THE PERFORMANCE OF GOATS OFFERED ELEPHANT GRASS *(PENNISETUM PURPUREUM)* WITH VARIED AMOUNTS OF LEUCAENA OR CONCENTRATE

N. G. YATES[1] and T. PANGGABEAN

Project for Animal Research and Development P. O. Box 123, Bogor, Indonesia
[1]Present address: Roseworthy Agricultural College, Roseworthy, South Australia 5371

ABSTRACT

Thirty Kambing Kacang does were divided into 9 groups and given the following treatments: Elephant grass ad lib. *(A); Elephant grass* ad lib. *plus either 25% of* ad lib. *concentrate (B); 50%* ad lib. *concentrate (C); 75%* ad lib. *concentrate (D);* ad lib. *concentrate (E); 25%* ad lib. *leucaena (F); 50%* ad lib. *leucaena (G); 75%* ad lib. *leucaena (H) or* ad lib. *leucaena (J).*

Liveweight change, dry matter intakes, feed conversion ratios and the proportions of each feed consumed were measured over a 12-week period.

Animals offered 100% elephant grass lost weight (−19g/day). Liveweight gains increased with increasing intakes of both leucaena and concentrate up to ad lib. *intakes of each. The intake of elephant grass declined with increasing intakes of concentrate and leucaena. The maximum liveweight gains were 76g/day with concentrate and 43g/day with leucaena and the corresponding feed conversion ratios were 6.3 and 12.9.*

RESUMEN

Treinta cabras Kambing Kacang fueron divididas en 9 grupos y sometidas a los siguientes tratamientos: pasto Elefante ad lib. (A); pasto Elefante ad lib. mas 25% de concentrado ad lib. (B); más 50% de concentrado ad lib. (C); ó más 75% de concentrado ad lib. (D); concentrado ad lib. (E); ó más 25% de leucaena ad lib. (F); más 50% de leucaena ad lib. (G); ó más 75% de leucaena ad lib. (H); ó leucaena ad lib. (J).

Durante un periodo de 12 semanas se midió el cambio de peso vivo, el consumo de materia seca, la eficiencia de conversión y las proporciones de consumo de cada alimento.

Los animales sometidos a una dieta de 100% de pasto Elefante perdieron peso (−19 g/dia). La ganancia de peso incrementó con incrementos del consumo tanto de leucaena como de concentrado hasta el consumo ad lib. de cada uno individualmente. El consumo de pasto Elefante declinó con incrementos en el consumo de concentrado y leucaena. La máxima ganancia de peso fue de 76 g/dia con concentrado y 43 g/dia con leucaena y las correspondientes proporciones de conversión fueron de 6.3 y 12.9.

INTRODUCTION

Tropical grasses generally have low protein levels and a high proportion of cell wall. Their nutritive value is lower than for temperate grasses grown in temperate climates and they support lower levels of production by ruminants (Minson 1981).

Protein intake can be increased by increasing the nitrogen content of grass through fertilizer application (Minson 1973), or by supplementation of the diet with protein or non-protein nitrogen. Both strategies increase feed intake (Graham 1967; Minson and Milford 1967; Minson 1973).

Once the protein requirement of animals has been satisfied, the supply of other nutrients determines the level of production. The occurrence of a mineral deficiency or imbalance can be corrected with supplements, but if the aim is to maintain a high proportion of grass in the diet, increasing the energy supply is more difficult. It is generally necessary to replace the grass of high cell-wall content with a more digestible feed to obtain a substantially higher energy intake and level of production.

This paper reports a study of the effects of increasing amounts of (a) an energy- and protein-containing concentrate and (b) leucaena (*Leucaena leucocephala*) on feed intake and performance of goats offered *ad lib.* Elephant grass (*Pennisetum purpureum*). The levels of concentrate and leucaena varied from zero to 100% of the *ad lib.* intake of each.

MATERIALS AND METHODS

Thirty Kambing Kacang does with an initial liveweight of 12.3 ± 1.9 kg were used. They had been treated for internal and external parasites before the experiment began and were housed in individual pens with slatted floors in a closed shed.

The animals were allocated by stratified randomization based on liveweight to the following treatments; the number of animals per treatment is shown in brackets:

A. Elephant grass *ad lib.* (3)

Elephant grass *ad lib.* plus commercial concentrate at the following levels:

B. 25% *ad lib.* (3)
C. 50% *ad lib.* (3)
D. 75% *ad lib.* (3)
E. *ad lib.* (4)

Elephant grass *ad lib.* plus leuceana at the following levels:

F. 25% *ad lib.* (3)
G. 50% *ad lib.* (3)
H. 75% *ad lib.* (3)
J. *ad lib.* (4)

The elephant grass, from 6-week regrowths, was cut daily and chopped in a commercial forage harvester before feeding. The leucaena used was either cv. Hawaii or cv. Cunningham; it was cut daily and the leaves and small twigs were chopped before feeding. The commercial concentrate contained 50% wheat pollard, 42% ground maize, 2% leucaena leaf meal, 2.3% soybean meal, 2% calcium carbonate, 0.7% salt and 1% trace element mix. Water was available *ad lib.*

There was a 3-week adjustment period followed by a 12-week measurement period. Feed intakes were recorded daily and means calculated on a weekly basis. Liveweights were recorded weekly. Feed samples were taken weekly; 1 subsample was dried at 100 °C for dry matter determination and another subsample was stored at −10°C for chemical analysis. In treatments B to J, feed materials were offered in separate containers. Feed residues were weighed daily and discarded.

Feed samples were freeze-dried and ground in a laboratory mill with a 1 mm screen. They were analyzed for NDF (Van Soest and Wine 1967), and ash, crude protein, ether extract, gross energy, calcium and phosphorus by methods described by Wahyuni *et al.* (1982). The results are shown in Table 1.

TABLE 1

Chemical composition of feed ingredients offered to goats (DM basis).

	Gross Energy	Crude Protein	NDF	Ash	Ether Extract	Ca	P
	(MJ/kg)	(%)	(%)	(%)	(%)	(%)	(%)
Elephant Grass	17.5	7.5	69.8	10.8	2.9	0.31	0.27
± s.e.	0.5	0.9	2.2	1.1	1.6	0.13	0.04
Concentrate	18.2	13.6	18.2	5.4	3.7	1.12	0.51
± s.e.	0.3	0.6	1.6	0.8	1.2	0.30	0.09
Leucaena	20.5	22.5	33.8	6.4	4.2	1.07	0.31
± s.e.	0.4	3.0	4.2	0.7	0.6	0.26	0.05

The relationships between liveweight change and intakes and between the intake of leucaena or concentrate and either total dry matter intake or the intake of elephant

grass were determined by least squares using multiple regression analysis. Liveweight changes were determined from initial and final liveweights.

RESULTS

Animals offered 100% elephant grass lost weight at the rate of 19 g/day (Table 2). As concentrate and leucaena intakes increased there were positive responses in liveweight change (Fig. 1). Maximum liveweight gains were 76 and 43 g/day for concentrate and leucaena respectively at *ad lib.* intakes. Approximately 180 and 220 g/day of concentrate and leucaena, respectively, were required in addition to the grass intake to maintain liveweight.

TABLE 2

Intakes and performance of goats offered elephant grass with graded levels of leucaena or concentrate.

	Leucaena eaten[1]:					Concentrate eaten[1]:				
	Nil	27%	53%	75%	100% (% *ad lib.*)	Nil	25%	48%	73%	100%
Total Dry Matter Intake (g/day)	310	350	430	520	660	310	340	360	460	560
Liveweight Change (g/day)	−19	−3	15	32	43	−19	−14	25	56	76
Feed Conversion Ratio	–	–	23.9	14.1	12.9	–	–	12.0	7.0	6.3
Leucaena/Concentrate										
– Intake (g/day)	0	170	340	480	640	0	130	250	380	520
– Percentage of Total DMI	0	49	79	92	97	0	37	69	83	93

[1]The proportions of *ad lib.* intakes actually eaten varied slightly from that proposed in the design.

At any level of total feed intake, the performance of goats was always better on the grass/concentrate diet compared with the grass/leucaena diet. On the other hand, at any level of total feed intake, the intake of protein was always greater with the grass/leucaena diet.

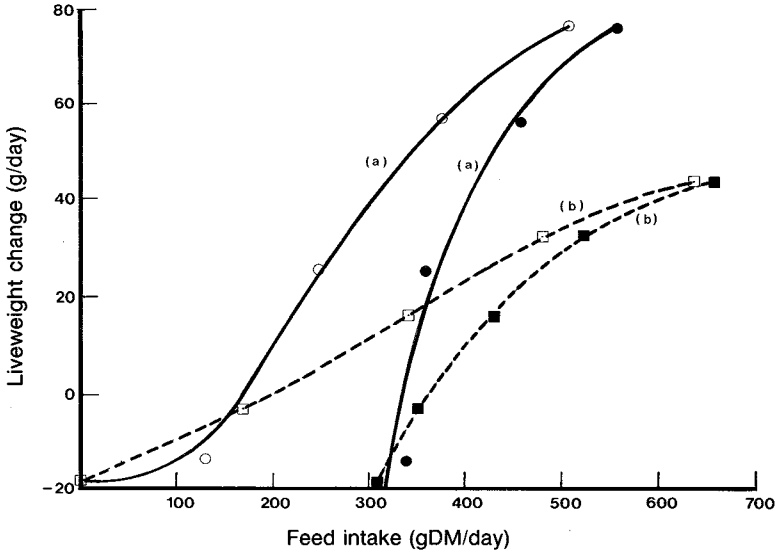

FIGURE 1

(a) The relationships between intakes of concentrate o———o and total dry matter ●———● and liveweight change in goats offered elephant grass with graded levels of concentrate.
(b) The relationships between intakes of leucaena □- - - -□ and total dry matter ■- - - -■ and liveweight change in goats offered elephant grass with graded levels of leucaena.

The relationships between liveweight change and either total dry matter intake or the intakes of concentrate or leucaena can be expressed by the following equations:

(1) for grass plus concentrate:

$$LWC = -405.0 + 1.7160\ DMI_T - 0.001530DMI_T^2$$

$$LWC = -19.6 - 0.1229DMI_C + 0.001642DMI_C^2 - 2.03 \times 10^{-6}DMI_C^3$$

(2) for grass plus leucaena:

$$LWC = -268.6 + 1.3170DMI_T - 0.001970DMI_T^2 + 1.04 \times 10^{-6}DMI_T^3$$

$$LWC = -19.0 + 0.0672DMI_L + 0.000168DMI_L^2 - 1.88 \times 10^{-7}DMI_L^3$$

where LWC = liveweight change (g/day)

DMI_T = total dry matter intake (g/day)

DMI_C = concentrate intake (g DM/day)

DMI_L = leucaena intake (g DM/day)

These equations were used to fit lines to the data in Fig. 1.

Total dry matter intake increased with increasing intakes of leucaena and concentrate. The relationships between total dry matter intake and the intake of concentrate and between total dry matter intake and the intake of leucaena (Fig. 2) were indistiguishable statistically, the only difference being that not as much concentrate could be consumed, compared with leucaena. The data were therefore pooled and the relationship between total dry matter intake and the intake of leucaena and concentrate was expressed by the equation:

$$DMI_T = 308.5 + 0.0974DMI_{L/C} + 0.000724DMI_{L/C}^2$$

This equation was used to fit a line to the data in Fig. 2(a).

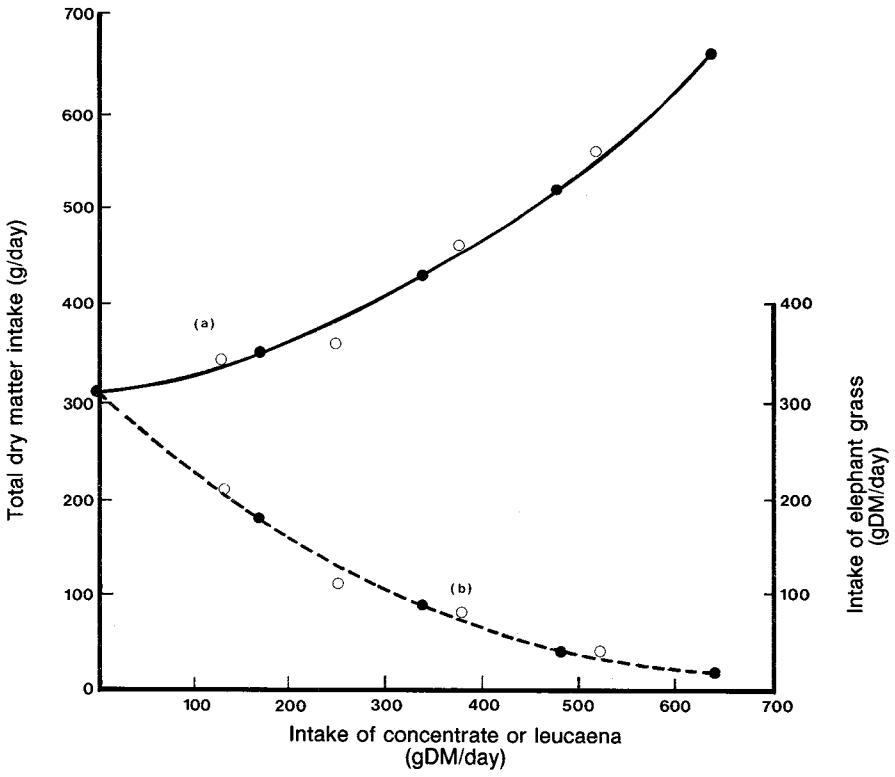

FIGURE 2

The relationships between intakes of concentrate (o) and leucaena (●) and (a) total dry matter intake, and (b) intake of elephant grass, in goats.

The intake of elephant grass declined with increasing intakes of leucaena or concentrate. The relationships between the decline in the intake of elephant grass with increasing intake of leucaena and between the decline in the intake of elephant grass with increasing intake of concentrate were indistinguishable statistically. The data were therefore pooled and the relationship was expressed by the following equation:

$$DMI_{EG} = 308.5 - 0.9026DMI_{L/C} + 0.000724DMI^2_{L/C}$$

where DMI_{EG} = elephant grass intake (g DM/day)

This equation was used to fit a line to the data in Fig. 2(b).

Feed conversion ratios improved with increasing intake of concentrate and leucaena but the feed conversion ratios for the leucaena/grass diet were, in all cases, about double those for the concentrate/grass diet (Table 2).

DISCUSSION

Dose-response studies in animal nutrition provide useful practical information and the results can be used for economic analyses at any time as input and output values alter.

Even though sheep (Obst, Napitupulu and Boyes 1982) and cattle (Moran 1980) eating elephant grass as a sole diet can gain weight, their performance is poor and additions to the diet must be made to improve performance. This strategy is critical in situations such as those observed in the present study where goats lost weight on a sole diet of elephant grass.

On the other hand offering goats a grain-based balanced concentrate *ad lib.* with the grass allowed them to express their potential growth rates, shown to be approximately 80 g/day. A comparison of this strategy with one where leucaena was provided *ad lib.* in addition to the grass demonstrated the superiority of the concentrate in promoting liveweight gain both in terms of efficiency of feed use and the maximum liveweight gains obtained. In fact over the range of intakes of concentrate and leucaena from nil to *ad lib.* the goats performed better with concentrate, when intakes of concentrate and leucaena were similar. This difference was not explained by differences in total dry matter intake but was more likely due to a higher metabolizable energy intake on the concentrate/grass diet because of the higher metabolizable energy content of the concentrate compared with leucaena.

The addition of small quantities of legume to the diet of sheep fed Pangola grass (*Digitaria decumbens*) stimulated grass intake in the study of Minson and Milford (1967), i.e. there was a supplementary effect of the legume. With higher intakes of legume total feed intake continued to increase but there was a substitution, or replacement, effect because the intake of Pangola grass declined. There was no evidence of a supplementation effect due to either concentrate or leucaena in the present study even at, or below, those levels of concentrate or leucaena required for maintenance of liveweight.

The response to small quantities of legume in Minson and Milford's study was explained in terms of the legume overcoming the depressing effect that the low crude protein content of the grass (3.6%) was having on grass intake. One of the reasons why no supplementary effect was observed in our study could have been because the crude protein content of the elephant grass used was 7.5%. This level of crude protein *per se* was probably not limiting grass intake based on information cited by Minson and Milford.

An interesting observation in our study was that similar intakes of leucaena and concentrate resulted in similar total feed intakes. The corollary of this, of course, is that goats ate the same quantity of grass at equivalent intakes of leucaena and concentrate. We interpret this as meaning that intakes of leucaena, up to *ad lib.* intake, did not impose a physical limitation on total feed intake.

The other aspect relating to feed intake—that of the depression in grass intake by leucaena and concentrate—has parallels in other studies involving the provision of

concentrate supplements to grazing animals (see Allden 1980). Although the relationships between the intake of grass and the intakes of leucaena and concentrate were best expressed by the inclusion of a quadratic function in our study, for the purposes of comparison with other data, a linear relationship is assumed in order to calculate a value for the depression in grass intake in relation to increases in intake of leucaena or concentrate. Using this method, the intake of grass was depressed by 45g per 100g leucaena eaten (DM basis) and by 50g per 100g concentrate eaten (DM basis). These values are lower than the range of 50 to 70 quoted by Allden (1980) for depression in forage intake with concentrate supplements.

In conclusion, this study has demonstrated the usefulness of leucaena in improving the performance of goats offered elephant grass. Although grain-based concentrates such as the one used in this study have consistently given the best liveweight gains in small ruminants at this Centre, they generally require a cash outlay whereas leucaena may not. This is a significant consideration for stockowners in developing countries.

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