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Potency of Palm Oil Plantation and Mill Byproduct as Ruminant Feed in Paser Regency, East Kalimantan

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Abstract *- By-product produced from plantation and palm oil mill can be utilized for energy and protein source of ruminant feed. Thus, it still has potency for further exploration. The objective of the research was to investigate the nutrient value of palm oil plantation and mill's by-product used to formulate ruminant feed. The research located in 66,118.5 ha of palm oil plantation in Paser regency, East Kalimantan province. The research was carried out in palm oil plantation and mill of PTPN XIII comprising productive plants (TM) in ±14,000 ha arranged in 9 divisions (afdeling). Measured variables consisted of: 1) dry mass production (mass of midrib every cutting and frond) (kg); 2) Centrosema sp mass production (kg); 3) mass of empty fruit bunches (kg); palm pressed fiber (PPF) (kg), palm kernel cake (PKC) (kg) dan palm oil sludge (POS) (kg); 4) nutrient content analyzed under proximate analysis in accordance with the procedure of Ruminant Feed Nutrient Laboratory, Faculty of Livestock, Diponegoro University. The result showed that total dry matter (DM) production was 14.82 ton/ha/year, consisting: midrib 29.09% (crude protein (CP) 3.16% and crude fiber (CF) 37.85%), frond 10.31% (CP 6.53% dan CF 30.39%), Centrosema sp. 2.48% (CP 22.58% and CF 35.12), EFB 24.31% (CP 7.01% and CF 40.22%), PPF 1.23% (CP 5.56% and CF 50.36%), PKC 1.29% (CP 15.49% and CF10.45) and POS 1.20% (CP 17.86% and CF 45.99%). This could be concluded that palm oil plantation and mill's by-product was recommended for ruminant feed as it had huge amount and appropriate nutrient content.*

Keywords— *potency, by-product, palm oil, feedstuffs, ruminant (;)*

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I. INTRODUCTION

Indonesian palm oil plantation area of 4,888 million ha may provide vast opportunity for ruminant production. Livestock integration into palm oil plantation agro-ecosystem could give direct or indirect added value. Livestock could utilize plantation by-product as feed source and give benefit for trees as it produces organic fertilizer. Ruminant integration into palm oil plantation is a potential diversification model to support the development of plantation and livestock (Purwoko and Sumantri, 2007; Mathius, 2008; Mayulu, 2008[a]; Suryana, 2009; BPS, 2010). The main constraint on this implementation is lack of cooperation and coordination in planning and implementation level. Livestock integration in palm oil plantation could improve the management of palm oil plantation and ruminant to generate more effective productivity. Information related with palm oil plantation resource is still very limited. Therefore, this potency should be optimized to develop the economic value and environmentally friendly trees and livestock integration production.

The increasing area of palm oil plantation increases the production of by-product obtained from palm oil plantation and mill such as midrib, frond, empty fruit bunch (EFB), palm press fiber (PPF), palm kernel cake (PKC), and palm oil sludge (POS). One alternative that can reduce their environment contamination is utilization as feed material. Some of researches show that palm oil by-products have great potential as energy and protein source for ruminant. However, they have not been optimally utilized; have low protein and high crude fiber content (Sutrisno, 2001; Sutrisno, 2002; Balitbang Pertanian, 2005; Harfiah, 2007). The quality of these resources should be optimally increased and utilized to provide cheap material for ruminant feed. Appropriate nutrient content of feed material is determined based on the livestock production response towards their intake (Sunarso, 2003[a,b]; Mahaputra, 2003; Akhadiarto, 2009; Sutama and Budiarsana, 2009).

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The problem faced is insufficient information related with quantity, quality and continuity of feed material from palm oil plantation and mill. In this regard, exploration in this matter should be studied in order to gain previous information in palm oil plantation and mill ecology system, and to obtain appropriate ration formulation. Thus, it was expected that ration feeding formulation could increase the economic value and environmentally friendly trees and livestock integration production.

II. MATERIAL AND METHOD

The research was conducted in Long Ikis district, Paser regency, East Kalimantan province covering 66.118,5 ha of palm oil plantation. The research was carried out in palm oil plantation and mill of PTPN XIII comprising productive plants (TM) in ±14,000 ha arranged in 9 divisions (*afdeling*).

The objective of the research was to collect various data related with the agro ecosystem of palm oil plantation and mill, i.e.: by-product produced from palm oil plant including mass production of palm oil midrib in every cutting (kg) and mass production of palm oil frond (kg); 2) cover crop vegetation including mass production of *Centrosema sp.* (kg) as dominant tree; 3) by-product produced from palm oil mill including mass production of empty fruit bunch (kg), palm pressed fiber (kg), palm kernel cake (kg) and palm oil sludge (kg).

PTPN XIII, Paser regency, East Kalimantan province as research location was determined using purposive sampling method (Nasution, 2011). This method was assumed as appropriate method due to consideration that each hectare is relatively producing homogenous productive plant (TM) (±130 trees, 10-20 year, has *Centrosema* sp.). Data collection was carried out according to the harvesting season of palm oil in which occurred differently at each population per hectare. Thus, collecting data of mass production of midrib, frond, fresh fruit bunch (FFB) and *Centrosema* sp. was carried out in harvested location.

Data at each *afdeling* was collected for nine repetitions, including: 1) calculating number of palm oil tree per hectare, number of midrib/tree and FFB per tree through calculating number of fallen midrib and harvested FFB per tree; 2) weighing mass production of midrib, frond, and FFB per tree through weighing midrib before and after removing outer peels and flesh, weighing frond before and after removing the palm frond, and weighing all produced FFB per tree; 3) *Centrosema sp*. population was calculated using quadratic method of 2 x 2 m^2, then cut and weighing. Quadratic measurement was repeated nine times. Quadratic point was determined at each measured harvested location. Calculation was carried out by assuming if the crown has reached a length of 4m then unutilized land was 50.29 m^2 (22/7 x 4 x 4), if every ha had been planted by 130 trees then it equal to 6,573.14 m^2. According to the previous calculation, available land for *Centrosema* sp was about 3,462.86 m^2 (10,000–6,537.14 m^2). Cutting was done every 60 days giving a total 6 replications during one year (Sumarsono, 2001; Sumarsono, 2003; Kusnadi, 2008); 3) calculating palm oil mill's by-product covering EFB, PPF, PKC and POS based on FFB fractionation. Some of FFB fractionation were 21.5% EFB and 67% fruit**.** Fruit produced 23.5% kernel and waste**,** and 43.5% CPO. Kernel and waste produced 23.5% PPF and 5% PKC, while CPO produced 4.1% POS (Dirjen PPHP, 2006); 4) analyzing feed material nutrient content comprising palm oil plantation and mill's by-products was carried out through proximate analysis (DFID, 2006). Analysis was carried out in accordance with the procedure of Ruminant Feed Nutrient Laboratory, Faculty of Livestock, Diponegoro University; and 5) collecting secondary data obtained from the office of estate and livestock of Paser regency which included the area, palm oil plantation area, climate, topography and soil fertility.

III. RESULT AND DISCUSSION

The Characteristic of Paser Regency

Paser regency locates in the south of East Kalimantan province between 00.45'18.37"–2027'20.82" south latitude and 115,036'14.5"–166,057'35.03" east longitude. In 2010, the area of Paser regency was 10,745.26 km^2 consisted of 130 villages.

Rainfall rate is the most dominant factor in determining the climate of an area. According to eight observations plot, it is reported that rainfall rate in Paser regency is 2,100 mm/year. Batu Sopang, Long Ikis and Tanah Grogot regency experienced the highest rainfall rate. The highest rate occurs during January to June and at the end of the year with the average number of rainy days are 14 days.

It has gentle slope topography, good soil fertility, soil type ranges from ultisol and insectisol with pH 4.5–6. The area of PTPN XIII covers Tajati, Tabara, Longkali, Pandawa and Muara Koman plantation and divided into nine *afdeling*. The population of palm oil plantation reaches up to ±130 trees per ha with average 10-20 year productive plants.

Palm Oil Plantation and Mill's By-Product as Ruminant Feed Source

Palm oil plantation and mill's by-products in PTPN XIII, East Kalimantan is potential to be explored for ruminant feed source. The observation result showed that number of midrib cutting reached up to 22 midrib/tree /year. The average weight of midrib was 8,756.55 kg per ha or 8.76 ton/ha/year which obtained from 14,037.66 kg multiplied with dry matter (DM) 62.38%. The average weight of frond was 1,528.04 kg/ha or 1.53 ton/ha/year which obtained from 2,529.86 kg multiplied with DM 60.40%. Fresh *Centrosema* sp was calculated based on plotting, weighing, and calculation on utilized land with six times cutting per year. Thus, it can be calculated that fresh *centrosema* sp had reached up to 368.11 kg/ha or 0.37 ton/ha/year which obtained from 1,027.64 kg multiplied with DM 35.82%.

Weighing and calculation on EFB fractionation mass resulted 3,616.71 kg/ha or 3.62 ton/ha/year which derived from 5,598.28 kg multiplied with DM 64.60%. PPF fractionation mass was 188.43 kg/ha or 0.19 ton/ha/year

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which derived from 287.94 kg multiplied with DM 65.44%. PKC fractionation mass was 194.61 kg/ha or 0.19 ton/ha/year which derived from 204.99 kg multiplied with DM 94.94%. POS fractionation mass was 177.36 kg/ha or 0.18 ton/ha/year which derived from 327.74 kg multiplied with DM 54.11%. Table 1 shows the palm oil plantation and mill's by-product as ruminant feed source.

Table 1. The Total of Palm Oil Plantation and Mill's By-product Derived Prom PTPN XIII, East Kalimantan

Afdeling	Produksi/ha/th (kg)						
	Midrib	Frond	EFB	PPF	PKC	POS	*Centrosema sp.*
1	8,672.41	1,746.63	3,755.82	320.40	202.09	174.85	381.44
2	9,078.78	1,602.68	3,611.36	308.08	194.32	168.12	369.03
3	8,216.49	1,679.46	3,647.48	155.66	196.26	169.81	379.37
4	8,914.25	1,717.84	3,743.78	159.82	201.45	174.29	373.17
5	8,811.17	1,449.13	3,551.17	150.35	191.08	165.32	377.30
6	8,632.77	1,372.36	3,599.33	152.14	193.67	248.40	366.97
7	9,068.87	1,410.74	3,563.21	149.63	191.73	165.88	352.49
8	8,533.66	1,401.15	3,551.17	150.35	191.08	165.32	358.70
9	8,880.55	1,372.36	3,527.10	149.45	189.79	164.20	354.56
Total	78,808.95	13,752.34	32,550.42	1,695.88	1,751.48	1,596.20	3,313.03
Average	8,756.55	1,528.04	3,616.71	188.43	194.61	177.36	368.11

The Quality of Palm Oil Plantation and Mill's By-Product as Ruminant Feed Source

Analysis of midrib, frond, EFB, PPF, POS and *Centrosema* sp. which carried out together with primary data collection aimed to investigate the nutrient content of palm oil plantation and mill's by-product using proximate analysis (Table 2).

Proximate analysis showed that site specific material produced from palm oil plantation and mill's by-product had appropriate nutrient content ranged from 3.16–17.86% of CP. It could also be concluded that the by-products were potential for ruminant feed source in regard with DM, CP and TDN content (Table 3).

Table 2. Nutrient Content of Palm Oil Plantation and Mill's By-product

Feed Source	Nutrient Content							
	Water[1]	DM[1]	Ash[1]	Crude Fat[1]	Crude Fiber[1]	Crude Protein[1]	BETN	TDN[2]
Pelepah sawit	37.62	62.38	3.63	3.50	37.85	3.16	51.86	51.32
Daun sawit	39.60	60.40	10.36	1.95	30.39	6.53	50.77	56.20
Centrosema sp.	64.18	35.82	10.89	4.30	35.12	22.58	27.11	49.67
TKS	35.40	64.60	12.09	1.14	40.22	7.01	39.54	46.92
SPB	34.56	65.44	5.78	3.18	50.36	5.56	35.12	40.45
BIS	5.06	94.94	3.19	7.86	10.45	15.49	63.01	82.53
LMS	45.89	54.11	15.79	6.06	45.99	17.86	14.31	47.81

[1]Proximate analysis result conducted in Ruminant Feed Nutrient Laboratory, Faculty of Livestock and Agriculture, Diponegoro University
[2]Calculation result (Sutardi, 2001)

Almost 70–80% vegetation found in palm oil plantation could be used as ruminant feed source. The forage quality could be enhanced through legume plants. Besides of cover crop vegetation, palm oil midrib and frond were potential to be utilized as ruminant feed source. However, the digestibility is considered low (Umiyasih and Anggraeny, 2003). Some of technology treatment can be introduced in order to increase the quality of palm oil midrib and frond such as physical, chemical and biological treatment and or its combination (Valarini and Possenti, 2006).

Palm oil midrib and frond can be found along the year together with harvesting FFB. Quality analysis found that palm oil midrib consisted of crude protein (CP) 1.9%, fat 0.5% and lignin 17.4%. In regard with high content of lignin, it is recommended to do physical, chemical and biological treatment or its combination such as chopping and using urea or probiotics prior feeding. Palm oil frond is very potential for ruminant feeding, but somehow the productivity is limited. It should be collected from 1-2 midrib/harvesting/palm oil tree in a very wide area in order to obtain sufficient amount for one ruminant (Umiyasih and Anggraeny, 2003). Palm oil by-product such as midrib and frond is economically feasible for commercial ruminant production if combined with additional ration containing adequate protein and energy to comply with nutrient standard of NRC (Sianipar et al., 2005).

Table 3. Potency Produced From Palm Oil Plantation and Mill's By-Product in PTPN XIII, East Kalimantan

Feed Source	Nutrient Content							
	Water[1]	DM[1]	Ash[1]	Crude Fat[1]	Crude Fiber[1]	Crude Protein[1]	BETN	TDN[2]
Pelepah sawit	37.62	62.38	3.63	3.50	37.85	3.16	51.86	51.32
Daun sawit	39.60	60.40	10.36	1.95	30.39	6.53	50.77	56.20
Centrosema sp.	64.18	35.82	10.89	4.30	35.12	22.58	27.11	49.67
TKS	35.40	64.60	12.09	1.14	40.22	7.01	39.54	46.92
SPB	34.56	65.44	5.78	3.18	50.36	5.56	35.12	40.45
BIS	5.06	94.94	3.19	7.86	10.45	15.49	63.01	82.53
LMS	45.89	54.11	15.79	6.06	45.99	17.86	14.31	47.81

[1]Proximate analysis result conducted in Ruminant Feed Nutrient Laboratory, Faculty of Livestock and Agriculture, Diponegoro University
[2]Calculation result (Sutardi, 2001)

Palm oil sludge was potential for ruminant feed as it contained DM 81.56%, CP 12.63%, CF 9.98%, crude fat 7.12%, calcium 0.03%, phosphor 0.003% and energy 154 kal/100 g. Besides of the nutrient content, it is available in abundant number and do not compete with human needs. The utilization of POS as ruminant feed is expected to avoid lack of feed stock in dry season and also increases ruminant productivity (Utomo and Widjaja, 2004). Palm kernel cake had higher nutrient content compared with other by-products. It consisted of DM 90%, CP 16.1%, CF 15.2%, ash 4%, BETN 63%, calcium 0.29%, phosphor 0.71% and metabolic energy 6.2% which functions as concentrate material (Sabu *et al*., 2005).

Present condition shows that POS can be obtained freely in palm oil mill as it belongs to waste material that can contaminate the environment. Storing POS requires high cost as it needs a big hole to place the POS. Meanwhile, POS will give benefit if palm oil mill can process this material into ruminant feed. The nutrient content can be utilized by ruminant and can be enhanced through processing it into complete feed.

Palm pressed fiber produced from palm oil processing was also potential for ruminant feed. Its abundant amount will increase along with the increasing of palm oil plantation area and concentrated in one specific area are two factors in utilizing this material. The constraint of PPF as grass supplementary is high amount of lignin and low digestibility. Besides of these factors, PPF can only substitute one third of DM of grass if feeding without technology treatment. Ammonization treatment using urea is proven can increase the digestibility of low fiber material and also increase the live weight of ruminant. Zain (2007) mentioned that processing treatment can't optimally increase the digestibility of low fiber material.

Site specific by-products produced from palm oil plantation and mill can be formulated using two methods. First method is employing the percentage of available material without considering the limit and nutrient content. Second is formulating ration based on the purpose, limit and nutrient content of each material. Ration formulation using percentage of actual available material found in the field was

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5.30% CP, 30.63% CF and 50.91% TDN. This nutrient ration balance is presumably can't fulfill the basic needs of ruminant either for production or fattening. Protein utilization is very associated with protein content of ration and ruminant live weight. The increasing of protein content in ration will increase the protein intake (Orskov, 1992). Based on the research conducted by Sunarso *et al.* (2007), protein content in ration for fattening purposes ranges between 11% up to 14% of CP.

The second option of ration was formulated based on the purpose and nutrient content obtained from proximate analysis. The ration formulation was 11.04% CP, 30.63% CF and 57.26% TDN. The formulation result was better than the first option, but somehow the limit is on the palatability. Technology introduction is needed to overcome this constraint. Ammonization-fermentation (amofer) is widely applicable technique to increase the nutrient content of some feeding material.

The commercial production of livestock particularly ruminant is gaining some difficulties align with the decreasing of forage production and agricultural field. Thus, innovation is required such as using by-product from palm oil plantation. According to Umiyasih and Anggraeny (2003), livestock integration in palm oil plantation such as cattle, sheep and goat is a promising innovation for livestock industry. In this integration system, plantation tree is term as principal component and the livestock is the complementary component. Haryanto (2009) stated that livestock integration in palm oil plantation could be a mechanism that can increase the productivity both the plantation and the livestock through maintaining soil fertility using organic material. Thus, it can increase the benefit of the farmer.

Palm oil plantation and mill's by-product can also increase the ruminant population that can be improved into breeding center in the future. The strategy in livestock integration in palm oil plantation is objected for breeding development, fattening and feed production industry using palm oil plantation and mill's by-product as the development center of sustainable revitalization and acceleration (Umar, 2009).

The development of livestock integration in palm oil plantation should be supported by sustainable by-product as the input material for livestock feeding and organic fertilizer. This mechanism provides zero waste concept for clean and sustainable environment. Livestock integration in palm oil plantation should also be supported by appropriate technology to generate more efficient, competitive and sustainable production (Umar, 2009; Mayulu, 2012).

The increasing ruminant productivity to fulfill Indonesian dietary needs should be carried out through: 1) optimizing the utilization of local feed material obtained from agriculture, plantation and agroindustry by-product through integrating livestock and tree; 2) implementing feed management strategy to secure the nutrient content, secure the feed availability along the year and increase the feed utilization efficiency; 3) increasing livestock's population and productivity; 4) guarantee agribusiness sustainability through appropriate farmer institution management; 5) developing sustainable, integrated and environmentally friendly of farmer business system that can improve farmer's welfare (Haryanto, 2009; Kuswandi, 2011).

Palm oil estate is a promising sub-sector in East Kalimantan in terms of economic structure besides of oil and gas. East Kalimantan is provided with agro climate and wide supporting area for palm oil plantation development as it locates in equator and has high rainfall rate. Those two factors are very important in determining the suitable condition for palm oil growth and development. According to analysis assessment, climate has significant value in determining land suitability analysis scoring system for palm oil plantation.

The palm oil plantation area in East Kalimantan has developed widely along the year. Palm oil plantation and mill are very potential to support the livestock development in term of feed resource either in forage form or by-product. Livestock integration in palm oil plantation shows positive result. The success of livestock development very depends on the availability of feed source. However, additional feed is needed besides of grass in order to increase the livestock productivity. Livestock development should be suited with plantation local resource. In this regard, ruminant is very potential due to availability of forage obtained from cover crop vegetation in palm oil plantation. Besides of these, some of potential by-products are frond, stem, EFB, PPF, PKC, and POS.

By-products produced from palm oil plantation and mill has potential value for livestock development in term of feed source material. One of the technologies that had been studied is feed processing technology for ruminant feed source. Palm oil sludge was one of palm oil's by-products that could be processed for feed material due to cheap price, abundant amount, appropriate nutrient content (CP ranged between 12.63–17.41%), continue and didn't compete with human needs. Other by-products for increasing livestock productivity were PKC and POS. Palm oil sludge for cattle and goat could increase daily average live weight to 0.77 kg/cattle/day and 0.03 kg/goat/day (Widjaja and Utomo, 2005). In regard with farming business efficiency, the suitable ruminant development model is integrated with palm oil plantation. Thus, it needs support and commitment from all related sectors.

IV. RESULT AND DISCUSSION

According to the result and discussion, it can be concluded that by-product produced from palm oil plantation and mill in Paser regency had abundant amount and had appropriate nutrient content. Thus, it could be used for ruminant feed source.

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