The 15th edition of INTROPica is published by the Institute of Tropical Forestry and Forest Products (INTROP), a Higher Institution Centre of Excellence for Research (HiCOE). INTROP is taking the lead in wood and fibre in biocomposite research while also growing its role in upstream research. Now in its 12th year, INTROPica is increasingly impactful through the publication of cutting-edge research.

Themed “Wood and Fibre: Drivers for Future Bio-Economy”, this edition of INTROPica features eight high-impact research articles from UPM focusing on wood and fibre from palm, Eucalyptus, Agarwood and Kenaf.

In this issue, bio-economy strategies have been reviewed to provide comprehensive information on industry case studies in Malaysia. Technology and science are requisite in INTROPica, therefore, research on tree canopy technology mapping in upstream research is featured, illustrating its potential now and in the future.

Additionally, emphasis is given to the control of tree diseases which greatly influences tree mortality and can restrict wood and fibre growth. Also, an article on tree canopy provides tree health information especially for the maintenance of wood and fibre resources. Finally, a microclimate-related article in the urban forests area has also been presented in this magazine as it is a pathway to strategize bio-economy in Malaysia.

Researchers, especially those with keen interest in bio-economy will find this edition of the magazine both useful and engaging.

Your sincerely,

The Editors
WOOD AND BIOFIBER INTERNATIONAL CONFERENCE 2017 (WOBIC2017)

Wood and Biofiber International Conference 2017 (WOBIC2017) was successfully held on 21st to 23rd November 2017 at Bangi-Putrajaya Hotel, Selangor. It was the first conference organized by Institute of Tropical Forestry and Forest Products (INTROP) which mainly focusing on wood and biofiber. The latter international conference organized by INTROP was known as International Conference on Kenaf and Allied Fibers (ICKAF) conducted in 2009 and 2013. WOBIC2017 was officiated by Malaysia Minister of Plantation Industry and Commodity, Datuk Seri Mah Siew Keong. The conference was co-organized with Malaysian Timber Industry Board (MTIB), Malaysian Palm Oil Board (MPOB), National Kenaf and Tobacco Board (NKTB), Forest Research Institute Malaysia (FRIM) and Fujian Agriculture and Forestry University (FAFU). Not to forget the collaborators: Asia Pacific Association of Forestry Research Institutions (APAFRI), Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), Universiti Tun Hussein Onn Malaysia (UTHM) and Politeknik Seberang Prai (PSP) who have given a full support to UPM in making this event a success.

The theme ‘Lignocellulose for Future Bioeconomy’ provided an excellent platform for industry, academia, researchers, policy makers, administrators, students and financiers to share ideas, findings and experiences on wood and biofiber parallel to the global bioeconomy initiatives. During the opening ceremony, there were MoU signings between UPM and two local industries which are MoU signing between UPM and MPMA (The Malaysia Panel-Products Manufacturers Association) which involves two projects: firstly on pre-commercialization of Marine-grade Equivalent (MGE) plywood from oil palm trunk, and secondly on the development of database for Eucalyptus plantation in Malaysia; and MoU and NDA signing between UPM and Nextgreen Pulp and Paper Sdn. Bhd. for a project on nanocellulose development from oil palm biomass.

The conference was joined by 188 participants comprises of 29 international and 159 local participants from 16 international and 15 local institutions respectively. The international participants came from 9 countries consisted of China, Japan, Thailand, Iran, India, Korea, Netherlands, Indonesia and Canada. The first two days of conference was filled with oral and poster presenters while technical and excursion took place on the third day. There were another two pre-conference workshop been conducted on the 15-16 November 2017 namely as Mechanical Characterizations of Biofiber and Biocomposite Materials, and Response Surface Methodology for Process Optimization. Based on survey evaluation analysis from the respondents, WOBIC2017 Organization Committee received excellent marks for all aspects listed as Conference Management & Coordination, Technical, Program and Miscellaneous. One of the exciting parts for all researchers is that an amount of 50 selected papers will be published in IOP Proceedings by early 2018. The next WOBIC is suggested to be organized in 2019 by one institution of WOBIC2017 Steering Committee members.

Speech quotes by Datuk Seri Mah Siew Keong

“The importance of fibres in our world today can be seen through its usage as a cash crop, especially in developing countries. The use of fibres does not only increase income levels for the rural community but is also important to some national economies. It cannot be denied that fibres are useful resource that is environmentally-friendly, and can be used in various industries, such as composites, pulp and paper, biopolymers, textiles, biofuels, biochemicals and other bioproducts industries. For instance, the
need for renewable fibre reinforced composites (FRC) has never been as prevalent as it currently is. Natural fibres offer both cost-saving and reduced-density when compared to synthetic fibres. Although the strength of natural fibres is not as great as glass, aramid and carbon, the specific properties are comparable. The use of FRC has penetrated many new sectors such as automotive, buildings, sports and recreation, defence and to some extent; aerospace. To ensure the sustainability of these uses, a concerted effort must be gathered to strategize the right policies and its implementations right from the seeds source to planting and harvesting, processing, product manufacturing, marketing and quality assurance. This is where the researchers meet the entrepreneurs in a smart partnership."
SUGAR PALM: FIBERS, BIOPOLYMERS AND BIOCOMPOSITES

S.M. Sapuan and R.A. Ilyas

1 Laboratory of Biocomposite Technology, Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia
2 Department of Mechanical and Manufacturing Engineering, Universiti Putra Malaysia

Introduction

Synthetic fibers are dominantly used in the composites industry for the past several decades. However, the negative environmental and health effects associated with these fibers fueled the increasing usage of natural fibers as promising alternatives. The escalating usage of natural fibers can be ascribed to their availability, affordability, processability, renewability, recyclability, biodegradability, specific tensile properties, less health hazards, acceptable insulating properties, low density and less energy consumption during processing over synthetic fibers (Sanyang et al., 2016). Natural fibers are classified depending on their origin either from plants, animals or minerals. However, natural fibers from plants are the most widely used reinforcement material in biocomposites. Plant fibers are subdivided based on the type of plants or parts of the plant the fibers were extracted included leaf, seed, stalk, fruit, grass fibers, and bast (Jawaid & Abdul Khalil, 2011). Malaysia has rich and vast untapped natural fiber resources available as potential alternatives to synthetic fibers. These indigenous existing natural fibers range from kenaf, coconut trunk fibers, sugar palm fibers, sugarcane, sago, pineapple leaf, cocoa pod husk to oil palm fruit bunches oil palm fronds, oil palm trunks and many others. This article attempts to explore potential uses of one of the natural fibers namely sugar palm and its fiber composites to further develop sugar palm trees as a new crop in the near future.

Sugar Palm

Sugar palm (Figure 1.) belongs to the sub-family of Arecioideae and the tribe of Caryoteae (Dransfield & Uhl, 1986; Mogea et al., 1991). In 1917 during the International Congress of Botany in Vienna, it was officially named as Arenga pinnata. In Malaysia it is known as either enau or kabung. Sugar palm is a natural forest species that originates from the Palmae family. It is known as a fast growing palm that is able to reach maturity within 10 years (Mogea et al., 1991). It is a tall and large palm with a single unbranched stem which can grow up to 20 m high and 65 cm in diameter. Geographical distribution of sugar palm trees covers as wide as Asia to West Africa from Taiwan to the Philippines, Indonesia, Papua New Guinea, India, Thailand, Myanmar, Vietnam, North Australia, Malaysia, The Gambia, Senegal, Guinea Bissau and other West African countries (Ishak et al., 2013). Sugar palm is one of the most versatile palm species because almost all parts of the tree can be used, with at least 60 different products can be generated from a single sugar palm tree. This including palm neera, fresh juices, traditional sugar blocks, toddy, crystal and brown sugar, vinegar, bio-ethanol from sugar palm sap, edible hear from fruits, leaves for roofing, sea water resistant fiber, septic tank base filter, door mats, brooms, matting, baskets, cigarette papers, rope, chair/sofa cushion, cattle feeds from fiber and its starch inside the stem can be processed to make biopolymer (Ishak et al., 2013; Ilyas et al., 2016; Sanyang et al., 2016).

Figure 1. (a) Sugar palm tree (Arenga pinnata (Wurmb) Merr.), (b) sugar palm fiber, and (c) sugar palm fruit
Sugar Palm Fibers

Sugar palm starch (SPS) accumulates in the core of the stem of the sugar palm. Not all sugar palm trees yield sugar rich sap from the flower bunches. The non-productive palms can sometimes sum up to half the trees in a plantation. Starch is normally harvested from these unproductive trees following similar procedures as in the production of sago starch. The starch is extracted from the trunk of the sugar palm tree. It was reported that one sugar palm tree can yield 50–100 kg of starch. In the SPS extraction process, the sugar palm tree is brought down just before the first bloom and the trunk is split lengthwise to remove the woody fiber mixed with the starch powder from the inner soft core of the sugar palm trunk. This is followed by the washing process, where water was gradually introduced into the fiber and starch mixture and thoroughly kneaded by hand. The mixture is filtered to allow the water to flow through the sieve with starch granules in suspension. The starch is granted enough time to settle at the bottom of the container and the water is later decanted. Thereafter, the white powdered starch is kept in an open air for a moment and later dried in an air circulating oven at 120 °C for 24 h. Sahari et al. (2013) investigated the properties of SPS to explore their potential as a novel alternative polymer. SPS registered superior Amylose (37.60%) when compared to other starches such as tapioca (17%), sago (24–27%), potato (20–25%), wheat (26–27%) and maize (26–28%).

Sugar Palm Starch/Fibers as Reinforcement for Polymer Composites

Utilization of natural fibers with polymer matrices is essential for the mitigation of ecosystem devastation and provides low cost polymeric reinforced composites. The introduction of sugar palm fibers into polymer matrices further helps to address environmental problems associated with land filling of non-biodegradable conventional composites. In the past decade, a number of articles were published on sugar palm fiber reinforced polymers composites. Table 1 shows summary investigations on sugar palm fiber reinforced polymers composites.

Table 1: Summary of sugar palm fiber reinforced polymer composites research project at UPM

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Form of Fiber</th>
<th>Matrix</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sahari (2011)</td>
<td>Frond, Bunch Fiber</td>
<td>Unsaturated polyester</td>
<td>Hand lay-up</td>
</tr>
<tr>
<td>Bachtiar (2012)</td>
<td>Short Fiber</td>
<td>Polystyrene</td>
<td>Compression molding</td>
</tr>
<tr>
<td>Sahari (2013)</td>
<td>Ash</td>
<td>Sugar palm starch</td>
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</tr>
<tr>
<td>Sanyang (2015)</td>
<td>Cellulose Fiber</td>
<td>Sugar palm starch</td>
<td>Solution casting</td>
</tr>
<tr>
<td>Ilyas (2017)</td>
<td>Nanocellulose Fiber</td>
<td>Sugar palm starch</td>
<td>Solution casting</td>
</tr>
</tbody>
</table>

Fiber Applications

Sugar palm fibers are extremely durable, even in contact with seawater. They possess good resistance to seawater and thus, use for making shipping ropes. A 12 ft (length) hybrid composite boat that was fabricated from the combination of sugar palm and glass fiber with unsaturated polyester as the matrix. In addition, a safety helmet was also developed from epoxy reinforced with sugar palm fiber. It is water resistant and could absorb and withstand high impact. The helmet was referred to as Helmet-Ijuk Reinforced Composite (HIREC). Besides, this strong fiber can
be manufactured into broom, brush and portable composite table. The figures below show some of the fiber application such as broom (Figure 2), rope (Figure 3), boat (Figure 4), fibers used in automotive anti-roll bar (Figure 5), brushes (Figure 6a and b), portable composite table (Figure 7) and Helmet-Ijuk Reinforced Composite (HIReC) helmet (Figure 8).

Figure 2: Broom (NBOS project)  
Figure 3: Rope from sugar palm fiber resistance to seawater  
Figure 4: Hybrid composite boat combination of sugar palm and glass fiber with unsaturated polyester  
Figure 5: Hybrid glass/sugar palm fiber reinforced polyurethane composite used in automotive anti-roll bar  
Figure 6: (a) (b) Brushes from sugar palm fibers  
Figure 7: Portable composite table  
Figure 8: Helmet-Ijuk Reinforced Composite (HIReC) (Credited to Dato’ Ahmad Mujahid Mohd Zaidi, Universiti Pertahanan Nasional Malaysia)

Acknowledgements

The authors would like to thank the Management of Institute of Tropical Forestry and Forest Products and Universiti Putra Malaysia Grant scheme HICOE (vote number 6369107).

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<tr>
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<td>Frond, Bunch Fiber</td>
<td>Unsaturated polyester</td>
<td>Cold press</td>
</tr>
<tr>
<td>Sairizal (2011)</td>
<td>Long Fiber</td>
<td>Unsaturated polyester</td>
<td>Hand lay up</td>
</tr>
<tr>
<td>Bachtia (2012)</td>
<td>Short Fiber</td>
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The most readily recognisable characteristics of Eucalyptus species are the distinctive flowers and fruit (capsules or “gumnuts”). Flowers have numerous fluffy stamens which may be white, cream, yellow, pink, or red; in bud, the stamens are enclosed in a cap known as an operculum which is composed of the fused sepals or petals or both. Thus, flowers have no petals, but instead decorate themselves with the many showy stamens (Refer to Figure 2 for the Eucalyptus structure). As the stamens expand, the operculum is forced off, splitting away from the cup-like base of the flower; this is one of the features that unite the genus. The name Eucalyptus, from the Greek words eu-well and kaluptos-cover, meaning “well-covered”, describes the operculum. The woody fruits or capsules are roughly cone-shaped and have valves at the end which open to release the seeds, which are waxy, rod-shaped, about 1 mm in length, and yellow-brown in colour. Most species do not flower until adult foliage starts to appear; E. cinerea and E. perriniana are notable exceptions. Figure 3 shows the structure of the Eucalyptus fruits (Australian National Botanic Gardens, 2006).

The appearance of Eucalyptus bark varies with the age of the plant, the length of the bark fibres, the degree of furrowing, the thickness, the hardness and the colour. All mature Eucalyptus put on an annual layer of bark, which contributes to the increasing diameter of the stems. In some species, the outermost layer dies and is annually deciduous either in long strips (as in E. sheathiana) or in variably sized flakes (E. diversicolor, E. cosmophylla or E. cladocalyx). These are the gums or smooth-barked species. The gum bark may be dull, shiny or satiny (as in E. ornata) or matte (E. cosmophylla). In many species, the dead bark is retained. The outermost layer gradually fragments with weathering and sheds without altering the essentially rough-barked nature of the trunks or stems— for example E. marginata, E. jacksonii, E. oblique and E. porosa. Furthermore, many species are ‘half-barks’ or ‘blackbutts’ in which the dead bark is retained in the lower half of the trunks or stems – such as E. brachycaulix, E. orthophylla and E. occidentalis – or only in a thick, black accumulation at the base as in E. clevelandii.

In some species in this category for example E. youngiana and E. viminalis the rough basal bark is very ribbony at the top, where it gives way to smooth upper stems. The smooth upper bark of the half-barks and that of the completely smooth-barked trees and malless can produce remarkable colour and interest for instance E. deglupta. Figure 4 shows the structure of the Eucalyptus bark.

Figure 2. Flowers of Eucalyptus
(Source: Australian National Botanic Gardens, 2006)

Figure 3. Fruits of Eucalyptus
(Source: Australian National Botanic Gardens, 2006)

Figure 4. Bark of Eucalyptus
(Source: Australian National Botanic Gardens, 2006)
Eucalyptus plantations started in Australia in the 1980’s to service the Eucalyptus oil industry. Due to its success, other countries such as Indonesia, China and the United States have initiated Eucalyptus growing programs. Nowadays, Eucalyptus tree plantations are valuable for timber, oil and biomass. Eucalyptus is currently present in over 90 countries and is spread over more than 22 million hectares worldwide, although only 13 million hectares have a productivity of interest from the industrial standpoint (Zalesny et al. 2011).

Eucalyptus began to be used in plantations outside its natural distribution area (Australia), over 200 years ago in Europe. In the United States, it was introduced in the mid-nineteenth century as a result of the migratory flow with New Zealand and Australia. Eucalyptus reached South Africa and Brazil in the late nineteenth century and in the early twentieth century. In South Africa, it was prompted by the demand for wood, needed for mining activities; in Brazil to produce the coal used in the steel industry.

Forest plantation is not a new concept and practice in Malaysia. Rubberwood and Acacia spp. are the two major species of the nine-selected species, other additional fast growing timber species promoted including Tectona grandis, Azadirachta excelsa, Khaya spp., Neolamarckia cadamba, Falcatoria moluccana, Octomeles sumatrana and Bamboo spp. Recently Eucalyptus species has attracted the attention of the industry players particularly the plywood manufacturers, and investors in Malaysia.

Earlier attempts to plant Eucalyptus in Malaysia were in lowland area with 40 ha of Eucalyptus plantation as trial plots in 1931-1941 mainly with Eucalyptus robusta. In Sabah, a total of 7,000 ha were planted with Eucalyptus deglupta by Sabah Softwood Sdn. Bhd. and another 620 ha planted with Eucalyptus grandis, E. urophylla, E. globulus and E. camaldulensis by Sabah Forest Industries Sdn. Bhd. in 1991. Seeds from Australia, New Guinea, Indonesia and Sri Lanka have been used for plantations in Malaysia. Seeds from some of the older plantations have also been collected for further small scale plantation programmes (Appanah & Weiland, 1993). Most of the land used for plantation was logged-over forest, wasteland - consisting of mainly lalang grassland (Imperata cylindrica) and non-commercial secondary forests. These lands have been classified as ‘not suitable’ to ‘marginally suitable’ for agricultural use.

Forest plantations have been expanding yearly. In 2014, a total of 127,849 ha of forest plantation area in Peninsular Malaysia. However, in 2016, the number dropped to 113,503.99 ha. Table 3 shows forest plantation area in Sarawak while Table 4 shows in Sabah.

Table 1: Forest Plantation Area (ha) in Peninsular Malaysia by Species, 2008-2014

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>Acacia</td>
<td>22,092</td>
<td>25,846</td>
<td>24,846</td>
<td>25,392</td>
<td>21,649</td>
<td>26,126</td>
<td>24,238</td>
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<tr>
<td>Teak</td>
<td>2,618</td>
<td>2,709</td>
<td>2,709</td>
<td>2,901</td>
<td>2,847</td>
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<tr>
<td>Pine</td>
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<td>2,667</td>
<td>2,156</td>
<td>374</td>
<td>374</td>
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<td>Rubberwood</td>
<td>17,544</td>
<td>21,936</td>
<td>22,201</td>
<td>21,930</td>
<td>34,877</td>
<td>40,372</td>
<td>71,094</td>
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<tr>
<td>Antirrhinum macleodii</td>
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<td>281</td>
<td>281</td>
<td>281</td>
<td>868</td>
<td>868</td>
<td>875</td>
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<tr>
<td>Others</td>
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<td>21,673</td>
<td>8,112</td>
<td>6,521</td>
<td>6,489</td>
<td>7,099</td>
<td>18,401</td>
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<tr>
<td>Total</td>
<td>101,069</td>
<td>108,762</td>
<td>108,657</td>
<td>108,155</td>
<td>87,444</td>
<td>97,706</td>
<td>127,049</td>
<td></td>
</tr>
</tbody>
</table>

Source: Forestry Department of Peninsular Malaysia (2015)

Table 2: Forest Plantation Development Area (ha) in Peninsular Malaysia, 2016

<table>
<thead>
<tr>
<th>State</th>
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<tbody>
<tr>
<td>Johor</td>
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<td>Kedah</td>
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<td>Kelantan</td>
<td>33,820.42</td>
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<td>Melaka</td>
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<td>Negeri Sembilan</td>
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<tr>
<td>Pahang</td>
<td>20,547.75</td>
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<td>Perlis</td>
<td>2,870.55</td>
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<tr>
<td>Pulau Pinang</td>
<td>671.00</td>
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<tr>
<td>Sarawak</td>
<td>11,381.00</td>
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<tr>
<td>Terengganu</td>
<td>2,909.00</td>
</tr>
<tr>
<td>Wilayah Persekutuan</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>113,503.99</td>
</tr>
</tbody>
</table>

Source: Forestry Department of Peninsular Malaysia (2017)

Table 3: Forest Plantation Area (ha) in Sarawak by Species, 2008-2015

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Acacia</td>
<td>168,317.40</td>
<td>162,358.60</td>
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<td>154,080.00</td>
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<td>22,201.00</td>
<td>21,601.00</td>
<td>21,201.00</td>
<td>20,801.00</td>
<td>20,401.00</td>
<td>20,101.00</td>
<td>19,801.00</td>
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<td>Falcatoria</td>
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<td>22,103.00</td>
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<td>21,601.00</td>
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<td>12,290.70</td>
<td>12,190.70</td>
<td>12,090.70</td>
<td>11,890.70</td>
<td>11,690.70</td>
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<td>Eucalyptus</td>
<td>13,890.70</td>
<td>13,790.70</td>
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<td>13,590.70</td>
<td>13,390.70</td>
<td>13,290.70</td>
<td>13,090.70</td>
<td>12,890.70</td>
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<tr>
<td>Others</td>
<td>15,390.70</td>
<td>15,290.70</td>
<td>15,090.70</td>
<td>14,890.70</td>
<td>14,790.70</td>
<td>14,690.70</td>
<td>14,590.70</td>
<td>14,390.70</td>
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<tr>
<td>Total</td>
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<td>223,658,70</td>
<td>218,728,70</td>
<td>213,838,70</td>
<td>208,948,70</td>
<td>204,058,70</td>
<td>199,168,70</td>
<td>194,278,70</td>
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</table>

Source: Forest Department Sarawak (2016)
Planting of E. deglupta in Malaysia was stopped in 1982 due to poor performance when compared to other species (Sulaiman, 1996). Problems with insect and fungal pathogens are noted based on the historical background of this species in Malaysia. Thus, up to this date, most investors have a negative perspective towards this tree (Japarudin, 2016). Nevertheless, for the past several years Eucalyptus trees have been planted in some parts of Peninsular Malaysia, Sabah and Sarawak and the planted areas are growing. The sudden change of interest towards Eucalyptus may have arisen as a result of new interests by other countries, in particular China and Vietnam.

**Table 4: Forest Plantation Area (ha) in Sabah by Species, 2008-2016**

<table>
<thead>
<tr>
<th>Species/Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016 (as of October)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia mangium</td>
<td>72,771.33</td>
<td>68,872.23</td>
<td>70,697.75</td>
<td>62,595.40</td>
<td>84,928.00</td>
</tr>
<tr>
<td>Arak Gajah</td>
<td>1,999.00</td>
<td>2,021.80</td>
<td>1,743.00</td>
<td>2,948.00</td>
<td>1,166.00</td>
</tr>
<tr>
<td>Althea rubra</td>
<td>12,486.23</td>
<td>12,351.90</td>
<td>12,351.90</td>
<td>12,351.90</td>
<td>12,351.90</td>
</tr>
<tr>
<td>Citronelle amara</td>
<td>765.20</td>
<td>704.20</td>
<td>743.20</td>
<td>704.20</td>
<td>743.20</td>
</tr>
<tr>
<td>Eucalyptus grandis</td>
<td>18,581.20</td>
<td>13,941.80</td>
<td>16,714.20</td>
<td>19,861.30</td>
<td>16,084.30</td>
</tr>
<tr>
<td>Eucalyptus grandis</td>
<td>7,254.00</td>
<td>7,984.00</td>
<td>7,784.00</td>
<td>7,984.00</td>
<td>7,784.00</td>
</tr>
</tbody>
</table>

**Source:** Sabah Forestry Department (2017)

**References**


THE ECONOMICS OF BIOMASS WASTES TO BIOENERGY

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Introduction

Energy security has become a major challenge in human development in this era. Increasing energy demand, depletion of fossil resources, greenhouse gas emission and climate change bring complications to our environment and urges toward sustainable alternatives. One of the possible coping strategy is to develop renewable energy. Malaysia is blessed with tropical climate and fast-growing biomass. The biomass from crop residues can be used to generate biofuel without causing changes in land use, thus, avoiding competition with food. Many studies did show that Malaysia has good potentials to utilised biomass residues for biofuel. The estimated available biomass in Malaysia from agricultural and forest residues is up to 45.78 million dry tonne in year 2007, equivalent to 9.2 million ton of biofuel (Goh & Tan, 2010). Although biomass is seen as valorising wastes, it does not come with no cost. Biorefineries could aspect 33 to 50 percent of total production cost just for feedstock transportation (Kumar, Sokhansanj & Flynn, 2006). Even though biomass waste has low or no market value, the underlying natures of these resources have certain constraint to bioenergy industry.

The Natures of Biomass Resources

The main factor that affects transportation cost of biomass is accessibility. The accessibility of each biomass is affected by its spatial diversity. As illustrated in Figure 1, it varies in terms of density and distribution. Depending on the location of the mill, the accessibility to the resource will differ greatly and will significantly impact the transportation cost. In each section of Figure 1, location I can access more biomass areas with less distances compare to location II. When more distances are required, the higher transportation cost would be incurred.

To evaluate the impact of biomass spatial structure, a GIS simulation was performed by computing distances of biomass from different potential biorefinery locations, using the road network within Peninsular Malaysia. The findings are illustrated in Figure 2. Each of the biomass source has its own best location. In each section, the optimal biorefinery location is able to minimise distance and maximise supply, as it requires less distance to access the biomass areas. For non-optimal biorefinery locations, more distance is required to access the same biomass areas. In Peninsular Malaysia, the forest logging residues and oil palm trunk spatial structure reflect the patterns from Figure 1A and 1B respectively. Their accessibility curves show that the areas of biomass sources follow a sigmoid shape. Rice straw structure is illustrated in Figure 1C. Its accessibility takes a staircase-like curve. This is because areas of rice straw are clustered, with a lot of distance between the...
different clusters. Rubberwood residues are geographically dispersed and are quite scattered. Thus, their accessibility graph increases steeply, suggesting that every area of rubberwood require a substantial amount of distance to reach.

**A Paradigm Shift on Productivity**

In conventional economic theory, when one increases the quantity produced, its marginal cost will diminish due to increased productivity. As shown in Figure 3, the unit cost decreases as the quantity increases up to its optimal point due to the scale effect. Unlike conventional economy of scale, the biorefinery is influenced by the nature of biomass resources. When the biorefinery increases its scale, the input required increases and more distances and cost would be incurred to acquire the biomass feedstock. Thus, the location of the mill is pivotal to the biorefinery’s feasibility and sustainability, because it is the key to optimise the feedstock supplies and cost.

![Figure 3. Conventional economy of scale](image)

The following figures show the estimated unit production cost for biorefinery in Peninsular Malaysia, in the case of oil palm trunk and rice straw. For oil palm trunk at its optimal location, the spatial effect is larger than the scale effect as shown by the increasing per-unit production cost. However, when distance and supply are optimised, the cost escalates at a slow and steady rate. Conversely, the magnitude of increment for biomass supply distance to non-optimal location diminishes significantly the cost efficiency from scale effect, making the per-unit production cost increase quite steeply. In the case of rice straw, the cost of optimal location and non-optimal location differ significantly, due to substantial differences in supply distance and quantities. As illustrated, the situation for biorefineries is different than conventional economy of scale. To determine the feasibility, one way is to compare the market price and manage the production cost at a lower threshold. For example, if the market price is at fifty units, both non-optimal location would not be profitable. This also highlights the importance of location factor to the success of biorefinery.

![Figure 4. Estimated biorefinery production cost and biomass supply in Peninsular Malaysia](image)

**Way Forward**

Today in Malaysia there is a notable potential to utilise abundant biomass residues for sustainable energy. However, there are two factors that have the most impact on biorefinery cost. One is the conversion efficiency and another is the changes in biomass spatial structure and transportation distance (Gan & Smith, 2010). With technology advancement, conversion technology could reduce its cost by improving the productivity and yields. Nevertheless, the biomass geography affects the biorefinery externally and such factor has a major importance. Fortunately, this factor can be assessed through modelling and simulations. It is important to consider the distinct dynamics of bioenergy industry for decision making and policy formulation. This could minimise the difficulty in developing alternative energy for our sustainable future.
Acknowledgement

The authors would like to express sincere gratitude on supports from the consortium of Aerospace Malaysia Innovation Centre, Airbus SAS, French Agricultural Research Centre for International Development (CIRAD) and University Putra Malaysia, with funds provided under the project “Centre of Excellence on Biomass Valorization for Aviation”, Grant no. 6300142 and 9300428.

References


A REVIEW ON THE EU COUNTRIES’ BIO-ECONOMY STRATEGIES: CASE ON MALAYSIAN INDUSTRIES

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Introduction

“A bioeconomy can be seen as a world where biotechnology contributes to a significant share of economic output. It involves; the use of advance knowledge of genes and complex cell processes to develop new processes and products; the use of renewable biomass and efficient bioprocesses to support sustainable production; and the integration of biotechnology knowledge and applications across sectors. The bioeconomy offers technological solutions for many challenges facing the world, but achieving its potential will require appropriate national, regional, and global policies.” The Organization for Economic Co-operation and Development (OECD), 2009.

In response to (OECD) agenda, in 2012, the European Commission presented a comprehensive proposal to address the challenges faced by the world due to the ecological, environmental, energy, food supply and natural resources. They established a bio-economy term which reflects an economy where the production of food, feed, fibre, bio-based products and bio-energy employ efficiently and sustainably using renewable resources from land, fisheries, and aquaculture environments. The efficient and sustainable production ecosystems satisfy industry demand, consumers’ needs and environmental challenges (van de Pas, 2015).

There are some EU Member countries which have low levels of adaptation in strategic planning towards bioeconomy activities and its value chain. The objective of the study is to map the intended priorities and activities of EU members regarding research & innovation (R&I) on bioeconomy according to the current Smart Specialisation Strategies. This is to assist in understanding the similarities, commonalities and specificities among the EU member countries and to further analyse their gaps.

On the other hand, Malaysia developed a National Biotechnology Policy in 2005, and 7 years after, comes the Bioeconomy Transformation Program strategy. It is reaching newer heights in developing Malaysia in the bioeconomy driven nation.

This strategy development is aligned with the global agenda, but the Malaysia’s current status of meeting the milestone in the strategy is not clear. In understanding the current position, it is good to understand the development status of other developed nations. This paper is to review the status of bioeconomy strategies among the EU country members, and based on this, Malaysia could better strategize its position in driving towards a bioeconomy nation. There are various Malaysia bioeconomy reports published by Bioeconomy Corporation, but for this article, only Bioeconomy Malaysia Report: Towards a Bioeconomy Nation: Rethinking Industries was referred.

Since Malaysia is a nation with rich in natural resources which could drive further the bioeconomy strategy. In 2016, about 19000 bio-based companies in Malaysia who generating up to RM 430 billion per year in revenue. The size of the bioeconomy industry in Malaysia is RM 142 billion, where 75% consisting of upstream agriculture activities (oil palm cultivation, rubber plantation, livestock, forestry and fishing). Meanwhile, 25% is consists of downstream sectors (oil & fats, beverages, renewable fuel, wood products, organic, chemicals, and food processing).

EU Experiences in Developing Bioeconomy Strategies

Thematic variations

Based on the document analysis, 98.6% of the European countries and regions include bioeconomy in their research & innovation priorities and plans. However, there are variations in the denomination of the bioeconomy aspects. The variations are among, low-carbon, green growth, sustainable agriculture, innovative food production, green chemistry, eco-innovation, and circular economy to blue growth. There is also thematic variations within the countries...
and regions, for example, agro-food, bio-based fuel and energy, and other bio-based industry.

Among the themes, there could be seven different areas of bioeconomy projects which could be further developed specifically: knowledge generation; knowledge transfer, engagement, stakeholder network; new generation and re-definition of value chains and value cycles/demonstration/technological readiness; public awareness, dissemination of information; bioeconomy coordination, governance and platforms; education; and learning from other regions, alliances.

**Value chain analysis**

Understanding bioeconomy in the perspective of value chain analysis is prominent approach in Europe. It involved value chains of biomass supply over biomass processing up to the production of bio-energy and innovative bio-based products. Bio-energy and fuel from biomass, and food and beverages, were the two most frequent specific value chain approaches. Malaysia is carrying out measures to map a complete value chain from the upstream to the commercialisation in the R&D elements.

In EU experience, there is a wide variety in knowledge and expertise needed for different bioeconomy activities. There is no general territorial pattern for specific bioeconomy aspect in the R&I. Agro-food is the broad theme that frequently ranked first in the strategic plans. Regions involved is in Portugal, Spain, North-West France, Northern Germany, Sweden, Latvia, Lithuania, Czech, Slovakia, Hungary, Romania, Bulgaria, Greece, Croatia, Slovenia, and Italy.

Theme bio-based fuels and bioenergy covered territories in Southern France, Southern Germany and Southern Poland, Southern and Central Finland, Scotland, Ireland, and Galicia (Spain). Other bio-based industries including biorefinery, biochemicals, and biopharmaceuticals is found in Estonia, regions in France, Austria, England, Poland, Belgium and The Netherlands.

**Bioeconomy maturity index and Distribution by countries/states**

Bioeconomy R&I maturity index among EU countries were calculated as to rank the overall innovation capacity of a territory, the extent of existence of specific bioeconomy features. Regions and countries with high bioeconomy maturity index represent 5% of the EU, they are Sweden, Finland, England, Austria, Flemish Region in Belgium, Central Jutland in Denmark, Southern Netherlands, parts in Germany. There are 46% regions with middle-high maturity, 23% middle maturity, and 36% low maturity.

Currently, information on Malaysia maturity index is unavailable. It is important to obtain the similar index for Malaysia to further understand the current situation in aligning the strategies towards bioeconomy. This is the gap where researchers or agencies could take to provide more insights in Malaysia’s status towards bioeconomy.

As of today, Malaysia analysed the distribution of bioeconomy industries on the state basis. Figure 1 shows the sectoral contribution in the bioeconomy based on the number of companies involved in the bioeconomy related activities.

![Figure 1: Malaysia bioeconomy sectoral contribution by states](Source: Bioeconomy Malaysia Report, 2017)

**Bioeconomy drivers, external factors and supports**

There is a wide array of drivers of the bioeconomy. Different drivers have important influence on how the bioeconomy is implemented (i.e., resource driven, value-chain driven, business driven, or knowledge driven). In most cases, the driver is in the regional assets and resources which makes it supply-side driven.

There is an external factor that drive and stimulate the bioeconomy activities. Political decisions can increase competitiveness and promote economic development activities specifically within the theme of the bioeconomy. It can also be a response to the environmental and territorial challenges (i.e., loss of population in rural areas, and climate change).

There are 19 Member states have strategic approach in supporting bioeconomy with having bioeconomy strategy or in process of developing it. For others which do not have explicit bioeconomy strategy, it supported
do not have explicit bioeconomy strategy, it supported in embedded in several strategic documents or funding programs. It includes, national and regional R&I strategies and plans, sectorial innovation strategies and plans (innovation in agriculture, fisheries, and waste management).

**The stakeholders and clusters**

Regional bioeconomy ecosystems in Europe involved usual stakeholders: Governments and public administration, businesses, sectoral associations and business intermediaries, academic and scientific and technological institutions.

Clusters are important tool to gather stakeholders around specific bioeconomy sectors. Bioeconomy related clusters need to be integrated between, producers of biological resources (Farmers, fishermen, and their association), and among the government coordinators in various policy areas (R&I, agriculture, environment).

Intermediaries organisations are important as many technologies are immature and inter sectoral cooperation is important. Bioeconomy does not always has its own actors. There is lacking of specific bioeconomy bodies and network and limit the development of organised bioeconomy areas. Among the specific and emergent stakeholders are; Bioeconomy Strategy Council, Specialised Technology, Research and Innovation Centers, operational cooperation agencies, and cross-border and interregional cooperation project.

**Financial sources**

About 67% of the regions intend to use European Structural and Investments Funds (ESIF) as a funding source to support their bioeconomy activities. The analysis showed European countries and regions also use variety of other EU programs to support bioeconomy promotion, such as, Interreg, LIFE+, CIP/COSME, ERASMUS+, and Intelligent Energy Europe.

**Conclusion**

In response to EU experiences in positioning their regional strategies, there are needs and bottlenecks to manage in relation to; strategic planning and governance; value chain/cycle development; R&I on technologies, knowledge transfer, education and new bioeconomy skills; funding and synergies between instruments; public awareness and acceptance; and external factors. These challenges are global challenges which Malaysia could be better prepared in overcoming it.

To conclude, 36% of the EU regions have low maturity level in bioeconomy activities and support. Therefore, further development are needed in few areas; common definition/classification of bioeconomy; coordinated support between the higher maturity regions and low maturity regions in strategic planning, communication, and knowledge transfer; leadership in coordinating, aligning, and combining the efforts on R&I to engage stakeholders; more specialised support in different bioeconomy maturity and profiles; support on developing the transdisciplinary and specific bioeconomy competences and skills; better access to finance; and activities to raise public awareness and acceptance towards bioeconomy.

Similar to Malaysia as a country, there are states that have low capacity and support in achieving the national bioeconomy goals. These findings should be embraced and able to be better equipped in implementing bioeconomy strategies at the local level.

**References**


INTROP HIGHLIGHTS

URBAN FORESTS, MICROCLIMATE AND HUMAN THERMAL COMFORT: A PATHWAY FOR BIOECONOMY STRATEGY

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Introduction

The concept of bioeconomy is to grow and increase the needs for natural resources which leads to Land Use and Cover Change (LUCC) hence pressures on the ecosystem services, soil and water resources. Overcoming these situations is important through implementation of possible pathways that contributes to bioeconomy sustainability. One of the key drivers for green economy strategy is the need for improvement in sustainable resource management (Rosegrant et al., 2012). In relation to sustainable resource management, urban forests, climate change mitigation and human health are some of the important indicators relevant for bioeconomy strategy (Wolflechner et al., 2016).

Figure 1: Street trees and green roof garden as part of urban forest

Long-term provision of urban forest benefits is essential in supporting this strategy. Sustainably managed urban forests can provide important environmental and social values and ecosystem services such as microclimate benefits that contributes to climate change mitigation and improve human health issues for urban residents such as human thermal comfort. These benefits can direct and indirectly influences bioeconomy through several ways such as energy saving from the cooling effect of urban forest and, public health cost saving from decrease heat related health risk especially during extreme weather events (i.e heat waves) (Sun et al., 2017; Salata et al., 2017). Therefore, in order to facilitate sustainable urban forest resource management as a pathway in bioeconomy strategy, assessment of the microclimate and human thermal comfort benefits from urban forest is important as this can determine how the urban planners and managers can manage and improve the urban forest.

Figure 2: Taman Saujana Hijau is one of the urban parks in Malaysia

Methods Applied for Microclimate and Human Thermal Comfort Assessments

Besides natural forest in urban areas, trees located at streets, parks, green roof utility and transportation corridors are also considered as urban forests where these places are usually used in the microclimate and human thermal comfort assessments (Figure 1 and Figure 2). The parameters measured in microclimate assessment are listed as wind speed, air temperature, relative humidity and solar radiation. Based on these measurements, microclimate benefits of urban forest can be obtained by comparing the microclimate conditions in the areas with green vegetation such as trees and away from it (Wang et al. 2015; Nice et al., 2018).
For human thermal comfort assessment, direct estimation of human thermal comfort and human thermal comfort perception can be done. In order to estimate the human thermal comfort, microclimate parameters for microclimate assessment are needed (Figure 3). It is also necessary to include Mean Radiant Temperature measurement ($\text{TR}$), which is the measurement of mean temperature from all sources of radiation surrounding human body includes direct sunlight, shortwave and longwave radiation, and reflected radiation in all directions (Fanger, 1970). $\text{TR}$ can be measured using black hollowed globe with a temperature sensor (Nikolopoulou et al., 1999; Sanusi et al., 2016). The human thermal index can be estimated by using Physiologically Equivalent Temperature (PET) and Universal Thermal Climate Index (UTCI) (Mayer and Höppe 1987; Błażejczyk, 2010). On the other hand, human thermal comfort perception can be assessed by preparing a perception survey where relevant information such as visitor’s demographic background, perception and preference of current thermal and shading conditions, clothing, activities and purpose of visit can be gained (Lam et al., 2018).

**References**


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**Conclusion**

The existence of urban forest has great impact on environment and residents. Related to that, information on microclimate and human thermal comfort benefits that provided by urban forests is very important in terms of designing, planning and managing the urban forest landscape. In addition, the benefits may contribute towards sustainable urban forest resource management which should be highlighted as value-added goals for the development of sustainable bioeconomic.
IDENTIFICATION OF INSECT PESTS OF KENAF
(Hibiscus cannabinus L.) AT LADANG PUCHONG, TAMAN PERTANIAN UNIVERSITI, UPM

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Introduction

Hibiscus cannabinus L. or kenaf belongs to the Malvaceae family. It is similar with Hibiscus genus with cotton, bend and roselle plants. H. cannabinus is commercial species grown in China, Myanmar, India, Bangladesh, Thailand and Malaysia. In Malaysia, total area of kenaf planting is about 328,600 km² and the area including Peninsular Malaysia is 131,600 km², Sabah is 73700 km² and Sarawak is 123,300 km² (EAPAP, 1994 in Basri et al., 2014). The kenaf was planted in Malaysia because it is a short-day crop, which can harvest from plantation within 3 to 4 months. It also can grow in this country with have suitable of temperature climates, thrives with abundant solar radiation and high rainfall. It is also an important species due to global environmental issues and inadequate raw fibre resources. Scientists have developed more important potential economic and environmental benefits of the utilization of kenaf in the areas of soil remediation, reduced soil erosion due to wind and water, toxic waste clean-up, removal of oil spills on water, replacement or reduced use on fibre glass in industrial products, the increased use of recycled plastics reduced chemical and

However, kenaf also been attacked by pests, as recorded by Aminah et al. (2006) and Wong et al. (2001) that some of the pests of kenaf can damage young shoots, flower buds and developing fruits. Moreover, nematodes are an important pest which can inhibit the growth of the plant, especially effect on fibre quality (Daud, 2006). Due to this, spray application of furadan was used for controlling the nematodes (Daud, 2006). Kenaf has been attacked by pests such as Dysderes cingulatus and Aphis gossypii also recorded by Basri et al. (2014). Thus, we need to observe and record the pests and diseases in order to ensure good growth performance and fibre quality of the kenaf.

Kenaf Planting at Taman Pertanian Universiti

27 varieties of kenaf seeds were planted in Ladang Puchong on 16th May 2017, Taman Pertanian Universiti (TPU), Universiti Putra Malaysia. The experiment was conducted using a line planting method with the distance between of the plant is 30cm x 30cm. The crops were treated with NPK green after sowing and NPK blue a month after sowing. Chemical pesticide such as malathion and herbicide (Basta 15) were also applied on the crops 2 times, which applied a month after sowing and 2 months after sowing, whereas plot area with no pesticide was used as a control. In this study, the pests and diseases of the kenaf varieties were observed and recorded. The pests of kenaf were collected and identified in laboratory based on physical insect characteristics. The insect damage percentage of kenaf varieties were also recorded in the site.

Results and Discussions

The results showed that most of the kenaf variety at four-month old of control treatment (without pesticide) show serious attacked by insect. For example, Hibiscus flea beetle (Nisotra sp.) was seriously attacked on the plant as shown in Figure 2. However, no insect pest recorded of the kenaf plants treated with chemical pesticide.

Figure 1. Kenaf planting areas in Peninsular Malaysia (sources: LKTN, 2017)
Most of these varieties were attacked by *Nisotra* sp. except kenaf variety of GSK 124 and GSK 048. The effect of this insect pest also resulted in the alteration of the photosynthesis process for the plant growth (Haimidin Kadir, 2012). However, possibility the strong kenaf variety from attack by *Nisotra* sp., due to chemical content in the plant. The bioactivity of insecticide compounds presents in some of the plants such as coumarin compound, can against Coleoptera pests (Moreira et al., 2007). Phytochemicals from the plant offer not only effective control agents, but also are birational alternatives to organic synthetic pesticides (Sukumur et al. 1991). Besides, the phytochemicals from the plant active act as antifungal, for example alkaloids, phenolics, flavonoids, terpenoids, benzofurans, essential oil, and coumarins is normally used by researchers (Venugopala et al., 2013). The insect pests of kenaf plants were recorded in this study are shown in Table 1.

To obtain the quality yield and fiber, chemical pesticide such malathion and furadan was used for controlling the insect pests. However, the chemical pesticide application causes negative effects on human and environment (Lee et al., 2007). One alternative to the pesticide for pest control that receives attention is organic pesticide containing plant-derivative chemicals (Bennner, 1993). It is good reason to protect them from attack by insect pests.

### Table 1. Insect pest of kenaf

<table>
<thead>
<tr>
<th>Insect pest</th>
<th>Symptoms</th>
<th>Larva, nympha and adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hibiscus leaf blight (Nisotra sp.)</td>
<td>Eating young and old leaves also flower, that causes reduction in the number of leaves that interfere with the growth process of the tree.</td>
<td></td>
</tr>
<tr>
<td>Corton leaf roler (Haralacolades derogate)</td>
<td>Eating young leaves and leaves will be curled. Often it will cause a reduction in the number of leaves that interfere with the growth process of the tree.</td>
<td></td>
</tr>
<tr>
<td>Caterpillar (Amata nigriceps)</td>
<td>Eating young and old leaves leads to a reduction in the number of leaves that interfere with the growth process of the tree</td>
<td></td>
</tr>
<tr>
<td>Keeping (Dysdercus cinigulatus)</td>
<td>Suck the leaf fluid by using a sharp portion of mouth to puncture the hole. The leaves will be twitching or twitching effect of the crumpling activity.</td>
<td></td>
</tr>
</tbody>
</table>

In conclusion, most of the kenaf varieties is serious attacked by beetle such as Hibiscus flea beetle (*Nisotra* sp.), except kenaf variety of GSK 124 and GSK 048. The organic pesticide should be use for controlling the pests and diseases of the kenaf crops in plantation. It is a good reason to promote the good quality of the environment.

### References


MODIS SATELLITE LAUNCHED FOR LAND RESOURCES MAPPING

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Introduction

Moderate Resolution of Spectro radiometer (MODIS) is a satellite with a cross-track scanner (whiskbroom) that makes observations on the Earth in 36 spectral bands. MODIS scan wavelengths from 0.41 to 14.41 μm (X. Xiong et al., 2009). The satellite is capable of capturing data in these bands simultaneously with various temporal resolutions, for examples: 1-day, 8-day, and 16-day intervals. The satellite was designed with three spatial resolutions of 250 m, 500 m and 1 km with a wide field of view (FOV).

The first MODIS was launched in December 1999 on the polar orbiting NASA Earth Observation System (EOS) Terra satellite. The second one was launched on the polar orbiting Aqua satellite on May 2002 (Fensholt & Sandholt, 2003). The Terra and Aqua were built with special attention paid to the structure’s thermal sensitivity and the mechanical isolation of the instruments and spacecraft components. This makes the satellite more relevant for multipurpose forest canopy and surface research that recent and previously reported (Biudes et al., 2014; Fensholt & Sandholt, 2003).

MODIS produced multi land and ocean products that can be used for scientific climate assessment for terrestrial, regional and local. The products are divided into three overall families, namely, radiation budget variables, ecosystem variables and land cover characteristics Xiaoxiong Xiong et al. (2006) (Table 1.0). We presented only MOD09 and MOD12Q product here because they are frequently applied for various studies.

<table>
<thead>
<tr>
<th>Products code</th>
<th>Products broad name</th>
<th>Spatial Resolution</th>
<th>Temporal resolution/Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD09</td>
<td>Surface Reflectance</td>
<td>250 m, 500 m, 1 km</td>
<td>1-day, 8-day</td>
</tr>
<tr>
<td>MOD011</td>
<td>Surface Temperature and Emissivity</td>
<td>1 km</td>
<td>5-min, 1-day, monthly</td>
</tr>
<tr>
<td>MOD013</td>
<td>BRDF/Albedo</td>
<td>1 km</td>
<td>16-day</td>
</tr>
<tr>
<td>MOD010</td>
<td>Snow Cover</td>
<td>500 m</td>
<td>5 min, 1-day, 8-day</td>
</tr>
<tr>
<td>MOD029</td>
<td>Sea Ice extent</td>
<td>500 m</td>
<td>5 min, 1-day</td>
</tr>
<tr>
<td>MOD11</td>
<td>Vegetation indices</td>
<td>1 km, 500 m, 250 m</td>
<td>16-day</td>
</tr>
<tr>
<td>MOD15</td>
<td>LAI and FPAR</td>
<td>1 km</td>
<td>8-day</td>
</tr>
<tr>
<td>MOD17</td>
<td>GPP and NPP</td>
<td>1 km</td>
<td>8-day, 1 year</td>
</tr>
<tr>
<td>MOD12</td>
<td>Land cover type and Vegetation Dynamics</td>
<td>500 m, 1 km</td>
<td>1-year</td>
</tr>
<tr>
<td>MOD14</td>
<td>Thermal Anomalies and Fire</td>
<td>1 km</td>
<td>5-min, 1-day, 8-day</td>
</tr>
<tr>
<td>MOD44</td>
<td>VCC and VCF</td>
<td>500 m, 250 m</td>
<td>96-day, 1 year</td>
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</tbody>
</table>

In general, each MODIS image or product came with a unique code, whereby represented their product short name, data of acquisition, collection and etc. An example of the code is shown in the Table 2.0 below.

Table 2. MODIS data unique codes and full description, based on the example given.

<table>
<thead>
<tr>
<th>MOD09A1.A2006001.h08v05.005.2006012234567.hdf</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD09A1</td>
<td>Product Short Name</td>
</tr>
<tr>
<td>A2006001.h08v05</td>
<td>Julian Date of Acquisition (A-YYYYDDD)</td>
</tr>
<tr>
<td>.005</td>
<td>Tile Identifier (horizontal:XXvertical:YY)</td>
</tr>
<tr>
<td>.2006012234567</td>
<td>Collection Version</td>
</tr>
<tr>
<td>.hdf</td>
<td>Julian Date of Production (YYYYDDDHMMMS)</td>
</tr>
<tr>
<td>.hdf</td>
<td>Data Format (HDF-EOS)</td>
</tr>
</tbody>
</table>

MOD09

MODIS Surface Reflectance product (MOD09) is available in two spatial resolutions: MOD09A1 is for 500 m and MOD09A2 is for 1 km resolution. The products were used for estimating Net Primary Production (NPP) and Gross Primary Production products (MODIS Gross GPP/NPP) based on Light Use Efficiency models. In the incoming section, MODIS GPP/NPP will be known as MOD17. MOD09A1 captured images by 8-day intervals and carries seven spectral bands (Table 3.0).
Table 3. MODIS spectral properties.

<table>
<thead>
<tr>
<th>Band</th>
<th>Colour</th>
<th>Wavelengths (nm)</th>
<th>Typical use</th>
</tr>
</thead>
<tbody>
<tr>
<td>band 1</td>
<td>Blue</td>
<td>(459–479 nm)</td>
<td>Vegetation</td>
</tr>
<tr>
<td>band 2</td>
<td>Green</td>
<td>545–565 nm</td>
<td>Soil</td>
</tr>
<tr>
<td>band 3</td>
<td>Red</td>
<td>620–670 nm</td>
<td>Vegetation</td>
</tr>
<tr>
<td>band 4</td>
<td>Near infrared</td>
<td>841–875 nm</td>
<td></td>
</tr>
<tr>
<td>band 5</td>
<td>Near infrared</td>
<td>1230–1250 nm</td>
<td>Water detection</td>
</tr>
<tr>
<td>band 6</td>
<td>Shortwave infrared</td>
<td>1628–1652 nm</td>
<td>Snow</td>
</tr>
<tr>
<td>band 7</td>
<td>Shortwave infrared</td>
<td>2105–2155 nm</td>
<td>Snow</td>
</tr>
</tbody>
</table>

MOD09A1 is a good source for development of vegetation index, especially the Normalized Vegetation Index (NDVI) that was employed in many studies (Caccamo et al., 2011; Sheldon et al., 2012).

**MOD12Q**

MODIS Land Cover products (MOD12Q) are images of current state and seasonal-to-decadal scale dynamics of global land cover properties (Friedl et al., 2010). MOD12Q has two products: MODIS Land Cover Type (MLCT) (MOD12Q1) and Land Cover Dynamics (MOD12Q2) that include five and seven land cover layers, respectively. Hereafter, we refer MOD12Q1 as MLCT products. In this study, we discussed MLCT only because we employed the products for our study.

Table 4. The classification of land cover included in MLCT (Hansen et al. 2003).

<table>
<thead>
<tr>
<th></th>
<th>IGBP</th>
<th>UMD</th>
<th>LAI/FPAR</th>
<th>BGC</th>
<th>PFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forest</strong></td>
<td>Evergreen needle leaf forest</td>
<td>Deciduous needle leaf forest</td>
<td>Evergreen needle leaf forest</td>
<td>Evergreen needle leaf vegetation</td>
<td>Evergreen needle leaf tree</td>
</tr>
<tr>
<td></td>
<td>Woody savannah</td>
<td>Savannah</td>
<td>Savannah</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Savannah</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grasses/ Cereals</strong></td>
<td>Grasslands</td>
<td>Grassland</td>
<td>Grasses/Cereal crops</td>
<td>Annual grass vegetation</td>
<td>Grass</td>
</tr>
<tr>
<td></td>
<td>Closed shrublands</td>
<td>Closed shrublands</td>
<td>Shrublands</td>
<td>Annual grass vegetation</td>
<td>Shrub</td>
</tr>
<tr>
<td></td>
<td>Open shrublands</td>
<td>Closed shrublands</td>
<td>Shrublands</td>
<td>Annual grass vegetation</td>
<td>Shrub</td>
</tr>
<tr>
<td><strong>Croplands and mosaics</strong></td>
<td>Croplands</td>
<td>Broadleaf crops</td>
<td>Annual broadleaf vegetation</td>
<td>Cereal crop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cropland/natural vegetation mosaic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seasonally or permanently inundated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban and built-up land</td>
<td>Urban and built-up land</td>
<td>Urban</td>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barren or sparsely vegetated</td>
<td>Barren or sparsely vegetated</td>
<td>Unvegetated</td>
<td>Unvegetated</td>
<td>Barren or sparsely vegetated</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Permanent snow and ice</td>
<td></td>
<td>Snow and ice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Land cover classifications for MLCT are: forest, woodlands, grasses/cereals, shrub lands, croplands and mosaics, seasonally or permanently inundated and unvegetated. The classification was developed using ensemble supervised classification algorithm, specifically based on decision tree algorithm. Based on the MLCT, further land covers were developed by International Geosphere-Biosphere Programme (IGBP) and the University of Maryland (Hansen et al., 2003) (Table 4.0). An example of MLCT by IGBP classification for Asian region is further showed in Figure 1.0.

Figure 1. MLCT with IGBP classification: ENF (Evergreen needle leaf forest), EBF (Evergreen broadleaf forest), DNF (Deciduous needle leaf forest), DBF (Deciduous broadleaf forest) and MF (Mixed Forest) presented in the study. Source: Adapted from (Friedl et al., 2010).

The MCD12Q1 is one of the products used in the development of MODIS GPP/NPP model. The products have been continuously integrated in new NPP studies; for instance, a study by Alves et al. (2013) conducted for terrestrial NPP; Nunes et al. (2012) and Propastin et al. (2012) utilize the products for the tropical forests. We found MOD12Q1 is offering a good source of land cover data for scientific investigation.

Comparison of MODIS with Other Satellite

MODIS spectral, spatial and various functions have made MODIS a more advanced choice compared to other satellites such as NOAA AVHRR, Landsat TM and SPOT.

1. **NOAA AVHRR**

NOAA was launched in 1978. NOAA AVHRR is radiation-detector imager carrying the latest six channels (Table 5.0).

Table 5.0 NOAA AVHRR spectral properties included NOAA-6-12 and 14 (NOAA, 2013).

<table>
<thead>
<tr>
<th>Channels</th>
<th>Resolution at Nadir(m)</th>
<th>Wavelengths (um)</th>
<th>Typical use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0.58-0.68</td>
<td>Daytime cloud an surface mapping</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.725-1.00</td>
<td>Land-water boundaries</td>
</tr>
<tr>
<td>3A</td>
<td></td>
<td>1.58-1.64</td>
<td>Snow and ice detection</td>
</tr>
<tr>
<td>3B</td>
<td>1.09</td>
<td>3.55-3.93</td>
<td>Night cloud mapping, sea surface temperature</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>10.30-11.30</td>
<td>Night cloud mapping, sea surface temperature</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>11.50-12.50</td>
<td>Sea surface temperature</td>
</tr>
</tbody>
</table>

2. **Landsat TM**

Other satellite image is products of Thematic Mapper scanner such as Landsat TM that was launched in 1982 carried on board Landsat 4 and 5. The satellite has 16-day repeat cycle and the image consists seven spectral bands (Table 6.0). However, the satellite was started decomposing in January 2013.

Table 6.0 Spectral properties of Landsat TM (USGS 2012).

<table>
<thead>
<tr>
<th>Bands</th>
<th>Resolution at Nadir (m)</th>
<th>Wavelengths (um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 1</td>
<td></td>
<td>0.45-0.52</td>
</tr>
<tr>
<td>Band 2</td>
<td></td>
<td>0.52-0.60</td>
</tr>
<tr>
<td>Band 3</td>
<td></td>
<td>0.63-0.69</td>
</tr>
<tr>
<td>Band 4</td>
<td>(Band 6, 120 m)</td>
<td>0.76-0.90</td>
</tr>
<tr>
<td>Band 5</td>
<td></td>
<td>1.55-1.75</td>
</tr>
<tr>
<td>Band 6</td>
<td></td>
<td>10.40-12.50</td>
</tr>
<tr>
<td>Band 7</td>
<td></td>
<td>2.08-2.35</td>
</tr>
</tbody>
</table>

There are also many satellites under TM successor for instance Landsat 7 ETM+, however they are carrying higher spatial resolution of 15 m.

3. **SPOT**

New enhanced SPOT satellite is such as SPOT 5, 6 and 7 are so sophisticated with development of enhanced capability. However, all of them scanning the land surface at very higher resolution of between 2.5 to 1.5 m. The spectral properties of SPOT are showed in Table 7.0.
Table 7.0 Spectral properties of SPOT (AIRBUS, 2018).

<table>
<thead>
<tr>
<th>Bands</th>
<th>Resolution at Nadir (m)</th>
<th>Wavelengths (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mono-spectral/ Panchromatic</td>
<td>(2.5, 5, 10)</td>
<td>0.61-0.68/0.48-0.71</td>
</tr>
<tr>
<td>Band 1</td>
<td></td>
<td>0.50-0.59</td>
</tr>
<tr>
<td>Band 2</td>
<td></td>
<td>0.61-0.68</td>
</tr>
<tr>
<td>Band 3</td>
<td></td>
<td>0.78-0.89</td>
</tr>
<tr>
<td>Band 4 SWIR: short-wave</td>
<td>10-20</td>
<td>1.58-1.75</td>
</tr>
<tr>
<td>infrared, on SPOT 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and SPOT 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


References


Waveness (µm)
COMMUNITY ENGAGEMENT TOWARDS PRODUCTION OF AGARWOOD IN PENINSULAR MALAYSIA

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1Laboratory of Sustainable Bioresource Management, Institute of Tropical Forestry and Forest Product, Universiti Putra Malaysia
2Persatuan Pengusaha Gaharu Bumiputra Malaysia (PENGHARUM), Kuala Lumpur, Malaysia.

Introduction

Persatuan Pengusaha Gaharu Bumiputra Malaysia (PENGHARUM) and Institute of Tropical Forestry and Forest Products (INTROP) have initiated joint collaboration to solve the problem of agarwood planting in Peninsular Malaysia. This collaboration is expected to enhance the knowledge and information transfer on the agarwood industries for farmers in facing the challenges effectively to produce a superior inoculum at an affordable price. The purpose of the collaboration between INTROP and PENGHARUM is to study the identification of Aquilaria species, its pest and disease, plantation, environment factors, inoculation, economy aspect, as well as quality and grading of agarwood product. Generally, the collaboration between INTROP and PENGHARUM is a perfect platform to educate and deliver the knowledge about agarwood to farmers through training, practical, and seminars (Figure 1).

Company needs additional expertise to improve business

Academic provides expertise and assists with implementing the goals of the Company

Associate experience graduate works for company to carry out Project

Project created by Company to improve business

Aquilaria species

Aquilaria spp. is agarwood tree and it belongs to the family Thymelaeaceae. There are generally 19 Aquilaria species worldwide, including eastern India, Southeast Asia such as Vietnam, Laos, Thailand, Malaysia, Brunei, Singapore, Indonesia and New Guinea. The species is Aquilaria malaccensis, A. agallocha, A. crassna, A. subintegra, A. sinensis, A. microcarpa, A. beccariana, A. hirta, A. filaria, A. rostata, A. secundaria, A. apiculata, A. baillonii, A. banaeense, A. grandiflora, A. khasiana, A. cumingiana, A. brachyantha and A. ovate (Ismail and Mohd Zin, 2011). In Malaysia, there are five species of Aquilaria recorded namely A. malaccensis, A. microcarpa, A. hirta, A. rostata and A. beccariana. The establishment of Aquilaria species producing agarwood is gaining attention at national and local levels. This cause, the tree resources from the natural forest are depleting over the years. The agarwood is a fragrant wood that has been traded for a long time for its use in religious, medicinal and aromatic preparation (Ismail et al., 2016). According to Donovan and Puri (2004), the production of agarwood is uncertain and it is estimated that only about 10% of the Aquilaria trees in the forest may contain agarwood. In Malaysia, almost 100% of the agarwood are still collected from natural forest sources. The major states that allow the production of agarwood is Kelantan; which has issued 8 licenses of Aquilaria spp. and the wood of agarwood. Meanwhile, states such as Pahang, Kedah, and Johor also have been issued with permission from Forest Department (Ismail et al., 2017). The Aquilaria spp. has been listed as a threatened species by international organizations because it is highly susceptible to extinction (Mohd Farid et al., 2015). Due to the problems, the Aquilaria species especially A. malaccensis and A. crassna is the most tree species planted in the Peninsular Malaysia areas as described in Table 1.
Table 1. Distributions of Aquilaria species planting areas in Peninsular Malaysia.

<table>
<thead>
<tr>
<th>Species</th>
<th>Country</th>
<th>Number of Tree</th>
<th>Area (ekar)</th>
<th>Number of member</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aquilaria</em></td>
<td>Johor</td>
<td>28,893</td>
<td>25.6</td>
<td>52</td>
</tr>
<tr>
<td><em>Malaccensis</em></td>
<td>Kedah</td>
<td>7,280</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>and <em>A. crassna</em></td>
<td>Kelantan</td>
<td>23,500</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Melaka</td>
<td>22,600</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Negeri Sembilan</td>
<td>10,200</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Pahang</td>
<td>56,700</td>
<td>57</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Perak</td>
<td>25,500</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Sarawak</td>
<td>3,300</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Selangor</td>
<td>20,568</td>
<td>22</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Terengganu</td>
<td>5,400</td>
<td>5.5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Lain-lain</td>
<td>101,059</td>
<td>102.9</td>
<td>31</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>305,000</strong></td>
<td><strong>307</strong></td>
<td><strong>225</strong></td>
</tr>
</tbody>
</table>

Sources: PENGHARUM, 2018.

Oleoresin production from Agarwood

Oleoresin is an ester or chrome derivative, hydrocarbon and sesquiterpenes or terpene (not polymer) that occurs in agar wood. It is also known as an essential oil, which is volatile when burned or heated to remove exotic fragrance scent (Ismail and Mohd Zin, 2011). The oleoresin in agarwood is highly commercial. The agarwood price of high quality oil can be as much as US$ 65,200 per liter in the year 2016 (MTiB, 2017). Ajmal Perfumes Company recorded US$ 3 trillion to US$ 3.6 trillion a year including pure agarwood oils, agarwood chips, perfumes and others downstream agarwood based on the product (Ismail et al., 2016). The agarwood is estimated that for the production of one litre of oil about 100 to 150 kg of agarwood (Gerard, 2007). However, Malaysian Timber Industry Board (MTiB) estimated the exchange rate of agarwood by industry for the production of agarwood oil is 100 kg of agarwood (MTiB, 2017).

In traditional industry, the oleoresin from agarwood tree used for perfume production. In the year 1970, the oleoresin agarwood in traditional industry has grown rapidly especially oleoresin production in Malaysia, due to high market demand mainly from the Middle East, North East Asia, and Europe (Ismail and Mohd Zin, 2011). Until now, the agarwood tree is considered as a valuable natural resource for producing various products especially perfumes to meet the needs of the well-being of the community and as a source of foreign exchange earnings (Ismail, 2017). It has also been used in traditional medicines to treat abdominal pain during pregnancy and after childbirth, fever, body as well as menstrual syndrome. In China and Asia countries, the agarwood also used in homeopathy medication (Burkill, 1996).

Collaborations between INTROP and PENGHARUM

PENGHARUM was established based on the cooperation between agarwood farmers and entrepreneurs to improve bumiputra economic status in agarwood industry. It was established on July 9, 2009 and currently has a total of 225 members (Table 2). The number of *Aquilaria spp.* registered under PENGHARUM is 305,000 trees equivalent to 307 acres, whereby the average of tree maturity is between 5-6 years old and the rest are over 10 years old. The distribution of *Aquilaria* species planting areas under PENGHARUM in Peninsular Malaysia is shown in Table 2.

Table 2. Number of PENGHARUM member in 2018.

<table>
<thead>
<tr>
<th>Member of PENGHARUM</th>
<th>Number of member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>120</td>
</tr>
<tr>
<td>Retired Government Staff</td>
<td>43</td>
</tr>
<tr>
<td>Government Staff</td>
<td>28</td>
</tr>
<tr>
<td>Company</td>
<td>21</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>225</strong></td>
</tr>
</tbody>
</table>

Sources: PENGHARUM, 2018

In 2010, PENGHARUM and Forestry Faculty of UPM have collaborated in organizing the National Seminar of Agarwood. The seminar was held to develop knowledge among the public on issues related to policy, natural resources, harvesting, processing, marketing, and promotion of agarwood in Malaysia. In addition, the Forestry Department of Peninsular Malaysia, Universiti Putra Malaysia (UPM), Malaysian Timber Industry Board (MTiB), and Forest Research Institute Malaysia (FRIM) have also worked on development of agarwood industry in Malaysia with PENGHARUM. However, the most successful inoculum product is very expensive and
farmers are forced to spend a high cost for the inoculation process of each tree per hectare. This situation hinders the development of agarwood industry especially to farmers. Due to this problem, INTROP and PENGHARUM as the knowledge transfer provider under the collaboration of agarwood production are highly required for these farmers.

In 2017, PENGHARUM continues to share knowledge with INTROP as the extension of knowledge transfer program with agarwood farmers. The results of the collaboration between INTROP and PENGHARUM showed a significant result in screening the inoculum product with low cost (Figure 2). The studied inoculum product is being tested on *Aquilaria crasna* and *A. malaccensis* trees in several areas such as Jasirn, Melaka and Semenyih, Selangor (Figures 3 and 4). The inoculum also will be induced in several agarwood plantation areas in Peninsular Malaysia.

![Figure 2. One-month symptom of inoculum induce](image)

**Conclusion**

Generally, collaboration between INTROP and PENGHARUM is a perfect platform to educate and deliver the knowledge about agarwood to farmers through training, practical, and seminars. Especially, to study the identification of *Aquilaria* species, its pest and disease, plantation, environment factors, inoculation, economy aspect, as well as quality and grading of agarwood product. In addition, the *Aquilaria* species is considered as a valuable natural resource for producing various products especially perfumes to meet the needs of the well-being of the community and as a source of foreign exchange earnings.

**References**


COMMUNITY OF PRACTICE PROGRAM (COP) 2017

Date : 3rd to 4th April 2017
Venue : Seminar Room, the Undercroft, Universiti Teknologi PETRONAS

Laboratory of Biocomposite Technology has sent 2 staff to University Teknologi Petronas (UTP) in conjunction to its LFSD Open Day. The main objective of the participation is to join the Community of Practices (COP) and the main objective of this COP formation is to establish a platform for networking and collaborating in MS ISO/IEC 17025:2005 and in any other field or opportunities. By gathering the communities, it is LFSD hope to promote UTP’s capabilities leading towards strategic collaborations besides sharing knowledge, experience and latest technologies with universities, agencies and industry players. After the program, the committee hope of the formation of virtual community of practice, collaborative program through online i.e. communication via email, facebook and sharing and exchange information on latest technology, issue, daily machine problems etc.

PLANT CULTURE TISSUE COURSE

Date : 16th to 18th May 2017
Venue : Institute of Bioscience (IBS), UPM

The course is organized by Biodiversity Unit, Institute of Bioscience, UPM. The objective of the course is to provide participants with an introduction and disclosure of the basic things that need to be done in the conduct of plant tissue culture. There are three important bases when one wants to do plant tissue culture, namely the provision of media, sterilization methods and aseptic techniques of apparatus, tools, media, explant and methods of tissue culture either directly from explosives or subculture to multiplication purposes. The speakers are Mrs. Julia Abdul Aziz (Senior Science Officer) and a contract lecturer from Faculty of Agriculture UPM, Prof. Madya Dr. Maheran Abdul Aziz.
9TH CONFERENCE INTERNATIONAL GEOPOLYMER CAMP WITH SHORT COURSES

Date : 10th to 12th July 2017
Venue : Saint Quentin, France

The course is organized by Geopolymer Institute as Saint Quentin, Paris. There are two sessions in this Camp: 1st day start with short courses for the newcomers and the following days were conference sessions. During short courses, participants were exposed to the right technique in producing geopolymer binder or resin especially for cement, composite and coating applications. In addition, the geopolymer founder, Prof Dr Joseph Davidovits explain on the right terminology for geopolymer, chemistry behind formulation of geopolymer and its properties. He also highlights on the successful products which have use geopolymer process as to form binder, concrete, composite, anti-corrosive coating, architectural design and many more from various industries around the world. During conference sessions, various topics from geopolymer research and applications were highlight. Keynotes was given by Prof Waltraud Kriven from University of Illinois, USA on “The geopolymer route to high tech ceramics” and “Natural fiber reinforced geopolymer”. In addition, many industries with geopolymer based products were in the conference session to share their latest finding and projects on geopolymer. The industry involved were from GeoMITS (show their latest mixers for making geopolymer), Renca (Geocement and its 3D printing machine for infrastructure), Monolith (invented by sculptors to create a monument by using ancient secrets and modern science of stone) and many more. Researchers from universities were also in the conference to share their current projects in geopolymer which are from Sejong University (Korea), Ostfold University College (Norway), Universidade do Minho (Portugal), Universiti Teknologi Petronas, Universiti Putra Malaysia and many more.

25TH ANNUAL INTERNATIONAL CONFERENCE ON COMPOSITES AND NANO ENGINEERING

Date : 16th to 22th July 2017
Venue : Rome, Italy

The conference was organized by Prof David Hui from University of Orleans (USA), with co-organizer from University of Salerno, Italy. Around 700 to 800 papers were presented during this conference from researcher around the world. The conference sessions were divided into different theme such as materials for sustainable energy; nanotechnology; sandwich and FGM structures; design and development; damage, durability and structural integrity; mechanical behaviour, and many more. Many interesting keynotes were presented such as from Professor Jagannathan Sankar (North Carolina A&T State University, NC) on “Revolutionizing metallic biomaterials”, Professor Pantelis Botsaris (Democritus University of Thrace, Greece) on “Funding trends on research, Horizon 2020”, Professor Abdalla M Darwish (Dillard University, USA) on “Inorganic nanocomposite films with polymer nanofillers made by concurrent multi-beam multi-target pulsed laser deposition”, Professor Marek Godlewski (Institute of Physics, Polish Academy Science, Poland) on “High-K oxides from electronics to biomedical applications” and many more. In addition, discussion on future collaboration between Universiti Putra Malaysia and Universiti di Salerno, Italy was also done during the conference. Professor Luciano Feo and Dr Rossa from University of Salerno have agreed to discuss further on the possible collaboration in term of research between University of Salerno and UPM.
ARCGIS ESSENTIAL WORKFLOW AND BUILDING GEODATABASE

Date: 2nd – 4th and 9th – 11th August 2017
Venue: Esri Malaysia, Menara PIX-HM Shah Tower, Petaling Jaya

Essential workflow and building geodatabase is a training for handling various data types for various application such as mapping forest for high quality wood demarcation, wood disease area which also can be integrated with climatological data. In fact, land use area information can be exquisite by collecting area information in points, line and shape that can be further applied for specific application, for example, mapping land use type (plantation or forestry) area, assessing suitable drainage systems for efficient water irrigation, mapping plantation area before planting to maximize land usage and so on. There were many participants involves included researcher form Lembaga Koko Malaysia, universities and from private companies.

TRAINING WORKSHOP ON PULP AND PAPERMAKING TECHNOLOGIES ON NON-WOODY FIBER MATERIALS

Date: 21st August - 9th September 2017
Venue: Beijing, China

Three staffs from Laboratory of Biopolymer and Derivatives, INTROP represented Malaysia to the Training Workshop on Pulp and Papermaking Technologies on Non-Woody Fiber Materials on 21 August to 9 September 2017. This training workshop was organized by China National Pulp and Paper Research Institute (CNPPRI) and was sponsored by China Ministry of Science and Technology. The participation involved seven different countries listed as Malaysia, Bangladesh, Indonesia, Philippines, Egypt, North Korea and China which successful gathered 19 experts of Pulp and Paper Technology. It was a fruitful training workshop which encompassed theoretical lectures, laboratory practical, pilot plant visits and factories visits. The content of the training workshop started from the forest, pulping, bleaching, papermaking, waste treatment and management and latest technology in pulp and paper area either not only in research and development but also the practice in the industries of China.
5th SOIL & WATER ASSESSMENT TOOLS CONFERENCE AND WORKSHOP IN SOUTH EAST AND EAST ASIA

Date : 27th to 28th October 2017  
Venue : Hotel Bangi-Putrajaya, Bangi

The Soil and Water Assessment Tool (SWAT) is a public domain model jointly developed by USDA Agricultural Research Service (USDA-ARS) and Texas AgriLife Research, part of The Texas A&M University System. Various application can be implemented by applying this tools for example for plantation area and forest assessing land use impact after logging activity. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds. In specific, SWAT is a river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land management practices on different soil patterns and land use patterns.

THICK FILM FABRICATION WORKSHOP 2017

Date : 7th - 8th November 2017  
Venue : Institute of Advanced Materials (ITMA), UPM

Thick Film Fabrication Workshop 2017 was organized by Institute of Advanced Materials (ITMA) on the 7-8 November 2017. The workshop was divided into three session namely theoretical lectures, laboratory hands-on and mill visit. The lectures comprised of ‘Introduction to Thick Film Technology’ and ‘Screen Printing Process’. During laboratory hands-on, the participants were taught on how to self-prepare the thick film paste which then applied them during screen printing process and thick film final fabrication. The participants were brought by bus to visit Khai Lien Silk Screen Suppliers (M) Sdn. Bhd. which situated in Bandar Baru Bangi, Selangor. The mill is applying the technology of thick film fabrication and also supplying screen printer, pad printer and other related machineries dedicated for silk screen printing materials and equipment. The content of this workshop is very useful towards the research for making specialty paper such as security paper or information storage paper.
WORKSHOP ON NANO ENABLED PRODUCTS AND MEDICAL DEVICES: TESTING AND REGULATION OF NANOSAFETY

Date : 13th – 14th November 2017
Venue : SIRIM Berhad, Kulim Hi-Tech Park, Kedah

The workshop was organized by Industrial Centre of Innovation in Biomedical, SIRIM Industrial Research, SIRIM Berhad with the aim to provide knowledge on toxicological background of nanomaterial and the current recommended practices for safe and healthy work in nanomaterial laboratories and producing industry. The course includes a series of lectures that addressed exposure routes and the toxicological principles of nanomaterials as well as hands-on training of experimental approaches for in vitro cell-nanomaterial interactions. Among the topics discussed were Basic Introduction to Biological and Environmental Aspects of Nanoparticles/Nanomaterials, Health and Environmental Impact of Nanomaterials, Basic Introduction to Toxicology on the Micro- and Nano-Scale and Risk Assessment and Regulations. The invited speaker was Prof Harald F. Krug, the Manager for the International Research Cooperations in the General Management of Empa – Swiss Laboratories for Materials Science & Technology in Switzerland (St. Gallen). His company NanoCASE GmbH focuses on education and consulting of manufacturing companies on the safe production and use of nanomaterials or nanomaterial-containing products. He is also a Professor at the University of Berne since August 2008. His work is focused on applications and implications of new materials, especially nanomaterials.

WORKSHOP ON RESPONSE SURFACE METHODOLOGY

Date : 15th - 16th November 2017
Venue : InfoComm Development Centre, UPM

Response Surface Methodology (RSM) is a statistical methodology of constructing approximations of the system behavior using results of the response analyses calculated at a series of points in the variable space. This method is applied in various fields such as chemistry, physics, engineering as well as biotechnology to find the optimum response. The objective of these 2 days’ workshop is to provide both theoretical and practical aspects, especially for process optimization. The speakers of this workshop were Assoc. Prof. Dr. Rosfairizan Mohamad from INTROP, Dr. Tan Joo Shun from Universiti Sains Malaysia and Dr. Nagasundara Ramanan Ramakrishnan from Arkema Thiochemicals Sdn. Bhd. This workshop has attracted 41 participants from various government agencies such as UPM, UiTM, IIUM and Malaysian Rubber Board, and also from private universities such UTP, Unisel and UTAR.
MECHANICAL CHARACTERIZATIONS OF BIOFIBER AND BIOCOMPOSITE MATERIALS WORKSHOP

Date : 15th - 16th November 2017
Venue : Seminar Room, INTROP, UPM

The Laboratory of Biocomposite Technology (BIOCOMPOSITE) has organized a workshop on mechanical characterizations of biofiber and biocomposite materials. This workshop was officiated by YBrs. Dr. Norkhairunnisa Mazlan, Head of Programme of Biocomposite Technology and Design, INTROP. The main objective of this workshop was to impart a platform for sharing the knowledge regarding the machines used for wood and natural fiber researches. This workshop was also providing trainings for participants to operate the universal testing machine and dynamic mechanical analyzer, as well as analyzing related data. There was a total of 21 participants have attended this workshop, most of them consisted of researchers and postgraduate students of INTROP. The speakers of the workshop were Prof. Ir. Dr. Mohd Sapuan Salit, Dr. Norkhairunnisa Mazlan from UPM, and Dr. Ridhwan Jumaidin from UTeM. In addition, the demonstrators of the workshop were Mr. Josh Lai Say Alk from TA Instruments Malaysia and Mr. Hanafi Abdullah from Instron Malaysia.

SEMINAR ON NANOCHELLOUSE 2017

Date : 27th November 2017
Venue : OSH Hall, Universiti Putra Malaysia

The seminar was organized by Laboratory of Biopolymer and Derivatives, Institute of Tropical Forestry and Forest Products (INTROP). The aim of the seminar was to provide a platform for researchers working on nanocellulose to gain new knowledge related to their research, as well as to discuss the progress of nanocellulose research and development in Malaysia. The speakers were Prof. Derek Gray from McGill University, Canada; Dr Rezal Khairi Ahmad from NanoMalaysia Berhad and Mr Kamarulzaman Kamaruddin from National Nanotechnology Centre, MOSTI. Prof. Gray is one of the pioneer in nanocellulose research. During the seminar, he shared his experience in nanocellulose development as well as potential applications of the nanocellulose.
TRAINING ON CORRESPONDENCE ANALYSIS, DATA MINING AND EXPLORATORY MULTIVARIATE STATISTICS STRATEGIES

**Date**: 27th – 28th November 2017  
**Venue**: Garcinia and Morinda Room, Auditorium FRIM, Forest Research Institute of Malaysia, Kepong, Selangor

The Factominer software is a package in the R software for various analyzes such as multivariate analysis. Furthermore, this R software is suitable for data mining in various fields of study and research. This is especially in the field of natural resource related research to study and control environmental factors that affect quality of fiber production. Therefore, participants from the course can find out the patent of the data being studied including: the type of relationship between the variables, the axis that has a great impact in the analysis, classification of groups that may result from the data being used, while it may alter the type of final decision and the way of final results presentation. The course was conducted by Dr. Marc Roda INTROP Research Fellow. This training course is one of the MoU activities between UPM and FRIM since 1986.

NANOTECH MIDDLE EAST 2017 INTERNATIONAL CONFERENCE AND EXHIBITION

**Date**: 4th - 6th December 2017  
**Venue**: Dubai, UAE

The Nanotech Middle East Conference and Exhibition (Previously known as Nanotech Dubai) is organized by Setcor Conferences and Exhibitions, Dubai jointly with Surtech Middle East 2017 and Biotech Middle East 2017. Its remains the main and most dedicated and commercially-focused Nanotechnology and Nanoscience conference and exhibition in the Middle East, Gulf Region, North Africa, Africa and South Asia region offering scientists, technology developers, business leaders, including senior executives of leading nanotech companies, business development teams from large and mid-size companies, investors and other industry experts, a unique opportunity to identify new technology trends, development tools, product opportunities, R&D collaborations, and commercialization partners. I attended this conference during Dec 4-6, 2017 and presented my research finding on Dynamic Mechanical properties of Oil palm nano filler/Kenaf hybrid composites. Conferences attracted high profile plenary and keynote lectures from Middle East and Europe. Besides that, several good researches work on nanotechnology and its application in different field shared by researchers from around the world in special sessions, oral and poster sessions. Few companies from Middle East, Pakistan, India, Europe display equipment, accessory and solution developed for different application through Nanotechnology.
NETWORKING AND LINKAGES

VISIT TO BINTANG HIJAU FOREST RESERVE, PERAK

Date : 27th – 28th July 2017
Venue : Bintang Hijau Forest Reserve, Perak

Bintang Hijau Forest Reserve is comprised of 3 forest areas, namely Hulu Perak, Kuala Kangsar and Larut/Matang. This study focused only on the Bintang Hijau Forest Reserve (Larut Matang). Lately, water catchment is often associated with water security and emphasis is given to the value assessment for water catchment services. Among the major sources of forest is the supply of clean water. Forest is a catchment area. With the water catchment area, it is capable of providing clean water as well as other functions such as flood control agents, irrigation and agricultural irrigation for aquaculture. In general, this study was conducted to determine the economic value and to establish the payment of ecosystem services (PES) of the water catchment forest in Permanent Forest Reserve. Therefore, the research team was visited the forest reserve for collecting ground information from villagers and also from District Forest Officer.

RESEARCH COLLABORATION REPORT BETWEEN INTROP, UPM & SNU, SOUTH KOREA

Date : 2nd September – 30th October 2017
Venue : Seoul National University (SNU), South Korea

Research Collaboration between INTROP, UPM and Seoul National University (SNU), South Korea was held for 2 months. SNU is a South Korean University that has many fields of science and technology. I have been placed in College of Agriculture and Life Sciences (CALS) in Lignin Laboratory and Biocomposite. Within two months, I was able to complete a study related to the research of lignin modification coupled with biopolymer and kenaf wood fibers to produce insulating composites. The above research work is divided into three stages. The first stage was the provision of lignin modification from sulphite lignin with maleic anhydride. The method is to use microwave oven. Second stage of composite material preparation. Modification of lignin is mixed with biopolymer by using extender twin screw machine to produce compound between lignin, biopolymer and kenaf fiber. The compound is in the form of pellets. Third stage testing of composite materials. The pellets were inserted into injection molding in certain temperatures and channeled into dog-shaped molds. The sample was tested for durability such as tensile and flexural. Data is recorded and analyzed. My two-month experience found that SNU’s working culture was very diligent and cooperative with each other. Laboratory equipment is sufficient to do research work. Every Monday is a presentation of student research work with lecturers in the laboratory. We can share research information made by the student until they graduate.
TECHNICAL VISIT FROM SCG PACKAGING PUBLIC COMPANY LIMITED (SCGP), THAILAND

Date : 26th – 28th September 2017
Venue : Institute of Tropical Forestry and Forest Products (INTROP), UPM

Two representatives from SCG Packaging Public Company Limited (SCGP), Thailand visit Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia on 26th until 28th Sept 2017. The main objective of the visit was to observe the extraction activity, synthesis of tannin resin, lab visit and discuss on the progress of the project on the Eucalyptus tree bark for value added product adhesive for wood based panels. Three days visit in UPM give an opportunity to the representatives of SCGP to observe the whole process of tannin extraction until the synthesis of tannin resin. They also have an opportunity to observe current technology in UPM. Apart of that, more collaboration and networking with Thailand industry can be made in the future on the utilization of waste material such as Eucalyptus barks.

PUBLIC LECTURE ON FRANCE–MALAYSIA POTENTIAL INITIATIVES IN RESEARCH AND EDUCATION OF FOREST WOOD BIOECONOMY

Date : 30th October 2017
Venue : Briefing Hall, Administration Building, UPM

The public lecture was co-organized by the Laboratory of Bioresource Management and Laboratory of Biocomposite Technology, INTROP in cooperation with the French Agriculture Research Institute, (CIRAD). The lecture was focuses on sharing the potential opportunities in research and education of forest wood and bioeconomy. There was a session that specifically discussed the potential initiatives that could be collaborated. Postgraduates’ degree/double-degree, researcher attachment, joint supervision of postgraduate students, are among the potential future collaboration activities. The speaker is the Director at Agroparistech in France. Agroparistech is the leading French university in engineering, agronomy and forestry. Besides being the Director, she is also the top French scientist in wood mechanics and wood industry.
VISIT TO SABAH SOFTWOODS BERHAD

Date : 9th – 10th October 2017
Venue : Tawau, Sabah

A research group from INTROP and the Faculty of Forestry, UPM had visited Sabah Softwoods Berhad (SSB) to discuss research collaboration between UPM and SSB and the Borneo Forest Consortium (BFC). During the meeting, INTROP also intends to hold a Memorandum of Understanding (MoU) with University of Sunshine Coast, Brisbane which involves activities such as research collaboration on Eucalyptus plantation, exchange of student and staff as well as short-term training for graduate students. We were also visited to the Eucalyptus tree planting area, seed trial, research nursery, showcase area for breeding of Eucalyptus species and tissue culture laboratory for production of Eucalyptus and Acacia mangium seedlings.

VISIT TO INNOVATIVE COMPOSITE CENTER (ICC), KANAZAWA INSTITUTE OF TECHNOLOGY, JAPAN

Date : 19th – 21st December 2017
Venue : Kanazawa Institute of Technology, Japan

Innovative Composite Centre (ICC) is a research centre under Kanazawa Institute of Technology (KIT), Japan. ICC KIT is one of the Japan’s leading research centres in biocomposites, which involved in numerous national and industrial projects. Among the collaborations are with Toyota, Mitsubishi, Kuka, Chuetsu Pulp, and etc. Assoc. Prof. Dr Hidayah Ariffin received an invitation from ICC KIT to visit their facilities and discuss the potential collaboration between UPM and KIT. It was a fruitful visit as several potential collaborations have been agreed. A MoU between both institutions will be signed soon. This networking activity is expected to increase the potential of INTROP staff to have more international research collaborations, especially with Japan.
**NEW MEMBERS**

**Name:** Assoc. Prof. Ir. Ts. Dr. Mohamed Thariq bin Haji Hameed Sultan  
**Email:** thariq@upm.edu.my  
**Field of specialization:** Structural Health Monitoring (SHM), Composite Materials and Impact Studies  
**Recent Projects**  
Project’s name: Design and fabrication of Crash Box and Food Tray Table from Bamboo/Roselle Hybrid Composites  
Source of fund: Grant Putra IPB  
Amount: RM152,300.00  
**What is your feeling when joining INTROP?**  
I am excited and motivated to join INTROP as my expertise can be clearly seen here at INTROP.  
**What is your opinion of INTROP’s working environment?**  
Happy working environment.  
**How do you see INTROP 5 years onwards?**  
We are now given the status of HCIC. Hope that we can be equivalent to the international standards in near future.

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**Name:** Dr. Sairizal bin Misri  
**Email:** sairizal@upm.edu.my  
**Field of specialization:** Composite Material, Concurrent Engineering  
**Recent Projects**  
Project’s name: Selection of Material & Fabrication of Safety Helmet  
Source of fund: Sime Darby  
Amount: RM 65,000  
**What is your feeling when joining INTROP?**  
Once I’ve been with INTROP, a lot of potential can be produced. In INTROP, there are various types of natural resources for research. It makes it easier for me to know every kind of nature resource more deeply in term of strength and cellulosic.  
**What is your strategy for the future as Post-Doctoral in INTROP?**  
I will help in finding the funds. Introducing INTROP to the industry in order to facilitate the relationship in research.  
**What is your opinion of INTROP’s working environment?**  
The working environment is intimately friendly and interoperable among staff. This simplifies and refines existing tasks.  
**How do you see INTROP 5 years onwards?**  
INTROP will be the main source of UPM in producing natural resource-based products as well as a source of information resources in all types of natural materials.
### STUDENTS GRADUATED IN 2017
#### DOCTOR OF PHILOSOPHY

<table>
<thead>
<tr>
<th>Name</th>
<th>Matric No.</th>
<th>Field of Study</th>
<th>Thesis Title</th>
<th>Supervisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmaen Ahmad Saffian</td>
<td>GS30023</td>
<td>Biocomposite Technology</td>
<td>Development of Slow Release Fertilizer from Oil Palm Empty Fruit Bunch Biopolymer Composites</td>
<td>Assoc. Prof. Dr. Khalina Abdan</td>
</tr>
<tr>
<td>Naheed Saba</td>
<td>GS38067</td>
<td>Biocomposite Technology</td>
<td>Development and Characterization of Flame Retardant Oil Palm Filler/Kenaf Reinforced Hybrid</td>
<td>Prof. Dr. Paridah Md. Tahir</td>
</tr>
<tr>
<td>Amin Moradbak</td>
<td>GS35347</td>
<td>Pulp and Paper Technology</td>
<td>Production of High Quality Packaging Paper from Bamboo Asam Pulp with Addition of Cellulose Nanocrystals</td>
<td>Prof. Dr. Paridah Md. Tahir</td>
</tr>
<tr>
<td>Mazlina Bt Mahdzar</td>
<td>GS34712</td>
<td>Nature Tourism</td>
<td>Effects of Memorable Tourism Experiences as Mediators on Visits to Mulu National Park, Sarawak, Malaysia</td>
<td>Prof. Dr. Ahmad Bin Shuib</td>
</tr>
<tr>
<td>Chia Kei Wei</td>
<td>GS31944</td>
<td>Nature Tourism</td>
<td>Economic Impact of Rural Coastal Tourism in Semporna, Sabah, Malaysia</td>
<td>Prof. Dr. Ahmad Bin Shuib</td>
</tr>
<tr>
<td>Emiliana Rose Binti Jusoh</td>
<td>GS34548</td>
<td>Biopolymer and Derivatives</td>
<td>Blend of Jatropha Oil/Palm Oil-Based Acrylated Epoxidized Prepolymer For Ultraviolet Curable Coating</td>
<td>Prof. Dr. Luqman Chuaiah Abdullah</td>
</tr>
<tr>
<td>Seyed Eshagh Ebadi</td>
<td>GS35286</td>
<td>Biocomposite Technology</td>
<td>Multivariate Optimization of Hydrothermal Treatment of Oil Palm Wood in Buffered Media</td>
<td>Prof. Dr. Zaidon A shaari</td>
</tr>
</tbody>
</table>
STUDENTS GRADUATED IN 2017

**MASTER**

Name: Mohd Asim Khan  
Matric No.: GS39945  
Field of Study: Biocomposite Technology  
Thesis Title: Development and Characterization of Kenaf/Pineapple Leaf Fibre-Reinforced Phenolic Hybrid Composites  
Supervisor: Dr. Mohammad Jawaid

Name: Nor Atirah Bt Mohd Aridi  
Matric No.: GS41986  
Field of Study: Biocomposite Technology and Design  
Thesis Title: Mechanical and Morphological Properties of Rice Husk-Filled Polypropylene Composites with Struktol Compatibiliser  
Supervisor: Prof. Ir. Dr. Mohd Sapuan Salit

Name: Nur Marliana Binti Mohamad  
Matric No.: GS42780  
Field of Study: Biocomposite Technology and Design  
Thesis Title: Effect of Immersion Treatment of Fibre on Mechanical Properties of Pultruded Kenaf Vinyl Ester Composites  
Supervisor: Prof. Ir. Dr. Mohd Sapuan Salit

Name: Muhammad Mirza Bin Ariffin  
Matric No.: GS42128  
Field of Study: Biopolymer, Pulp and Paper Technology  
Thesis Title: Preparation and Characterization of Jatropha Oil-Based Polyurethane Acrylate with Graphene Oxide/Zinc Oxide for Anti-Corrosive Coatings  
Supervisor: Dr. Min Min Aung @ Aishah Abdullah

Name: Shahirah Binti Manap  
Matric No.: GS36898  
Field of Study: Biopolymer and Derivatives  
Thesis Title: Production and Optimization of Carboxymethyl Cellulose and Filter Paperase of Locally Isolated Streptomyces Lucitanus CS/2 Under Submerged Fermentation of Napier Grass  
Supervisor: Prof. Dr. Rosfarizan Mohamad

Name: Nurhasnah Binti Mohd Hawari  
Matric No.: GS39002  
Field of Study: Biocomposite Product Design  
Thesis Title: Design and Fabrication of Eco-Friendly Prosthetic Leg Socket Made from Woven Kenaf-Glass Fiber Hybrid Composite  
Supervisor: Dr. Mohammad Jawaid
POSTGRADUATE STUDIES STATISTICS

INTROP’s Postgraduate Students by Country (Active)

INTROP’s Postgraduate Students - Trends in Enrolment
INTROP’S ACHIEVEMENTS FOR 2017

PUBLICATIONS

POSTGRADUATE STUDENTS

INNOVATIONS

LINKAGES & COLLABORATIONS

NEW RESEARCH GRANTS

Private Grant
RM597,196

International Grant
RM2,545,300

Public Grant
RM1,358,671.56

TOTAL
RM4,501,167.56