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Carrying Capacity Estimation of Herbicide-Treated and Untreated Palm Oil Plantation for Bali Cows

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ABSTRACT

This study aims to estimate the carrying capacity of oil palm plantations with the use of herbicides based on the forage availability for Bali cows. The research was performed in palm oil plantation owned by PTPN V Riau, from March 2016 until March 2017. The parameters observed were 1) Forage production that grows between palm trees at 6 weeks cutting age. The forage sample was taken from 5 point of 1x1m^2, then subjected to proximate analysis. Data were analyzed with one-way random design, 2) Forage consumption; obtained by observation of 5 pregnant Bali cow and 7 non-pregnant for seven consecutive days 3). Estimated carrying capacity for Bali cows, obtained from the calculation of forage production (/ha/year) divided by forage consumption. The result of the research showed that 1). The production of dry matter (DM) forage in herbicide-treated areas was 689.55 kg/ha/year, not significantly different compared to untreated areas (622.33 kg/ha/year). Crude protein (CP) forage content of forage obtained from herbicide-treated area was significantly higher ($p<0.05$) than untreated area, whereas the total content of DM and total digestible nutrients (TDN) was not significantly different. DM consumption of pregnant Bali cow was on average 3.68±0.29 kg/head/day or 1,343.20±105.85 kg/head/year and non-pregnant 4.02±0.36 kg/head/day or 1,467.30±131.4 kg/head/year. The estimated carrying capacity on herbicide-treated (0.51 head of pregnant cow/ha), did not show any significant difference compared to untreated area (0.46 head/ha). For non-pregnant, the carrying capacity of herbicide-treated area (0.47 head/ha) was not different with non-treated area (0.42 head/ha). It was concluded that the use of herbicide on palm oil plantation had no effect on the carrying capacity of the Bali cow.

Keywords: Bali cattle, Carrying capacity, Herbicides, Oil palm plantations

Introduction

Palm oil plantation holds great potency for cattle production through integration system with it – as it provides various forages for ruminant (Sisriyenni dan Soetopo, 2013). Syahputra *et al.* (2011) reported, around young trees that have not yielded any fruit, at least 18 types of weed from 13 families were found. Meanwhile, more types of weed, as many as 21 types form 15 families were found around the fruit-producing trees. According to study performed by Adriadi *et al*. (2012), there are 3,934 forages, 56 species, 47 genus, and 20 family in the palm oil plantation. These numbers comprise of 7 types of sedge, 10 types of grass, 18 family with 38 types of large leaf plants, and 1 family with 1 type of fern. Among of them, *Paspalum conjugatum* is the most forage found (1,029 number) and *Cuphea platycentra* being the least (2 number).

Chin (1998) reported that forages growing under young palm oil trees can yield 1,600 to 2,600 kg/ha of dry matter. It will fall off to 600 kg/ha along the age of the trees. The annual production of dry matter of forages growing under palm oil trees aged 3 to 4 years can be higher, up to 13,280 kg/ha (Abdullah, 2006).

Theoretically, 2 hectares of palm oil trees aged 3 to 15 years can carry one unit of cattle with 250 kg of body weight (Liang, 2007). Carrying capacity of plant oil plantation with trees aged under 3 years is 1.44 unit/ha, while it will decline to 0.71 unit/ha for 6 years old trees (Daru *et al*., 2014).

Forages on palm oil plantation are managed as weed and exterminated by using herbicide. The treatment is commonly performed annually. As a consequence, there is a certain time that forages and grasses could not be harvested. Unfortunately, the forage production on this herbicide-treated area has not been fully elucidated.

One of important aspects on cattle-palm oil integrated system is the fulfilment of nutrient

requirement, especially for the cow. Carrying capacity estimation is a resourceful guideline to determine the number of animal can be reared. Unfortunately, this type of information has not been widely known. Thus, this study is performed to estimate the carrying capacity of the herbicide treated and untreated palm oil plantation for cow, according the forage production.

Materials and Methods

Location and time

This study was carried out on palm oil plantation area of PTPN V Riau, from March 2016 until March 2017. Proximate analysis was performed at Laboratory of Nutritional Biochemistry, Faculty of Animal Science Universitas Gadjah Mada.

Material

Material on this study are forages collected from palm oil plantation with trees aged around 10 years, 6 months-pregnant Bali cow with average initial body weight 249.58±12.31 kg and 7 non-pregnant cow with average initial body weight 241.46±15.58 kg.

Method

This study on the potency of forages on the herbicide-treated and untreated palm oil plantation was performed by direct observation for 4 cutting periods, in which each period lasts for 42 days. Each treatment was replicated 5 times. Parameter observed on this study includes forage production (/ha/year), feed intake, and carrying capacity calculation.

Forage production (/ha/year). Forages on each treatment was randomly sampled by using 1 m^2 quadrant. Forages were cut 10 cm above the soil. On the day-42, forages was cut to measure its production and nutrient content (proximate analysis). Cutting was performed 4 times with 42 days of interval. The yield from first cutting was not subjected to evaluation. The first cutting was intended to synchronize the cutting age. The forage production (/ha) was estimated by using Daru *et al*. formulation (2014) that has been modified: P = C x 10,000 – [(LP x JS) + LJP + LJM + LK] in which P stands for forage production per hectare (kg), C stands for average weight of the obtained forage per m^2 (kg), LP stands for disc area around the palm oil tree (m^2), JS stands for number of palm oil trees in one hectare, LJP stands for the area of track used in transporting palm oil (m^2), LJM stands for the area of dead end track used for piling up palm oil midrib, and LK stands for the water pool area next to palm oil used to supply water during herbicide treatment.

Herbicide-treated area and untreated area were distinguished. Forages collected from each area were weighed, and then sampled for proximate analysis (Van Soest, 1982; AOAC, 2005) to evaluate the content of dry matter (DM), crude protein (CP), crude fat (CF), crude fiber (CFF), and Nitrogen free extract (NFE). Herbicide used on this study was active compound of glifosat with dosage 100 ml for 14-15 liter of water for 400 m^2 area. Secondary data collected on this study include rainfall, temperature, humidity (Climatology, Meteorology, and Geophysics Agency of Riau).

Feed Consumption. Daily feed consumption were recorded for 7 days. During data collection cow were fed with forages and drinking water (ad libitum). Feed sample and unconsumed feed were collected each day and chemically evaluated (proximate analysis). Feed sample were collected as much as 100 gram and 25% of unconsumed feed for each cow – then exposed to sunlight for drying. Samples were then dried in 55˚C oven until constant weighed was obtained. At the end of collection period, each sample was composited, 10% was used for proximate analysis to evaluate the feed quality and nutrient content (Soejono, 2004).

Carrying capacity calculation. Carrying capacity for Bali cow was calculated by dividing dry matter production (/ha/year) by dry matter consumption (/cow/year).

Data analysis

Forage production and nutrient content were analyzed by using t-test, while carrying capacity was analyzed descriptively.

Result and Discussion

Forage production

The proximate analysis that has been performed shows no significant difference on dry matter content of forage from herbicide-treated and untreatment area (P>0.05). Conversely, crude protein and total digestible nutrient (TDN) (shown Table 1) are significantly

Table 1. Forage composition (%) of nutrients on land with and without herbicides

Nutrient	Herbicide-treated	Non-treatment
Dry Matter^{ns}	13.29	9.23
Organic Compound	83.15	85.24
Ash	14.81	13.08
Crude Protein	19.45^{a}	13.97^{b}
Crude Fat	5.77	6.55
Crude Fiber	21.95	29.74
Nitrogen-Free Extract	38.03	36.52
Total Digestible Nutrient	62.89^{a}	58.27^{b}

Source: Chemical analysis performed at Laboratory of Nutritional Biochemistry, Faculty of Animal Science, UGM. Total Digestible Nutrient is calculated according to Hartadi *et al*. (2005)

^{a,b} superscripts on a same row shows significant difference (P<0.05).

Table 2. Botanical composition of forages from land with and without herbicides

No	Species	Summed dominance ratio (%)	
		Herbicide-treated	Non-Treatment
1	*Paspalum conjugatum*[g]	18.92	8.35
2	*Oplisnemus sp*[g]	17.09	26.04
3	*Cyperus rotundus*[f]	5.74	8.50
4	*Kyllinga sp.*[f]	6.17	7.97
5	*Panicum trigonum*[g]	9.58	2.10
6	*Lopatherum gracile Brogn*[g]	9.67	6.06
7	*Asystasia gangetica*[f]	11.30	5.05
8	*Ochthocharis bornensis BI*[f]	21.52	-
9	*Axonopus compressus*	-	7.43
10	*Portulaca villosa* Cham.[f]	-	10.15
11	*Phyllanthus urinaria*[f]	-	5.03
12	*Peperomia pellucida*[f]	-	8.27
13	*Platycerium sp.*	-	5.05

Note: g = grass; l = legume; f = forbs; b= browse.

Table 3. Dry matter and organic matter production of forages from land with and without herbicides on the cutting age 42 days

	Cutting time				Mean
	1	2	3	4	
DM production[ns]					
Herbicide-treated	23.75±6.96	21.79±15.42	3.27±1.49	4.34±2.06	13.29±13.73
Non-Treatment	9.89±4.17	15.37±8.53	2.94±3.30	8.73±6.87	9.23±0.82
OM production[ns]					
Herbicide-treated	19.67±5.43	18.07±12.60	2.73±1.28	3.62±1.71	11.03±9.09
Non-Treatment	8.44±3.62	13.13±7.47	2.52±2.87	7.47±5.99	7.89±0.69

different (P<0.05), that might be resulted as the herbicide-treated area is dominated by *Octhocharis bomensis BI*, while *Oplisnemus sp*. grows well on non-treatment area (Table 2).

Table 3 shows dry matter production and organic compound of forages obtained from herbicide-treated and untreated areas (cutting age each 42 days; 4 times cutting), in which there is no interaction between herbicide usage treatment and cutting age. The forage production on herbicide-treated area is greater compared to non-treatment area, as much as 689.55 kg/ha/year vs 622.33 kg/ha/year. It might be caused by the limited species grow on the herbicide-treated area (Table 2) – corresponding for the less competition among forages in acquiring nutrient from the soil.

According to Table 3, forage production on non-treatment area from first to second cutting period is increasing that might be a result from the growing rainfall volume (Table 4). On the third cutting period, there was no rainfall that might result in declining forage production. On the fourth cutting period, there forage production is increasing along with the increasing rainfall.

Forage production in first and second cutting period on the herbicide-treated area were high as the average rainfall during that period was high as well. A no rainfall might be the cause of the declining forage production during the third and fourth cutting period. According to regression analysis, there is interaction between treatments on this study and rainfall (number of raining days and total rainfall). Forage cuttings were performed on these following date: first cutting (May 27th, 2016), second cutting (July 12th, 2016), third cutting (August 23rd, 2016), and fourth cutting (October 4th, 2016).

Forage production (weed) in palm oil plantation with trees aged 10 years old is 5 ton/ha/year (Lubis *et al*., 2005). Daru *et al*. (2014) reported that dry matter production of forage obtained on palm oil plantation with trees aged 6 years old is 1.2 ton/ha/year. The result on this study is smaller than Farizaldi (2011) who reported that dry matter production in palm oil plantation of PTPN IV Jambi with palm oil trees aged 8 years is 18.74 g/m^2.

Other feed availability parameters, such as : available forage production and carrying capacity for certain period of time can be calculated based on dry matter content of the forages. Carrying capacity of each treatment on this study for Bali cow in one year is shown on Table 5.

Feed consumption

The average of dry matter consumption of 6 months-pregnant cow is 3.86±0.29 kg/head/day or 1,343.20±105.85 kg/head/year. While the dry matter consumption of non-pregnant cow 4.02±0.36 kg/head/day or 1,467.30±131.4 kg/head/year. The pregnant cow consumed more feed compared to non-pregnant. It might be caused by the decreasing size as much as 30% of rumen volume during late pregnancy phase. The ventral part of rumen will be pressed that led to the reduced ability in consuming dry matter. Result obtained in this study was smaller compared to previous studies by (Anggraeny dan Umiyasih, 2010; Farizaldi, 2011; Imran, 2013; Mudhita *et al*., 2016) who reported dry matter consumption of Bali cow are 2,952.485; 2,742.71; 1,397.95-2,847; 1,624.25 kg/head/year. Kearl (1982) added that daily dry matter consumption of pregnant cow (3 months away from partum) with 300 kg of body weight is 7.4 kg.

Table 4. Average of rainfall during study

Cutting Period	Average of rainfall (mm/hg)
I	59.58
II	67.62
III	0
IV	85.75

Table 5. The carrying capacity of Bali cows on lands Herbicide-treated and Non-Treatment for 1 year

Description	Herbicide-treated	Untreated
Real production (kg/ha/year)	689.55	622.33
Consumption (kg/head/year)		
a. pregnant cow	1,343.20	
b. unpregnant cow	1,479.36	
Carrying capacity (animal unit/ha/year)		
a. pregnant cow	0.513	0.463
b. non-pregnant cow	0.466	0.421

Carrying capacity estimation

According to forage production and feed consumption data, carrying capacity was estimated as much as 0.51 head/ha/year for non-treatment area, and 0.46 for herbicide-treated area. While for non-pregnant cow, the carrying capacity of herbicide-treated and non-treatment are 0.47 and 0.42 head/ha/year. Body weight of cow used on this study is 240 kg and considered as 1 animal unit (AU) (Table 5). This result is according to Liang (2007) who estimate the average of carrying capacity of palm oil plantation with treed aged 3 to 15 years old is 1 cow weighed 250 kg for each 2 hectare. By using calculation based on animal unit, Daru *et al*. (2014) reported that carrying capacity of palm oil plantation with trees aged 3 years old is 1.44 animal unit/ha., and 0.71 animal/unit for area with trees aged 6 years old. The implication of this study is to become the useful resources in management of integrated system between cow and palm oil production. Based on this study, it is suggested that palm oil plantation can be used as pasture land for Bali cow.

Conclusions

As conclusion on this study, dry matter production on herbicide-treated and non-treatment areas is not significantly difference. Crude protein content and total digestible nutrient (TDN) of forages obtained from herbicide-treated are is greater compared to non-treatment area. Carrying capacity (head/ha/year) of herbicide-treated and non-treatment ares for pregnant cow is 0.513 and 0.463; and 0.466 and 0.421 for non-pregnant cow.

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