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MEASUREMENT OF EFFICIENCY UTILIZATION OF OIL PALM SOLID WASTE TO REDUCE FUEL IMPORT LEVELS IN INDONESIA

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ABSTRACT

Indonesia is one of the countries that have a fairly high level of consumption of fuel oil (BBM), based on data from BPH Migas (2018) throughout 2018 which reached 75 million kiloliters or an average of 1.6 million kiloliters per day. The consumption includes 16.2 million kiloliters of certain types of fuel (JBT), special types of fuel for assignment (JBKP), and general types of fuel around 51.3 kiloliters. The data is growing this study aims to measure the efficiency of reducing imports of fuel oil by utilizing solid waste of palm oil and to make proposals for the formulation of planning scenarios to optimize the functions of the Indonesian palm oil downstream industry. This research method combines quantitative and qualitative methods using the concept of efficiency and the Scenario Planning model. The method used in this paper is to calculate the level of efficiency using quantitative data on oil palm based on the amount of plantation area and the solid waste it produces. Then a mapping of the downstream palm oil industry will be carried out by reviewing the results of previous research as well as data and information obtained from accurate sources. The result is that by optimizing the utilization of palm oil solid waste, 7.4 billion liters of bioethanol can be obtained which can be used to produce biofuels to reduce the level of imports of fuel oil in Indonesia.

Keywords: Optimization; Efficiency; Scenario Planning; Downstream Industry; Biofuel.

1. INTRODUCTION

Indonesia is one of the countries that has a fairly high level of consumption of fuel oil (BBM), based on data from BPH Migas throughout 2018, reaching 75 million kiloliters or an average of 1.6 million kiloliters per day. The consumption includes 16.2 million kiloliters of certain types of fuel (JBT), specifictypes of fuel for assignments (JBKP) and types of general fuels of around 51.3 kiloliters. The data has increased Pertamina's oil production level reached 392 thousand barrels of crude oil per day or the equivalent of 22.1 million kiloliters per year [1] . Of the total production, not all of them become BBM. With this amount of production, Pertamina is still unable to meet domestic fuel needs.

The steps taken by Pertamina to meet the level of domestic demand for fuel are by importing fuel and utilizing biodiesel or fuel derived from palm oil. As of August 2018, Pertamina's average daily import of BBM was 393 thousand barrels per day or the equivalent of 22 million kiloliters per year, and this number has increased from the previous year.

Apart from imports, Biodiesel is also used to meet domestic fuel needs. BPPT Deputy Head of Information Technology and Materials, Unggul Pryanto (2018) revealed that there are

several alternatives to reduce the supply of fuel with biofuel sources for fuel substitution.

Biofuel (BBN) is an alternative energy from other raw materials which is still abundant and renewable is one of the government's discourses to be able to meet the increasing demand for fuel every year which is not balanced by the decreasing production of petroleum due to reduced exploration conducted by Pertamina. One of the raw materials that can be used for biofuel is palm oil. According to the news page of the official website of the Ministry of Industry, which was revealed by the Director General of Plantation, Ministry of Agriculture of the Republic of Indonesia (2018), Indonesia is the largest palm oil producer in the world. Until now, it is recorded that Indonesia's palm oil land area of 14.03 hectares, of which 5 million hectares are plantations owned by the people.

From the plantation area, it can be estimated what percentage of the potential of the palm oil can be processed and used into biofuel. Currently, research has started both within academics, practitioners and by Pertamina on the use of palm oil which is converted into BBM. According to ITB researchers (2018) currently only 25% of palm oil production is contributed to various research needs for fuel oil development.

To optimize the potential of palm oil, it is necessary to have a special industry for processing palm oil derivative products as raw material for making biofuel that is directly integrated with the downstream palm oil industry. The purpose of this research is to find out how much potential of palm oil to reduce imports of fuel oil and to make a proposed draft scenario mapping the palm oil processing industry into biofuel that is integrated with the downstream oil palm industry.

Development of Indonesian Palm Oil

Based on the Director General of Plantation of the Ministry of Agriculture of the Republic of Indonesia (2019), the area of oil palm plantations in Indonesia increased from 14.04 million ha in 2017 to 14.32 million tonnes in 2018 and it is estimated that in 2019 it will continue to increase to 14.67 million Ha.

However, the increase in the area of oil palm plantations and abundant production was not accompanied by an increase in prices both domestically and globally, according to the Indonesian Palm Oil Association, the price of Indonesian palm oil in 2018 was recorded at US $ 596,5 per metric ton or decreased comparedto the average price in 2017 of US $ 714.3 per metric ton. According to GPKSI, the decline was caused by several factors, among others; abundance of world vegetable oil stocks including palm oil in Indonesia and Malaysia, the trade war between China and the United States and. weak purchasing power due to slowing economic development in export destination countries. The decline in CPO prices also had an impact on the erosion of the country's foreign exchange value even though the export volume increased year on year.

In 2018 Indonesian palm oil exports as a whole (CPO and derivative products of biodiesel and oleochemicals) increased by 8%, from 32.18 million tonnes in 2017 to 34.71 million tonnes in 2018 [2].

Oil Palm Downstream Industry

Since 2006 Indonesia has become a producer of crude palm oil (MSM), which is a combination of the largest CPO and CPKO in the world [3]. Based on Presidential Regulation number 28 of 2008 concerning National Industry policy, the oil palm processing industry (MSM derivative) is one of the priorities to be developed and has a higher added value, such as; the oleofood, oleochemical, energy and pharmaceutical industries.

In Permenperin number 111 / M-IND / PER / 10/2009 concerning the Road Map for the development of palm oil processing industry clusters, it is stated that the medium-term development of the Oil Palm Downstream Industry (IHKS) cluster (2010-2014) in Sumur, Riau and long term will be integrated in East Kalimantan, West Kalimantan, South Kalimantan and Papua. The basic strategy for developing IHKS is to encourage the processing of crude palm oil (MSM) to the third derivative product (metallic salt, fatty amine, fatty alcohol, fatty amide) in the country at least 50% of total production.

The Institute for Development Economy & Finance (2018) quotes data from GAPKI (2016) that the export composition of CPO derivative products has reached 74% (Refine CPO 64%, Lauric 6%, Biodiesel 3%, oleochemical 1% (, the export portion of CPO only remains 26% or about 7 million tons.

The gateway to palm oil downstream is the refinery industry, namely the industry that processes CPO and CPKO into products, including olein, sterin and palm fatty acid distillate (PFAD). In general, the downstream palm oil currently applied in Indonesia can be grouped into 3 routes, namely: Biofuel Downstream Path, namely industries that process industrial refinery products to produce products between biofuels and finished products such as; biodiesel, biogas, biopremium and bioavtur.

Potential of Palm Oil Biofuel Industry

One of the by-products of palm oil downstream is biofuel which produces biodiesel as a supplement for diesel motor fuel (Kuncahyo et al, 2013). Based on table 1, Indonesia has a large amount of palm oil production which has great potential to produce biodiesel as raw material.

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Table 1. Palm Oil Production by Province in Indonesia, 2016-2020.

No	Production	2016	2017	2018	2019	2020**
1	Aceh	732.714	911.697	1.037.402	1.081.822	1.158.631
2	Sumatera Utara	3.983.730	5.119.497	5.737.271	6.163.771	6.601.399
3	Sumatera Barat	1.183.058	1.302.952	1.248.269	1.298.038	1.390.199
4	Riau	7.668.081	8.113.852	8.496.029	9.127.612	9.775.672
5	Kepulauan Riau	21.434	28.664	28.853	31.067	33.272
6	Jambi	1.435.141	1.849.969	2.691.270	2.891.336	3.096.621
7	Sumatera Selatan	2.929.452	3.199.481	3.793.622	4.075.634	4.365.004
8	Kepulauan Bangka Belitung	726.623	853.648	900.318	958.013	1.026.031
9	Bengkulu	750.182	893.322	1.047.729	1.073.531	1.149.752
10	Lampung	425.867	486.714	487.203	508.772	544.895
11	DKI Jakarta	-	-	-	-	-
12	Jawa Barat	32.825	43.660	46.024	49.446	52.956
13	Banten	27.469	32.581	38.406	41.261	44.190
14	Jawa Tengah	-	-	-	-	-
15	DI. Yogyakarta	-	-	-	-	-
16	Jawa Timur	-	-	-	-	-
17	Bali	-	-	-	-	-
18	Nusa Tenggara Barat	-	-	-	-	-
19	Nusa Tenggara Timur	-	-	-	-	-
20	Kalimantan Barat	2.192.591	2.784.180	3.086.889	3.316.363	3.551.825
21	Kalimantan Tengah	4.260.093	5.778.611	7.230.094	7.748.444	8.298.584
22	Kalimantan Selatan	1.750.389	1.933.721	1.464.226	1.556.612	1.667.132
23	Kalimantan Timur	2.358.392	2.840.710	3.786.477	4.044.753	4.331.930
24	Kalimantan Utara	167.668	219.223	305.126	327.809	351.083
25	Sulawesi Utara	-	-	-	-	-
26	Gorontalo	10	1.709	9.941	10.680	11.439
27	Sulawesi Tengah	316.781	456.608	383.617	412.134	441.396
28	Sulawesi Selatan	105.057	113.972	105.708	113.565	121.628
29	Sulawesi Barat	434.106	568.719	386.211	414.921	444.381
30	Sulawesi Tenggara	65.405	99.427	106.113	114.001	122.094
31	Maluku	7.315	11.959	23.590	25.344	27.144
32	Maluku Utara	-	-	-	-	-
33	Papua	20.645	176.728	345.115	370.771	397.095
34	Papua Barat	135.930	143.622	98.127	105.422	112.907
	Indonesia	**31.730.961**	**37.965.224**	**42.883.631**	**45.861.121**	**49.117.260**

Biodiesel has complex productioncharacteristics with multi-sector and multi-actorconditions and the addition of sustainability problems from various stakeholders creates complex challenges for building the biodiesel industry [4]. Achieving sustainable biodiesel production in a target and timeframe is not possible without releasing the price of diesel fuel subsidies and further direction from the government.

To support the sustainability of the biodiesel industry in Indonesia, it is necessary to review the current conditions of the biodiesel sector with the aim of obtaining a comprehensive description of both the development of production technology and perspective analysis. The direction of development of the biodiesel industry must start from biodiesel production technology to increase production at low costs [5].

Apart from the support of production technology, the implementation of the industrial cluster strategy has a positive effect on the three agro-industrial palm oil clusters in Riau, North Sumatra, and East Kalimantan Provinces. It can be seen based on the assessment of the four elements of competitiveness, namely company agglomeration, added value and value chains, cooperation networks, and economic infrastructure [1].

For the sustainability of the Hilirization industry, the government must continue to suppress environmental issues in terms of global warming which suppresses Indonesian palm oil products through the contribution of greenhouse gases which is quite disruptive to the national palm oil trade [6].

Converting Oil Palm Oil into Biodiesel

According to the optimal conversion of palm oil is 86.75% in the reaction conditions of 6 hours, 5 wt. % Of the amount of catalyst and the ratio of methanol to oil is 12: 1. Despite its reusability. The developed catalyst can be used for up to three consecutive cycles after regeneration using methanol washing and followed by recalculation at 850 oC for two hours [7].

However, the conversion of palm oil into biodiesel is still a lot of criticism from several LSPs in the world on the grounds that it will damage the ecosystem of orangutans and food [8]. According to [9] this can be restored through sustainable palm oil cultivation, developing familiar agriculture and eco-areas.

1. 2. MEHODS

The method used in this paper is to calculate the level of efficiency based on quantitative data on oil palm based on the number of plantation areas and the solid waste it produces.

Then a mapping of the downstream palm oil industry will be carried out by reviewing the results of previous research as well as data and information obtained from accurate sources.

2. 3. RESULT AND DISCUSSION

The Ministry of Energy and Mineral Resources (ESDM) in the 2021 RAPBN states that land consumption is assumed to reach 480,000 kiloliters (kl) - 500,000 kl or lower than the 2020 State Budget of 560,000 kl.

Meanwhile, diesel consumption is 15.31 millionkl - 15.80 million kl, this assumption is stagnantwhen compared to the 2020 State Budget, whichis 15.31 million kl. Meanwhile, the volume ofLiquefied Petroleum Gas (LPG) is also assumed to be stagnant with a volume of 7 million tons. Data from BPH Migas (2020) apart from thefactors leading to a new normal, is also due torestrictions on the volume of certain types offuel for certain types of vehicles, as well as theexistence of a SPBU digitization program sothat the volume of fuel tends to slope.

As economic growth has begun to improve,energy demand has increased. However, in the new normal condition after the calculation will not be much different from the 2020 quota.

Although the fuel consumption trend will decline. However, his party ensures that the realization of the subsidized fuel can be correct."BPH Migas and other institutions continue to supervise," he said.

Meanwhile, PT Pertamina (Persero) noted that along with the direction of a new normal, the consumption of fuel in the West Java region has

increased from 3 to 6 June 2020. It is still 10-15 percent low compared to normal conditions.The amount of reduction in fuel consumption during the Covid-19 pandemic has reached more than 40 percent.

The company noted that gasoline consumption in West Java, which includes Banten, DKI Jakarta, reaches 23 thousand kilo liters (KL) per day. Meanwhile, the types of gasoline for gasoline consist of Premium, Pertalite, Pertamax, Pertamax Turbo. Dewi said that the amount of consumption was 12 percent lower than normal conditions.

As is known, during the Covid-19 pandemic, fuel consumption decreased drastically. Since March 2020, Pertamina has noted that gasolinedemand has continued to fall in the range of 17percent, gasoil has decreased by an average of 8percent and aviation fuel has decreased by 45 percent.

Petroleum production in the past 10 years has shown a downward trend, from 346 million barrels (949 thousand bpd) in 2009 to around 283 million barrels (778 thousand bpd) in 2018.The decline in production was caused by the main oil production wells are generally old, while production of new wells is still relativelylimited. To meet the demand for refineries, Indonesia imports petroleum, especially from the Middle East, so that import dependencereaches around 35% in figure 1.

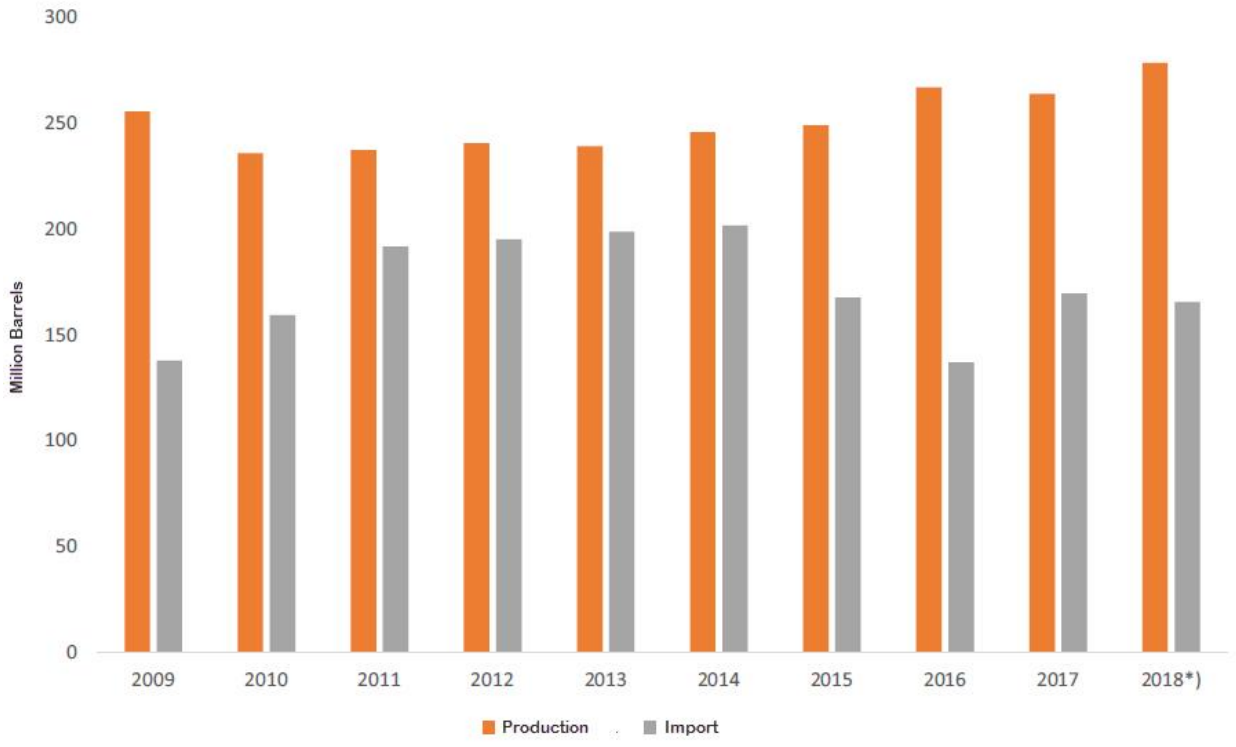

Figure 1. Oil Production and Import Rate

The potential of palm oil waste to become biofuel

Palm oil waste is the residue from the process of cultivating oil palm plants and from the palmoil processing industry (PKS) into. From figure 2 it can be seen that palm oil waste that has the potential to be processed into biofuel is empty bunches which become organic material. According to [10] solidwaste has a percentage of empty bunches of around 20% of fresh fruit bunches. In 1 ton of empty bunches containing nutrients N, P, K, and Mg, respectively, equivalent to 3 Kg of Urea; 0.6 Kg CIRP; 12 Kg MOP; and 2 Kg Kieserit(10).

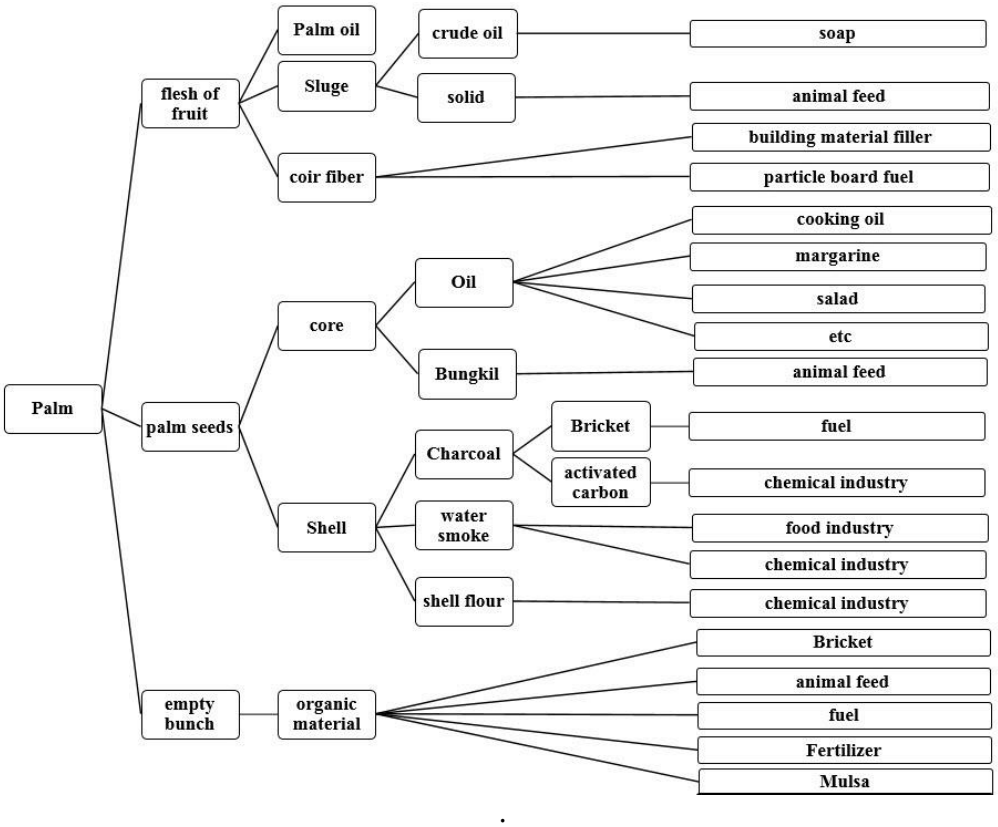

Figure 2 : Industrial tree utilization of palm oil mill waste [10]

With this content, empty bunches in addition to potential as a source of energy. Based on research conducted at the Palm Oil Research Center (PPKS), each tonne of CPO produces 1.2 - 1.4 tonnes of empty bunches. From 1 ton of empty bunches contain 46% cellulose. Based on the formula proposed by [11] can be shown at table 2, each material containing 45% celluloseis capable of producing 151 liters bioethanol. Bioethanol is a fuel that is used as a substitute for gasoline for vehicles because it has a high octane level. This fuel has been widely used for vehicles in developed countries.

Oil Palm Downstream Industry Mapping Scenarios.

Indonesia is a major producer and exporter of palm oil with an annual increase in exports of 6.65%. Based on table 1 at the end of 2019, theamount of CPO production in Indonesia was 49,117,260 tons of CPO. From this amount, thepotential to produce bioethanol is also large . The following is a calculation of the potential amount of bioethanol based on the amount of production . The potential for producing bioethanol in each region can be seen in table 3.

Table 2. Element Ratio of Palm [11]

CPO (Tonue)	Empty Bunch (Tonue)	Cellulose (%/tonue)
1	1,2	46

Table 3. Potential of Bioethanol produced in each region

Num	Production of CPO	2020**	Empty Bunch (Tonue)	Cellulose (%/tonue)	Bioethanol (liter)
1	Aceh	115,831	138,997	63,939	9,654,746
2	Sumatera Utara	6,601,399	7,921,679	3,643,972	550,239,809
3	Sumatera Barat	1,390,199	1,668,239	767,390	115,875,867
4	Riau	9,775,672	11,730,806	5,396,171	814,821,813
5	Kepulauan Riau	33,272	39,926	18,366	2,773,288
6	Jambi	3,096,621	3,715,945	1,709,335	258,109,554
7	Sumatera Selatan	4,365,004	5,238,005	2,409,482	363,831,813
8	Kepulauan Bangka Belitung	1,026,031	1,231,237	566,369	85,521,736
9	Bengkulu	1,149,752	1,379,702	634,663	95,834,129
10	Lampung	544,895	653,874	300,782	45,418,088
11	DKI Jakarta		0	0	0
12	Jawa Barat	52,956	63,547	29,232	4,413,989
13	Banten	4,419	5,303	2,439	368,332
14	Jawa Tengah		0	0	0
15	DI. Yogyakarta		0	0	0
16	Jawa Timur		0	0	0
17	Bali		0	0	0
18	Nusa Tenggara Barat		0	0	0
19	Nusa Tenggara Timur		0	0	0
20	Kalimantan Barat	3,551,825	4,262,190	1,960,607	296,051,717
21	Kalimantan Tengah	8,298,584	9,958,301	4,580,818	691,703,574
22	Kalimantan Selatan	1,667,132	2,000,558	920,257	138,958,786
23	Kalimantan Timur	4,331,930	5,198,316	2,391,225	361,075,029
24	Kalimantan Utara	351,083	421,300	193,798	29,263,470
25	Sulawesi Utara		0	0	0
26	Gorontalo	11,439	13,727	6,314	953,464
27	Sulawesi Tengah	441,396	529,675	243,651	36,791,239
28	Sulawesi Selatan	121,628	145,954	67,139	10,137,937
29	Sulawesi Barat	444,381	533,257	245,298	37,040,045
30	Sulawesi Tenggara	122,094	146,513	67,396	10,176,779
31	Maluku	27,144	32,573	14,983	2,262,507
32	Maluku Utara		0	0	0
33	Papua	397,095	476,514	219,196	33,098,662
34	Papua Barat	112,907	135,488	62,325	9,411,024
		48,034,689	57,641,627	26,515,148	4,003,787,398

From table 3 can be obtained, 1 tonue ot empty bunch is 46% cellulose and 45% cellulose produce 151 liters of bioethanol. Therefore total bioethanol can be generate are 4,003,787,398 liters or about .4 billion liters as the main component to produce biodiesel.

4. CONCLUSSION

This paper only converts the amount of bioenanol produced from the total amount of CPO production in Indonesia with the potential to produce bioethanol can be generate about .4 billion liters. By using bioethanol as biofuel, it is hoped that it can reduce consumption of fossil fuels and reduce imports of fossil fuels. It is hoped that inthe next research, it is possible to calculate the efficiency of reducing fuel oil imports based onthe calculations in this paper.

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REFERENCES

[1] Wati, E., et al. (2019). 'From Rubber to Oil Palm': Livelihood Structural Transformation of Local and Transmigrant Farmer Households in Minangkabau. *Sodality: Jurnal Sosiologi Pedesaan, 7*(2), 86-94.

[2] Wibowo, L.R., et al., *Penyelesaian tenurial perkebunan kelapa sawit di kawasan hutan untuk kepastian investasi dan keadilan*. Vol. 247. 2019: CIFOR.

[3] Industry, G. (2011). Ministry of Industry. *Direktorat Jenderal Industri Kecil dan Menengah [Directorate General of Small and Medium Industries]*.

[4] Hidayatno, A., et al. (2015). System dynamics sustainability model of palm-oil based biodiesel production chain in Indonesia. *International Journal of Engineering and Technology (IJET), 15*(06), 20-26.

[5] Murtiningrum, M. and A. Firdaus. (2016). Perkembangan biodiesel di indonesia tinjauan atas kondisi saat ini, teknologi produksi & analisis prospektif. *Penelitian dan Aplikasi Sistem dan Teknik Industri, 9*(1), 182836.

[6] Hasibuan, S. and H. Thaheer. (2017). Life Cycle Impact Assessment Produksi Biodiesel Sawit Untuk Mendukung Keberlanjutan Hilirisasi Industri Sawit Indonesia. *Prosiding SENIATI*, C47. 1-7.

[7] Adler, S., et al. (2016). Getting rid of performance ratings: Genius or folly? A debate. *Industrial and Organizational Psychology, 9*(2), 219-252.

[8] Lam, M.K., et al. (2009). Malaysian palm oil: Surviving the food versus fuel dispute for a sustainable future. *Renewable and Sustainable Energy Reviews, 13*(6-7), 1456-1464.

[9] Kuss, V.V., et al. (2015). Potential of biodiesel production from palm oil at Brazilian Amazon. *Renewable and Sustainable Energy Reviews, 50*, 1013-1020.

[10] Susanto, J.P., A.D. Santoso, and N. Suwedi. (2017). Perhitungan Potensi Limbah Padat Kelapa Sawit untuk Sumber Energi Terbaharukan dengan Metode LCA. *Jurnal Teknologi Lingkungan, 18*(2), 165-172.

[11] Horbar, J.D., et al. (2002). Trends in mortality and morbidity for very low birth weight infants, 1991–1999. *Pediatrics, 110*(1), 143-151.