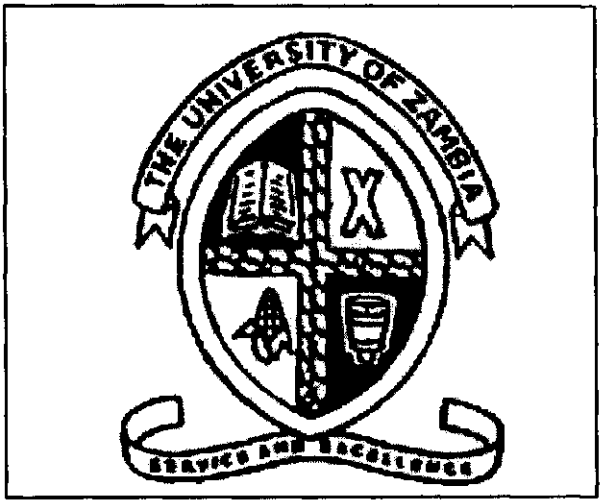

EVALUATION OF CALLIANDRA CALLOTHYRSUS, GLIRICIDIA SEPIUM, LEUCAENA LEUCOCEPHALA AND SESBANIA SESBAN AS SOLE DIETS FOR GROWING GOATS.

BY

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ABSTRACT.

A study to determine voluntary feed intake and body weight change of growing goats fed wilted twigs and leaves of *Calliandra callothyrsus*, *Gliricidia sepium*, *Leucaena leucocephala* and *Sesbania sesban* was conducted at the university of Zambia , School of Agricultural Science field station.

8 female goats with average weight range of 22 to 32.6kg were fed on randomly allotted wilted twigs and leaves of *Calliandra callothyrsus*, *Gliricidia sepium*, *Leucaena leucocephala* and *Sesbania sesban* in a 2,4 by 4 Latin square design with four feeding periods lasting 15 days each.

The effect of feed type on dry matter intake was highly significant ($p<0.01$), goats consumed highest (1306g) levels of *Gliricidia sepium*, followed by *Leucaena leucocephala* (976g) and then *Sesbania sesban* (663g) and the least was *Calliandra callothyrsus* (570g).There was no significant effect of type of feed on body weight ($p<0.05$), *Gliricidia sepium* had 25.93kg, *Sesbania sesban* had 25.43kg, *Calliandra callothyrsus* had 25.14kg and the least was in *Leucaena leucocephala* with 24.37kg.

The results of this study indicate that *Gliricidia sepium* is the most preferred diet among the four feeds, followed by *Leucaena leucocephala* while *Calliandra callothyrsus* was the least preferred

DECLARATION.

The research work for the publication of this thesis was done by myself and all sources of information have been acknowledged by means of references. This material has not been presented previously to the University of Zambia or any other establishment for a degree.

NDHLOVU MAKABANISO.

AUGUST 1998.

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Pamela Chiza Kamwambi : you will always occupy a special place in my life.

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CHAPTER ONE.

1.0 INTRODUCTION.

Goats are important animal resource in the subsistence farming system of Zambia. They can easily be converted into cash,source of meat,hides and manure. Goats can also act as an insurance against crop failure. Goats can even survive on limited water supply (Dombrowski 1993).

During the dry season when the native forages reach their mature stage of growth dietary crude protein (CP) decrease and are characterised by high neutral detergent fibre (NDF) and acid detergent fibre (ADF) and low in mineral content (Butterworth ,1985). Consequently intake, digestibility and rate of passage reduces (Campling *et al.*, 1962) and results in loss of body weights in ruminant animals grazing these forages (Kronberg and Malechek,1997).

The multipurpose fodder trees such as Calliandra callothyrsus, *Gliricidia sepium, Leucaena leucocephala* and Sesbania sesban remain green throughout the year and can play a special role in supplying the animals particulary sheep and goats with the dietary protein and energy during the dry season(Mtenga *et al.*,1991),when the native pastures are dry ,fibrous and low in nutrient content(Butterworth, 1985).

CHAPTER TWO.

2.0 LITERATURE REVIEW.

2.1 INTRODUCTION.

Most goats in Zambia are owned by small scale farmers and approximately about 50% of the total (600,000) national resource are found in the low rainfall areas of Zambia (Agro-ecological region I) where feed resources and water are inadequate during the dry season (MAFF pamphlet,1983).

The use of multipurpose fodder trees as feed for goats would therefore form an important feed resource and help maintain the body weight changes of goats which are positively related to the content of crude protein in their diets (ILCA ,1979.; Kronberg and Malechek,1997).

Leguminous trees and shrubs are common in Zambia and there twigs and leaves are high in protein as shown by the (Table 1). and have the potential to improve the voluntary feed intake and digestibility of low quality roughage by ruminant animals (Reeds *et al.*,1990). The potential of multipurpose trees as feed for goats and other ruminants have not been fully exploited in Zambia due to lack of knowledge on their potential as feed resources. A revieew of the available literature indicated that very little research has been conducted on the use of these multipurpose fodder trees as feed for goats (Lupindula,1991).

2.2 Utilization of *Calliandra callothyrsus, Gliricidia sepium, Leucaena leucocephala* and *Sesbania sesban* as feed for goats.

Callandra callothyrsus, Gliricidia sepium ,Leucaena leucocephala and *Sesbania sesban* are well adapted forage bushes found in the humid tropics and provide protein supplements for goats.

Leucaena leucocephala when compared to other indigenous legume species showed similarity in palatability (Zambia ICRAF Research Project 1994). Other studies on the use of multipurpose fodder trees as ruminant livestock diets for instance, Saada, (1993), showed that feeding *Leucaena leucocephala* at 50% in the ration improved the yield and composition of goats milk.

Mtenga *et al.*,(1992) observed that the intake of *Gliricidia sepium* and *Leuceana leucocephala* by goats was higher for *Leucaena leucocephala* compared to those fed *Gliricidia sepium*. Dry matter intake was 453+25g and 45+22g per day for *leucaena leucocephala* and *Gliricidia sepium* respectively. This study showed that *Leucaena leucocephala* was more palatable than *Gliricidia sepium*.

Onwuka (1986) reported an intake of 176.83g per day for dried *Gliricidia sepium* leaves while Mba *et al.*,(1982) reported an intake of between 233.80 and 294g per day for goats offered fresh *Gliricidia sepium* material.

Studies by Bosman (1995) revealed that goats fed on 50% mixtures of *Gliricidia sepium* and *Leucaena leucocephala* each had higher performance . This was attributed to the fact that the mixtures of such nature are palatable and met the nutrient requirements for protein ,minerals ,vitamins and energy.

Studies by Ademosun *et al.*, (1988) indicated that a 1:1 mixture of *Leucaena leucocephala* and *Gliricidia sepium* improved the growth rate of goats compared to those achieved at the same level of supplements with either sole or predominantly *Leucaena leucocephala* and *Gliricidia sepium* mixtures. The results of this study suggested that a 1:1 mixture of *Leucaena leucocephala* and *Gliricidia sepium* may be recommended as the appropriate ratio of feeding the two tree forages in goats diets.

Awah *et al.*, (1996) when comparing various diets of *Gliricidia sepium* and concentrates observed that goats maintained on *Gliricidia sepium* alone had high dry matter intake 294.7+14.94g per day per head and fed to appetite compared to those fed various combinations of *Gliricidia sepium* and the concentrates diets at rates of 25%, 50% and 75%. These workers further observed that goats on the diet with 50% *Gliricidia sepium* and 50% concentrates had slightly greater live weight change (0.7kg) than the other two which had 0.6kg live weight change. These results further revealed that the utilization of *Gliricidia sepium* by goats was economically desirable when fed at 75% *Gliricidia sepium* and 25% concentrates.

The studies by Kaitho *et al.*(1996) with long term intention of predicting dry matter intake of

Calliandra callothyrsus, Gliricidia sepium ,Leucaena leucocephala and *Sesbania sesban* showed that *Leucaena leucocephala* and *Sesbania sesban* had higher palatability and ranked *Gliricidia sepium* and *Calliandra callothyrsus* as diets of medium palatability. Other studies on palatability of *Gliricidia sepium* showed that goats prefer *Leucaena leucocephala* as opposed to *Gliricidia sepium* (Dharia *et al.*,1993). These workers suggested that palatability of *Gliricidia sepium* may be improved by wilting or drying.

When compared to grasses alone, goats on *Sesbania sesban* recorded a higher intake than those maintained on grass (Ahn *et al.*,1989). These levels of intake were due to low levels of tanins in *Sesbania sesban* and high digestibility of dry matter and nitrogen. Goats fed on *Calliandra callothyrsus* had a low intake because it is reported to have high levels of condensed tanins (vanillin Hcl method),(Ahn *et al.*,1989).

Although the multipurpose trees are useful sources of feed for goats they have anti-nutritional factors such as mimosine and tanins in *Leucaena leucocephala*, condensed tanins in *Calliandra callothyrsus*, toxic substances such as coumarin,o-coumaric acid and hydrocyanic acid in *Gliricidia sepium (Griffiths,1962).* Appreciable amounts of condensed tanins have been reported in *Leucaena leucocephala* (Hammond,1995).

Work by Jones *et al.*, 1992 and Ram *et al.*,1994 revealed that mimosine depress growth, causes loss in weight (emaciation), alopecia, ulceration of mouth ,eyes and ear lesions such effects of *Leucaena leucocephala* may be avoided by minimising the inclusions of *Leucaena leucocephala* in the diet to only 50% (Awah,1996) or the use of low mimosine containing

cultivars of *Leucaena leucocephala such as cunningham* (Jones,1992).

A search through available literature indicate that inadequate research has been conducted to evaluate the utilization of *Calliandra callothyrsus* and *Sesbania sesban* as feed for goats.

CHAPTER THREE.

3.0 MATERIALS AND METHODS.

3.1 LOCATION.

The study was conducted at the University of Zambia, Great East Road Campus School of Agricultural Sciences, Field Station.

ANIMAL AND FEED MANAGEMENT.

8 female goats divided into two (2) groups of approximately equal weights were used in the study. The average weights were 32.6kg and 22kg for latin square one (1) and latin square two (2) respectively.

The goats were housed in individual pens measuring 75 by 100 cm. Body weights of the goats were recorded at the start of the experiment and the goats were re-weighed at the end and beginning of each period.

Diets were randomly allotted to each pen at the beginning of the experiment and wilted twigs and leaves of *Calliandra callothyrsus, Gliricidia sepium ,Leucaena leucocephala* and *Sesbania sesban* were randomly assigned such that each goat had an opportunity to feed on each of the four feeds once during the study period.

The experimental diets *Calliandra callothyrsus, Gliricidia sepium ,Leucaena leucocephala* and *Sesbania sesban* were harvested from woodlot plots at trial sites of the of the International Centre for Agroforestry Research (ICRAF),on a weekly basis. The harvested fodder was wilted before being offered individually as sole diets to goats.

The experimental design used in this study was 2,4 by 4 latin square with four periods each lasting 15 days was used in the study. The first ten (10) days of each period were used as the adaptation period and data was collected in the last five (5) days of each experimental period.

After each period the test feeds were re-randomised following the format shown in the table 1 and 2. After wilting a sample of each feed was collected in a plastic for CP ,NDF and ADF analysis (McDonalds *et al.*,1987) .

Goats were fed on the test feeds every morning at 7:00 hours.The feed was weighed before and after feeding (weigh back), the difference was used to determine the feed intake.

The feed samples which were stored were dried and pooled. Representative samples for each test feed were selected and ground to pass through a 2mm sieve. The ground samples of the test feeds were analyzed for dry matter, crude protein, neutral detergent fibre and acid detergent fibre using the methods outlined in the AOAC (1984).

Statistical Analysis of Variance was conducted on the data from the experiment using the Statistical Analysis Software (SAS) package (1985) on IBM 386 model computer.

Table 1. Randomization of experimental feeds by goat and by period.

PERIOD	GOAT	LATIN SQUARE	FEED
1	1	1	CC
1	2	1	LL
1	3	1	GS
1	4	1	SS
2	1	1	SS
2	2	1	GS
2	3	1	LL
2	4	1	CC
3	1	1	GS
3	2	1	SS
3	3	1	CC
3	4	1	LL
4	1	1	LL
4	2	1	CC
4	3	1	SS
4	4	1	GS

Where CC= Calliandra calloythyrsus. SS= Sesbania sesban.

GS= Gliricidia sepium. LL=Leucaenaleucocephala.

TABLE 2.Randomization of experimental feeds by goat and by period.

PERIOD	GOAT	LATIN SQUARE	FEED
1	5	2	LL
1	6	2	SS
1	7	2	CC
1	8	2	GS
2	5	2	GS
2	6	2	CC
2	7	2	LL
2	8	2	SS
3	5	2	CC
3	6	2	GS
3	7	2	SS
3	8	2	LL
4	5	2	SS
4	6	2	LL
4	7	2	GS
4	8	2	CC

Where CC= Calliandra callothyrsus. LL= Leucaena leucocephala.

GS= Gliricidia sepium. SS= Sesbania sesban.

CHAPTER FOUR.

4.0 RESULTS.

4.1 VOLUNTARY FEED INTAKE.

4.1.1 Effect of feed type on intake.

The results presented in table 3 and figure 1 show that there was a highly significant difference in feed type on voluntary feed intake among the four diets. *Calliandra callothyrsus* and *Sesbania sesban* were not significantly different but both were significantly different from *Gliricidia sepium* and *Leucaena leucocephala* ($p<0.01$). Goats consumed more of Gliricidia sepium (1306g), followed by *Leucaena leucocephala* (976g), then *Sesbania sesban* (663g) and the least was *Calliandra callothyrsus* (570g). *Gliricidia sepium* was the most preferred among the four diets.

4.2 BODY WEIGHT.

4.2.1 Effect of diet type on body weight change.

There was a general decrease in body weight for all the feeds during the study period (this could have been due to restriction to a single sole diet per period and confinement) Table 4 and figure 2 show that there was no significant effect of feed type on body weight changes

($p<0.05$). The body weights were 25.14+8.15, 25.92+8.56, 24.37+11.22 and 25.42+5.66 kg for *Calliandra callothyrsus, Gliricidia sepium, Leucaena leucocephala* and *Sesbania sesban* respectively. *Gliricidia sepium* showed the highest body weight change. The intake as percentage of body weight was significantly different for all the diets (Table 4). The percentage of intake to body weights were 2.27, 5.05, 4.30 and 2.59 for *Calliandra callothyrsus, Gliricidia sepium, Leucaena leucocephala* and *Sesbania sesban* respectively. *Gliricidia sepium* had the highest intake as percentage of body weight. Results on the interaction between the feed type and the metabolic body weight show no significant differences ($p<0.05$). *Gliricidia sepium* had 11.39±2.81kg , *Sesbania sesban* had 11.28±1.90kg, *Leucaena leucocephala* had 10.43±4.57kg and *Calliandra callothyrsus* had 11.14±2.67kg. *Gliricidia sepium* had the highest metabolic body weight change.

TABLE 3. Dry matter intake and palatability ranking of the four diets by growing goats.

DIET TYPE	INTAKE (gDM/day	RANK
CC	570[c]	4
GS	1306[a]	1
LL	976[b]	2
SS	663[c]	3

Where CC= *Calliandra callothyrsus.*

GS= *Gliricidia sepium.*

LL= *Leucaena leucocephala.*

SS= *Sesbania sesban.*

[a-c] Values in the same column with different letters are significantly different (P<0.01).

TABLE 4.Effect of diet type on body weight change and feed intake.

INTAKE	CC	GS	LL	SS
(kg/day)	0.57^{c}	1.31^{a}	0.98^{b}	0.66^{c}
%BODYWGT	2.27^{d}	5.05^{a}	4.30^{b}	2.59^{c}
g/W0.75	11.14^{a}	11.39^{a}	10.43^{a}	11.27^{a}
BODYWGHT	25.14^{a}	25.93^{a}	24.37^{a}	25.43^{a}

Where CC= *Calliandra callothyrsus*.

GS= *Gliricidia sepium*.

LL= *Leucaena leucocephala*.

SS= *Sesbania sesban*.

[a-d] Values in the same row with different letters are significantly different ($P<0.01$).

TABLE 5. Chemical composition of wilted twigs and leaves of *Calliandra callothyrsus*, *Gliricidia sepium*, *Leucaena leucocephala* and *Sesbania sesban*.

DIET	DM%	CP%	NDF%	ADF%	Ca%	P%
CC	89.31	21.88	23.30	20.47	1.11	0.3
GS	88.21	28.12	35.80	21.90	1.55	0.2
LL	87.72	25.62	34.68	26.40	1.80	0.2
SS	90.14	23.78	18.20	13.40	1.40	0.18

Where CC= *Calliandra callothyrsus*.

GS= *Gliricidia sepium*.

LL= *Leucaena leucocephala*.

SS= *Sesbania sesban*.

FIGURE1: EFFECT OF FEED TYPE ON INTAKE BY GROWING GOATS

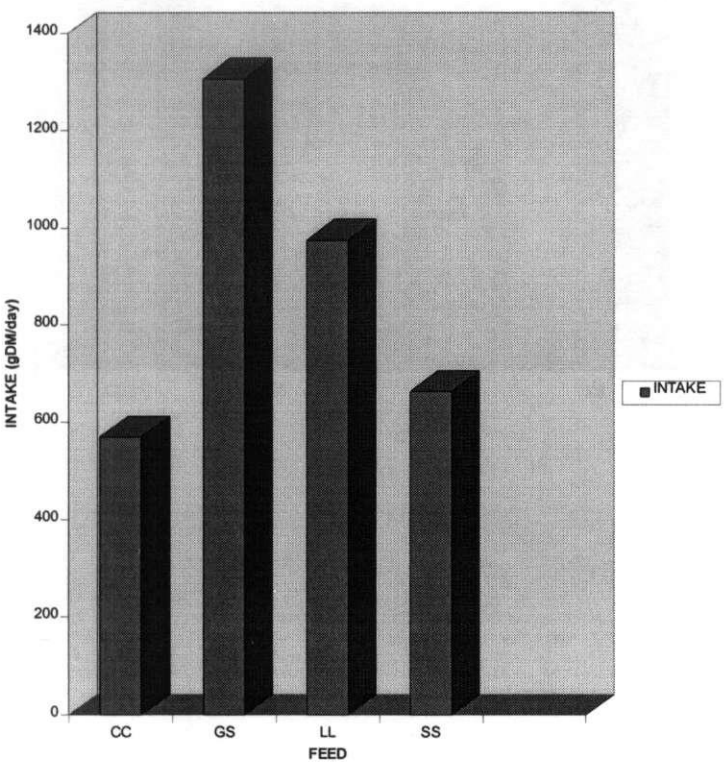
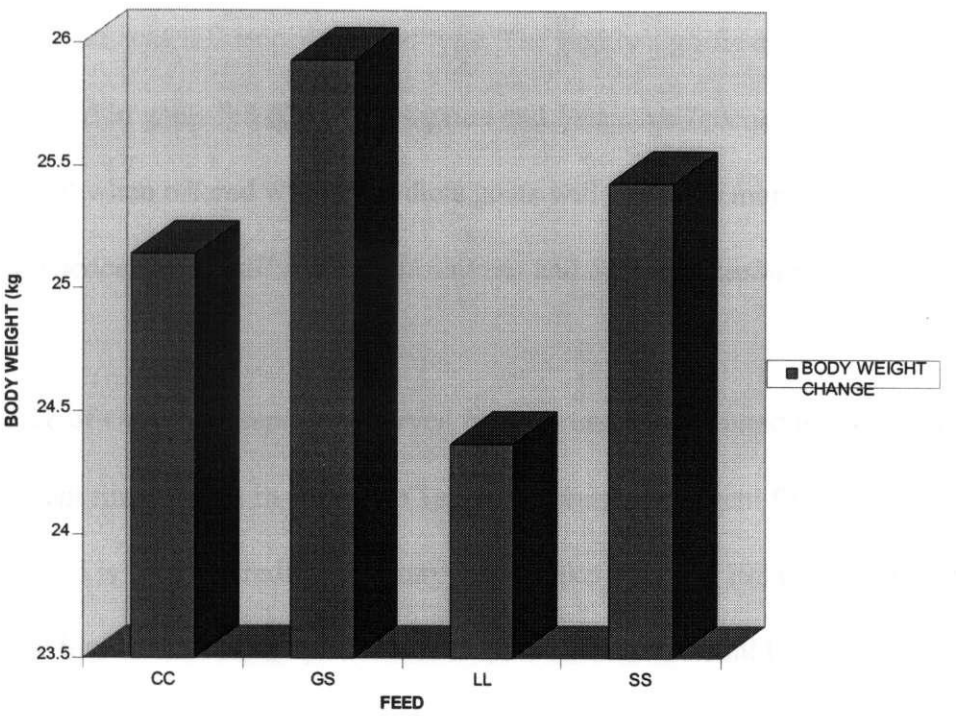


FIGURE2: EFFECT OF FEED TYPE ON BODY WEIGHT CHANGES OF GROWING GOATS



CHAPTER FIVE

5.0 DISCUSSION.

Voluntary feed intake was influenced by feed type. The highly significant ($p<0.01$) voluntary feed intake observed in goats fed *Gliricidia sepium* and *Leucaena leucocephala* (Table 3 and figure 1) show that when offered with other diets goats will consume more *Gliricidia sepium* than *Leucaena leucocephala, Calliandra callothyrsus* and *Sesbania sesban.*

The higher intake of *Gliricidia sepium* observed in goats can be attributed to the differences in neutral detergent fibre (NDF) in the diets (Table 5). Neutral detergent fibre (NDF) is the index of gut fill and is used to predict voluntary feed intake (Jurgens,1988). The higher the fibre content ,the higher the voluntary feed intake. The other factor could have been wilting ,this is in agreement with Mtenga *et al.* (1991) who suggested similar treatment of *Gliricidia sepium* as means to improve palatability. Dharia (1993) also suggested similar treatment of *Gliricidia sepium* before feeding.

Gliricidia sepium also has a higher nutritive level than *Leucaena leucocephala* in terms of crude protein (CP) table 5 meaning that *Gliricidia sepium* is a nutritionally well balanced forage tree than *Leucaena leucocephala.* This result is in agreement with the findings of Sampet *et al.*,(1987). Results obtained in this study are in agreement with those reported by (Butterworth,1967, Milford and Minson,1968) who observed a reduction in the intake of forages when the crude protein level content in goats diet is low,this is so because it leads to reduced energy digestibility and feed intake as shown in tables 3 and 5 .

As table 3 shows *Calliandra callothyrsus* was the least preferred diet ,these results are in agreement with the findings of of Kaitho *et al.*,(1996) who observed in a palatability trial that goats ate more of *Sesbania sesban* than *Calliandra callothyrsus* because *Sesbania sesban* did not contain the tanins and exhibited higher digestibility of dry matter intake and nitrogen. Goats fed on *Calliandra callothyrsus* had low intakes due to high levels of condensed tanins in this diet which somewhat restricts the ability of goats to consume higher levels of *Calliandra callothyrsus*. Kaitho (1996) also further established that *Sesbania sesban* is more preferred than *Calliandra callothyrsus* and goats fed *Sesbania sesban* recorded positive weight change than goats fed *Calliandra callothyrsus*.

Similarly poor weight changes in goats fed *Leucaena leucocephala* can be attributed to the toxic effects of mimosine in the feed when it is given at levels more than 50% in the diets, this is in agreement with Saada (1993) who observed that feeding *Leucaena leucocephala* at 50% in the ration improved goats performance. Jones et al.,1992, and Ram et al.,1994 reported that mimosine depresses growth and causes weight loss (emaciation), such effects of *Leucaena leucocephala* can be avoided by minimising the inclusions of *Leucaena leucocephala* in the diets at 50% as equally agreed by Awah (1996). The palatability ranking show that *Gliricidia sepium* is the most palatable feed followed by *Leucaena leucocephala* and the least was *Calliandra callothyrsus*,though *Calliandra callothyrsus* was the least preferred when compared to *Leucaena leucocephala* and *Calliandra callothyrsus*. Goats fed on *Calliandra callothyrsus* had a positive weight change than *those fed on Leucaena leucocephala* ,this could be attributed to its high acid detergent fibre (ADF) levels which reduces digestibility.

Gliricidia sepium had the highest crude protein (CP) 28.12% as shown in Table 5, this was seconded by *Leucaena leucocephala* and the least was *Calliandra callothyrsus* with 21.88%. This trend followed was similar to the intake preference pattern. These observations are in agreement with Kronberg and Malechek (1997) who concluded that crude protein level in the feed positively affected intake and weight change in goats.

CHAPTER SIX.

6.0 CONCLUSION AND RECOMMENDATIONS.

The results of this study have shown that when offered with *Calliandra callothyrsus* , *Leucaena leucocephala* and *Sesbania sesban* goats will consume higher amounts of *Gliricidia sepium*.This is because *Gliricidia sepium* has a well balanced nutrient content as shown in table 5. The results of this study suggest that *Gliricidia sepium* may be used as a sole diet in goats feeding. However,more information is required to establish the expected intake and associated body changes.

With reference to the chemical composition (table 5 and table 3) and figure 1. It can be concluded that voluntary feed intake and body weight changes observed in the four feeds are due to differences in crude fibre (NDF and ADF), gut fill and crude protein.

From the results of the study farmers should be encouraged to establish feeder banks of *Gliricidia sepium* to be used in goat feeding.

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APPENDICES.

Analysis of variance for Voluntary Feed Intake.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	3.80591205	0.29276247	6.24	0.0005
Error	16	0.75030875	0.04689430		
Corrected Total	29	4.55622080			

R-Square	C.V.	Voluntary feed intake mean
0.835322	24.53001	0.88280000

Source	DF	Type IV SS	Mean Square	F Value	Pr > F
PRD	3	0.31826775	0.10608925	2.26	0.1205
PEN	6	0.62318168	0.10386361	2.21	0.0955
SQ	0	0.00000000	.	.	
FEED	3	2.45549477	0.81849826	17.45	0.0001

Duncan's Multiple Range Test for voluntary feed intake.

Duncan Grouping	Mean (kg)	N	FEED
A	1.306	8	GS
B	0.976	7	LL
C	0.663	7	SS
C			
C	0.570	8	CC

Means with the same letter are not significantly different. (P<0.001)

Analysis of variance for body weight changes

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	1612.8899283	124.0684560	5.95	0.0005
Error	17	354.4055556	20.8473856		
Corrected Total	30	1967.2954839			

R-Square	C.V.	Body weight Mean
0.819851	18.08852	25.24193548

Source	DF	Type IV SS	Mean Square	F Value	Pr > F
PRD	3	324.97099206	108.32366402	5.20	0.0099
PEN	6	494.32173611	82.38695602	3.95	0.0117
SQ	0	0.00000000	.	.	.
FEED	3	40.57420635	13.52473545	0.65	0.5945

Duncan's Multiple Range Test for Body Weight Changes.

Duncan Grouping	Mean (kg)	N	FEED
A	25.925	8	GS
A			
A	25.425	8	SS
A			
A	25.138	8	CC
A			
A	24.371	7	LL

Means with the same letter are not significantly different. (P<0.05)