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ANNUAL DRY MATTER YIELD AND NUTRITIVE VALUE OF IMPROVED GRASSES FOR DAIRY PRODUCTION IN MALAYSIA

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Keywords: Improved grasses, Dry matter yield, Nutritive value, Milk production.

RINGKASAN

Kajian tentang penghasilan bahan kering (BK) bagi jarak potongan (JP) dua, empat, enam dan lapan minggu sekali dan penilaian pemakanan selama tiga tahun bagi lima spesies rumput terpilih yang biasa ditanam di negara ini telah dijalankan. Spesies-spesies tersebut ialah *Brachiaria decumbens, Digitaria setivalva* USDA 299892, *Panicum maximum* jenis Coloniao, *Pennisetum purpureum* dan *Setaria sphecalata* jenis Splendida. Rumput-rumput ini dibaja menggunakan 300 kg N, 50 kg P dan 100 kg K/ha. tahun selepas setiap kali rumput dipotong. Keputusan menunjukkan bahawa 17–26 t BK/ha. tahun foraj yang bermutu sederhana (7–9 MJ tenaga metabolisma/kg BK) dapat dihasilkan daripada rumput-rumput tersebut. Hasil BK bagi tahun kedua dan ketiga untuk kesemua jenis rumput merosot menjadi setengah hasil yang didapati bagi tahun pertama. Penghasilan BK bagi rumput-rumput ini tidak berbeza dengan nyata pada tahun pertama tetapi pada tahun kedua dan ketiga rumput jenis Digitaria menghasilkan BK yang paling rendah. Kesemua jenis rumput ini apabila dipotong di antara dua hingga empat minggu sekali perlu ditanam semula selepas satu hingga dua tahun.

Rumput-rumput ini mempunyai perbezaan yang nyata daripada segi nilai pemakanannya. BK dan kandungan gentian kasarnya (GK) meningkat dengan amat nyata apabila selang pemotongan dilanjutkan manakala protein kasar, abu dan ekstrak lemak didapati menurun ($P>0.01$). Kajian ini juga menunjukkan bahawa BK, nilai pemakanan dan ketahanan rumput terpilih mempunyai pertalian yang rapat. Selang masa pemotongan yang lama akan menambahkan hasil BK dan ketahanannya tetapi nilai pemakanannya menjadi rendah. Sebaliknya nilai pemakanan yang tinggi akan diperoleh jika rumput-rumput itu dipotong di dalam jangka masa yang pendek tetapi hasilnya rendah dan cepat mati. Kajian ini menunjukkan bahawa hasil BK dan nilai pemakanan bagi rumput-rumput ini adalah seimbang di antara enam hingga lapan minggu jarak masa pemotongan dan kajian lanjut disyorkan untuk menentukan pengeluaran susu bagi lembu yang diberi setiap spesies rumput ini dan sistem-sistem pengurusan yang praktis bagi penternak-penternak kecil tenusu di Malaysia.

INTRODUCTION

It has been recognized that quality and availability of feed are important factors limiting dairy cattle production in Malaysia and other tropical countries (DEVENDRA, 1973; STOBBS and THOMPSON, 1975). Dairy farmers in Malaysia depend almost exclusively on native pastures which are low in nutritive value (LIM, 1968; NG, 1972; HASSAN and DEVENDRA, 1982). Only small quantities of concentrates are generally offered to lactating dairy cows (SIVARAJASINGAM and KASIM, 1974). With the introduction of crossbred dairy cattle to the smallholdings under the National Dairy Development programme, these problems will be more critical unless positive steps are taken to improve feed quality and availability.

Although earlier studies (KEEPING, 1951; HENDERSON, 1955a, b, c; URE and JAMIL, 1957; NG, 1972; TAN, YEOW and PILLAI, 1973; NG, (1976); ENG, KERRIDGE and MANNETJE, 1978; DEVENDRA, 1979; THAM, 1980; WONG, 1980) indicated that the climate of Malaysia is favourable for improved tropical pasture production, there is no available information on the comparative productivity, chemical composition and nutritive value of a range of forage species at different cutting intervals under similar cultural and management conditions. The information is essential to enable dairy farmers to decide on a suitable forage species to grow and level of management required to produce high quality herbage for their animals.

The experiment was therefore designed to evaluate dry matter (DM) yield, chemical

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composition and nutritive value of six grasses which had performed well in the plant introduction nursery at MARDI (WONG, CHEN and AJIT, 1982a).

MATERIALS AND METHODS

Species Examined and Experimental Design

Five grasses namely *Brachiaria decumbens* (Signal), *Digitaria setivalva* USDA 299892 (MARDI Digit), *Panicum maximum* cv. Coloniao (Guinea) *Pennisetum purpureum* (Napier) and *Setaria sphecalata* var. Splendida (Setaria) were evaluated in a split-plot experiment with two replicates. The grasses were cut at two, four, six and eight weekly intervals. Each main plot (grass species) was 24 m x 24 m and each sub-plot (cutting interval) was 24 m x 6 metres. On removing the guard areas of 1 m x 2 m, each sub-plot gave a sample area of 4 m x 20 metres.

Statistical analysis was done by using SAS methods (ANON., 1985) and methods for confounded split-plot designs by CORCHRAN and COX (1957).

Site

The experiment was conducted at MARDI Research Station, Serdang, Selangor on land previously planted with rubber. The soil was well drained with a sandy loam to clay loam top soil belonging to the Serdang series (LAW and TAN, 1975; WAN HASSAN, 1986).

Climate

The rainfall at Serdang is fairly evenly distributed throughout the year with a minimum monthly rainfall of 70–90 mm in June-July and a maximum of 340–390 mm during the wet months of March–April and October–November. The rainfall distribution throughout the experiment is shown in *Figure 1*. Temperatures are fairly constant throughout the year, varying from a mean maximum of 33°C in March to 34°C in July, and a mean minimum of 21°C in September to 22°C in May.

Grass Establishment

The experimental plots were ploughed to a depth of about 15 cm, cultivated and levelled to obtain an even surface for planting. After marking the plots, a basal fertilizer consisting of 60 kgN, 40 kgP and 50 kg K/ha were applied two weeks before planting. The grasses were hand planted from vegetative root cuttings at 30 cm x 30 cm planting distance.

Grass Maintenance

During the establishment period the plots were hand weeded. This was discontinued when sampling started.

The maintenance fertilizer for the grass was 300 kgN, 50 kgP and 100 kgK/hectare. It was applied in split applications after each harvest. Fertilizer types used were urea (N), triple-superphosphate (P) and muriate of potash (K).

Harvesting and Sampling

The first sampling was started seven months after planting. The grasses were cut by using hand shears at a cutting height of 10–15 centimetres. Crop weights were recorded in the field. Sub-samples were taken to the laboratory and were chopped, mixed, weighed and then dried in a force draught oven at 80°C for 48 hours. They were re-weighed to determine the DM content and then kept for chemical analysis.

Chemical Analysis

Total N, P, K, Ca and Mg were analysed using a Technicon AA2 Auto-Analyser. Nitrogen values were multiplied by 6.25 to convert them to crude protein (CP) values (g/kg DM). Crude fibre (CF), ether extract (EE) and ash contents were determined by A.O.A.C. methods (1975) and dry matter digestibility (DMD) was

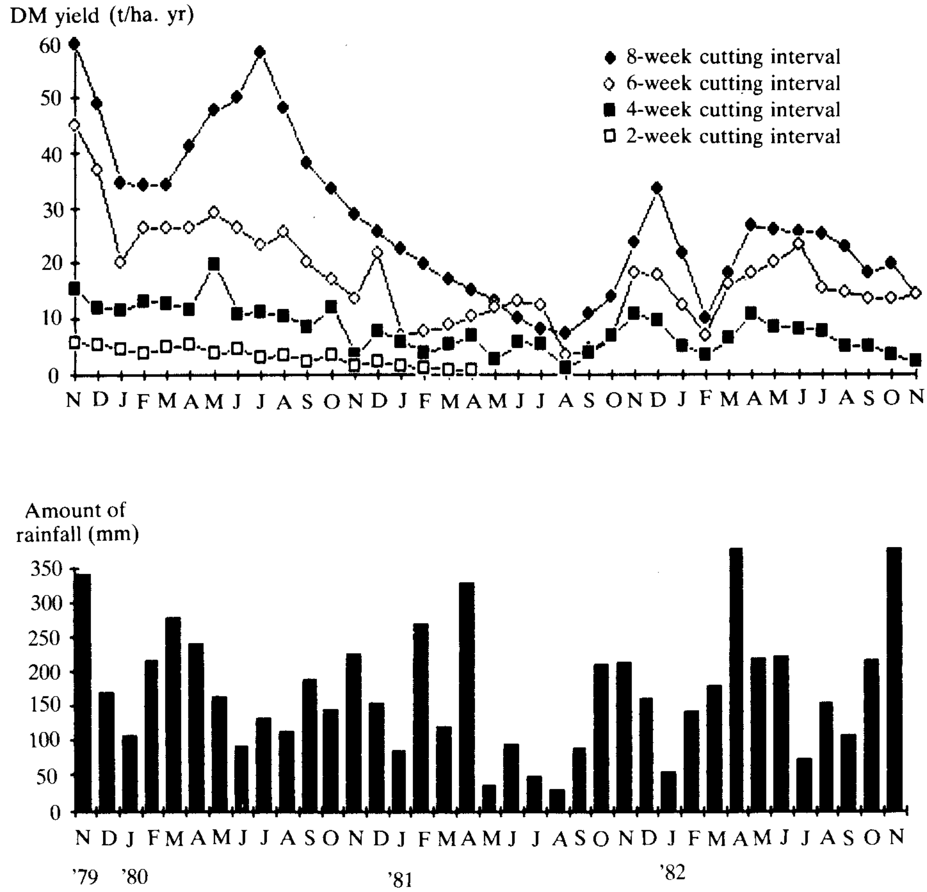

Figure 1. Average DM yield of all grasses at different cutting intervals and rainfall disribution.

determined by an *in vitro* method (GOTO and MINSON, 1977).

RESULTS

Dry Matter Yield

The average DM yield of Setaria, Digitaria, Napier, Guinea and Signal grasses at different cutting intervals (CI) (two, four, six and eight weeks) throughout the experimental period is shown in *Figure 1* (for illustration purposes, DM yields at various CI were adjusted to monthly basis) and on an annual basis is shown in *Figure 2*.

In each year the average DM yield of the grasses increased significantly ($P<0.01$) as CI increased. During the first year DM yield increased from 4.2 to 42.4 t/ha. yr as CI was increased from two to eight weeks. Intermediate values were recorded for the four and six-week cutting intervals.

In the second and third year the corresponding DM yields were lower than those recorded for the first year. However, a similar trend occurred with an increase in DM yield as CI was increased. Dry matter yield increased from 1.5 to 17.7 t/ha. yr as CI was increased from two to eight weeks in the second year, and from 6.5 to 19.0 t/ha. yr as CI was increased from four to eight weeks in the third year.

There was no significant difference between the mean DM yield of the grasses in the first year and only small and generally non-significant differences were observed in the second and third year. However,

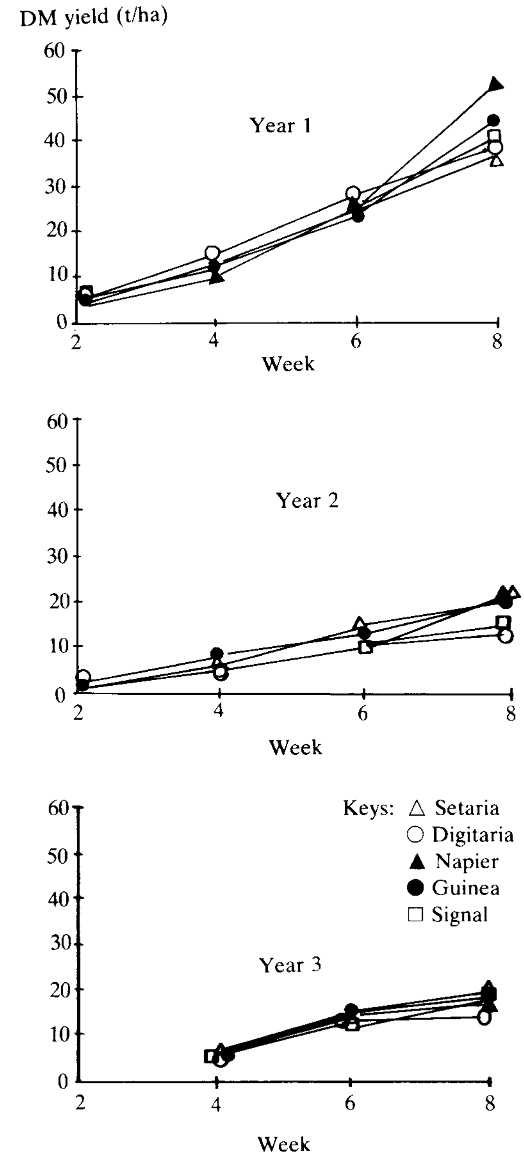

Figure 2. The effect of CI on DM yield of grasses on annual basis

Digitaria produced the lowest DM yield in both the second and third year of the trial.

The DM yield of all grasses in the second year was approximately half of that recorded in the first year. Nevertheless, there was some increase in DM yield of the grasses in the third year, especially at the six and eight-week cutting intervals. All grasses at a two-week CI ceased to produce after the first 1.5 years of cutting *(Figure 2).*

The highest DM yield of 52.3 t/ha. yr was produced by Napier at the eight-week CI in the first year and the lowest DM yield of 0.8 t/ha. yr was produced by Setaria at the two-week CI in the second year.

Crude Protein Content

The CP content of the grasses at different CI is shown in *Figure 3.*

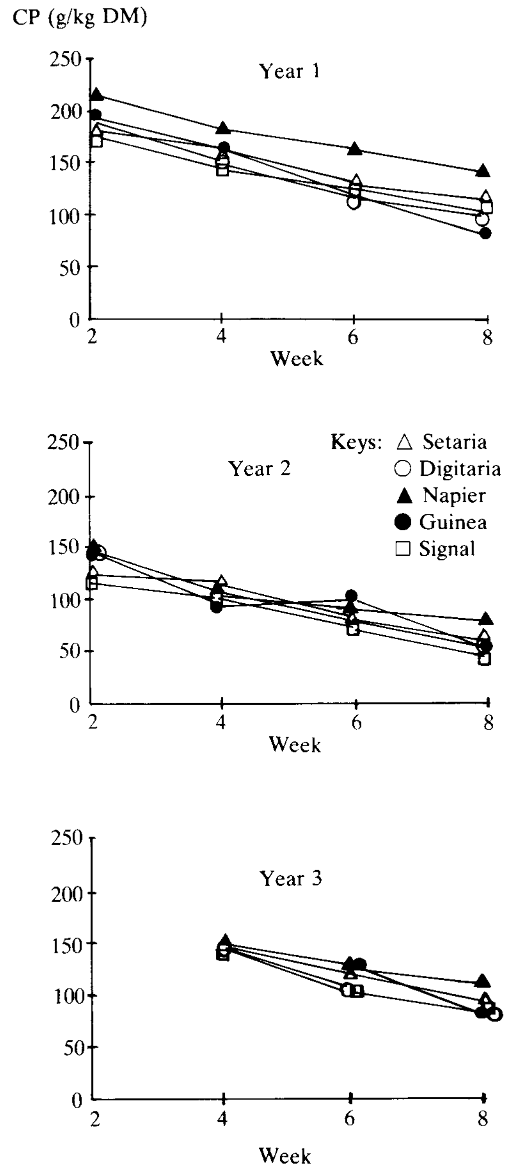

Figure 3. The effect of CI on CP content of grasses on annual basis

In each year the average CP content declined significantly (P<0.01) as CI increased. During the first year the CP content declined from 190 to 106 g/kg DM as CI was increased from two to eight weeks. Intermediate values were recorded for the four and six-week cutting intervals.

In the second and third year the corresponding CP values were lower than those recorded in the first year. However, a similar trend was observed with a decrease in CP content as CI increased. Averaged within the three years the CP content declined by 29 g/kg DM (±1.39) for each two-week increase in cutting interval.

The CP content of all grasses was substantially lower in the second and third year of the trial, compared with the first year. However, in each year the CP content for Napier was significantly higher than that of the other grasses (P<0.05) while the values for Signal were consistently the lowest. The other grass species had intermediate values.

The highest CP content recorded was 215 g/kg DM for Napier at the two-week CI in the first year while the lowest was 42 g/kg DM for Signal at the eight-week CI in the second year.

Crude Fibre Content

The average CF content of the grasses at different CI is shown in *Figure 4.*

In each year, the average CF content of the grasses increased significantly (P<0.01) as CI increased. In the first year CF content increased from 268 to 334 g/kg DM as CI was increased from two to eight weeks. Intermediate values were recorded for the four and six-week cutting intervals.

In the second and third year a similar trend was observed with an increase in CF content as CI increased. Averaged within the three years the CF content increased by 26 g/kg DM (±4.11) for each two weeks increase in cutting interval.

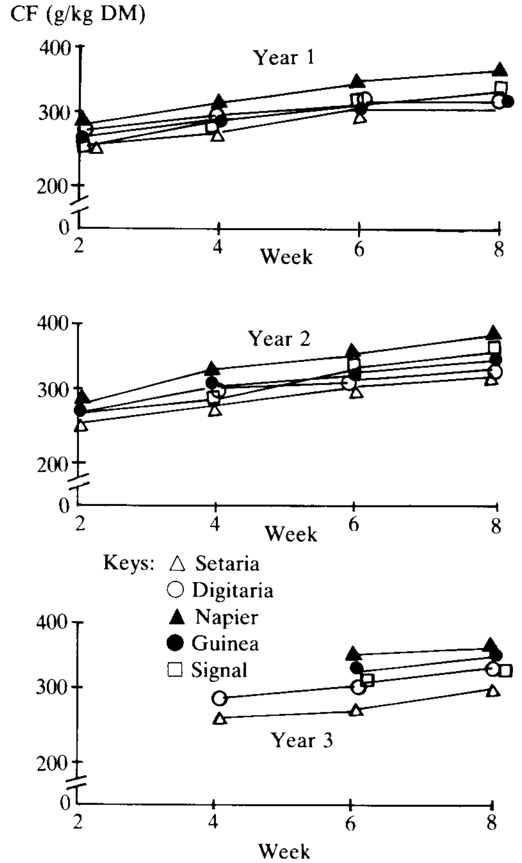

Figure 4. The effect of CI on CF content of grasses on annual basis

Napier contained significantly higher CF content (P<0.05) than the other grasses in each of the three years, while Setaria consistently contained the lowest CF content. The other grasses had intermediate values.

The highest CF content recorded was 385 g/kg DM for Napier at the eight-week CI in the second year and the lowest was 255 g/kg DM for Setaria at the two-week CI in the first year.

In vitro Dry Matter Digestibility

The average *in vitro* DMD of the grasses at different CI is shown in *Figure 5.*

In each year the average DMD of the grasses declined significantly (P<0.01) as CI increased. During the first year the DMD

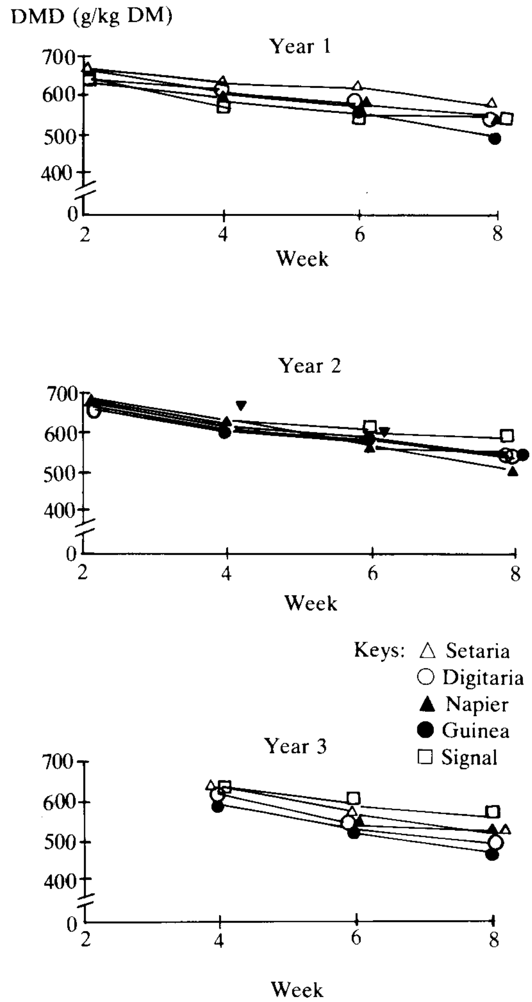

Figure 5. The effect of CI on DMD yield of grasses on annual basis

declined from 650 to 537 g/kg DM as CI was increased from two to eight weeks. Intermediate values were recorded for the four and six-week cutting intervals.

In the second and third year the corresponding DMD values were slightly lower than those recorded for the first year. However, a similar trend was observed with a decline in DMD as CI increased. Averaged over the three years the DMD values declined by 43 g/kg DM (±4.3) for each two-week increase in cutting interval.

The average DMD value for Setaria in the first year was significantly higher ($P<0.05$) than the other grasses while the value for Signal was the lowest. However, in the second and third year, the average DMD value for Signal was significantly higher ($P<0.05$) than the other grasses. In the third year the DMD values for Digitaria, Napier and Guinea were similar.

The highest DMD value recorded was 667 g/kg DM for Setaria at the two-week CI in the first year while the lowest was 471 g/kg DM for Napier at the eight-week CI in the second year.

Ash and Ether Extract

Ash and EE values were determined for the first year only and their average values at different CI are shown in *Table 1.*

Table 1. Average ash and EE content of grasses at different CI in Year 1 of the trial

CI (wk)	Ash (g/kg DM)						EE (g/kg DM)					
	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean
2	102	96	116	105	95	103	53	38	38	33	32	39
4	99	82	97	106	87	94	46	35	30	27	27	33
6	86	80	95	87	81	86	35	30	29	22	28	29
8	79	75	73	83	69	76	29	31	24	23	24	26
Mean	92	83	95	95	83		41	34	31	26	28	
s.e. diff. bet. two:		s.e.d	d.f.		LSD (0.05)			s.e.d.		d.f.	LSD(0.05)	
Grasses		1.6	4		4.4			0.5		4	1.4	
Cuts		2.1	15		4.6			0.9		15	1.9	
Cuts within a grass		4.8	15		10.2			2.0		15	4.2	
Grasses within a cut or diff. cuts		4.4	a^{++}		9.7			1.8		a^{+}	3.9	

a^{+}; a^{++} = error is a weighted mean of Ea and Eb (Ea = Grass x Replicate; Eb = Cut x Replicate)

Ash and EE content declined significantly ($P<0.01$) as CI was increased. Ash declined from 103 to 76 g/kg DM and EE declined from 39 to 26 g/kg DM respectively when CI was increased from two to eight weeks. On the average, ash declined by 9 g/kg DM (±0.58) and EE declined by 4 g/kg DM (±0.88) respectively for each two-week increase cutting interval.

Napier, Guinea and Setaria contained a significantly higher ($P<0.05$) ash content than Digitaria and Signal.

The mean EE content of the grasses differed significantly ($P<0.01$) between species. Setaria contained the highest EE while Guinea the lowest.

Minerals: P, K, Ca and Mg

The average P, K, Ca and Mg content of the grasses are shown in *Table 2, Table 3, Table 4* and *Table 5* respectively.

In each year the average P and K content declined significantly ($P<0.01$) as CI was increased from two to eight weeks. Averaged within the three-year period, P content declined by 0.28 g/kg DM (±0.06) and K content declined by 0.5 g/kg DM (±0.11) for each two-week increase in cutting interval.

Digitaria and Napier had a higher P content than the other grasses while Setaria contained the highest K values within the three-year trial period.

Cutting interval and type of grass did not affect the mean Ca and Mg content. However, Digitaria consistently had the highest Ca content and Signal the lowest.

DISCUSSION

This experiment showed that high DM yields could be produced from improved grasses in Malaysia. At six to eight-weekly CI, 17–26t DM/ha. yr (average for more than three years) could be obtained from either Digitaria, Guinea, Napier, Setaria and Signal grasses. The results of this experiment confirm the earlier observation by WONG, *et al.* (1982a) on the potential of Digitaria, Guinea, Napier, Setaria and Signal grasses for forage cultivation in Malaysia.

Higher DM yield in response to less frequent cutting intervals recorded in this study are of the same order as reported for both tropical and temperate grasses (VICENTE-CHANDLER, SILVA and FIGRARELLA, 1959; CHEDDA and AKINOLA, 1971; OSMAN, 1979; WILLIAMS, 1980; WONG, and DEVENDRA, 1982). However, the significance of the current finding is the establishment of a profile of DM yield of locally grown improved tropical grasses in relation to CI on a long term basis. As shown in *Table 1, Figure 1* and *Figure 2*, the tall and erect-type species like Napier and Setaria were least resistant to intensive defoliation. Analysis of variance showed that a Grass x CI interaction was significant ($P<0.05$). If these grasses were to be cut at four-week or less CI, they will have to be replanted every one to two years. This is costly and not a practical proposition for the local dairy farmers who are mainly smallholders.

Figure 1 and *Figure 2* also show that the yield of the grasses declined markedly from the first harvest for about a year to reach a plateau of production (except for the two-weekly CI). The average DM yield in the second and third year was approximately half that of the first year's. Similar observations were reported by WONG (1980), WONG *et al.* (1982a), CHEN and BONG (1983) and BAUER (1984) for the same species grown locally. This difference arose because of the difference in the rate of regrowth and persistency of the grasses as a result of cutting. In the first year the rate of the mean increment of DM yield expressed in terms of DM yield was 12.7 t/ha. yr for each two-week increase in cutting interval. In the second and third year it was 5.4 and 6.3 t/ha. yr respectively. The difference between the second and third year could

Table 2. Average P content (g/kg DM) of grasses at different CI on annual basis

CI (wk)	Year 1						Year 2						Year 3					
	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean
2	2.0	2.1	2.6	2.2	1.7	2.1	2.6	3.0	2.8	2.5	2.6	2.7	n.a	n.a.	n.a.	n.a.	n.a.	n.a.
4	1.6	2.0	2.4	1.7	1.6	1.8	2.1	2.2	2.2	1.9	2.1	2.1	2.6	2.8	n.a	2.3	2.1	2.4
6	1.5	1.8	2.3	1.5	1.5	1.7	1.6	2.0	2.0	1.7	1.6	1.8	2.2	2.3	2.2	2.2	1.9	2.1
8	1.5	1.8	1.9	1.6	1.2	1.6	1.7	1.5	2.0	1.7	1.3	1.6	2.1	1.7	1.9	1.5	1.7	1.8
Mean	1.6	1.9	2.3	1.7	1.5		2.0	2.2	2.2	1.9	1.9		2.3	2.2	2.0	2.0	1.9	
s.e. diff.bet. two:		s.e.d.	d.f		LSD(0.05)			s.e.d.	d.f.		LSD(0.05)			s.e.d.	d.f.		LSD(0.05)	
Grasses		0.1	4		0.2			0.1	4		0.2			0.03	4		0.1	
Cuts		0.1	15		0.2			0.1	15		0.2			0.1	9		0.1	
Cuts within a grass		0.2	15		0.4			0.2	15		0.3			0.1	9		0.2	
Grass within a cut or diff. cuts		0.2	a^+		0.4			0.2	a^+		0.5			0.1	a^{++}		0.2	

a^+; a^{++} = error is a weighted mean of Ea and Ea (Eb = Grass x Replicate; Eb = Cut x Replicate).
n.a. = not available.

Table 3. Average K content (g/kg DM) of grasses at different CI on annual basis

CI (wk)	Year 1						Year 2						Year 3					
	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean
2							49	31	47	41	34	40	n.a.	n.a.	n.a.	n.a.	n.a	n.a.
4							35	27	32	29	31	31	32	28	35	35	31	32
6			not available				34	21	30	26	27	28	28	22	25	30	28	27
8							37	26	24	26	22	25	24	19	22	21	24	22
Mean							37	26	33	31	28		28	23	27	29	28	
s.e. diff. bet. two:								s.e.d.	d.f.		LSD(0.05)			s.e.d.	d.f.		LSD(0.05)	
Grasses								1.5	4		4.2			1.1	4		3.1	
Cuts								1.3	15		2.7			0.5	10		1.2	
Cuts within a grass								2.8	15		6.0			1.1	10		2.6	
Grass within a cut or diff. cuts								2.7	a^+		6.2			1.5	a^{++}		3.8	

a^+; a^{++} = error is a weighted mean of Ea and Eb (Ea = Grass x Replicate; Eb = Cut x Replicate).
n.a. = not available.

Table 4. Average Ca content (g/kg DM) of grasses at different CI on annual basis

CI (wk)	Year 1						Year 2						Year 3					
	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean
2	1.2	2.6	2.3	2.1	1.5	1.9	1.8	3.3	2.5	2.1	2.1	2.3	n.a	n.a.	n.a.	n.a.	n.a.	n.a.
4	1.2	2.4	1.9	2.1	1.5	1.8	2.2	2.5	2.3	2.2	1.7	2.2	1.9	2.9	1.8	2.4	1.8	2.1
6	1.3	2.9	2.0	1.7	1.5	1.8	2.6	2.9	2.6	2.5	1.9	2.5	1.9	3.6	2.3	2.8	1.7	2.4
8	0.9	2.8	1.9	1.9	1.7	1.8	2.6	2.9	2.6	2.5	1.9	2.5	1.9	3.6	2.3	2.8	1.7	2.4
Mean	1.1	2.6	2.0	1.9	1.5		2.0	2.9	2.4	2.2	1.8		2.0	3.2	2.1	2.5	1.8	
s.e. diff.bet. two:	s.e.d.		d.f		LSD(0.05)		s.e.d.		d.f.		LSD(0.05)		s.e.d.		d.f.		LSD(0.05)	
Grasses	0.2		4		0.4		0.6		4		1.7		0.2		4		0.7	
Cuts	0.1		15		0.2		0.1		15		0.3		0.1		9		0.3	
Cuts within a grass	0.5		15		1.2		0.3		15		0.7		0.2		10		0.6	
Grass within a cut or diff. cuts	0.2		a^+		0.5		0.4		a^+		1.0		0.2		a^{++}		0.6	

a^+; a^{++} = error is a weighted mean of Ea and Eb (Ea = Grass x Replicate; Eb = Cut x Replicate).
n.a. = not available.

Table 5. Average Mg content (g/kg DM) of grasses at different CI on annual basis

CI (wk)	Year 1						Year 2						Year 3					
	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean	Set	Dig	Nap	Gui	Sig	Mean
2	1.0	1.3	1.1	1.1	1.4	1.2	1.1	1.2	1.2	1.2	1.6	1.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
4	1.0	1.1	1.0	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.1	1.1	0.9	1.1	1.1	0.9	1.0
6	1.0	1.3	1.2	0.9	1.2	1.1	1.1	0.9	1.2	1.2	1.4	1.1	0.9	0.7	1.3	1.1	1.1	1.0
8	0.7	1.1	1.1	1.0	1.1	1.0	1.3	0.8	1.3	1.4	1.3	1.2	0.8	0.8	1.2	1.0	0.9	1.0
Mean	0.9	1.2	1.1	1.0	1.2		1.1	1.0	1.2	1.2	1.3		0.9	0.8	1.2	1.1	1.0	
s.e. diff. bet. two:	s.e.d.		d.f		LSD(0.05)		s.e.d.		d.f.		LSD(0.05)		s.e.d.		d.f.		LSD(0.05)	
Grasses	0.1		4		0.3		0.2		4		0.5		0.1		4		0.3	
Cuts	0.1		15		0.1		0.1		15		0.2		0.1		10		0.3	
Cuts within a grass	0.1		15		0.2		0.2		15		0.3		0.1		10		0.3	
Grass within a cut or diff. cuts	0.1		a^+		0.3		0.2		a^+		0.5		0.2		a^{++}		0.5	

a^+; a^{++} = error is a weighted mean of Ea and Eb (Ea = Grass x Replicate; Eb = Cut x Replicate).
n.a. = not available.

also be due to variation in climatic conditions especially rainfall and perhaps soil fertility *(Figure 1)*. Although chemical fertilizer was applied regularly, the indigenous nutrients in the soil could have been depleted. This reduction in DM yield over the years of cutting is an important point to take note because in practice it will determine stocking rate and level of milk production per hectare. Thus, further work is needed to determine optimum stocking rate because this is an important factor influencing both short and long term productivity. Perhaps in the first year, when the grass is plentiful, under cut-and-carry system, a smallholder can keep an extra cow or fatten one or two steers to earn an extra income. However, care has to be taken if a grazing system is adopted as the grazing pressure at the early stages of establishment has an effect on herbage productivity in the later years (WONG, 1980).

The effect of intensive defoliation on regrowth of tropical forages is not fully understood as there is relatively little evidence in the literature. However, WAN MOHAMAD (1983) stated that the effect was similar to temperate pastures. Regrowth was significantly decreased with defoliation intensity and cutting height and was affected by the size of residual leaf area remaining in the stubble. Frequent and intensive defoliation depleted soluble carbohydrate reserves in the roots and stems of the plant (which is required for growth initiation) thus reducing its growth rate (DORRINGTON, 1970). Nevertheless, further research is suggested to look into factors that determine long term productivity of tropical grasses and methods of reducing these losses.

In this experiment, the non-significance in average DM yield between the grasses indicated that there was little difference in their potential production under cut-and-carry system at this level of management. However, a relatively higher DM yield of Guinea, Napier and Setaria compared with Digitaria and Signal grasses, suggested that these species are more suitable for cut-and-carry system.

Besides physiological factors, moisture is also a major factor limiting forage production. Although WONG (1980), CHEN and ABDULLAH HASHIM (1984) reported that DM yield of improved pastures was positively related to the amount of rainfall and number of rainy days, no such relationship (regression analysis between DM yield and rainfall) was found in the current study. However, the results, apparently showed that there was some effect of rainfall on DM yield but the response was after a certain period following the rain. Unfortunately, rain water runoff, soil moisture holding capacity, rate of evapotranspiration and water status of the grasses were not measured to enable the relationship to be established. Thus, in view of reduced DM yield during periods of low rainfall, for example, from May to September, 1981 *(Figure 1)*, further investigation is suggested to determine the degree of adverse effect of moisture stress on forage production. This information will help the farmer to decide whether to irrigate his pasture during the dry season or increase concentrate supplementation to his cows. The level of concentrate supplementation would, however, depend on the quality and availability of the herbage.

The nutritive value of the grasses in this study differed significantly between the species and it decreased significantly with increase in cutting interval. It confirmed similar observations by BUTTERWORTH (1963; 1965), BAUMGARDT, BAYER, JUMAH and KRUEGER (1964), BUTTERWORTH and ARIAS (1965), MINSON and MCLEOD (1970), REID, POST, OLSEN and MUGERWA (1973) and DEVENDRA (1976). The significance of this finding is that maturity of the grasses is associated with reduced availability of nutrients to the animals. For example, CP content declined by an average of 2.1 g/kg DM. day of increasing maturity *(Figure 3)*. *In vitro* DMD value declined by 0.3% units/d *(Figure 5)* while P and K declined by 0.02 and 0.36 g/kg DM. day *(Table 2* and *Table 3)* respectively. Although these rates of decrease in the chemical content of the grasses might look small, they are critical in limiting animal production because the grasses started at a relatively low value. If it is considered that 60 – 80 g CP/kg DM in the pasture is the critical level required by beef cattle before intake is reduced by N deficiency (FRENCH, 1957; BLAXTER and WILSON, 1963; MILFORD and MINSON, 1966a; and BUTTERWORTH, 1967), it means that intake of all grasses at eight-weekly CI in the second and third year by the dairy cattle will be curtailed by N deficiency. Therefore in practice, it is necessary to supplement these grasses with legumes and/or high quality concentrates. Under temperate conditions, dairy cattle rations are formulated to contain at least 160 gCP/kg DM (PHIPPS, WELLER and SMITH, 1981).

As herbage intake by dairy cows is related to digestibility (MILFORD and MINSON, 1966a,b; MINSON, 1971), the decrease in digestibility of the grasses from 650 g/kg DM at two-week to 51 g/kg DM at eight-week regrowth *(Table 4)* will lead to a lower daily intake and consequently lower milk production. WAN HASSAN (1987) estimated that the energy level in these grasses have a potential for supporting a maximum of about 9 kg milk/cow. day. This is consistent with the report by STOBBS and THOMPSON (1975). Higher milk production from these grasses could only be achieved by increasing the stocking rate and concentrate supplementation. However, one has to be careful especially under a grazing situation. COWAN, BYFORD and STOBBS (1975) have shown that although milk yield/ha increased with an increase in stocking rate, milk yield/cow and lactation length decreased markedly. If stocking rate is too high it will have an adverse effect on health, reproduction and pasture stability.

With regards to minerals, even at two-week CI they are already insufficient to meet the requirement of dairy cows producing 10 kg/d of milk (ANON., 1966). Irrespective of maturity of the herbage, mineral supplement is necessary for dairy cows fed on these grasses.

While differences existed in both DM yield and chemical composition of grasses, they were generally small and likely to be relatively unimportant in practical terms, particularly when compared with the major influence of cutting interval. The results suggest that smallholder dairy farmers in Malaysia have a range of improved grasses to choose from, all of which appear capable of producing high DM yields of moderate quality with reasonable persistency if cut at six-week intervals to give a compromise between DM yield, forage quality and persistency. As the results from the current study were obtained from hand-cut replicated plots, further work have to be carried out with lactating cows to evaluate not only the species but also the management systems applicable for smallholder dairy farmers in Malaysia.

ABSTRACT

An evaluation study on dry matter yield and nutritive value at two, four, six, and eight-week cutting intervals within three years was carried out. Five species of locally grown improved grasses namely *Brachiaria decumbens, Digitaria setivalva,* USDA 299892, Panicum maximum cv. Coloniao, *Pennisetum purpureum* and *Setaria sphecalata* var. Splendida were used. The grasses were fertilized with 300 kgN, 50 kgP and 100 kgK/ha. yr in split applications after each cutting. The results showed that 17–26 t DM/ha. yr of medium quality forage (7–9 MJ metabolisable energy/kg DM) could be obtained from these grasses. Dry matter yield of all grasses in the second and third year was approximately half that of the first year's. These was no significant difference in DM yield between the grasses in the first year of production but in the second and third year, Digitaria produced the lowest DM yield and all grasses cut at two and four-week intervals required replanting after one to two years.

The chemical contents were significantly different between the grasses. Dry matter yield and CF content increased significantly with increase in CI while CP, ash and EE contents decreased markedly with increased in CI ($P<0.01$). Similarly *in vitro* DMD declined significantly with increased in CI ($P<0.01$). The results of this experiment also showed that quality, DM yield and persistency to defoliation of these grasses are interrelated. Long CI increased yield and persistency but decreased

quality while short CI increased quality but decreased yield and persistency. Although this study showed that the best CI with respect to quality, DM yield and persistency was between six to eight-week CI, further work with lactating cows to determine milk production potential for each species and the management system applicable for Malaysian dairy smallholders is suggested.

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