Comparison of Emission and Energy for Biodiesel Production from Oil Palm (*Elaeis guineensis)* and Jatropha Curcas (*Jatropha curcas* L.) Based on Life Cycle Assessment (LCA) in Indonesia.

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Energy sector plays an important role for Indonesia in achieving its economic development goal. Indonesia is still heavily dependent on fossil based energy, which is accounted for more than 90% of its energy mix (including oil, gas and coal). Biodiesel is one of the biofuel being developed and used intensively in Indonesia. Biodiesel can be produced from various oil borne plants, such as palm oil, jatropha curcas, rapeseed, soybean, etc. The USA produced their biodiesel from soybean, Euoropean countries from rapeseed, while Indonesia mainly from palm oil. Currently, environmental consideration becomes the most important issue in biodiesel production. Even though the source of the energy is considered as carbon neutral, the production path can emit various environmentally hazardous gasses. European and American countries claim that production of biodiesel from palm oil contributes carbon emission to atmosphere along its production path. Furthermore, US EPA-NODA and EU RED stated that palm oil based biodiesel can only reduce emission of GWP by 17% and 19% compared to fossil-fuel based. Considering that the minimum requirement is 20% for US and 35% for EU, CPO from Indonesia experiences difficulties to enter the global market. Scientific approach should be undertaken by Indonesia to address this issue. However nowadays we only still have few numbers of international scientific publications regarding the environmental aspect of biodiesel production. Appropriate method to analyze aforementioned problems is Life Cycle Assessment (LCA) which complies with the International Organization for Standardization (ISO). This study is aimed to compare life cycle assessment of biodiesel production from oil palm and jatropha produced in Indonesia. The LCA system boundary for this study was from cradle to gate, which consists of eight subprocesses, with functional unit (FU) of 1 ton biodiesel fuel (BDF). Life cycle inventory (LCI) analysis was performed using the data collected from oil palm plantation and *Jatropha curcas* centre, both located in western part of Jawa island in Indonesia, become primary data. The analysis was also grouped into unstable production stage and stable production stage in order to accommodate the natural growth characteristics of both crops. The LCI results were utilized to perform impact assessment using software MiLCA-JEMAI version 1.1.2.5 for data processing. The results of this study show that biodiesel production from oil palm give higher value of global warming potential (GWP) than jatropha, it is also shown at a value of oil palm has higher material and energy input utilization than *Jatropha curcas*. The use of agro-chemicala, such as fertilizers, herbicides, insecticides and pesticides, give significant contribution to the total GWP value, which was 68.14% and 37.56% for the respective oil palm and jatropha for scenario 2. Emission characteristics of both crops during unstable productivity period were found to be different from that during the stable productivity. The calculation on stable productivity is lower than unstable productivity. Where as there is 4/5 part or 20 years of 25 years of its life cycle (oil palm and *Jatropha curcas*) lies on this condition. Therefore, appropriate calculation method is needed. In some journals, the calculation is only performed in the first five years. Annual GHG emission value, eutrophication, acidification and energy consumption for producing biodiesel from oil palm was found to be higher than that from jatropha. For oil palm, the emission and energy consumption due to pre-harvest activity was higher compared to post harvest activity, while for jatropha, the postharvest activity was higher than the pre-harvest one. The characteristics of GWP emission and energy consumption by biodiesel production from oil palm was higher than that from jatropha, both during unstable and stable productivity period. The emission and energy consumption from oil palm was dominated by pre-harvest activity due to the requirement of more intensive

maintenance of the plant compared to that of jatropha. The use of organic fertilizer is very influential in the reduction of GHG value impact in fertilization sub-process. It could reduce up to 96.2 % for oil palm and 76.8% for *Jatropha curcas* or for all life cycle could reduce up to 37.4 % for oil palm and 61.4% for *Jatropha curcas.* By scenario 5, using jatropha based biodiesel for electricity generation is still better than using other fossil fuel. The energy input for production biodiesel from CPO is higher than CJCO as show by higher the NEB which is 146,948.08 and 39,334.79 for BDF from CPO and BDF from CJCO, respectively and by lower the RI value which is 0.162 and 0.270 for BDF from CPO and BDF from CJCO, respectively (result of the scenario 3). Scenario 3 is the best scenario which reflects real condition in Indonesia, in which GHG value before stable productivity is 2575.47 kgCO_2eq./ton-BDF for oil palm and 3057.74 kg-CO_2eq./ton-BDF for *Jatropha curcas*. When the productivity has reached stability, the GHG value is 1511.96 kg-CO_2eq./ton-BDF for oil palm and 380.52 kg-CO_2eq./ton-BDF for *Jatropha curcas*. With if we compared to diesel fuel, CO_2eq. emission is reduced up to 49.27% and 88.45% for BDF-CPO and BDF-CJCO, respectively.

Keywords : Biodiesel, crude palm oil, crude *Jatropha curcas* oil, life cycle assessment