Environmental Impact of Palm Oil Industry in Indonesia

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Abstract: Indonesia is one of the world largest palm oil producer after Malaysia with over 12 million tons of crude palm oil(CPO) production in 2004. About 60% of CPO is exported. Among the rest of it, around 30 % is used for cooking oil followed by 7% of oleochemical, 2% of soap and 1.6 % of margarine. In the process of CPO production, many types of bio-wastes are generated in plantations and CPO mills. In plantations, fell trunk, fronds at felling and annual pruning are the main bio-wastes. Empty fruit bunch(EFB), fibres and shells are generated in CPO mills. One part of fibres and shells are, in some cases, utilized for mill boiler fuels. The purpose of this study is to clarify environmental impacts of palm oil industry in Indonesia. This paper conducted literature review and surveyed on selected palm oil factories in Indonesia. In conclusion, most of bio-wastes were utilized: EFB and effluent for fertilizer, fibre and shell for boiler fuel, etc. However, there is still possibility to effectively utilize these bio-wastes.

Keywords: palm oil, Indonesia, bio-waste, environmental impact

1. INTRODUCTION

Indonesia is one of the world largest palm oil producer after Malaysia with over 12 million tons of crude palm oil(CPO) production in 2004[14]. About 60% of CPO production is exported. Among the rest of it, around 30 % is used for cooking oil followed by 7% of oleochemical, 2% of soap and 1.6 % of margarine [10].

Fig. 1 shows the schematic material flow of palm oil industry in Indonesia. Palm oil industry consists of the following five stages: plantation, CPO mills, palm kernel oil mills(PKO mills), refinery factories and others. Fresh fruit bunches (FFBs) from palm oil plantation are transported to a CPO mill, in which CPO, kernel and bio-wastes are produced. Then kernel and CPO are transported to a kernel factory and a refinery factory where palm oil products are produced. After consumption of these palm oil products in domestic market, one part of the products is wasted as municipal waste. Also environmental impacts are caused in each stage of palm oil production process.

In the process of palm oil product production, many kinds of

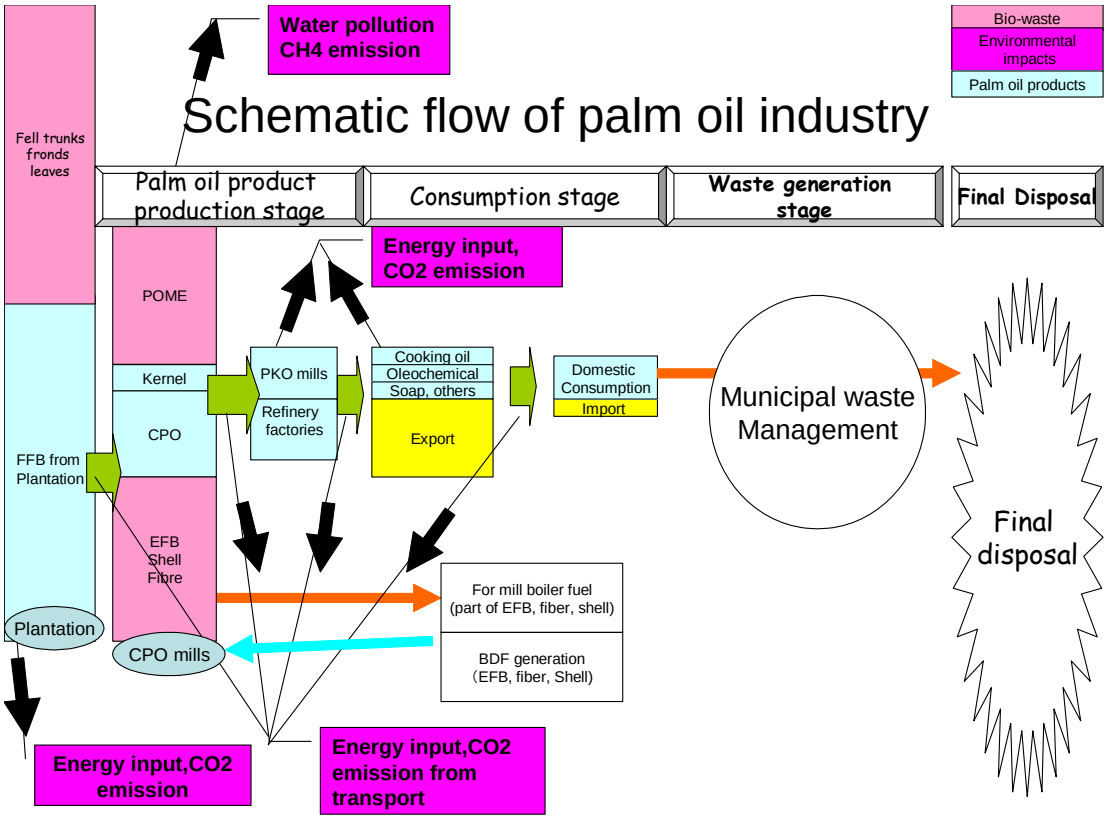

Fig.1. Schematic flow of palm oil industry

Source: [5] revised by the author

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bio-wastes are generated in plantations as well as palm oil factories. In plantations, fell palm trunk, palm fronds at felling and annual pruning are the main bio-wastes. Empty fruit bunch(EPB), fibres and shells and palm oil mill effluent(POME) are generated in CPO mills. One part of fibres and shells are, in some cases, utilized for mill boiler fuels. Recently, oil palm has been given great attention as renewable energy resources and is being recognized as a candidate of potential projects for the clean development mechanisms (CDM) under the Kyoto protocol for the prevention of global warming.

There are a lot of CPO mills in Indonesia. However there are not so much available information relating to the performance of each CPO mill from the perspective of material balance and environmental impacts. Of course, each CPO mill must have their factory information on material balance and environmental impacts. However usually these are confidential and not open to the public. [2], [7] are few reports which provide information on material balance and environmental impacts of CPO mills but these are limited to Thailand examples. So the performance of Indonesian CPO mill was not well analyzed in academic literatures.

The purpose of this paper is to clarify environmental impacts of palm oil industry mainly focusing on plantation, transportation and CPO mill stages in Indonesia. Material balances of selected CPO mills, including plantation and transportation stages, were analyzed by utilizing a factory visit survey. Then environmental impact analysis was also conducted to these factories.

2. STUDY METHODS

First, to clarify a schematic picture of palm oil industry, especially for CPO mills, extensive literature survey was conducted on palm oil related information including types of bio-wastes and its generation amount in Indonesia, Malaysia and Thailand. These included: CDM Feasibility Studies(CDM-FSs); Each company web-site; Development assistant reports by Japan International Cooperation Agency(JICA), World Bank and Asian Development Bank; and Academic literatures for both international and Indonesian domestic. Then most palm oil companies monitored their products and its bio-wastes from the perspective of types and amounts, however, there are a limited number of reports which include detailed information.

Second basic information of Indonesian palm oil industry was collected including plantation, CPO mills, PKO mills and refinery factories from academic articles, industrial association documents, web-based information, etc. Then lists of palm oil related companies were developed including candidates for the factory visit survey in Indonesia.

Third the factory visit survey on palm oil factories was conducted in July 2007 for four CPO mills, four plantations[1] and one refinery factory to get information on material balance and environmental impacts of factories. Then comparative studies between factories and between Indonesia and Thailand examples were conducted.

3. RESULTS AND DISCUSSIONS

3.1. Overview of bio-wastes in CPO mills in Southeast Asia

According to the literature survey, 9 examples of CPO mills, including 5 from Malaysia, 3 from Indonesia and one from Thailand, were collected as Fig.2. Average figures of each bio-waste were concluded that EFB, fibre, shell, POME, kernel and CPO were 22.5%, 14.3%, 6.7%, 54.8%, 5.4% and 21.8% per one t-FFB respectively. In these examples most of bio-wastes were utilized and/or is planning to utilize as boiler fuel, bio-diesel production, feed for cattle, etc. In other cases, as for CDM-FS study, CH_4 from POME is planning to use for boiler fuel.

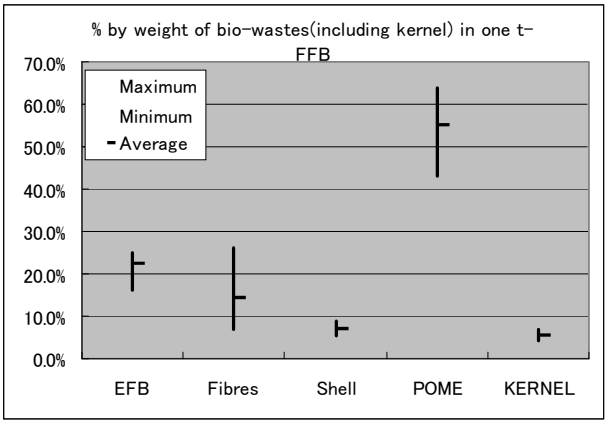

Fig.2. % weight of bio-waste in selected cases
Source:[1], [3],[4], [6], [8], [9], [11], [12] and [13]

3.2. Palm oil industry in Indonesia

According to literatures and web-based information, 336 companies and organizations were identified in Indonesia, which involved in palm oil business including plantation and palm oil related factories. Among them, there are six biggest players in CPO business in Indonesia: PT. Perkebunan Nusantara (PTPN) consisting of 9 PTPN, Sinar Mas, Raja Garuda Mas, Astra Agro Lestari, Minamas Plantation and Indofood. They are managing more than 50% of plantation estate in Indonesia and are leading the Indonesian palm oil business. So, the best way to grasp the information of plantation and CPO mill stages in Indonesia was to focus on these biggest players. Then, in this study among these several companies were selected to conduct the factory visit survey for getting detailed information on material balance and environmental impacts of plantation and CPO mill stages.

3.3. Basics of field survey

In this survey, four CPO mills, four plantations and one refinery factory were selected for the visiting survey among six biggest players. All these are located in North Sumatera province. Most of these are located near or in their plantation and the capacity of mills was averaged to around 30 t-FFB per hour. The production level was between 300 and 750 t-FFB per day. According to the interview survey to their factories, these are average mills in Indonesia.

3.4. Typical CPO process and environmental impacts

Fig.3 shows a typical CPO production process of a CPO mill in Indonesia. FFBs are collected in plantation and are transported to a CPO mill by motor trucks. Then FFBs are loaded to lorries which go into sterilization process. Detailed CPO process was described in many documents (see [8], etc).

In several factories, EFBs are currently used as fertilizer. All

[1] The author visited mainly two plantations, however, the author also got information on plantations from each CPO mill located just inside plantation. In total four plantations' information was collected.

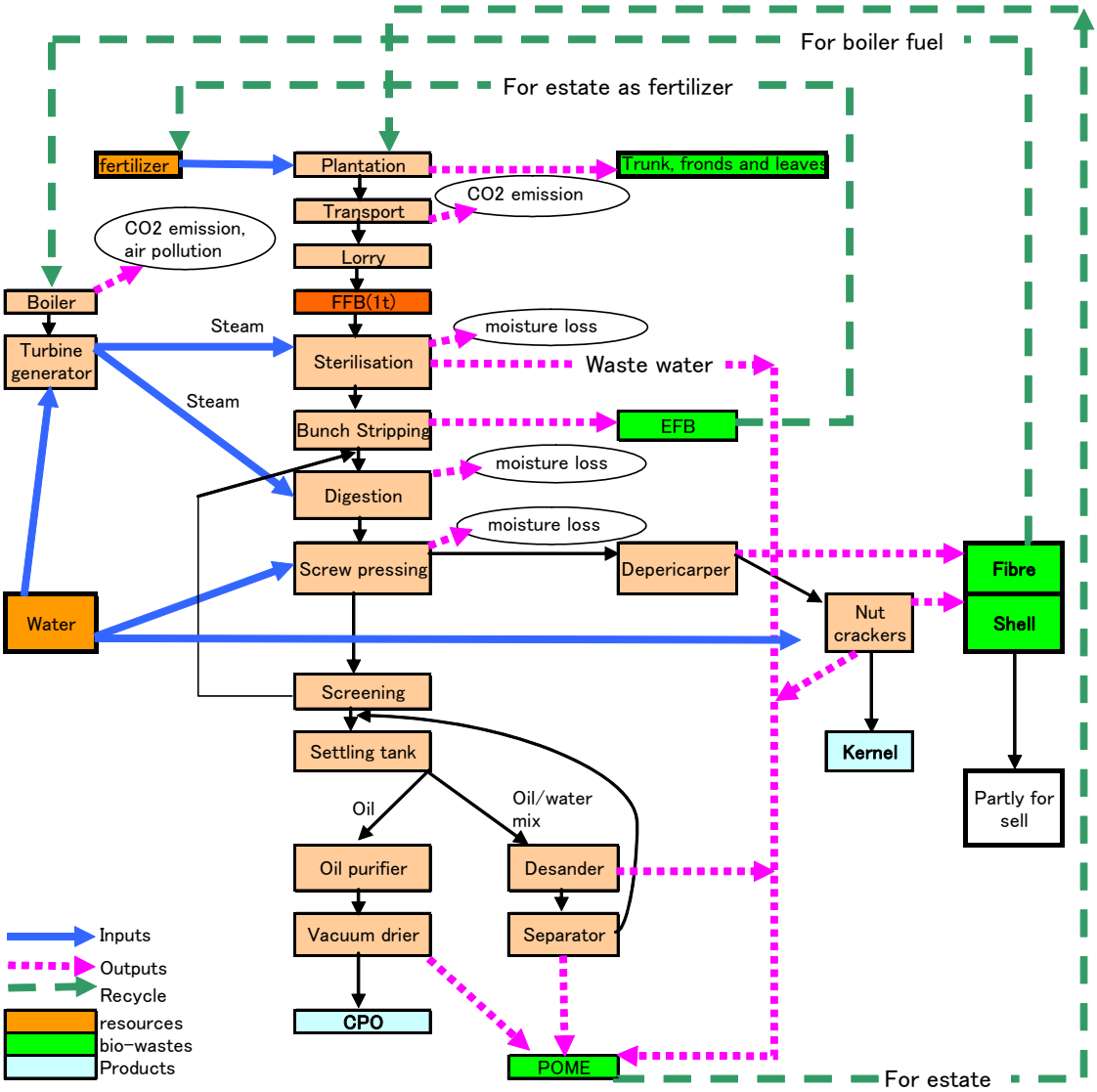

Fig.3. Production process of a CPO mil in Indonesia

fibres and one part of shell are utilized for boiler fuel which covers whole energy demand in a relevant CPO mill. Other part of shell is sold to other factories for boiler fuel. POME is usually distributed to plantation near from the mill by pipeline after purification. Then trunk, fronds and leaves in plantation are left in plantation as fertilizer.

3.5. Bio-waste utilization and environmental impacts

Material balance and environmental impacts in plantation and CPO mill stages were developed by utilizing the information obtained through the factory visit survey in the averaged figure basis (Fig.4). In this development of a material balance sheet, plantation and CPO mill were focused and the inclusion of others, like, PKO mill and refinery factory to develop a whole picture of palm oil industry, was recognized as a future challenge.

In the CPO production process, inputs are mainly divided into two parts: Natural resources including water, fuel, electricity; and Raw material, namely, FFB. Outputs are categorized into two kinds: Products including CPO and palm kernel; Solid wastes including fibre, shell, EFB; Waste water including flow, BOD and oil; and Gases including steam, CH_4, CO_2 etc. It seemed that most Indonesian CPO mills used almost same CPO production process according to the interview survey, however, the amount of the inputs and the outputs may be different, especially for small holders. To study on small holder situation is a future task.

Referring to this process, the inputs are only limited to FFB, motor fuel and water in plantation, transportation and CPO mill stage. Products in outputs are CPO and kernel in CPO mill stage. Bio-wastes in outputs are: Fibres and shells which are used for mainly boiler fuel to produce electricity and steam; EFB which is used for fertilizer for plantation; and POME which is also utilized as fertilizer in plantation. Other outputs, like, BOD, COD and sludge in liquid wastes and CH_4, CO_2 and air pollution from boiler in gases, are not effectively utilized.

Most of the factories visited tried to introduce the concept of the zero waste emission, for example, all bio-wastes are utilized as fertilizer and materials for energy generation. However, there are a lot of environmental impacts which should be taken into consideration. Water input as natural resource is huge and it produces plenty of waste water after CPO process. Then during the production of energy by burning bio-wastes for example fibre, it caused air pollution that the factories do not recognize that it is important environmental problem. Regarding climate change issues, CO_2 emission from the transportation sector

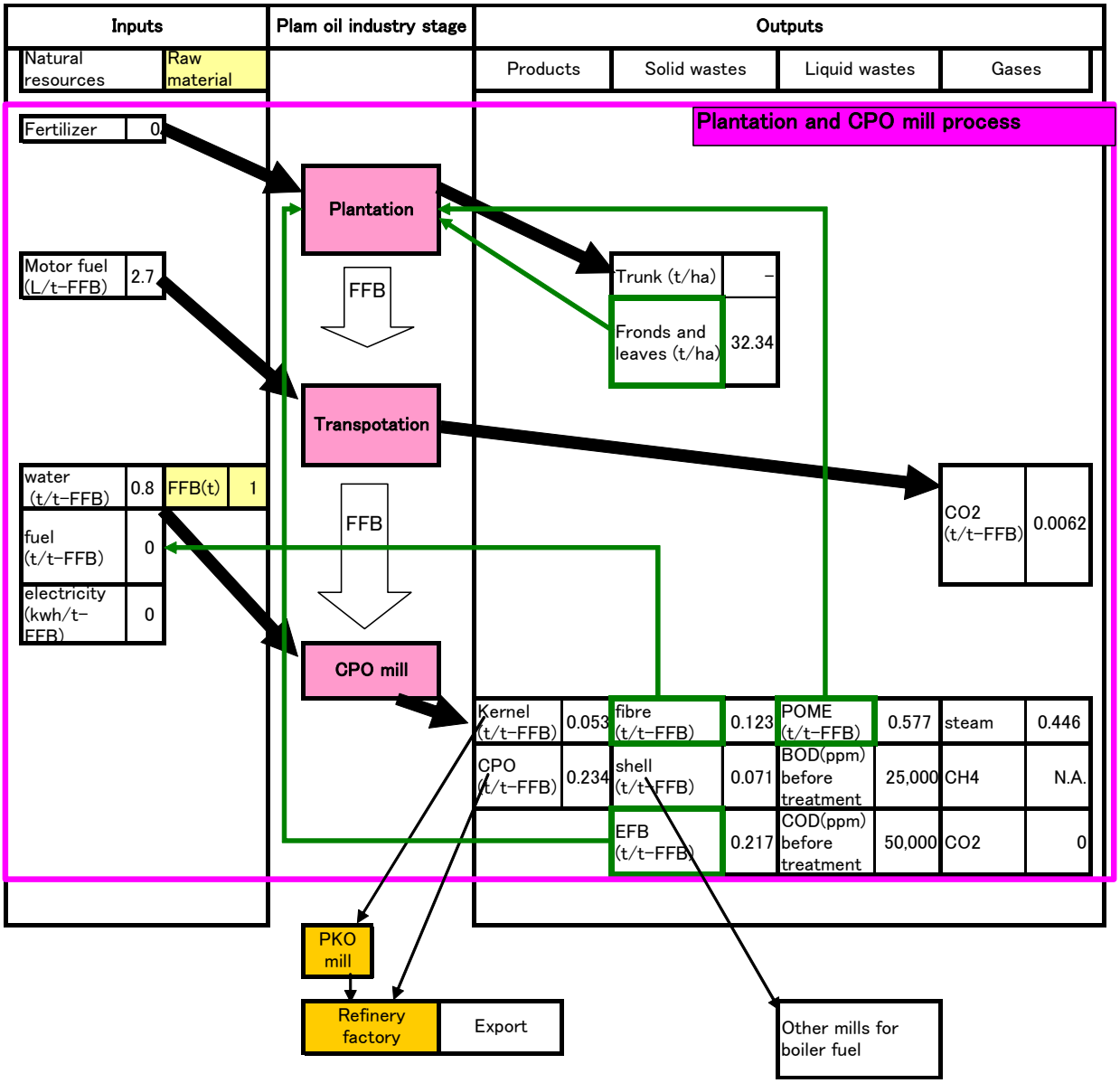

Fig.4. Material balance of typical palm oil plantation and CPO mil in Indonesia (per one t-FFB basis)

should also considered. It is difficult to prioritize these outstanding environmental issues. Even if the zero waste emission concept was tried to introduced, there is still need to effectively utilize these bio-wastes for example, by employing bio-refinery technology which is a cascade process that consists of (1) extracting chemicals such as lignin and medicine etc., (2) transforming bio-wastes into bio-fuel, and producing hydrogen and methane by gasification, and (3) producing thermal energy by oxidation or combustion. The environmental effectiveness of this technology will be planned to study in the near future.

3.6. Comparative study with Thailand example

As previously mentioned, [2] is rare example of academic article provided the detail material balance and environmental impacts of CPO mills. Here Indonesia examples were compared with this Thailand example. First, CPO process flow was almost same, starting from sterilizer and end in CPO storage tank. In this process, the types of inputs and outputs were almost same too. However, there were several different points. One was waste water treatment from sterilization process. Thailand example utilized waste water more effectively and it also proposed an industrial ecosystem approach for CPO industry including reuse, recycling and utilization of solid and liquid wastes and appropriate energy management. Several Indonesian CPO mill tried to establish zero waste management however, there is a room for improvement. These include the effective utilization of waste water, EFB treatment before leaving in plantation as fertilizer and the treatment of air pollution from boiler etc. Currently, EFB and waste water were used as fertilizer for plantation. Then it needs careful consideration for fertilizer in plantations if EFB and waste water used other ways.

3.7. Rough estimation of whole Indonesian situation

By utilizing the above data set, environmental impacts of whole Indonesian CPO mills were roughly calculated by utilizing the units in Fig.4 multiplying the CPO production figure in Indonesia. In addition, in Fig. 5 Maximum(MAX) and Minimum(MIN) data were also added, which were obtained

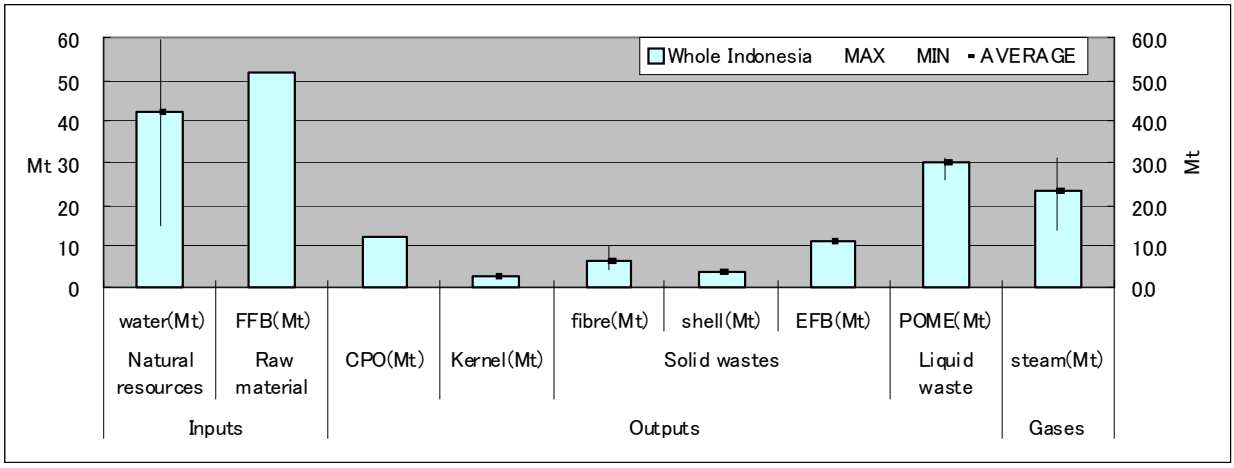

Fig.5. Rough estimation of environmental impacts of palm oil plantation and CPO mills in Indonesia

though the factory visit survey. Usually, around 52 Mt of FFB and 15 to 60 Mt of water are input into CPO mill and get approximately 12 Mt of CPO, 2.6 to 3.0 Mt of kernel, 20 to 25 Mt of solid wastes including fibre, shell and EFB and around 26 to 31 Mt of POME. However, it needs careful consideration of each factory situation. For example, all CPO mills in this study produce their energy by burning fibres without buying electricity from outside. However small holders may have different material balances, for example, usage of electricity, energy etc.

The author insisted that it was just preliminary estimation and a rough calculation of whole Indonesian situation. Having said that, the estimation could contribute to generally understand the rough situation of Indonesia as a first step. Of course, further detailed study should be conducted. For the next step, comparative assessment of environmental items should also be conducted.

4. CONCLUSION

In this study, Indonesian palm oil business was analyzed supported by the factory visit survey. Then general picture of palm oil business, especially for plantation, transportation and CPO mill stages, was described from the perspective of material balance and environmental impacts. Also it clarified the recent situation of the way to utilize bio-wastes generated from CPO mills and its future improvement possibility. Finally, it also quickly estimated the whole picture of total amount of bio-wastes generated from Indonesia in total.

Future issues to be solved include the followings. First, the development of a material balance sheet including from plantation to PKO mill and refinery factory should be developed to clarify the whole picture of palm oil business in Indonesia. Second, each company's information, especially for small holders, should be collected to analyze environmental impacts of palm oil in Indonesia by, for example, a questionnaire survey. Third there is a room to improve effectively utilizing bio-wastes from CPO mills. In this regard, new ways and technologies of treating these bio-wastes should be evaluated.

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