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Effects of sheep grazing on the productivity, species changes and succession in native forages under mango

(Kesan ragutan biri-biri terhadap daya pengeluaran, perubahan spesies dan perturutan foraj asli di bawah tanaman mangga)

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Key words: native pasture, stocking rate, species succession, sheep grazing under mango

Abstrak

Musim kering selama 4 bulan di zon iklim tani No. 1 di utara Semenanjung Malaysia telah menimbulkan masalah kekurangan foraj bagi ternakan ragutan. Kadar muatan ternakan yang tinggi antara 17 dan 21 ekor biri-biri sehektar telah mengurangkan foraj di ladang mangga. Walau bagaimanapun, pada kadar muatan ternakan yang rendah iaitu 11 ekor biri-biri sehektar, kawasan tersebut mampu mengekalkan penghasilan foraj berat kering sebanyak 1 000 kg/ha. Keseimbangan komposisi botani jenis rumput dan kekacang dalam foraj terganggu dengan kehadiran ternakan biri-biri. Ini mengakibatkan penambahan populasi jenis-jenis rumput. Kemunculan rumput seperti *Pennisetum polystachion* dan spesies *Brachiaria* tempatan (tidak dapat dikenal pasti) dalam sistem disebabkan oleh ciri agronomi tumbuhan seperti penghasilan biji benih dengan banyak serta pertumbuhan secara agresif di kawasan yang berlembapan rendah dan keadaan persekitaran yang buruk.

Abstract

The 4-month distinct dry season in the agro-climatic zone No. 1 in the north of Peninsular Malaysia has posed a problem on forage resources deficit to grazing animals. High stocking rates of 17 and 21 sheep/ha were detrimental to the persistency of native forages in a young mango plantation. However, at a lower stocking rate of 11 sheep/ha the area was able to maintain the forage dry matter at 1 000 kg/ha. The balance of botanical composition in grass and legume in the forage sward was disturbed by sheep resulting in increased population of monocotyledon grasses. The subsequent succession of grasses such as *Pennisetum polystachion* and an unidentified indigenous *Brachiaria* sp., in the system was due to their agronomic characters of profuse seed setting and aggressive growth in low moisture soil and harsh environments.

Introduction

Kedah is the rice bowl state of Malaysia. Since the implementation of double cropping of padi in the mid-1960s, livestock which is an integral component of such farming system, has been affected.

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Livestock farmers in Kedah generally experience a drop in ruminant production due to the lack of space and shortage of forage. Agro-climatically, the state is situated in the northern part of Peninsular Malaysia in zone No. 1, with a prominent 4-month dry season between December and March. Such condition aggravates the forage resources situation during the long dry season.

The existing mango plantations in the northern states, as in any rubber and oil palm plantation, harbour tremendous amount of green forages which are useful for livestock production. There are reports available indicating the productivity of animals under oil palm (Chen 1991), rubber (Chong et al. 1991) and coconut (Shelton 1991). Yet there is no document available on utilization of such feed resources under mango orchard.

The main aim of this study was to monitor the changes in native forage species and the subsequent succession of plant communities due to sheep grazing in a mango plantation. Attention was also given to the performance of native pastures during the dry season and the level of pasture carrying capacity in sheep production. The records on sheep productivity have been reported separately (Chen and Khairuddin 1993).

Materials and methods

Tree crop and site

Eight hectares of 2-year-old mango trees were selected for this sheep grazing study. The 531-ha plantation was situated at Jeniang, 60 km south of Alor Setar, Kedah (6^{o} N Lat. and 101^{o} E Long.) and located in agro-climatic zone No. 1 with a prominent 4-month drought from December till March yearly. The plantation was mainly planted with mango clone Harumanis at a spacing of 10 m x 10 m. Other clones were Mau Lagi and Simpang Empat. Sunlight penetration and temperature under mango canopy were taken once i.e. 8 months after initiation in early February 1988 *(Table 1)*, but no subsequent reading was taken due to the inavailability of equipment at site. It was observed that more than 60–70% of grazing forage received 70–80% of full sunlight. As such, the mango canopy did not impose a problem to forage growth during the course of the study. Mango yield was not included in this study because the tree crop was not in proper bearing stage then.

Table 1. Changes in temperature and sunlight under mango canopy in early February 1988

Time (h)	Temperature (^{o}C)			Sunlight* (%) under canopy at 3 distances (m) from tree			
	Open	Under canopy	Diff.	1.5	3.0	9.0	10.5
0800	24.8	23.8	1.0	85.8	92.8	91.4	84.3
0830	25.4	24.4	1.0	70.8	96.0	96.0	96.0
0900	27.5	26.4	1.1	58.0	94.8	100.0	95.8
1000	29.4	28.4	1.0	62.0	87.6	89.0	94.7
1100	31.4	29.8	1.6	74.1	99.5	100.0	91.4
1200	33.0	31.8	1.2	90.2	100.0	100.0	97.2
1300	35.2	33.4	1.8	91.2	96.1	100.0	93.7
1400	34.0	33.0	1.9	75.3	80.4	99.1	73.5
1500	35.0	33.8	1.2	93.6	98.2	98.2	52.4
1600	37.4	35.2	2.2	93.9	98.7	96.3	38.8
1700	33.6	32.8	0.8	94.0	98.5	61.7	35.3
1800	32.8	31.4	1.4	96.3	100.0	52.0	34.4

*in east-west direction

Forage

A randomised complete block design was adopted to incorporate four grazing treatments of 11 sheep (SR11), 17 sheep (SR17), 21 sheep (SR21) and no animal (control, SR0 - zero grazing) in two replications. For each treatment, the 1-ha paddock was sub-divided into four sub-paddocks to enable a rotational grazing system of 1 week grazing and 3 weeks resting. The experimental site was an even ground with fairly mixed stands of native forages managed in a normal plantation operation where standard leguminous cover crops viz. *Calopogonium mucunoides, Pueraria phaseoloides* and *Centrosema pubescens* were planted. Monthly forage yield samplings were taken at 12 random sample sites (or 3 samples per sub-paddock) within the 1-ha treatment. The samples were oven dried at 80 °C for 48 h for forage dry matter (DM) yield estimation and later bulked for proximate chemical analysis. Dry weight rank (DWR) method (Mannetje and Haydock 1963) was used to monitor the changes in botanical composition of forage dry weight and frequency of species occurrence in the grazing field. Based on dry matter weight, species which appeared in the 1 m x 1 m quadrat were ranked 1, 2 and 3. The remaining species which were not contributing to the effective forage yield, were recorded with their occurrence. In case of over dominance by a particular species exceeding 75% of the total forage dry weight in the quadrat, modification was made to give two rankings at a time. All those species, irrespective of their ranking, were recorded and added to work out their frequencies of occurrence. The scoring was taken once in every 3–4 months at random over 1% of the total grazing area.

Attempt was made to compute grazing pressure based on the forage DM availability and total liveweight biomass. This would facilitate further scrutiny of the changes in forage resources due to the demand of animals.

Animal

A total of 92 Malin (Malaysian indigenous sheep) ewes of 1.0–1.5 years of age and six rams were used in this study. Animals of different stocking rates viz. SR11, SR17 and SR21 per hectare were confined separately in their respective 1-ha treatment paddock. New born lambs produced from the year-round breeding system were allowed to be with their dams until 3 months of age after which they were weaned and managed separately. In view of the yearly drought, all adult sheep were each given 250 g of rice bran supplement daily during the dry season. Sufficient water and mineral lick were provided in the paddock.

Statistical analysis

All data were subjected to randomised complete block design analysis and to the Duncan Multiple Range Test for level of significance between treatment means. In order to detect the relationship between parameters measured with environmental factors such as rainfall and rainy day, correlation and regression analyses were done.

Results and discussion

Results of correlation and regression analyses showed that there was no direct relationship of forage information such as dry matter (DM) availability and botanical composition to the climatic data except for the nutrient contents of the pasture sward. The overall nutrient contents collected over the grazing period were significantly affected by rainfall. Positive responses of crude protein (CP) and ash, and the negative effects of acid detergent fibre (ADF) from rainfall were detected *(Table 2)*. Details of nutrient contents were given and discussed separately from this article (Chen and Khairuddin 1993). The relationship between rainfall and forage nutrient contents delivered a message that the seasonal changes in forage species and the succession of other plant communities influenced the nutritional values of herbage which

Table 2. Relationship of rainfall with nutrient contents of native forage grazed by sheep in a mango plantation in Kedah

Forage nutrient	Stocking rate (heads/ha)	Correlation coefficient	Regression equation
Crude protein	0	$r = 0.68^{**}$	$y = 9.98 + 0.01x$
	11	$r = 0.75^{**}$	$y = 7.83 + 0.01x$
	17	$r = 0.68^{**}$	$y = 9.48 + 0.01x$
	21	$r = 0.73^{**}$	$y = 8.39 + 0.01x$
Acid detergent fibre	0	$r = 0.53^{*}$	$y = 45.54 - 0.008x$
	11	$r = 0.56^{*}$	$y = 48.08 - 0.013x$
	17	$r = 0.44$ns	$y = 48.65 - 0.013x$
	21	$r = 0.37$ns	$y = 47.89 - 0.010x$
	Overall mean	$r = 0.51^{*}$	$y = 48.21 - 0.012x$
Ash	0	$r = 0.51^{*}$	$y = 4.32 + 0.002x$
	11	$r = 0.64^{*}$	$y = 3.98 + 0.004x$
	17	$r = 0.26$ns	$y = 4.54 + 0.001x$
	21	$r = 0.71^{**}$	$y = 4.04 + 0.005x$
	Overall mean	$r = 0.70^{**}$	$y = 4.19 + 0.003x$

Significance level: * $p < 0.05$, ** $p < 0.01$
ns = non-significant

subsequently affected the performance of grazing sheep.

Forage availability and grazing pressure

The effects of grazing on forage dry matter availability were detected after 9 months of initiation when grazing pressure then built up on the sward *(Table 3)*. DM yields were significantly lower at all stocking rates than that of the control. However, such significant effects on forages were not recorded during the dry season. Similar patterns were shown in the subsequent dry seasons. The DM yields recorded in the first dry season were 1.06–1.44 t/ha at SR21, 1.44–1.80 t/ha at SR17 and 1.23–1.65 t/ha at SR11. Whilst in the last dry season before termination of the experiment, these values dropped to 0.52–0.53, 0.91–0.93 and 0.97–1.10 t/ha for the respective stocking rates of 21, 17 and 11 animals/ha *(Table 3)*. Similar results were obtained from the transformation of feed availability into grazing pressures. The subsequent increases in grazing pressure (or a drop in numerical reading) of the first, second and third dry season were registered respectively as 3.5, 1.6 and 1.4 kg DM/kg liveweight at SR21; as 5.1, 1.5 and 2.8 kg DM/kg liveweight at SR17; and as 6.5, 4.8 and 4.6 kg DM/kg liveweight at SR11 *(Figure 1)*. It was reported that the main forage species were affected when high grazing pressures of 0.98–3.20 units were recorded under oil palm (Chen and Shamsudin 1991) and that subsequently the performance of animal dropped (Mohamad et al. 1987).

Nevertheless, SR11 treatment paddock recorded relatively impressive dry matter yields without much fluctuation when compared with those paddock of medium and high stocking rates. The forage on offer of SR11 was always maintained at around 1 000 kg DM/ha even during the dry season *(Table 3)*.

Botanical composition

There were 28 native species found contributing to effective forage yield. For the ease of statistical analyses, these species were grouped broadly into grasses, legumes, non-edible broadleaved, and edible broadleaved species, according to their acceptability to grazing animal. There were 14 monocotyledon species being grouped together as grasses, whereas the legume

Table 3. Effects of stocking rate and rainfall on mean monthly forage dry matter on offer in a mango plantation in Kedah

Sampling	Forage dry matter on offer (t/ha) at 4 stocking rates (heads/ha)				Rainfall (mm)
	0	11	17	21	
Jul. 87ns	1.96	1.61	1.62	1.62	136
Aug. 87*	2.12a	1.56ab	1.63ab	1.30b	347
Sept. 87*	1.54ab	2.19a	1.50ab	1.20b	305
Oct. 87*	1.53a	1.03ab	1.30a	0.45b	596
Nov. 87ns	1.67	1.16	1.21	0.89	443
Dec. 87ns	1.86	1.65	1.44	1.06	98
Mean	1.78a	1.53ab	1.45b	1.09c	
Jan. 88ns	2.02	1.55	1.95	1.50	25
Feb. 88ns	3.78	1.23	1.85	1.44	162
Mar. 88ns	3.40	1.47	1.80	1.44	89
Apr. 88**	3.30a	1.40b	0.50b	0.88b	267
May 88**	2.08a	1.21b	0.37b	0.48b	209
June 88*	2.43a	1.20b	0.48b	0.45b	168
Jul. 88*	2.04a	1.28ab	0.53b	0.42b	267
Aug. 88*	2.12a	1.40b	0.55b	0.37b	273
Sept. 88ns	2.22	1.86	1.35	1.11	365
Oct. 88*	2.85	2.44a	1.57b	1.10b	276
Nov. 88ns	3.40	2.90	1.57	1.59	290
Dec. 88ns	2.31	2.59	1.67	1.51	36
Mean	2.66a	1.70b	1.18c	1.02c	
Jan. 89*	1.76a	1.71a	1.10b	0.96b	77
Feb. 89ns	1.33	1.24	0.67	0.70	32
Mar. 89ns	1.02	1.04	0.51	0.64	168
Apr. 89*	1.05a	0.96ab	0.39c	0.50bc	463
May 89*	2.08a	1.03b	1.0b	1.10b	291
June 89*	1.81b	1.03b	1.05b	1.04b	150
Jul. 89ns	1.85	1.23	1.58	1.06	239
Aug. 89**	2.15a	1.36	1.20b	1.41b	192
Sept. 89ns	1.99	1.38	1.29	1.46	191
Oct. 89	nr	nr	nr	nr	nr
Nov. 89	nr	nr	nr	nr	nr
Dec. 89ns	2.53	1.53	1.25	1.44	494
Mean	1.77a	1.25b	1.00b	1.03b	
Jan. 90ns	2.32	1.47	0.97	2.88	83
Feb. 90ns	2.44	0.97	0.93	0.53	136
Mar. 90*	2.57a	1.10b	0.91b	0.52b	130
Mean	2.44a	1.18b	0.94b	1.31b	
Overall mean**	2.18a	1.47b	1.15c	1.06c	–

Significance level : * p <0.05, ** p <0.01
ns = non-significant
nr = not recorded
Mean values in the same row with different letters are significantly different at 5%

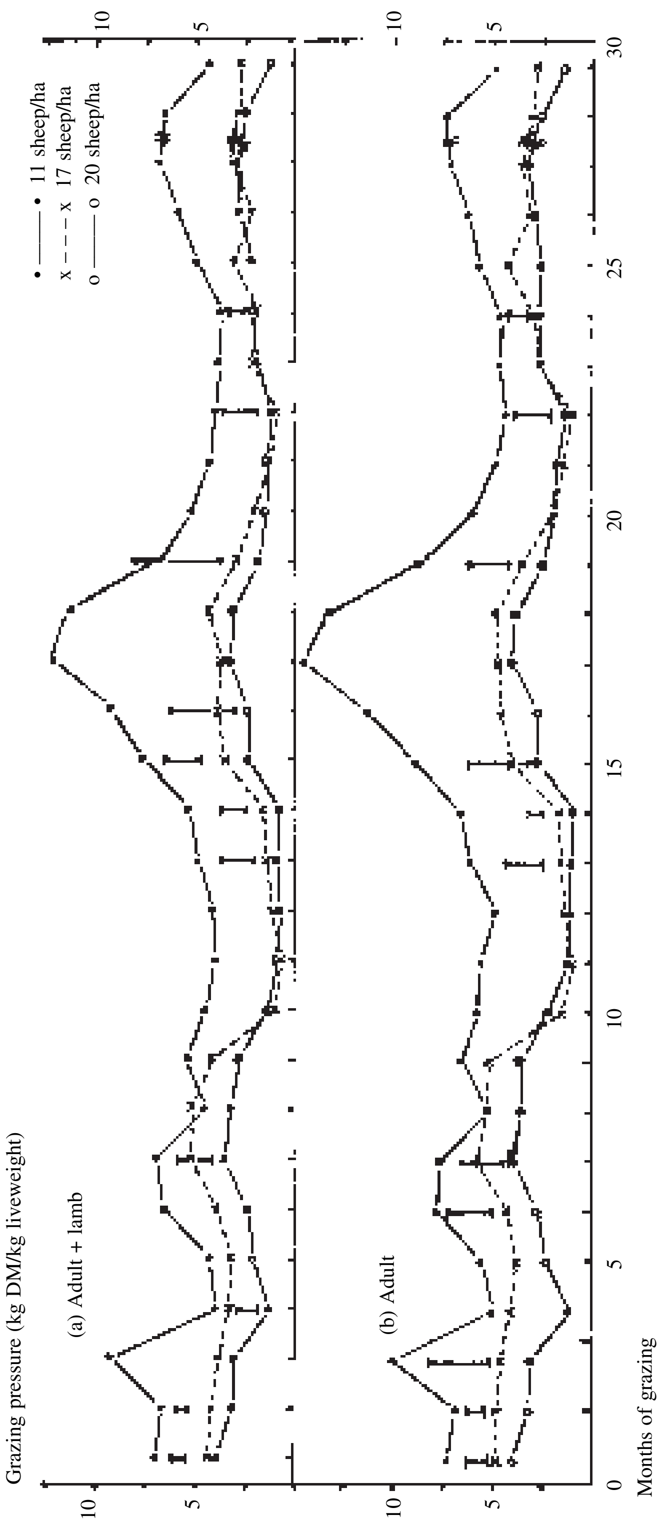

Figure 1. Changes in grazing pressure on native forage in mango plantation

grouping comprised mainly *Calopogonium mucunoides* (about 80%) with a small amount of *Centrosema pubescens* (about 15%) and *Pueraria phaseoloides* (about 5%). The major components of the 50–70% of the total DM were grasses viz. *Brachiaria* sp. (not identified), *Pennisetum polystachion* and *Imperata cylindrica* with the rest made up of *Digitaria adscendens, Chrysopogon aciculatus, Sporobolus diander, S. indicus, Paspalum conjugatum, P. commersonii, Axonopus compressus, Rhynchelytrum repens* and *Ottochloa nodosa.* The non-edible woody species comprised basically those woody plants such as *Eupatorium ordoratum, Lantana camara, Mimosa invasa, M. pudica* and other jungle tree regrowths. The edible dicotyledon plants were mainly *Mikania cordata, Passiflora foetida* and the negligible growth of *Asystasia intrusa.*

Percent dry weight of forage Soon after the initiation of grazing, tremendous differences between forage groups ($p < 0.01$) classified as grasses and legumes were recorded. However, the stocking rate effects on pasture species became evident only a year later. The legume component generally was on the decline irrespective of stocking rates, whereas the grass component showed a progressive increase in its dry weight in the pastures (*Table 4*). The contribution of other groups such as edible and non-edible broadleaved species in the total forage yield was low (around 10% of the total DM yield), particularly the edible broadleaved species. The edible broadleaved plant community was fairly localized and tended to be seasonal.

Frequency of species occurrence This parameter indicates the existence and distribution of forage species in the field. The results showed similar pictures as what were described in the dry weight of forage. The frequency of species occurrence of the grass component increased from 31.7% at the beginning to 65.8% at the end of the study, whereas the legume compositions dropped from 54.4% to 17.7% within the same period, giving an overall mean of 48.7% in grasses and 33.2% in legumes *(Table 5)*. Despite the small contribution of non-edible woody weeds, mainly *Eupatorium ordoratum* and *Lantana camara* (in %DWR), their frequency of occurrence in the field increased from 12.6% initially to as high as 21.6% eventually. This plant community tended to increase its colony steadily among forage sward. The existence could be a threat to the pastures due to their aggressiveness in adaptation and competition. Possibly, some forms of control to limit the spread of *Eupatorium* and *Lantana* species are needed, once in every

Table 4. Changes of botanical composition in dry weight of native forage grazed by sheep in a mango plantation in Kedah

Sampling	Dry weight rank (%)							
	SR0		SR11		SR17		SR21	
	Grass	Legume	Grass	Legume	Grass	Legume	Grass	Legume
Aug. 87	28.8	65.1	49.9	44.5	7.4	68.9	27.3	68.9
Feb. 88	41.0	50.1	61.7	22.3	26.7	37.6	38.8	37.6
Sept. 88	56.4	37.4	78.4	16.9	23.4	37.2	54.6	37.2
Dec. 88	76.8	21.5	88.3	10.9	42.8	22.2	76.5	22.2
Apr. 89	84.2	9.9	88.9	8.1	58.1	13.4	75.3	13.4
June 89	76.6	12.0	62.7	14.6	41.2	41.7	47.2	41.7
Sept. 89	69.8	19.4	63.8	20.9	64.8	25.9	53.7	25.9
Jan. 90	71.6	12.6	92.5	6.2	84.5	3.7	62.0	3.7
Mean	63.2	28.5	73.3	18.1	43.6	31.3	54.4	31.3

Table 5. Changes in frequency of species occurrence of native forages grazed by sheep in a mango plantation in Kedah

Sampling	Species occurrence (%)			
	Grasses	Legumes	Non-edible broadleaved	Edible broadleaved
Aug. 87	31.7b	54.4a	12.6c	2.4c
Feb. 88	46.5ns	33.6ns	17.9ns	2.2ns
Sept. 88	44.5a	37.2b	15.9c	2.5d
Dec. 88	49.6a	34.2b	14.8c	2.8c
Apr. 89	56.4a	29.2b	12.6c	2.5c
June 89	44.3a	31.9b	20.8c	3.2d
Sept. 89	47.4a	29.3b	21.6b	2.1c
Jan. 90	65.8a	17.7b	17.5b	0
Overall	48.7a	33.2b	16.6c	2.6d

Mean values within the same row with different letters are significantly different at $p < 0.01$
ns = non-significant

2 years. Under such ecological environments and with the designed grazing pressure, the edible broadleaved plants (*M. cordata* and *P. foetida*) might not be able to prosper.

Succession of the main forage species

The influence of rainfall and stocking rate on both the pasture productivity and botanical composition was not significant. It indicated superficially that either the design of stocking rate was too high initially or the persistence of forage failed to sustain the grazing. Yet, research results proved otherwise. It is clearly shown in this study that the grass communities were more favoured than those of the legumes and the edible broadleaved plants. When scrutinizing the changes and succession of individual forage species, all those major contributors to forage yield, for instance the grasses such as *Brachiaria* spp. and *Pennisetum polystachion* (mission grass or *ekor kucing* in Malay), were building up in population with time. These species seemed not to be affected by grazing very much. *Brachiaria* spp. increased the contribution from 19.7% of total DM yield initially to 25.4% before termination, whereas the *ekor kucing* increased in population from a negligible level to as high as 31.6% (or equivalent to 36.9% of total forage DM) within the same period of time *(Figure 2)*. Kerridge et al. (1986) stressed on constraint to plant growth that in all climatic zones plant species differred in their adaptation to low fertility soils. Plant species that are adapted to the unfavourable rainfall and soil fertility have developed strong survival mechanisms. These are based on vegetative propagation and competitive ability to exclude other species or on ability to produce copious seed.

It was observed that the aggressive colonizers i.e. the grass communities were having specific means either of fast growing in the grazing field or of profuse seed setting as compared with the legumes which either failed to flower, had little seed set or slow in sward establishment. *Brachiaria*, a local unidentified species, grows fast but has little seed set, colonizes the area through its strong stoloniferous-like runners. It roots easily at the nodes whenever it touches the ground and remains green even during the dry season. *Ekor kucing* sets viable seed profusely, and has been renowned for its aggressive growth on poor soils and water-stressed areas (Mannetje and Jones 1992).

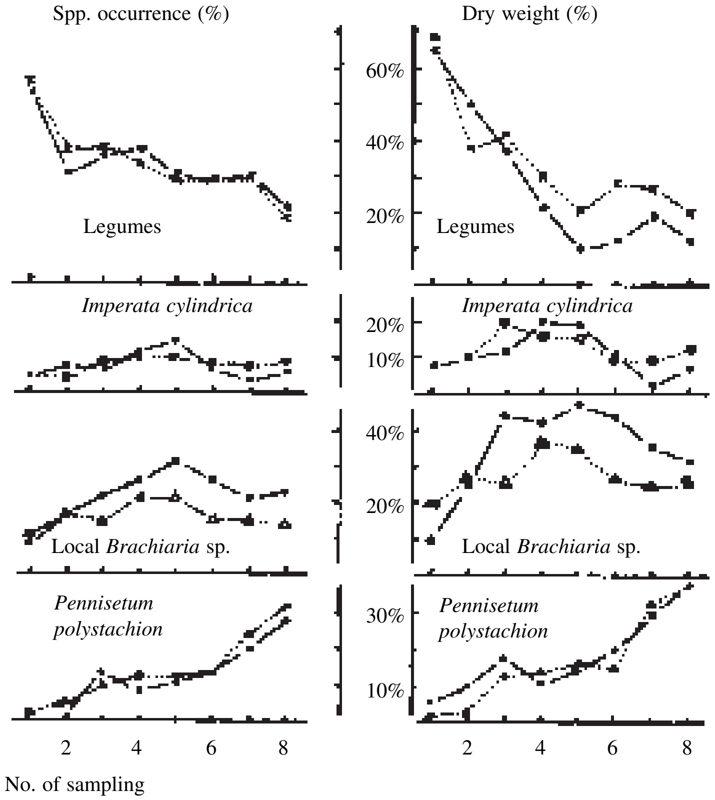

Figure 2. Changes and succession of major forage species in species occurrence and forage dry matter as affected by sheep in mango plantation

Surprisingly, the noxious weed, *Imperata cylindrica* (lallang) was confined to about 10% level and the legumes dropped from 68.3% to 19.4% in yield contribution. The increase in population of the non-edible woody species was actually due to their non-palatability of sward and the deep rooting agronomic characters.

Implication of the findings

The 4-month distinct dry season of agro-climatic zone No. 1 in the north poses a problem of forage resources to grazing animals. Pasture sward with a balanced botanical composition of grass and legume components was disturbed. Optimal stocking rate at which stable native pastures were maintained, was observed to be at 11 sheep/ha. However, such optimal stocking rate may be difficult to comply with in mob grazing in uncontrolled public grazing reserved area. To ease the management problem on feed resources, supplementary feeding in the forms of concentrates, agro-byproducts, other fodder tree leaves or silage/hay could be a useful strategy to help the animals through dry season. Results indicate that the succession and persistence of forage species under grazed situation would depend upon the aggressiveness of its agronomic characters, such as profused seed setting of *ekor kucing*, and the aggressive runners in the case of *Brachiaria* species.

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