Dynamics of Carbon and Nitrogen Cover Crop Land in Cow Oil Palm Integration Area

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Abstract. The increasing number of oil palm plantations from year to year has opened up new land opportunities for the maintenance and provision of grass in the livestock sector. One of the provinces that has a sizeable area of oil palm plantations is the province of South Kalimantan with an area of oil palm plantations reaching 479.30 thousand hectares [2]. The plantations are spread across several districts, one of which is in Satui District, Tanah Bumbu Regency.The oil palm plantation business creates jobs and economically provides a very large amount of foreign exchange. However, on the other hand, it has the potential to reduce the number of flora and fauna species due to large-scale clearing of agricultural land and forests.The change from a new agro-ecosystem to an integration system for oil palm has a positive impact on productivity and some negative impacts that need to be scientifically proven, namely changes in biodiversity and the carbon cycle. This change needs to be analyzed to support the integration system between oil palm and cattle plantations in Indonesia. Therefore it is necessary to carry out exploration in the integration area of cattle oil to identify, measure and interpret the biodiversity of cover crop plants and the carbon cycle. The method used in this research is exploration which will be carried out in two stages, namely 1) determining the sampling location. 2) testing the type of cover crop vegetation, soil samples, and gas samples. Vegetation samples will be identified and analyzed for chemicals as well as estimation of their carrying capacity, Soil samples will be measured for carbon and other minerals. While gas samples taken at several locations in the area will be analyzed for their greenhouse gas content (methane, CO_2 and N_2O). The purpose of this study is to produce complete data on cover crop vegetation in oil palm plantations and their surroundings as well as data on carbon cycle measurements in the integration area of cattle oil. on grazing land (Grazing) and non-grazing land (Non Grazing).

Keywords: Integration of Cattle Palm Oil; Carbon & Nitrogen Dynamics; ; Cover crop plants

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1. Introduction

The palm oil industry that has developed in Indonesia with a land area of more than 16 million hectares is a source of national income. The increasing number of oil palm plantations from year to year has opened up new land opportunities for the maintenance and provision of grass in the livestock sector. One of the provinces that has a sizeable area of oil palm plantations is the province of South Kalimantan with an area of oil palm plantations of 479.30 thousand hectares [2]. As a result of the development of its land area, special attention has been paid to environmental issues. Currently the palm oil industry in Indonesia is encouraged to carry out RSPO (Roundtable on Sustainable Palm Oil) certification in realizing a sustainable industry that is environmentally friendly [4]. With the existence of a new program carried out by the government through the development of an integration system for oil palm businesses with cattle grazed in oil palm plantations, it will form a new agro-ecosystem which also requires an assessment of changes in the carbon cycle and biodiversity to remain an environmentally friendly sustainable industry. Apart from being caused by the expansion of oil palm plantations, changes in biodiversity also occur because livestock carry out grazing activities and consume some of the cover crop vegetation in oil palm plantations [6]. The presence of livestock will also invite other fauna which will bring seeds from other plant vegetation outside the plantation area. Changes in the carbon cycle in the area occur due to the contribution of greenhouse gases which is quite large from methane gas (CH_4) from the digestion of the stomach (Enteric fermentation) of cattle and through the emission of CH_4 and N_2O gases from livestock feces [14]. Livestock contributes to greenhouse gas emissions through Methane gas. Meanwhile, the palm oil industry provides greenhouse gas emissions from the use of fertilizers in oil palm plantations and the use of fossil energy for processing palm oil and vehicles for transportation.

2. Method

The method used in this study is exploration which will be carried out in two stages, namely:

a. determine the location of sampling.
b. testing the type of cover crop vegetation, soil samples, and gas samples.

Vegetation samples will be identified and chemically analyzed, soil samples will be measured for carbon and other minerals. Meanwhile, gas samples taken at several locations in the area will be analyzed for their greenhouse gas content (methane, CO_2 and N_2O).

Table 1. Summary of sample exploration methodology in agroecosystem area

Sample Type	Intake Method	Tools and materials	Amount
Cover crop vegetation	sampling quadrant size 1 x 1 m at five points	Ethanol, Sample bag, Scales, Calipers, Digital camera	16
Land	quadrant measuring 1 x 1 m at five points	Soil drill, sample bag	4
Ground-level gases	Contain gas collection at ground level and over faeces	Fiber cover, Plastic bag Tedlar, Filter, Gas pump	60
Air Gas around the Area	Direct capture	Plastic bag Tedlar, Gas filter, Gas pump and Portable gas box	20

3. Results and Discussion

3.1 Types of Vegetation Growing in Grazing and Non-Grazing Land

Based on the results of research that has been carried out on grazing and non-grazing land integration of cattle and oil palm in the plantation of PT. Buana Karya Bhakti from October to November 2022, there are several types of vegetation that grow on grazing and non-grazing land, which can be seen in the table below.

Table 2. Types of Cover Crop Vegetation Growing on Grazing and Non-Grazing Lands

No	Vegetation Name	*Grazing*	*Non-grazing*
1.	*Ageratum conyzoides*	√	√
2.	*Cyperus iria*	√	-
3.	*Euphorbia hirta*	√	√
4.	*Melustoma malabathricum*	√	-
5.	*Brachiaria mutica*	√	-
6.	*Hyptis capitata*	√	-
7.	*Loersia hexandra*	√	-
8.	*Athyrium filex femina*	√	√
9.	*Mimosa pudica*	√	√
10.	*Digitaria abyssinica*	√	-
11.	*Brachiaria decumbens*	-	√
12.	*Nephrulepis biserrata*	-	√
13.	*Mikania micrantra*	-	√
14.	*Lophatherum gracile*	-	√
15.	*Macaranga gigantea*	-	√
16.	*Cyperus kyllingia*	-	√

Based on table 2, it can be seen that there are differences in the type of forage on grazing and non-grazing land. Where on grazing land there are plants*Cyperus iria, Melustoma, Brachiaria mutica, Hyptis capitata, Loersia hexandra,*and Digitaria abyssinica and are not found on non-grazed land. This is likely to occur because This type of forage can grow in upland land and enough sunlight. This is in line with the opinion of [3]who argued that topographical aspects in the form of land height and slope affect the quality of Pastura because it determines the environmental temperature and the intensity of sunlight that plants receive.

Meanwhile, plants such as Brachiaria decumbens, Nephrulepis biserrata, Mikania micrantra, Nephrulepis biserrata, Macaranga gigantea, and Cyperus kyllingia, are only found on non-grazed land and do not grow on grazing land. This is likely to occur because the non-grazing land is not touched by livestock at all so that the amount of forage is quite abundant where the sun can still freely penetrate the grass. In line with opinion [12] which states that in non-integrated areas that have not been touched by cows, they are abundant, especially in areas with young age of oil palm plants where the sun can still penetrate the grass freely. This means that besides livestock, lighting is another factor that affects the growth of the grass.

The high and low productivity of forage in the land*grazing*And*non-grazing*influenced by several factors, namely season and climate. [9] states that the growth of forage plants is influenced by environmental conditions, temperature, rainfall and light intensity. The alternation of the rainy season and the dry season has a negative effect on the quality of available forage in the pasture and indirectly affects the production and reproduction processes of livestock [10].

3.2. Estimation of Cover Crop Plantation Production in Grazing and non-Grazing land

Data on estimated forage production on grazing and non-grazing land can be seen in Table 3. Based on the results of sampling it appears that the production of fresh, dry matter and organic matter on non-grazing land is higher than that on grazing land.

Table 3. Estimated calculation of cover crop forage production on grazing and non grazing land

Forage Production (kg/ha)	Grazing	Non-grazing
Fresh produce	1187.40	2405.2*
Dry matter production	197.30	457.33*
Production of organic matter	172.07	398.81*

*= Shows significantly different and*significant(P<0.05)

The results of the analysis using the t-test show that fresh production on grazing and non-grazing land is significantly different, with the estimated amount of forage production on grazing land1187.40kg/ha/year while on non-grazed land it is 2405.2kg/ha/year. This happens because grazing is not carried out on non-grazed land so that the forage is more abundant than grazing land which is used for grazing. This opinion is in line with [11] regarding the calculation of estimated forage production per unit area in PT. Buana Karya Bhakti, before grazing was 2,813 kg/ha/year and after grazing was 1,066 kg/ha/year.

3.2 Production and Amount of CH_4 Emissions in Grazing and Non-Grazing Land

Based on the research conducted, the data is obtainedMean Flux (g CH_4/ha/day)on grazing and non-grazing lands which are presented in Table 4.

Table 4. Average CH4 Flux Data in Grazing and Non-Grazing Land

Day	**CH_4 emissions (g CH_4/ha/day)**	
	Non Grazing Land	Grazing Land
1	1.05	-327.07
4	3,13	984.31
7	10.50	69,58
10	3.46	8,74
13	11.75	1.75
16	7.96	-11,14
19	2.76	9.76
22	-3.11	9.78
25	-1.02	15.99
28	5.83	3.45
Average	**4,23**	**76,51**

The average CH_4 flux in grazing and non-grazing land in the table above shows different results, on each day of data collection. The highest average CH_4 emission in non-grazing land was produced on day 13 with an average amount (11.75 CH4 m2/hour) and the lowest on day 22 with an average amount (-3.11 CH4 m2/hour) , while on grazing land the highest CH_4 gas emissions were produced on day 4 with an average amount (984.31 CH_4 m2/hour) and the lowest on day 1 with an average amount (-327.07 CH_4 m2/hour) .

From table 3 it can be concluded that the average CH4 flux on non-grazing land (4,23CH_4 m^2/hour) is lower than the average production on grazing land (76.51CH_4 m^2/hour).This is due to the presence of ruminant livestock on grazing land which emits manure, causing increased gas emissions CH_4 released. It is the manure from cattle that causes higher CH_4 gas emissions on grazing land than on non-grazing land.

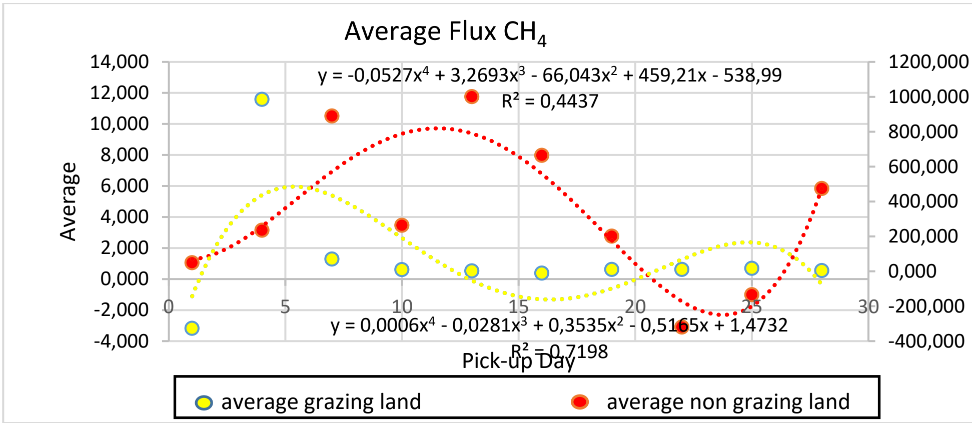

Fig. 1. Average CH_4 Flux on Grazing and Non-Grazing Land

It can be seen that the increase in grazing land occurred on day 4 and decreased on day 1, while on non-grazing land (figure 2) there was an increase on day 13 and the lowest emission on day 22. The increase and decrease in CH_4 gas emissions was influenced by many factors, one of the factors is soil temperature. According to [1], the value of R2> 0.33 indicates a linear relationship between soil temperature parameters and CH4 gas emissions. Thus, the effect of temperature is not too strong for CH_4 emission.

3.4 Production and Total N_2O Emissions in Grazing and Non-Grazing Land

Based on research conducted on oil palm plantations at PT. Buana Karya Bhakti, Satui District, Tanah Bumbu Regency obtained dataMean Flux (g N2O/ha/day) on grazing and non-grazing land which is presented in Table 5.

Table 5. Average N_2O Flux Data in Grazing and Non-Grazing Land

Day	**N_2O emissions (g N_2O/ha/day)**	
	Non Grazing Land	**Grazing Land**
1	4.05	5,72
4	2,20	1.87
7	-2.01	4.09
10	4.51	-2.75
13	8,48	-3.27
16	4.51	8,73
19	7,87	9,48
22	-2.37	6,16
25	5,25	7,40
28	9.39	13.65
Average	4,19	5,11

The average Flux N_2O data on grazing and non-grazing land in the table above shows different results, on each day of data collection. The highest average N_2O emission on non-grazing land was produced on day 28 with an average amount (9.39 N m^2/hour) and the lowest on day 22 with an average amount (-2.37 N m^2/hour) , while on grazing land the highest N_2O emissions were produced on day 28 with an average amount (13.65 N m^2/hour) and the lowest on day 13 with an average amount (-3.27 N m^2/hour) .

From table 4 it can be concluded that the average N_2O production on non-grazing land (4,12 Nm^2/hr) is lower than the average production on grazing land (5,11 N m^2/hr).This is due to the presence of ruminant livestock on grazing land which emits manure, causing an increase in N_2O gas emissions released. The manure from cattle causes higher N_2O emissions on grazing land than on non-grazing land.

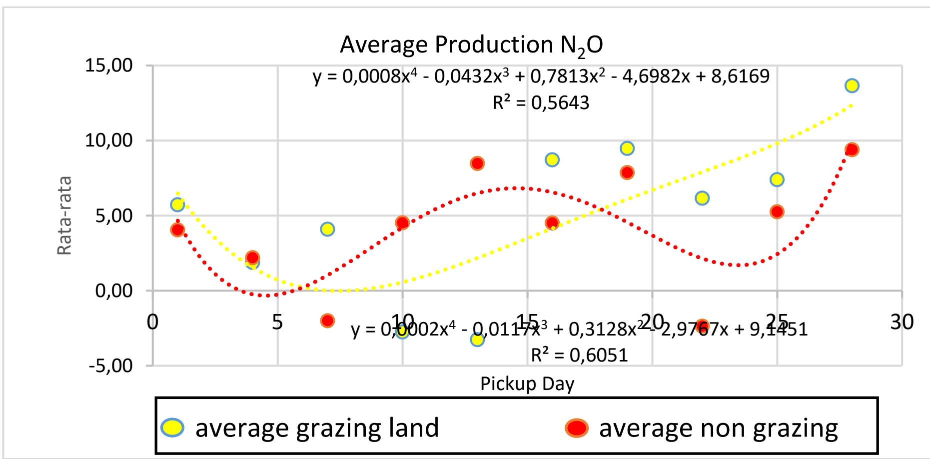

Fig 2. Average N_2O Production on Grazing and Non-Grazing Land

It can be seen that in grazing land the increase occurred on the 28th day and there was a decrease on the 13th day. Meanwhile in non-grazing land the increase occurred on the 28th day and there was a decrease on the 22nd day. The increase and decrease in N_2O gas emissions is influenced by several factors, one of which is is the condition of the microenvironment. Microenvironmental conditions that can affect N_2O flux are air temperature, air humidity, soil temperature, soil moisture.

A positive relationship indicates that when the value of microenvironmental conditions increases or increases, the N2O flux will also increase and vice versa in a negative relationship [7].

3.5 CH_4 and N_2O T-test in Grazing and Non Grazing Land

The results of the T-test in this study regarding CH_4 and N_2O gas emissions obtained results where grazing land was higher than non-grazing land which can be seen in table 6.

Table 6. Calculation of CH_4 and N_2O gas emissions on grazing and non-grazing land.

Gas	Location	
	Grazing	***Non Grazing***
CH_4land 1	61,47	4.98
CH_4land 2	91.56	4.52
N_2OLand 1	4.65	3.59
N_2OLand 2	5.56	4.78

Note: the t-test shows that gas emissions produced on grazing and non-grazing land are significantly different ($P<0.05$)

Based on the results of the t-test analysis, it shows that gas emissions produced on grazing and non-grazing land are significantly different. This occurs because the amount of CH_4 and N_2O emissions in grazing and non-grazing lands have significant differences. This difference occurs due to cattle grazing on grazing land, while on non-grazing land there are no cattle grazed.

3.6 Soil Nutrient Content in Grazing and Non Grazing Land.

The results of soil sample analysis tests on grazing and non-grazing land in the laboratory can be seen in table 7 below.

Table 7. Results of analysis of soil nutrient content from Grazing and non-grazing locations

Areas	pH		C org	Ntot	P2O5tsd	P2O5pot	K2OPot
	H2O	NKCL	%	%	mg/kg	mg/100g	mg/100g
Non Grazing	6.60	4.20	2.51	0.15	6.60	40.00	31.00
Non Grazing	5.90	4.00	3.30	0.16	5.00	13.00	27.00
Non Grazing	5.20	4.00	2.45	0.14	3.40	28.00	34.00
Non Grazing	5.10	3.90	1.82	0.17	2.40	12.00	36.00
Average	**5.70**	**4.03**	**2.52**	**0.16**	**4.35**	**23.25**	**32.00**
Grazing	6.20	4.70	3.32	0.23	25.00	179.00	32.00
Grazing	6.50	4.80	3.17	0.28	40.50	273.00	45.00
Grazing	6.50	4.80	3.49	0.25	33.70	206.00	31.00
Grazing	6.40	4.80	3.09	0.22	29.80	195.00	37.00
Average	**6.40**	**4.78**	**3.27**	**0.25**	**32.25**	**213.25**	**36.25**

From the analysis of soil samples analyzed in the laboratory, it can be seen that grazing areas have a higher nutrient content than non-grazing areas. This shows that beef cattle that are grazed in oil palm plantations can contribute to increasing nutrients through livestock manure and urine that is wasted in the area.

4. Conclusion

Based on the results of the above research, it can be concluded that:

1. There are 16 types of cover crop vegetation on grazing and non-grazing land,with the different types of forage in grazing land there is forage*Cyperus iria, Melustoma, Brachiaria mutica, Hyptis capitata, Loersia hexandra,*and Digitaria abyssinica which is not found in non-grazed land. Meanwhile, forages such as Brachiaria decumbens, Nephrulepis biserrata, Mikania micrantra, Nephrulepis biserrata, Macaranga gigantea, and Cyperus kyllingia, are only found on non-grazed land.
2. Estimation of cover crop forage productionon non-grazing land it is higher than on grazing land where the amount of forage production on grazing landas big1187.40±952.68kg/ha/year and on non-grazed landas big 2405.2±354.65 kg/ha/year.
3. CH_4 gas emissions produced on grazing land amount to(76.51CH_4 m_2/hour)and N_2O(5.11N m^2/hr) higher compared to CH_4 gas emissions produced on non-grazing land (4.23CH_4 m^2/hour) and N_2O (4.12 N m^2/hr).
4. There is a difference in the amount of gas emissions produced on grazing and non-grazing land (significantly different based on the T-test).
5. Land on areaGrazing has a higher nutrient content than non-grazing areas. This shows that beef cattle that are grazed in oil palm plantations can contribute to increasing nutrients through livestock manure and urine that is wasted in the area.

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