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The Influence of Crude Oil Price in Biodiesel and its Implication on the Production of Palm Oil: The Case of Indonesia

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Abstract:

Over the last five years (2012-2016) there has been a rise in world oil prices which were very noticeable on an average of 17,85 percent per year. This increase encouraged the increased use of alternative fuels, one of which was biodiesel.

It was estimated that the average increase in global biodiesel production amounted to 43.18 percent per year. Because one of biodiesel feedstocks was CPO, the increased production of biodiesel causes CPO export demand to increase simultanesly. The Bio-diesel utilization is also expected to reduce oil consumption.

The purpose of this paper is to examine the influence of crude oil price increase on the Bio-diesel utilization, oil consumption reduction, and pollutant emission reduction.

Keywords: *Crude Oil Price, Biodiesel, Palm oil*

JEL Classification: *F3, G15*

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1. Introduction

Nordin, Simeh, Shariff and Baharim (2007), proved in their studies that there is a relationship between the price of crude oil and biodiesel. The results showed that the increase in oil prices during the period of the last few years encouraged some countries to begin to pay attention to the use of alternative fuels, among others from the plant (biodiesel). The increase of petroleum will increase biodiesel production. Ramli, Abas, R. and Ayatollah (2007) in their studies proved that the crude oil price is affected by biodiesel, the first derivative product of palm oil which produces palm oil (known as crude palm oil or abbreviated with CPO), utilizing biodiesel which comes from palm oil, the results showed that the biodiesel increase has affected the crude palm oil price.

The development industries based on this CPO in addition directed to produce food products such as cooking oil, margarine, shortening, Cocoa Butter subtitute (CBS), and vegetable ghee, it is also directed to produce non-food products, such as industrial oleochemical primary (fatty acid, fatty alcohol, glycerin) and other oleochemical derivatives, namely surfactants, cosmetics, farmacy, and bioenergy. Oil palm plantations and palm oil industry as a means to improve the socio-economic conditions of rural communities through the implementation of operations Inti-Plasma programs (Zen *et al.,* 2006). When the world oil price increases, many countries use CPO as raw material of bio-diesel fuel as a substitute (Karuppuswamy, Sundararaj and Elangovan, 2007; Pociovalisteanu *et al.,* 2010; Thalassinos and Politis, 2012; Thalassinos *et al.,* 2012). These conditions favor the use of biodiesel as a variety of targets alternatives to fossil energy applied to several countries in the world (Kennerly and Neely, 2003).

In 2020, the European Union set a target of 10 percent biofuels of raw palm oil. Zen, Barlow and Gondowarsito (2006) studied that the crude oil prices have an influence on the palm oil as pointed out by Ahuja and Khamba (2008). It has been proved that there is an influence of biodiesel on the production of palm oil. The research result on the biodiesel and its impact on crude palm oil and its implications for palm oil, showed that the growing number of biodiesel has a positive and significant effect towards crude oil palm as well as the implications for the production of palm oil rises (Ashayeri, 2007). The increase of demand and the use of palm oil as a fuel is expected to cause disruption of the availability of CPO as raw materials for food, especially palm oil (Chand and Shirvani, 2000; Enkawa and Schvaneveldt, 2001). Novelty of this research is to add the existing variables into world oil price of the biodiesel and its impact on crude palm oil and its effect on oil palm.

2. Theory and Hypothesis

As Santoso (2014) has pointed out bio-diesel is a natural renewable energy source that made from biomass or vegetable oil. As the bio-diesel has physical properties very similar to petroleum derived diesel fuel or ADO (Automobile Diesel Oil), bio-

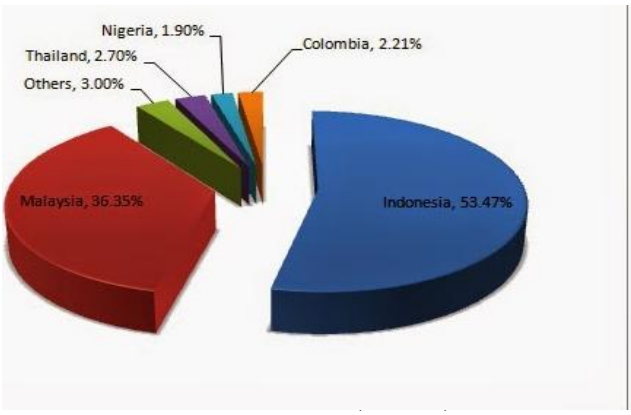
diesel has been used for motor engine since 1880's. In 1920's, bio-diesel production infrastructure has been nearly eliminated since diesel engine manufacturers altered their engine to utilize petroleum diesel that was much cheaper than Bio-diesel production. Recently, an increase on oil consumption, crude oil price, and ADO import have lead to consider bio-diesel utilization for transportation sector in Indonesia. An increase of the crude oil price that lead to a decreasing cost differential for bio-diesel production, bio-diesel utilization as alternative energy source in Indonesia is a real possibility. Some environmental impact concerns would also increase the bio-diesel utilization prospect.

Oil palm is a highly profitable crop adapted to the humid tropics and the area devoted to this crop is likely to expand significantly in the future. It has many environmentally favourable attributes over its full life cycle. When well managed it has a positive carbon balance and when grown in a landscape mosaic it can play a role in biodiversity conservation. It has driven rapid economic growth in several tropical developing countries and contributed to the alleviation of rural poverty. Abuses during periods of rapid estate expansion into areas of natural forest and onto the lands of poor rural communities have led to criticism by environmental and social activists. With good governance oil palm can make valuable contributions to development and the resulting prosperity may free people to invest (Sayer, 2012). The data shows that the demand for CPO as raw material MGS, margarine and shortening in Indonesia in 2004 amounted to 6.5 million tons increased to 10.6 million tons in 2010, or an average increase of 10.3 percent per year. While the CPO demand for non-food, especially for fatty acid, fatty alcohol, and glycerin in 2004 amounted to 114.8 thousand tons increased to 158 thousand tons in 2010. It showed that the average increase was 6.3 percent annually (Directorate General Agro and Chemical industry, 2004).

A researh conducted by Hartoyo (2011) has used an econometric model using simultaneous equations. An increase in world crude oil price of 0,192 percent caused the real export price of Indonesian palm oil to raise by 10,64 percent. Consequently, a larger biodiesel production is needed to meet their increase of world's consumer demand for bio-diesel. Also, with the increase in real export price of Indonesian palm oil, it will encourage palm oil producers to push their export volume. Indonesian palm oil exporter expected to increase by 6,37 percent to finally push the domestic CPO price increase by 1,85 percent. The rising of domestic oil prices are causing oil demand in the palm oil industry to decline by 0,49 percent and in the end resulting in the decline of palm oil production by 1,56 percent. The existing data indicate that the current national solar requirement amounted to 27 billion liters per year. It is meant that CPO could substitute 10 percent of the national diesel fuel requirements (Asian Development Bank and the Ministry of Industry, 2003). Ten (10) percent of the diesel fuel substitution has implications for the availability of palm oil as a raw material of food. With the increasing need for diesel fuel as a raw material to fuel, the demand for CPO as the raw material for fuel allegedly will continue to increase. Hameed and Arshad (2009) in their research showed that in the

long term there is a directional relationship between the crude oil prices to the demand of oil from four plants, namely palm oil, rap seed, soybean, and sunflower. The fuel prices which continue to rise will increase the demand for biofuels such as bio-diesel. Currently, Indonesia was the biggest oil palm producer in the world with more than 50% of the market.

Table 1. *Breakdown of global palm oil production*



Country	(*000 Mton)	%
Indonesia	33,500	53.47%
Malaysia	21,250	36.35%
Others	3,654	3.00%
Thailand	2,250	2.70%
Nigeria	930	1.90%
Colombia	1,070	2.21%
	62,654.00	

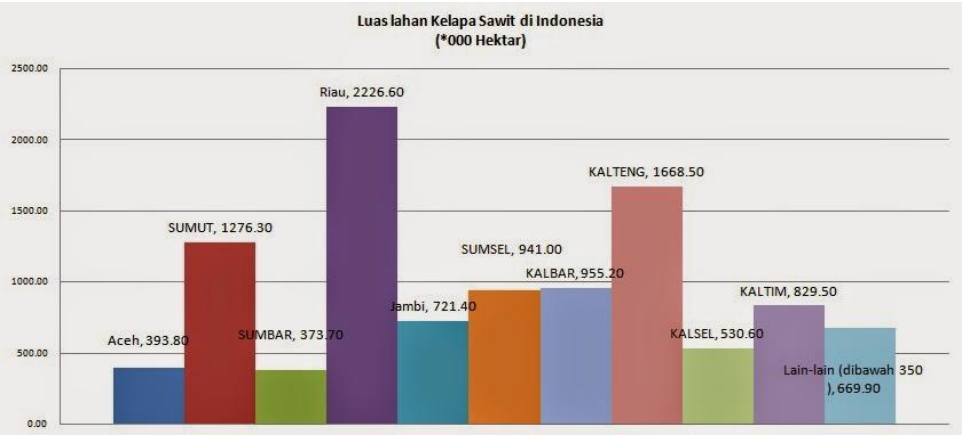
Palm oil itself is a commodity product in Indonesia which during 2002-2013, overtook oil as the main stay with an average growth of 13.4% per year. The largest increase was in 2001 and 2002, which is also called the palm booming due to an increase of 42% per year. Indonesia has a big contribution in control of oil palm price in the world (Figure 1).

Figure 1. *Oil Palm Production*

3. Oil Palm Condition in Indonesia

Using rough calculations, if in 2020 the world needs from Indonesia amount to 39 million tons of CPO a total of about 39 million tonnes of FFB is needed. If one hectare of oil producing a maximum of 6 tonnes / hectare, then in 2020 at least 29 million hectares of oil palm is required. Indonesia currently has 10.2 million hectares of oil scattered in several provinces and the greatest potential is in the province of Riau (Figure 2).

Figure 2. *Production of Palm Oil by Region in Indonesia*



Source: *Badan Pusat Statistik Indonesia*

Table 1. *The mean increase in production, CPO prices, fuel prices and Edible Oil Prices (% per year)*

Period	CPO Production	CPO Price	CPO Export Price	Fuel Prices	Edible Oil Price	Cooking Oil Production
2002-2006	13,00	1,60	13,40	18,80	2,08	9,68
2007-2011	7,68	1,87	15,16	19,65	2,99	9,06
2012-2016	4.58	1,69	12,30	17,85	2,54	7,89

Sources: *Compiled from various sources, the year of 2016*

In the period 2002-2016 the rate of average production growth increased significantly, but the domestic CPO price, the price of CPO exports and the price of cooking oil was unstable. The jump of fuel price was very sharp occurred in the period 2002-2006 compared to the period 2007-2011. At the same time the production of cooking oil rose sharply in the period 2007-2011 compared to the period 2012-2016.

4. Hypothesis Development

The effect of rising oil prices on the export of crude palm oil (CPO) and palm oil availability is explained below. If the price of oil increases, is expected to lead to

alternative fuels, in this case in the biodiesel. The increase of biodiesel in the world is predicted to lead to the increase of exporting CPO demand. CPO export volume has increased while the availability of domestic CPO has declined. With the increasing demand for CPO the CPO production volume should be increased (Sri and Novivdra dan Hastuty, 2011). From the above description, it can be hypothesized that if there is an increase in oil prices it will lead to the increase of biodisel and palm oil exports, CPO prices increase, the demand for CPO as raw material for cooking oil declines and cooking oil production also declines.

5. Research Methodology

The research is based on quantitative methodology with simultaneous equations model building using secondary data of time series during the period 2002-2016. The model consists of seven structural equations that are: (1) response of CPO production; (2) The CPO demand for edible oils; (3) the export of CPO; (4) The export price of CPO; (5) domestic CPO price; (6) palm oil production response; (7) the domestic demand for palm oil; and the last two (2) are identities. Based on these variables, the model is consisting of 9 endogenous variables and 17 exogenous and endogenous lag variables. The model equations are as follows:

CPO export price: $HEC_t = q_0 + q_1 HMM_t + q_2PEC_t + q_3JEM_t + q_3HEC_{t-1} + u_1$ (1)
Indonesian CPO exports: JEMt = p0 + p1 HECt + p2NTRt + p3PECt + u2 (2)
Demand for edible oils: JCMt = s0+s1HMGt+s2HCRt +s3JCMt-1+s4T +U (3)
CPO production in response: PCIt = t0 + t1HCRt-1 + t2URPt-1 + t3PCIt-1 + u4 (4)
Domestic CPO price: HCRt = k0 + k1HECt + k2PCIt-1 + k3T + u5 (5)
MGt = l0 + l1HMGt-1 + l2HCRt-1 + l3PMGt-1 + l4T + u6 (6)
Palm oil domestic demand DMGSDt = M0 + m1HMGt + m2HRMt + m3PPRt + m4DMGSDt-1 + U7 (7)

In the identification process equation 7 comes to be overidentified. Therefore, to estimate the parameters of the structural equations we used the two stage least squares methodology (2SLS).

6. Analysis

The influence model CPO demand for fuel on the availability of edible oils is presented in Table 2. The results of the estimation of the economic model of CPO in this study is quite good as seen from the determination coefficient (R2) of each behavioral equation ranged between 49.06 per cent up to 98 percent. In general, the independent variables (independent variables) that exist in the behavioral equation are able to explain quite well the dependent variable (Table 2).

Table 2. *The Model Estimation for the Effect on Fuel Price Increase to Biodesel CPO Export and the Availability of Domestic Palm Cooking Oil*

Variable	**Estimation Parameter**	**Prob > |T|**
Biodiesel		
Bio diesel	-0,021	0,0605
Constants	276,6731	0,0143
First order autocorrelation	0,03861	
Price of CPO export	0,0106	0,4169
Price of World Crude Oil	6,5439	0,0693
Prob>|F|	0,0275	
R-squared	0,4906	
Tax on CPO Export	5,6947	0,0319
CPO Export Price		
Constants	-6080,107	0,0033
Durbin-W statistic	1,518	
Exchange rate	1,2012	<,0001
First order autocorrelation	0,2585	
CPO export Price	12,7534	0,0121
Prob>|F|	<,0011	
R-squared	0,8789	
Tax on CPO Export	-198,6298	<,0001
Domestic Price of CPO		
0253Constants	338,8	0,561
Constants	-1372,32	0,0264
CPO amount requested for cooking oil	0,4554	0,033
CPO demand on cooking oil industry		
Domestic- real price of CPO	-0,1991	0,1991
Domestic -real price of palm cooking oil	0,4851	0,0154
Durbin-H statistic	-1,2705	
Durbin-W statistic	1,9019	
Indonesian-CPO Production	-0,1177	0,0253
Price of CPO export	2,166	0,0066
Prob> |F|	<.000011	
R-squared	0,8162	<,00011
T (Trend)	160,568	<,00011
Constants	153,207	0,9658
Domestic- real price of CPO	0,1716	0,2607
Durbin-H statistic	0,0858	
Prob>|F|	0,0055	
Production of domestic CPO	1,199	<,0011
Real wages in the plantation	-0,0473	0,3586
R-squared	0,8768	
Response of domestic - palm cooking oil production		

Variable Biodiesel	Estimation Parameter	Prob > |T|
Constants	-4525,38	0,022
Domestic- real price of palm cooking oil	1,8623	0,0154
Domestic -real price of CPO	-1,2340,	0,0583
domestic - palm cooking oil production	0,2244	0,1815
First order autocorrelation	-0,2564	
Prob>|F|	<,000011	
R-squared)	0,8437	
T (Trend)	331,6511	0,0022
Palm Cooking Oil Domestic Demand		
Amount requested for domestic palm cooking oil	388,043	0,6251
Constants	-0,352	0,0121
Domestic- real price of palm cooking oil	0,2299	0,0605
Domestic- real price of coconut cooking oil	0,3234	
First order autocorrelation	0,0374	0,2409
Indonesian real per capita income	0,00077	
Prob>|F|	0,7007	
R-squared)		

Based on the statistical test of Durbin-W (DW), values obtained within the range of 1.4949 to 1.892, the statistical test of Durbin-H (dh) get a range of values up to 0.858 -1.2705 and first order autocorrelation is between the range 0.2464 to 0.3861. From these results it can be concluded that all the structural equation allegedly not having problems of serial correlation seriously. Therefore the estimation results of the model in this study can be used to describe the phenomenon of the effect of rising oil prices on exports and domestic availability of palm oil.

The increase of crude oil prices are influential against CPO exports and the availability of domestic palm cooking oil. The validation result that is based on the U-Theil is between 0.055 and 0.143. Similarly, when viewed under a portion bias (UM) where the value reaches zero and the value of covariance (UC) is approaching 1 the range is between 0.33 and 1,089. From the value of the U-Theil, UM and UC, we conclude that this model is valid and it can be used for simulation.

The average increase in the price of high CPO export is suspected because it relates a high increase in fuel prices, in the period 2002-2006, when the price of fuel rose to the level of 9.24 percent per year, while in the period from 2002 to 2016 there was a very high increase in fuel prices reaching 23.32 percent per year. This of course will affect the price of CPO exports due to the rising demand for palm oil for biodiesel. The fluctuations in average of domestic oil production growth was affected by domestic edible oil price fluctuations. With the rise in CPO prices also allegedly would result in a rise in the prices of cooking palm oil and coconut cooking oil. The increase in edible oil is attributed to increasing demand for cooking oil as the result of increasing population and income, it is also thought to be caused by the presence

of competition feedstock (CPO) for the fuel to the CPO as the raw material for cooking oil.

Petroleum prices have a real impact on the price of Indonesian CPO exports at the level of α = 0,0693. If the price of oil increases, it will cause the price of CPO exports also to increase. The export price of CPO in addition is having a real impact on CPO export volume at the level of α = 0,0121, which indicates a significant effect on the domestic CPO price at the level of α = 0,0066. This means that if the export price increases, in addition to causing an increase in the volume of the Indonesian CPO exported, it will also cause the price of CPO in the country (domestic) increased (Table 3). CPO in addition to an output of the plantation company, it is also an input for the cooking oil company. Therefore, domestic CPO price changes will cause changes in the production of palm oil. From Table 2 above, it can also be shown that the domestic CPO price has a significant influence on the production of palm oil at the level of α = 0,0583. If the domestic CPO price increases it will lead to the decline of palm oil production.

The simulation results show that the rise of 18,80 percent in the world crude oil led the real price of Indonesia's CPO exports to be increased by 11.860 percent. The increase in the real price of CPO exports due to the increasing number of CPO used is going to produce biodiesel as a commodity crude oil substitute. This result is in line with the research by Ramli *et al.* (2007) and Shri Devi *et al.* (2010) which stated that the increase in demand for biodiesel would cause the increase of CPO prices.

Table 3. *The Increase Simulation of The World Crude Oil Price*

Variable	Early Condition	Simulation	Changes (%)
CPO amount requested for cooking oil industry (thousand tons)	3997,22	3979,31	-0.448
Domestic CPO real price (USD / kg)	422,33	472,42	11.860
Domestic palm oil production (thousand tons)	9113,20	9693,91	6,372
Domestic total amount requested of CPO (thousand tons)	3506,32	3571,22	1,850
Indonesian CPO exports (thousand tons)	4903,25	9693,91	1,9770
Indonesia's CPO export real price (US $ / tons)	4903,25	4826.69	-1561
Indonesian CPO production (thousand tons)	17013,7.	17466,79	2.663
The number of domestic CPO offered (thousand tons)	12.045.33	11916,76	-1.067

The increase in the real price of CPO exports as a result of the increase in world crude oil prices, in addition to causing an increase in the CPO export volume, also causes the domestic CPO real price, increasing it. The increasing oil price of domestic CPO as a result of the increasing price of oil CPO exports amounted to 13,046 percent. The influence of the real price of CPO exports to the domestic CPO real prices caused by the large volume of Indonesian CPO exports to other countries. During the period 2002-2006 the volume average of CPO exports to other countries

amounted to 1,9770 percent. The world bio-diesel production during the period 2002-2006 increased sharply. It was estimated on an average increase of 43.18 percent per year. The increase in the real price of CPO exports caused Indonesia's CPO export volume to increase. The increase in the volume of exports as a result of the increase in the real price of CPO exports amounted to 1,9970.

CPO production increase in Indonesia was attributed to domestic CPO price increase, it was also caused by the increase in Indonesia's CPO exports to other countries. Despite an increase in domestic CPO production, turns the volume available for domestic CPO decreased by 1.067 percent. The decline in the volume of domestic CPO provided illustrates that CPO production increase was smaller than the increase in CPO export volume.

The price increase of oil domestic CPO causes the increase in CPO production, the decline of CPO demand for cooking oil industry causes the decline in cooking oil production. This study is also in line with the results of Susila and Munadi (2008) which states that the development of biodiesel led to rising oil prices of domestic CPO which in turn have a positive impact on CPO industry but have a negative impact on the cooking oil industry. The increase in crude oil prices by 11.860 percent through real price increase of export and the domestic price increase causes the production of CPO to increase by 2.663 percent.

CPO or palm oil in the country, apart from being used as raw material for cooking oil, it is also used for other products such as margarine, shortening, cocoa butter subtitute (CBS), vegetable ghee, fatty acid, fatty alcohol, glycerin and derivatives oleo chemicals, namely surfactants , cosmetics, pharmaceutical and bioenergy. The volume of domestic CPO used as raw material for cooking oil amounted to 47.52 percent of the volume of domestic CPO offered. Therefore, although the volumes of domestic CPO offered down by 1.2947 percent, the CPO volume required for vegetable oil raw material is not as big as the falling volume of the offered amount which is only down by 0.50 percent. This illustrates that the CPO is used as raw material for cooking oil products in addition to obtaining a greater impact as a result of the increase in world crude oil prices.

This is similar to results of the research conducted by Abdullah *et al.* (2007) which indicated that due to the increasing demand for biodiesel in the transport sector led to a demand for the oil palm for fats industry which also increased. The study by Autoregressive Integrated Moving Average (ARIMA) model found that there was a positive effect of the increase in the price of palm oil biodiesel demand. In Malaysia, a high demand for biodiesel had a great impact on the increase in crude palm oil prices after few months, namely in 2007 between RM 2700 to 3000 into 3500 RM RM in 2008 (Abdullah *et al.,* 2007). Nordin *et al.* (2007) added that prices were also influenced strongly by the volume of palm oil supplies as an important indicator of supply and demand for fats industry. The volume of supplies depends on the production, export, import and domestic consumption of palm oil.

Results are in accordance with a research conducted by Baskett and Jacquemard (2006) which has showed that global demand for palm oil (CPO) for biodiesel fuel consumption is positively correlated with the consumption of food. In 1999-2000, the world will need deals plant oils and fats represented with about 18.8 kilograms per capita. CPO demand for non-food needs 50 percent of the need for actual food. This means that the world should anticipate an increase in CPO demand for non-food needs, which reached 25.3 percent of the total market requirements, together with soybean oil in 2012-2016 (Corley and Tinker, 2003).

Since CPO was the main raw material of cooking oil, then the increase in CPO prices led to a decreased production of domestic cooking oil. As a result of the increase in world crude oil production amounted to 23.30 percent through higher prices of CPO exports, the domestic- CPO price increase causes the volume of palm oil produced in the country to fail by 1.72 percent.

7. Conclusion

Utilization of bio-diesel as a renewable energy source substitute for diesel oil in the transport sector is determined not only by the price of bio-diesel itself, but also determined by the price of crude oil, the higher the price of crude oil, the lower the difference in cost of procurement of bio-diesel with the procurement of diesel oil, so the greater the competitiveness of bio-diesel as a substitute or a mixture of diesel oil in the transport sector

The increase in CPO exports led to a rise in domestic CPO production. But as the percentage of increase in CPO production was smaller than the percentage of the export increase in CPO exports, then it led to the availability of domestic CPO declined. Beside this decrease causing an increase in the the CPO price, it also leads to the demand for CPO as the raw material for cooking oil declines. As a result, oil production decreases significantly. From the above it can be concluded that the increase in petroleum prices will lead to Indonesia's CPO exports increase. The increase in demand as a result of the increased domestic CPO price is the decrease of palm cooking oil availability in Indonesia.

Over the last five years (2002-2016) there had been a rise in world oil prices which were very noticeable, an average of 17,85 percent per year. This increase encouraged the increased use of alternative fuels, one of which was biodiesel. It was estimated that the average increase in global biodiesel production amounted to 43.18 percent per year. Because one of biodiesel feedstocks was CPO, then the increased production of biodiesel causes CPO export demand to increase. As a result the price of CPO exports and domestic Indonesian CPO prices also increased.
At the time of rising petroleum prices, it needs to increase CPO exports due to the increased demand of exports, but it should be aware of the availability of oil needs of domestic cooking oil. The advantages of using bio-diesel can not be seen from just the economic point of view, but should also be seen in terms of social and

environmental impacts. Bio-diesel as a renewable energy source made from biomass of agricultural production, is expected to create new jobs in rural areas, particularly in the informal sector. Bio-diesel is also an environmentally friendly fuel, because it is non-toxic and biodegradable, and contains less pollutant emissions (pollutants) and the greenhouse gas CO2.

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