. BIOLOGY DIVISION

AGRONOMY AND GEOSPATIAL TECHNOLOGY UNIT (AGT)

11 projects from the Agronomy and 5 projects from the Geospatial Technology Group were discussed.

1 AGRONOMY-SOIL AND NUTRIENT MANAGEMENT GROUP

i. Soil Erosion and Nutrient Losses from slopes under Oil Palm
   Besides reporting a total soil loss to be within USDA tolerance of 2 t ha\(^{-1}\)yr\(^{-1}\). Actual figures from the experiment were not available. The experiment should be reassessed to see if the location of study has been suitable along the lines of the objectives of the study. Texture of soil and slope (%) are prerequisite considerations. Rainfall frequency and intensity should also be provided.

ii. Density x Progeny x N Fertilizer Trial on Alluvium Soils.
   It is surprising that nitrogen does not give a significant response to yield. The soil fertility level should be elucidated to support the finding. A more careful evaluation of the year to year response to nutrient is required. It is very well established that nitrogen is the most important element for yield increases in oil palm.

iii. Long Term Impact of Fertilizer Inputs on Soil Fertility Changes, Oil Palm Productions and Environment
   Whilst it has been shown that high levels of MOP application of more than 4 kg MOP per palm increases significantly the CI level in oil, it must also be verified that the optimum rates generally recommended 2-3 kg MOP p\(^{-1}\) does not or does also contribute to high levels of CI. The threshold of CI in oil should also be given. Do not create an alarm of high CI in palm oil due to fertilizer application. Further verification is required to elucidate the role of MOP towards CI content of palm oil and its relationship to 3-MCPD ester level in palm oil. Data on nutrient use efficiency and on soil fertility status over the years is yet to be provided.

iv. Nitrogen Fertilizer Requirement in Relation to Ground Cover Management for Oil Palm Planted on Peat
   Trial results should be carefully evaluated to derived suitable recommendations with respects to use of nitrogen fertilizer in the presence of leguminous cover crop. It should
also take into cognizance that in the fields it is difficult to establish a uniform cover crop coverage over large areas. Hence the variability of nitrogen contribution from cover crop should be carefully considered.

v. Assessment of Nutrients and Carbon Stock from Different Cover Vegetation and their Effect on Oil Palm Performance on Peat in Sarawak.
An important variable influencing the results would be how well the cover crop has been established. It is reported that cover crop did not grow well and this could be related to land preparation activities and other management practices. The results should be carefully evaluated as some of the treatment effects related to cover crop may not be useful.

vi. Assessing Micronutrient Status In Oil Palm Plantations
Though some results were provided, further elucidation is necessary to identify proportion of estates with below optimal levels of micronutrients. Some of the findings appear to conflict with what is seen in the field with respect to micronutrient deficiency.

The variations in the measured soil parameters should also be reported rather than just means. Additionally, water retention under various pressures should also be determined via suction pressures in the laboratory so as to get an understanding of water retention/availability of water under various pressures (pF curves) for the different treatment studied in the field.

viii. Oil Palm Nutrient Management For High Yielding Materials.
The long term trial at Keratong is only in its third year and two other potential sites have been identified.
The researchers should characterize the trial locations at all the three sites and report it at the next 2017.

ix. The Potential Use of Biochar on Soil and Oil Palm Agronomic Benefits
The trial is encountering multiple nutrient deficiencies of potassium, magnesium and Boron. These deficiencies have to be corrected in a timely manner so as to have minimal disruption. It may be prudent to correct the deficiencies by using more frequent applications of straight fertilizer rather than a blended compound.
x. **Role of Boron in Pollination and Fruit Set Formation of Oil Palm on Peat**
   At all planting densities evaluated, fruit set was low, <50%. Not much progress reported since commencement of the study in 2014. A more detailed progress report of the effects of boron and planting density should be provided in PAC 2017.

xi. **Investigation on Premature Frond Desiccation in Oil Palm Planted on Peat Soil in Sarawak.**
   This is an important study as the problem is intensifying in most peat areas. There is an urgent need for management practices to alleviate the malady. The likely causes should be identified as soon as possible with recommendation for mitigation measures. PAC recommends that a background survey be conducted to categorise the severity of the malady into severe, moderate, mild and normal and should be tracked over time to understand the recovery with management practices that will be studied.

### 2 GEOSPATIAL TECHNOLOGY GROUP

i. **Establishment of Oil Palm Resource Information System (OPRIS)**
   Remarkable progress has been made. The project is basically complete. PAC suggest that it be released to the industry as one achievement of MPOB during the TOT after refinements. Target it for 2017.

ii. **Remote Sensing for Oil Palm Plantation Management (Sub-Project: Management of the outbreak of bagworms and leaf eating pests by GIS and Remote Sensing).**
   The project is almost completed but objective of prediction of pest outbreak as an early warning system is not achievable. However PAC suggests that the data gathered could be analysed to see if there are some regular patterns of outbreaks in the bagworm prone areas e.g. Perak Besout region, Lower Perak region so as to alert the estates and to ensure that ground census are carried during specific months of the year.

iii. **Modeling of Oil Palm Biomass for Carbon Stock SAR (Synthetic Aperture Radar).**
   HV filtered data used with allometric equation of Syarinudin (2005) provided the best correlation for biomass and the polynomial function was better than the linear. The project is nearing completion and a publication should be produced upon completion.

iv. **Oil Palm Crown Detection Using Remote Sensing Technology as a Tool for Plantation Management.**
The methodology is not well explained. PAC requires a further clarification of the methodology.

v. *Precision Oil Palm Plantation*

The project has been completed. A comprehensive report should be produced. Report should be evaluated to see the suitability of adoption by the industry particularly on the evidence of VRT fertilizer application and yield improvements.

**RECOMMENDATIONS**

1. Due to the impending labour shortages, the industry has to move towards mechanization as soon as possible. The Farm Mechanization Unit is within the Biology Sub-Committee. It is recommended that a local panel be established to evaluate if it should be upgraded to a Mechanization Sub-committee with more competency to drive research on mechanization.

2. The Agronomy unit should develop a study on relationship of some of the GAPs in relation to *Ganoderma* incidence.
   e.g. cover crop, trunk injection, EFB application, windrowing of biomass after felling and chipping.
FARM MECHANISATION UNIT
On-going projects
A special discussion was held between PAC Members namely Ir Izhar Mahmood and Mr Mahbob Abdullah with the MPOB team on mechanization led by Hj Abd Rahim Shuib to deliberate on the status of the works done on the existing projects. These included enhancement of various aspects of the previous model of the Cantas, namely improvement on the durability of the cutting head, reduction in vibration and weights with lighter and higher pole reach up to 7 metres palm height. Also the 4-wheeled mini FFB transporter/grabber for difficult ground conditions and portable sideway mounted conveyor to assist in FFB loadings. Other ongoing works that have been carried out include the possibility of using electromagnetic power and laser for FFB harvesting. The latter is being carried out through collaboration with UPM Engineering faculty. It is recommended that the team to updates periodically to the members on the progress of the on-going projects for their comments and/or inputs.

In order to ensure the continuity and sustainability of the technology introduced to the industry, it is recommended that MPOB to maintain updated database on the machines including its performance, productivity, costs and issues for future reference and improvements. It is also recommended that MPOB to forge and strengthen relationship with the industry and vendors to improve on the P&M technical backup services in order to maintain the market confidence with regard to the machines reliability and thereby avoid bad publicity due unfounded accusations by irresponsible users due to their own poor management rather on the machinery itself.

PAC Members Remarks: To continue with the ongoing projects with the necessary improvements as per comments

Other matters
Fertiliser Applicators. Besides focus given to works to produce good planting material, P&D, FFB harvesting, it is equally important that the MPOB mechanization team look into another very important aspect of the plantation operation that affects the industry enormously on the Company bottom line, i.e effective fertilizer applicators. This is very important whereby about 30-40 % of the estate COP is on manuring and the present method of fertilizer applications has led to very high nutrient losses namely through leaching and evaporation.

The industry badly needs an efficient mechanize subsoil fertilizer applicator to ensure minimum losses and sufficient nutrient are given to the palms to produce higher yields.
In this respect, the member suggested that the MPOB mechanization team to search and develop effective and efficient subsoil fertilizer applicators as the next very important project to save the industry billions of Ringgit from importation of fertilizers. Similar smart partnership arrangements can be made with relevant group involving MPOB, plantation, manufacturers and fertilizer producers to ensure the project can be carried out effectively, speedily and at affordable costs.

Project operation. In order to ensure the effective execution of the proposed projects by the team, members propose immediate action by the management on the followings:

- **Identification of site suitability**
  MPOB team to establish crucial database on suitability of sites with the proposed technology for it to meet the intended purposes. Factors to be considered includes the ground conditions, terrains, accessibility, mobility, productivity etc. This will facilitate logistics, operations, saving on costs, manpower and improve productivity.

- **Improvements on Projects Team & Management**
  In view of the pressing needs by the industry following lower palm prices, steep increase in the production cost and acute labour shortage it is crucial now for MPOB to review their present manpower strength and to draw up comprehensive roadmap for the mechanization department to meet the present and future challenges and remain relevant for the industry.

- **Product Promotion Team**
  In view of the importance of good marketing plans required to promote commercially viable plant and machineries developed by the mechanization unit, it is important and timely for MPOB to consider the establishment of its own trained market personnel's with good technical background and communication skills to promote to the industry users all machines and equipment successful developed by the Unit for commercial use.
APPLIED ENTOMOLOGY AND MICROBIOLOGY UNIT

Progress reports on seventeen projects of the AEM group were presented by Dr Siti Ramlah on behalf of the three working groups. The core work of the AEM group covers key entomological and microbiological topics; the pollinating weevil, bagworm, rhinoceros beetle and soil microbiology. PAC responses are grouped in these theme areas. It is good to see that a candidate for the Group Leader, Soil Microbial Biodiversity and Function, has been appointed and will start work with MPOB in May. Some of the projects have been running for many years with a monitoring role for the key insects. It will be good to revise these projects and, where appropriate, combine them into renovated projects for these key theme areas.

_Elaeidobius kamerunicus_

Projects BD6-1.1.1. (82) A study on the biology and population dynamics of _Elaeidobius kamerunicus_


These two long running projects have provided useful information about populations of _E. kamerunicus_ on reference sites in Malaysia. The study has shown that _E. kamerunicus_ is abundant in the reference oil palm plantations, leading to satisfactory fruit set, in most parts of the country. The exception was Sarawak, where the three monitored locations had poor fruit set and relatively low weevil numbers. However, industry have noted the problem of poor fruit set and due to their concern about the weevil a Steering Committee of MPOB, Government agencies, universities and industry was convened in January to address the problem of “Fruit Set and Pollinating Weevil”. Minutes have been circulated and a permanent Steering Committee and a Task force to evaluate and resolve the problem have been established.

PAC agree with the Terms of Reference for the Steering Committee;

- a) To identify reasons and issues related to low weevil populations, low fruit set and oil extraction
- b) To obtain general consensus on how to resolve issues related to low weevil population and fruit set
- c) To identify possible collaborative research work among the members

and compliment MPOB on leading this multi-agency initiative to resolve a problem raised by industry.
In carrying out the project it is important to focus on the fruit set and identify problem areas before trying to evaluate the role of the pollinating weevil. It is also important to evaluate the role of the two parasitic nematodes that were introduced with the weevil and, if further introductions of different weevil species are contemplated, to ensure that these are free from parasites and pathogens. The current long term projects should be closed and combined into a single project focusing on the problem areas for fruit set guided by the targets of the Task Force and presented to PAC as a new project in 2017.

**Bagworm**

Projects; BD6 – 1.3.2. (88). Beneficial plants for sustenance of parasitoids and predators for control of bagworm
BD360-2006. Identification of the sex pheromone of bagworms
BD390-2009. Development of mass rearing system for predator *Sycanus dichotomus*
BD390-2009. Potentials of insectivorous birds on bagworm control in oil palm plantations

The reported projects describe fragmented work around the bagworm problem and it is difficult to see how they are contributing to building an effective IPM strategy. The census for parasitoids at Teluk Intan seems to have taken place in an area with low bagworm numbers and it is hard to interpret parasite numbers. Conversely high numbers of bagworm were evident at the Pahang site where the pheromone traps were tested but these dropped to relatively low levels during the period of the experiment. As suggested previously, replicates of treated and untreated populations should be monitored to provide statistically valid results. Mass rearing of the predator *Sycanus dichotomus* appears now to be more successful but assessment of its effect in cages and/or field is necessary before too much effort is allocated to mass rearing. The response of insectivorous birds to bagworms is interesting and suggests there is potential to obtain some control of bagworms through encouragement of birds in the plantations.

BD 417-2013. Development of an automated counter for bagworm census

It is good to see a range of activities being carried out against the bagworm outbreak around Teluk Intan and affected smallholder blocks. Application of Ecobac-1 to 18,189 ha is a major effort but this does not appear to have been assessed in a way that
measures impact in relation to trends in untreated control blocks. Pre and post application assessments of bagworm numbers are provided and, while reductions are recorded following most treatments, the residual populations appear to be very high and well above the Economic Threshold Level (ETL) of 10 bagworms/leaf (P 49). The extensive effort of pheromone trapping also appears to have been made without an experimental design including replicates and controls. As a result it is not possible to assess the effectiveness of the trapping and bagworm numbers appear to have been unacceptably high for much of the monitored period.

The MPOB team have been working on bagworm control measures for several years and it is now time to show that these measures can be incorporated into an effective IPM programme for control of the pest. It is premature to promote an IPM bagworm control programme until this can be validated in plantations and approved to control the pest to acceptable levels by the farmers. This needs a large scale experiment carried out with replication and controls for proper evaluation.

The current bagworm control programmes are operated by two teams within AEM and another programme on bagworm detection is carried out by the Geospatial Technology Unit. These projects should be managed in a coordinated manner under a designated leader for bagworm research. The role of trunk injections should also be assessed.

A new, modified IPM project should be planned (with input from a statistician) and implemented with progress measured against established targets. Progress should be regularly reported to MPOB leadership. The cost effectiveness of the programme and satisfaction of the farmers should be recorded.

The results should be reported to PAC 2017. If the bagworm outbreak is still not controlled it may be necessary to form a Task Force to develop and implement controls for this difficult pest.

Pests of oil palm in Sarawak

BD402-2011. Biopesticides for termites
B65-84/2011 Bunch moth infestation on peat soil.
It appears that Fipronil is still the best control option for termites on peat soil but care must be taken with this toxic chemical and training in pesticide application by MPOB has been appropriate. Research should continue to look for less toxic alternatives including evaluation of the entomopathogenic fungi. An effective formulation will be
necessary for successful use of fungi. Use of insecticides and biologicals against bunch moth is giving promising results but the need for four rounds of application seems excessive. This work should be continued to find an effective, practical and economic option for control.

**Rhinoceros beetle**

BD 304-96-877. Use of *Metarhizium anisopliae* to control rhinoceros beetles
BD 391-2009. Development of integrated bio-management systems for rhinoceros beetle
BD434 -2015. Genetic diversity, virulence and population dynamics of *Oryctes* nudivirus

Rhinoceros beetle remains a significant problem for oil palm especially as renovation of old plantations provides trunks for breeding sites. It is good to see that *Metarhizium* is an effective control and the isolation of the insect pathogenic *Paecilomyces amoeneroseus* is an interesting and useful discovery. The MPOB team have successfully established the black beetle cell line in the laboratory and are using it for production of pure strains of virus which have been tested and found effective against beetles. This is not a simple matter and the team are to be complimented for progress in this area. They have initiated the new project looking at genetic diversity of the *Oryctes* nudivirus which is urgent to counter the threat of the new *Oryctes* rhinoceros Guam strain which is spreading from the Pacific into the Asia region.

**Soil Microbial Biodiversity**

R009711000. Microbial study on Deep Peat Sarawak

Q0012005001. Underground microbial biodiversity, Belaga, Sarawak

The team report the welcome news that the new Group Leader, Soil Microbial Biodiversity and Function has been appointed to lead the soil microbiology biodiversity research area and will start work with the MPOB in May. It is important that the new GL work with a top international team in soil microbial ecology (recommended Brajesh Singh, UNSW) who will provide training and mentoring to the MPOB soil microbial biodiversity team. The work in this area should be revised together with the new GL and the international expert to look at functional biodiversity within the oil palm environment.
Biofertilizer

Work with microbial biofertilisers was presented but no details are given of the microbiology of the bio-fertiliser, its chemical content and possible costs of production. A field trial has been carried out but more details will be needed to assess the value. There is no indication that the project staff carried out the field testing in collaboration with the soils/fertilizer group and GanoDROP as suggested by PAC in 2014 and 2015.

GANODERMA AND DISEASES RESEARCH FOR OIL PALM (GanoDROP)

Note that the IAPGD (International Advisory Panel on GanoDROP) 2016 report comments in detail on a number of these projects and offers recommendations. These will only be referred to briefly here. For further detail the reader should access that report.

Efforts of the GanoDROP group (other than key remaining issues such as biosecurity and exotics) should be absolutely directed to understanding and control of BSR/USR which continues to increase in prevalence.

GANODERMA RESEARCH GROUP

Studies on biology, epidemiology and etiology of Ganoderma pathogenic to oil palm.

R0094110001 (BD6-2.2.1)

This project involves a continuing survey of the degree of BSR incidence in oil palm smallholders and is conducted in collaboration with IRED Division.

By June 2015 >14,000 smallholders had been visited representing >5700 ha in Peninsular, Sabah and Sarawak. 17% reported the presence of BSR. 14% incidence is reported, surprisingly, the same as presented for PAC 2015.

IAPGD: The questionnaire was presented to us and it appears comprehensive.

Clearly disease modelling would be advantageous using this and other data (especially from industry from as presented for UPB by Dr Arulandoo). This could incorporate, palm age, soil type, treatments etc.

The project title is misleading as no studies are being conducted on biology or epidemiology.

Early detection of Ganoderma.

R009411000-2 (BD6-2-2-2)

Sub project 1: Hyperspectral remote sensing.
Clearly large scale evaluation of BSR incidence would be advantageous to industry and to understanding of BSR epidemiology.

Spectral indices are suggested as suitable for *Ganoderma* detection. The influence of palm genotypes and other forms of biotic and abiotic stress must be very carefully evaluated before this method is validated.

Refinements are ongoing and are described in a new project proposal (see elsewhere).

IAPGD: The method must be carefully linked to actual BSR incidence on the ground. The spectral analysis could be linked to other agronomic/physiological traits and pests and relevant agronomists or entomologists should then be included.

Sub project 2. Molecular techniques.

No data are presented in the report.

IAPGD: We were generally critical of the approach of using defence-related (AKA pathogenicity-related) genes as a means of specific detection of *Ganoderma* infection. These are a general response to most pathogens and to various abiotic stresses. This comment applies equally to ABBC using this approach. The cost and practicality of use in a field situation is questioned.

VOCs.

Comments/data are not included after the method failed last year to discriminate between infected and healthy palms.

However our comment from PAC 2015: “There seems little progress from 2014, when we questioned the origin of VOCs as palm or *Ganoderma* and gave suggestions as to how to distinguish the latter”.

IAPGD: Again we strongly recommend a simple technique to obtain *Ganoderma* VOCs by growing it *in vitro* on sterilised palm wood blocks, taking the head space and testing for those volatiles in the field.

**Investigation of fungicides to control Ganoderma.**

R009411000-3 (BD6-2.2.3)

Comments from 2015 still apply. “Clearly there is benefit in some situations to using tetraconazole. It is hoped that in time this large volume application will not be required for economic and environmental reasons. This continues to emphasize the need to find effective resistance to prevent the establishment and spread of the disease in the first instance”.
IAPGD: Progress on optimizing the method for disease resistance screening. Establish the ways that *Ganoderma* infects. Spores are likely to contribute and, for example, might enter via cut frond bases. If so, this could influence targeted application of chemical or biocontrol.

**Biological control of *Ganoderma***.

R009411000-5 (BD6-2.2.5)
R009411000-7 (BD6-2.2.7)

Treatments and new data are presented for Endophytic fungi-GanoEF fertilizer and endophytic bacteria-EMBIO actinoPLUS.

With seedlings, increased growth parameters are claimed but what level of fertilisation was given to control seedlings? This information must be provided or the experiment is invalid. Under field conditions bait seedlings is arguably the best method. Dramatic disease control (>83%) is claimed for GanoEF and 6.6 vs 75% death for EMBIO treatment.

Organic fertilizer.
Seedling trials gave a claimed 77.8% reduced BSR incidence. Field trials gave <5% death in treated bait seedlings cf >83% untreated.

IAPGD: these data suggest the products give substantial control, but must be validated mid and long term by growers using them.

Note that industry members advocate MPOB to test without prejudice commercial bio-products. However, as you are producing such products there would seem to be a conflict of interest.

The result with the organic fertilizer lacking any biological antagonist is quite remarkable and contrasts with control of other plant diseases. The claimed key factor is silicon. Evidence for the role of this element in resistance is very limited. Here it is claimed that oil palm cell walls are thicker. This is based merely on SEM (scanning electron microscopy) and is not a rigorous technique in view of how samples are prepared and which tissues are being compared. This same comment was made last year. A rigorous scientific study of Si nutrition, soils, amounts in palm roots and use of elemental analysis under SEM or TEM (EDAX or ESEM) would reveal if it is contributing and if so, makes the basis for an important paper in an international refereed journal.
Endophytic bacteria
Nursery trials with two isolates gave some disease suppression of DSI 25% cf 75% untreated.
Field trials initiated in 2013 so far show no infection.
IAPGD: Academic study of siderophores and putative antifungal compounds will not assist in the application of this work, yet it is understood that as part of PhD training is valuable. These comments apply also to work on *Trichoderma* (see below). They should not however be allowed to detract from the main thrust.

**Screening of oil palm for resistance to *Ganoderma***.
R009411000-6 (BD6-2.2.6)
Fifteen progenies were screened using three inoculation techniques: germinated seed, 4 month, 12 month seedlings.
Significant differences between lines were obtained with 4 and 12 month seedlings.
IAPGD: As an addition to the useful study above, we strongly recommend optimisation of a technique for screening for disease resistance that can be recommended for industry. This also comes at their request. We list the many criteria that should be evaluated.
Disease resistance must be the long term solution and this basic technique underpins that progress.
MPOB have a very extensive collection or world sourced oil palms. Using the optimised inoculation protocol it seems clear that representatives of this diversity should be screened for resistance. If extreme resistance exists it gives hope and possible breeding route for a resistant genotype longer term. Strong resistance to many major crops such as tomato, potato, cereals was derived from wild relatives from the centre(s) of diversity.
See also comments in the Breeding and Tissue Culture Report.

**EMERGING AND EXOTIC DISEASE GROUP (EEDG)**

**Development of *Trichoderma* as biofungicide for *Ganoderma* basal stem rot infection in the field.**
BD415/2013

Two potential isolates of *Trichoderma* from soil (of five initially selected) are being field tested by incorporation into the planting holes.
Five treatments are described and compared with chemical treatments. Thus far no infection by *Ganoderma* has been detected.

The rest of the report concerns identification of metabolites. A patent has been filed for phenylethyl alcohol although it has been reported in papers before and has not been tested against *Ganoderma*, so we are surprised at the reason behind this filing.

IAPGD: see comments above about academic study. Comments from last year question the likely value of any metabolite in disease control as fungi are the best delivery vehicles: “Extracts active against *Ganoderma* were obtained and some identified. There is at this stage no data on individual toxicities. It is not clear how these compounds might be used in disease control. Are they likely to be more effective than applying *Trichoderma* itself, which has an invasive capability?”

GFP as a marker for *Trichoderma* in roots as an endophyte could be useful.

IAPGD. GFP transformation of *Ganoderma* would be even more useful in order to follow its infection route(s).

**Biology, epidemiology, economic impact of orange spotting-coconut cadang-cadang viroid (OS-CCCVd) variant in oil palm.**

BD414/2013

Extraction protocols, detection (including RT-PCR, qRT-PCR and LATE-PCR), prevalence based on the 2013 survey are described.

A pictorial guide on orange spotting will be released in 2016

IAPGD: We are still unclear as to the significance of this disorder and how it relates to palm genotypes and locations (see questions from last year). We are aware of regional and quarantine implications, but the time given to this study should be in proportion to its actual importance with regard to yield loss, if any.

Lab diagnostics set up is likely to require revision to avoid contamination.

**Pathogenicity study on oil palm with Malaysian *Phytophthora palmivora* isolates.**

BD414/2013

In summary: inoculations of oil palms at MPOB and at University of Nottingham suggest that *Pp* is unlikely to be the primary agent behind so called spear/bud rots in Latin America.

ITS sequencing revealed Colombian and Malaysian isolates are not closely related.
IAPGD: This is an important study in terms of biosecurity. MPOB should maintain a watching brief because *Phytophthora* species are notorious for adaptation. Clearly the situation in Latin America requires international investigation. Should MPOB become involved in view of the level of devastation caused there? We make a suggestion that spear rots in this region be investigated for associated pathogens and compared to those reported from Latin America.

**CROP BIOSECURITY AND BIODIVERSITY GROUP (CBBG)**

**Influence of herbicides on BSR**

BD400-2011

This study continues to confuse us. Comments from last year: “Is this study on *Ganoderma* based on confirmed field observations or more on anecdotal evidence? Where is this information presented? What is still omitted is the likely level of exposure *Ganoderma* might encounter in the field. This is fundamental information.” The same questions were posed in 2014 and 2015.

**Development of bioherbicides for controlling noxious weeds in plantations**

BD368-2007

A powder formulation of *Phoma* is described which results in 90% death of *Eleusine indica* after 28 days

IAPGD: Comments from industry suggested that they have weed control as routine and that it should not be part of R&D of MPOB. Also note that the RO involved in this work obtained an overseas PhD in plant pathology and in view of the importance of BSR, his time and expertise should be directed to that major issue.

**Biosecurity plan for Malaysian oil palm industry**

R000941000

Final reports on the Biosecurity plan were submitted by CABI in November 2015. This describes 691 pests, diseases and weeds associated with Palmae in 44 oil palm producing countries. 224 of this list are absent from Malaysia. Spread and threat potentials are provided along with fact sheets. IAPGD: We recommend you prepare by obtaining diagnostic kits where possible for the main threats, not just relying on images/keys. Ensure you are well familiar with the
main threats (morphology, biology, symptoms, as appropriate. See comments about lab set-up to avoid contamination during diagnostics).

TROPICAL PEAT RESEARCH INSTITUTE (TROPI) UNIT
The TROPI team presented progress for all 10 projects across the Crop Physiology, Peat Research, and Biodiversity Groups during a formal presentation of progress in the research programme. This was followed up at an informal roundtable discussion the following day. The panel was pleased to see that good progress had been made in most of the projects, and that many of the recommendations from PAC2015 had been taken on board. In particular, the panel was delighted that the MPOB had appointed an International Advisory Panel for the Peat Soil research programme, and were impressed by the calibre of the individuals on that Panel. The Panel made a formal report of its activities to the sub-committee, along with the project progress reviews. During the Q&A session for that report, it transpired that the Panel did not have terms of reference which was a little surprising since the PAC2015 report recommended terms of reference for the Panel. We were also pleased to see the appointment of an RO to support the critical flux measurements of Dr. Kho’s team and that appropriate training had been provided. However, we were astonished to find that money allocated for the establishment of the flux tower in Sarawak had not yet been released despite prompt requests having been submitted to finance in response to our Recommendation 1 in the PAC2015 report.

Crop Physiology Group
Following on from a previous successful project on water use efficiency, this new project aimed to develop and validate the use of carbon stable isotope discrimination as a tool for use in screening for improved water use. The initial results suggest that the delta-C values correlate well ($r^2 = 0.69$) with the WUE. The panel noted that the positive correlation was at odds with other findings where WUE decreased with increase in delta-C, and that the team would investigate effects of age and season to probe this discrepancy.

The continued work on CO$_2$ enrichment studies sees this project nearing an end stage. A robust correlation between standing biomass and ambient CO$_2$ concentration has been established. The panel noted that for many other metrics, trends were being claimed where there was no statistically significant difference in the data. This reflected a wider pattern of quoted results being at odds with their statistical significance. Recommendation 6 of PAC2015 was to appoint a cross-divisional expert in biometrics
and experimental design, and PAC noted that this appointment had not been made, and that an informal arrangement to ‘work with’ statisticians on a project basis was in place. PAC cannot state strongly enough that robust analysis and interpretation of data is a critical core capability and must not be left to chance. **PAC again recommends that a full-time appointment of a statistician is made to support staff across Divisions.** As reported last year, PAC were of the view that there was a consensus that the method employing enclosed chambers would introduce artefacts that are difficult to correct for. As the project was coming to a close, PAC recommended discontinuing the use of the method and considering the use of Free Air CO₂ Enrichment (FACE) in the future.

The Belaga study of carbon stocks and flows continues to produce fascinating results. The measured net primary productivity of the primary forest in Sarawak is similar to that calculated for the Amazon. The standing carbon stocks in primary forest are significantly higher than in the plantation, as expected. However the values for plantation and degraded secondary forest are similar. Moreover, there is significant variation in carbon stocks between different study plots in the same secondary forest. PAC noted that, in light of likely HCS Approach Steering Group recommendations, it is important to understand the consequences of this variability in setting carbon stock thresholds. **Proper characterization of spatial variation and optimal (adaptive) sampling methodologies are required.** In addition to this, PAC strongly recommends that mapping of peat in areas relevant to Palm Oil production is undertaken with urgency to ensure that the best information on spatial variability of peat is obtained. Not only is this important for assessment of GHG emissions and carbon stocks, but it is also likely to be critical to future better management of peat soil plantations to increase yields.

**Peat Research Group**

The PAC were pleased to see that an International Advisory Panel (IAP) for palm oil in peat soil had been established, chaired by Dr. Param. One of the international members of the Group, Dr. Susan Page, attended the meeting and presented a report of the Panel’s activities, which is summarized in Appendix 1.

Good estimates of carbon loss from peat soil are critically important for assessing the sustainability of palm oil grown on peat, and results were presented using a range of different measurement methodologies. The methodologies compared were eddy covariance, portable soil respiration chambers, and peat subsidence. The highest
values (64Tha-1yr-1) were recorded using the Eddy flux tower, while the other methods produced 45Tha-1yr-1; and between 27 and 37Tha-1yr-1, respectively for the other methods. The reasons for the comparatively high Eddy flux measurement is not clear, though the team proposed this was due to the additional contributions of decomposing woody materials on the soil surface that are cleared before the chamber measurement. The low value for peat may be due to the fact that samples to calculate bulk density and carbon content were taken from 5cm depth, and this may not be representative of peat at different depths. It is obviously critically important to understand the discrepancy in the values between the different measurement methodologies if the data is to be interpreted correctly.

An update on the project to study the effect of water table height on subsidence and carbon emissions was provided. CO₂ efflux was not correlated with water table height. However, the range in water table height was small, ranging from 30cm – 32cm. there was significant difference in yield, with lower water table correlating with higher yield. However, PAC remarked on the very low yields being achieved on the peat soil plantations.

As well as water table height, agronomic practices can have an important effect on carbon fluxes. A study of different cover crops did not show any significant effect on fluxes. Interestingly, though, the eddy covariance data showed that the plantation was both a net source and a net sink of carbon during the year depending on the whether the season was wet or dry. This is important data and the PAC were keen to see it published. In the discussion that followed, the IAP noted that the results were almost ready for publication. The IAP wanted to first assure itself of the appropriateness of the flux tower setup and that the proper cross-checks had been undertaken. The PAC noted that these results have been available for more than a year and strongly recommended that this data be published as soon as quality assurance was complete and that this was given priority.

As carbon is not the only, or even the most important, greenhouse gas, the team are also undertaking measurements of nitrogen and methane fluxes. This work, comparing fluxes from a 7 years old plantation on peat with fluxes from a secondary swamp forest is now in its second year. CO₂ flux showed significant differences across different peat types and the PAC agreed that this was a very significant finding that reinforced the importance of peat classification. Root biomass distribution was a significant predictor of soil respiration. There was a very significant dependence of respiration rate on
distance from palm trees. This dependence was significant close to the tree (< 1m), but the correlation coefficient fell to 0.13 at distances > 1m. Analysis showed that heterotrophic respiration dominated the flux at distances >1m from the palm by a factor of about 2. This stressed the importance of incorporating spatial heterogeneity in flux measurements in forests. Biochar application was reported to have a surprisingly large effect on N2O emissions after only 3 days of application. However the results were not statistically significant due to the lack of sufficient replication. **This reinforces earlier comments on the need for more statistical input to experimental design.** The loss of carbon in the form of DOC was significantly higher in these tropical peatland systems compared with losses in temperate peat soils. Most fluvial carbon is in this form. The losses in plantation and degraded secondary forest seem similar. PAC were impressed by these findings and hoped the results could be confirmed and published as soon as possible. These results, together with those reported above on yield effects, provide further evidence of how different tropical peat systems are from temperate peat systems. It is therefore going to be important to account for the differential effects of different peat types are different.

**Biodiversity Group**

Results from the biodiversity impacts of peat cultivation were presented by the biodiversity group in two projects that are at an advanced stage of completion.

A biodiversity assessment of three different levels of swamp forest disturbance was undertaken: primary peat swamp forest, secondary peat swamp forest, and disturbed primary swamp forest. This was compared to the same measures in a nearby peat soil plantation. There was a biodiversity gradient from primary to secondary, to disturbed swamp forest as one might expect. Species number is more or less halved between primary and disturbed swamp forest.

The impacts of peat cultivation on water quality and aquatic fauna is important and samples are being collected quarterly in the same locations as the other biodiversity studies. A similar gradient in species richness was observed as above with fish species declining from 32 to 18 species. However macroinvertebrates seem to follow the opposite trend. Results on water quality indicate differences between the different peat systems, except for pH.

The PAC congratulated the biodiversity team on the thoroughness of their work. The Committee reinforced previous comments on the need to create a synthesis of these
results and to analyse the data in terms of functional groups that will allow the consequences for ecosystem services to be understood. Furthermore, **PAC recommended a new emphasis on biodiversity that not only examined impacts of production on biodiversity, but also created a new synthesis with the benefits of biodiversity on production (IPM) and most importantly of all, to understand how production systems and adjacent non-agricultural land may be managed to optimize production and boost the quantity and resilience of biodiversity.**

**Summary**

In summary, PAC we extremely pleased to see that last years recommendation to establish an International Advisory Panel (IAP) had been adopted and welcomed the high caliber panel members. This work continues to increase in strategic importance for the MPOB both from the point of view of informing environmental sustainability and in helping increase the productivity of peat soil plantations. In light of this urgency, PAC support the recommendation of the IAP that additional personnel are transferred to the project to ensure that outputs are accelerated. However the Committee was disappointed that an inordinate delay has occurred between the time of requesting funds to be released for the construction of a flux tower, and the release of the funds by the finance department. We expect that MPOB will regard this as unacceptable given the importance of the work. We were also disappointed that a previous high-level recommendation to make available senior statistical input to the Biology Division has not been supported, as much of the work of TROPI would benefit from more sophisticated input in sampling design and data analysis. PAC support the view of the IAP, that the publication of high quality and high impact papers is a priority for the group. The PAC noted the significant progress that the biodiversity group had made and the hard work of the team. We urge that this work will see renewed support and, along with the emissions work, start to position itself towards mitigation strategies in the near future.

**Summary of recommendations**

To recap, the PAC recommends that:

1. The PAC welcomed the formation of the International Advisory Panel (IAP) for palm oil in peat. We were surprised to learn that the international members were not aware of the terms of reference for the Group, and urge the MPOB to ensure that these are drafted and agreed by the Group before any further activity is undertaken.
2. PAC supports the recommendation that more human resource is made available to the measurement of stocks and flows in peat soil systems to accelerate outputs, given the urgency with which quality data is required.

3. The TROPI group should make full use of the IAP to ensure the rapid publication of results from the peat soil GHG and carbon stock measurements, and that nothing impedes this progress.

4. In light of recommendation 3, PAC was astonished to find that money allocated for the establishment of the flux tower in Sarawak had not yet been released despite prompt requests having been submitted to finance in response to our Recommendation 1 in the PAC2015 report. PAC requests that the highest-level mechanisms in the organization are used to ensure that the Finance Dept releases these funds without further delay.

5. PAC recommends that TROPI seeks high level statistical input to help in the design of sampling regimes and in the interpretation of measurements. This is in line with recommendations relating to other programmes where input from experts in statistics is required. It is particularly important here, because of the exceptional spatial and temporal variability across all scales. There must be full characterization of spatial variation and this information used to design optimal (adaptive) sampling methodologies to improve the statistical power of the sampling.

6. PAC strongly recommends that mapping of peat in areas relevant to Palm Oil production in Sarawak is completed with urgency to ensure that the best information on spatial variability of peat is obtained, both for the purpose of improved measurement of GHG stocks and flows, and to inform better management of peat to increase the unacceptably low yields on peat soil.

7. The PAC noted that results on source-sink relationships for carbon fluxes have been available for more than a year and strongly recommended that this data be published as soon as quality assurance was complete and that this was given priority.

8. PAC recommended a new emphasis on biodiversity that not only examined impacts of production on biodiversity, but also created a new synthesis of this
work with work on the benefits of biodiversity on production (IPM) and most importantly of all, to understand how production systems and adjacent non-agricultural land may be managed to optimize production and boost the quantity and resilience of biodiversity in the landscape.

**New PAC idea from Dr Trevor Jackson**

In 2015, after reviewing extensive data on sightings of the Sumatran rhinoceros, scientists concluded “It is safe to consider the species extinct in the wild in Malaysia” (Oryx 50(2) 2015). The demise of this species has been attributed to human impact and habitat loss and, whatever the direct cause, the extinction of such iconic species is a tragedy for Malaysia and the world. Oil palm is perceived to be the cause of such extinctions through conversion of rainforest to plantation and is a target for criticism from many in the palm oil consuming countries. While the Oil Palm industry has taken a positive and conservationist approach through adoption of the MSPO and RSPO criteria for sustainability and positive conservation initiatives have been developed by individual companies, the perception of palm oil is often tainted by the environmental downside of production.

Last week I was fortunate to see some of the positive initiatives for wildlife conservation from the oil palm industry for wildlife conservation in Sabah. The MPOB team at Lahad Datu and Sime Derby were able to arrange visits to the conservation programme of the Sabahmas (Wilmar) plantation and the reafforestation programme supported by Sime Derby at Ulu Segama. These projects are impressive in their vision and are beginning to have an impact. They show that Malaysia can have both successful palm oil production and a positive wildlife conservation impact.

Where is the role for MPOB in wildlife conservation? MPOB can coordinate efforts for wildlife conservation on and around the oil palm estates. It can develop “best practice” for conservation planning, riparian planting, wildlife monitoring, etc. It can promote wildlife conservation among industry workers. It can coordinate presentation and publicity for positive efforts in the conservation arena.

**Recommendations:** MPOB should:

- take a positive leadership role in promotion of wildlife conservation in and around oil palm plantations.
- appoint an appropriate conservation specialist to PAC
- hold a stakeholder meeting to review oil palm impacts and the potential to enhance wildlife conservation
• establish a pilot programme in key areas for endangered wildlife in Sabah
• use positive results from wildlife conservation to improve the image of palm oil
5.3 INTEGRATION RESEARCH AND EXTENSION DIVISION

CROP AND LIVESTOCK INTEGRATION UNIT

This Unit seeks to help oil palm smallholders by finding ways to add to their income through several trials to assess the effect of integration with other crops or with livestock.

One of the projects for crop integration is to plant pepper in double avenue plantings of oil palm in Sarawak and Pahang. The trial is already halfway through the six-year duration. The yield of fresh berries has increased each year with a targeted yield of 6 kg per plant in future years. There was no significant difference in yield of the oil palm crop compared to control plots.

Pepper seems to be a highly suitable choice as an integrated crop for smallholders, and it is likely that the trial results will be ready for a transfer of technology for this year.

Another intercropping trial is for the salak fruit, which starts fruiting three years after planting. It is planted in both double avenue and in single avenue. The trial is halfway through its duration of 8 years, and it indicates that it can provide additional income to the smallholders. The trials however had faced some labour shortage in Trengganu, but went on smoothly in Johor, and Sabah.

Bamboo shoots are in demand as a food and a delicacy, and the trials for growing them have been set up in Pahang, Johor and Sabah. The project has a duration of 5 years with over 3 years to go. Already it is producing the bamboo shoots at 1,700 kg per hectare per year. The leaves also form a mulch which reduces the weed population.

Trials on intercropping with coffee have been started in 2015 by planting robusta and another variety called catimor, with a project duration of five years. They are expected to fruit about 12 to 18 months after planting.

In order to raise yield through organic fertiliser, a trial is conducted using livestock manure for pepper integrated with oil palm. Goat, chicken and cattle manure are used in Pahang, and goat and chicken manure in Sarawak. Samples of soil are sent to the laboratory for tests on changes in chemical and physical properties.
Livestock Integration

The two years of study on the effect of cattle grazing on avian species has been completed. The observations were made in several plantations where cattle grazing was managed in a systematic way, in plantations with free grazing with no system, and in plantations with no grazing at all used as control. The species diversity was highest in the systematic grazing areas, and with higher bird numbers compared to the other two areas. Weed control costs were also lowest in the systematic grazing plantations with RM107.00/ha compared to the cost of RM132.00/ha in the control areas.

A trial that has also been completed is on the intensive cow-calf integration in oil palm, which shows that the smallholders can earn an additional income through rearing the local Kedah Kelantan breed, or the crosses with Brahman, or the yellow cattle imported from China. However, the trials show that the smallholder and his family will be likely to have to spend more time on the land to cut napier grass and feed the cattle which can have better live weight gain when kept under shelter rather than on open grazing.

An integration trial with dairy goats has been going on for three years out of a six year program, using the hardy Anglo-Nubian breed. Although originally some problems were faced with diseases, these are now solved, and the goats are producing milk which has a demand in the local market.

A 7-year trial is being done to assess the suitability of rearing the Katjang goat under oil palm which is planted in the double avenue system. The feed includes a trial with napier grass and soy hull. The program is 60% completed and indicates that the project is financially viable.

The performance of dairy beef cattle is being assessed on integration with oil palm at the MPOB Pahang station. The trial has just been started, which shall be go on for three years. Improved pasture is being grown under oil palm with double avenue planting.
Suggestions

1. Smallholders will have to be persuaded to plant on double avenue system for many of these integration practices, so they can earn more income. Therefore, persuading them to do so will be one of the big tasks to be addressed.

2. The research trials must get the benefit of advice from specialists from outside MPOB such as veterinary services, and managers with long experience on specific crops and livestock.

3. Selected PAC members should be invited to visit the sites and see the trials, and discuss the figures on yield, costs and financial feasibility.

4. MPOB can be invited to approach PAC members for advice, through email or phone in advance of next year’s presentation on proposed projects.

5. Some of the papers could have been edited more carefully to reduce errors such as in spelling and grammar, befitting a major research centre.

EXTENSION AND SERVICES UNIT

This Unit has presented a detailed and comprehensive report of activities related to extension and support services given by TUNAS officer to the smallholders. It is interesting to note that with the ratio of TUNAS officer to smallholders of 1:1,200 it is certainly a challenging task to effectively disseminate information and technology to the smallholders. The extension activities planned in 2015 have been successfully conducted. This has included technical visits, lectures, project monitoring and MPOB GAP certification auditing. Similarly the support services managed to conduct several courses, a study tour, road shows and one-day program for 30 Tonner Club Member.

Individual Smallholder Certification

The activities of Individual Smallholder Certification cover MPOB GAP, MPOB CoP and MSPO which require TUNAS officer to conduct auditing on several smallholder farms. Out of 4,389 farmers only 295 comply to MPOB GAP, while two SPOC’s have been certified with MPOB CoP. Additionally three SPOC’s have been certified with MSPO certification.

Cooperative Activities

Through the initiative of cooperatives, this Unit is also involved in marketing fresh fruit bunch (FFB). To date there are 15 KPSM that are actively involved in selling FFB. The target set in 2015 at 26,000 MT has recorded an achievement of 147%.
Media Support
Dissemination of knowledge and information on oil palm to the smallholders is also carried out through local media. A total of three issues of Warta Sawit have been published and distributed to the target group, including smallholders. In order to ensure the accessibility of information to a wide range of target groups, a hot line and e-Aduan have been implemented.

Research Projects in 2015
The five research projects have been implemented according to the milestones and the outputs have been delivered according to timelines.

General Discussion
1) Prioritization of extension activities to the smallholders
PAC is of the opinion that extension activities and support services need to further enhanced considering the huge number of smallholders which are spread all over the country.

Extension activities and support services are conducted based on the knowledge base and competency of the smallholders. Packaged training programs are designed for different groups of smallholders which are organised for different locations. There should be follow up visits by TUNAS officer to continuously assist the smallholders and to ensure the effectiveness of the extension activities.

2) Accessibility of smallholders to ICT facilities
In view of the advance in information and communication technology, PAC is of the opinion that the smallholders should have quick access to information.

A dedicated web site for the smallholders has been installed to allow smallholders to routinely interact with TUNAS officer. A hot line will allow the smallholders to get a rapid response from TUNAS officer. Evidently there are problems in getting access to information in remote areas. It is therefore important that remote areas, especially in Sabah and Sarawak, should be seriously considered and TUNAS officers may be required to make scheduled visits to these areas.

3) Visits to model farm
PAC is of the opinion that more programmed visits for smallholders should be made to model farm to encourage them to adopt modern technology and GAP.
Visits to the model farms, which include the 30 tonner club members, should be organised by TUNAS officers.

4) Consistency of 30 tonner club member to sustain high productivity.

PAC is concerned about the consistency of the 30 tonner club members to sustain high productivity of their farms. Regular monitoring and evaluation is made by TUNAS officers to ensure high productivity is sustained over consecutive years. Continuous support and advice are given to these dedicated smallholders. Additionally the members are given the opportunity to attend conferences, seminars and visits as incentives for them to further enhance their performance.
PROJECT IMPLEMENTATION UNIT

The Project Implementation Unit Comprises (i) the Oil Palm Replanting Group and (ii) the Oil Palm New Planting Group

(i) Oil Palm Replanting Unit.

Two projects were discussed i.e.

a) Accelerated Oil Palm Replanting Scheme for Smallholders (TSSPK).

A commendable 95.8% of 21,898 applications received had been approved as of December 2015. This corresponds to an approved replanting area of 53,198.90 hectares (85.3% on an area basis).

However, only 70.5% of the approved applications had replanted their fields totalling 37,436 hectares (70.4% of the approved area). The reasons for not pursuing the replants while it has been approved requires further investigation so as to prevent any exploitation of the incentives provided under the replanting programme.

b) Cantas Discount’s Schemes (SKIDIC)

Since 2010, from the start of the programme there had been a total of 3896 applicants, as of which 3770 applicants had been approved (96.8%), with 2763 cantas delivered to the applicants (70.9%). PAC recommends that harvest productivity be monitored and feedback as to breakdowns and problems related to services of machines be recorded with the necessary guidance to overcome their problems so that the adoption of innovative practices are sustained.

(ii) Oil Palm New Planting Groups

(a) Oil Palm New Planting Schemes

Since 2011 to December end 2015, there were a total of 95,572 applicants with an approval rate of 97.7%. However, only 54.5% of
the approved applicant had completed planting amounting to a new planting area of 40,141 hectares of which 57.5% was in Sarawak, 22.2% in Sabah and 20.3% in Peninsular Malaysia.

The causes for the low rate of approved applicants not planting should be identified and addressed. Further, extension services should be provided to monitor and ensure good agricultural practices are adopted in the new plantings.

(b) Farm Roads to Smallholders

In the recent two years (2014 and 2015), 43 of the 54 planned projects had been implemented covering 93km with an expenditure of RM11.5M which is 46% of the approved allocation of RM24.9M. As the project implementor is the Drainage and Irrigation Department, MPOB officers should endeavour to have regular meetings with the implementation group to speed up the implementation of the road projects especially in areas where planting has been completed.

(c) Oil Palm Smallholders Fertilizer Aid Scheme

In the recent two years of 2014 and 2015, 788 out of 1009 applicants have been approved to receive assistance (78%). However, only 99 applicants corresponding to an area of 1162 had claimed their reimbursements. The fertilizer expenditure per hectare is RM2665 which is rather very high.

MPOB should carefully monitor the fertiliser assistance programme and also should recommend judicious rates to ensure optimal yields are achieved. Timely application of fertilizers should also be monitored. As only 12.6% of the applicants have claimed reimbursements, MPOB extension officers should study the cause of this poor rate of claim and conduct perhaps some briefing us to the importance of fertilizer application to yield increases.
(d) Factors affecting FFB production among participants of Quality Oil Palm Seedlings Assistance Scheme (SBABB)

The project has been confined to Sarawak and Sabah. As the study involves a lot of data collection and subsequent analysis, it is best to discuss with the statistical analysis would be reliable for a meaningful interpretation and inferences.
PART 6. NEW PROJECT PROPOSALS

14 new projects were assessed in 2016. Of these 4 were from ABBC, 9 from Biology and 1 from IRED. All projects were approved at either A or B category.

ABBC

1. Mesocarp-specific promoter for genetic engineering of oil palm
This project seeks to isolate and characterise a mesocarp specific promoter from oil palm that could be used to manipulate gene expression in a fruit specific manner in transgenic plants. Tissue specific promoters are a challenge to identify and there may be opportunities to broaden the study to target genes that are particularly highly expressed, rather than solely expressed, in fruit tissues as an alternative strategy.

Generalising the target of the work to identifying promoters with strong mesocarp expression at a range of stages of mesocarp expression may be more appropriate. It would also be appropriate to classify the genes that these promoters come from into the sets of co-expressed genes that they are expressed in across a range of tissues and developmental stages. This may help by providing a sequence resource for comparative promoter analysis which in turn may identify key motifs that underpin mesocarp expression.

The Subcommittee recognised the potential merits of this project but felt that not all elements of the work were of equal value. In particular, whilst the expression study in tomato was of scientific interest the Subcommittee felt that it would be difficult to draw any definitive conclusions from this part of the programme about the specificity of the promoter in monocot oil palm using this model dicot system and as a consequence it should be omitted. This work package should be replaced by further data mining from the replicated RNA-seq experiments that have been undertaken at different stages of fruit maturation and ripening to explore the identification of a suite of promoters exhibiting some mesocarp specificity at different stages of fruit development.

RECOMMENDATION: Grade A
FUNDING APPROVED subject to some restructuring of the work packages relating to the project.

2. Annotation and development of species-specific markers for Ganoderma
This project to annotate the Ganoderma sequences from four species and to develop a species specific set of diagnostic markers is sensible and timely with industry support. However, there are two major hurdles to its successful operation and
conclusion. The first of these concerns the quality and timeliness of the Ganoderma sequence annotation. This will be to some extent compromised or at least complicated if there is not yet a good quality mono-karyon sequence from at least one of the species. There is good reason to consider this a necessary prerequisite before significant resource is focussed on the annotation component for the project. The second major pre-request for the completion of the project is the availability of a significant set of hyphal tip purified clean strains for each of the four target species. If these are not available the second major phase of the project to validate potential species-specific primers sets should be placed on hold until this is available.

It does however appear that when primers sets are available a major target is to fingerprint the Ganoderma strains that are being used for screenhouse assessment of germplasm and also to characterise the strain complexity in the pathogen hot spots that are being used for Ganoderma performance assessment.

RECOMMENDATION: Grade B
FUNDING APPROVED subject to independent evidence of the quality control of the purity of Ganoderma cultures and a start date that co-ordinates with other projects ongoing within Ganodrop.

3. Investing the regulation of high-value fatty acid production in oil palm using shotgun proteomics
The PAC members considered this a worthwhile project and, in general, approved the overall thrust of the work. Clearly, an understanding of the basic biochemistry behind fatty acid biosynthesis is fundamental to MPOB’s work. Successful results from this project would provide useful background information that would aid in the future production of different quality palm oils.

The choice of germplasm should be carefully re-assessed. It is certainly of interest to compare a set of high and low oleic acid germplasm. However, rather than choosing a relatively arbitrary set of palms it would be worthwhile, assessing whether there is a set of progenies derived from a low x high cross. If this is the case if the progeny have been typed for oleic acid levels then it would be possible at the very least to randomise the effect of background genotype. It might also be possible to use the data to create two phenotype pools to underpin a bulk segregant analysis (BSA). This approach has the potential with appropriate genotype data to extend the study to map potential transcription factors or other factors regulating the process.

Though this has primarily been conceived as a proteomics study it is important that tissue sample are preserved to allow for RNA-seq analysis using all the strict sampling required to avoid effects such as confounding the effects of germplasm with
diurnal patterns of gene and protein expression. In addition it is important to consider this an open proteomics study without preconceptions of likely target proteins.

As a consequence of these comments from PAC members it is suggested that some modification to the work packages take place:

- The proteomics should include as many proteins relevant to fatty acid formation as possible.
- Samples should be retained to allow parallel metabolomics (and, if necessary, genomics) analysis.
- Samples to be used should be considered carefully. For example, segregating progeny that have been well characterised in terms of oleate production, would allow the generation of more robust data (not just use of high or low oleate species)
- Although the project is focussed around oleate, other useful fatty acid products could be considered for the future. Thus, palmitoleate which is an useful renewable chemical for industry should be relatively easy to produce given that palm oil is already enriched in palmitate.

RECOMMENDATION: Grade A

FUNDING APPROVED subject to some restructuring of the work packages relating to the project as indicated above.

4. Annotation and development of species specific markers for Ganoderma

2 years. Cost 55500 RM

This proposal is linked closely to another from Dr Sundram in GanoDROP. It aims to annotate genes in the four key Ganoderma species (three pathogenic, one non-pathogenic), to develop markers from the four genomes, then validate these markers across samples to be collected from Malaysian estates. The outcome should enable molecular identification across Malaysia of oil palm-related Ganoderma isolates and confirm identity of isolates in the new culture collection. Also, although not given emphasis here, to track infections following artificial inoculations. Microsatellites and SNPs on targeted genes would be identified.

We are supportive partly because in line with the IAPGD review, this work focuses on the key issue of Ganoderma and is collaborative with GanoDROP.

Other comments:

There will be a likely delay in availability of newly collected isolates, which must be identified and microbiologically homogeneous, free from contamination. Therefore hyphal tip procedure must be first conducted. Thought must be given to the start time
of this project that runs for just 2 years, whereas the collection and characterisation is planned to run to 4 years.
The time frame needs amending because Phase 1 has already been done but appears in 2018.
The much needed monokaryotic genome is ongoing and availability of this within the time will be important.

Grade A

BIOLOGY RESEARCH DIVISION

1. Loose Fruit Collector (B)

The need for efficient and robust loose fruit collecting machine by the industry has long been proposed but yet to be realised. The portable prototype model proposed by the team need to be reviewed to ensure its durability and effectiveness in separating the LF from the debris mainly decayed organic matter, sands and laterite. It is recommended that the team to evaluate the performance of similar machines previously tested and to carry out the necessary improvements especially wrt the working mechanisms and the high cost of the proposed LF collector to before project implementation. This is to save on costs and time.
PAC Members Remarks: To carry on with the project on LF collector but with the necessary change in the project executions as per above.
Grade B.

2. Mechanical Harvester powered by Electro Magnet

The efforts to search for more efficient and cost effective harvesting method is very critical in view of the escalating cost of production and the acute labour shortage encountered by the oil palm plantation owners. The situation is further aggravated with the uncertainties by the policy change imposed by our government on foreign workers recruitments. The new type of FFB harvester proposed is expected to be more costs effective, cheaper and the machine is expected to address problem on the tall palm harvesting.
The new harvesting machine will be a hybrid powered with electro magnet compared previously using fuel and hydraulic transmissions and will use lighter and stronger composite material.
In view of the difficult working environments in the plantation with undulating steep terrain and soft soggy ground conditions, it is crucial that the team develop and adopt
proven technology. Preferably those that are already in the market but not necessarily those that were used in the plantation industry. For example automation and robotics systems that are used in the automobile assembly plant etc. In view of the urgent need by the industry for efficient, cost effective and robust harvesting machine, it is strongly recommended that team to establish collaborations with other experienced bodies through smart partnership, namely the manufacturers and fabricators both locally and overseas and fabricators for the transfer technologies. This may be done through appropriate MOU between MPOB with the respective players including the manufacturers/fabricators, plantation owners and higher learning research institutes. Such an arrangements will facilitate technology transfer and fast track the proposed projects urgently needed in the plantation industry through the usual "Win Win" tripartite business arrangements.

**Remarks by PAC Members:** Project to carry on with the necessary improvements as mentioned above

**Grade B**

3. Development of molecular diagnostic tools for detection of BSR in oil palm

Madihah Ahmad Zairun et al

Project duration 3 years. Cost 326,000RM

This proposal describes the use of defence-related genes expression to detect BSR infection, using qRT-PCR and RT-LAMP.

The IAPGD review has already expressed significant concerns about this approach. The genes are expressed generally to many pathogens and sometimes to abiotic stresses. The chances of any gene expressed specifically to *Ganoderma* are slim, and cost and applicability under field conditions are questioned. Also this approach is being used by ABBC, so we must ask what is new?

We do realise the potential of LAMP detection in the field but only after discriminatory genes have been identified. The presentation provided extra information to the written version in terms of soil detection for *Ganoderma*, and the testing of stressed plants.

Looking ahead, development of LAMP targeting the pathogen itself might be worth exploring for use with natural infections and with artificial inoculations to track route of infection and rate of colonization. Also the late inclusion of soil detection could be valuable.

**Grading C**
4. Suppression of fusarium wilt of oil palm by non-pathogenic *Fusarium oxysporum* species and other microorganisms recovered from a disease suppressive soil.

Mohd Hefni Rusli et al

Duration 3 years. Cost 250,000 RM

Fusarium wilt remains a threat to Malaysia, yet has never appeared here in spite of myriad seed being planted before quarantine was enforced in the 1970s. This proposal asks the interesting question as to whether the absence reflects fusarium-suppressive soils (which are known elsewhere). The study cannot be conducted in Malaysia, so Cameroon is suggested as the host location and laboratory.

This is a potentially highly complex study involving analysis of soil, rhizosphere and root (endophytic) microflora. Some methods for microbial profiling were questioned along with practicality of soil transportation and facilities of the Cameroon lab(s).

Overall this remains a potentially interesting study, but especially in light of the IAPGD recommended focus on *Ganoderma*, it is not supported at this stage

Grade C

5. Development of integrated airborne hyperspectral and 3D tomography for detection of *Ganoderma* disease in oil palm

Mohd Izzuddin bin Anuar

4 years. Cost 1.1 million RM

Benefits to industry and epidemiologists of widespread disease detection are clear. This detailed and well researched and presented proposal offers some hope for successful detection of BSR. It is robust in terms of linking aerial survey with disease assessment at ground level as symptoms and extent using 3D tomography.

The approach is in line with recommendations made in the IAPGD Review with regard to detection and modelling the disease.

Grade A

6. Dual efficacy of hymenomycetes in degrading oil palm generated wastes and controlling BSR caused by *Ganoderma*

R. Yuvarani Naidu et al

3 years. Cost 250,000 RM

Removal of diseased stumps of oil palm is often a major issue, especially on difficult terrain or for large companies. Rapid degradation of the chipped wood should reduce the problem and possibly eliminate residual *Ganoderma* inoculum. This proposal describes use of several hymenomycetes. The proposal includes a significant
academic component (e.g. lignase production, secondary metabolites) that would be linked to the proposer’s PhD training experiences.

The disturbing aspect is that a closely related funded project was performed within the last few years by the Biology Division Applied Microbiology group. Yet no mention is made of this. That study has not been put into practice, so is the approach flawed or did it need further development?

We cannot be supportive of projects that fail to build on previous ones or show no apparent awareness of their existence.

The approach might be a valid one, but it needs to be joined up and convincing to obtain support. Perhaps a future proposal might be more discerning. IAPDG recommendations include the need to understand where and for how long *Ganoderma* inoculum survives in the field.

**Grade C**

7. **Investigation of UVC radiation on induced disease resistance in oil palm against major oil palm diseases**
Shariffah Muzaimah Syed Arpin et al
4 years. Cost 760,000 RM
This proposal offers an interesting concept that is being trialed in other species. The work would be primarily performed at University of Nottingham with associated costs.

Overall we consider this to be an academic study that is best confirmed first with other more tractable plant-disease models. Certainly *Ganoderma* does not offer a model system.

Suggestions of influencing soil microflora appear to be a digression from the main theme of induced resistance. Note that inclusion of *Phytophthora* is probably no longer valid because of failure to obtain disease symptoms.

**Grade C**
8. Updating the systematics of diversity of *Ganoderma* based on morphotaxonomy, ultrastructural, biochemical and molecular techniques

Shamala Sundram et al

4 years. Cost 450,000 RM

There is a long overdue requirement for GanoDROP to obtain and maintain a reference culture collection of the key *Ganoderma* species. This need was highlighted in the IAPGD Review.

The utility of such a collection will be to test then provide isolates with degrees of aggressiveness for [1] screening for disease resistance/tolerance [2] understanding pathogenicity. Also in conjunction with proposed work on molecular characterization by Dr Low in ABBC, confirmation of the identity, location and frequency of the 4 (or more?) species will be possible. This collaboration between divisions is also underlined by IAPGD as crucial for progress with *Ganoderma*.

Arguably the collection should focus on the key species, which most agree is *G. boninense*.

It will be crucial to ensure that isolates to be subjected to ‘omics are microbiologically pure. The equivalent of a single spore culture (not possible with *Ganoderma*) is hyphal tip isolation.

Culture and storage conditions must quickly be optimised for long term survival and at least two staff trained in re-isolation and periodic transfers.

Evaluation of aggressiveness of isolates will be a long job and here, focus on optimisation of the screening technique (see IAPGD report) will be crucial. Your proposal cites the germinating seed technique, yet that did not yield significant results in contrast to 4 and 12 month seedlings; please amend.

The ABBC molecular analysis of the four species will require cultures in the near future. Note that the last half of the proposal cites references that are not listed in the bibliography. Please amend this as reviewers cannot access those references to check methods etc.

The section on spores seems completely out of place here and should be removed. The role of spores (see IAPGD report) warrants a separate proposal and this study should be made in the very near future.

Grade A
9. Potential Impact of Climate Change and Related Factors on Oil Palm Growth and Productivity.

This project aims to use a model-based approach to create yield gap maps to help identify areas where palm yield is significantly below the potential water-limited yield, and therefore to prioritise extension effort to improve profitability, particularly relevant to smallholder plantations. The approach will also be used to predict likely impact of climate change on future production levels.

This project is well designed and the Committee are pleased to see that this project builds on a previous recommendation by PAC to develop the modelling capacity and capability in MPOB. We are particularly pleased to see that more than one modelling approach will be used from the outset for evaluation purposes. There are many advantages to using an ensemble of models to help improve prediction and estimation of uncertainty. The co-researchers have some experience in the use of models, however the Committee felt that maximum benefit to the project and to the MPOB would come from using this project to begin to build an international network of collaborators in modelling. We therefore recommend that links are made to the crop modelling group at Rothamsted Research in the UK where similar work has been undertaken targeting arable crops, and through them to experts the Universities of Reading and Bristol where additional expertise in the models proposed for this study reside. PAC member Crawford will facilitate these links and will offer support to the team as required for this work.

Grade A

For Grade C projects in the Ganoderma area, we suggest that relevant officers propose new projects that are aligned with the recommendations of the International Review Panel within the next 6 months

IRED NEW RESEARCH PROPOSALS

1. The application of targeted grazing using small ruminant for weed control and biodiversity enrichment in oil palm agriculture

The application was made to start a trial using small ruminants for weed control, while allowing for biodiversity enrichment. Goats and sheep will be used in trial areas separately. In one area the two will be combined, as the goats are browsers, while the
sheep are essentially grazers. Only areas of palms over 5 years old will be used, in order to avoid frond damage. This method of weeding could reduce the use of herbicides, and probably preserve the insect population on the ground and in the streams, which would also be monitored. Similarly the population of rats would also be monitored to see if there is a reduction. The project is planned for 3 years and costs RM265,000.00.

It is recommended that the project is approved, after modification. The monitoring of rat population is not necessary to be included, as the system may not have a direct bearing on the population.

Grade B
MALAYSIAN PALM OIL BOARD

PAC
PROGRAMME ADVISORY COMMITTEE
36TH MEETING : 11TH – 15TH APRIL 2016

COMBINED REPORT
FOOD NUTRITION AND QUALITY
SUB-COMMITTEE

Plenary Session
Date. 15th April 2016
Time. 2.45 pm
Venue. Grand Ballroom, Marriott Putrajaya
MALAYSIAN PALM OIL BOARD (MPOB)

PROGRAMME ADVISORY COMMITTEE MEETING
36TH MEETING: 11TH - 15TH APRIL 2016

FOOD NUTRITION AND QUALITY SUB – COMMITTEE

Venue: Conference 2, Level 2, AOTD Building
MPOB Head Office, Bandar Baru Bangi, Selangor

PRESENT:
1. Tan Sri Emeritus Prof. Datuk Dr. Augustine Ong Soon Hock, Chairman
2. Datuk Er Kok Leong
3. Associate Prof. Dr. Pramod Khosla
4. Dr. V. Raghavan
5. Dr. Kaushik Banerjee
6. Prof. Dr. Eckhard Floter
7. Prof Dr. Aishah A. Latiff
8. Prof. Dr. Md. Pauzi Abdullah
9. Prof. Dr. Tom Sanders

ABSENT WITH APOLOGY:
1. Dr. Trevor Tomkins
2. Prof. Datuk Dr. Looi Lai Meng
3. Prof. Yang Yue Xin

IN ATTENDANCE:
1. Datuk Dr Choo Yuen May, Director General MPOB
2. Dr. Ahmad Kushairi b. Din, Deputy Director General (R&D)
3. Cik Rosidah Radzian -Director Product Development & Advisory Services
4. Dr. Halimah Muhamad – HOU Analytical and Quality Development
5. Dr. Miskandar Mat Sahri - HOU Protein & Food Technology
6. Dr. Kanga Rani a/p Selvaduray - HOU Nutrition
7. Dr. Yeoh Chee Beng
8. Raznim Arni Abd Razak
9. Dr. Zaliha Omar
10. Dr. Nuzul Amri Ibrahim
11. Wan Nooraide Wan Mohamed
12. ‘Abidah Md Noh
13. Nur Atikah Ibrahim
14. Dr. Sitti Rahma Abd. Hafid
15. Abdul Niefaizal Abdul Hammid
16. Dr. Azmil Haizam Ahmad Tarmizi
17. Che Anishas Che Idris
18. Dr. Zaida Zainal
19. Dr. Elina Hishamuddin
20. Farah Khuwailah Ahmad Bustaman
21. Dr. Maznah Zainol
22. Dr. Fu Ju Yen
23. Gowri Nagapan

Page 1 : PAC 2016 – Food Nutrition and Quality Sub-Committee
24. Muhammad Roddy Ramli
25. Najwa Sulaiman
26. Noor Lida Habi Mat Dian
27. Norizah Halim
28. Nur Haqim Ismail
29. Puvaneswari Meganathan
30. Radhika Loganathan
31. Rafidah Abd.Hamid
32. Salmi Yati Shamsudin
33. Saw Mei Huey
34. Siti Hazirah Mohamad Fauzi
35. Dr. Sivaruby Kanagaratnam
36. Dr. Voon Phooi Tee
37. Dr. Yap Sia Yen
38. Dr. Darren Gouk
39. Dr. Judith Teh
40. Wan Rosnani Awg. Isa
41. Zaizuhana Shahrim

ABSENT WITH APOLOGY:
1. Dr. Teng Kim Tiu
2. Zaizuhana Shahrim
3. Muhammad Roddy Ramli
The Sub-Committee (SC) have been briefed on the highlights of the achievements of MPOB, the Division of Product Development and Advisory Services and its Units. The SC have evaluated 13 New Research Proposals and awarded 6(A), 6 (B), and 1 (C) as reported in Appendix I. The members have had useful discussion with research officers during the poster session for 46 on-going projects. Their comments are recorded in Appendix II. The SC complimented the Division on the general progress of research and follow-up of its recommendations. As an example, the task force recommended by the SC to re-vitalize the Energy and Protein Centre has been successful in re-activating and completing several projects. Another example is in the acquisition of GCMS/MS Triple Quadrupole. The tender for the instrument has been opened on 4 April and will be closed on 21 April 2016. Improvements on the presentation of on-going projects and the method of evaluating new research proposals are also recorded.

**Brainstorming**

The SC had brainstormed for a new idea to be recommended. It had the benefit of interacting with the SC on Technical Promotion and Market Development under the Chairmanship of YBhg Dato’ Carl Bek Nielsen. It proposes a protocol for production of Malaysian Palm Oil with low 3-MCPD/GE at <1ppm level, as given in Appendix III. This presents a formidable challenge for Malaysia. A success in this direction will contribute positively to the risk management of the Malaysian Palm Oil industry and possibly put the image of Malaysian Palm Oil at an advantage to other competing Palm Oil from other sources.

**General Comments**

i. **GCMS/MS Triple Quadrupole**
   
The SC enquired on why the process of acquiring GCMS/MS took almost one year (from last PAC meeting in 2015).

   The SC was informed that the tendering process is on-going. The acquiring process took longer time due to sourcing of fund. The tender has been opened on 4 April and will be closed on 21 April 2016.

ii. **3-MCPD esters**

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The SC commented that the muriate of potash (MOP), a common fertilizer used in estate, is the source for chloride. Some estates have started to apply chloride-free fertilizer e.g. potassium sulphate.

iii. Analysis of MCPD and glycidol esters

There are a number of new and ongoing projects that require the analysis of MCPD and glycidol esters. It appears that the samples that will be generated for this analysis will increase continuously in the near future. As the issue with MCPD esters is regarded as a priority area, MPOB should consider upgrading the resources to serve this need. The following may be considered:
- Additional manpower that can be trained to provide the analytical service to researchers on a routine manner.
- Back-up equipment that can ensure continuity of analysis and no downtime.

iv. Communication

It is proposed to disseminate information to the industry on the good practices to reduce 3-MCPDE and GE levels during processing.

v. Centralized Lab

The SC would like to commend on the organization of the PDAS Virtual Centralized Lab; this will serve to provide efficient response to requests for various analysis. With the LIMS in place, the SC looks forward to receive a progress report on the management of laboratory workflows.

vi. Feedback on poster session

- Generally good set up allowing for detailed discussions
- The feedback should be in a different format instead of ‘post its’
- Some posters are not of sufficient quality, the information on the poster is sometimes incomplete.

Acknowledgement
The Chairman and the SC members would like to thank the Director-General, Senior Management Staff, Research Officers and Administrative Staff for their co-operation and support during the tenure of the SC (2014 – 2016).
NEW PROJECTS

1. PD211/16 - Mitigation measures for 3-MCPD ester: Identification of sources of chloride at plantations and palm oil mills.

In light of possible external pressure it is recommended that the project focusses on MCPD and is fast tracked. Attempts to execute the project within 6 months with focus on chlorine and its organic sources are encouraged.

The SC commented that overripe palm fruitlets contribute to high level of organochlorine content, which is more reactive for the formation of 3-MCPDE.

The SC suggested to look into chlorine-free fertilizers such as potassium sulfate for comparison.

The SC informed that EU is going to implement the limit for 3-MCPDE and GE, contents most probably by mid 2016. Nevertheless, the methods for quantification of 3-MCPDE and GE need to be harmonized before implementing the limit.

(Priority A)

2. PD207 / 16 - Study on the development of 3-MCPD Esters and Glycidol Esters During Frying

The SC emphasized that degradation of 3-MCPD is due to the polarity of oil upon frying.

The SC suggested to also identify oxidation or degradation products in the oil during frying by using non-targeted method such as by LCMS/MS or
LCQTOF. This is to broaden the scope of the research. To this end the chemistry of frying should be looked into in detail.

In order to have a better reference that monitors the generation of MCPDE and GE in the oil it is suggested to additionally use a wet neutral carrier material as standardized frying material. This is so because hydrolysis is necessary to create the partial glycerides. Possible neutral frying material are for example cotton balls containing predetermined levels of moisture (recommended to check the literature for other options).

The SC proposed to utilize 2 different palm oleins, one with lower 3 MCPDE and GE content and one with relatively high levels as frying media. It is recommended to also use high oleic sunflower oil as a reference oil because there is a study claiming its superiority in frying with respect to MCPDE formation.

The SC suggested to identify whether the decrease in the 3-MCPDE and GE level in frying oil is due to the migration onto the product surface or chemical reactions.

Another recommendation is to explicitly add chlorine (salt) to the fried food as additional experimental parameter to stimulate MCPD/GE formation. This could as well be done with the model frying materials by wetting the material (cotton) with salt water.

The SC is further concerned with the possible adsorption of the contaminants to the food matrix. This sheds doubt on the reliability of assessing the MCPD levels by soxhlet extraction. The determined contaminant levels might not reflect the level in the food. This needs to be checked/validated.

(Priority A)

3. PD212/16 - Influence of polyglycerol fatty acid ester on the thermal properties of palm olein under extended frying conditions.
The SC suggested to study different grades of palm olein produced by different companies, *i.e.*, melting point, cloud point, iodine value. The need to use PGE to suppress crystal formation and hence cloudiness in cold stored oil might correlate with the level of DAG’s.

The SC suggested to study the cause of reduced color formation for palm olein with PGE added when subjected to frying. It is unclear if this is due to the presence of diglycerides or other partial glycerides, chemical reaction or just physical phenomena (emulsification/concentration).

The SC agrees with the necessity to understand what the consequences of PGE addition to palm olein are during frying applications.  

(Priority A)

4. PD208 / 16 - Development of multiresidue analytical method for the determination of triazole fungicides in palm oil matrices

The SC suggested the researchers focus on using LC-MS/MS alone for the project, this is because the use of GC-μECD requires a further confirmation step in compound determination.

The SC suggested the use of QuEChERS matrix enhancement removal method specific for oil to reduce effect of matrix enhancement in palm oil matrix

The SC suggested to refer to the Q-oil developed by EU reference lab methods. Although this is not specific for palm oil, it may just need a slight modification, which has been suggested.

The analysis using LC/MS/MS requires 1-2 internal standards (depending on where it elutes in the chromatogram); deuterated or a carbon-13 standards of any of the 7 triazole fungicides may need to be acquired for this purpose.

The method using LC/MS/MS should be elaborated with regards to acquisition mode (MRM of fullscan MS/MS), which column will be used as well as the mobile phase that will be used. The type of instrument used will influence the extraction protocol that needs to be developed.
Seeing that the project is on the fungicide residues in palm oil, it is sufficient to analyse these in palm oil matrices; it is not necessary to analyse other oils (olive, sunflower, corn, etc) as the matrices are similar. Method development and analysis in palm oil is the focus of this proposal and comparison with other oils is not necessary.

(Priority A)

5. PD214/16 - Nutritive values of treated oil palm frond and empty fruit bunch as the potential feedstuff for ruminant.

The SC suggested to check the cost of mixtures and treatments on the samples to be used in this study because the expected expenditure reported is quite low. Cost of analysis should be included in the proposed budget.

The SC also suggested to run the project by reviewing the percentage of the combined mixture of the treatment groups instead of running all the treatments simultaneously.

(Priority A)

6. PD215/16 - The efficacy of crude palm oil in broiler feed ration and comparison with other palm fats available in the market.

The SC suggested to add other oils such as soybean oil and rice bran oil for comparison with other palm fats used in this study as they are of importance to importing countries.

The SC informed that there is a study conducted by Dr Neo from Soon Soon Oil Mills on the usage of interesterified palm olein which provides a higher metabolizable energy than palm olein and found that the interesterified palm olein is suitable for animal feed.

(Priority A)

7. PD213/16 - Crystallisation behaviour of palm olein with the addition of a legume seed oil.

The SC suggests after having assessed the properties of winged bean seed oil (WBSO) - triacylglycerol (TAG) and diacylglycerols (DAG) - to reformulate the project outline. It is recommended not to study WBSO for the purpose of
improving the olein fractionation. Properties of WBSO give little support for a hypothesis that this is actually beneficial.

Alternatively the SC recommends to study in detail the different options for improvement of the fractionation for the production of superolein. Different means to improve fractionation have been studied primarily for palm oil fractionation. Basic options are:

a) dissolution of higher melting material. It is not clear what the best composition of this material is; FA composition of tri-, or di-saturated TAG's.

b) Seeding performed in powder form.

c) use of emulsifiers influencing the crystallization process.

It is recommended to evaluate the existing literature thoroughly and design an experimental program accordingly. Consequently the project title has to be adjusted.

(Priority B)

8. PD216/16 - Effect of Empty Fruit Bunch (EFB) oil on the bleachability and fractionation of palm oil.

The PAC SC suggested to include 3-MCPDE and GE analyses. Nevertheless, the SC was informed that the effect of EFB oil / liquor on the formation of 3-MCPDE and GE is already covered in another new project i.e., mitigation measures for 3-MCPD ester: Identification of sources of chloride at plantations and palm oil mills.

It was noted that the quality parameters of the EFB oil indicate that it is not advisable to mix it with good quality CPO. Therefore, the SC recommended to use this oil for biodiesel / oleochemical applications.

The SC emphasized that the presence of CI not only triggers the formation of 3-MCPDE, but also initiates the development of other contaminants such as furans and dioxins.

The committee emphasized that adding poor quality oil into the processing stream (cycle) will result in inferior end products.
Furthermore, incorporation of EFB liquor would also increase the amount of 3-MCPDE in the refined oil. It is recommended to search for other options to increase OER without affecting oil quality.

The SC was informed that this research would provide guidance to the industry that adding EFB liquor into the system is not recommended. Thus the objective is certainly not the formulation of safe blending rules but rather the documentation of the risks and consequences of adding an oil of really low quality to good quality CPO.

(Priority B)

9. PD217 /16 - Chewable tablets fortified with palm vitamin E.

The SC commented that single supplementation is not preferable and suggested a multi-supplement chewable tablets instead. The SC was informed that the chewable tablets could also be fortified with vitamin C and vitamin A(carotene).

The SC also suggested that:-
   i. the term “palm tocotrienols or TRF” be used instead of palm vitamin E.
   ii. other analyses i.e., dermatology, radioprotection and neuroprotection should be looked into.
   iii. the bioavailability protocol should be fine-tuned.

(Priority B)

10. PD218 /16 - Nutrition bars fortified with palm vitamin E.

The SC requested that more information on other nutrients e.g., protein, fibre, vitamins and calories be provided. It also suggested that free sugar content be declared and the term “palm TRF or tocotrienols” be used instead of “palm vitamin E”.

The SC questions the bioavailability in this food format.

(Priority B)
11. PD219/16 The Effect Of Biscuits Containing Red Palm Oil On School Children With Vitamin A Deficiency In East And West Malaysia.

The SC informed that the vitamin A deficiency is more prevalent in children less than 5 years old.
The SC commented that if the study is not a randomised controlled trial with a control group to compare to; it will be more difficult to publish.

The SC commented that the children will be susceptible to gastro-intestinal infection which will affect the absorption of vitamin A.

The SC suggested conducting sample size calculation based on prevalence of low serum retinol concentration among the Orang Asli children or from the recently completed China study.

The SC suggests to study a smaller group, possibly within the population on plantations. Further details
- Need for a randomized control trial.
- Clustered trails at different locations.
- Dosage biscuits administering possibly 3 times a week at high dosage
- Attendance in school to be normalized (asked)
- Overall design needs to be simplified to reduce work and costs.
- The primary and secondary outcome need to be defined

(Priority B)

12. PD220/16 - Effect of Palm Carotene Mix on Molecular Targets Implicated in Human Disease: A High Throughput Screening Approach.

The SC enquired on the delivery of carotene mix to the cells and was informed that carotene mix will be dissolved in tetrahydrofuran for cell culture.
The SC queried on the composition of carotene mix and has been informed that the carotene mix is mainly composed of 56% β-carotene, 32% α-carotene and others.

The SC enquired on the aim of this study and was informed that this study will serve as a basis to guide future animal and clinical trials of carotenes. The SC commented that the lack of breakdown product, metabolites and binding proteins in cell studies will affect the translation to clinical trial.

(Priority B)

13. PD221/16 - Assessment of 3-MCPD fatty esters (3MCPDE), Glycidyl Esters (GE), 3-MCPD and Glycidol after feeding with prolonged frying palm olein in animal model

The PAC SC suggested using other oils for comparison, e.g: corn oil.

The PAC SC commented that lower level of 3-MCPDE and GE across frying time could be due to their migration to the fried product.

The SC was informed that this study will monitor the bioavailability of the two esters.

In order to conduct proper toxicology study, the PAC SC emphasized that the expected cost would be 10 times higher than the proposed expenditure.

The SC enquired on how to differentiate the effects of other compounds that are toxic other than 3-MCPD in this study.

(Priority C)
ONGOING PROJECTS

1. QUALITY DEVELOPMENT & ANALYTICAL UNIT

Programme: Life Cycle Assessment

1.1.1 PD175/14- Method Development for Determination of Metsulfuron Methyl in Palm Fruit Oil and Palm-Based fatty Acids

The SC members are generally satisfied with the progress of the project and agree to close the project.

1.1.2 PD176/14-Development of a Method for the Analysis of Dimehypo Residue in Palm Oil

The SC suggested to study the conversion rate of dimehypo to its metabolite, nereistoxin during sample preparation and injection.

1.1.3 PD177/14 – Method Development for the Determination of 2,4-Dichlorophenoxy Acetic acid in Palm fruit Oil and Palm Based fatty Acids

The SC recommended to verify the method developed using esterified 2,4-D standard and modify the method if necessary.

It is also important to study the possibility of finding of 2,4-D in its esterified form, and the method of analysis may be developed accordingly.

The researchers are requesting a time extension of this project due to new recommendations by PAC members.
1.1.4 PD178/14 – A Survey on Quality of Crude Palm Oil in Malaysia

The SC commented that adding of QC data to the table is useful when presenting results of MCPD levels for quality purpose.

This will illustrate method efficiency and extraction recovery. It is possible to use LOD as QC level.

1.1.5. PD193/15 - Development of phytonutrient-rich bread incorporated with oil palm leaves

The PAC-SC commented that this work has illustrated a number of components within the OPL. The LC peaks appeared to be concentrated within 0.5 minutes. In that regard it is recommended to change mobile phase composition and gradient conditions to spread the peaks across 3-5 minutes instead of 0.5 minutes.

1.1.6 PD194/15 - Development of Multi-residue Method for the Determination of Pesticides and Chemical Contaminants in Palm-Based Fatty Acids

The SC commented that the peaks appeared to have some tailing even with pure standards. Care of columns should be practiced to preserve the C18 column. The mobile phase composition and gradient should be optimized to improve peak shapes.

The extraction method with QuEChERS needs to be revised as there is a lot of ion suppression in the analysis. Researchers need to include the actual method so that optimization can be suggested.

It may be useful to look at other QuEChERS products with enhanced matrix removal (EMR).

Programme: Food Safety

1.1.7 PD130/09 – Assessment of Mycofloral and Mycotoxins In Palm Kernel Cake/Meal Produced In Malaysia

No comments
1.1.8 PD149/10 - Determination of Na, Mg, Al, S, K, Ca, Ni, Zn, Sb and Hg in Palm Oil by ICPMS

The SC commented that the calibration curve used for all 10 elements may not be appropriate as a few like Hg would be expected to be at very low levels. So a calibration solution from 0.5-10ppb may be more appropriate. Researcher should refer to past analysis of palm oil.

1.1.9 PD168/13 - A reliable and Sensitive Method for Determination of Paraquat in Oil Matrix and Investigation of Its Residue in Palm Oil Products

It is proposed that the points for the calibration curve be revised, have a blank sample as zero concentration and have one point below the cut-off unit, for example 0, 0.05, 0.1, 0.2, 0.4, 1.0 and 2.0ppb.

The condition for LC needs to be changed so that the peak does not elute at the solvent front. Perhaps changes in the mobile phase condition or use of a gradient instead of isocratic separation will improve the analysis.

The analysis is ready for validation; one matrix is sufficient for full validation with 3 QC levels at LOQ, mid point and upper limit. For other matrices, a verification (one-day) is sufficient with 2 QC levels.

1.1.10 PD180/14 – Study of 3-MCPD esters and Glycidol Esters in Vegetable Oils

The SC suggested that a table with RSDs, etc. would be beneficial.

The SC commented about the good accuracy and agreement of the results with Eurofins and SGS. It may be nice to know which method is adopted by these two labs.

It was also suggested that this method to be used for monitoring of refined oils from industry to evaluate compliance with the 1ppm limit.
Programme: Crystallization

1.1.11 PD169/13 - Development of a Composite Post-Hardening Index of Palm-Based Blends for Palm-Based Low Saturated Fat Margarine

The SC commented that there are 2 factors / causes of the margarine/product failure:
1. Formulation and processing
2. Storage and handling

These 2 factors could contribute to the different crystallization phenomena. Therefore, this project could be used to identify or predict the product failure. Consequently hardness changes in a homogeneous structure and the formation of grains (inhomogeneities) have to be described separately and respective rules for their occurrence formulated.

1.1.12 PD179/14 – Characterization and Evaluation of Palm-Based Organogel

The SC suggested trying of different parameters on preparation of organogels. He also suggested the researcher to concentrate more on polyglycerol behenic acid esters (PBA) for this project since little is known on this system. Waxes and monoglycerides in contrast are already reasonably studied.

The effect of palm olein compared to other seed oils on the gels should be studied with focus on the question of the type of interaction. Is there a) just an additional independent effect from POP crystals and other crystals, or b) formation of mixed crystals, c) effects on nucleation and growth, d) simple effects of viscosity.

1.1.13 PD195/15 – Development of Palm-Based Edible Coating for Prolonging the Quality and Post-Harvest Life of Guava (Psidium guajava L.) and Star Fruit (Averrhoa carambola L.)

No comments and proceed with preferred formulations.
2. PROTEIN & FOOD TECHNOLOGY UNIT

2.1.1 PD184/14 – Characterization of Commercial Available Palm Oil Based Solid Fraction For Food Formulations
The SC was informed that this work was carried out to evaluate the various palm solid fractions which were produced by the local companies. The solid fractions were categorized by its TAG composition.

2.1.2 PD185/14 – Determination of The Oil Binding Capacity of Palm Stearin Fractions (iodine value 30 and below)
The SC was satisfied with the progress of the research project and advised the researcher to proceed with publication.

2.1.3 PD186/14 – Formulation of Trans Free Margarine That is Stable From Temperature of 15°C to 30°C
The SC was informed that the project was in the stage of identifying the suitable formulations as the market survey has been completed.

2.1.4 PD187/14 – Structured fat from Interesterification of soft
The SC commented that interesterification of soft PMF will add cost to the PMF which is already expensive. Researcher informed that the soft PMF is the by-product of palm olein (IV56) fractionation and is available in abundance in few countries such as Middle East countries and China. Interesterification of PMF may improve the physical properties of the PMF and make it more suitable for food formulation.

2.1.5 PD196/15 – Effect of palm based fat on texture and mouth feel perception of ice-cream
The SC was informed that the different blends with soldi fat content (SFC) profiles close to commercial reference products have been identified. The SFC(40°C) in palm oil has to be reduced through blending. It is recommended to study only a subset of the blends presented and add a few blends with different SFC profiles. This is to establish how the SFC translates into perceivable product properties such as stand up and organoleptic properties.
2.1.6 PD197/15 – Utilization of Soft Stearin As Confectionery Fat

It was commented that it is very difficult to produce a chocolate like coating when levels of only approximately 40% of Sat-O-Sat triglycerides are present. Improved blends with higher SFC values have to be looked for. Option such as limited addition of POs or alternatively blend with sheastearin and enzymatically interesterified mixes of soft stearin with shea stearin could be studied. These 3 fats should not be used exclusively but mixed such that best structures are achieved.

2.1.7 PD198/15 – Physicochemical Properties of Various Bakery Using Palm-Based Fluid Shortening

The SC suggested to additionally include palm olein as one of the ingredients to make the bakery products to compare with the other fats. Currently differences between structured products 20% palm stearin/80% PO and 100% PO are very limited. Inclusion of palm olein as third fat would extend the viscosity range to verify the robustness of certain applications.

2.1.8 PD199/15 – Synthesis of Hydrocolloid From Palm Kernel Meal

There was no comment from the SC

2.1.9 PD161/12 – Enzymatic Degumming of Crude Palm Oil

PAC SC commented the effort to look for an alternative degumming method in addressing the 3-MCPDE issue since acid degumming has been proven to have a positive effect. However, the study would provide a better understanding of the mechanism for the formation of the ester if it also covers the effect of acid degumming in the absence of CI. If the esters are still formed, then this could be due to other factors or pre-cursors.

2.1.10 PD171/13 – Post-Frying Vacuum Application As A Route To Minimise Oil Degradation And Oil Uptake In Fried Product

The integrated frying system has been designed and fabricated. Nevertheless, the system is yet to be delivered and commissioned in MPOB due to the application process of safety and health certification which consumed significant amount of time; the system complexity contribute to the delay in the certification process.
Suspension of experimental work involving the integrated frying system has been highlighted during the last PAC Meeting. Considering that the certification process is still in progress, it is proposed by the PAC SC to allow more time to ensure the certificate to be issued and hence commissioning of the system, since the extension does actually not increase the project’s costs.

2.1.11 PD172/13 – Comparative Studies Between Intermittent And Continuous Frying of Extruded Product
There was no comment from the SC

2.1.12 PD181/14 – Palm Kernel Reference Materials For The Determination of Iodine Value And Slip Melting Point
The SC recommended for extension of the project for at least another 9 months to allow completion of the on-going stability monitoring programme on the reference materials.

2.1.13 PD91/06 – Growth performance of tilapia fed with diets formulated with MPOB-HIE and CPO
The SC commented positively on the project and its good prospects.

2.1.14 PD133/09 – Quality of Floating Fish Feed Formulated With Different Levels of MPOB-HIE
The SC advised to do more work to gather information on the performance under different levels.

2.1.15 PD134/09 – Quality of Broiler Finisher Pellet Formulated With Different Level of MPOB-HIE
The SC commented that the project has been well explained and should continue.

2.1.16 PD158/11 – Development of β-Mannanase Enzyme Derived from PKC as Microbes Carbon Sources and Its Effects in Broiler
The SC suggested to carry on with the future programme as suggested
3. NUTRITION UNIT

3.1. On-going Projects

3.1.1 PD162/12-Molecular Mechanism of Palm Tocotrienol on Wound Healing
   No comments.

3.1.2 PD164/12 - Red Palm Olein and Cardiovascular Health.
   No comments.

3.1.3 PD165/12-GEMM – Gamma-Delta Tocotrienol as a potential maintenance treatment in women with metastatic breast cancer
   Phase 1a: A randomized, 2-period cross-over study to compare the bioavailability of Gamma-Delta Tocotrienol (GDT) with that of tocotrienol rich fraction (TRF) in twelve healthy subjects.
   No comments.

3.1.4 PD167/12-Elucidating the effects of Gamma-Tocotrienol (γ-T3) supplementation on the ratio of T-helper: T-regulatory cells in a syngeneic mouse model of breast cancer.
   No comments.

3.1.5 PD174/13- Chronic effects of natural palm-margarine, interesterified palm-margarine and modified soy-based margarine on cardiovascular diseases risk, inflammation, insulin resistance and obesity in Malaysian adults.
   No comments.

3.1.6 PD188/14-The Effects of Tocotrienol Adjuvanted Dendritic Cell in Established Mammary Tumour in BALB/C Mouse Model.
   No comments.

3.1.7 PD189/14-Gene Expression profiling of combination therapy using tocotrienols (gamma- and delta-) with leukemic drugs in acute myeloid leukemic cells.
   No comments.
3.1.8 PD190/14- Effects of Positional Distribution of Stearic Acid on Triacylglycerol backbone on lipid, lipoproteins and Atherosclerosis. 
The subcommittee suggested that liver lipid levels be looked into.

3.1.9 PD191/14- Study on the effect of palm tocotrienol fraction supplementation on collagen-induced arthritis in rat Model. 
No comments.

3.1.10 PD192/14- To study the effect of triacylglycerol (TAG) structure on lipid profile using hamster model. 
A SC member commented that the data shows that the sn-2 fatty acid is not impacting lipid levels in this study.

3.1.11 PD200/15- Clinical study on the effect of tocotrienol rich fraction (TRF) supplementation in patients with primary osteoarthritis (OA) of knee joints. 
No comment.

3.1.12 PD201/15- Effect of palm tocotrienol rich fraction (TRF) and palm carotenes on asthmatic Inflammation. 
No comments.

3.1.13 PD202/15-Biodistribution, pharmacokinetics and targeting efficacy of tumour-targeted tocotrienol nano-formulations in mice model. 
No comments.

3.1.14 PD203/15- Development of nano-carrier delivery systems of tocotrienols for oral, subcutaneous and topical administration. 
No comments.

3.1.15 PD204/15-Study of the effect of the positional fatty acids on triacylglycerol backbones on cardiovascular risk markers and fat deposition in mice. 
No comments.
3.1.16 PD205/15- (Project 1a) Multicentre studies on the effects of positional distribution of fatty acids at triglyceride backbone on serum lipids, lipoprotein (a) and LDL-subclasses in healthy Malaysian volunteers.
The SC commented that the sample size might be under powered.

The SC commented that only minor changes may be expected as the study was done among normal individuals and the fat energy exchange is only 30%.

The SC enquired on compliance issues and was informed that the compliance was good with more than 95% attendance.

The SC enquired on the cholesterol levels among groups so far and was informed that the cholesterol readings have not been stratified according to groups and would only be done at the end of the feeding intervention.

3.1.17 PD205/15 (b)- Multicentre studies on the effect of positional distribution of fatty acids at the triglyceride backbone of vegetable oils on fat deposition and health outcome measures-Malaysia.
The SC suggested obtaining protocol for fecal analysis from King's College, London.

The SC also suggested that the fecal samples be subjected to bomb calorimeter analysis.

The SC suggested that the study from Clement Ip et al. in the 1980s/1990s be referred to.

The SC suggested that the labels on the diagram for corn oil be corrected.

The SC advised that the timeline for the project be adhered to, in order to obtain the results on time.
Importance of keeping the level of DAG low

\[
\begin{align*}
\text{CH}_2\text{OCOR} & \quad \text{CH}_2\text{OCOR} \\
\text{CHOCOR} & \quad \text{Lipolysis} \quad \text{CHOH} \\
\text{CH}_2\text{OCOR} & \quad \text{CH}_2\text{OCOR}
\end{align*}
\]

Mesocarp Oil \hspace{1cm} \text{Diacylglycerol (DAG), (I)}

Reactions of DAG:

\[
\begin{align*}
\text{I} & \quad \text{H}^+ & \quad \text{CH}_2\text{OCOR} & \quad \text{CH}_2\text{OH} \\
& & \quad \text{CHOH} \\
\text{Cl}^- & \quad \text{CHOCOR} & \quad \text{H}_2\text{O} & \quad \text{CHOH} \\
\text{acid condition} & \quad \text{CH}_2\text{Cl} & \quad \text{CH}_2\text{Cl} \\
& & \quad \text{3-MCPD}
\end{align*}
\]

\[
\begin{align*}
\text{I} & \quad \text{OH}^- & \quad \text{CH}_2\text{OCOR} \\
& & \quad \text{Glycidyl ester (GE)}
\end{align*}
\]

**Proposed Protocol**

Low FFA CPO \( (\text{FFA < 3\%}) \)

-Cl\(^-\) \( (\text{washing}) \) \( \text{Low DAG} \)

\[
\begin{align*}
\text{CPO} & \quad \text{(Low DAG, Low Cl\(^-\))} \\
\text{Degummed (H}_3\text{PO}_4) & \\
& \quad \text{Low arsenic neutral bleaching earth}
\end{align*}
\]

Neutralised /bleached PO

Deodorised at ca. 210°C

- good vacuum \( P<2 \text{ Torr} \)

RBD PO \( (3\text{-MCPD/GE<1ppm}) \)

**Protocol in Layman language**

- To produce good quality CPO with FFA<3%
- To reduce organochlorine by washing oil palm fruits\(^1\)
- To reduce Cl\(^-\) by washing at mills
- To bleach with low arsenic neutral bleaching earth
- To deodorise at low temperature (ca.210°C) and good vacuum (P<2 Torr)
- To aim for production of RBD PO with 3-MCPD/GE< 1ppm.

COMBINED REPORT
OLEOCHEMICAL SUB-COMMITTEE

Plenary Session
Date: 15th April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
PRESENT:

1. Dr. Wolfgang Rupilius, Germany (Chairman of Sub-Committee)
2. Prof. Dr. Howard Anthony Barnes, University of Chester, UK
3. Dr. Vahid Sendijarevic, Troy Polymers Inc., USA
4. Prof. Dr. Chong-Su Cho, Seoul National University, South Korea
5. YBhg. Datuk Hong Ngit Ming, Teck Guan Group, Malaysia
6. Prof. Gianni Carvoli, Khemistar S.r.l, Italy
7. Dr. Toshio Kakui, Lion Corporation, Japan
8. Prof. Dr. Douglas G. Hayes, University of Tennessee, Knoxville, TN, USA
9. Dr. Burghard Gruening, Germany

IN ATTENDANCE:

1. YBhg. Datuk Dr. Choo Yuen May, Director General of MPOB
2. YBrs. Dr. Ahmad Kushairi Din, Deputy Director General (R&D) of MPOB
3. Dr. Hazimah Abu Hassan (Director, AOTD)
4. Dr. Yeong Shoot Kian (Head, Synthesis & Product Development)
5. Dr. Zainab Idris (Head, Process Development & Design)
6. Ms. Razmah Ghazali (Head, Quality & Environment Assessment)
7. Mr. Zafarizal Aldrin Azizul Hassan (Head, Consumer Product Development)
8. Ms. Rosnah Ismail
10. Ms. Haliza Abdul Aziz
11. Ms. Norashikin Ahmad
12. Dr. Ismail Ab. Raman
13. Ms. Tuan Noor Maznee Tuan Ismail
14. Dr. Lim Wen Huei
15. Dr. Hoong Seng Soi
16. Ms. Noorazah Zolkarmain
17. Mr. Mohd Azmil Mohd Noor
18. Dr. Abdul Rashid Yatim
19. Ms. Bonnie Tay Yen Ping
20. Mr. Mohd Norhisham Sattar
21. Ms. Hajar Musa
22. Ms. Nurul ‘Ain Hanzah
23. Ms. Chua Siaw Kim
24. Ms. Nik Siti Mariam Nek Mat Din
25. Ms. Noor Khairin Mohamad
26. Ms. Srijanum Adnan
27. Ms. Arniza Mohd Zan
28. Ms. Norhayati Mohd Noor  
29. Mr. Zailan Abu Bakar  
30. Ms. Siti Afida Ishak  
31. Ms. Yusrabbi Amiyati Yusof  
32. Ms. Noor Azeerah Abas  
33. Ms. Nurul Aishah Mohammad  
34. Ms. Nur Anis Albakry  
35. Ms. Wan Nur Fatihah Wan Muhammad Zulkifli  
36. Ms. Fadzilina Abdullah  
37. Ms. Asma Liyana Shaari  
38. Ms. Cheong Mei Yee  
39. Mr. Ahmad Syafiq Ahmad Hazmi  
40. Dr. Noor Armylisa’s Abu Hassan  
41. Ms. Nik Nurfatmah Pz Nik Pauzi

**ABSENT WITH APOLOGY:**

42. Ms. Srihanum Adnan - Maternity Leave  
43. Ms. Kosheela Devi Poo Palam - Study Leave
RECOMMENDATIONS BY OLEOCHEMICAL SUB-COMMITTEE MEMBERS

1. AOTD should adopt scientifically high risk R&D projects. For example
   - Metathesis of palm oil products (olefins, dicarboxylic acids, polyols etc.).
   - Production of ether-type compounds (lubricants).

2. Non-successful projects should be terminated early.

3. Focus on fewer projects.

4. Improve collaborations between divisions and between PAC Sub-Committees.
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<thead>
<tr>
<th>TITLE / PROJECT NO.</th>
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<td>AOTD 097/2016 – Zinc glycerolate as a catalyst for methyl ester production</td>
<td>C</td>
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<td>AOTD 098/2016 – Esterification of PFAD for drilling mud application</td>
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<td>AOTD 099/2016 – Separation modeling of crude glyceryl carbonate via reactive distillation</td>
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<td>AOTD 101/2016 – Determination of ecotoxicological behavior of poorly water-soluble surfactants</td>
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<td>AOTD 105/2016 – Effect of dihydroxyl fatty acid (DHSA) on the polymorphic behaviour of palm fatty acids</td>
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<td>AOTD 106/2016 – Palm-based polyurethane binder for rebond foams</td>
<td>B</td>
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</table>
1. **AOTD 096/2016 – Development of oil in water emulsion (EW)-based insecticides for aedes control**

The Sub-Committee asked whether the non-ionic surfactant used is of palm-based origin to which the researcher commented that the non-ionic surfactants used are of vegetable-oil based, obtained from a local oleochemical company.

The Sub-Committee stated that the high shear homogenizer pilot plant equipment is fabricated locally.

The Sub-Committee enquired whether the size of microemulsion is smaller than nanoemulsion. The researcher replied that in colloid science, ‘microemulsion’ is defined as an emulsion system with very small droplets size (<200nm) and thermodynamically stable. A ‘Nanoemulsion’ is defined as an emulsion system with droplets size ranged between 20-500nm, and it is thermodynamically unstable.

The Sub-Committee enquired on the advantages of nanoemulsion over emulsion concentrate (EC). The researcher said that an oil-in-water nanoemulsion uses palm-based materials with low concentration of solvent. On the other hand, EC-insecticide uses 100% petroleum-based solvents and is not environmentally friendly.

The Sub-Committee enquired whether a high amount of pyrethoid can be dissolved in the nanoemulsion in view of the fact that pyrethoid must be free from nanoemulsion monolayer to be bio-available and effective. The Sub-Committee asked if there are data on bioefficacy. The researcher replied that the bioefficacy test will be conducted at the Institute for Medical Research, Kuala Lumpur.

The Sub-Committee commented on the need to start collecting proof of concept data on bioactivity much earlier in the project timeline. The Sub-Committee also commented on obtaining a prototype system by 6 months and to test the prototype system vs controls on Aedes mosquitoes. The Sub-Committee was also informed that there are two types of emulsifiers which can be used that have the required HLB value. An oleic acid based ethoxylated emulsifier and APG with stearyl alcohol, otherwise known as Evonik Tegocare.

The Sub-Committee asked if the researcher intended to go directly into pilot plant scale to which the researcher said he will perform benchtop trials before doing the pilot plant scale.
The bioefficacy test will be compared with standard EW-insecticides, which are commercially available.

(Priority A)

2. **AOTD 097/2016 – Zinc glycerolate as a catalyst for methyl ester production foams**

The Sub-Committee enquired whether the size of the catalyst used is controlled in the methyl ester reaction. The researcher replied that the catalyst is sieved to obtain a particle-size of 125 µm before using. The Sub-Committee commented that zinc as a catalyst can be used both in esterification and transesterification reactions. In addition, high temperature and pressure are needed to activate the zinc catalyst. Under low temperature, the conversion rate will be poor. For example, in the case of zinc acetate during transesterification, zinc soap will be formed which is insoluble in glycerol pitch. The methyl ester formed can be distilled off easily.

The Sub-Committee also suggested that the synthesis should be carried out with conventional catalyst as a control for comparison of price and performance.

The Sub-Committee enquired whether there is an increase in the market for biodiesel. The researcher replied that it was previously favourable to export to the EU. The Malaysian government has also implemented the national biodiesel policy of using blended diesel with methyl ester. Hence, the local market is assured.

(Priority C)

3. **AOTD 098/2016 – Esterification of PFAD for drilling mud application**

The Sub-Committee stated that most of the ingredients used in drilling mud are not cheap, and therefore enquired how this project would help in producing cheap drilling mud. The Sub-Committee was then informed that the esters of PFAD could be potentially cheap and could replace the mineral oils used in the drilling mud formulation.

The Sub-Committee was informed that the field testing will be carried out together with a collaborator, where it will involve the utilization of facilities that will mimic the actual drilling mud application. The Sub-Committee was also informed that the 25 kg pilot plant can be used to produce sufficient quantity of PFAD esters for field testing.
The Sub-Committee informed that for this drilling mud application, CPO cannot be directly used as drilling mud because of its high kinematic viscosity compared to PFAD. The source of the PFAD was also enquired about and it was informed that the PFAD will be provided by the industrial collaborator.

The Sub-Committee recommended that the esterification should first be carried out without the presence of catalyst. The incorporation of ester during the initial stage of esterification would also help the reaction go to completion.

The Sub-Committee commented that the replacement of mineral oil with the bio-based-esters should not compromise the performance of the drilling mud.

The Sub-Committee also recommended that the researcher study a patent on the same subject where glycerol is added to the PFAD as a water entrainer in the esterification. (Priority A)

4. AOTD 099/2016 – Separation modeling of crude glyceryl carbonate via reactive distillation

The Sub-Committee was informed that the crude glycerol carbonate to be used in this new project is produced from the reaction of glycerol and ethylene carbonate. The crude glycerol carbonate consists of glycerol carbonate and ethylene glycol.

The Sub-Committee reminded the researcher not to be disturbed by the high price of pure glycerol carbonate. The researcher should just target the price of the industrial grade.

The Sub-Committee was informed that the development of vapor-liquid equilibrium (VLE) for the four components is time-consuming. The researcher intends to proceed with reactive distillation experimental work.

The Sub-Committee commented that the Aspen Plus software is expensive and suggested a collaboration with a university or business firm that has a software license. The researcher informed the Sub-Committee that there are two possible ways to have access to the software. Collaboration with a university is possible but their license is restricted for academic purposes. The researcher is currently looking at the possibility of collaborating with a suitable business firm.
The Sub-Committee commented that glycidol is dangerous. Therefore thermal decomposition of glycerol carbonate to glycidol should be prevented. 

(Priority A)

5. **AOTD 100/2016 – Environmental life cycle assessment (LCA) on the production of glycerol from oleochemical processes**

The Sub-Committee pointed out that it would be beneficial to see the impact of glycerine production from fatty acid and methyl ester routes with respect to the energy consumption used for both routes.

The Sub-Committee was informed that the proposed project covers only the production of glycerine from methyl ester and fatty acid routes obtained from the oleochemical industry. For this study, glycerine production from the biodiesel industry is not included.

(Priority A)

6. **AOTD 101/2016 – Determination of ecotoxicological behavior of poorly water-soluble surfactants**

The Sub-Committee enquired about the number of ethoxylates with a range of EO to be used and was informed that the commercial alcohol ethoxylates (AEO) will be used in this project which includes AEO with 2,3,5 and 9 ethoxylate numbers.

The Sub-Committee enquired on the positive and negative controls to be used in the test and they were informed that 3,5-Dichlorophenol will be used as a reference control in ecotoxicity studies, while aniline will be used as a positive control in the biodegradation study as stipulated in the standard methods.

The Sub-Committee also enquired on the source of microorganisms used for the MITI (301C) test, as the microorganisms must be taken from various sites. It was informed that the microorganisms will be sourced from 10 different sites in Selangor.

(Priority A)
The Sub-Committee commented that the reaction between oleic acid and hydrogen peroxide could also yield polyol, instead of just polyhydroxy estolides. The researcher stated that an initial study to synthesize the polyhydroxy estolides at laboratory scale has been carried out. Results from NMR and MALDI-TOF analyses showed that the formation of polyhydroxy estolide was successful.

The Sub-Committee enquired how the researcher could prevent transesterification from occurring during the derivatization of polyhydroxy estolide with glycerol. The researcher stated that the optimum reaction temperature and catalyst would be determined, whereby transesterification is at the minimum. Previous publications also suggested that ester bonds of polyhydroxy estolides are very stable towards transesterification and hydrolysis.

The Sub-Committee was informed that the global market size of Group IV and Group V base lubricant was projected to be about 830,000 metric tonnes by the year 2020, based on a report by Radiant Insight in January 2016.

The Sub-Committee commented that the molecular weight of polyhydroxy estolide is important in determining its application and enquired about the molecular weights of the prepared polyhydroxy estolides. The researcher told The Sub-Committee that the molecular weight of prepared polyhydroxy estolides were ~ 1200 Da.

The researcher informed the Sub-Committee that one of the targeted applications of polyhydroxy estolides derivatives is lubricant base oil with a better pour point and cloud point characteristics.

(Priority B)

The Sub-Committee asked why glycerol carbonate was used to produce polyglycerol instead of glycerol. The Sub-Committee was informed that it is to diversify the use of glycerol carbonate that was synthesized in AOTD and also that this project is for academic purposes. The Sub-Committee commented that they are not aware of reaction between glycerol carbonate with diacid being reported in the literature. The researcher pointed out that there is a patent by Croda on the reaction between fatty acid with glycerol carbonate. As such, the
Sub-Committee was informed that the researcher would like to study the reaction of glycerol carbonate with diacid.

The Sub-Committee suggested that the researcher be aware of the possible miscibility problem between glycerol carbonate and azelaic acid.

The Sub-Committee suggested using dimethyl azelate because it is easier to remove methanol from the reaction mixture instead of water.  

(Priority C)

9 AOTD 104/2016 – Corrosion inhibition properties of some fatty acid derivatives

No comment.  

(Priority A)

10 AOTD 105/2016 – Effect of dihydroxyl fatty acid (DHSA) on the polymorphic behaviour of palm fatty acids

The Sub-Committee enquired on the purity of DHSA and was informed that the purity was between 74 and 94%. 

(Priority C)

11 AOTD 106/2016 – Palm-based polyurethane binder for rebond foams

The Sub-Committee suggested that PolyFAME polyol also be incorporated in this study. The Sub-Committee highlighted that some of the test methods listed may not be applicable for this study.

The Sub-Committee was informed that MDI is better than TDI because of its low volatility and no special safety equipment is required. 

(Priority B)
1. POLYOLS

1.1 AOTD 052/2009 – Catalysis study on the production of polyol

The Sub-Committee enquired about the high hydroxyl value that was obtained for one of the polyols in the presentation. The Sub-committee was informed that the alcoholysis reaction was carried out with ethylene glycol.

The Sub-committee was also informed that the epoxidized palm olein (EPOo) used was from the same batch. The Sub-committee pointed out that the different unsaturation values (IV) in palm-based polyols might be an indication of an elimination reaction that could have occurred during the alcoholysis process for the reaction with methanol. The Sub-Committee was informed that the reaction was conducted under reflux at 60°C.

1.2 AOTD 080/2012 – Synthesis of azelaic ester polyol

The Sub-Committee suggested using lipase enzyme for the esterification reaction at low temperature (60°C - 70°C) which could improve the colour of the product. The Sub-Committee also pointed out that applying vacuum during the reaction at a lower temperature could also improve the colour of the products.

The Sub-Committee suggested conducting the transesterification of dimethyl azelate with 1,4-butanediol instead of esterification of azelaic acid with 1,4-butanediol.

The Sub-Committee also suggested carrying out the esterification of azelaic acid with methanol to produce dimethyl azelate of high purity, for the transesterification reaction.
2. POLYURETHANE

2.1 AOTD 038/2008 – Palm-based rigid polyurethane foam for insulation material

No comment.

2.2 AOTD 049/2009 – Polyurethane elastomer made from palm oil polyol

The Sub-Committee pointed out that the purpose of using polyFAME was not highlighted in the presentation.

The Sub-Committee was informed that PolyFAME was used as a chain extender to produce a soft elastomer.

2.3 AOTD 091/2015 – One component palm-based polyurethane (PU) wood adhesives

The Sub-Committee commented that the adhesive currently prepared is more like a 2K rather than 1K because a gelling catalyst was used. The Sub-Committee suggested preparing quasi-polymer with a high excess of isocyanate.

2.4 AOTD 071/2011 – Development of low density rigid PU foams based on palm oil polyols

The Sub-Committee reported that there are new regulations imposed on Enovate-3000 as a blowing agent and requested that the researcher study the new requirements. The Sub-Committee also informed on the availability of a new commercial blowing agent in the market.

The Sub-Committee suggested varying the amount of catalyst used to increase the density of the foam. In addition, the researcher should measure the average cell size of the foam because there is a direct effect between density, cell size and thermal conductivity.
2.5 AOTD 092/2015 – Evaluation of palm-based polyols on viscoelastic foam

The Sub-Committee recommended changing the type of surfactant when 35% PolyFAME E-185 was incorporated at a isocyanate index of 75% in the foam formulation in order to improve the cell structure of the foam.

The Sub-Committee suggested that the average cell size of the viscoelastic foams be measured as it directly affects the morphology of the viscoelastic foams.

The Sub-Committee also suggested that the tensile strength of the viscoelastic foams be determined. It was then informed that the tensile strength was planned to be measured later.

3. SURFACTANT

3.1 AOTD 055/2009 – Production of palm-based rhamnolipid biosurfactant

The Sub-Committee enquired about the advantages of using palm oil as a feedstock over other vegetable oils. The Sub-Committee was informed that the balanced composition of saturated and non-saturated fatty acids contributed to the unique properties of the biosurfactant.

Palm oil as a feedstock would lower the cost of biosurfactant production. Furthermore, waste effluent from the palm oil mill can also be used to produce rhamnolipid.

The Sub-Committee also enquired as to what would be the major product (mono or dirhamnolipid) using palm oil as feedstock. The Sub-Committee was informed that the production of biosurfactant, whether mono or dirhamnolipid, is determined by the medium conditions.

The Sub-Committee suggested using PKO as the feedstock to produce biosurfactant as it has never been tried in this study.

The Sub-Committee enquired about the difference in foaming properties between rhamnolipid and sophorolipid. The Sub-Committee was informed that some foams were observed during the production process of both sophorolipid and rhamnolipid. The Sub-Committee was informed that sophorolipids are commercially used as the surfactant in low
foam detergents for automatic dish washing machines.

3.2 AOTD 086/2013 – Commercial scale production of palm-based sophorolipid biosurfactant

The Sub-Committee commented that one should increase the yield of sophorolipid to be commercially viable and was informed that the production of sophorolipid with a high yield of about 300g/L has been reported.

The Sub-Committee enquired whether the carbon source chain length would affect the biosurfactant properties. The use of glycerol as a feedstock to produce biosurfactants was suggested.

The Sub-Committee suggested collaboration with Saraya Corporation which is producing sophorolipids in Japan.

3.3 AOTD 061/2010 – Enzymatic synthesis of palm-based sucrose esters in green solvent

The Sub-Committee enquired whether the reaction was carried out in an open vessel setup. The Researcher confirmed that the reactions were carried out in an open beaker on a hotplate.

The Sub-Committee suggested that fresh sugar be introduced in stages to the reaction mixture. The researcher stated that it had been done as suggested. However, due to the multiple filtration steps throughout the reaction, most of the fatty acid was lost through the processes.

The Sub-Committee commented that as this is a solid liquid phase reaction, the size distribution of the sucrose powder is important as it can affect the rate of reaction.

3.4 AOTD 074/2012 – Synthesis of cationic gemini surfactant from fatty hydrazides

No comment.
4. LUBRICANTS

4.1 AOTD 058/2010 – Synthesis of dimerate ester as lubricant base stock

The Sub-Committee enquired whether the stability of the synthesized dimerate ester was affected by the presence of ester linkage and the Sub-Committee was informed that with reference to petroleum-based lubricants, dimerate ester would be less stable. An oxidative stability study will be carried out to investigate the stability of the products.

The Sub-Committee was informed that the price of the dimerate ester lubricant could be quite high because the price of dimer acid itself is also high.

The Sub-Committee suggested the use of a catalyst such as an ion exchange resin for the reaction with 2-propanol so that the reaction could be carried out at a lower temperature (maximum 120°C).

4.2 AOTD 063/2010 – Palm-based lithium complex grease

The Sub-Committee was informed that the high amount of soap in grease would be disadvantage in terms of cost. However, from the study, it was found that a lower amount of soap did not give products that meet the specifications.

5. FINE CHEMICALS

5.1 AOTD 043/2008 – Enzyme-catalysed acyl transfer reaction of dimethyl azelate and amino acid ethyl esters

No comment.

5.2 AOTD 044/2008 – Fatty esteramine derivatives from various palm-based methyl ester feedstocks

The Sub-Committee suggested that future work should be focused on the synthesis of gemini surfactant, vis-à-vis addition of a spacer on the amine derivatives.
5.3 **AOTD 081/2012 – Derivatization of glycerol with levulinic acid**

The Sub-Committee was informed that Novozyme 435 enzyme was used for this study. Based on reports in the literature, the Sub-Committee suggested using an ionic liquid which can act as a good solublizer and catalyst.

The Sub-Committee also suggested that the reaction be conducted between 70°C to 90°C using an ion exchange resin as the catalyst.

The Sub-Committee was informed the glycerol layer and levulinic acid layer can be completely homogenised on heating and stirring.

5.4 **AOTD 084/2013 – Silane functionalized palm oil derivatives**

The Sub-Committee recommended that the prepared silane products, which are transparent and tacky, be used in development of pressure-sensitive adhesives.

5.5 **AOTD 093/2015 – Synthesis of glyceryl polyalkylether**

No comment.

5.6 **AOTD 095/2015 – Preparation of epoxidised sucrose ester of oleic acid**

The Sub-Committee commented that epoxidised trimethylolpropane ester is not suitable to be used as a cosmetic ingredient. The researcher agreed and suggested that the trimethylolpropane ester is to be used in grease and lubricants.

6. **ENVIRONMENT**

6.1 **AOTD 069/2011 – Physico-chemical properties of palm-based 9, 10-dihydroxystearic acid (DHSA) and Alpha-Sulphonated Methyl Ester (SME/MES) for EU REACh requirement**

No comment.
6.2 AOTD 078/2012 – Determination of ethylene oxide (EO) distribution in palm-based alcoxyalted products

No comment.

6.3 AOTD 073/2011 – Method development and analysis of volatile organic compounds emitted from palm-based polyurethane products

No comment.

6.4 AOTD 077/2012 – Determination of bio-based content in polyols and polyurethanes

The Sub-Committee was informed that $^3$H standard solution was used only for instrumental self-normalization and calibration. However, $^3$H standard solution was not used for the quantitation of bio-based content.

6.5 AOTD 076/2012 – Determination of by-products in methyl ester sulphonate and cosmetic products containing palm-based esters

The Sub-Committee suggested applying the method developed for the cationic gemini surfactant which had used dimethyl sulphate. The Sub-Committee was informed that the method might not be suitable for Gemini surfactant because it is a different matrix. The sample preparation method might not be suitable for the cationic gemini surfactant developed for methyl ester sulphonate.

The Sub-Committee expressed concern about the method being developed for analysing of IPTS in the final product, e.g., cosmetic but instead suggested that the method should be developed for isopropyl esters (raw material). The Sub-Committee was informed that the work on detection of IPTS in cosmetics had already been done and the work had been published in ‘International Journal of Cosmetic Science’. The current project is actually a continuation work for the detection of IPTS in isopropyl esters.

6.6 AOTD 089/2014 – Determination of chlorpurifos in palm-based fatty acids

No comment.
6.7 AOTD 079/2012 – Long term toxicity studies of palm-based products to aquatic invertebrates

No comment.

6.8 AOTD 087/2014 – Ecotoxicity study of palm-based surfactants towards green algae

No comment.

6.9 AOTD 088/2014 – Life cycle assessment on the production of fatty acids produced in Malaysia

The Sub-Committee enquired on the variations of inventory data obtained from the fatty acid producers and was informed that several assumptions were made in this study to obtain a narrow range of inventory data.

The Sub-Committee was informed that the project is a collaborative project with the Malaysian Oleochemical Manufacturers Group (MOMG). The data on the production of fatty acids were obtained from MOMG. Plant visits were also conducted to verify the validity of the data. Progress reports of the study were also submitted regularly to the MOMG.

7. TECHNOLOGY

7.1 AOTD 001/2005 – Ethoxylation of palm based derivatives (DHSA, Methyl Ester and Polyol)

The Sub-Committee stated that the stability of sorbitol monooleate is dependant on the reaction parameters and it might decompose at extreme ethoxylation temperatures.

The researcher informed the Sub-Committee that the production of ethoxylated sorbitol monooleate is the know-how process of the technology provider, i.e., Inventa Technologies.

7.2 AOTD 055/2007 – Improvement on the polyol pilot plant production

The Sub-Committee was informed that the wastewater treatment system is located in the vicinity of the 1 tonne polyol pilot plant.
The Sub-Committee was also informed that the treated waste originated from the polyol process only.

7.3 AOTD 064/2010 – Synthesis and characterization of catalyst system for methyl ester ethoxylates

The Sub-Committee was informed that the ethoxylation reaction was conducted at Lion Corporation Laboratory in Japan using a stirred batch reactor.

The Sub-Committee asked whether there will be any effect of using a solid catalyst in the loop reactor.

The Sub-Committee was informed that MPOB will work closely with Lion Corporation on the ethoxylation of ME with solid catalyst using loop reactor.

7.4 AOTD 072/2011 – Determination of non-catalytic esterification protocol

The Sub-Committee informed that the quality of DEG ester will not be significantly affected by the moisture content present in the final product. After all, the DEG ester will be used as a pearlizing or opacifying agent. The Sub-Committee also informed that the “non-catalytic” terminology should be replaced with “auto-catalytic” because the esterification reactions are being catalyzed by the carboxylic acid used as the reactant in the esterification reactions.

The Sub-Committee enquired about the need for vacuum at the beginning of the esterification reaction. The Sub-Committee was informed that the protocol was set to conduct the experiment at high temperature with no vacuum and no catalyst. The Sub-Committee recommended running the reaction by purging N₂ gas and to use excess of glycols so that reaction can be run at lower temperature.

The Sub-Committee was informed that in previous experimental work, the esterification reactions were conducted at a temperature of 120 °C using amberlyst A46 catalyst. However the conversion rate was not high. Attempts at using tin oxalate at 230 °C for production of DEG ester successfully produced high diester after reaction duration of 13 hours.

The Sub-Committee mentioned that the commercial product used was based on stearic acid.
from tallow. Tin oxalate was used as a benchmark catalyst. The Sub-Committee recommended the use of excess glycol in the reaction and the removal of unreacted DEG can be conducted at the final stage of reaction.

7.5 AOTD 082/2012 – Production of fatty amides from triglycerides via microwave technology

The Sub-Committee commented that there is a possibility of the formation of nitrile from dehydration of amide because the reaction was conducted at high temperature. Consequently, the Sub-Committee requested that the presence of nitrile in the reaction mixture be analysed. The Sub-Committee also recommended the use of column chromatography for purification of the product.

8. AGROCHEMICAL

8.1 AOTD 066/2010 – Palm-Based aerosol insecticides for public health importance

The Sub-Committee was informed that the new project proposal is focused on the development of nanoemulsion as a fogging agent to control mosquitoes in public areas. However, this on-going project is focused on the production of microemulsion as an aerosol insecticide for household use only.

The Sub-Committee was informed that the size of the aerosol spray mist will also be determined in a collaborative study with a local university. The Sub-Committee emphasized that the mist droplets should not be less than 5µm to reduce the chance of entering the body through respiratory tract.

8.2 AOTD 094/2015 – Water in biodiesel microemulsion for fuels

The Sub-Committee was informed that the research is currently in progress and the economic study including cost analysis will be calculated at the final stage of the research work. The researcher expects the cost of microemulsion-fuels should be cheaper or comparable to conventional diesel due to the high water content that can be incorporated in the microemulsion-fuels.
The Sub-Committee enquired if companies such as Petronas are interested in adopting the technology. The Sub-Committee was informed that there is a local company that has expressed interest on the project. However, the researcher will also approach Petronas. The Sub-Committee was informed that the water content ranges between 5% to 20% (w/w) in commercial microemulsion-diesel fuels.

9. **COSMETICS**

9.1 **AOTD 047/2009 – Preparation, characterization and applications of palm based lipid nanoparticles**

The Sub-Committee enquired about the stability of solid lipid nanoparticles (SLN). The Sub-Committee was informed that the formulated SLN is quite stable based on the particle size and polydispersity index (PDI) values obtained after one month storage at 25°C and 45°C.

The Sub-Committee enquired about the negative value obtained for the zeta potential. The Sub-Committee was informed that the negative value of zeta potential was influenced by the type of lipid used in the SLN formulation which would provide for the stability of SLN.

The Sub-Committee mentioned that nanoparticles has a bad reputation in the market. The Sub-Committee was informed that the use of different term for “nanoparticles” in this study will be considered. The Sub-Committee was also informed that griseofulvan was used in the study because it was poorly soluble in water.

9.2 **AOTD 068/2011 – Palm phenolics as active ingredient for topical application**

The Sub-Committee was informed that oil palm phenolics (OPP) were obtained from palm oil mill effluent (POME) and it is already produced at a pilot plant located in MPOB Experimental Mill at Labu, Negeri Sembilan.

The Sub-Committee was informed that OPP used in this study contains phenolic compounds such as p-hydroxybenzoic acid and shikimic acid with total phenolic content of 1500 ppm gallic acid equivalent.

The Sub-Committee was informed that the process to produce OPP has been established and standardized to control the product composition. The Sub-Committee highlighted that
kojic acid is no longer used in Europe as it may induce skin irritation and allergic reactions.

9.3  AOTD 085/2013 – Evaluation of in vitro ocular irritation for palm oleochemicals through Bovine Corneal Opacity & Permeability (BCOP) test

No comment.

9.4  AOTD 075/2012 – Potential application of proteins derived from pkc for cosmetic products (chua sk)

The Sub-Committee pointed out that the low protein yield may be due to the high temperature used during protein extraction and may cause changes in the protein conformation. The researcher informed that the extraction parameters had been optimized and used by the co-researcher for protein extraction.

The researcher planned to carry out the application of PKC protein on hair care products once the protein extraction process is optimized. The Sub-Committee was informed that the protein was hydrolyzed with sulphuric acid and derivatized before it was analyzed using HPLC.

The researcher explained that once the project is concluded, a new project on the derivatization of the PKC protein to cationic surfactant (or other products) will be proposed.

9.5  AOTD 067/2011 – Efficacy of palm-based tocotrienol nanoemulsion

No comment.

9.6  AOTD 090/2014 – Establishment of bacterial reverse mutation assay for assessment of genotoxicity of methyl ester sulphonate

No comment.
PROGRAMME ADVISORY COMMITTEE
36TH MEETING : 11TH – 15TH APRIL 2016

COMBINED REPORT
PROCESSING & ENGINEERING
SUB-COMMITTEE

Plenary Session
Date: 15th April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
PRESENT:

1. Prof. Dr. Stanislav Miertus, Int. Centre for Applied Research and Sustainable Technologies, Slovakia - Chairman
2. Dr. Gee Ping Tou, Palm Nutraceuticals Sdn. Bhd., Malaysia
3. Mr. Lee Keong Hoe, IHMS Sdn. Bhd., Malaysia
4. Prof. Dr. Ing. Volker Thole, Eberswalde University for Sustainable Development (HNEE), Germany
5. Hj. Ismail Hassan, Malaysia
7. Mr. Lee Hock Leang, Kretam Holdings Bhd., Malaysia
8. Prof. Dr. Stephen M. Saler, University of Maine, USA
9. Dr. Tong Soo Loong, Oiltek Nova Bioenergy Sdn. Bhd., Malaysia
10. Prof. Dr. Matthias Finkbeiner, Technische University Berlin, Germany
11. Prof. Dr. Ing Martin Kaltschmitt, Hamburg University of Technology (TUHH), Germany

ATTENDANCE:

1. Y. Bhg. Datuk Dr. Choo Yuen May, Director-General, MPOB
2. Dr. Lim Weng Soon, Director, Engineering & Processing
3. Dr. Astimar Abd Aziz, Head, Biomass Technology
4. Dr. Loh Soh Kheang, Head, Energy & Environment
5. Dr. Hj. Zulkifli Abd Rahman, Head, Milling & Processing
6. Dr. Anis Mokhtar
7. Dr. Andrew Yap Kian Chung
8. Che Rahmat Che Mat
9. Dr. Eliyanti bt Ali Othman
10. Fatah Yah bt Abd. Manaf
11. Dr. Fatiha Ismail
12. Dr. Fazliana bt Abd Hamid
13. Dr. Harrison Lau Lik Nang
14. Haryati bt Zainal
15. Hasliyanti bt Alias
16. En. Kamarudin Hassan
17. Mohamad Azri b. Sukiran
18. Muzzammil b. Ngatiman
19. Nabilah Kamaliah bt Mustaffa
20. Nahrul Hayawin bt Zainal
21. Nor Faizah bt Jalani
22. Noorshamsiana Abd Wahab
23. Nur Azreena bt Idris  
24. Nur Sulihatmarsyila bt Abd Wafti  
25. Nurul Adela bt Bukhari  
26. Nu’man Abd Hadi  
27. Nasrin Abu Bakar  
28. Rohaya Mohamed Halim  
29. Ropandi Mamat  
30. Dr. Roila Awang  
31. Dr. Ridzuan Ramli  
32. Rusnani Abd Majid  
33. Stasha Eleanor Rosland Abel  
34. Dr. Teh Seok Sin  
35. Dr. Vijaya a/p Subramaniam  
36. Wan Hasamudin W. Hassan  
37. Yahaya Hawari  
38. Yung Chee Liang  
39. Zawawi Ibrahim

ABSENCE WITH APOLOGY:

1. Ir. N. Ravi Menon, Senior Research Fellow  
2. Dr. Sivasothy Kandiah  
3. Nursyairah bt Jalil  
4. Dr. Ng Mei Han
The Sub-Committee (SC) met on 11th-15th April 2016. During the period they were briefed by the Director-General, Director Processing and Engineering Division and Heads of Units. Some updates on biomass utilization (bioenergy, biochemicals, wood based products) were provided by members of the SC. The interaction with research officers regarding on-going projects provided the basis for the SC recommendations. Their comments are recorded in Appendix 1. SC appreciated the high quality of achieved results as well as the effort of streamlining of individual projects. The SC gave more time to deliberate on the 5 proposed projects. As a result of the review, 2 projects were approved without amendment (ranked A) and 3 were approved with proposed changes (ranked B). - see Appendix 2 for more detail.

On April 13th 2016 the lecture for PAC SC members and Processing & Engineering and MPOB Division on “Nanocellulose: Research and Market Trends” was delivered by the SC member Prof. S. Shaler (see Appendix. 3). On 12th and 13th April 2016, brainstorming sessions of SC members were organised together with the Director of Processing & Engineering Division and Heads of Unit tackling the following issues:

1. On the issue of MPOB to become World Class and strengthening the integrated strategy of MPOB research programme
2. On new research projects/ideas to be further developed
3. On further increase of MPOB impact on palm oil industry efficiency and sustainability (see also Appendix 4)
4. On further improvement of performance of MPOB researchers and strengthening of interaction with PAC members
5. On further improvement of research projects proposals (see also Appendix 5)

1. On the issue of MPOB to become World Class and strengthening the integrated strategy of MPOB research programme

- The effort of Processing & Engineering Division, MPOB in streamlining of individual projects into more integrated research programme is highly appreciated. Obviously this effort should be continued.
- Bearing in mind that MPOB has been actively involved in the elaboration and implementation of National Key Economic Areas (NKEA) and the 10 R&D strategic focus areas, it is recommended to start the preparation of the vision “Sustainable Palm Oil Production 2025”. It should take into consideration changing conditions in Malaysia as well as at the global level.

- To continue exploring possible involvement of MPOB in international R&D programs such as HORIZON 2020, USDA, bilateral programs, industrial programs, etc. The involvement of MPOB in these programs would increase its international recognition.

2. On new projects/ideas to be further developed.

The following areas of possible future research and development have been discussed and addressed:

- To streamline development of the integrated bio-refinery concept within palm oil utilization (bio-energy - biofuel – bio-based products and materials) taking into account cascade approach and including also sustainability assessment.

- To consider complex utilization of waste (EFB, POME, etc.) as well as of by-products (especially glycerol) to value-added products, phytonutrients, fine chemicals, biodegradable plastics (PLA), etc.

- New Palm Bio-based Materials
  Continue the developing effort on higher value added materials from OPT focusing on engineered lignocellulosic products for which engineering and physical properties must be well defined. Further, consider sensor technology to evaluate veneer structure to enable a better defined resource for conversion to products. Modifications of veneer through chemical and thermal means have potential to upgrade quality and should be considered. Thorough descriptions of the properties and potential of OPT veneers has high potential for dissemination through peer reviewed articles (see Appendix 6).

- On the Issues of Sustainability
  With regard to sustainability assessment and life cycle assessment (LCA), water footprinting and social LCA are topics of increasing relevance complementing the focus on carbon footprint. Both topics have been taken up in the research programme of the division based on previous advice from the PAC. It is
acknowledged, that starting the work on social LCA is both very relevant and at the same time challenging. As this topic depends on the support of other divisions and companies of the palm oil industry, it is recommended to solicit and encourage such support for this emerging topic. As a topic, that could get relevant to promote some environmental solutions, it is recommended that the potential of Material Flow Cost Accounting (MFCA) is explored in the future.

3. On further increase of MPOB impact on palm oil milling efficiency and sustainability (see also Appendix 4):

The proposals are focused mainly on:

- Oil Extraction Rates (OER) on Fresh Fruit Bunches (FFB)
- Environmental Quality (Crude Palm Oil Mill) Regulations Review
- Biogas (Anaerobic Treatment) Capture & Avoidance

4. On further improvement of performance of MPOB researchers and strengthening of interaction with PAC members

- It is recommended to explore the opportunities to train young scientists from MPOB at recognized centres of excellence worldwide and specifically those at PAC SC members institutions thus creating network cooperating institutions. Here, PAC SC members expressed availability to host the fellows from MPOB for short/medium terms (six – twelve months) as well as for PhD or post doc study stays
- SC expressed availability for tutoring/mentoring of MPOB researchers during the year via mail contacts
- PAC members are available at: the manuscripts pre-review, at focusing on suitable journal selection, at facilitating interaction of authors and journal’s editorial board and at evaluation of responses to reviewers’ comments

5. On further improvement of research projects proposals (see also Appendix 5)

- It is recommended to continue clustering and integrating of the research projects. Links and possible integration among projects within the Division and/or with other Divisions should be explored.
- It is recommended that the new proposals should have a more detailed description of the work plan/phases/milestones, clear definition of goals as well as indication of end-up/follow up.

Acknowledgements

Sub-Committee would like to express their appreciation to the Director-General, Deputy Director-General, Director and staff of the Processing and Engineering Division for their cooperation and warm hospitality. Sub-Committee expressed appreciation to Dr. Loh Soh Kheang for her efficient assistance at all works of Sub-Committee. Sub-Committee wish that all research officers will achieve even greater success in their future endeavours.
ENGINEERING AND PROCESSING RESEARCH DIVISION
ON-GOING PROJECTS

1. PROGRAMME : BIOENERGY

1.1 ON-GOING PROJECTS

1.1.1 EP 113/2009 - Glycerol Utilization for the Production of 1,3-Propanediol (1,3-PD)

The Sub-Committee (SC) congratulated the group for the good job on utilizing response surface methodology for optimum production of 1,3-PD.

The production of 1,3-PD and other by-products were conducted in triplicates. SC recommended the graph should include error bars to indicate variations in the data.

SC proposed to explore other routes of transformation of glycerol into value-added products such as lactic acid and other relevant compounds.

This project could also be integrated/clustered in the future with other related projects focused on transformation of glycerol and its use e.g. EP 175/2015, EP 168/2014.

1.1.2 EP 115/2009 - Bioenergy Production from Algae

SC highlighted large variations was observed on the maximum growth rate of microalgae.

SC noticed a large difference in the fatty acid composition between the microalgal oil and the biodiesel obtained from in situ transesterification of the same microalgal oil. SC commented that these values should be similar.

SC was informed that digested POME (5-10%) from anaerobic pond was used to cultivate the microalgae.

Although cultivating algae using commercial medium (BBM) was quite promising, SC commented that it may be not worth looking into cultivating the microalgae for biodiesel production in the algae pond.
SC questioned on the commercial value and the future prospect of this project, as this has been raised 2-3 years ago. SC was informed that the commercialization would not materialize now since it is a very costly process. Harvesting and extraction of the oil from algae is still a problem.

SC commented that even though the results were not viable for commercialization, they are good enough for scientific publication.

1.1.3 EP 125/2010 - Hydrocarbon Fuel from Palm

SC commented that the distortion of the ILCD LCIA was actually from uncertain normalization data and normalization references. Researcher cannot do much about this data as they are from EU references.

SC was informed that there will be no difference between the weight and energy allocation since the boundary of the LCA is the palm oil refinery and hydro processed fuel plant. This is because the products from palm oil refinery i.e. refined palm oil and PFAD have a similar lower heating value.

SC was informed that MPOB has managed to obtain some information about the processes conducted in the UOP facility.

SC encouraged the researcher to publish the results.

1.1.4 EP 174/2015 - Torrefaction of Oil Palm Biomass

SC was informed that the yields of torrefied oil palm biomass followed similar trend as those from other feedstocks.

SC was informed that the bio-oils produced as a by-product of the torrefaction process can be used for extraction of fine chemicals and as a flavouring agent. The previous projects conducted i.e. EP112/2009 on fast pyrolysis of oil palm biomass and EP155/2012 on potential value-added chemicals from pyrolysis oil (bio-oil) are relevant and can be integrated here to look into the feasible utilisation of the bio-oil produced.

SC advised that future efforts need to be specific with indication of appropriate timeframe.
SC queried on the selection of EFB rather than other oil palm biomass *i.e.* shell, frond and trunk; as shell seems to be a suitable material because of its homogeneity and in ready form.

SC suggested to include the error bars on the data presented for EFB, frond and trunk.

SC suggested to compare the energy value of the torrefied pellet produced with that produced by a simple moisture reduction. The researchers also need to study the economic and market accessibility of the torrefied pellet.

**1.1.5 EP 175/2015 - Glycerolysis of Palm Fatty Acid Distillate as Biodiesel Feedstock using Heterogeneous Catalyst**

SC suggested using commercial CaO which is cheaper and readily available in the market. In addition, calcinated eggshell caused an undesirable darker colour in the final product.

SC was informed that the objective of using eggshell was to reduce the solid waste.

SC also suggested to look into the possibility of integration of glycerol project with that in the production of lactic acid, 1,3-propanediol, *etc.*
2. PROGRAMME: ENVIRONMENT AND SUSTAINABILITY

2.1 ON-GOING PROJECTS

2.1.1 EP 158/2013 - Water Footprint of the Production of Crude Palm Kernel Oil and Palm Kernel Expeller

SC suggested to use the UNEP-SETAC consensus method (WULCA) to compare the water footprint.

SC suggested to include the uncertainty in the inventory data, and to conduct sensitivity analysis.

SC was informed that the researchers intended to submit the results for publication, preferably in the Journal of LCA.

2.1.2 EP 159/2013 - Consequential Life Cycle Assessment of the Production of Palm Kernel Expeller (PKE) Specifically used as Animal Feed

SC commented that the displacement of feed just based on protein may not be good enough as not all the protein in PKE are absorbed. Efficiency of absorption should be considered.

SC commented that the IPCC calculation of biogas based on chemical oxygen demand may not be suitable for the actual scenario because different anaerobic treatment systems have different digestion efficiency. The anaerobic digestion efficiency has to be considered.

SC commented that the GHG emissions of the vegetable oil varies, the displacement calculations must also be carried out using the sensitivity analysis approach.

SC commented that the European data may not be applicable for tropical conditions. SC cautioned that one has to be careful when using the data from literature.

2.1.3 EP 166/2014 - Bioflocculant Production from Palm Oil Mill Effluent (POME)

SC appreciated the interesting results obtained and active research conducted.

SC was informed that the better bioflocculant yield from bio-reactor than the shake flask was probably due to the flexibility in adjusting and manipulating the process parameters as compare with that in bioreactor.
SC suggested to look into using bioflocculant for raw water treatment as there is a ready market for this application.

SC also suggested to look into the possibility of integrating this project with other relevant projects or any other potential upcoming new projects as a follow-up from the conclusion of this project.


SC was informed that the high ash content (>10%) for Plants A and B was due to the poor quality of pressed EFB received from the mills. The pressed EFB has been stored either at the mills or the plant for quite some time and exposed to soil and other foreign materials. This has caused physical degradation and silica contamination prior to pellet production, hence contributing to a higher ash content. Plant C has an additional pretreatment facility for the reduction of ash content. Plant A was integrated with a palm oil mill, receiving fresh supply of EFB for immediate processing, therefore it has a lower ash content of < 4%.

SC requested the researchers to include a detailed report on sampling procedure and sources of EFB contributing to increased ash content of the pellet produced. Characteristics of the ash should also be determined.

SC advised to consider a sensitivity analysis for EFB as a product. In that case, the LCA study starting from zero burden should be compared with EFB having allocated some burden from upstream.

2.1.5 EP 172/2015 - Investigation on the Practice of Disposing Treated POME into Plantation and its Impact on Adjacent River Quality

SC commented that the revised methodology was very site specific; thus the data transferability is questionable. It may be difficult to generalize the results obtained for meaningful plantation operations on land application.

SC commented that potential saving of fertilizer can be achieved by the proper POME utilization. It has been well-established that application with bio-solids from POME can increase FFB yield without using inorganic fertilizers and also beneficial in
alleviating water stress, if the project can be conducted in a proper manner. The current project can only relief water stress but without any nutrient value.


SC suggested a particle size analysis be performed on the sample.

SC commented that the high moisture content from the TGA analysis could be due to water of crystallization in the compounds.

SC commented that the project should decide whether the objective is to avoid clogging due to crystal formation in the pipeline or to utilize the crystal as fertilizer. The methodology involved in these two objectives are different. SC suggested that avoidance in accumulation of the crystal is a better approach.

SC commented that this project was contradicting with EP 172/2015 as the latter was deemed to be more cost-effective due to its direct application to the plantation.
3. PROGRAMME: MILLING TECHNOLOGIES

3.1 ON-GOING PROJECTS

3.1.1 EP 132/2010 - Development of a New Palm Oil Clarification Process Based on Evaporation

SC was unconvinced about using evaporation process for water removal from the effluent since the system is very costly and consumed a lot of energy as compared with membrane filtration technology. The researcher clarified that this evaporation system is using undiluted liquor from the pressing station. Thus, the water content in the sludge is at a minimum level and it is economic to go for the evaporation system.

SC was informed that the purpose of the project was to work towards zero POME discharge. It is one of the alternatives that has been used to help the industry to solve the BOD problem.

3.1.2 EP 151/2012 - Potential Air Control Technologies for Particulate Reduction from Palm Oil Mill Palm Waste

SC was informed that the chosen technology has the potential to bring down the particulate level of chimney smoke from 400 to 150 mg/Nm$^3$ based on the previous experience in the wood industry. The pre-commissioning trial showed that the particulate level was below 100 mg/Nm$^3$ even though the inlet emission was more than 1,000 mg/Nm$^3$.

SC commented that commercial systems are available and they are installed and used in Europe.

SC was informed that the project was to cater for existing boilers. The role of MPOB was to provide to the technology provider information on palm oil mill processing, boiler operation and parameters required for the design purposes, etc. MPOB will also be involved in monitoring and improvement of the boiler operation, if any, to suit the technology in order to comply with the DOE requirement.

3.1.3 EP 152/2012 - Study on the Applications of Ionic Liquid in Oil Palm Processing

SC inquired on the possible reasons for the low content of carotene in the raffinate. SC suggested that the researcher to check the pH of the ionic liquid as carotene is easily degraded in acidic condition.
3.1.4 EP 157/2013 - Value Addition of Palm-pressed Fibre Oil

SC was informed that the partitioning of carotenes into olein and stearin fractions is dependent on the solvent ratio used. Carotenes have higher partition into olein (liquid fraction) with increasing of solvent ratio.

SC requested the researchers to check the data as inconsistency was observed.

SC was informed that the carotene and vitamin E were analyzed using UV-vis spectrophotometer and HPLC-Fluorescence detector, respectively. The vitamin E profile of fiber oil and crude palm oil was different as fiber oil contains about 50% α-tocopherol as compared with about 20% in crude palm oil. SC commented that individual forms of vitamin E should have been included instead of the total vitamin E content. SC also suggested to check on oxidized carotenes.

SC was informed that in order to facilitate crystal formation at high solvent to oil ratio e.g. 10:1, lower temperature e.g. 0°C was required to induce crystallization.

3.1.5 EP 163/2014 - Production of Feed Quality Palm Kernel Expeller (PKE) for Poultry Industry

SC was informed that the high feed conversion ratio (FCR) was due to high crude fibre content in the PKC used in the feed formulation. Currently, the installation of pre-cleaning system is pending due to finalizing the agreement. Once the installation is completed, the crude fibre in the feed could be reduced to a minimum level comparable to the commercial feed. Therefore, the feed intake per bird will be lower. SC advised the researchers to look into wastage of feed.

SC was informed that the use of enzyme in the feed formulation is to enhance the absorption of amino acids and phosphorus, and especially to increase the digestibility of fibre by the broilers. Lower absorption and digestibility of nutrients in the feed contributed to high FCR value.

SC was informed that a pre-cleaning system is capable of removing shell to a minimum level. This will contribute to low crude fibre in the PKC. Therefore, the use of enzyme may not be required in the future feed formulations.
3.1.6 EP 170/2015 - Trash Removing System (Trash-RID) for Palm Oil Mill

SC was informed that the issue of trash removal during rainy season will be addressed during the trial.

SC was informed that there are two stages of screening system in this study in order to take care of various sizes of trash including stones with similar size with the fruitlets.

SC was informed that the trend of trash coming together with loose fruits can be up to 8 to 10% per consignment.

The researchers requested for extension of 6 months and SC has agreed to the extension.
4. PROGRAMME : PHYTONUTRIENTS

4.1 ON-GOING PROJECTS

4.1.1 EP 078/2005 - Development of a Combined Production System of Tocotrienols, Squalene and Phytosterols from PFAD

SC was informed that the feed capacity of the pilot plant was 500 mL/min. It was also highlighted that the proposed patent will focus on the process to recover squalene from PFAD.

4.1.2 EP 155/2012 - Potential Value-Added Chemicals from Pyrolysis Oil (Bio-oil)

SC commented to provide further details on the research programme in 2016 i.e. to include the overall outlook and the possible next step to be taken e.g. publication or transfer of technology. This is also applicable to other researchers.

SC suggested to explore efficient methods for extraction of fine chemicals from bio-oil as well as to characterize and identify the extracted fine chemicals.

SC queried on the progress of the economic analysis (phase 5) of the project. SC was informed that it is necessary to establish the extraction method prior to economic evaluation.

SC encouraged researchers to present results including difficulties encountered and abnormal observations. The PAC platform should be used to get feedback for further improvement of the project.

4.1.3 EP 171/2015 - Process Development for the Production of Intermediate Palm Tocotrienols Products for Food and Beverages Applications

SC was informed that the desired target for a stabilized emulsion product should be with a particle size of 100 nm for a minimum of 30 days without phase separation.

SC suggested that nitrogen blanketing could be considered to prevent degradation of tocotrienols. SC also suggested the researchers to look into the pH of the emulsion.

SC requested the researcher to speed up the project as the progress for 2015 was only 35%.
5. PROGRAMME: BIOMASS PRODUCTS

5.1 ON-GOING PROJECTS

5.1.1 EP 123/2009 - Production of Furfural from Oil Palm Biomass Fibres

SC was informed that the furfural produced can be used as a fuel additive particularly for the aviation industry. SC suggested to look into other applications of furfural once this project is completed (e.g. as platform chemicals).

SC was informed that the chemicals used are quite standard. It was informed that to reduce the cost of production, this process would be part of the integrated process in the production of fine chemicals where cellulose and lignin can be recovered.


SC was informed that the fibre length produced from this machine complied with the requirement for the production of fibreboard.

SC was informed that the justification of using 3 machines is to produce different fibre lengths from EFB for downstream applications such as bio-composites, energy pellets and animal feed.

SC was informed that the earlier cost of maintenance was RM 0.13 per tonne of EFB processed. At that time, the cost was higher as the first version of the snipper press was using fin cutter and fixed knives. The design has been improved using a worm screw to cut and press the oil palm biomass. SC suggest to benchmark against existing processes.

SC recommended to study the homogeneity of the fibre mixture and resin, and to include the maintenance costs in the next report.

SC also requested to include the oil recovery revenue and to report on the effects of the oil content to the quality of the product.
5.1.3 EP 169/2014 - Production of High Density Fibreboard (HDF) From Empty Fruit Bunch Fibres for Flooring Application

SC requested to include the screen analysis of the refined materials and other analysis such as moisture content, before forming and pressing.

SC was informed that pre-treatment of the shredded EFB was not included as this project is a commercial collaborative project. The collaborator would try to avoid any additional costs on the chemical pre-treatment. The oil content in the HDF product will be reported in the next report.

SC was informed that the problem on the usage of high wax content to reduce the high water intake of the HDF will be further studied for optimization.

5.1.4 EP 178/2015 - Production of Sandwich Board from Oil Palm Trunk

SC requested the results on the particle size analysis (in percentage of different sizes) to be included in the next report.

SC recommended that the result on IB should be higher than 0.4 N/mm² for the sandwich panel to be successful. The study should be continued to achieve that target.

SC was informed that the parenchyma tissues (soft material) will reduce the strength of the particleboard, but in this product, the weakness in the particleboard will be catered to by layering with veneer, which eventually may give optimum results.

SC suggested that the high density area of the trunk (high mechanical properties) is used for the veneer-based surface layers whereas the low density trunk for particleboard-based core layer, therefore all the materials can be fully utilized.

5.1.5 EP 179/2015 - Two-in-one Carbonization and Activation Systems for the Production of Activated Carbon from Oil Palm Biomass

SC requested to include the capacity of production and the cost of maintenance in the economic feasibility study in the next report.

SC was informed that the inconsistent results in Table 1 may be due to
heterogeneity of the samples since samples were taken from different points in the furnace.

SC commented on the title of the project. The title should be more specific on the use of PKS rather than oil palm biomass for the activated carbon production.

6. PROGRAMME : GREEN PRODUCTS

6.1 ON-GOING PROJECTS

6.1.1 EP 138/2010 - Resource Recovery from Palm Oil Mill Effluent (POME)

SC was informed that the objective of the project has been changed due to the low content of recovered resource in POME in the earlier experiments; therefore the current project is not in tandem with the title.

SC requested to include the economic evaluation of the study even though the project has not been completed yet. The parallel analysis would enable the researcher to take any necessary actions to move towards the optimization of the process.


SC requested to check on the differences in the initial results of oil content of the materials. The researchers may need to repeat or recalculate the results.

SC was informed that the rapid composting has been achieved in the earlier study using the composter reactor, in which the target C/N value of 20 was reached less than 21 days. The current study is on the isolation of indigenous composting microorganisms that can reduce the cost of production of compost.

SC was informed that the isolation and identification of the microorganisms was carried out by a research collaborator.


SC requested to include the error bars in the data obtained. The measurements need to be replicated, not as a single experiment.
SC requested to explain on the phenomena or to re-check on the accuracy of the SEM magnification, as the size of the voids were inconsistent based on the SEM image.

SC was informed that the experiment was carried out in high temperature, therefore the high soap content and high viscosity of the glycerol used would not interfere with the process.

SC requested to specify the biopolymer product the researcher would like to obtain.

6.1.4 EP 176/2015 - Eco-Friendly Bio-based Lubricants from Palm Alkyl Ester

SC suggested to use other methods on identifying the unknown compound, such as LCMS, NMR or GPLC. The use of FTIR can be useful for identify the functional groups available from the bio-lubricants produced.

6.1.5 EP 177/2015 - Diversifying the Palm Based Sodium Carboxy Methyl Cellulose Characteristics for Different Applications

SC acknowledged the progress but commented on the different format of the written report as compared to the slides in the presentation.
PROGRAMME : PHYTONUTRIENTS

1. Solvent Fractionation of Palm Pressed Fibre Oil and Concentration of Phytonutrients from Palm Pressed Fibre Olein using Nanofiltration Process

The Sub-Committee (SC) urged that a proper plan on experimental design and analyses be conducted considering the constraints on man-power, resources and facilities available.

SC suggested to use up-to-date advanced instrumentation for sample analyses. SC suggested NIR for IV, replacing the time-consuming titration method; UPC² for simultaneous vitamin E, carotene and other phytonutrients analyses. Method development is needed and can be rapidly carried out. SC requested RM600,000 budget allocation for the two additional instruments. These two instruments are to be shared with other MPOB projects.

SC was informed that the use of nanofiltration in this project is new for the palm oil industry.

SC was informed that the project cost is low as the nanofiltration set-up is already available in MPOB.

SC also requested details in the purpose of using nanofiltration technology. It should clearly state that nanofiltration is to be used for molecular separation of phytonutrients from the triglycerides based on differences in molecular weight.

(Priority: B)
2. **Measurement of Odour Emission Levels at Palm Oil Mills**

SC was informed that this project was formulated to address the request from DOE on the proposed odour regulatory compliance *i.e.* at 12,000 OU/m³.

SC was informed that this project will be carried out in collaboration with USM using their olfactometer and related services. It will be conducted at 4 different mills with different type of effluent treatment systems.

SC requested to conduct detail analysis on odour-causing chemical components including identification of the odour sources.

SC was informed that the DOE’s proposed regulation does not need the detail on chemical components. Therefore, MPOB proposes to conduct the odour measurement first as a feasibility study, and then if needed MPOB will proceed with a detailed study in the second phase.

SC highlighted the importance of representative sampling. If the samples are non-representative, the results obtained are meaningless and can even be misleading.

SC recommended that the project should proceed only if proper sampling procedure is established. The sampling procedure is unique in this case because of the unique topography, different treatment systems, environmental changes, etc.

*(Priority: B)*

3. **Social Life Cycle Assessment of Crude Palm Oil : A Cradle to Gate Assessment**

SC was informed that the performance indicator reference is not necessarily an international law but can also be a local law, industry standard, industry target or government policy, etc.

SC suggested the inclusion of an additional stakeholder group since the oil palm industry is a very important industry for Malaysia as a whole.
SC was informed that the study is aimed to be a national study and will involve as many plantations and palm oil mills similar to the approach used for the E-LCA and water footprint studies.

SC suggested attention be paid to the questionnaire format in order to avoid biasness. It was informed that respondents may be alarmed by very difficult questions. The best way to gather data is to have a face to face interview with the respondents.

SC suggested increasing the budget, especially for travelling and training since this is a new emerging field.

SC highlighted that there may be a vast difference between the RSPO-certified and the non-RSPO-certified companies on social impact.

(Priority: A)

PROGRAMME : BIOMASS PRODUCTS

4. Integrated Process for the Production of Xylooligosaccharides and Product Recovery from Cellulosic Residuals

SC suggested that the lignin fraction be recognized in addition to the cellulose and hemicellulose fractions of the EFB.

SC suggested to start writing report and publication during the experimental phases.

(Priority: A)

5. Manufacture of Structural Composite Lumber Using Rosin-treated Oil Palm Veneers

SC proposed to consider the possibility on the use of other types of adhesive, besides PVA. SC doubted that PVA is suitable for the purpose.

SC was informed that all suggestions pertaining to the project will be looked into and be carried out accordingly.

SC suggested that emphasis should be given on research to improve the quality oil palm veneer prior to product making.
SC suggested that consideration of preservative treatment after manufacture of the structural composite lumber be considered as an alternative to treatment of the veneers. For structural applications, mechanical and hygroscopic properties are needed. The required mechanical properties can be achieved by disintegration of OPT to veneers and processing of veneers to plywood or LVL. The hygroscopic properties and the durability of veneers can be significantly improved by physical modification of veneers by impregnation with natural or petrochemical-based polymers. If this is possible, moisture-resistant and high durable veneers can be produced. There are many opportunities to use the veneers for high value added products.

(Priority: B)
The forest products industry in the United States is experiencing significant turmoil due to dynamic global competition. Research and development in the area of nanocellulose has progressed to the point that significant new markets for forest products are being rapidly developed. Sufficient resources from sustainably managed forests are available to support large volume markets.

Nanocellulose has been produced from a wide variety of plant materials including wood, bagasse, corn stover, and oat hulls. The two primary means of production are through use of hydrolysis (typically with sulfuric acid) to obtain cellulose nanocrystals (CNC) or the production of cellulose nanofibrils (CNF) through fibrillation processes including grinding, refining, homogenization, and steam explosion. There are now several entities in the United States which produce CNF at rates of 1000 kg/day (dry basis).

The rapidly increasing availability of larger amounts of CNF or CNC has allowed academic and industrial researchers to explore applications which represent significant market volumes. The market report from 2015 identified the global market for nanocellulose at $46.8 million USD in 2014 with projected growth to $277.7 million USD by 2019. The application markets with the largest volume of cellulose nanomaterials enabled products are packaging coatings, replacement for plastic packaging, plastic film replacements, absorbent products, and paper coatings. Active research is also be conducted in application areas such as structural foams, use of CNF as a binder to replace formaldehyde containing adhesive systems, and CNF/polymer filaments for 3D printing.

Examples of commercial activities include food (Nata de Coco from coconut nanocellulose is produced by Cocosong Food Industries Sdn. Bhd. - Johor, Malaysia), industrial and automotive components (Zelfo Technology GmbH - Brandenburg, Germany), nanocellulose/polypropylene composites for automotive, consumer, and industrial products (GreenCore Composites - Toronoto, Canada), and nanocellulose enhanced epoxy being used for bonding wood beams (InnovaWood (Belgium) and InWood (UK)).

A discussion about the potential for conversion of palm oil biomass to nanoparticles (such as CNF) ensued. Current research on extracting chemicals from EFB would provide an
interesting feedstock for this conversion. It was also discussed how this is an area of global interest and that research in this area has high potential for science contributions through peer reviewed journal articles.
NEW PROJECT IDEAS (MILLING)

Oil Extraction Rate (OER) on Fresh Fruit Bunches (FFB)

- MPOB has established an effective FFB Quality Penalty System that has resulted in higher oil contents in FFB for milling.
- An effective Audit System on Oil Extraction Loss on FFB (OEL) is needed to achieve consistent and optimised oil recovery efficiency.
- This project is to target Palm Oil Mills with low OER initially to establish representative sampling and reliable oil loss determination. Instrumental analytical techniques such as near infrared (NIR) spectrometry has been used commercially for quality assurance in the palm oil mills and refineries.

Environmental Quality (Crude Palm Oil Mill) Regulations Review

- Parameters for treated POME for water course discharge.
- Parameters for POME in land application and irrigation.
- Potential new parameter for treated POME - colour.
- Reduction in boiler flue gas particulates limit from 400 mg/m$^3$ to 150 mg/m$^3$.
- A plan to carry out a preliminary feasibility study to explore the odour emission levels in palm oil mills has been proposed. Subsequent study should only proceed if a proper sampling procedure is established.
- Re-activation of expert committees comprising of representatives from all the stakeholders is timely and necessary to evaluate impacts of new or revised parameters on the environment and the palm oil industry; and also technical committee to evaluate and monitor proper sampling and testing procedures.

The above items require urgent management.

Biogas (Anaerobic Treatment) Capture & Avoidance

- 86 mills has built biogas plants.
- MPOB milling licencing requires new mills and mills applying for capacity upgrading or extension to have biogas capture / avoidance plants.
- SC supports a licencing policy requirement for the remaining operating mills to install biogas capture / avoidance facilities.
• Improvements in economic viability and reliability in biogas engine, biogas quality and upgrading technologies will enhance the drive towards biogas capture implementation by palm oil mills.

Minimizing Oil Quality Degradation in Milling Processes

Efforts to re-visit CPO quality degradation in the palm oil milling can provide palm oil refineries with a better quality feed-stock.
COMMENTS AND SUGGESTIONS FOR IMPROVEMENTS IN PROJECT PRESENTATION AND REPORTING

1. Reports
Many projects indicated that publications or reports shall be submitted by the end of 2016. By sending a copy of the publication to SC members, it can serve to inform and update SC members on the progress or closure of the project.

2. Closely-related Projects
Many projects are closely related or strongly linked to each other. These projects can be treated in integrated way. Researchers are strongly encouraged to submit joint publication. Joint publications usually can have more contents to be published in a peer-reviewed journal, and thus a clearly better chance of being accepted by a journal with a higher impact factor.

3. Projects with Little Data
Projects with no or little data respective results available at the time of presentation should summarize the presentation in not more than 3 slides, explaining the difficulties encountered.

4. Project Novelty and Uniqueness
Researchers should summarize the novelty and state of the art features of the project. A summary slide can facilitate SC members to understand the value of the project at a glance.

5. International Exposure
Researchers can be attached to a good organization overseas in order to acquire knowledge and skills in carrying out research. Such a short-term visit also provides better interactions and closer contact with overseas researchers and institutions.

6. Measurement and Data Reporting
Experiments are often replicated to increase the confidence of the results. The data obtained from replicated experiments should be reflected in the results. Thus, number of replicates, measurement uncertainty or errors, normally expressed as ± SD or SEM and error bars in the graphs should be included in the presentations and reports.
NEW PROJECT IDEAS (BIOBASED MATERIALS)

- Investigation of the causes of high swelling of EFB and OPT based particleboard or MDF (particle size, parenchyma content, fiber structure)

- Polymer impregnated OTP-veneers for multi-use concrete formwork panels

- Polymer impregnated for laminating furnitureboards and floorboards

- Palm oil-based pMDI as an adhesive for wood based panels

- Pyrolysis oil (torrefaction oil) as a wood protection agent (preliminary study)

- The tensile strength of OPT veneers depending on the density with and without compression (densification) (general study)

- Thermoplastic based filament for 3D printing with oil palm lignocellulosic filler

- Cellulose nanofibril (CNF) production from extracted EFB fiber or other selected biomass residual and evaluate quality
PAC
PROGRAMME ADVISORY COMMITTEE
36TH MEETING: 11TH – 15TH APRIL 2016

COMBINED REPORT
TECHNICAL PROMOTION & MARKET DEVELOPMENT SUB-COMMITTEE

Plenary Session
Date: 15th April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
PRESENT:

1. YBhg. Dato’ Carl Bek-Nielsen, United Plantations Bhd., Malaysia – Chairman
2. YBhg. Datuk Franki Anthony Dass, Sime Darby Plantations, Malaysia
3. Mr. Thomas Mielke, ISTA Mielke GmbH, Germany
4. Mr. Sushil Goenka, Foods Fats & Fertilisers Ltd., India
5. Mr. U.R. Unnithan, Carotino Sdn. Bhd., Malaysia
6. Mr. Chin Kok Tian, Erapoly Global Sdn. Bhd., Malaysia

IN ATTENDANCE:

1. YBhg. Datuk Dr. Choo Yuen May, Director-General MPOB
2. Dr. Hj. Ahmad Kushairi Din, Deputy Director-General (R&D)
3. Tn. Hj. Mohamad Nor Abdul Rahman, Deputy Director-General (S)
4. Ms Rosidah Radzian, Director PDAS
5. Ms Fauziah Arshad, Head, Technical Advisory Services Unit
6. Dr. Tan Yew Ai, Head, Head, Sustainable, Conservation and Certification (SCC) Unit
7. Dr. Ainie, Kuntom, Senior Research Fellow
8. Mr. Mohamed Salleh Mohd. Kassim, Senior Research Fellow
9. Dr. Kalanithi Nesaretnam, TAS Regional Manager, Europe
10. Dr. Ooi Cheng Keat, TAS Regional Manager, Far East
11. Dr. Nagendran Bala Sundram, TAS Regional Manager, South Asia
12. Tn. Hj. Isa Mansor, TAS Regional Manager, Africa
13. Mr. Johari Minal, TAS Regional Manager, Americas
14. Mr. Mohamad Fairus Hidzir, TAS Regional Manager, West Asia/CAR
15. Tn. Hj. Hisamuddin Mohd. Aspar, TAS Regional Manager, ASEAN
16. Ms Juanita Lourdes Nathan, TAS Regional Manager, Australasia/Oceania
17. Ms Subashini Nadras, TAS Unit
18. Mr. Yoong Yun Hao, TAS Unit
19. Tn. Hj. Hashim Hussain, TAS Unit
20. Ms. Rafizah Mazlan, TAS Unit
21. Ms. Nor Asliza Samiran, TAS Unit
22. Ms Eliza Johari, TAS Unit
23. Dr. Puah Chiew Wei, SCC Unit
24. Mr. Nik Mohd. Aznizan Nik Ibrahim, SCC Unit
25. Ms. Rozanna Rosdin, SCC Unit
26. Ms Nazira Khabibor Rahim, SCC Unit
27. Nik Sasha Khatrina Khairuddin, SCC Unit
OBSERVER:

1. YBhg. Datu Jaul Samion, MPOB Board Member
2. Ms Belvinder Kaur Sron, Malaysian Palm Oil Council

ABSENT WITH APOLOGY:

1. **PREAMBLE**

The Chairperson (CP) welcomed all members of the PAC Sub-Committee to the 36th PAC meeting. He emphasized the importance for all the presentations to be precise and to focus on the substance and in this regard, recommended that the presentations focus on the overview and follow-ups on last year PAC’s recommendations for the gap analysis in order to spend more time on the SWOT analyses, MPOB’s initiatives, the main issues to be addressed and a conclusion with a maximum of 20 slides. This will provide more time for deliberation amongst PAC members and TAS Officers.

The CP also recommended that any suggestions given last year that had not been followed up and those that require continuous efforts would automatically be included into the current year’s recommendations in order to avoid duplication and waste.

The Sub-Committee also expressed their appreciation for the presence of YBhg. Datu Jaul Samion, Permanent Secretary, Ministry of Land Development Sarawak and the presence of Ms. Belvinder Kaur Sron, Director of Promotions and Branding Division, as the representative from the Malaysian Palm Oil Council as observers.

The Sub-Committee also placed on record a deep sense of appreciation and gratitude to the CP, for chairing the meeting in the usual efficient and professional manner.

The PAC Sub-Committee was pleased with the performance of the TAS regional managers in promoting palm oil products and their innovative approach in its promotion particularly in the Far East, West Asia, Europe and the Africa regions.

The Sub-Committee also placed on record, their appreciation for the good progress made with regard to the establishment of the MPOB India Branch Office.

2. **BRIEFING BY THE DIRECTOR OF PRODUCT DEVELOPMENT AND ADVISORY SERVICES DIVISION**

Cik Rosidah Radzian, Director of Product Development and Advisory Services (DPDAS) welcomed Members of the Sub-Committee to the 36th meeting of the PAC and briefed the Sub-Committee on the house keeping rules, the current organizational structure for PDAS and the activities of each Unit under the division.
Organizational Structure for 2016 and its Functions under the Division

Cik Rosidah informed the PAC Members that there were four Units under the Division i.e. Analytical and Quality Development (AQD) Unit, headed by Dr Halimah Mohammad, Nutrition Unit, headed by Dr Kanga Rani Selvaduray, Protein and Food Technology (PFT) Unit, headed by Dr Miskandar Mat Sahri and the Technical Advisory Services (TAS) Unit, headed by Puan Fauziah Arshad.

The PAC Members were informed that the organizational structure remains the same except for the appointment of Dr Kanga Rani following the appointment of Dr Nagendran Bala Sundram as the Regional Manager for South India. There were also two newly appointed contract Research Officers i.e. Ms Nor Asliza Semiran in the TAS Unit and Ms Nur Atikah Ibrahim in the Energy and Protein Centre in Keratong, Pahang under the PFT Unit. The PAC Members noted that the AQD, Nutrition and PFT Units were research oriented while TAS focused on the technical promotion of palm oil and palm oil products worldwide.

The Sub-Committee also noted that MPOB has established its sixth Regional Office in Mumbai, India which will mirror the R & D activities of PORTSIM China besides technical promotional activities.

Issues and Challenges Currently Faced by the Malaysian Oil Palm Industry relevant to PDAS

The Sub-Committee was informed that the French National Assembly has recently proposed for an amendment to increase the tax for palm oil similar to olive oil, which was an increment of Euro 86/tonne from the existing tax of Euro 104/tonne if palm oil is not sourced from un-certified sustainable suppliers. Noted that the tax will be maintained at Euro 104/tonne if the palm oil is sourced from certified sustainable suppliers.

The Sub-Committee was also informed that Malaysian palm oil is still listed under the List of Goods Produced by Child Labour or Forced Labour as reported by the US Department of Labour since 2009. This is an important issue to the Malaysian oil palm industry in view that forced labour has been included in the Trans Pacific Partnership Agreement (TPPA).
It was noted that while the Indonesian palm oil has been blamed for issues such as deforestation, transcontinental smog and greenhouse gas emissions, the NGOs do not differentiate between Malaysian and Indonesian palm oil, and as such issue of sustainability and the environment continue to be a challenge.

The Sub-Committee was also informed as Malaysia moves towards becoming a fully developed nation by 2020, obesity has also becoming an issue for the country as more than 18% of the country’s population are obese. Noted that MPOB has initiated to engage with the Ministry of Health (MOH), Malaysia will collaborate with the MOH to conduct studies to provide the evidence that palm oil is not a risk to CHD and obesity. The Sub-Committee also noted on the Multi Centres Studies on lipid nutrition conducted in several countries i.e. China, India, Australia, UK, France, US and Malaysia.

As a way forward, the Director proposed for a Roundtable Discussion between the Technical Promotion and Market Development and Food, Nutrition and Quality Sub-Committees on Tuesday afternoon at 2 pm to discuss and come up with strategies to address the current issues.

3. MATTERS ARISING FROM THE 35TH PAC MEETING (13-17 APRIL 2015)

The matters arising were presented to the Sub-Committee. The Sub-Committee was very pleased with the follow up from the last PAC meeting which for the first time applied to all TAS regions to which the PAC members wished to express their compliments.

The Sub-Committee commended on the efforts done by MPOB in developing the promotional material on nutrition which the Sub-Committee had earlier made a strong recommendation to counter allegations particularly on nutritional aspects concerning health.

The Sub-Committee, however, was not pleased with the slow progress of not being able to address the issue concerning forced labour and child labour which had been linked to the palm oil industry over the last 6 years. The sub-committee very emphatically stressed that this issue should be given the highest priority by the MPOB and the relevant authorities, for example MPIC, MoHR, in addressing the above issues
as these issues have now become an acute liability for the industry in terms of its market penetration into the USA with the potential impacts of this spreading to other importing countries. The Sub-Committee urged the above mentioned authorities to do the utmost to comply with the ILO Standards without further delay. This was especially relevant in view of the forthcoming implementation of the Trans Pacific Partnership Agreement (TPPA) in which Malaysia is one of its member countries.

4. KEY ISSUES

The Sub-Committee made the following general recommendations:

i. The Sub-Committee also discussed on the need to expand the engagement with the schools in Malaysia to include the private international schools and international universities as well. In this regard, the Sub-Committee also proposed that promotional materials be made available which would also include messages to convey the correct information on sustainability and the environment to the relevant institutions. This would also involve the likelihood of the private sector being invited along to participate in such educational activities. The Sub-Committee also noted that the importance of the social media in influencing the general public and agreed for MPOC to take the lead in the promotion in the social media. In this respect, it was requested that emphasis be given on using much of the available information from various scientific and reputable institutions including science based NGOs, e.g. World Resource Institute, to help distribute positive information and counter the allegations made against Malaysian palm oil. The Sub-Committee also recommended for this initiative to be extended to the private and international schools and universities in Singapore.

ii. The Sub-Committee recommended that the MPOB to continue their engagement with the Ministry of Health in Malaysia as well as in Singapore involving MPOC to jointly help clarify some of the misunderstandings circulating on palm oil and its health attributes in order to arrive at a more balanced approach. The Sub-Committee recommended that a minimum of two meetings be held with the Singaporean authorities over the next 12 months. In this connection,
the Sub-Committee urged the MPOB to speed up or to accelerate nutrition studies on the aspect of palm oil for these to be used for promotional purposes. In this respect, the Sub-Committee specifically recommended that Cambridge/Harvard University be contacted to undertake this study.

iii. The Sub-Committee discussed the increasing importance of the social media. The Sub-Committee agrees that MPOC to take the lead in the promotion in the social media and encouraged MPOC to enhance their promotional efforts in this area and for MPOC to enhance the palatability of the contents to create more interest amongst the young and old people and to reach out to a wider coverage.

iv. The Sub-Committee also recommended to intensify the translation of promotional materials into other languages such as in the Hindi, Tamil and Telegu for the expanding Indian market in addition to the other languages that are already proposed by the various Regional Managers.

v. The Sub-Committee recommended that MPOB develop a peanut butter flavoured formulation by using palm oil based fractions. This will eliminate the risk of aflatoxin contamination in peanut butter especially in the African region.

vi. The Sub-Committee recommended that the MSPO certification be directed towards the smallholder segment thereby be able to fulfil the UN recommendations on improving the livelihood of the poor and simultaneously ensuring that responsible development can go hand in hand with protecting the environment. The Sub-Committee was of the opinion that the MSPO certification would be able to fill the void which currently exists with the RSPO certification, particularly amongst the smallholders who either did not have the resources or finances to proceed with sustainable farming.

vii. The Sub-Committee recommended that there should be less focus on protecting market share but on increasing the sales of higher value-added products.
viii. Whilst the Sub-Committee appreciated the work done on 3-MCPD and its mitigation by the MPOB, it nevertheless recommended that more work needs to be done in order to prepare the industry for a potential backlash which very well could be just around the corner. The question posed by the Sub-Committee—are we ready to address issues in the international media relating to 3-MCPD in an affirmative manner? In other words, the Sub-Committee wished for the MPOB to pre-empt such an outcome.

ix. The Sub-Committee recommended that the regional offices interact with their counterparts at the Indonesian Embassies (and any other palm oil producing countries) with regard to the sustainable development of palm oil.

x. The Sub-Committee recommended for all the RMs and TAS Officers to fully understand the issues affecting palm oil across the globe and to be consistent in the dissemination of messages in the various regions. A standard fact sheet comprising all the necessary information to be used by TAS RMs and officers. This standard fact sheet (environmental and oil palm facts & figures) should be in every MPOB publications. These should be data from unbiased parties (e.g. MPOB Statistics, Oil World, FAO, etc…).

xi. The Sub-Committee also recommended the MPOB to commission an independent study on life cycle assessment comparing palm oil vs soybean and rice cultivation and to compare the results between these three primary agricultural crops and to assess the differences in each of these crops’ GHG emissions- carbon footprint expressed in kgCO$_2$eq product produced, i.e. per tonne of oil and per tonne of rice.

xii. The Sub-Committee recommended that the contract of Dr. Ooi Cheng Keat and Dr Kalanithi Nesaretnam to be extended to assist in the technical promotional activities in the Far East and Europe regions.

xiii. The Sub-Committee recommended that MPOB together with the Ministry of Natural Resources (NRE) and MPIC to formulate a
strategic master plan providing a clear policy on the targeted area that would be permanently set aside under protected forest and what would be used for agriculture specifying plantation crops. The intention of the aforementioned is to create a landscape use master plan for Malaysia, which can be used for promoting the country’s Green Agenda.

xiv. The Sub-Committee recommended that the MPOB & MPOC to form a ‘War Room’ to formulate strategic communications/rebuttals as expeditiously as possible when serious allegation arise. In this connection, it was specified that the MPOB should take the lead on allegations surrounding health-science related issues and that the MPOC should take the lead on environmental and social issues. The Sub-Committee advocated that the culture of readiness to pre-empt any such problems.

xv. The Sub-Committee expressed their strong concern with the acute labour shortages currently experienced in the Malaysian palm oil industry, considered to be the worst in the last 10 years arising from the freeze on recruiting foreign labour. The Sub-Committee specifically mentioned the urgent need for the MPOB (ideally the Chairman’s personal intervention) to engage with the relevant ministries to overcome the current freeze on foreign workers as this would inevitably become a liability for Malaysia in terms of lower tax revenues arising from lower yields, higher loses and a smaller production and export volume of palm oil during 2016.

xvi. The Sub-Committee recommended that future presentations to give an overview of total oils and fats export, overall palm oil export before focusing on Malaysian export data.

xvii. The Sub-Committee also appealed to the MPOB top management to consider compressing the PAC meeting schedules from 5 days to 3 days in view of the fact that many representatives found it difficult to justify being away from their other responsibilities for more than 3 days. The proposal will be as follows:
Monday | Seminar with presentations by PAC members and invited speakers (addressing current issues which can be taken up in the sub-committee discussion later) & Cross Cutting Forum

Tuesday | Opening plus presentations in the respective Sub-Committees

Wednesday | Presentations in the respective Sub-Committees and report writing & Dinner

Thursday | Morning: Finalisation of recommendations and conclusions of the Sub-Committee  
Afternoon: Plenary

**General Recommendations brought forward to 2016 in view of its on-going activities:**

i. The Sub-Committee also recommended that findings from the meta-analysis which highlights that saturated fat is not bad for health published by researchers from the Cambridge University should be translated into consumer-friendly messages and communicated extensively particularly through social media.

ii. In view of the fact that the information in the technical material would be dynamic, the Sub-Committee recommended that the information be revised annually based on new research findings and to update the members of the PAC Sub-Committee on 1st March every year.

iii. The Sub-Committee recommended for MPOB and MPOC to intensify efforts and to continue to participate actively in the relevant trade seminars, food and feed exhibitions to promote Malaysian value added palm based products. The Sub-Committee recommended that either MPOB or MPOC or both should be represented at each of these events.

iv. The Sub-Committee recommended that technical promotional materials be translated into the local language particularly in those importing countries where language is a barrier.
v. The Sub-Committee also highlighted on the importance to build brands which incorporate Malaysian palm based products as a way to build loyalty and realise a higher value for palm products including both food and feed and recommended for the MPOB TAS Regional Managers to assist in the promotion of these Malaysian Brands.

vi. The Sub-Committee noted that there was a decline in the Malaysian export for two consecutive years, which is partly a result of declining yield and production for which weather factors cannot be blamed alone. The reasons for the decline should be carefully analysed. In this regard, the Sub-Committee requested for information on the pattern on the total planted area, areas under replanting (small holders and private estates) and the age profile based on the following breakdown: 3-10 years, 10 - 15 years, 15 – 20 years and >20 years to know the trend for the last five years (2011-2015) which has an impact on the oil yield and palm oil production. Nevertheless, there are also other factors to be analyzed.

vii. The Sub-Committee also recommended that locally recruited staff (LRS) be recruited to facilitate and assist with the market development activity in the respective regions.

5. Technical Advisory Services

5.1 European Region

The Sub-Committee made the following recommendations:

- The Sub-Committee recommended that the issues surrounding endocrine disruptors be thoroughly followed and that mitigative measures be taken in Malaysia to pre-empt the likelihood of the thresholds for various pesticides used in the industry being lower than 0.01 ppm. This would include a comprehensive sampling of CPO of all Malaysian states.

- The Sub-Committee recommended that the issues surrounding 3-MCPD & glycidyl esters be thoroughly followed and monitored and that mitigative measures be taken in Malaysia to keep 3-MCPD levels below 1 ppm at the point of export.
• The Sub-Committee noted that Europe remains an important region, the Sub-Committee recommends that MPOB & MPOC continue to enhance the lobbying and promotion of sustainable palm oil vigorously.

5.2 Americas Region

The Sub-Committee recommended the following for the Americas Region:
• The Sub-Committee was displeased with the slow progress to resolve the alleged forced/child labour issue and strongly urged MPOB to convey to the Malaysian Government the acute need to resolve the issue before the Trans-Pacific Partnership Agreement (TPP) is enforced. The Sub-Committee stressed that the alleged forced/child labour issue could be very damaging to the image of Malaysian palm oil.
• The Sub-Committee also recommended for MPOB to request through MPIC that the Malaysian Government to amend related laws for fully compliance and adherence with the International Labour (ILO) standard.

5.3 Australasia/Oceania Region

The Sub-Committee made the following recommendations:
• The Sub-Committee recommended that technical promotion to focus on expanding the market share of palm kernel cake in Australia and New Zealand.
• The Sub-Committee recommended that to explore further potential use of palm kernel expeller (PKE) and to conduct analysis on the current use of PKE vis-à-vis use of other oilseed meals in animal feed especially during the time when the milk price is declining. The Sub-Committee also recommended to come up with ways for a higher price realisation to reduce the price gap between palm based animal feed against other oilseed meals.

5.4 China and Far Eastern Region

The Sub-Committee made the following recommendations:
• The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in China led by the Director General
of MPOB, through tripartite R&D and commercialization and engagements with local authorities, and recommended that these efforts be intensified.

- The Sub-Committee noted promotional efforts of MPOB and MPOC to disseminate information on palm oil through social media and recommended that this effort be intensified to broaden reach of Malaysian palm oil to users of palm oil and consumers in China.

- The Sub-Committee recommended that the presentations at Palm Oil Health and Nutrition Forums in China be uploaded and shared to the public in MPOB Official Website in China.

- The Sub-Committee noted the importance of promoting palm oil in animal feed industry in China and recommended intensified R&D works be extended on animal feed be conducted by PORTSIM and to extend animal feed trials to include triglyceride based fat powders.

5.5 India and South Asia Region

The Sub-Committee made the following recommendations:

- The Chairman and the Sub Committee noted that they were very pleased with the current initiatives, progress and efforts by the MPOB India Branch Office. They recommended that MPOB India Branch office replicate the effective research activities conducted in PORTSIM China to enhance palm oil utilization in India.

- The Sub Committee commented that MPOB India should take a pro-active approach to chart strategies to overcome any nutrition or sustainability issues which are currently affecting the developed countries.

- The Sub-Committee recommended that MPOB India engage or lobby policy makers, health authorities and various government agencies to improve the perception of palm. One of the suggestions is to establish strong networking with Dr. RBN Prasad, former Chief Scientist & Head Centre for Lipid Research, Indian Institute of Chemical Technology who is currently the Chairman of the
Oils & Fats scientific panel under the Food Safety and Standards Authority (FSSA) of India.

- The Sub-Committee recommended that MPOB India explore the possibilities of blending palm oil with olive oil in the blending projects that will focus on blending of palm olein with indigenous oils to cater to the preference in the different regions of India and enter the premium market through health benefit of the blended oil.

- The Sub-Committee recommended that Malaysian Palm Industry take the opportunities from the initiative taken by the Central government of India which allows 100% Foreign Direct Investment (FDI) in oil palm plantations. The Sub-Committee however noted that this will need efforts and initiatives from the Malaysian palm oil industry.

- A Sub-Committee member (Mr Unnithan) expressed his keenness to assist MPOB India in the snack food project proposed between MPOB and ICT as India’s snack food market is expanding rapidly. MPOB should explore the application of palm oil products in snack food industry both as frying medium using palm olein and as a colorant and functional food using red palm olein.

- The Sub-Committee recommended that MPOB India explore the potential of palm biodiesel market and value added products in oleochemicals/chemical industry in India.

- The Sub-Committee recommended that MPOB should assist the Malaysian industry to take advantage of the existing potential of export of palm kernel cake in India and present the findings to the Sub-Committee next year. Emphasis should be given to the cattle feed industry in India where PKC can be utilized as feed.

- The Sub-Committee recommended that MPOB and MPOC focus more on promoting palm oil to the southern and eastern part of India.
5.6 West Asian & Central Asian Region

The Sub-Committee made the following recommendations:

- The Sub-Committee commended the various efforts by MPOB to enhance export and the image of Malaysian palm oil in Pakistan and the Middle East, through technical collaboration efforts such as development of palm based formulation, introducing Malaysian palm oil brand and engagements with local authorities, and recommended that these efforts be intensified.

- The Sub-Committee recommended for MPOB West Asia to follow up the status of convenient banking channels for export to Iran.

5.7 African Region

The Sub-Committee made the following recommendations:

- The Sub-Committee recommended that MPOB Africa to obtain on growth trend of middle class across African countries to estimate potential growth in demand. This is because the emergence of the middle class citizen will contribute to an increase in the calories consumed per person per day.

- The Sub-Committee recommended the MPOB to consider setting up two offices in the African region to tap the huge African market.

5.8 ASEAN Region

The Sub-Committee made the following recommendations:

- The Sub-Committee recommended that MPOB assess the domestic consumption of coconut oil for food and to evaluate the feasibility to blend palm olein with coconut oil in the Philippines.

- The PAC Sub-Committee recommended technical and scientific data related to palm oil be translated in local languages within the ASEAN countries. This is to ensure that the technical promotion and the message of the nutritional benefit are well conveyed to the consumers in the ASEAN region. The translated documents are recommended to be in hard copy as well as in electronic version.
Programme Advisory Committee
36\textsuperscript{th} Meeting: 11\textsuperscript{th} – 15\textsuperscript{th} April 2016

Combined Report
Techno-Economics Sub-Committee

Plenary Session
Date: 15\textsuperscript{th} April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
PRESENT MEMBERS:
1. Y.Bhg. Tan Sri Dato’ Dr. Mohd Noor Hj. Ismail, Tradewinds (M) Bhd.
2. Y.Bhg. Tan Sri Datuk Dr. Yusof Basiron, Malaysian Palm Oil Council (MPOC)
3. Dr. James Fry, LMC International Ltd. UK
4. Prof. Dr. Khalid Abdul Rahim, Universiti Putra Malaysia (UPM)

IN ATTENDANCE:
1. Y.Bhg. Datuk Dr. Choo Yuen May, Director-General
2. Dr. Ahmad Kushairi Din, Deputy Director General (R & D)
3. Mr. N. Balu, Director, Economics & Industry Development Division
4. Mr. Azman Ismail, Head, Techno-Economics Research
5. Tn. Hj. Wahid Omar, Director, Integration & Extension Division (IRED)
6. Tn. Hj. Hamdan Abu Bakar, Head, Extension Services Unit
7. Tn. Hj. Zulkifli Ab. Manaf, Head, Project Implementation Unit
8. Mr. Ayatollah Khomeini Ab. Rahman, Group Leader, Sustainability, Socio Econ.Study – TE Unit
9. Mr. Kamalrudin Mohamed Salleh, Group Leader, Market Dev. Group – TE Unit
10. Mr. Ali Zulhusni Ali Nordin, Group Leader, Production Economics Group – TE Unit
11. Tn. Hj. Khairuman Hashim, Group Leader, Extension & Group Services Unit
12. Mrs. Nur Hanani Mansor, Group Leader, Extension Project Implementation Unit
13. Tn. Hj. Mad Hashim Hj. Omar, Group Leader, Extension Project Implementation Unit
15. Ms Norhidayu bt. Abdullah, TE Unit
16. Mrs. Siti Mashani Ahmad, TE Unit
17. Mr. Zaki @ Aki Aman, Extension Services Unit
18. Mrs. Nazirah Che Jaafar, Extension Services Unit
19. Mrs. Ainul Shazwin Sahidan, Extension Services Unit
20. Mrs. Nursuhana Dahari, Extension Services Unit
21. Mrs. Hasmiza Desa, Extension Services Unit
22. Mr. Amran Ariffin, Extension Services Unit
23. Mr. Khairul Abidin, Extension Services Unit
24. Mr. Mohd. Khairul Anwar Isnin, Extension Services Unit
25. Mr. Mohamad Arfan Johari, Extension Services Unit
26. Mr. Mohd. Haidhar Abdul Hamid, Extension Services Unit
27. Mr. Parthiban a/l Kannan, Extension Services Unit
28. Mr. Tan Say Peng, Extension Services Unit
29. Mr. Nur Hana Basarudin, Extension Services Unit
30. Mr. Shakir Ali, Extension Services Unit
31. Mr. Khairul Abidin, Extension Services Unit
32. Mrs. Rahmahwati Rasuddin, Project Implementation Unit
33. Mrs. Humaira Mat Taib, Project Implementation Unit
34. Mrs. Sheilyza Mohd. Ishak, Project Implementation Unit
35. Mrs. Sheilyza Mohd. Ishak, Project Implementation Unit
36. Mr. Mohd. Ridzuan Sohimi, Project Implementation Unit
37. Mr. Mohd. Noor Izuddin Zanal Bidin, Project Implementation Unit

ABSENT WITH APOLOGY:
1. Mr. Shariful Ab. Wahab, Project Implementation Unit
1. **Welcome Remarks by the Chairman of the Sub-Committee**

Y. Bhg. Tan Sri Dato’ Dr Mohd Noor Ismail as the Chairman of the Sub-Committee welcomed all the PAC members to this 36th Programme Advisory Techno Economics Sub-Committee Meeting. All PAC TE Sub-Committee members attended the session, except for Dr. Susan Martin, University of Hertfordshire, United Kingdom due to health reasons.

2. **Briefing by the Director of the Economics and Industry Development Division**

The Sub-Committee was briefed on activities conducted by the Division, performance of the Malaysian oil palm industry in 2015 as well as research projects which are on-going and new research projects from the TE Unit. The Sub-Committee was also briefed on achievements of the 3 Units under the Division in 2015. For TE Unit, 4 projects were vivaed last year and 4 papers were subsequently published in Oil Palm Industry Economic Journal (OPIEJ). Regarding to the vacant posts in TE Unit, the Sub-Committee was informed that 4 candidates have been shortlisted and will be interviewed very soon.

The Sub-Committee suggested that the recruitment of new TE Research Officers should not only focus on candidates who have econometric background, but more importantly the candidate should have strong academic background on applied economics and the understanding of oil palm industry in general so that they can produce high quality research in-line with industry needs.

In the discussion on stagnating FFB yield, the Sub-Committee was informed that there are several contributing factors to the stagnating yield such as old and unproductive palm trees, (not replanted), higher proportion of young trees and lack of sufficient fertilizer application among independent smallholders. The Sub-Committee was also informed that FGV has developed two high yielding seed varieties i.e. “Yangambi” variety which yields O/B 29% and 3 WayCross variety, which can increase oil yield up to 9T/ha. It was also suggested that these high yielding materials should also be made available to smallholders who participated in the Replanting Scheme in order to increase their FFB yield. PAC members also highlighted that implementation of the “irrigation system” could help increase FFB yield. Therefore, it was suggested that to minimize the effect of El Nino, oil palm plantations should adapt the smart irrigation system.

The Sub-Committee commented that palm oil mills should focus on zero-waste technology. The Government needs to come out with a policy on zero-waste or discharge in order to add value to the oil palm industry. The Sub-Committee suggested that EID Director and his relevant TE Officers make a visit to a Thai palm oil mill (Tha Chang...
Industry in Surat Thani, Thailand), which has a high processing capacity of 120 tonnes per hour and all the FFBs supply for the mill are from smallholders. The mill also adopt zero waste technology and contributes to the production of energy to the national grid.

3. New Project Proposals of the Techno-Economics Research Unit

3.1 Labour Requirement in the Oil Palm Independent Smallholders Sector in Sabah and Sarawak (Azman Ismail)

The Sub-Committee was informed that the objective of this study is to estimate the labour requirement and shortage in the oil palm independent smallholders (ISH) sector in Sabah and Sarawak and also to formulate a solution to resolve the labour shortage problem in the sector. It will also provide information on current labour requirement in the oil palm independent smallholders sector. The information can be used by the State Governments in formulating appropriate labour policies and strategies to assist ISH for overcoming the labour shortage problem and increasing their productivity.

The Sub-Committee suggested that ethnicity group such as Bajau, Kadazan, Murut, Bidayuh and etc. should be included in the questionnaire. The Sub-Committee also suggested that the researcher includes qualitative measures in the study. Level of mechanization (if any) also should be studied since mechanization can reduce labour utilization.

The Sub-Committee Approved the project.

3.2 The Impact of Currency Fluctuation on Malaysian Palm Oil Export (Nur Nadia bt. Kamil)

The Sub-Committee was informed that for the past few months, the Ringgit was weakening against the U.S Dollar. In general, the fluctuation of the currency will give an impact on the performance of the agricultural commodities trade. As one of the largest exporter of palm oil, the Sub-Committee was informed that Malaysian palm oil exports are also significantly influenced by the volatility of the foreign exchange rates. Thus, the objective of this project is to gauge the degree of the impact of the currency fluctuations towards Malaysian palm oil export performance. In addition, this project also aims to identify and formulate appropriate strategies to minimize the impact of currency fluctuations on Malaysian palm oil exports.

The Sub-Committee commented that CPO & PPO should be separated in the study. Besides the US Dollar, the study should also focus on the impact of Indonesian Rupiah against RM (i.e. comparing local delivered CPO and FOB Belawan CPO). The Sub-Committee informed that the exchange rate gives more impact to the downstream sector
such as refined products, oleochemical and biodiesel. The Sub-Committee suggested that the researcher consults the industry players on how important exchange rate is to their businesses (e.g. hedging activity). The study should also make comparison between the impact of exchange rate to other vegetable oils like soyabean oil, rapeseed oil and others.

The Sub-Committee Approved the project.

3.3 An Empirical Analysis of Malaysian Palm Oil Export to TPPA Member Countries (Nur Nadia bt. Kamil)

The Sub-Committee was informed that Malaysia has signed the Trans-Pacific Partnership Agreement (TPPA) in February 2016. Being a very open economy, Malaysia is said to benefit from its participation in the TPPA as it addresses the trade barriers issue. However, there are disputes saying that the cost of joining the TPPA has outweighed the benefits. Being the largest exporter of palm oil, the elimination of trade barriers is expected to enhance the performance of Malaysian palm oil exports to the TPPA Member countries. Therefore, the project will analyse the performance of palm oil exports to other TPPA Member countries. The objective of the project is to estimate/gauge the impact of Malaysia’s participation in TPPA in terms of palm oil export performance. Additionally, a simulation study will be done as to analyse the scenario of Malaysian palm oil export volume with and without the participation in TPPA.

The Sub-Committee suggested that the study should also make comparisons between FTA, TPPA, Bilateral agreements and analyse the impact on the Malaysian palm oil export to these selected countries. The study also should disaggregate between CPO & PPO in the study. The Sub-Committee suggested that the researcher apply WITS (online model) in order to analyse global perspective for trade agreement and for the purpose to make comparison between the 2 models. Besides that, proxy variables are also suggested to be used instead of dummy variables in the model.

The Sub-Committee Approved the project.

3.4 Economic Assessment of Zero Waste Technology for Palm Oil Mills in Malaysia (Ali Zulhusni Ali Nordin)

The Sub-Committee was informed that the project objective is to evaluate the economic viability of zero waste technology i.e. POMEDfree technology for palm oil mills in Malaysia. The researcher informed that the visit will be made to palm oil mills that have adopted the technology to evaluate the economic benefits and returns of the technology adoption.
The Sub-Committee commented that the researcher should make a comparison in terms of economic analysis between the existing technology (POMEDfree) and other alternatives technologies for producing energy. Therefore, the duration of the study should be extended to 1 year instead of 6 months. The Sub-Committee suggested the follow-up action as suggested to DEID in the Divisional Highlights. 

The Sub-Committee Approved the project with some amendments.

3.5 The Total Contribution of Oil Palm Industry to the Malaysian Economy (Kamalrudin Mohd. Salleh)

The Sub-Committee was informed that the oil palm industry is one of the largest contributors to the National economy, after oil and gas, tourism and manufacturing sectors. Under the Economic Transformation Programme, the Government has set an ambitious GNI contribution target of RM178.0 billion in 2020 through programmes that improve its upstream productivity and sustainability and downstream expansion and sustainability. The importance of this industry to the country’s economic well-being is indeed very significant. In 2015, the industry contributed RM60.2 billion worth of export earnings or 55.3% of the overall nett export value of all commodities. However, the total contribution of the industry to the National income is believed to be beyond this export value. Therefore, the Sub-Committee was informed that the objective of this project is to estimate the total contribution of the oil palm industry to the Malaysian economy, as well as to estimate the scale of the current economic activity associated with the overall oil palm industry.

The Sub-Committee commented that this is a good project and will benefit the palm oil industry. However, The Sub-Committee suggested that the duration of the study should be shortened to 6 months.

The Sub-Committee Approved the project.

3.6 The Impact of Indonesian Export Duty Structure and Levy on the Malaysian Palm Oil Export Competitiveness (Kamalrudin Mohd. Salleh)

The Sub-Committee was informed that Indonesia has drastically widened the values between CPO and PPO export duties since October 2011 in order to encourage more downstream investments and production of PPO products. Indonesia revised its duty structure again in July 2015. Under the revised export duty structure, CPO is cheaper as feedstocks for downstream activities in Indonesia. Since Malaysia and Indonesia are close competitors, competing in the same market, a change in the export duty in one country will affect the other. Therefore, the Sub-Committee was informed that the
objectives of this project is to quantify the extent to which Malaysia is affected from the restructuring of Indonesian PO export duty, as well as to estimate the impact of Indonesian PO export levy on Malaysian CPO and PPO export competitiveness.

The Sub-Committee commented that the study should focus more on the downstream sector. In addition, a distinction between refined product and oleochemical is suggested to be made in this study. For data analysis, the Sub-Committee commented that the methodology needs to be simplified and easier for the industry to interpret. The Sub-Committee also commented that a comparison between MPOB local delivered price and FOB Belawan price to be included in the analysis of the study.

**The Sub-Committee Approved the project.**


The Sub-Committee was informed that the project focuses on analyzing the effect of the Malaysian export tax on CPKO and RBD PKO with regards to export competitiveness and its impact on the local processing sectors. Besides this, the project also focuses on simulating export competitiveness scenarios under different levels of Malaysian and Indonesian export tax imposed on CPKO and RBD PKO. The Sub-Committee also was informed that since Malaysia and Indonesia are close competitors, they compete in the same market place and hence a change in export tax rate in one country will affect the other. The Malaysian palm kernel crushers are seeking for a reduction of the export tax imposed on CPKO, while both PORAM and MEOMA are requesting for the removal of the 5% export tax RBD palm kernel oil to increase their export competitiveness. This is because based on the current scenario, the processors are facing challenging times due to uncompetitive pricing, slower recovery in investments for setting up their manufacturing plants and also the problem of lower utilization rate. Arising from uncompetitive pricing of Malaysian CPKO and RBD PKO, both PORAM and MEOMA have complained that their Members have lost market share to the Indonesian exporters.

The Sub-Committee suggested to the researcher to reconcile trade data with that of domestic consumption data. In addition, the researcher has been also requested to calculate the growth in domestic consumption of CPKO.

**The Sub-Committee Approved the project.**
4. On-Going Projects of the Techno-Economics Unit

4.1 An Economic Study on Mechanization in Oil Palm Plantations in Malaysia (Azman Ismail)
The Sub-Committee was informed that the objectives of the project are to measure the degree of mechanization in the oil palm plantations, to study workers’ productivity in relation to utilizing machineries in harvesting and in-field collection in oil palm plantations and to examine the effect of mechanization of the reduction of manual labour in various job categories / operations in oil palm plantations.
The Sub-Committee suggested for the researcher to include an analysis on marginal product on labour against marginal product on mechanization since the analysis can give better explanation on the benefit of using mechanization as against manual. The findings of the study should be shared with the oil palm plantation sector so that the level of mechanization can be increased.

4.2 Consumers’ Perceptions on the Implementation of Biodiesel in the Malaysian Transportation Sector (Kamalrudin Mohamed Salleh)
The Sub-Committee was informed that studies on biofuel from the social perspective, specifically on social perception is very limited, especially in the context of Malaysia. Realizing the fact that Malaysia is moving towards B10 biodiesel, such studies are very important to facilitate the implementation of B10 and to enable the provisional Malaysians Standard to be accepted as a full standard. Consequently, the question of whether Malaysians perceive B10 biodiesel as premium fuel for their engine or whether they perceive B10 biodiesel as improving the environment are yet to be answered. Therefore, the objective of this project is to understand consumers’ perceptions towards B10 biodiesel implementation in Malaysia as well as to understand consumers’ knowledge on renewable energy and biodiesel. The Sub-Committee was also informed that the relative weight that individuals attach to their perception on B10 biodiesel may influence their willingness to accept the mandatory programme. Therefore, it is very essential for the policy makers as well as biofuel producers to know consumers’ perception on B10 biodiesel before introducing it to the public.
The Sub-Committee also requested the researcher to clarify on the suitability of petrol users as the respondents for the project. For the data analysis, the Sub-Committee suggested that the researcher carry out cross-tabulation analysis from the survey results. The Sub-Committee also suggested that the researcher should identify a proper method to enhance awareness on biodiesel programme and the method should be included in the final report. The Sub-Committee also suggested that a further study on biodiesel
programme in terms of engine manufacturer’s perspective for further policy recommendation.

4.3 Labour Requirement in the Oil Palm Independent Smallholders Sector in Peninsular Malaysia (Azman Ismail)
The Sub-Committee was informed that the independent smallholders also play an important role in the oil palm industry in Malaysia. The oil palm planted area of independent smallholders increased from 241,992 ha in 1995 to 883,004 ha in 2015. However, the main issue in the oil palm independent smallholders sector is that they produce low FFB yield and quality. One of the reasons is that the independent smallholders are not practising Good Agricultural Practice (GAP). Besides that, the independent smallholders are also facing a labour shortage problem. Thus, the study is aimed at estimating labour requirement in the oil palm independent smallholders sector in Peninsular Malaysia. In addition, the study also aims at formulating a solution to overcome labour shortage problem in the sector. Based on the survey that has been done, 58% of the total hired workers by independent smallholders are foreigners and the remaining 42% are locals. It is estimated that total workers required by independent smallholders in Peninsular Malaysia for harvesting and FFB collection are 12,440, if the harvesting round is based on once a month.

The Sub-Committee requested that the researcher includes age of palm, especially for independent smallholders who hire workers for harvesting and FFB collection. The Sub-Committee informed that the findings of the study are very important to the oil palm independent smallholders sector. Therefore, the study should be given priority to be completed due to urgency of the findings to be given to the Government for policy recommendations.

4.4 A Study on Market Behaviour and Buying Pattern of Edible Oils in India and China (Kamalrudin Mohd. Salleh)
The Sub-Committee was informed that China and India continue to remain as the world’s major edible oils importing and consuming countries. Palm oil has been found to be responsible for the significant increase in total imports of edible oils in both these importing countries. It was the largest oil component among the imported edible oils, followed by soybean oil. Thus, India and China are two (2) important markets for palm oil as they showed significant increases in their population in the past and also in future. They can also be expected to become the world’s engine of growth. With this in mind, it is important for this project to analyse and understand the market behaviour and purchasing pattern of edible oils in these two markets. Therefore, the Sub-Committee
was informed that the general objective of this project is to explore market behaviour of India and China in importing their edible oils. Meanwhile, the specific objectives of this project are to explore the change in consumption pattern in China and India as they pass through the latest economic developments as well as to understand their marketing problems.

The Sub-Committee further suggested that the researcher should include and mention the changing pattern of demand in China such as changing preference for noodles.


The Sub-Committee was informed that the project focuses on understanding the GST mechanism of the Malaysian oil palm industry to examine the benefits of GST on the Malaysian oil palm industry and to estimate the potential earnings that the Government will gain from the implementation of the GST. The Sub-Committee was also informed that the Malaysian oil palm industry is a taxable supply under GST rules and regulations. Therefore, each sector in the Malaysian oil palm industry has to be registered under the GST if their annual sales turnover has exceeded the prescribed threshold level of above RM500,000. Only a registered person can charge and collect GST on the taxable supplies of goods and services effectively on 1st April 2015. All sectors in the Malaysian oil palm industry are standard-rated supply (6% GST), except for the sectors that are producing cooking oil to sell in the domestic market and for oil palm export products incurs (0% GST). The Sub-Committee was also informed that the Malaysian Government managed to collect revenue estimated at RM342.51 million from the oil palm industry since the implementation of the (for the period April – December, 2015).

The Sub-Committee raised the question about the total tax paid by the oil palm industry to the Government and was subsequently informed that there is no tax collected by the State Government in Peninsular Malaysia. However for Sabah and Sarawak, the State Governments imposed sales tax on the Industry.

The Sub-Committee was informed that the study was aimed at examining and analysing the implications of the GST on prices of agricultural inputs, the cost of production and profitability of the OP small businesses. The small business operators are not mandated to register under the GST if their annual turnover was less than the GST threshold level of RM500,000 and cannot claim all GST paid for their inputs used for furtherance of their businesses. The initial analysis shows that the cost of production for oil palm nursery operators, smallholders and estates had increased due to the 6% GST imposed on agricultural inputs. The Sub-Committee was also informed that the majority of the OP smallholders are not qualified to be GST registrant persons due to their annual sales being less than the GST threshold level of RM500,000. However, smallholders can apply for the Flat Rate Scheme (FRS) under GST rules & regulations, which allows smallholders to include a prescribed flat rate addition of 2% from the GST registered persons. The initial analysis showed that the additional cost faced by the oil palm smallholders was estimated to increase by RM163.80/ha/year or RM9.40/tonne due to GST implementation:

- Threshold level: Annual sales >RM50,000 – effective 1 Jan 2016 (revised from RM100,000 in 2015).
- As at Dec 2015, there were 404 OP smallholders who obtained approval under FRS.

There were no further comments or suggestions by the Sub-Committee on this project.

4.7 An Economic Study on Technical Efficiency among Independent Oil Palm Smallholders (ISH) in Sabah & Sarawak (Ali Zulhusni Ali Nordin)

The Sub-Committee was informed that the objective of this project was to measure the technical efficiency of ISH in Sabah and Sarawak. The researcher informed that the survey in Sabah had been carried out and the result of the survey was presented to the Sub-Committee. The result showed that the mean technical efficiency for immaturesd oil palm is 0.5245, while for matured palm is 0.5517. The researcher also informed that the survey in Sarawak has been carried out and the result is in the process of being analysed.

The Sub-Committee suggested for the researcher to include the type of soil as one of the variables. It was also suggested that the most efficient and inefficient district in Sabah should be identified from the survey results. For Sarawak, the Sub-Committee requested the researcher to include the background of the study as part of the research design.
4.8  The Impact of Minimum Wages on Labour Productivity in Oil Palm Plantations  (Ali Zulhusni Ali Nordin)
The Sub-Committee was informed that the project was aimed at examining the impact of minimum wages on labour productivity and cost of production in the oil palm plantation sector. The researcher presented literature reviews related to this project. The minimum wages policy was the latest policy implemented by the Government of Malaysia in January 2014. In the Budget 2016, the presentation in October 2015, the revision has been made to Minimum Wages Rate. Beginning 1 July 2016, the minimum wage will be increased from RM900 to RM1,000 a month in Peninsular Malaysia, while for Sabah and Sarawak and WP Labuan, it will be increased to RM920 from RM800 for all sectors, except the domestic sector. The survey was completed for Selangor and Negeri Sembilan, and will later be extended to other States in Peninsular Malaysia. There were no further comments or suggestions by the Sub-Committee on this project.

4.9  Labour Productivity among Harvesters and FFB Collectors by Country of Origins: A Case Study in Peninsular Malaysia (Siti Mashani Ahmad)
The Sub-committee was informed that the objective of this project was to estimate labour productivity for oil palm harvesting and FFB collection activities in Peninsular Malaysia among workers from different sourced countries (i.e. Indonesia, Bangladesh, Nepal, India, Thailand, Myanmar, Pakistan, Cambodia and Vietnam). Specifically, the project was to examine the different levels of labour productivity of these workers from different countries of origins. The Sub-committee was also informed that visits have been conducted to three (3) estates and the results of the visits have been presented to the Sub-Committee. The results showed that the workers from Indonesia are more productive as compared to foreign workers from other countries. Most of the oil palm estate owners in Malaysia prefer to hire workers from Indonesia as compared with other countries for harvesting and FFB collection activities. The Sub-Committee commented that incentives given by the estates to the workers, especially harvesters and FFB collectors needs to be studied since incentives have been identified as one of the factors that influences productivity.

5.  Briefing by the Director of the Integration Research and Extension Division
The Sub-Committee was informed about the activities and achievements of the Integration Research and Extension Division (IRED) which comprises of three units; i) Crops and Livestock Integration Unit (CLI), ii) Extension Services Unit (ESU), and iii) Project Implementation Unit (PIU). The Sub-Committee was also informed that there
were six (6) TUNAS Regional Zones with 55 TUNAS offices with 177 TUNAS officers all over the country. Efforts in improving independent smallholders (ISH) fresh fruit bunches (FFB) production was carried out by ESU through trainings, farm visits, sustainability certifications and exhibitions. There were 30 cooperatives (KPSM) have been established and 15 of these cooperatives have implemented the FFB group selling to the mills. The Sub-Committee was informed that the main problems faced by oil palm ISH were low FFB productivity, high cost of production and uneconomic land size. Beside the assistance schemes that have been carried out by MPOB, the Sub-Committee suggested that the financial assistance for ISH from other agencies should be provided. This assistance is needed because there are ISH who do not have enough capital to sustain good agricultural practices (GAP) for their oil palm management. The ratio of the extension agents and ISH is too high. The Sub-Committee suggested grouping the ISH and identifying one of them to be a leader. This person will assist TUNAS officers in disseminating the information to the others ISH and also provide ISH information to TUNAS officers. The Sub-Committee also suggested MPOB to collaborate with other agencies in implementing oil palm extension activities. The Sub-Committee recognizes that the 30 Tonner Club is a good effort to encourage more ISH to be high achiever. They suggested MPOB to register more 30 Tonner Club members in the future. The Sub-Committee also suggested to regroup the ISH and plantation base on the harvesting size. In doing this, management of the group can be carried out by only one management unit and more mechanization can be introduced in daily oil palm managements.

6. New Project Proposals of the Integration Research and Extension Division

6.1 Evaluating Training Effectiveness by Understanding Oil Palm Small Holder’s Attitude towards Training (Humaira Taib)

The Sub-Committee was informed that MPOB had provided fund and many programs to train oil palm smallholders to achieve individual average yield performance at the rate of 22 tons per hectare per year. The achievement of the set yield performance target does not rely on a single factor but due to several contributing factors. In this context, the importance of training cannot be denied. It is a common practice that every agencies to conduct evaluation of training programs. The objectives of this study are i) to investigate the influence of smallholders’ attitude towards training effectiveness, ii) to determine the
influence of smallholders’ attitude on oil palm production and iii) to examine the return on investment (ROI) of a training program.

The Sub-Committee recommended the researcher to define the “attitude” and determine the parameters to measure the “attitude” in this study. The Sub-Committee suggest to conduct the comparative study between ISH with basic knowledge of oil palm and the ISH attended the training program.

The Sub-Committee Approved the project.

6.2 An Evaluation of Oil Palm Replanting Scheme (TSSPK) & New Planting Scheme (TBSPK) as EPP1-Oil Palm NKEA Project (Sheilyza Mohd Ishak)

The Sub-Committee was informed that under EPP1, the aim is to replant old and unproductive oil palm trees which have low yield then extended to New Planting Scheme (TBSPK) to increase oil palm areas. These two schemes were provided to increase smallholders’ income by planting good quality of seedling and implementing Good Agricultural Practices (GAP). Through the scheme, smallholders will be provided with training, input and incentives with sum RM7,500 (Peninsular) and RM9,000 (Sabah & Sarawak) for oil palm felling, land clearing, high quality oil palm seedling supply, fertilizer and chemicals. Through TSSPK and TBSPK, there are 38,149ha has been planted with oil palm started from 2011-2016. The objectives of this study are to determine the FFB yield, income achievement, and GAP practices by the smallholder, information of oil palm integration existence among the EPP1’s participants and perception of participants towards scheme and MPOB as the implementer.

The Sub-Committee commented that the researcher should rephrase the problem statements as well as the objectives of the study.

The Sub-Committee Approved the project.

7. On-Going Projects of the Integration Research and Extension Division

7.1 Factors Affecting FFB Production among Participants of Oil Palm Seedling Scheme (SBABB) (Rahmawati Rasuddin)

The Sub-Committee was informed that in the 9th Malaysian Plan (2006-2010), Government has allocated RM37.6 million grant for the implementation of Oil Palm Seedlings Assistance Scheme (SBABB). The objectives of the study are i) to assess the FFB yield of the participants and ii) to determine agriculture practices affecting FFB
production among the participants of SBABB Scheme. The Sub-Committee was informed that 51% of the respondents achieved FFB yield between 23 – 28.89 ton/ha/year, 43.2% and 5.6% achieved FFB below 22 ton/ha/year and more than 29 ton/ha/year, respectively. The study revealed that six factors have significant impact on the FFB yield were weather, TUNAS services, harvesting, fertilizer application, pest and disease and farm size.

The Sub-Committee suggested that the TUNAS services factor should be discussed separately in this study. The Sub-Committee also suggested that separate data analysis for Sabah and Sarawak. The recommendation of the study should be based on the finding/result of the study.

7.2 A Preliminary Study on the Economic Stimulus Package II Incentive Scheme (PRE2) on FFB Yield and Income of Smallholders in Peninsular Malaysia (Mohd. Haidhar b. Abdul Hamid)

The Sub-Committee was informed that MPOB had implemented PRE2 in 2009 – 2010. The scheme provides RM 6000 per hectare, and as such each smallholder can get up to RM 7000 [RM 1000 from Skim Insentif Tanam Semula (SITS) and RM 6000 from PRE2] to replant their old oil palms. The objectives of the study are to identify the first year FFB yield and income gained by the participants as well as the relationship between participant’s background with their FFB yield and income.

The Sub-Committee was also informed that the first year of harvesting by the participants is at 9.32 tonne/hectare/year. This yield is much higher compared to Oil Palm Seedlings Assistance Scheme (SBABB) participants where they manage to get the first year FFB yield at 7.30 tonne/hectare/year. (Zulkifli et al., 2013). The PRE2 participants’ income gained is estimated at RM4,169/hectare/year higher than SBABB participants. The regression analysis shown that the smallholder’s status is one of the factor that effect the FFB yield of the participants while the other factors such as age, gender and level of education is not significant.

The Sub-Committee suggested to the researcher to add the other variable in order to increase the result of the regression analysis.

7.3 The Study on the Acceptance Level of Extension Service Activities by Pusat TUNAS among Independent Oil Palm Smallholders (Nur Hana Basaruddin)
The Sub-Committee was informed that Pusat TUNAS under Malaysian Palm Oil Board (MPOB) was established in 2002 to disseminate new technologies and knowledge to the independent oil palm smallholders and assessment must be made to determine to what extent Extension Service Activities by Pusat TUNAS are accepted by the independent oil palm smallholder. The objectives of the study are i) to determine the social demographic profile of the respondents. ii) to determine the perception and attitude of independent oil palm smallholders toward the Extension Service Activities by Pusat TUNAS. iii) to investigate the different demographic factors with the perception and attitude of independent oil palm smallholders towards extension service activities by Pusat TUNAS.

The Sub-Committee was also informed that the independent oil palm smallholders have positive perception and attitude towards Extension Services Activity by Pusat TUNAS where it can lead to the high acceptance level (mentally acceptance) of Extension Services Activity by Pusat TUNAS among independent oil palm smallholders.

As a result from this study, it is recommended that improvement should be done to make Question and Answer under TUNAS Activities such as training, technical lectures and others to be more effective to increase smallholders confident to ask question. Moreover, TUNAS Officers need to possess more skills and knowledge in delivering extension services such as by attending courses and programs organized by MPOB.

### 7.4 Knowledge Assessment of Fertilizer Management among Independent Oil Palm Smallholders in Malaysia (Tan Say Peng)

The Sub-Committee was informed that the numbers of independent smallholders (ISH) were 204,970 with a total area at 807,008 hectares. This represents 15% of the total oil palm area in Malaysia. The independent oil palm smallholder sector is a small-scale production entity. Thus, it is generally perceived that this sector is inefficient and unproductive as compared to the large-scale production system of the estate sector. The main objective of Pusat TUNAS is to create awareness among smallholders on the importance of knowledge, skill and attitudinal change to improve oil palm productivity through planned and excellent extension services. This study aims to determine the level of knowledge regarding fertilizer management among ISH in Malaysia and to identify relationship between respondents' background with their knowledge level.
The finding shows that more than 70% of the respondents have a basic knowledge on fertilizer management. This might be due to the fact that most of the respondents were referring to the MPOB and the fertilizer shop as the source of information.

The Sub-Committee also suggested the researcher to look into the factors such as weather or soil type influence the selection of compound fertilizer rather than mixture and straight fertilizer as resulted in the earlier finding.

The Sub-Committee recommended to study on the correlation between rainfall pattern and fertilizer application.

The Sub-Committee also suggested the researcher to study the influence of FFB prices on the rate of fertilizer application.

7.5 Factors Affecting FFB Production of Independent Smallholders’ in Sabah (Ainul Shazwin Sahidan)

The Sub-Committee was informed that the average of FFB production for 2013 decreased about 1.76% to 18.21 tonne per hectare from the previous year. The drops in FFB production can be attributed to yield decline of 16% observed in Sabah. The objectives of the study are i) to determine the agriculture practices that influence FFB production among ISH in Sabah, ii) to determine the constrains that faced by the ISH and the effect on FFB production and iii) to determine relationship between the various factors and personal background of independent smallholders towards the FFB production. The study revealed that two factors have significant effects on the FFB yield among ISH in Sabah are frequency manuring of young palm and weeding method (chemical).

The Sub-Committee suggested that to include the weeding method other than chemical method into the regression analysis.

The Sub-Committee also commented that the agriculture variables normally can be explained by log square in order to get more practical finding. For example effect of using fertilizer to the oil palm yield. In one stage the yield will be decreased when the using of fertilizer is keep increase.
PROGRAMME ADVISORY COMMITTEE
36TH MEETING: 11TH – 15TH APRIL 2016

COMBINED REPORT
CROSS-CUTTING ISSUES ON
SUSTAINABILITY SUB-COMMITTEE

Plenary Session
Date: 15th April 2016
Time: 2.45 pm
Venue: Grand Ballroom, Marriott Putrajaya
Malaysian Palm Oil Board (MPOB)

Programme Advisory Committee Meeting
36th Meeting: 11th - 15th April 2016

Cross-Cutting Issues on Sustainability Sub-Committee

Date: 13 April 2016 (Wednesday)
Venue: Board Room, Level 2, Admin Building
MPOB Head Office, Bandar Baru Bangi, Selangor

Present:
1. YBhg. Dato’ Carl Bek-Nielsen (Chairman of the Sub-Committee)
2. Dr. Trevor Anthony Jackson
3. Dr. Paramananthan Selliah
4. Prof. Denis J. Murphy
5. Prof Monique Leclerc
6. Prof John W. Crawford
7. Prof. Dr. Tom Sanders
8. Datuk Hong Ngit Ming
9. Prof. Dr. Matthias Finkbeiner
10. Prof. Dr. Ing Martin Kaltschmitt
11. Mr. U R Unnithan
12. Mr. Thomas Mielke
13. Dr Burghard Gruening

In Attendance:
1. Datuk Dr. Choo Yuen May, Director General, MPOB
2. Dr. Ahmad Kushairi Din, Deputy Director General (R&D), MPOB
3. Dr. Norman Hj. Kamaruddin
4. Hj. Wahid Omar
5. Dr. Lim Weng Soon
6. Dr. Ahmad Parveez
7. Cik Rosidah Radzial
8. Dr. Kamil Azmi Tohiran
9. Dr. Kalanithi Nesaretnam
10. En Johari Minal
11. Dr. Ooi Cheng Keat
12. Ms. Juanita Lourdes
13. Mr. Yoong Jun Hao
14. Dr. Halimah Muhamad
15. Dr. Mohd Haniff Harun
16. Dr. Siti Ramlah Ahmad Ali
17. Dr. Zulkifli Hashim
18. Dr. Kho Lip Khoon
20. Ms. Ella Michael Dosi
21. Cik A’fifah Abd. Razak
22. Ms. Bettycopa Amit
23. Cik Hasimah Mos
24. Ms. Law Mei Ching
25. En. Hasnol Othman
26. Dr. Mohd Hefni Rusli
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A. PREAMBLE

1.0 Introductory Remarks by Datuk Dr Choo Yuen May on behalf of Dato’ Ar. Wan Mohammad Khair-il Anuar Wan Ahmad, Chairman, Chairman of MPOB

Datuk Dr Choo conveyed the apologies of YB Chairman of MPOB who was unable to attend the Cross-Cutting meeting because he had to meet with the MPs who would be setting off on a Palm Oil Mission to France and Belgium.

Datuk Dr Choo welcomed PAC members before reading out the introductory remarks of YB Chairman. Two key developments in the oil palm industry were highlighted, namely:

- Establishment of the Malaysian Palm Oil Certification Council (MPOCC) which is tasked with the implementation and operation of the MSPO certification scheme;
- Setting up of the Council of Palm Oil Producing Countries (CPOPC) founded jointly by Malaysia and Indonesia to harmonise sustainability standards and enhance the competitiveness of palm oil. CPOPC would allow both the governments to pool resources and effectively circulate accurate and credible information to the public regarding the oil palm industry as a proactive step to contain negative campaigns by NGOs.

Datuk Choo also conveyed MPOB’s thanks to the Chairman Dato’ Carl Bek-Nielsen who has indicated that because of heavy work commitments this will be his last tenure as chairperson of this sub-committee.

2.0 Opening Remarks by the Chairman of the Sub-Committee

After a note of thanks to the Chairman of MPOB, the Chairman of the Cross-Cutting Sub-Committee laid down some ground rules for the presentations to be given at the meeting to ensure that maximum time could be spent on discussions amongst the PAC and members in order to properly address the issues surrounding sustainability and thereafter provide pragmatic recommendations. Henceforth, all presentations must be concise and precise, limited to not more than 15-18 minutes or a maximum of 20 slides. If a more elaborate presentation is needed, this could be sent out to PAC members one or two weeks earlier but remembering that only an executive summary should be provided at the meeting.

He also kindly requested Mr U R Unnithan to present the recommendations by the Cross-Cutting Sub-Committee at the plenary session on Friday as he could not be present due to prior business commitments.

In his opening remarks, the chairman noted that this is the eighth year of this forum and a lot has taken place over those years. The world is changing fast and so are demands and
requests on sustainability. Thus, this forum is one of utmost importance. He stressed that all officers must follow-through all recommendations and execute them diligently as he believes that “An inch of movement is better than a mile of good intention”.

The chairman stated that world population is now at 7.3 billion, with the middle class making up 1.7 billion. This is expected to go up to 9.5 to 9.7 billion by 2050. Vegetable oil demand is expected to go up to 125 to 150 million tonnes in the next five years. The drivers for this demand will come from the population growth and the booming middle class. In addition, when we go from the lower to the middle income, the consumption of calories will explode by 25 to 30%.

Sustainability is not only important but essential and absolutely necessary. However, it cannot be pursued in the absence of food security. In this respect, there is a range of tradeoffs affecting decisions involving food supply, ecosystem services, for example, relationship between biodiversity and the needs of the poor. This therefore needs a balanced approach. He reiterated that the United Nations consensus on sustainable development which was adopted in Rio in 1992, stipulated that sustainability should go hand in hand with actions to raise the living standards of the poor. This then should form the basis of the discussion at the cross-cutting meeting.

3.0 Presentations

Four (4) presentations were made to the Sub-Committee and they are as follows:

i. “A Perspective of MPOB’s Sustainability Endeavours” by Dr. Tan Yew Ai
ii. “An Analysis of National Oil Palm Yield Trends for the Past 20 years” by Mr. N. Balu
iii. “The Sime Darby High Carbon Stock Study and its Implications ” by Dr. Kho Lip Khoon
iv. “An Update on Peat Research” by Dr. Mohd Haniff Harun

B. KEY ISSUES AND RECOMMENDATIONS

4.0 Discussions by the Sub-Committee

i. Presentation on “A Perspective of MPOB’s Sustainability Endeavours” by Dr. Tan Yew Ai

The discussion was mainly centered on the issue of NGOs.

- The Sub-Committee suggested that engagement with NGOs has to be with personnel who are actually feeding the information to the general public.
ii. **Presentation on “An Analysis of National Oil Palm Yield Trends for the Past 20 years” by Mr. N. Balu**

- The Chairman of the Sub-Committee complimented Mr. Balu and MPOB for compiling the data and presenting it. This is one of the key core matters for the industry’s well-being and economic viability. Yields are important factors in terms of maintaining economic viability.
- It is clear that soil fertility and soil management are key factors in ensuring high yield.
- With the clamp down on the intake foreign of labour by the Government, there will be an acute shortage of labour which will raise the concern of the availability of palm oil for 2016/2017 if the labour issue is not solved.
- Modelling could be useful in looking at yield gaps.
- Higher OER could result in lower quality with a higher free fatty acid (FFA) content and this needs to be investigated.
- As 2015 was a disappointing year in terms of yield, it would not be appropriate to compare the current yield against that year. Conversely, 1997 was a record yield year and perhaps a clearer picture could be obtained by comparing with this a year.
- It is glaringly clear that the lower yields in Sarawak are due to cultivation on peat soil and more incidences of diseases (termites and ganoderma).
- Shortage of labour is an acute problem, resulting in crop losses due to rotting FFB in the field.
- The most significant innovations in the industry over the last 10 to 15 years were the Sikat and Cantas Cutter which MPOB helped develop. These have increased productivity by 30 to 50% but only in cases where palms are between 3 to 7 years. The MPOB should therefore direct much more attention and energy in finding a cost effective and pragmatic solution towards mechanizing tall palm harvesting i.e. palms that were > 10 meters in height.

iii. **Presentation on “The Sime Darby High Carbon Stock Study and its Implications” by Dr. Kho Lip Khoon**

- The United Nations consensus that sustainability must go hand in hand with actions to raise the living standards of the poor was stressed.
• When people are not allowed to develop on high carbon stock areas, there should be a monetary compensation without which they should be allowed to develop such land.

iv. Presentation on “An Update on Peat Research” by Dr. Mohd Haniff Harun

• It was pointed out that the wide range of values for carbon emissions from peat areas and from oil palm planted on peat arose because of the problem with the definition for peat. If peat were to be partitioned into categories of hemic, sapric, fibric and the amount of wood, whether soft or hard; then a clearer picture would emerge on the differences in emission values.

• It was suggested that differences in values could also be due to the different methods of measurement as well as spatial and temporal conditions.

5.0 Matters Arising from 2015 Cross-Cutting Session

The Sub-Committee went through matters arising from the 2015 Cross-Cutting session and took note of the responses. Further opinions and recommendations were proposed as follows:

Items 2 and 13

• To continue with efforts to link the MSPO certification scheme more towards a “fair-trade” set up often used for small-holders as this could then be viewed globally as being a holistic certification scheme that gives due consideration to the smallholders who cannot afford to go through a certification scheme e.g. RSPO certification.

• Additional effort should be put in to get more smallholders certified.

Item 4

• MPOB was requested to expedite and complete the LCA study on peat emission with special emphasis on the state of decomposition of the peat i.e. sapric, hemic and fibric peat swamps in oil palm plantings.
Item 7

- Prof. Dr. Denis Murphy suggested that the international Steering Committee to be recommended may meet and monitor peat studies as frequently as every four months. This was supported by the PAC members.

Item 9

- The Sub-Committee recommended that MPOB make full use of scientific literature citing the beneficial nutritional properties of palm oil (e.g. Chowdhury of Cambridge’s paper entitled “Association of Dietary, Circulating, and Supplement Fatty Acids with Coronary Risk: A Systematic Review and Meta-analysis”) by translating the scientific information into simple language which consumers and end users of palm oil could understand and thereby appreciate. MPOB and MPOC should work hand in hand in this endeavour.

Item 10

- The Chairman of the Sub-Committee recommended that MPOB should look into the matter of making dimehypo commercially available to the oil palm plantation industry.
  - Top priority must be given for MPOB, together with experts, to identify effective alternatives for Class 1A and Class 1B insecticides as there is a possibility that monochrotophos could be banned. However, the primary reason was to adopt the usage of more environmentally friendly pesticides vis-à-vis the class 1 pesticides.

Item 20

- MPOB is to make available the information on the Malaysian palm oil industry’s cost of production trend within the segment of smallholders, private estates, listed companies etc. on a yearly basis. The sub-committee stated that this was an incredibly important factor as it would help to shed more light on the considerable rise on the cost of production which was important from an economic viability point of view.
  - MPOB is to make available the information on the general cost of production in a booklet to be circulated to the PAC members one week before the next PAC Meeting.
  - The Sub-Committee requested a presentation on cost of production at the next PAC Meeting.
6.0 Recommendations by the Sub-Committee

The Sub-Committee recommended the following:

- MPOB to take a more proactive role in improving the sustainability of the overall oil palm industry.
- MPOB is to give an update on the yield trends through a presentation by Mr Balu next year so that we can monitor the trend.
- MPOB to urgently appeal to the Government to lift the freeze on the intake of foreign labour for the plantation sector on the ground that oil palm is a perishable crop.
- Step up efforts to find solutions to overcome problems associated with tall palm harvesting, loose fruit collection and evacuation of harvested stacks.
- Urged MPOB to try to engage with some foreign agriculturally reputable companies who have had a string and proven track record with mechanizing labour intensive agricultural tasks in order to hopefully arrive with a solution as to how to overcome what is probably the industry’s No 1 main problem, namely the harvesting of tall palms.
- MPOB to continue on the study on carbon emissions and combine it with UPCS to hopefully come up with a range of emissions specific for sapric, fibric and hemic.
- A 10-year masterplan to be developed for the oil palm industry by a Task Force consisting of selected PAC members, MPOB Officers and four to five members from the private sector. The selected members could spend a couple of days brainstorming to identify targets and common goals such as those for 3-MCPD, nutrition and yield.
- With regards to the request by the Chairman of MPOB for advice and inputs on how to effectively tackle issues/sentiments against palm oil in Europe especially in France, it is recommended that a ‘war room’ could be set up to respond to issues within 24 hours. This is a recommendation made by the Technical Promotion and Market Development Sub-Committee.
- With regards to the proposal to restructure the PAC programme, it is noted that this recommendation has been brought up at the Technical Promotion and Market Development Sub-Committee.

The meeting was adjourned at 12.45 p.m.