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Integration of a Palm Oil Plantation with R&D and Manufacturing of Polyhydroxyalkanoates in South Sulawesi

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Abstract: This paper proposes a business plan in which a palm oil plantation and an R&D and a manufacturing of Polyhydroxyalkanoates (PHA) are integrated at the same site in South Sulawesi. First, an argument is given for a general competitiveness of a PHA production. Next, a model case in which the upstream production of refined and/or fractioned oils, the downstream production of further processed oils and PHAs and R&D activities for the production of PHAs are integrated is elaborated for 25 years of the business operation. In order to lower production costs and find high value added applications, the R&D for a commercial production of new varieties of PHA must be carried out at a location where a constant supply of inexpensive fermentation substrates is available and experiments on a commercial production yield quick feedbacks to the researchers, namely near the plantation and manufacturing site of palm oil. Five steps are compiled in a chronological order for a start-up and an expansion of R&D, and the R&D plan is combined with a business plan of a construction of a palm oil plantation and manufacturing facilities for PHA, and their financing.

Keywords: R&D, Palm Oil, PHA (Polyhydroxyalkanoates).

1 . Introduction

This paper proposes an elaborated business plan for an integration of a palm oil plantation, an R&D of Polyhydroxyalkanoates (PHA) and its manufacturing in South Sulawesi. In order to lower production costs of PHAs and find their high value added applications, the R&D for their commercial production must be carried out at a plantation site of palm oil where a constant supply of feedstock as fermentation substrates is available. A model case is provided for 25 years of the operation of the company with the upstream activities, downstream activities and R&D activities.

The Upstream activities consists of the planning of palm oil plantation, cultivation, management of estates, construction and operation of mills, refining and fractioning of palm oils, recycling and waste management. The downstream activities consist of further refining of CPO into edible oils, fats and carbon sources for PHA production, manufacturing and distribution of edible oil, fats and PHA products. The R&D institutions develop new methods in the production process of PHAs and intermediate and/or end products using PHAs that are competitive in the international market.

Currently, there are a large numbers of palm oil plantation companies in Indonesia such as Wilmar, PT Astra plantation, Sinar Mas, Asian Agri and others. Asian Agri manages the plantations mainly in North Sumatra, Riau, Jambi and West Sumatra. The Sinar Mas Group engages in upstream and downstream business in the palm oil sector managing 280,000 hectare of the plantation

area in Sumatra and Kalimantan and producing oleochemical, biodiesel and cooking oil. Sime Darby plantation also invests in the upstream sector, develops over 200,000 hectare of palm oil plantation area mostly in Indonesia. Sime Darby's upstream activities involve manufacturing and distribution of oil and fats product, oleochemical and biodiesel. Downstream activities are operated in Malaysia, Asia, Europe, and Africa, which are refining CPO into edible oils, oleochemical and biodiesel. R&D activities of Sime Darby have created a palm oil seeds with high quality, and they are centralized at locations in Malaysia. There is no business which operates currently and integrates upstream activities, downstream activities and R&D activities for PHA at one location.

Production of PHA is the big part of this business because PHA still not produce commercially

There are four main step in this study. The first step mainly analyzed the general description palm oil industry in Indonesia, the second step mainly analyzed the competitiveness of PHA as big part of this business, the third step mainly analyzed Research & Development (R&D) for PHA industries in South Sulawesi and complete 5 stages in the start up of R&D, and schedules and stages in building a palm oil firm which has a major focus on research and production of PHAs from palm oil in South Sulawesi. Moreover, I complete 3 business model plan: a plan for manufacturing, a plan for planting palm oil industries. The fourth is conclusion.

2 . General Description of The Palm Oil Industry in Indonesia

The following is a sketchy description of palm oil plantation which is provided without any references, to give a background knowledge to the readers.

Palm oil production is most important to economy of Indonesia, providing almost a half of the world supply. Oil palm development in Indonesia indicates that the industry has a positive prospect, particularly in relation to the added value and competitiveness. Palm oil has been identified as one of the raw materials of many end-products that have a universal demand and the most attractive vegetable oil whose derivatives has a strong degree of vertical integration. Palm oil is particularly favoured on account of its low production cost. In 2011 global production of palm oil was 50.2 Mt, or about 28% of total vegetable oil production. In terms of land uses the palm oil trees is more efficient than any other oil crops, and in economic terms palm oil is highly competitive and have a potential for a high growth.

The most popular processed palm oil is produced from Fresh fruit bunch. Crude palm oil is processed into cooking oil raw materials and various derivatives, and has a high carotene content. Oil palm production takes 2.5-5 years from planting to harvest. The harvested fresh fruit bunches of palm oil trees are brought to palm oil extracting plant within 24 hours to avoid corrosion. Different types of oils can be extracted from the mesocarp and kernel of the oil fruit, respectively. Crude palm oil (CPO) is the primary product obtained from the mesocarp while crude palm kernel oil (CPKO) is derived from the kernel. Further refining and fractioning, chemical and/or physical, produce various palm oil products such as, palm olein (PO), palm stearin (PS), refined, bleached and deodorized (RBD) palm oil, kernel olein and kernel stearin, as well as their by-products such as palm kernel acid oil (PKAO), palm acid oil (PAO), and palm fatty acid distillate [PFAD]. These by-products are generated in the processes by the removal of free fatty acids from CPO and CPKO

which are detrimental to the oil properties. Refined palm oil products suit a variety of manufacturing needs in the forms that are ready to use and require no further processing. The oils derived from oil palm fruit may be used for edible as well as nonedible applications.

Indonesia is currently the largest producer and exporter of palm oil worldwide. In 2013, it produced 31 million tonnes of palm oil from the total cultivated area 8 million hectares. Most of the palm oil produced is exported as Crude Palm Oil (CPO) to China, India, Malaysia, Singapore and Netherlands. Oil palm plantations in Indonesia are located at Sumatra, Kalimantan, Java, Sulawesi and Papua. There were as many as 1601 oil palm plantation companies in 2013, of which as much as 159 were owned by the state. The big private enterprises are Sime Darby, Wilmar and Sinar Mas.

Development of the palm oil sector in Indonesia is still behind that of Malaysia. Malaysia has advanced further in technologies to offer innovations in varieties of products. For example, the Malaysian government owns a research technology company, Standards and Industrial Research Institute of Malaysia (SIRIM), which has built the first fully automated pilot plant in Malaysia to convert palm oil into a variety of PHA, P(3HB-co-3HV).

3 . Competitiveness of Polyhydroxyalkanoates (PHA)

The following is a general description of PHA and its production, references from monograph of Sudesh. In chapters 1: Introduction and chapter 3: Plant oils and agricultural by-products as carbon feedstock for PHA production in *Polyhydroxyalkanoates From Palm Oil: Biodegradable Plastics*, 2013.

PHA is a biodegradable plastic which can be synthesized by a wide variety of bacteria. PHA is generally produced by bacterial fermentation using various carbon feedstocks required for microbial growth and PHA accumulation.

It is expected that the biodegradability and the chemical-free production of PHA contribute to reduce a plastic waste accumulation, a global warming, a pollution, and a dependence on fossil fuels. The amorphous molecular structure and the biodegradability of PHA make it useful in packaging, tissue engineering, implants and controlled drugs

The researches on a production of PHA show that microbes used in a production can be found or genetically engineered to be flexible for intaking a variety of renewable feedstock which can be converted into PHA efficiently. This gives PHA products a room for a price competitiveness against their petroleum counterparts.

Plant oil has been investigated as attractive carbon sources for production of PHA. Palm oil is produced more efficiently than other plant oils. Not only two major product of palm oil, CPO and PKO, but also almost all palm oil products, including by-products, can be used as carbon sources for PHA production. PKO and CPKO have the best productivity among palm oil products. CPO has a superior productivity to sugars and most of other vegetable oils. Palm oil by-products such as PAO, PAKO and PFAD are as good as CPO in productivity since they are rich in free fatty acids that are potential carbon sources for PHA production.

The cost for carbon sources has been identified as a major obstacle to a commercial production of PHA. Plant oil based feedstocks are currently recognized as the cheapest renewable carbon sources,

and palm oil is generally much cheaper than other plant oils. Palm oil products have generated an interest lately due to its high yield and low cost for the PHA production. However, the production cost is still much higher than that for manufacturing of petroleum plastics and other bioplastics. For a full-scale commercialization worldwide, new attractive commodities using PHA must be brought into the market by R&D.

The production of polyhydroxyalkanoates (PHA) is a big challenge in Indonesia as a late-comer, since no systematic attempt to produce them commercially has been made in either the public sector or the private sector. There are two important aspects that should be taken seriously for a commercial production of PHA products. One is to lower the production costs of PHA, and the other is to find high value added applications of PHA. The industrial production of PHA becomes more profitable if it is carried out at locations where a constant supply of good fermentation substrates is readily available. Such an arrangement keeps the cost for supply of carbon sources and distribution of intermediate products at minimum and makes R&D efforts easier by supplying immediately sufficient amount of carbon sources for experiments. In other words, the location of production and R&D facilities of PHA must be near the plantation site.

4 . Research & Development (R&D) for PHA production in South Sulawesi

A model case of R&D for PHA production must be introduced in palm oil industries in South Sulawesi. As a late-comer, South Sulawesi must have a competitive advantage in palm oil industries in international market with a development of palm oil products with high added values. Today, in Indonesia, there is no business company which develops PHA products commercially. Moreover, many large company such as, Wilmar, Sime Darby, and Astra have concentrated in production of cooking oil, oleochemical and biodiesel in Sumatra, Kalimantan, and Papua.

The main point in introducing this business is to help rural communities by bringing an empowering research with an effective participation of communities to advance community-driven strategies for prosperity through an encouragement of rural entrepreneurship. In particular, the business involves, as a part of R&D activities, an education of locals by a short-time training in order to give them a knowledge about fermentation technology related to PHA.

Education of local community is very important in this business to develop the knowledge, attitudes, and skills of farmers. Moreover, the point is about a coordination and a cooperation for innovative activities. In addition, the establishment of large scale palm oil plantation to which manufacturing and R&D of PHA are integrated at one location triggers an economic growth of local and creation high-skilled worker by turning local communities to be a researchers.

Besides, the business model also develops an biomass power plant which produces an electricity by using Palm Oil Mill Effluent (POME) as its fuel. This ensures not only that an energy for the production of CPO and PHA is supplied in an environmentally friendly way, but also that the common problems to introduce new industries in local communities are avoided. The electricity not used for the operation of the company is sold commercially to add a source of revenue to the company in order to stabilize its financial position. Sustainability is always at the core of this business and consider some aspects, related to cooperation, socio-norm, identification of a common value,

and economic welfare.

In this study, I provide a business model, a plan for R&D, a plan for planting, a plan for financing and a plan for manufacturing. The basic assumption in this model is that there is no support from the government or big players. This company finances from venture capital (in US or Japan) and funds from domestic private companies for the cost which includes all administrative and managerial expenses to cover the cost of starting up the production of CPO and research projects, by allocating the right for obtaining stocks at the initial public offering. The length of this operation for the plan is for 8 years. The location of the palm oil plantation will be in South Sulawesi and the firm will be built and operated inside the plantation area, the firm must have an accessibility, a suitability topography, and a suitability layout. The infrastructure in this company such as weighbridge, Acceptance TBS and weighing (Loading ramps), Building Factory, CPO storage tank, Pool water supply, Swimming Waste, Office Buildings, R&D Laboratory, Workshop, The place of worship and a guardhouse and Housing

We should note that it is highly unlikely that the Indonesian government support the effort to create a large PHA industry because the government tends to prioritize the biofuels, oleofoods and oleochemicals. The governmental support for biofuel industry and oleofood industry is to fulfill domestic demands. Most of exports are CPO, a raw material, and the government has implemented progressive export tax on CPO. To support the development of industrial production of CPO, the government made a roadmap in the form of palm oil industrial cluster, in which the government projected to build four special economic zones by 2012. One of them was North Coast of Java which would be equipped with the new port development. Dumai Riau region was also specified to specialize in oleochemical-based economy. Borneo was specified for a region-based mineral, oil and gas industry combined with oleochemicals, Merauke was named for a food-based economic region. Namely, the focus of the policy is mainly the production of CPO and oleochemical. The development of oleochemicals in Indonesia has been advanced by private sectors. The big players such as Wilmar and Sinar Mas has penetrated into oleochemical industries to seek profits by international trades. But it is unlikely that they accept a large investment to R&D for a PHA production in Indonesia, since they, as international conglomerates, already have their own R&D laboratories for PHAs outside Indonesia. As a substitution to the support from the government and big players in the private sector, foreign Investment and partnership opportunities within the PHA industry must be found in order to bring Indonesia on par with Malaysia in terms of technology and innovation by being competitive in the international markets.

With these consideration in mind, I propose a business model in which the upstream production activities, the downstream production activities and the research and development (R&D) activities are integrated at the same location of South Sulawesi. The upstream production consists of the development of palm oil plantation, cultivation of oil palm trees, management of estates, construction and operation of mill and storage of Fresh Fruit Bunch (FFB) for CPO and kernel oil, construction and operation of facilities for refining and fractioning, recycling and waste management in CPO production for a later use in producing PHA. The downstream activities consists of further refining of CPO to edible oils, fats and carbon sources for PHA production, manufacturing and distribution

of edible oils, fats and PHA products. The R&D institution develops new methods in the production process of PHA and new intermediate and/or end products of PHA that are competitive in the international market. I compile 5 stages in the start up of R&D, and schedules and stages in building a palm oil firm which has a major focus on research and production of PHAs from palm oil in South Sulawesi. Moreover, I compile 3 business model plan: a plan for plantation palm oil industries, a plan for financing the business and a plan for manufacturing.

EVOLUTION OF R&D FOR PHA PRODUCTION IN PALM OIL INDUSTRY IN SOUTH SULAWESI

1 . Zero Stage

- a. Conducting presentation about PHA industry in seminars or workshops about production of PHA in the palm oil industry, and discussing about a prospect of PHA in the palm oil industry of South Sulawesi with agricultural scientists, economists, biochemists, bioengineers and businessman from domestic companies at Hasanuddin University.
- b. Forming a core group of researchers which consist of microbiologists, biochemists, biochemical engineers and economists from UNHAS, other universities and abroad (Japan) on the production and application of PHA to develop a basic interdisciplinary knowledge and make a blueprint of R&D.
- c. Finding locations in several places for suitable palm oil plantation area in South Sulawesi.

2 . Basic Research Stage

- a. Forming a R&D team by merging the core group researcher with industrial lab scientists at University of Hasanuddin (UNHAS) in order to develop an efficient PHA production from palm oil in South Sulawesi.

3 . Research & Development Applied Stage

- a. Conducting researches on an efficient organization and coordination of production processes and analyzing from the business perspective to determine whether the production of PHA and their derivative products can make a profit.
- b. Presenting the results of R&D to the local government and local communities in the projected area for palm oil plantations in South Sulawesi.

4 . Demonstration Stage

- a. Conducting an examination of the entire production process using real equipments, material and human resources.
- b. Completing a model of industrial PHA production.

5 . Pre Commercial and Investment Stage

Merging R&D with the projected industrial production

6 . Final and Commercial Stage

Start up the real production of PHA

BUSINESS MODEL

1 .Plan for the Plantation of CPO in South Sulawesi

- a. Finding Area and Planting Process
- b. Harvesting Fresh Fruith Bunchs

2 . Plan of Financing Palm oil and PHA Industries in South Sulawesi

- a. Finding Foreign Investment Stage
First is introducing a blueprint of R&D to the domestic private sector and foreign investments (Japan). Second is financing initial investments to cover the cost of starting up the production of CPO and research projects from venture capital funds (in US dollars or Japan) and funds from domestic private companies, where the cost includes all administrative and managerial expenses.
- b. Preparation company to go to the public in financial market
First is to have a general meeting with shareholders potential and starting a preparation for the underwriting of the company with a legal counsel, accountants and a notary public. The next step is submitting a statement to BAPEPAM (capital market regulatory bodies and financial institutions). The last is making the initial public offering, after the company is declared effective by Bapepam.

3 . Plan for Manufacturing Processed Palm Oils and PHA Products in South Sulawesi

- a. Site Investigation and Preparation Stage
In this stage the company will conducting Initial survey (including: zoning) and land survey, getting location permit, consultation with local people and compensation,conducting block design, getting licensing support such as; AMDAL (analisis of environment impacts), SITU (Location permit), HGB (Building right), IMB factory (Factory permit), IMB housing (Housing permit), izin gangguan HO (Hinder Ordonantie) (permission of interference), and permission for the construction of liquid waste.
- b. Development and Construction Stage.
The development and construction stage is the construction of a main building and providing laboratory facilities and technology for R&D for manufacturing PHA in large scale including fermentation process, biosynthesis process and recovery processes, materials and product testing, and product applications. Then construction of biomass power generation facilities and other infrastructures follows.

SCHEDULE OF BUSINESS PLAN

INFORMATION STAGE	YEARS																																			
	1				2				3				4				5				6				7				8							
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
I. EVOLUTION OF R&D PRODUCTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1. zero stage	✓	✓	✓	✓																																
2. basic research stage					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																				
3. R&D applied stage													✓	✓	✓	✓																				
4. Demonstration stage																	✓	✓	✓	✓																
5. Pre commercial & investment																	✓	✓	✓	✓																
6. Final and commercial stage																	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
II. BUSINESS PLAN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A. Plan for the Plantation of CPO in South Sulawesi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1. Find Area and Planting Process	✓	✓	✓	✓	✓	✓	✓	✓																												
a. Development of palm oil plantation area and licensing	✓	✓	✓	✓																																
b. Land clearing					✓	✓	✓	✓																												
c. Palm oil nursery					✓	✓	✓	✓																												
d. Planting and maintenance of palm oil plantation					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Harvesting fresh fruit bunches																	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
B. Plan of financing palm oil and PHA industries in South Sulawesi	✓	✓	✓	✓																																
1. Finding foreign investment	✓	✓	✓	✓																																
a. Introducing blueprint of R&D to domestic/foreign invest	✓	✓	✓	✓																																
b. Financing by venture capital	✓	✓	✓	✓																																
2. Preparation company to go public in financial market					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
a. Conducting meeting with shareholder					✓	✓	✓																													
b. Submitting a company statement to Bapepam					✓	✓	✓	✓																												
c. Offering IPO									✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Plan of manufacturing					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
a. Site Investigation and Preparation Stage					✓	✓	✓	✓																												
b. Development and Construction Stage.					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The table above shows the schedule of the business plan. The Evolution of R&D production have six stages. First, Zero stage include conducting presentation about PHA industries in seminar, forming a core group of researscher, and find location for palm oil plantation wil held in the first year. Second, Basic research stage will conducting from the beginning of the second year until the 1th quarter of the 4th year. Third, R&D applied stage will start from the 2nd quarter of the 4th year. Fourth, demonstration stage, will conducting in the 5th year. Five, Pre commercial & investment stage is Merging R&D with the projected industrial production which will conducting in the 5th year. Six, Final & commercial stage, is start up the real production of PHA, This stage will hold in the beginning of the 1th quarter in the 5th year.

The Business model have three main part:

First. Plan for plantation for CPO industries which is devided into two stages. The beginning is find area and planting process including development of palm oil plantation and licensing in the 1th year, land clearing and palm oil nursery will hold in 2nd quarter of the 1th year, then planting and maintenance of palm oil plantation in the beginning of the 2nd year. The last is harvesting fresh fruit bunchs. Normally the palm oil can produce Fresh Fruit Bunch (FFB) to be harvested first at the age of 2.5 years by assuming that the palm oil seeds of aged 6 month with an excellent quality are used. In this stage, harvesting FFB and processing to CPO start at the beginning of the 5th year. PHA is produced mainly from CPKO and manufacturing of PHA application products starts in beginning of the 5th year.

Second, Plan of Financing Palm oil and PHA Industries in South Sulawesi. There are two main stages in this part. First is Introducing blueprint of R&D to domestic/foreign invest and Financing by venture capital will hold in the 1th year. Second stage is Preparation company to go public in financial market by conducting meeting with shareholder in the 3th quarter of the 1th year. Next, Submitting a company statement to Bapepam in the 4th quarter of the 1th year and finally, Offering IPO in the 4th quarter of the 2nd year.

Third, Plan for manufacturing PHA of palm oil plantation will be conduct in the 4nd quarter in the 1nd years.

4 . Conclusion

The result of this research is a new business model of palm oil industries, which integrates a palm oil plantation with a R&D and a manufacturing PHA in one site location in South Sulawesi. South Sulawesi as a late-comer must have a competitiveness in international market with manufacturing PHA with high added values. The future research need to check the feasibility study of this business by assuming that the scale of the plantation to be 10,000 hectares. The income sources in this business is assumed to come from CPO sales, sales of PHA products and sales of electricity under Certified Emission Reduction under an uncertainty of CPO price in the international market and a risk that an export of PHA would be taxed by the Indonesian Government.

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