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Identification of Prospective Product for the Development of Integrated Coconut Agroindustry in Indonesia

Hermiza Mardesci[#], Santosa[*], Novizar Nazir[*] , Rika Ampuh Hadiguna [^]

[#] *Food Technology, Islamic University of Indragiri, Tembilahan, Indragiri Hilir, Riau, Indonesia*
E-mail: mimzaaci@yahoo.co.id

[*] *Agricultural Technology, Andalas University, Padang, West Sumatera, Indonesia*
E-mail: santosa764@yahoo.co.id, novizarnazir@safetainability.org

[^] *Industrial Engineering, Andalas University, Padang, West Sumatera, Indonesia*
E-mail: hadiguna10@gmail.com

***Abstract*— Indonesia is one of the largest coconut producers in the world. However, diversification of processed coconut products in Indonesia is still far below other countries, such as the Philippines. Concerning this, the Indonesian government expects the development of an integrated coconut industry in Indonesia. This research aims to determine the process of determining processed products of coconut commodities that are prospective to be developed in an integrated manner in Indragiri Hilir, Riau, Indonesia. Seven stakeholders involved in the development of coconut agroindustry are interviewed. They are asked to fill in the questionnaire. The data obtained from the interviews and questionnaires were analysed using Fuzzy Group Decision Making technique. The independent preferences used are Multi Expert-Multi Criteria Decision Making and the Analytical Hierarchy Process (AHP) method. The results showed that prospective products developed for integrated coconut agro-industry were coconut oil, palm sugar, and shell charcoal. This result was obtained based on nine assessment criteria conducted by seven experts on ten alternative coconut products processed products. Coconut oil is very prospective to be developed if viewed from the aspect of the criteria of market opportunities and its linkages with the downstream industries. Moreover, coconut sugar also has an excellent prospect as the world market demand for palm sugar in Indonesia is quite significant, besides its absorption of labour and environmentally friendly. Shell charcoal is an industry with low production costs, but it has a great influence on the employment. The high demand of the world market also resulted in shell charcoal having high potential to be developed.**

***Keywords*— integrated coconut agroindustry; processed coconuts; prospective products; multi expert-multi criteria decision making.**

I. INTRODUCTION

Coconut (*Cocos nucifera* L.) is one of the plantation crops known to the world. Coconut is also the most widely planted and utilized plant in the world. Coconut commodity has an excellent prospect to be developed as coconut is a multipurpose plant. All parts of coconut can be utilized and made processed products that have high economic value [1]. Indonesia is the largest coconut producer in the world, with 3.610.000 Ha coconut plant area in 2014. However, the diversification of products with high added value is less developed in Indonesia. Even though, the demand for coconut-based products, both in both domestic and world markets are still prospective. Indonesia is still less than the Philippines which is the producer of coconut no. 2 worlds after Indonesia with 3,502.00 Ha, but 80% of its products have been exported [2,3].

One of the long-term goals of the Indonesian Ministry of Industry related to the coconut processing is the development of an integrated coconut processing industry in Indonesia. Various government efforts to achieve these targets have been undertaken, such as providing integrated coconut processing equipment to coconut centres in Indonesia. One of them is Riau Province, the largest coconut producer in Indonesia. Riau Province is located in the central part of Sumatra island which has an area of 87,023,66 km^2. Riau is one of the richest provinces in Indonesia because it has a variety of natural resources, one of which is coconut. The area of coconut in Riau in 2015 is 515,167 Ha with the total production of 419,616 Ton [3].

Indragiri Hilir is one of the districts that have the largest area of coconut in Riau. Data statistics show that the area of coconut in Indragiri Hilir is 440.821 Ha [4]. This potential makes Indragiri Hilir regency belongs to one of the largest

coconut areas in the world, even dubbed the World Coconut Cover. However, coconut agroindustry in Indragiri Hilir is still underdeveloped due to lack of information and supporting data that can be used by coconut craftsmen for processing in the District. Agro-industry is part of the agricultural, industrial complex since the production of primary agricultural materials, processing industry or transformation until its use by consumers. Rapid and proper agro-industry development can increase the number of workers, farmer's income, export volume, foreign exchange, domestic and international market share, an exchange rate of agricultural products, and provision of industrial raw materials [5].

The development of coconut agroindustry has a tremendous opportunity to produce high-value products. Alternative products that can be developed is quite varied and perspective. This is because coconut is a versatile plant that from the root to the leaves has usefulness. The growing coconut industry is still being partially cultivated. This can cause difficulties in continuing the supply of sufficient quantities of raw materials to keep the industry in operation.

Therefore, it is necessary to research the processed coconut commodity product that is prospective to develop in an integrated manner in Indragiri Hilir. There are some studies that are related to this topic. Ref. [6] examined prospective product assessment using Analytical Hierarchy Process (AHP) method of 12 assessment criteria for eight coconut processed alternatives by six experts. The results showed that the sugar cane is a productive product to develop in District Ciamis, West Java. The research, however, reveals that the prospective product is limited to one type of processed product of coconut commodity. This result cannot be used as the reference to developing the coconut industry in an integrated manner. Ref.. [7] examine a prospective product using Bayes method from 4 assessment criteria to 16 alternatives of processed coconut products by one expert. The study indicates that products that are prospective to be developed in Indonesia are coconut oil, nata de coco, coco fibre, and charcoal. Though the result is representative for coconut commodity product to develop in an integrated manner, the study, however, only uses four criteria of assessment, namely competitiveness, market prospects, linkages with the downstream industry, and ease of application of technology. In fact, to develop an integrated coconut agro-industry other criteria, such as availability of raw materials, product quality, environmental impact, employment, government policy, and other criteria, need to be considered. Besides, this study is based solely on the opinion of one expert. The stakeholders associated with coconut agro-industry are very numerous and should be involved in reconciling the development of coconut agro-industry.

Based on these problems, the prospective coconut commodity processed products are identified to be developed in an integrated manner. This identification is reviewed from various assessment criteria by several experts related to the development of coconut agro-industry. This research aims to determine 1) coconut commodity processed alternatives, (2) prospective product selection criteria, and (3) processed coconut products developed in Indragiri Hilir.

II. Material and Method

The determination of coconut processed prospective product is done using expert opinion collected from a questionnaire. Expert opinion calculations are performed using the Fuzzy Group Decision Making technique, with independent preferences using Multi Expert-Multi Criteria Decision Making.

Multi Expert-Multi Criteria Decision Making (ME-MCDM) is a decision-making method with a variety of criteria provided. The decision making is done to find the best alternative based on expert opinion which is stated in non-numeric (qualitative) form to the situation at hand [8].

ME-MCDM is one of the models in decision-making developed by Ref. [9]. In the decision component, there are alternative decisions, decision criteria, weighting criteria, assessment model, model calculation, and decision-making type. ME-MCDM decision-making procedures in this study are; (4) determine the linguistic label of the non-numeric fuzzy preferences, (5) determine the aggregation of the criteria, and (6) determine expert aggregation.

Determination of product alternatives and assessment criteria is conducted by interviewing experts and doing literature study. Analytical Hierarchy Process (AHP) method is applied to assess the importance of the criteria.

III. Results and Discussion

A. Expert Determination

The expert used in this study amounted to 7 people, consisting of one person from the Coconut Growers Association of Indonesia in Indragiri Hilir, one from the Indragiri Hilir Industry Office, one from the Indragiri Hilir Plantation Office, one from the Peasants' Assistance Team, one from the Field Extension Workers, and two from the academics at Indragiri Hilir. The selection of experts is based on the relevancy of the stakeholders, directly or indirectly, to the coconut agro-industry.

The Indonesian Coconut Farmers Association (*Asosiasi Petani Kelapa Indonesia* / APKI) is a place to gather farmers to channel their aspirations and understand the problems that interfere with the business development experienced by coconut farmers in seeking their solutions. APKI election as one of the experts in this research is considered very appropriate as APKI directly interact with coconut farmers who are the primary source in the development of coconut agroindustry.

Department of Industry and Estate Crops Agency are two central supporting government institutions in the development of coconut agroindustry. Both institutions play a role in providing superior seeds, technical training, counselling and other related coconut cultivation and agroindustry. The activity also involves field assistant farmers and field extension workers. Therefore, these four stakeholders are also very appropriate as experts in this research.

In addition to the practitioners above, the expert who asked his opinion in this study also involves academies. This election is based on the role of academics itself in the development of coconut agroindustry. In this case, academics contribute through research results related to

coconut agroindustry. Therefore, academics are also very appropriate to be an expert in this research.

B. Determination of Processed Product Alternatives

The interviews, discussions with experts and literature review, shows that there are ten alternative products that have good prospects to be developed in Indragiri Hilir. The products are coconut oil (A_1), coconut milk (A_2), coconut sugar (A_3), nata de coco (A_4), handicraft industry (A_5), copra (A_6), VCO (A_7), coco fibre (A_8) desiccated coconut (A_9), and shell charcoal (A_{10}). However, all of them are limited to the primary level products. The development of these products would be related to the factors that influence product development such as competitiveness factors (both domestic and overseas), ease of application of processing technology in coconut production centres and linkages with the downstream industry.

In line with the opinion of Ref. [7], the selection of primary products is made to be more easily developed at the level of coconut artisans in coconut production centres. It is derived from several aspects, such as human resources, raw materials, production process methods, equipment, process technology, and capital aspects.

C. Assessment Criteria Determination Section

The criteria collected, after being corrected by the expert, includes the availability of raw materials, employment, technology used, value-added products, environmental impacts, market opportunities, product quality, product distribution, and government policies. The selection of these nine criteria is based on the profit aspect that will be obtained when developing agroindustry. According to Ref. [10], agro-industry development can provide benefits, such as providing higher added value, earning income of farmers and expanding employment that can overcome the problem of poverty.

Experts then assess these criteria based on their importance. Expert opinion data is further processed using AHP method developed by Ref. [11] with pairwise comparison technique to determine eigenvector. Table 1 shows a processing level of the necessary criteria.

TABLE I
CRITERIA AND VALUE

No	Criteria	Value
1	The availability of raw materials (K1)	0,270
2	Employment (K2)	0,087
3	Technology used (K3)	0,069
4	Product added value (K4)	0,111
5	Environmental impact (K5)	0,026
6	Market opportunities (K6)	0,113
7	Product quality (K7)	0,206
8	Product Distribution (K8)	0,036
9	Government policy (K9)	0,082

The highest weight is in the criterion of raw material availability, showing that the availability of raw materials is essential compared to other criteria. Meanwhile, the lowest criteria are the environmental impact and the product distribution.

D. Linguistic Label Determination

Linguistic labeling of non-numeric fuzzy preferences and multi-person preferences against a criterion in this study is a technique developed by Ref. [8]. In this study, an ordinal scale assessment of five scales was given. It is based on the ease of assessment that is influenced by the expert's optimal memory, and also for the speed of data processing.

VH = Very High (Value 5)
H = High (Value 4)
M = Medium (Value 3)
L = Low (Value 2)
VL = Very Low (Value 1)

The determination of the label of the criteria listed in Table 1 is based on some linguistic label. The label for the criteria can be seen in Table 2.

E. Determination of Aggregation Criteria

Aggregation of criteria is done by first determining the negativity level of essential criteria with the formula:

$$\text{Neg (W\_k)} = \text{W\_ (q-k + 1)} \quad (1)$$

Criteria, criterion weight, label, and negation of criteria importance level can be seen in Table 2.

TABLE II
CRITERIA, WEIGHTED CRITERIA, AND NEGATION

No	Criteria	Value	Label	Negasi
1	The availability of raw materials (K_1)	0,270	VH	VL
2	Employment (K_2)	0,087	M	M
3	Technology used (K_3)	0,069	L	H
4	Product added value (K_4)	0,111	H	L
5	Environmental impact (K_5)	0,026	VL	VH
6	Market opportunities (K_6)	0,113	H	L
7	Product quality (K_7)	0,206	VH	VL
8	Product Distribution (K_8)	0,036	VL	VH
9	Government policy (K_9)	0,082	M	M

Furthermore, the aggregation of criteria [10] by using formula:

$$V_{ij} = min\left[Neg(W_{ak})\ v\ V_{ij}(a_k)\right] \quad (2)$$

Aggregation Criteria for Alternative 'i' by expert 'j' .

The first alternative assessment by the first expert can be seen in table 3.

TABLE III
THE FIRST ALTERNATIVE ASSESSMENT BY THE FIRST EXPERT

Criteria	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9
Negation	VL	M	H	L	VH	L	VL	VH	M
Expert Score	VH	H	M	L	VH	VH	H	M	M

V_{11} = min [(VL ν VH),(M ν H),(H νM),(L ν L),
(VH ν VH), (L ν H),(VL νH), (VH νM), (M νM)]
= min [VH, H, H, L, VH, H, H, VH, M]
= L

Aggregation of criteria on the product alternatives of coconut oil (A_1) by expert 1 results in a decision level at a

low level (L). To obtain the result of the aggregation criteria, aggregation calculations are performed in the same way to all criteria by each expert. The result is presented in Table 4.

TABLE IV
CALCULATION RESULT OF AGGREGATION CRITERIA

Vij	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
Expert 1	L	M	L	L	L	M	M	VL	M	VL
Expert 2	H	M	M	M	M	M	M	M	M	M
Expert 3	VH	H	M	M	M	M	M	M	M	M
Expert 4	M	M	M	M	M	M	M	M	M	M
Expert 5	M	M	H	M	M	M	M	L	L	M
Expert 6	VH	H	H	H	L	H	L	L	M	H
Expert 7	H	M	M	M	M	M	M	M	M	M

Experiment aggregation is then performed using Yager method [12] based on OWA operator (ordered weighted averaging). Expert aggregation is done using a formula:

$$Q_k = \text{Int}\left[1 + \left(k * \frac{q-1}{r}\right)\right] \quad (3)$$

Q1 = Int [1+ (1 x ((5-1)/7))] = 1.57 = 2 = L
Q2 = Int [1+ (2 x ((5-1)/7))] = 2.14 = 2 = L
Q3 = Int [1+ (3 x ((5-1)/7))] = 2.71 = 3 = M
Q4 = Int [1+ (4 x ((5-1)/7))] = 3.29 = 3 = M
Q5 = Int [1+ (5 x ((5-1)/7))] = 3.86 = 4 = H
Q6 = Int [1+ (6 x ((5-1)/7))] = 4.43 = 4 = H
Q7 = Int [1+ (7 x ((5-1)/7))] = 5 = VH

Determination of prospective product is done by aggregation of opinion from all experts about an alternative of processed product of coconut commodity. This expert aggregation uses the formula: $V_i = f(Vi)$ Max [Qj bj]

A combined expert opinion on coconut oil product alternatives (A_1) is calculated in the following ways:

A_1 = Maks [(L ∧ L), (L ∧ H), (M ∧ VH), (M ∧ M), (H ∧ M), (H ∧ VH), (VH ∧ H)]
= Maks [L, L, M, M, M, H, H]
= H

Expert aggregation of coconut oil product alternatives (A_1) produces decisions at a high level (H). The same way is done to obtain expert opinion aggregation of other coconut processed products alternatives. The results are shown in Table 5.

TABLE V
EXPERT AGGREGATION RESULT ON COCONUT COMMODITY PROCESSED PRODUCT ALTERNATIVES

No	Coconut Commodity Processed Product Alternatives	The Value of the Decision
1	Coconut oil	High (H)
2	Coconut milk	High (H)
3	Coconut Sugar	High (H)
4	Nata de Coco	High (H)
5	Handicraft Industry	Medium (M)
6	Copra	High (H)
7	VCO	Medium (M)
8	Coconut Fibre	Medium (M)
9	Desiccated Coconut	Medium (M)
10	Charcoal	High (H)

Table 5 shows that prospective products worthy of development are coconut oil, coconut milk, coconut sugar, *nata de coco*, copra, and shell charcoal.

F. Integrated Coconut Agroindustry

There are several studies on integrated coconut agroindustry that have been carried out. Mukhtar, et al. [13], for example, suggests an integrated coconut development strategy in North Buton by optimizing the prospective aspects of cultivation, product diversification and marketing, and empowering farmers and related institutions. In this study, the economic prospective and integrated coconut processing are considered financially feasible. Research on other integrated coconut agroindustry is done by Ref. [14], which shows that an integrated coconut industry in Aceh Province can be a source of community income. According to Ref. [15], integrated coconut industry activities will give two advantages at once, namely in terms of agribusiness and sustainability of nature. In addition, for local governments and communities, coconut industry activities are an additional source of income. The operation of this integrated coconut industry will help the local economic cycle. Increased local revenue causes an increase in the economy of farmers.

In this study, integrated coconut agro-industry is associated with processed coconut commodity products that are prospective to be developed. The selection of product's potentiality is based on experts' opinion on nine criteria. Development of an agro-industry in an integrated manner should not rely on one particular processed product as this will waste the other parts of the coconut trees. The products must also be from different sources of raw materials. The development of integrated coconut agroindustry in this research is not limited to one industry that produces all coconut processed products but involves different industries for each processed coconut products. Each industry can support each other in the supply of raw materials.

The expert aggregation in this study results in six processed products with high decision value (H). The six products include coconut oil, coconut milk, coconut sugar, *nata de coco*, copra, and charcoal. Of the six products, coconut oil, coconut milk, and copra are produced from the same raw materials, namely the coconut's meat. For that, further analysis is needed to determine what products are more prospective for the development of an integrated coconut agro-industry. Meanwhile, coconut sugar comes from coconut "nira" (sap), *nata de coco* from coconut water, and charcoal from other parts of coconut plant, namely shell.

G. Processed Products from Coconut Meat

According to Ref. [16], one part of coconut that has many benefits is the meat of fruit. Fruit meat is the main component that can be processed into various products of high economic value. While water, shell, and coconut as a by-product of coconut fruit can also be processed into various products whose economic value is not inferior to the flesh.

Among the processed products that can be produced from coconut meat are coconut oil, coconut milk, and copra. Coconut oil is the most valuable part of the coconut. The oil content of old coconut meat is 34.7%. Coconut oil is used as

an industrial raw material or as cooking oil. Coconut oil can be extracted from fresh coconut meat (coconut milk) or dried coconut meat commonly called copra [17,18].

Until the 1950s, coconut oil was ranked first in the world in the production and international trade among all vegetable oils. However, after that, low-cost vegetable oil sources, such as palm oil, soybeans, canola, and others have taken over the coconut in oil production and trade. This fact is attributed to the alleged presence of high levels of saturated fatty acids in coconut. However, recently, it has been found that middle chain fatty acids from coconuts are not as dangerous as previously assumed. As a result, there are signs of a revival of the use of coconut and its oil as food [19].

Copra is dried coconut meat. The name "copra" comes from the word Malayalam *koppara*, which means "dry coconut." [20]. Copra is dry coconut meat that has a moisture content of about 15-20%. Copra is usually processed into coconut oil. The process of making copra can be done by drying under sun or fumigation.

Coconut Milk is a coconut oil emulsion in water, which is white. This grain can be obtained by squeezing fresh coconut meat that has been shredded or crushed with or without the addition of water. According to Ref. [21], coconut milk obtained by squeezing the fresh coconut meat. The yield of coconut extraction is greatly influenced by extortion.

Ref. [21] states that coconut milk is not just coconut oil and water emulsion but also a liquid containing some of the nutrients needed by the body. Nutrients include protein (42%), fat (34.3%), and carbohydrates (54.9%).

From the AAPC [2] data on the amount of coconut processed commodity exports, it can be seen that some processed products have export potential. The total export of processed products of coconut commodities in 2015 can be seen in Table 6.

TABLE VI
THE AVERAGE NUMBER OF COCONUT PROCESSED COMMODITY EXPORTS

No	Types of Products	Export Volume (MT)
1	Fresh Coconuts Mature Nuts	417,042
2	Copra	53,802
3	Coconut Oil	771,419
4	Copra Meal	281,336
5	Desiccated Coconut	86,797
6	Coconut Milk/Cream/Powder	19,440
7	Shell Charcoal	249,682
8	Activated Carbon	21,724
9	Fibre & Fibre Products	31,972

Source : APCC (2017)

Table 6 shows that the export volume of coconut oil (771,419 MT) is much larger than coconut milk and copra, which are only about 19.440 MT and 53,802 MT respectively. This indicates that more world market demand for coconut oil products. This data also reinforces the reason that in terms of market opportunity criteria, coconut oil is far superior to coconut milk and copra.

In addition, the export price of coconut oil is also higher than the price of copra. Based on data on APCC, the export price of Indonesian coconut oil is 1.015 US $ / MT, while the price of copra is 516 US $ / MT [2]. Based on data on the volume and export prices, it is concluded that the prospective product derived from fruit meat is coconut oil.

When associated with the derivative industry, coconut oil also has more derivative products than copra and coconut milk. Coconut oil itself is a processed product of copra, and or from coconut milk. Thus, in terms of product value added criteria, coconut oil is also superior to copra and coconut milk.

World coconut oil demand in 2014 was 2.18 million tons per year with a market value of 3.11 billion US dollars [22]. Indonesia is the two producer countries that supply the world's coconut oil in the international market. The total market share of the two producing countries to the world in 2014 was 76.86%. Total of each producing country is 35.31% for Indonesia and 41.55% for the Philippines, the remaining 8.58%; 8.59%; 1.44% respectively supplied by the Netherlands, Malaysia and the United States and the remaining 4.53% supplied by other countries. Indonesia and the Philippines are in the tropics and are the largest archipelagic country in the world that supports the growth and development of coconut plants. This could make them the world's largest producer of palm oil. So that coconut oil production from both countries can dominate world market share.

The Philippines has a greater comparative advantage than Indonesia as an exporter of coconut oil in the international market. However, when compared to other exporting countries such as the Netherlands, Malaysia, and the United States, Indonesia has a greater comparative advantage. In addition, in terms of coconut oil exports, Indonesia has a complementary relationship with the Netherlands. Therefore, cooperation between the two countries is needed [23].

H. Processed Product from Coconut "Nira" (sap).

According to Setyamidjaja (1991) in [16], "Nira" (sap) is a sweet liquid obtained by doing a special treatment of coconut 'manggar' (spatha) that has not opened at a certain age. Coconut sugar is a food made from the coconut "nira" (sap).

Coconut sugar contains more vitamins and minerals than white sugar. The content of vitamins and minerals of coconut sugar include vitamin C, potassium, phosphorus, magnesium, calcium, zinc, iron, and copper. Coconut sugar also provides small amounts of phytonutrients, such as polyphenols, flavonoids and anthocyanidins, and antioxidants. Concerning health, coconut sugar only has a glycemic index of 35, whereas ordinary sugar has a glycemic index between 60-75.. A glycemic index is a measure of the speed of food in the increase in blood sugar. Low glycaemic levels in one type of food show that the food can bind human blood sugar are not as big as the ability of glucose [24], [25].

According to the United Nations Food and Agriculture Organization, the coconut sugar is the most prospective sweetener to be developed in 2014. According to Ref. [26] the opportunity to develop coconut sugar business in Indonesia is very wide as the number of craftsmen who want to pursue this effort is limited in number. His research in Wonosobo regency, Central Java, shows that coconut sugar business is financially feasible as its BEP value is IDR 39.212, with total production units of 3.9 kg. In line with this,

coconut sugar business is also very feasible to be developed in Indragiri Hilir, Riau. Research by Mardesci et al. [27] showed that the financial analysis of coconut sugar business in Indragiri Hilir has a positive NPV, and the Net B / C ratio is 4.53. This finding indicates that coconut sugar business is financially feasible to develop in the area.

According to Ref. [28], market opportunities are external factors that have the highest score compared to the factors of science and technology development, local government support, availability of labour and the culture of the local community. This shows that coconut sugar agroindustry has the potential to be developed.

From the environmental impact criteria, coconut sugar is an environmentally friendly-product because the palm sugar is processed simply without using pesticides or other chemical products. The product resulted in belongs to the organic product and the process of making it environmentally friendly. So this will add value to the marketing of coconut sugar [29].

Meanwhile, risks in the development of agro-industries Coconut sugar is still relatively low, especially the risks at the cooking stage and the selling stage. According to Ref. [30], high risk is only found in the procurement of raw materials, namely the delay in the growth of coconut flowers.

Indonesia is one of the largest suppliers of coconut sugar in the world market, in addition to the Philippines and Thailand. Meanwhile, the countries which import coconut sugar products are mainly from northwest Europe, such as the UK, the Netherlands, and Germany. Data from the Central Statistics Agency shows that Indonesia's coconut import to the UK in 2016 is about the US $ 657,800, showing an increase of 113.7% from the realization of the previous year. However, palm sugar from Indonesia is only able to control 0.4% of the UK market, which is far below the market share of Thai coconut sugar. In fact, this value is high enough if it is associated with the demand for palm sugar in the UK. Thus, Indonesia has the potential to export more coconut sugar to the country. Besides, Indonesia has vast land and organic planting methods that can be the main attraction for Indonesian organic coconut sugar in the market in England. This fact is considered a comparative advantage of Indonesia compared to other Asian countries [31].

Data from the International Trade Centre (ITC) UN COMTRADE, indicates that during the period 2012-2016 import growth is 2.6% in an average per year. In 2016, Great Britain is the world's sixth largest importer of palm sugar, with import value reaching the US $ 57.2 million. Other palm sugar importer countries are Germany. The Government of Indonesia through the Ministry of Trade managed to facilitate coconut sugar trade transactions produced by one of the UKM in Indonesia. The buyer is a German company, Flores Farm Gmbh. The contract between the two companies is worth the US $ 800,000 or Rp 10.8 billion [32].

I. Processed Products from Shell (Charcoal)

Coconut shells can be utilized by various industries such as charcoal and carbon which function to absorb gas as well as handicrafts, household items and other art items, such as belts, bracelets, spoons, ashtrays, buttons and wall decorations. Coconut shell charcoal is a product obtained from incomplete combustion of coconut shells. As fuel, charcoal is more profitable than firewood. Charcoal provides a higher heat of combustion, and less smoke. Charcoal can be crushed, then pressed into briquettes in various forms. Briquettes are more practical than using firewood. Charcoal can be further processed into activated charcoal, and as fillers and dyes in the rubber and plastic industries.

Incomplete combustion in the coconut shell causes complex carbon compounds not to be oxidized to carbon dioxide. This event is referred to as pyrolysis. At the time of pyrolysis, heat energy encourages oxidation so that carbon molecules that are decomposed in complex are mostly carbon or charcoal. Pyrolysis for the formation of charcoal occurs at a temperature of 150-300^{o}C [33].

From table 6 it can be seen that the export volume of shell charcoal is 249,682 MT. This shows that the world market demand is quite large for shell charcoal. Indonesia has a big chance to export shell charcoal.

In terms of processing, shell charcoal can be processed traditionally, so it does not require a lot of capital. But this traditional processing is not safe for the environment, because it will produce a lot of smoke. Therefore, it is necessary to use methods that are safer for the environment, as suggested by Ref.. [34], namely by using the Top Lit Up Draft (TLUD) method. This TLUD method does not produce thick smoke as produced by traditional methods. So the processing of shell charcoal can be done without moving away from residential areas.

From the aspect of labor, processing shell charcoal can be done by adults, regardless of the level of education. This means that this shell charcoal business also has a high chance of absorbing labor.

IV. CONCLUSIONS

Based on the result of research, it can be concluded that experts used in this study were selected based on one's relevance to the development of integrated coconut industry. These experts are among others from the Indonesian Coconut Growers Association (Association of Indonesian Coconut Growers Association), the Office of Industry, the Plantation Service and Assistance Force of Farmer Groups, Field Extension Workers, and from academics.

The product alternatives considered to have good prospects for development are obtained from interviews and discussions with experts and supported by literature review. The products are coconut oil, coconut milk, coconut sugar, *nata de coco*, handicraft industry, copra, VCO, coconut fiber, desiccated coconut, and shell charcoal. Criteria are collected after corrected by experts, among others: the availability of raw materials, employment, technology used, value-added products, environmental impacts, market opportunities, product quality, product distribution, and government policies.

From the results of expert, aggregation obtained six prospective products to be developed, namely: coconut oil, coconut milk, coconut sugar, *nata de coco*, copra, and shell charcoal. After further analysis, there were three prospective products for integrated coconut development. These products are coconut oil, coconut sugar, and shell charcoal. The three products come from different sources of raw materials, namely: coconut oil from the pulp, coconut sugar

from “nira” (sap), and charcoal from shell. This already represents the requirement for the development of agro-industry in an integrated manner because for the development of the developed products should not just one processed product. Besides, developed products must also be from different sources of raw materials.

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