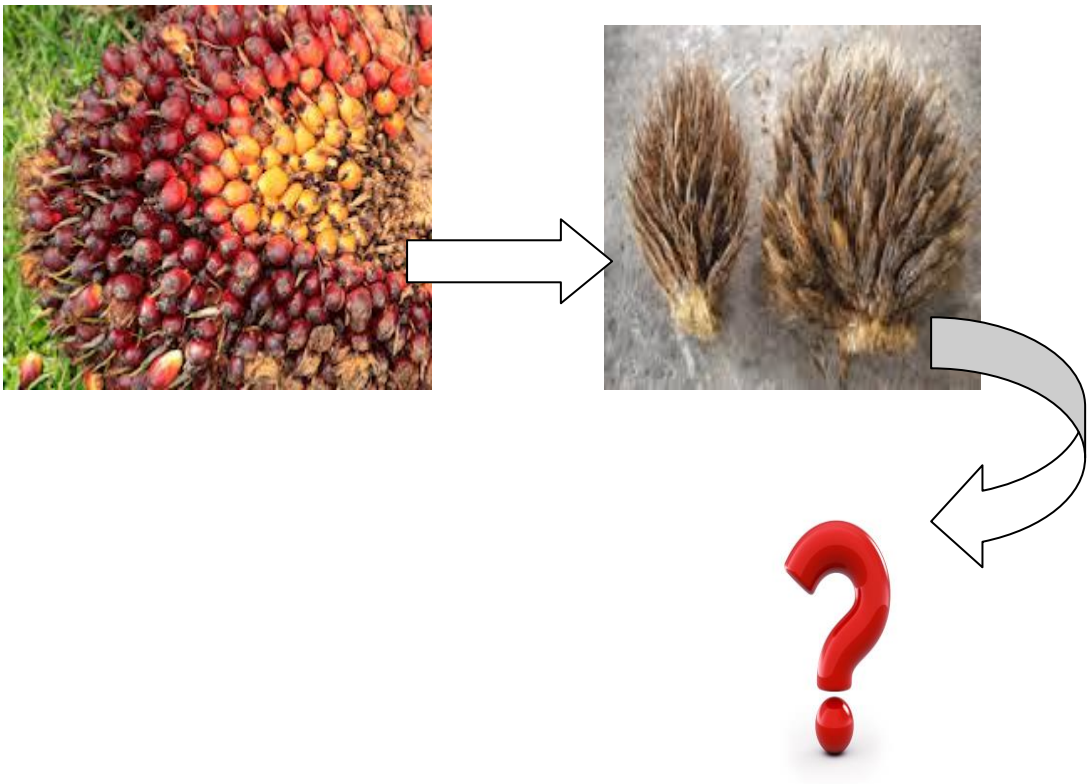
SUSTAINABLE MANAGEMENT
OF OIL PALM SECTOR IN MALAYSIA:

THE MULTIFUNCTION OF
EMPTY FRUIT BUNCHES (EFB)



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CHAPTER 1

INTRODUCTION

Malaysia is famous for palm oil production and plantation. The shift form rubber to palm oil in the 1970s was due to the change in the world market demand for palm oil products as a substitute to corn oil, soybean oil and conventional oil for consumption (Midun, Z. 1988). As demand increased the area for palm oil plantation increased with the expense of forest land. With the clearing of these forest land and continuous replanting of palm oil has reduce the fertility and the sustainability of land use. But with improved management processes and the reusing of palm oil waste products to improve soil fertility and as energy source to run the oil palm mills.

In 2013 the total area that had been cultivated for palm oil was 5.23 million hectares and increase of 3% from 2012. Sabah still has the largest palm oil area in Malaysia with an area of 1.48 million hectares, followed by Sarawak with 1.16 million hectares and Peninsular Malaysia about 2.59 million hectares. The total exports of oil palm products which include palm oil, palm kernel oil, palm kernel cake, oleo chemicals, biodiesel and finished products increased by 4.5% to 25.7 million tonnes in 2013 compared to 24.59 million tonnes exported in 2012. However total revenue declined by 14.1% to RM 61.36 billion compared to RM 71.45 billion in 2012 due to the lower export prices. (Choo, Y.M., 2013)

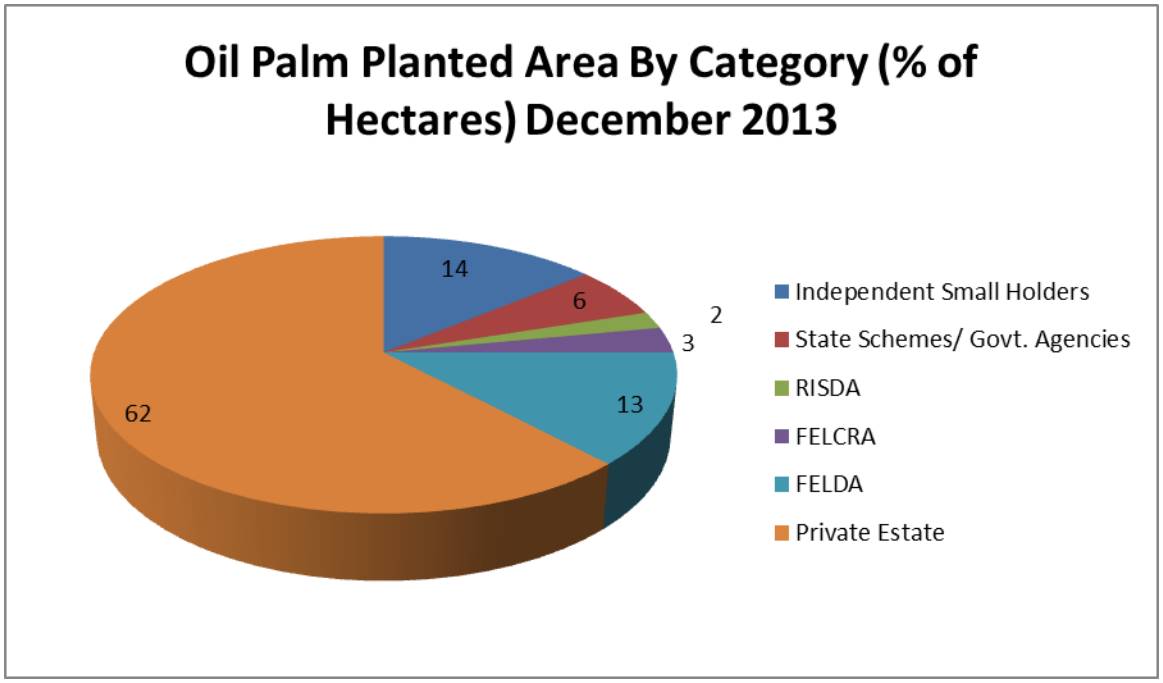

Diagram 1: Distribution of palm oil plantation holders in Malaysia at December 2013, [MPOB official website www.mpob.gov.my (2013)]

Malaysia still has a proximately 61% of area covered with forest. By introducing sustainable management of palm oil plantation these forest area can be maintained. By sustainable management the maximizing of oil palm products which includes the waste products can provide value added by-products to enhance revenues. To justify the commitment of the Government in providing sustainable oil palm plantation management, Malaysia has become a signatory to the various charters and conventions for example The Convention on Biological Diversity 1992, International Tropical Timber Agreement and the Charter of the Indigenous Tribal Peoples of Tropical Forests. (Basiron, Y, 2006)

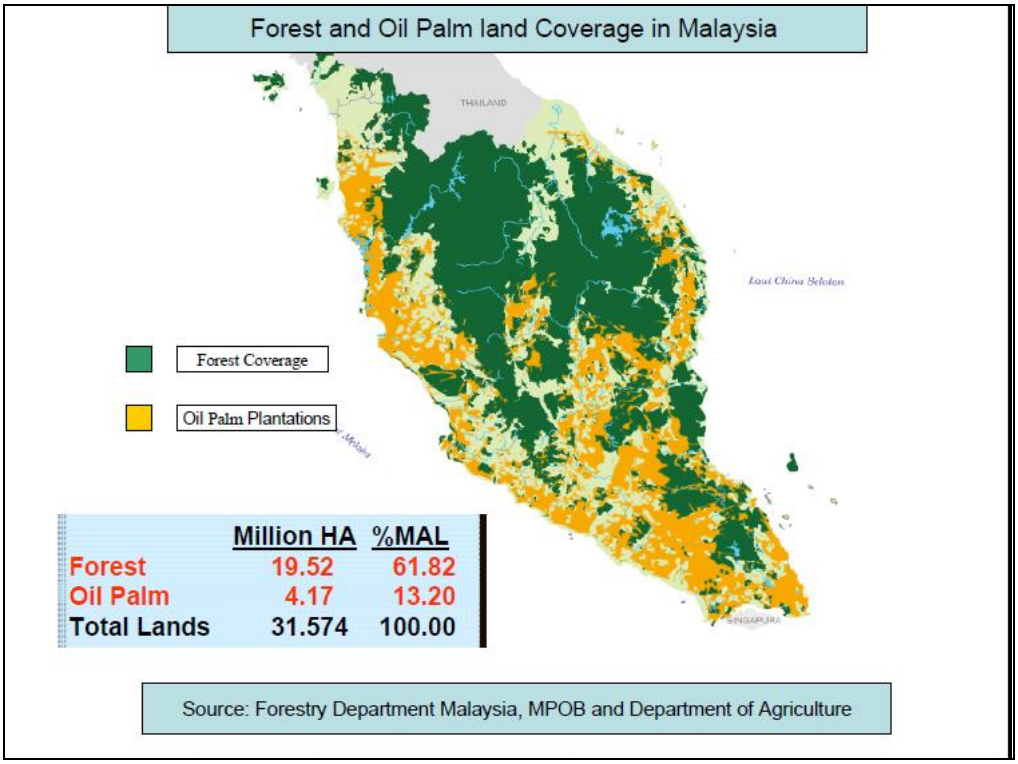

Diagram 2: Distribution of oil palm plantation compared to forest area in Peninsular Malaysia at 2006, (Basiron, Y, 2006).

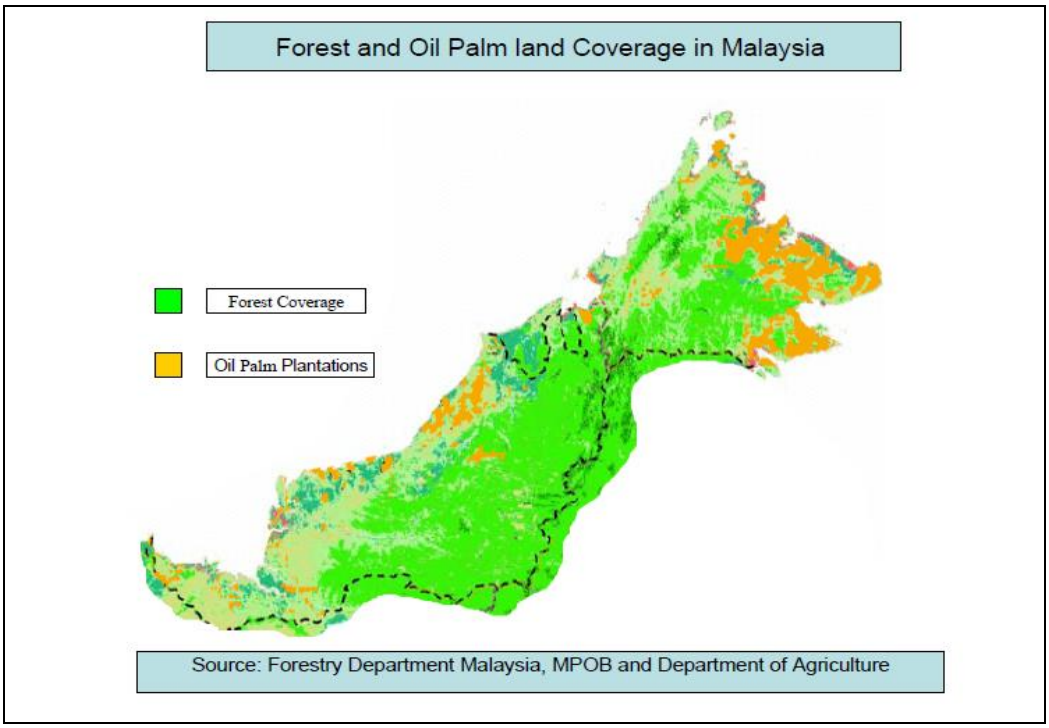

Diagram 3: Distribution of oil palm plantation compared to forest area in East Malaysia at 2006, (Basiron, Y, 2006).

Oil palm plantation is not immune to environmental issues. There are many environmental concerns that linger with the existence of oil palm plantations such as deforestation, biodiversity, sustainability, traceability, indiscriminate burning, carbon sequestration and destruction of local community (MPOB, 2014). These environmental issues are based on the outlook of conditions and situations in foreign countries which are being imposed on Malaysia. Oil palm plantation takes up a small amount of forest space in the world which totals to about 8.9 million hectares compared to soybean which takes up to 58 million hectares of forest globally (Basiron, Y, 2009). The introduction of zero burning in oil palm management reduces the carbon influx into the air which is closely linked to global warming. The reuse of empty fruit bunches, palm oil residues and treated palm oil mill effluents (POME) as fertilizers and soil amendments reduces the usage of fertilizers and chemicals which causes poisoning and leaching of nutrients to water supplies. These are some of the improvements that have been done.

The sustainable usage of oil palm waste has improved oil palm plantation management and the reduction of its waste which at a certain point considered very hazardous. The type of waste that are produced are oil palm trunks (OPT), oil palm fronds (OPF), empty fruit bunches (EFB), palm pressed fibres (PPF), palm shells and palm oil mill effluents (POME) (Abdullah, N. and Sulaiman, F., 2013). These materials provide a huge solid waste disposal headache if it is not recycled or transformed into other products. With new technological developments these waste have been reused as soil amendments, biomass energy, fertilizer and biochar. These methods have reduce the need for landfills to dispose of huge amounts of oil

palm waste and the culture of self sustenance of energy supply to run the mills from biomass energy is gaining importance.

This paper will have a much focused discussion on how empty fruit bunches (EFB) a major solid waste of oil palm plantation is recycled to provide biomass energy, acts as a soil amendment or fertilizer and the creation of a new product called biochar. By reinventing new uses for a waste product of palm oil production, it not only resolves many environmental issues but also provides added revenue and improvement of technology which will enhance sustainable land use through the reduction of dependency to chemical based fertilizers, non renewable energy to power the oil palm mills and finally improve the fertility of the soil to maximize production. The paper will also provide how the local legislation supports these innovations and the encouragement of the government and other entities to improvise even more about the recycling of empty fruit bunches.

CHAPTER 2

MULTIFUNCTION OF EMPTY FRUIT BUNCHES (EFB)

A. EFB AS BIOCHAR

Biochar is originally a 2,000 years of traditional practice that changes agricultural waste into a soil enhancer which keep carbon, enhanced food security and reduce deforestation. Biochar can be found in the soils all over the world due to vegetation fires and historic soil management practices. Biochar is considered as an important tool in increasing food security and diversifying cropland in areas with severely depleted soils, limited organic resources and inadequate water and fertilizer supplies. Biochar also improves quality as well as the quantity of water by enhancing soil retention of nutrients for plant and utilization of the crop. Therefore, there will be more nutrients kept in the soil instead of leaching through the groundwater thus resulting pollution.

It is also a powerful tool in mitigating climate change. Carbon which exists in Biochar resists degradation and can hold carbon in the soils up to thousands of years. Biochar is created through pyrolysis or gasification process which involved heating biomass in the absence or under limited of air. It can serve as carbon negative as the Biochar is buried in the ground as a soil enhancer and at the same time keeping the carbon from emitting into the atmosphere. It could also reduce nitrous oxide emission and at the same time can store annually about 2.2 Giga tonnes of carbon dioxide (CO_2) by the year 2050. Therefore, it is considered as among of the few technologies which relatively widely applicable, quickly scalable as well as inexpensive.

Diagram 4: Biochar in various shape and size, also as a mixture

In December 2009, Prime Minister Datuk Seri Najib Tun Razak announced in Copenhagen that Malaysia would be adopting an indicator of voluntary reduction of up to 40 percent in terms of emissions of GDP (Gross Domestic Product) by 2020 compared with 2005 levels. The reduction is subjected on receiving the transfer of technology financing from the developed world. Based on 2006 data by the United Nations shows Malaysia's carbon emissions was at the level of 187 million tonnes which means a reduction of 74.8 million tonnes must be achieved by the year 2020. The challenges posed by climatic changes have pushed developing countries like Malaysia to turn for green technology in the effort to reduce CO_2 emissions into the air. Therefore, Biochar is considered as one of the ways in reducing CO_2 emissions and mitigating climatic changes. This method was also chosen due to its practicality and low cost involved. Biochar can also serve as side

solution for open burning involving agro waste products such as empty fruit bunch (EFB) for the palm oil tree as well as rice husk for paddy.

To implement biochar, first we have to know how biochar works and why it is considered as carbon negative. Fossil fuels are carbon-positive which add more carbon into the air. Ordinary biomass fuels are carbon neutral whereby the carbon captured in the biomass by photosynthesis would eventually return to the atmosphere through natural processes which burning plants for energy just speeds it up. Sustainable biochar systems however are carbon negative because it holds a substantial carbon portion in the soil. This will result a net CO_2 reduction in the atmosphere which illustrated as below:

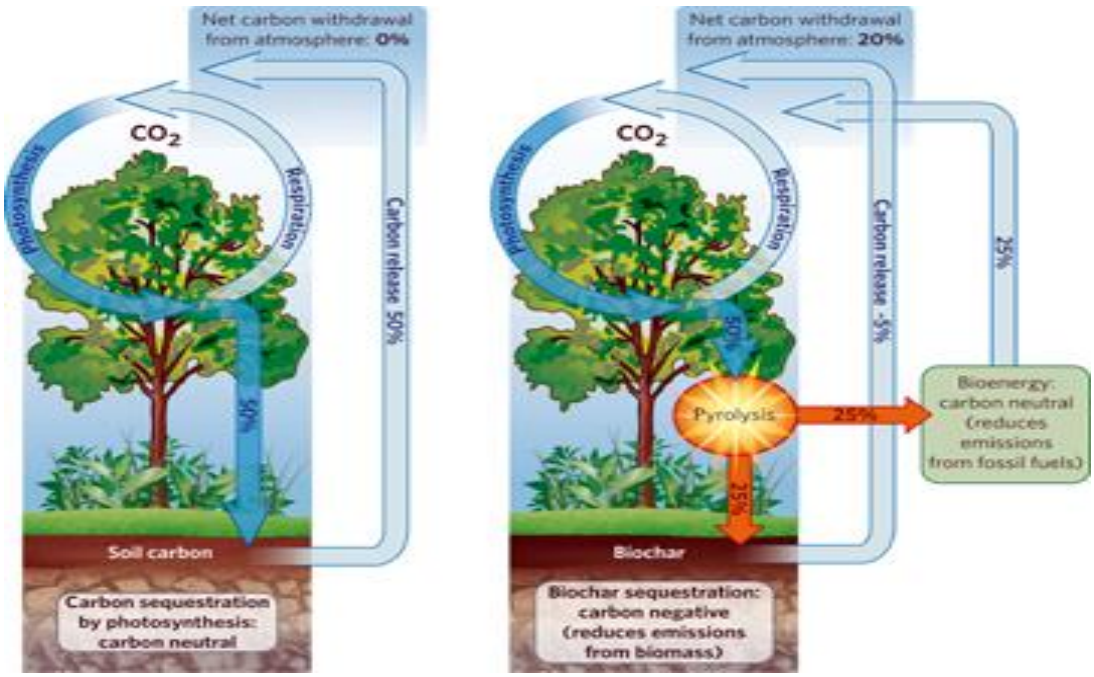

Diagram 5: Comparison of CO_2 Cycle

Through biochar innovation, the EFB will be converted into biochar through the pyrolysis process where it is heated at 300 to 450 degree Celsius with the absence of oxygen. Biochar is also considered as an alternative to charcoal as the price for charcoal is getting more expensive and difficult to source. Based on Four Sustainable Biochar Wedge Scenarios model introduced by International Biochar Initiatives (IBI), Malaysia could achieve maximum return on carbon sequestration pertaining to biochar production in 20 to 25 years subjected to 50 to 80 percent of all crop and forestry residues available to make biochar. This scenario has taken into consideration the estimated amount of biochar produced as well as the amount of carbon emission from fossil fuels which are replaced by the energy generated during production of biochar.

B. EFB AS BIO-ENERGY/ BIO-OIL

Besides creating a soil enhancer, sustainable biochar practices can also produce oil and gas by-products which can be used as fuel (syngas) thus providing clean and renewable energy. Biochar with the by-products in the form of syngas can assist in mitigating global climate change through replacing the use of fossil fuel and by carbon sequestration. Apart from 20 percent of the EFB which turns into biochar, the process also produces bio-fuel and synthetic gas (syngas) which is a form of renewable energy. In the carbonator-driven plant context, the energy is reused as an energy source for the heating of EFB in the next cycle.

In this context, Universiti Putra Malaysia (UPM) with the collaboration of local company named Nasmech Technology Sdn Bhd has established a plant to produce the biochar from the EFB in Dengkil, Selangor with the cost of RM3.98 million

funded by Ministry of Science, Technology and Innovation through Techno fund Program. This carbonator-driven plant at the Seri Ulu Langat Oil Palm Mill in Dengkil, Selangor produced biochar from residue materials including the EFB and able to process up to 20 tonnes of EFB a day. This will definitely see as the solution to the bio-mass waste disposal issue particularly the EFB which the country produces about 188 million tonnes a year. Usually the EFB is disposed by incinerating or used as the direct fuel source for boilers.

Diagram 6: Carbonator plant in Dengkil Selangor

Since the moisture content in EFB is around 67%, pre-processing is necessary before EFB can be considered as a good fuel. There is a large potential of transforming EFB into renewable energy resource that could meet the existing energy demand of palm oil mills or other industries. Pre-treatment steps such as shredding/chipping and dewatering (screw pressing or drying) are necessary in order to improve the fuel property of EFB. In Sabah, large quantities of EFB are available. In its raw state, EFB is both very fibrous and wet. If it could be dried, it would be an excellent fuel for power boilers. First American Scientific Corp (FASC)

Malaysia has installed a KDS machine in the 14 MWe TSH Biomass Power Plants in Kunak, Malaysia, for the purpose of drying EFB. Called the KDS MF-777, it dries and shreds EFB so that it can be burned as a fuel. At present, only one-sixth of the fuel input needed by the TSH power plant is supplied by the machine. However, the power plant engineers are working towards to maximise the percentage of EFB fuel to increase the electricity production.

In addition, fast pyrolysis represents a potential route to upgrade the EFB waste to value added fuels and renewable chemicals. According to N. Abdullah, F. Sulaiman and H. Gerhauser (2011), the pyrolysis of woody feedstock at temperatures around 500ºC, together with short vapour residence times will produce bio-oil yields of around 70% and char and gas yields of around 15% each. Bio-oil is a high-density oxygenated liquid, which can be burned in diesel engines, turbines or boilers, though further work is still required to evaluate the long-term reliability. It is also used for the production of speciality chemicals, such as flavourings, which are the main products.

C. EFB AS MULCHING FOR PLANTATION:

The application of empty fruit bunch (EFB) as an organic mulch in oil palm has been receiving increasing attention in recent years. Mulching is the application of materials on the surface to reduce soil temperature and conserve soil moisture to improve growth and yield of plants besides supplying varying amount of nutrients as they decompose. Studies have shown that every ton of empty bunches contains 18.0kg muriate of potash, urea 3.8kg, 3.9kg and 9.2 kg of rock phosphate kieserite. All this materials are required by all crops, including oil palm trees. The application

of Empty Fruit Bunch (EFB) is normally based on the age of palm to be applied. There are 3 categories of EFB application, namely for Immature palms (1-3 yrs), young mature palms (3-5 years) and fully mature palms (> 5 years).

Immature palms (0-2 years)	Young mature palms (3-5 years)	Fully matured palms (> 6 years)
EFB should be placed in a single closely packed layer around the palm	EFB should be placed in arising from 1.5 to 2.2 m away from the palm base in a single closely packed layer	EFB may be placed anywhere in the inter-rows, but away from the palm fronds and harvester path.
The EFB mulching should be from 0.2 to 1.5 m away from the palm base		EFB should be in a single pile closely packed preferably in rectangular shape of 1.5 m x 4.5 m per palm

Table 1: Application of EFB as mulching materials

D. EFB AS FERTILIZERS:

EFB is a common raw material used in composting. Other materials are often added, particularly chickens, goats, cattle manure and POME (Palm Oil Mill Effluent). The method is first exposing big piles of EFB in the open for two months.

The EFB was then mixed with 20% chicken manure and heaped in sheds measuring 12 x 36 x 3m. The heap was mixed at regular monthly intervals. The time taken to reach maturity was about four months. Maturity was determined when the temperature of the heap stabilized at 30°C, and the pH reading was 4.5 - 6.0.

E. EFB AS FIBER:

To become the useable fiber, the empty fruit bunches goes through processes which involve empty fruit bunches to be shredded, separated, refined and dried. No chemicals were involved in the production of oil palm fibres. High quality oil palm fibres are clean and toxic free. After the process, the end product of high quality oil palm fibres can be used by manufactures to make various fibre composites such as furniture, infrastructures, mattress, erosion control, paper production and also landscaping.

F. EFB AS ENERGY:

Unprocessed EFB is available as very wet whole empty fruit bunches each weighing several kilograms while processed EFB is a fibrous material with fiber length of 10-20 cm and reduced moisture content of 30-50%. Additional processing steps can reduce fiber length to around 5 cm and the material can also be processed into bales, pellets or pulverized form after drying. There is a large potential of transforming EFB into renewable energy resource that could meet the existing energy demand of palm oil mills or other industries. Pre-treatment steps

such as shredding/chipping and dewatering (screw pressing or drying) are necessary in order to improve the fuel property of EFB.

G. EFB AS MUSHROOM CULTIVATION:

EFB also can be used as substrate for mushroom cultivation. As a substrate for mushroom cultivation, EFB is pressed in a rectangular block and mushroom spores are inoculated into PEFB block. Finally the block is covered by plastic sheet to maintain moisture content and limit sunlight. The residue from mushroom cultivation is the composting EFB which can further be served as organic fertilizer. After a long duration of composting, the nutrients containing in EFB will substantially increase and benefits to the mushroom. The oil palm fiber is produced from empty fruit bunch that are considered as waste after the extraction oil palm fruits.

CHAPTER 3

RECOMMENDATIONS

A. EDUCATION PROGRAMME ON USE OF EFB WASTE:

The most basic approach to encourage the use of EFB waste especially for land enhancement is through educating programme. This sort of programme must be made to policy makers, communities and the oil palm industry players. The policy makers include the politicians and the government officials of every level as they are the ones who will determine the policy and direction of the use of EFB waste. The communities involve the community leaders, students and the laymen as they will become responsive towards their surrounding regarding the use of EFB waste and probably some of them will become players in the oil palm industries someday. The last group is the palm oil industry players which include small holders and companies who are the ones will be practicing the use of EFB waste.

B. AWARENESS CAMPAIGN THROUGH MASS MEDIA:

The use of mass media and new media will help accelerate the dissemination of information regarding the benefits of EFB waste use in soil enhancement. Today's active use of communication tools such as smart phones and new media such as Facebook is able to help raise awareness among the public especially the young generation the importance of having sustainable development in particular the use of EFB in oil palm industry.

C. TO ESTABLISH SUPPORTIVE POLICIES:

The government must establish national strategy to promote in terms of financial backing, sites, sustainable development and commercial partners that can build and operate the facilities that could process EFB to be useable for land enhancement. This requires the government to gather all the experts and the players in the industry, the academicians and the government officials for them to come up with clear and practical strategy and policy in achieving the sustainable development in oil palm industry. To make the strategy and policy much effective they can be tabled in the parliament for endorsement.

D. PROVIDING SPECIAL INCENTIVES AND TAX EXEMPTION:

The government may provide special incentives and tax exemption to companies to set up of their own carbonator-driven plant in their mill to process EFB to be biochar. Having done this the carbonator-driven plant use could be expanded to the whole country. The farmers also could get incentives of using EFB waste as soil enhancement instead of applying chemical fertilizers. The incentives could be in form of rebate or cheaper price of EFB waste bought from the palm oil mills.

E. UPGRADING THE EXISTING OIL PALM MILLS:

Existing oil palm mills should be upgraded, with the financial aid from the government and participating banks, to support pyrolysis heat process towards converting EPB into biochar. Besides that, other facilities such as storage, effluent

ponds and shipping area of EFB waste to be distributed to oil palm farmers also could be provided or upgraded that would help the management of EFB waste to be more efficient.

F. SETTING EXEMPLARY OIL PALM INDUSTRY PLAYER:

There are numerous large players in palm oil industry that could be made as exemplary organizations in making use EFB waste as one of sustainable development efforts. Companies such as Sime Darby, IOI and Golden Hope, to name a few, could be engaged by the government to set good example for other players and show the benefits could be earned by practicing this approach.

CHAPTER 4

CONCLUSION

Malaysia is the second largest palm oil producer in the world after Indonesia and palm oil industry is one of the major national money spinners. The growth of this industry will have huge impact on the national economy. To achieve faster and higher growth, huge area of land in the country has been planted with oil palm including some of forested land and this is always associated with destruction of natural forest and habitat of wildlife. Therefore, the need for having sustainable development alongside the industry is indeed a must. As far as this matter is concerned, the government must be serious in promoting this effort so as to ensure better environment for the people. However, judging on some events taking place in the country, the Malaysian government is already, presumably, committed to achieving sustainable management of oil palm plantation for the sake of environment conservation. Still, there are plenty of rooms for more undertakings to ensure the success of this struggle.

There are numerous ways to use EFB as well as other oil palm wastes as soil enhancement, land stabilizer, crop fertilizers, renewable energy source, and what not. Probably there are many more potentials of these oil palm wastes to be reused for other purposes. It is the role of the academicians and researchers to go further to find out and the government as well to provide some research grants on this matter. The existing technology or machinery related to the reuse of oil palm waste also can be upgraded in order to maximise the products produced by oil palm waste.

The success of use of EFB waste for soil enhancement definitely also depends on the willingness of the industries players especially in palm oil sector to adopt the method identified to reuse the EFB waste widely. They must take the responsibility, apart from making mere profits, by ensuring the sustainable usage of oil palm waste contributing to environmental conservation. The use of EFB waste as an alternative for the palm oil industries to move towards making better environment and cost-saving approach to improve the yield of palm oil and at the end will provide higher income for the industry players especially the small holders.

It is no doubt that sustainable usage of oil palm waste such as EFB has a significant role in minimizing the climate change impact or global warming by maintaining the influx of carbon dioxide, CO2. Thus, it is high time for the academicians, environmentalists and other related parties to promote the practice to the international stage so as to prove to other countries and international institutions that Malaysia has taken necessary steps to reduce the impact of global warming. This approach will refute the baseless accusation on our palm oil industry as a threat to global warming by developed countries or environmental activists.

The last but not least, everybody must be fully aware of the need for sustainable land development which is not just about palm industry but also about other industries or economic activities. The enthusiasm for profit and material progress alone could not assure our life happiness. The sustainable development especially the reuse of waste will help make our environment better and provide more promising future for our next generation.

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