EFFECT OF FLOCK SIZE ON THE PERFORMANCE OF GOATS FED GLIRICIDIA-SUPPLEMENTED DIET IN DRYLAND FARMING IN BALI, INDONESIA

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Summary

On-farm experiments were carried out in dryland farming in Bali for 48 weeks to study the effect of flock size on the growth and carcass characteristics of cross-bred goat fed gliricidia-supplemented diet. Eighty four bucks with average live weight of 15.87 kg were allocated in a completely randomized block design arrangement, consisted of three treatments and four blocks. The treatments were 3 goats/2.7 m^2 (A), 6 goats/5.4 m^2 (B) and 12 goats/10.8 m^2 (C), while the floor density was the same (0.9 m^2 per goat). Feed consumed by goat B was similar ($p > 0.10$), while feed consumed by goat C was lower ($p < 0.10$) than goat A. Live weight gain of goat B and C were lower ($p < 0.05$) than goat A. FCR of goat B was higher ($p < 0.10$) than goat A, while FCR of goat C was similar ($p > 0.10$) with goat A. Goat B has heavier ($p < 0.10$) head and digestive tract, while goat C has heavier ($p < 0.10$) hindlegs and digestive tract than goat A. Goat B has lighter ($p < 0.10$) shoulder, while goat C has lighter shoulder and heavier legs ($p < 0.10$) than goat A. The carcass quality (measured in terms of loin eye muscle area, meat, bone and fat portions) were not affected ($p > 0.05$) by the flock sizes.

(Key Words: Flock Size, Goat, *Gliricidia sepium*, Growth, Carcass Characteristics)

Introduction

Gliricidia sepium is believed to be the most widely cultivated multipurpose shrub legume, after *Leucaena leucocephala*. Under certain condition gliricidia produced as much as or more biomass than *L. leucocephala* (Stewart et al., 1992). *G. sepium* is commonly used to supplement poor quality roughage, and during the dry seasons it may become a major source of feed for goats and cattle in dryland farming areas (Wiersum and Nitis, 1992; Simons and Stewart, 1994).

Since 1977 the Indonesian Government has given priority to goat development in smallholder dryland farming areas, because they are quicker yielding, have lower capital investment and lower risk of capital lost, and have better manure quality than the large ruminant, and in certain cases as a component of a landless animal production system (Kearl, 1982).

Experiments showed that Bali cattle fed sole diet of *G. sepium* only consumed 1.9% dry matter of its body weight and gained 36 g/day (Nitis et al., 1990), while cross-bred goat fed sole *G. sepium* diet consumed 3.7% dry matter of its body weight and gained 80 g/day (Nitis et al., 1991). Some Bali cattle may go-off feed when firstly introduced to *G. sepium* diet (Nitis et al., 1989), while for the goat it was not the case (Nitis et al., 1991).

The bucks tend to bully one another when raised in a flock. The bullying become more intense when the flock density increased, since there is less chance of the weaker goat to run away from the stronger goat (Matsuzawa and Shiraishi, 1992). Although ranking order is finally established, the weaker goat still has less opportunity to select the feed and more opportunity to get bruises. The bullying effect can be minimised either by narrowing the live weight ranges in the flock, by increasing the floor space or by reducing the flock density.

The objectives of this experiment was to study the effect of flock size on the performance of the goat fed gliricidia-supplemented diet in dryland farming area in Bali, Indonesia.

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Materials and Methods

Location

The on-farm experiment was conducted in the dryland farming area of southern Bali, in the semi-arid climatic zone, 1681 mm average annual rainfall with 96 rainy days distributed during the four months wet season (Dec. to Mar.) and eight months dry season (Apr. to Nov.). The mean daily temperature varied from 25 to 29℃ with relative humidity varied from 65 to 86% (Nitis et al., 1989).

Goat

Ninety PE (Etawah and Kacang cross-bred) bucks with average live weight of 15.87 kg were bought in mid-dry season from Busungbiu village 112 km from the experimental site. Of the 90 bucks, 84 were selected for the experiment, while the other 6 were used as reserve.

Stall

The stall was housed in a shed with corrugated tin roof and hardened soil floor. The stall consisted of elevated bamboo slatted floor and bamboo feed trough (1 m above the ground). Each goat occupied 1.5 m length × 0.6 m width floor space, 0.6 m length × 0.5 m width × 0.5 m height bamboo feed trough with 10-15 cm feed rail and 0.5-1.0 cm spacing bamboo slatted floor. The floor space for the 3, 6 and 12 goats increased proportionally, so that the differences between the 3 stalls were due to its goat number per stall and not due to its goat density. To stop the goat from getting out the stall, the partition was adjusted in such that only the head of the goat can get in the feed trough. To minimise from bruising of the neck, whole bamboo (instead of splitted bamboo) was used as partition. The shed was fenced with *G. sepium*, planted at 10 cm spacing to stop intruder disturbing the goat.

Feedstuffs

The forage fed to the goat consisted of grass, ground legumes, shrub legumes and tree fodders as described in the Three strata forage system (Nitis et al., 1989).

Design

The completely randomized block design consisted of 3 treatments and 4 blocks. The 3 treatments consisted of 3 goats/2.7 m^2 (A), 6 goats/5.4 m^2 (B) and 12 goats/10.8 m^2 (C), with the same floor density (0.9 m^2 per goat). The 90 goats were ranked according to live weight, with the 3 extreme light and heavy weights were discarded (used as reserved). The 84 goats were selected in such that the live weight of each goat within block Ⅰ, Ⅱ, Ⅲ and Ⅳ and also the average live weight of goats in each block either Ⅰ, Ⅱ, Ⅲ or Ⅳ for flock A, B and C were similar, so that the average live weight of goat in flocks A, B and C was similar. This exercise was taken to prevent the bigger goats bullying the smaller goats as was the case of the previous experiment (Putra et al., 1994). Each goat was identified with different number within the treatments and between the blocks.

Feeding

The grass, ground legume, shrub and tree fodders were cut in the afternoon and fed to the goat the next day. The forage was offered *ad libitum* with feeding frequency twice a day (morning and afternoon). Drinking water was always available in the stall.

Observation

All the goats were weighed every 4 weeks without prior fasting before weighing. The feed offer and refuse were also weighed for 2 days before weighing the goat. One kg sample of the feed offered and 0.5 kg sample of the feed refuse were taken to determine botanical composition and sub-sample was taken for dry matter (DM) determination. At the end of the experiment, one goat representing the average live weight of each treatment and each block was slaughtered according to Moslems custom. It was partitioned for body composition (head, hide, tail, forelegs, hind legs, internal organ and digestive tract) and carcass composition (foreshank, brisket, shoulder, breast, rack, leg and short loin) according to the method described by Levie (1970).

Farmers participation

Twelve farmers, selected from members of the Three strata forage system, cut the forage, feed and care the animal. Each farmer either kept 3, 6 or 12 goats according to their preferences. At the end of the experiment all the goats (except those slaughtered) were sold and the proceeds was devided equally (half for the farmer and half for the project) after being deducted from the original price of buying the goat.

Duration of the experiment

The experiment which was carried out for 48 weeks consisted of 28 weeks dry season, 16 weeks wet season and 4 weeks dry season.

Statistical analysis

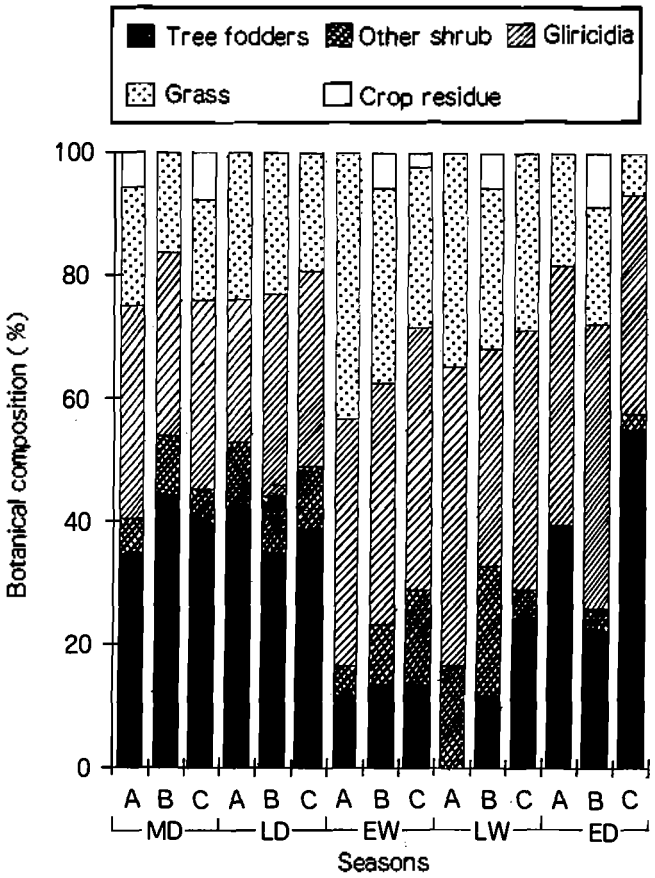
Data were analysed with analysis of variance and the significant differences between treatment means was assessed by the new Duncan's multiple range test (Steel

and Torrie, 1960). Since it is on-farm research 2 level of significants ($p < 0.05$ and $p < 0.10$) were applied.

Results

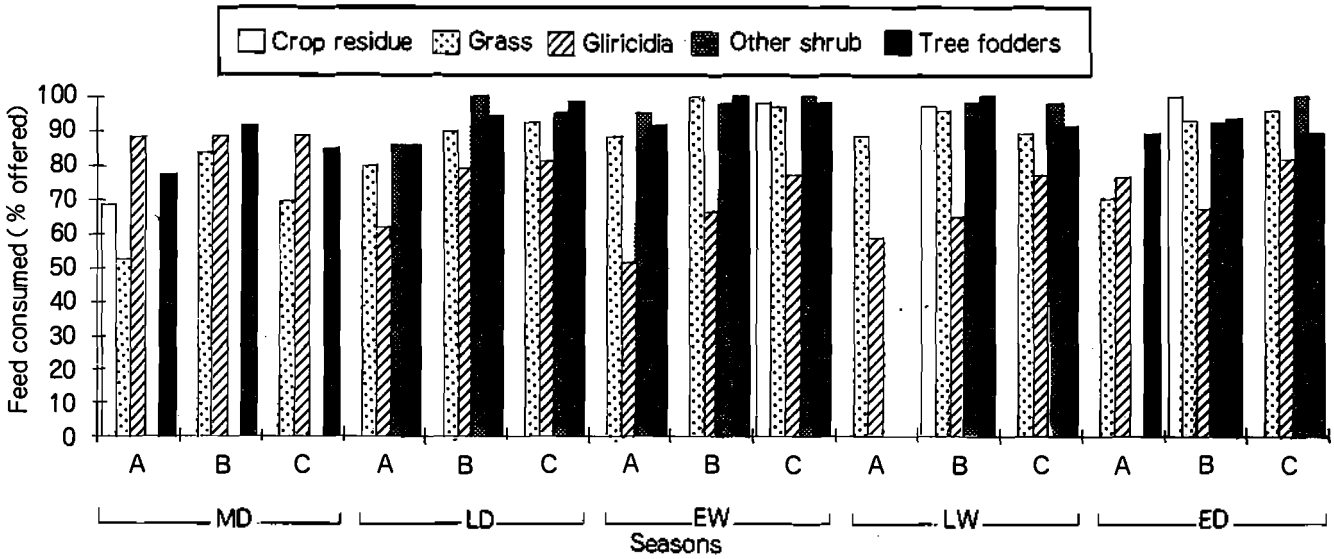
In terms of feed offered, gliricidia fodder was fed at similar amount to all the goat flock sizes, since the gliricidia was used as supplement (figure 1, table 1); while the feeding of more grass during the wet season and more tree fodder during the dry season was in accordance to the Three strata forage system concept. Eventhough gliricidia feeding was not in line with the Three strata forage system concept, however in terms of feed consumption, the higher amount of gliricidia consumption during the dry season by all the goat flock sizes, were in accordance to the Three strata forage system concept (figure 2, table 2). Furthermore, as the flock size increased, the shrub and tree fodder consumptions increased both during the wet and dry seasons. Such increased was mainly due to the more consumption of small branches, since the leaf rachis and stem peel consumptions were similar.

At the start of the experiment, the average initial live weight of goat A (3 goats/2.7 m^2), goat B (6 goats/5.4 m^2) and goat C (12 goats/10.8 m^2) were made similar ($p > 0.05$) (table 3). However, as the goat become bigger, the live weight discrepancy between goat A, B and C become bigger (figure 3). The smaller live weight gain ($p < 0.05$) of goat B and C than goat A at 48 weeks experimental period, was mainly due to the smaller live weight gain ($p < 0.05$) during 32 weeks dry season, since the live weight gain during the 16 weeks wet season was similar



MD = Mid dry, LD = Late dry, EW = Early wet, LW = Late wet, ED = Early dry, A-C = Goat

Figure 1. Botanical composition of the forage fed to the goat during the dry and wet seasons



MD = Mid dry, LD = Late dry, EW = Early wet, LW = Late wet, ED = Early dry, A-C = Goat

Figure 2. Botanical composition of feed consumed (% offered) of the goat during the dry and wet seasons

TABLE 1. BOTANICAL COMPOSITION OF THE FORAGE FED TO THE GOAT DURING THE DRY AND WET SEASONS

Season	Forage	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	Average	Season	Forage	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	Average
		····· Botanical composition (%) ·····						····· Botanical composition (%) ·····			
Dry season	Grass	21.44	24.43	14.04	19.97	Wet season	Grass	39.33	29.10	27.71	32.05
	Gliricidia	39.12	40.04	42.00	40.39		Gliricidia	44.76	37.32	42.14	41.41
	Other shrubs	5.29	7.83	5.73	6.28		Other shrubs	10.07	15.93	9.79	11.93
	Trees	30.33	25.24	36.22	30.60		Trees	5.84	11.49	18.98	12.10
	Crop residue	3.82	2.46	2.01	2.76		Crop residue	–	6.16	1.38	2.51

TABLE 2. BOTANICAL COMPOSITION OF THE FEED CONSUMED (% OFFERED) OF THE GOAT DURING THE DRY AND WET SEASONS

Season	Forage	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	Average
		··· Botanical composition (% offered) ···			
Dry season	Grass	66.75	87.23	84.70	79.56
	Gliricidia	74.34	77.27	82.17	77.93
	Other shrubs	28.00	62.89	64.41	51.77
	Trees	82.48	91.07	89.33	87.63
	Crop residue	22.33	33.33	0	18.55
	Forage components:				
	Leaf	90.78	92.43	92.10	91.77
	Peel	76.14	76.22	79.20	77.19
	Small branches	32.76	53.48	52.36	46.20
Wet season	Grass	86.98	97.00	91.78	91.92
	Gliricidia	54.38	64.73	75.70	64.94
	Other shrubs	46.50	96.50	97.50	80.17
	Trees	89.80	99.50	92.68	93.99
	Crop residue	0	50.00	48.00	32.67
	Forage components:				
	Leaf	86.28	88.51	92.82	89.20
	Peel	71.10	75.82	94.30	80.41
	Small branches	16.72	44.57	43.62	34.97

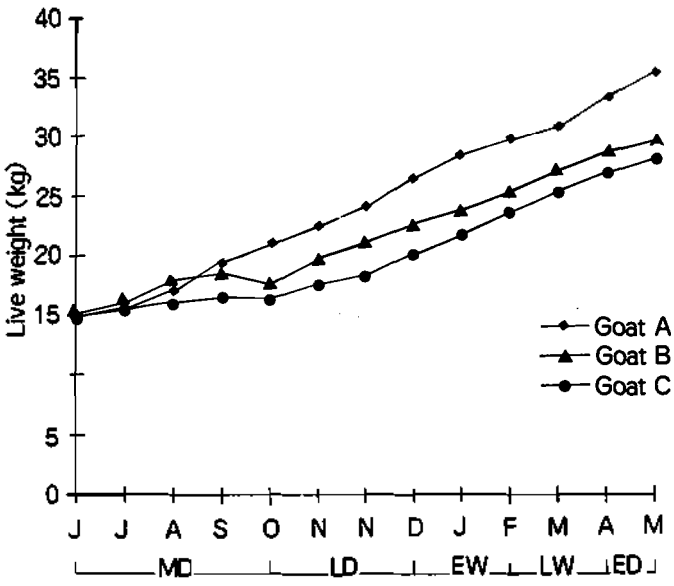


Figure 3. Live weight of the goat during the dry and wet seasons

($p > 0.05$). Furthermore, goat B even lost weight at the end of the dry season (figure 4). The slightly higher ($p > 0.10$) feed consumption of goat B than goat A was mainly due to slightly higher feed consumption during the wet season; while the lower feed consumption ($p < 0.05$) of goat C than goat A was due to lower feed consumption during the wet and dry seasons (figure 5). Therefore, the lower live weight gain of goat B than goat A was due to the inefficient feed utilization ; while the lower live weight gain of goat C than goat A was due to not enough feed being consumed despite the fact the forage was offered *ad libitum*, but not 100% consumed (vide table 2).

TABLE 3. EFFECT OF FLOCK SIZE ON THE PERFORMANCE OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

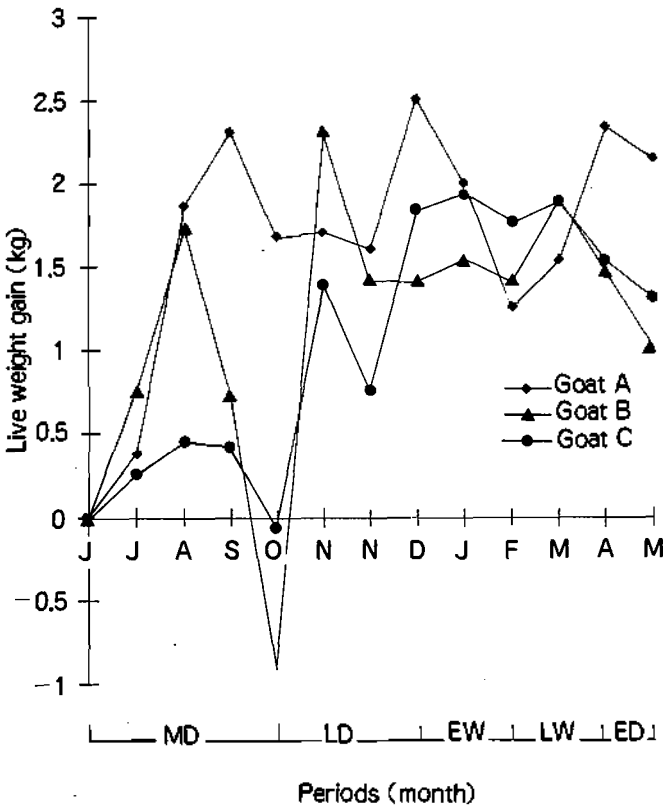
Parameter	Flocks size			SEM[1]
	A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	
Initial live weight (kg)	15.63[a]	16.04[a]	15.93[a]	0.82
Live weight at 48 weeks (kg)	38.74[a]	32.30[a]	30.99[a]	4.76
Live weight gain (kg)	23.11[a]	16.26[b]	15.06[b]	1.85
– Dry season (kg)	10.33[a]	6.60[b]	3.59[c]	1.60
– Wet season (kg)	12.78[a]	9.66[a]	11.47[a]	0.90
Feed consumption (kg DM)	454.00[d]	469.00[d]	326.00[e]	36.82
– Dry season (kg DM)	185.00[a]	174.00[a]	114.00[b]	1.70
– Wet season (kg DM)	269.00[a]	295.00[a]	212.00[a]	2.20
FCR (Feed / gain)	19.64[e]	28.84[d]	21.64[e]	4.27
– Dry season	17.91[c]	26.36[b]	31.75[a]	3.50
– Wet season	21.05[b]	30.54[a]	18.48[b]	2.70

[1] SEM = standard error of the treatment means

[a, b, c] Values within the same row with different superscripts letter differed ($p < 0.05$).

[d, e] Values within the same row with different superscripts letter differed ($p < 0.10$).

Base on the body composition, goat B has heavier head and digestive tract ($p < 0.10$); while goat C has heavier hind legs and digestive tract ($p < 0.10$) than goat A (table 4). The heavier digestive tract of goat B than goat A was due to heavier abomasum and small intestine, while the heavier digestive tract of goat C than goat A was due to heavier reticulum and small intestine ($p < 0.10$) (table 5). In terms of internal organs, goat B has heavier tongue and trachea ($p < 0.10$) than goat A, while goat C has similar weight of components of internal organs with goat A (table 6). In terms of carcass composition, goat B has smaller ($p < 0.10$) shoulder and goat C has also smaller shoulder but heavier legs ($p < 0.05$) than goat A (table 7). The carcass quality (measured in terms of loin eye muscle area, meat, bone and fat portions) were not affected ($p > 0.05$) by the flock sizes (table 8).



MD = Mid dry, LD = Late dry, EW = Early wet, LW = Late wet, ED = Early dry

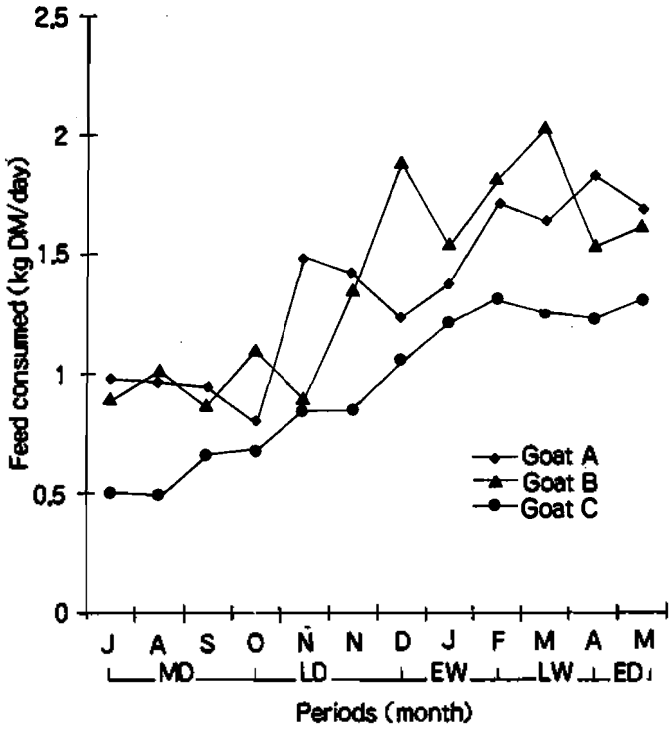
Figure 4. Live weight gain of the goat during the dry and wet seasons

TABLE 4. EFFECT OF FLOCK SIZE ON THE BODY COMPOSITION OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

Body composition	Flocks size			SEM[1]
	A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	
	····· g/100 g live weight ·····			
Head	6.95[b]	7.69[a]	7.13[b]	0.20
Hide	8.04[a]	8.06[a]	7.66[a]	0.46
Tail	0.17[a]	0.20[a]	0.20[a]	0.03
Forelegs	0.87[a]	0.88[a]	0.92[a]	0.05
Hindlegs	0.68[b]	0.64[b]	0.76[a]	0.04
Internal organ	6.24[a]	6.13[a]	6.39[a]	0.40
Digestive tract	5.03[b]	5.71[a]	5.85[a]	0.26

[1] SEM = standard error of the treatment means.

[a, b] Values within the same row with different superscripts letter differed ($p < 0.10$).



MD = Mid dry, LD = Late dry, EW = Early wet, LW = Late wet, ED = Early dry

Figure 5. Feed consumption of the goat during the dry and wet seasons

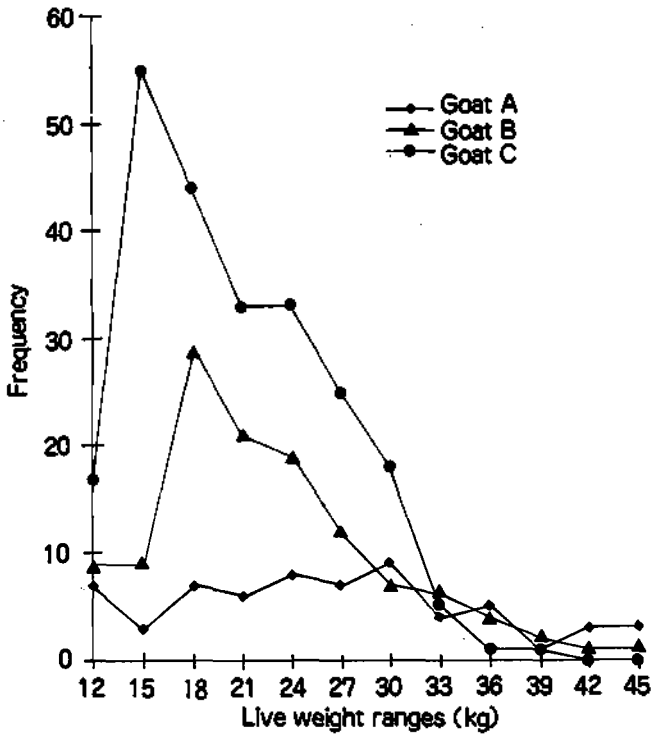


Figure 6. Live weight distribution of the goat within the flock size

TABLE 5. EFFECT OF FLOCK SIZE ON THE DIGESTIVE TRACT OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

Digestive tract	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	SEM[1]
	··· g/100 g live weight ···			
Oesophagus	0.21[cd]	0.17[d]	0.27[c]	0.04
Rumen	1.91[a]	1.94[a]	1.96[a]	0.19
Reticulum	0.33[d]	0.35[d]	0.58[c]	0.08
Omasum	0.33[a]	0.39[a]	0.33[a]	0.04
Abomasum	0.36[b]	0.47[a]	0.39[b]	0.02
Small intestine	0.92[d]	1.09[c]	1.06[c]	0.07
Large intestine	0.97[a]	1.27[a]	1.26[a]	0.18
Length of :				
Small intestine (m)	16.82[a]	19.33[a]	16.91[a]	1.62
Large intestine (m)	5.59[a]	5.57[a]	5.44[a]	0.47

[1] SEM = standard error of the treatment means

[a,b] Values within the same row with different superscripts letter differed ($p < 0.05$).

[c,d] Values within the same row with different superscripts letter differed ($p < 0.10$).

TABLE 6. EFFECT OF FLOCK SIZE ON THE INTERNAL ORGAN OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

Internal organ	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	SEM[1]
	··· g/100 g live weight ···			
Tongue	0.23[b]	0.29[a]	0.26[ab]	0.02
Trachea	0.17[b]	0.21[a]	0.17[b]	0.02
Heart	0.40[a]	0.36[a]	0.40[a]	0.03
Lung	0.76[a]	0.83[a]	0.86[a]	0.06
Liver	1.48[a]	1.62[a]	1.63[a]	0.08
Spleen	0.13[a]	0.14[a]	0.14[a]	0.01
Kidney	0.27[a]	0.28[a]	0.32[a]	0.03
Internal fat	2.81[a]	2.40[a]	2.61[a]	0.31

[1] SEM = standard error of the treatment means.

[a,b] Values within the same row with different superscripts letter differed ($p < 0.10$).

Discussion

In this experiment, the concept of Three strata forage system (in which more grass is fed during the wet season and more shrub and tree fodders are fed during the dry

TABLE 7. EFFECT OF FLOCK SIZE ON THE CARCASS COMPOSITION OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

Carcass composition	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	SEM[1]
	··· g/100 g live weight ···			
Foreshank	7.38[a]	7.54[a]	7.66[a]	0.34
Brisket	3.27[ab]	3.93[a]	2.85[b]	0.42
Shoulder	36.30[a]	33.70[b]	33.79[b]	0.96
Breast	5.30[ab]	5.37[a]	4.71[b]	0.32
Rack	8.11[ab]	8.67[a]	7.52[b]	0.32
Legs	30.84[b]	32.18[b]	35.19[a]	1.00
Short loin	8.80[a]	8.55[a]	8.28[a]	0.39

[1] SEM = standard error of the treatment means.
[a,b] Values within the same row with different superscripts letter differed ($p < 0.10$).

TABLE 8. EFFECT OF FLOCK SIZE ON THE CARCASS QUALITY OF GOAT FED GLIRICIDIA-SUPPLEMENTED DIET

Carcass quality	Flocks size A (3 goats / 2.7 m²)	B (6 goats / 5.4 m²)	C (12 goats / 10.8 m²)	SEM[1]
Dressing percentage (%)	46.30[a]	45.56[a]	45.81[a]	2.17
Carcass length (cm)	72.50[a]	68.50[b]	66.50[b]	1.18
Loin eye muscle area (cm²)	10.60[a]	11.05[a]	8.75[a]	0.76
Meat (%)	68.83[a]	67.39[a]	65.46[a]	2.04
Bone (%)	25.42[a]	27.32[a]	27.67[a]	1.33
Fat (%)	5.75[a]	5.29[a]	6.87[a]	1.05

[1] SEM = standard error of the treatment means.
[a,b] Values within the same row with different superscripts letter differed ($p < 0.05$).

TABLE 9. MEAN AND STANDARD DEVIATION OF LIVE WEIGHT (KG) OF GOATS WITHIN FLOCK DURING DRY AND WET SEASONS

Flock size	Replicates	June-July	Aug.-Nov.	Dec.-Jan.	Feb.-Mar.	Apr.-May	Average
		Late dry season		Wet season		Early dry season	
3 goats / 2.7 m²	I	20.4±0.4	24.1±1.9	27.9±3.1	30.2±3.6	33.4±4.4	27.2± 5.4
	II	12.9±0.8	19.8±4.9	28.6±6.9	31.7±7.3	36.7±6.9	25.9±10.2
	III	15.1±0.2	19.9±0.4	25.6±0.3	28.6±0.2	31.9±0.5	24.2± 6.2
	IV	15.0±0.5	23.3±1.2	32.5±0.9	36.5±1.5	41.4±3.5	29.7± 9.9
	Whole block	15.8±2.9	21.8±3.1	28.6±4.2	31.8±4.7	35.9±5.4	26.8± 8.3
6 goats / 5.4 m²	I	19.1±0.3	19.8±0.7	21.9±1.2	24.4±1.7	26.9±2.0	22.4± 3.2
	II	14.5±0.9	18.2±1.8	22.6±2.7	25.6±2.8	28.1±3.1	21.8± 5.5
	III	13.2±0.4	17.6±0.8	21.2±2.1	24.8±2.9	28.6±4.8	21.1± 6.0
	IV	19.1±0.7	23.6±1.6	31.4±3.5	34.9±4.1	37.9±4.6	29.3± 7.8
	Whole block	16.5±2.8	19.8±2.7	24.3±4.8	27.4±5.2	30.4±5.7	23.7± 6.7
12 goats / 10.8 m²	I	17.8±0.5	16.5±1.3	19.6±2.4	22.1±2.7	24.4±3.1	19.9± 3.5
	II	16.4±0.9	20.6±1.6	25.3±1.9	29.3±2.7	32.1±2.9	24.5± 6.1
	III	14.1±0.5	16.9±1.5	22.2±2.1	25.4±1.9	30.4±2.2	21.8± 6.1
	IV	16.0±0.9	16.4±1.5	20.9±2.6	25.5±2.9	28.0±3.1	21.2± 5.3
	Whole block	16.1±1.5	17.6±2.2	22.1±3.0	25.7±3.5	28.9±4.0	21.9± 5.6

season (Nitis et al., 1989) was applied to insure that enough amount of feed was available for the goat during the wet and dry seasons. The supplementation of 37-45% gliricidia fodder during the wet and dry seasons was to satisfy the browsing habbit of the goat that prefer to eat more shrub and tree fodders than grass. The higher

consumption of shrub and tree fodders than grass in the present experiment confirmed this browsing behavior suggestion. Furthermore, a survey in Bali (Nitis et al., 1980) showed that the diets of goat raised at different climatic zone, topography and land utilization contained 65-94% shrub and tree fodders.

Eventhough the shrub and tree fodders were offered *ad libitum*, goat at higher flock size (B and C) consumed more small branches than the goat at lower flock size (A). This is presumably due to the establishment of ranking order, in which larger variation in body size was found among the goats both within flock B and C than flock A (table 9). The more smaller body size than larger body size both within flock B (72.5 vs. 27.5%) and flock C (64.6 vs. 35.4%) and the evenly distributed live weight ranges between the small and bigger body size within flock A (48.3 vs. 51.7%) confirmed this suggestion (figure 6).

As the consequence of the wider ranking order, the smaller and weaker goat in this experiment get less opportunity to eat better quality of fodder than the bigger and stronger goat, so that the live weight gain of the flock become lower. Manika et al. (1991) showed that sheep at the higher ranking order will select better quality of feed, while sheep at the lower ranking order will have to eat the refuse or the low quality of feed.

According to Pezo et al. (1990), leaf rachis, stem peel and small branches of shrub and tree fodders contained high crude fiber (CF) and according to Van Eys et al. (1986), the high CF concentration in the diet could reduce feed consumption. Feed with high CF will not only stay longer in the small intestine but also take longer time to break down into smaller particle size (Richards et al., 1994). The heavier small intestine of goat B and C than goat A which consumed more small branches that contained high CF, presumably as consequence of such conditioning. Sukanten et al. (in press) showed that goat fed dried grass that contained high CF required more time to chew one bolus than the goat fed gliricidia young leaves that contained low CF.

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