Sheep-Oil Palm Integration : Grazing Preference, Nutritive Value, Dry Matter Intake Estimation and Digestibility of Herbage

C. Wattanachant*, I. Dahlan, A. R. Alimon and M. A. Rajion[1]
Department of Animal Science, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor D.E., Malaysia

ABSTRACT : Grazing preference, voluntary dry matter intake, stocking rate and digestibility of forage were investigated on sheep grazed in mature oil palm plantations in Malaysia. Dry matter intake (DMI) was estimated using the chromium sesquioxide marker method. The sheep were allowed to graze about 5 hours/day in oil palm plantations of age ranging from 9 to 21 years old. The crude protein, crude fibre and ash contents of selected herbage were 13.1 %; 24.6 %; and 8.3 %, respectively, while the gross energy (GE) and the metabolisable energy (ME) were 16.9 and 6.0 MJ/kg DM, respectively. Broad leaf plants and grasses were normally found in plantation of all ages. Legumes and oil palm seedlings formed the smallest group in the whole mixture. Fern content increased in older plantations. Legumes, oil palm seedlings, fern, broad leaves and grasses were 0.4, 1.3, 11.4, 28.0 and 59.0 %, respectively of total herbage. Grasses showed the highest preference index followed by broad leaf plants, legumes, oil palm seedlings and ferns in that order. The DMI and the metabolisable energy intake (MEI) of sheep at 6, 8, 10, 12 and 14 months of age were 64.8, 65.0, 65.3, 65.6 and 67.4 g/kg $W^{0.75}$ ($p<0.05$) and 0.39, 0.40, 0.40, 0.40 and 0.41 MJ/kg $W^{0.75}$, respectively. The average stocking rate was 4.3 sheep/ha. It was concluded that the performance of the sheep could be improved by increasing the daily grazing period and also by appropriate concentrate supplementation. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 2 : 209-214*)

Key Words : Sheep, Nutritive Value, Dry Matter Intake, Stocking Rate, Mature Oil Palm Plantation, Grazing Preference

INTRODUCTION

Sheep production in Malaysia is commonly integrated with oil palm plantations. The advantage of this production system is that the unwanted herbage growing under the oil palm canopy can be converted into a useful feed resource (Chin, 1991; Pillai et al., 1985; Chen and Dahlan, 1996). The herbage available under the oil palm plantation can be grouped into five groups, namely, grasses, broad leaf plants, legumes, ferns and oil palm seedlings (from natural germination). Dahlan et al. (1993) showed that the crude protein, metabolisable energy and the metabolisability of this herbage ranged from 11.0 to 16.3 %; 4.6 to 7.0 MJ/kg DM; and 0.35, respectively. Chen et al. (1991) mentioned that the amount of DM available under the canopy at the immature phase (2 to 5 year old tree crops) ranged from 2.8 to 4.8 tonne DM/ha but decreased to 0.1 to 1.0 tonne DM/ha when the tree crops were mature (8 to 22 years old). The amount of herbage available was shown to decline proportionally with the increasing age of palms and also with decreasing light penetration (Chin, 1991; Chen et al., 1991; Dahlan et al., 1993). Stocking rate is an important consideration in the utilisation of herbage growing under the oil palm canopy. A sustainable stocking rate basically depends on herbage yield in a particular area of the plantation (Chin, 1991; Chen et al., 1991). However, there is a lack of information on the grazing intake of sheep in oil palm plantations. This present study was conducted to determine the herbage intake of grazing sheep in an oil palm plantation using the chromium sesquioxide marker technique and also to estimate the optimum stocking rate of sheep in oil palm plantations.

* Corresponding Author: C. Wattanachant.
[1] Department of Biomedical Science, University of Putra, Malaysia.
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MATERIALS AND METHODS

Animals and management

This study was conducted at the Sungai Seraya plantation, Far East Holdings Bhd., Pahang, Malaysia. Eight Dorset x Siamese Long Tail (DSLT) sheep at the age of 6, 8 and 10 months and five DSLT sheep at the age of 12 and 14 months were used in this study. The animals were identified by tags and placed together in a herd of 580 similar sheep grazing in oil palm plantations aged 9, 13, 16 and 21 years old for 5 hours daily (09.00 a.m. to 02.00 p.m.). After 2.00 p.m. they were herded into their houses. Water and mineral blocks were provided in the house. The grazing area under study was 376 ha. The grazing area was divided into sub-areas of 75.2 ha for daily rotation grazing.

Herbage sampling

Herbage yield was sampled from five experimental plots at different areas in plantations with tree crops aged 9, 13, 16 and 21 years old at monthly intervals for 4 months. All herbage species available in the oil palm plantation were determined while the green vegetation selected by sheep was recorded. Samples of herbage similar to that grazed by the sheep in the oil palm plantation were collected at the grazing site at 10.00 to 11.00 a.m. and 12.30 to 01.30 p.m. daily for 6 days. Identification of herbage species from experimental areas was carried out and compared with a known herbage herbarium. Selective index (SI) and preference index (PI) of botanical groups were determined according to Dahlan (1989) as follows: PF=1.01-(1-

SI/100), where the 1.01 accommodates a positive preference even for plants in late phenological stages and SI is the percentage of selective index.

Herbage sample was done according to Mannetje (1978). The rate of herbage growth (RHG) was calculated by average monthly herbage growth in the plot divided by the duration of growing period. The chemical composition was determined according to the procedure of AOAC (1984) and the herbage *in vitro* digestibility was estimated according to the method of Goto and Minson (1977).

Administration of marker and faecal sampling

The administration of the marker and faecal sampling were carried out when the sheep were grazing under the 13 years old oil palm plantation. Since the herbage DM yield under the oil palm canopy at this age was similar to the mean herbage DM yield calculated for the oil palm plantations aged 9 to 21 years old (table 1).

The individual herbage intake was calculated from faecal output measured by the chromic susquioxide (Cr_2O_3) technique according to Dahlan (1989). Each animal was dosed orally with 2 ml of an edible gel suspension twice per day at 07:00 a.m. before grazing and 05.00 p.m. after grazing. The edible gel suspension contained 0.34201 g chromium/ml. Therefore, 1.36804 g chromium per sheep was administered daily.

Each sheep was dosed with Cr_2O_3 daily for 12 days, a six day adjustment period followed by six days of faecal collection. Faecal samples were grabs sampled, dried and kept for chromium concentration determination (Le Du and Penning, 1982).

The concentration of chromium, daily faecal output (FO), herbage dry matter intake (DMI) and metabolisable energy intake (MEI) were calculated according to Dahlan and Mahyuddin (1995).

Potential stocking density (PSD, sheep/ha) was estimated based on rate of herbage growth per day (RHGD; calculated from RHG/30 days), ME content of herbage available (MEA) and metabolisable energy intake (MEI) were estimated as PSD=RHGD * (MEA/MEI) (Dahlan, 1989).

Statistical analysis

Herbage data and age of oil palm plantations and intake of sheep at different ages were analysed using analysis of variance. The differences between the means from the analysis of variance were tested for significance using the Duncan's Multiple Range Test (Steel and Torrie, 1980). All computations were carried out using PROC GLM of the Statistic Analysis System (SAS) programme (SAS, 1981).

RESULTS AND DISCUSSION

Nutritive value and botanical composition of herbage under oil palm plantation

Table 1 shows the nutritive value of herbage under oil palm. In general, the DM and crude fibre contents (CF) increased while crude protein (CP) decreased with increasing plantation age. The average DM, CP, CF and ash contents of herbage were 23.6, 13.1, 24.6 and 8.3 %, respectively, while the GE and ME were 16.9 and 6.0 MJ/kg DM, respectively. The CP of herbage decreased with increasing age of the tree crop ($p<0.01$). Chen and Chee (1993) showed that the CP of herbage decreased with increasing canopy density. Legume species were also shown to be gradually replaced by shade-tolerant species.

Table 1. Chemical composition of herbage under oil palm plantation

Age of	DM	% of DM			DMD	GE	ME	DMHY
palm (years)	%	CP	CF	Ash	(%)	(MJ/kg)	(MJ/kg)	(kg/ha/mo)
9	18.9^{a}	12.7^{a}	24.9^{a}	12.7	50.6^{a}	17.2^{a}	6.0	110.9^{a}
13	19.8^{b}	10.7^{b}	26.9^{bc}	12.5	48.7^{a}	16.2^{b}	6.4	75.4^{b}
16	22.8^{c}	9.2^{c}	23.2^{b}	10.7	40.5^{b}	16.1^{b}	6.2	62.2^{c}
21	25.0^{d}	7.6^{d}	28.4^{c}	11.7	36.8^{c}	16.3^{b}	6.3	50.8^{c}
Mean	21.6	10.1	25.9	11.9	44.1	16.5	6.2	74.8
LS	0.01	0.01	0.05	NS	0.01	0.01	NS	0.01

DM=dry matter; CP=crude protein; CF=crude fibre; DMD=dry matter digestibility value; GE=gross energy (MJ/kg DM); q-value=metabolisability calculate from GE/ME; ME=metabolisable energy (MJ/kg DM) calculate from 4.184* (0.036154*% TDN) (NRC, 1985); DMHY=dry matter yield of herbage (kg/ hectare/month); Means within column with different superscripts differ significantly.

The GE and ME values of herbage in the present study were slightly lower than those reported by Dahlan et al. (1993) (16.9 vs. 17.5 MJ GE/kg DM and 6.0 vs. 6.3 MJ ME/kg DM). The average metabolisability of the herbage in this study was 0.37 suggesting the poor energy utilisation by grazing sheep. In terms of dry matter digestibility (DMD) of herbage, it was found that the DMD of herbage decreased with increasing plantation age ($p<0.01$) (table 1). Chen et al. (1991) explained that the DMD value of herbage under the tree canopy decreased due to an increase in low digestibility herbage, such as ferns and woody shrubs.

The herbage dry matter yields (DMHY) under plantations aged 9, 13, 16 and 21 years old were 110.9, 75.4, 62.2 and 50.8 kg/ha/month, respectively ($p<0.01$). Therefore, the reduction of DMHY under plantation

corresponded with the lower light penetration under the oil palm canopy.

The average botanical composition of grasses, broad leaf plants, ferns, oil palm seedlings and legumes was 59.0, 28.0, 11.4, 1.3 and 0.4 %, respectively (table 2).

Table 2. Botanical composition of herbage under oil palm plantation

Age of palm (years)	% Botanical composition				
	BL	GR	L	F	OPS
9	28.5^{a}	65.5^{a}	1.0^{a}	3.0^{a}	2.0^{a}
13	29.7^{a}	62.0^{b}	0.1^{b}	7.2^{b}	1.0^{b}
16	28.3^{a}	57.0^{c}	0.3^{b}	13.2^{c}	1.2^{ab}
21	25.5^{b}	51.4^{a}	0.1^{b}	22.1^{a}	0.9^{b}
Mean	28.0	59.0	0.4	11.4	1.3
LS	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01

BL=broad leaf plants; GR=grasses; L=legume; F=ferns; OPS=oil palm seedlings; LS=Level of significance.
NS=Non-significant difference.
Means within column with different superscripts differ significantly.

Broad leaf plants and grasses were normally found in plantations of all ages. The proportion of grasses under the oil palm canopy decreased with the increased age of plantation ($p<0.01$). The proportion of legumes and oil palm seedling oil was the lowest in the whole mixture. Usually, legumes were depleted probably due to species competition and shade intolerance. Ferns increased when the plantation aged ($p<0.01$). The present results were similar to those of Chin (1991), Chen et al. (1991) and Dahlan et al. (1993). The relationship between age of plantation and herbage DM yield, botanical composition of herbage and DMD are presented in figure 1 and 2.

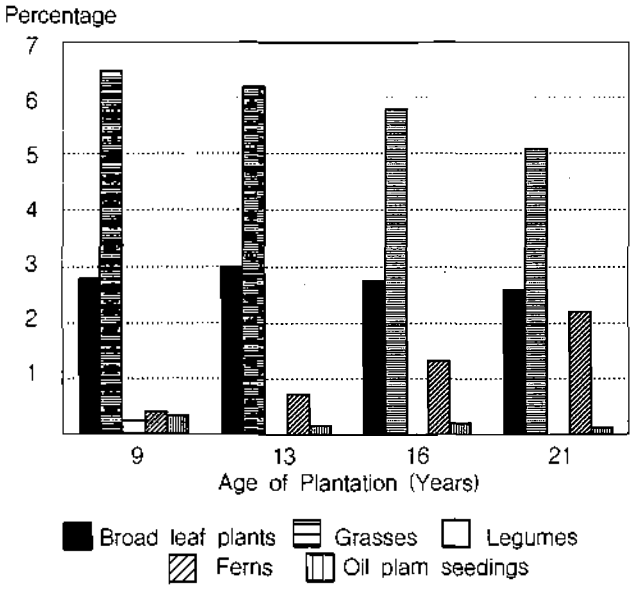

Figure 1. The relationship between botanical compositions of herbage in oil palm plantation and the age of plantations

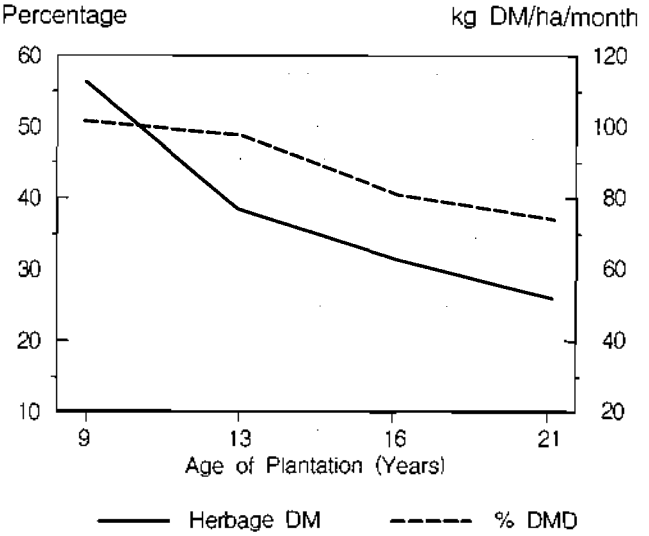

Figure 2. The relationship between DM yields and % DMD and the age of plantations

Animal acceptability

Animal acceptability of plants usually depends on palatability, and is associated with digestibility and nutritive value of the herbage. This study found that grasses showed the highest selective index (SI) and preference index (PI) (95 %, 0.96) followed by broad leaf plants (90 %, 0.91), legumes (80 %, 0.81), oil palm seedlings (70 %, 0.71) and ferns (35 %, 0.36), respectively. Dahlan (1989) reported that broad leaf plants showed the highest SI and PI in grazing beef cattle in oil palm plantation while the others showed similar patterns.

The nutritive value of herbage varied according to the age of plantation. It also varied according to the type and structure of the plant (Corbett, 1978). It was found that the herbage selected by sheep had a higher nutritive value than the whole sward cut from the experimental plots (table 3). Hodgson (1990) has explained that the roughage eaten by grazing animals usually contains higher proportions of leaf and live plant tissue and lower proportions of stem and dead tissue compared with the sward as whole.

Nevertheless, under the oil palm plantation where the amount of herbage DM decreased as the plantation aged, the occurrence of high preference herbage groups was also decreased, probably due to the increase in unpalatable herbage under the oil palm canopy (Chen et al., 1991). Thus, the acceptability of available herbage in oil palm plantation reduced as plantation age increased.

Chromium results

The values of live weight (LW), CRCF, FO, FO/LW and FI for each age of sheep are shown in table 4. The CRCF and FO of the sheep were mainly influenced by the level of feed intake (FI). Thus, the FO values corresponded to the LW of sheep. This study indicated that the Cr_2O_3 in gel suspension gave satisfactory results of the estimation of feed intake.

Table 3. Comparison of herbage yield and nutritive values of herbage under oil palm canopy between whole sward and selected by sheep

Age (years)	Type	Yield (kg/ha/d)	% DM				DMD (%)	GE (MJ/kg)	ME (MJ/kg)	q value
			CP	CF	Ash	EE				
9	Whole	3.7	12.7	24.9	12.7	2.0	46.9	16.0	5.8	0.363
	Selected	3.4	13.0	24.5	8.3	1.5	45.9	16.9	6.1	0.358
13	Whole	2.5	10.7	26.9	12.5	1.9	46.7	16.2	6.0	0.370
	Selected	2.3	13.4	24.5	8.2	1.5	45.7	16.8	6.1	0.358
16	Whole	2.1	9.2	23.2	10.7	2.1	44.1	16.1	5.7	0.358
	Selected	1.8	13.2	24.5	8.3	1.6	45.3	16.4	6.0	0.356
21	Whole	1.7	7.6	28.4	11.7	2.3	42.6	16.3	5.9	0.361
	Selected	1.4	12.8	25.0	8.1	1.7	44.6	17.0	6.0	0.353
Mean	Whole	2.5	10.1	25.6	11.9	2.1	45.1	16.1	5.9	0.363
	Selected	2.2	13.1	24.6	8.3	1.5	45.4	16.9	6.0	0.356

Whole = whole cut herbage from experimental plots; Selected = selected herbage as the sheep grazed; Herbage DM (kg/ha/d) yield at whole was determined from DMHY / 30; Herbage DM yield of selected group was calculated from DMHY * % botanical composition * PI; Nutrient available = (herbage DMY of selected * Nutrient value) / DMHY * 100; ME = 0.15146*(IVDMD*1.05) (Dahlan et al., 1993).

Table 4. Mean of LW, chromium concentration in faeces (CRCF), faecal output (FO), FO/LW, and feed intake (FI) of sheep in oil palm plantation

Sheep age (Months)	No. of sheep	LW (kg)	CRCF	FO (kg DM)	FO/LW	FI (kg DM/d)	DMI (%)
6	8	13.0^{a}	5.5190^{a}	0.2479^{a}	0.0191^{a}	0.44^{a}	3.4^{a}
8	8	14.8^{b}	4.9950^{b}	0.2740^{b}	0.0185^{b}	0.49^{b}	3.3^{a}
10	8	17.6^{c}	4.3631^{c}	0.3137^{b}	0.0178^{c}	0.56^{c}	3.2^{b}
12	5	20.9^{d}	3.8224^{c}	0.3582^{c}	0.0171^{c}	0.64^{d}	3.1^{c}
14	5	23.0^{e}	3.4577^{d}	0.3958^{d}	0.0172^{c}	0.71^{e}	3.2^{b}
LS	-	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01

CRCF=chromium concentration in faeces (mg/g faeces); FO=faecal output (kg DM) calculated from chromium concentration in the marker (CCM)×volume of chromium administered to the sheep (CV) / CRCF; FI=feed intake which calculated from F * LW / (1-DMD) where DMD=0.454; DMI=dry matter intake (%); LS=level of significant.
Means within column with different superscripts differ significantly.

Dry matter intake

From tables 4 and 5, the DMI of sheep at the age of 6, 8, 10, 12 and 14 months were 64.8, 65.0, 65.3, 65.6 and 63.8 g/kg $W^{0.75}$ ($p<0.05$) and the MEI of sheep were 0.39, 0.40, 0.40, 0.40 and 0.41 MJ/kg $W^{0.75}$, respectively. In this study the DMI and MEI of sheep were lower than those predicted from the nutrient requirement of Kearl (1982). It terms of the metabolisability (q-value) of selected herbage, it was found that the value was low (0.359), as was also reported by Dahlan (1989) (0.35). This poor value of metabolisability means that the poor energy utilisation of sheep corresponded to the low feed intake of the sheep. This was related to Chen et al. (1991) who found that the yields of edible dicotyledons, weeds and grasses were decreased while the yields of the non-edible dicotyledons and ferns increased as the plantation aged.

The performance of sheep under oil palm plantation has been reported by many researchers. Schrader (1994) reported that the Siamese Long Tail (SLT) sheep grazing in oil palm plantations (about 5.3 hours/day) and supplemented with mineral blocks exhibited poor growth performance compared to the SLT fed with oil palm based rations and mineral blocks. Wattanachant et al. (1996) reported that the growth performance of the Dorset×SLT sheep was poor under a limited daily grazing period (5 hours/day) in an oil palm plantation. This was probably due to an inadequate feed intake.

Although the daily grazing period needs to be increased, the poor herbage DM yields under the oil palm canopy is still the most important constraint factor. Even if the daily grazing period can be increased, the limitation of gut fill will not allow the DMI of herbage to be increased to get enough energy to meet daily requirements. Therefore, a concentrate supplementation is needed to compensate for the lack of the energy derived from the herbage under this integration system.

Potential stocking density

Table 1 indicates that the DM yield and the MEA of herbage under plantation decreased with plantation age. It was emphasised by Chin (1991) that the density of animals per unit area is related to the types of herbage and the quantity of herbage available under the

Table 5. Comparison of the actual DMI and MEI of grazing sheep in oil palm plantation for 5 hours daily and DMI and MEI of sheep estimated from the nutrient requirement of Kearl (1982)

Sheep Age (months)	No. of sheep	ADG (g/d)	DMI (g/kg $LW^{0.75}$/d)		Diff.	MEI (MJ/kg $LW^{0.75}$/d)		Diff.
			Actual	Kearl's	(%)	Actual	Kearl's	(%)
6	8	-	64.8[a]	65.7	-1.4	0.39	0.60	-35.0
8	8	31.7	65.0[a]	63.6	2.0	0.40	0.59	-32.2
10	8	46.7	65.3[a]	73.3	-10.9	0.40	0.68	-41.2
12	5	55.0	65.6[a]	66.5	-1.8	0.40	0.56	-28.6
14	5	35.2	67.4[b]	63.8	5.6	0.41	0.59	-30.5
LS	-	-	p<0.05	-	-	NS	-	-

ADG = average daily gain (g/d); Diff. = % deviation from literature values; MEI = metabolisable energy intake (MJ/kg $W^{0.75}$/d) calculated from (GE*q*FI)/$LW^{0.75}$ where FI=feed intake (kg DM); MEI of Kearl (1982)calculated by plus 25% of sheep in pen; Means within column with different superscripts differ significantly; NS = non-significant difference.

oil palm canopy. Thus, the estimation of potential stocking density (PSD) of sheep in this study was based on the growth rate of herbage per day (RHGD), MEA, MEI, the age of sheep and the age of plantation. This approach provides a better explanation on the estimation of PSD.

The average PSD of sheep calculated using the actual data was higher than the estimated value based on the nutrient requirement of Kearl (1982) (4.3 vs. 2.9 sheep/ha), because the actual values of MEI of sheep used in the calculation of PSD were lower. The PSD value was also higher than the stocking rate of 3 sheep/ha in areas with 4-26 years old tree crops recommended by Halim and Stoeber (1990 cited in Chin, 1991). The mean difference of PSD shown by the grazing of sheep in this study was 1.4 sheep/ha. In order to consume more energy, the grazing pressure of sheep needs to be reduced according to the age of the plantation and the physiological status of the sheep.

CONCLUSION

Under a limited grazing period (about 5 hr/d) in mature oil palm plantations, sheep do not consume sufficient feed for their daily requirements. The availability of herbage under the old oil palm canopy is poor in terms of quality and quantity. Therefore, in order to improve the growth performance of sheep, it is recommended that the daily grazing period is increased and that feed supplementation or concentrate is provided.

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