EFFECT OF SORGHUM-LEGUME INTERCROP ON QUALITY AND RUMEN DEGRADABILITY OF SORGHUM STOVER IN ADAMAWA STATE, NIGERIA.

ABSTRACT

An experiment was conducted to evaluate the effect of sorghum-legume intercrop on quality and rumen degradability of sole sorghum stover, sorghum stover with lablab or with groundnut intercrop at different stages of growth. The experimental design was randomized complete block design with three treatments and three replicates. Growth was significant ($P<0.05$) between treatments and higher at weeks 10 to 12. Crude protein was higher among sorghum with lablab or groundnut intercrop and least with sole sorghum stover and decreases with stage of growth, while ADF and NDF increases with stage of growth. A fistulated bunaji bull with 90mm internal diameter was used for the degradability. Degradability was higher with sorghum stover with legume intercrops and least with sole sorghum stover and increases with time of incubation, but decreases with age of sorgum stover. The result indicated that sorghum-legume intercrop could lead to improved quality of stover, degradability and general performance of the animals.

KEY WORDS: Bunaji bull, Degradability, Intercrop, Legume, Sorghum stover

INTRODUCTION

In Nigeria, the ability of ruminant animals to efficiently utilize non conventional feedstuffs is now attracting the attention of researchers. The Northern part which is the major ruminants animals producing area has available and cheap feedstuffs mostly cereals crop residues, native pastures and agro industrial by- products which support the pastoral households at least 46-58%. Unfortunately, these feedstuffs are low in nutritive value and hence results in reduced feed intake, digestibility and utilization (kosgey *et al*., 2008). Normally, the animals that rely solely on such poor quality feedstuffs for their nutrition always faced heavy weight losses during the dry season and drop in reproductive functions (Woyengo *et al*., 2004). In order to increase ruminant animal productivity as most of the cattle owners are pastoralists, a strategy has been adopted by the farmers which include settling in midst of arable farming communities. There are also many farmers who engage in mix farming systems in Northern Nigeria and extending into other zones of the country. Despite the erratic rainfall experienced in Northern part of Nigeria, the zones is favourable for cereal crops and livestock enterprises. However, arable farming is spreading at the expense of traditional grazing land, but it does not seem to discourage the movement of livestock from their permanent residence within the zone. The situation has imposed strain on the dwindling grazing resources. Under the present farming systems, the land deteriorates rapidly and under sowing of cereals with forage legumes appears to offer a simple method of enhancing the quality of stover for animals after grain harvest (Ajeigbe *et al*., 2001, Woyengo *et al*., 2004 and Owen, 1994). This has helped in minimizing the inconveniences to or change in traditional cultural practices. However, in order to predict which feedstuff can support productive functions in the animals and the nutritive values of these stovers must be ascertained. The nylon bag technique offers a convenient way of assessing locally available feedstuffs which are accessible to farmers in Nigeria.

Therefore, this experience was designed to assess the effect of intercropping sorghum with lablab or groundnut on chemical composition and in sacco dry matter disappearance of sorghum stover with stage of growth in fistulated cattle.

Materials and Methods.

Experimental Site

The study was conducted at the Small Unit of Teaching and Research Farm of the Department of Animal Science and Range Management, Modibbo Adama University of Technology, Yola, Adamawa State. Yola is located in the North Eastern part of Nigeria. It is situated within the Savannah region and lies between latitude 7^0 and 11^0 North and longitude 11^0 and 14^0 East and altitude of about 185.9m above sea level. Yola has a tropical climate marked by rainy and dry seasons. Maximum temperature can reach 40^0c particularly in April, while minimum temperature can be as low as 18^0c with annual rainfall of less than 1000mm (Adebayo and Tukur, 1999).

Table 1: Mean Annual Rainfall and Temperature of the Study Area During 2015 Season**.**

Month	**R**ainfall (mm)	Temperature (^{o}c)	
		max	min
January	0.00	25.0	21.0
February	0.00	29.5	23.4
March	0.00	37.2	25.0
April	9.25	34.7	28.3
May	25.40	37.0	26.5
June	80.15	31.6	25.0

July	130.04	28.0	23.0
August	150.85	30.0	24.0
September	130.28	31.0	25.5
October	21.15	34.0	26.1
November	0.00	35.2	22.0
December	0.00	30.0	20.5

Source: Meteorological Station, Modibbo Adama University of Technology, Yola, Nigeria

Experimental Design

A Land area of 98 x 98m was cleared, ploughed and harrowed to soften the soil for ease planting and germination. The main plot was divided into three sub- plots and replicated three times measuring 30 x 30m with inter and intra row spacing of two metres each in a randomized complete block design (RCBD). The treatments are as follows:

SS = Sole Sorghum

SL = Sorghum + lablab

SG = Sorghum + groundnut

The sorghum seeds (variety Sk 5912) was obtained from the Department of Crop Production, Modibbo Adama University of Technology, Yola. The lablab Seeds (Cultivar Highworth) was obtained from NAPRI, ABU Zaria. The groundnut seeds (Yar Michika) was purchased from Yola market.

The plots were all sown to sorghum at seed rate of 10kg/ha at 75 x 50 cm spacing. Three sub- plots of sorghum were randomly intercropped with lablab at 60 x 60cm at Seed rate of 20kg/ha and another three sub- plots were intercropped with groundnut at 60 x 30cm at seed rate of 80kg/ha, while the remaining three sub-plots were left sole sorghum as control. The planting was done on 10th June, 2015, while weeding was done at two, six, and nine weeks respectively.

Chemical Analysis

The samples for chemical analysis were taken from each of the harvested samples for the various stages of growth of sorghum and oven dried at 60^{0} C for 48 hours to constant weight.

Crude protein (CP) was determined by Kjeldahl method, ash by burning in a furnace at 550^0 C for 3 hours and crude fat by soxhlet extraction according to AOAC (2004) method. Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined according to Van Soest and Robertson (1991) method.

Determination of the Rumen DM Degradability of Feedstuffs

Experimental Animal and Management

A rumen cannulated Bunaji bull (White Fulani) with 90mm (internal diameter) was used at the Department of Animal Science and Range Management, Modibbo Adama University of Technology, Yola. The animal was provided with a diet that was able to meet the rumen microbial requirements for essential nutrients. The bull was confined in a pen and fed with 7 - 10kg of feed comprising of groundnut haulms, rice husk, corn stalks, while salt lick and water were given ad-lib daily during the period of the study. The feeds were offered twice daily at 8:00 am and 4:00pm.

Data Collection

The feed samples collected were dried at 60^0 for 48 hours and ground using a laboratory hammer mill to pass through 3mm screen. The nylon bags with mesh size of about 45mm and 140x90mm size were weighed and numbered for easy identification using a marker. The marked nylon bags were arranged serially for the series of the samples at time of the incubation. Approximately 2 grams of the samples were weighed in replicates and put into the bags. The feed samples used were roughage materials, therefore, the period of incubation chosen were 6, 12, 24, 48, 72 and 96 hours respectively. The animal was then fed and removed from feed 1-2 hours before the time of sample removal. The whole component of the plastic tubes and the nylon bags after withdrawal were taken to the laboratory and washed for 5 minute under running tap water till clear water was obtained. The removal was according to specified incubation period as indicated on the plastic tube tags. The bags with the content were dried in an oven at 60^0 c for 48 hours to constant weight to determine the amount of dry matter degradation rate. The washing loss (A) is the soluble portion of the feed, and was determined by weighing 2 grams of the feed samples into warm water at 40^0 c for one hour. They were removed, washed under running tap water for 5 minutes till clear water was obtained. The bags were oven dried at 60^0 for 48 hours to constant weight.

Statistical Analysis.

The results of the dry matter degradation rates obtained were fitted to the exponential equation of the form $P = a + b\ (1\text{-}e^{-ct})$ (Orskov and McDonald, 1979). In the final analysis, the various rument characteristics of sole sorghum, sorghum with lablab and sorghum with groundnut from the nylon bags, were defined as

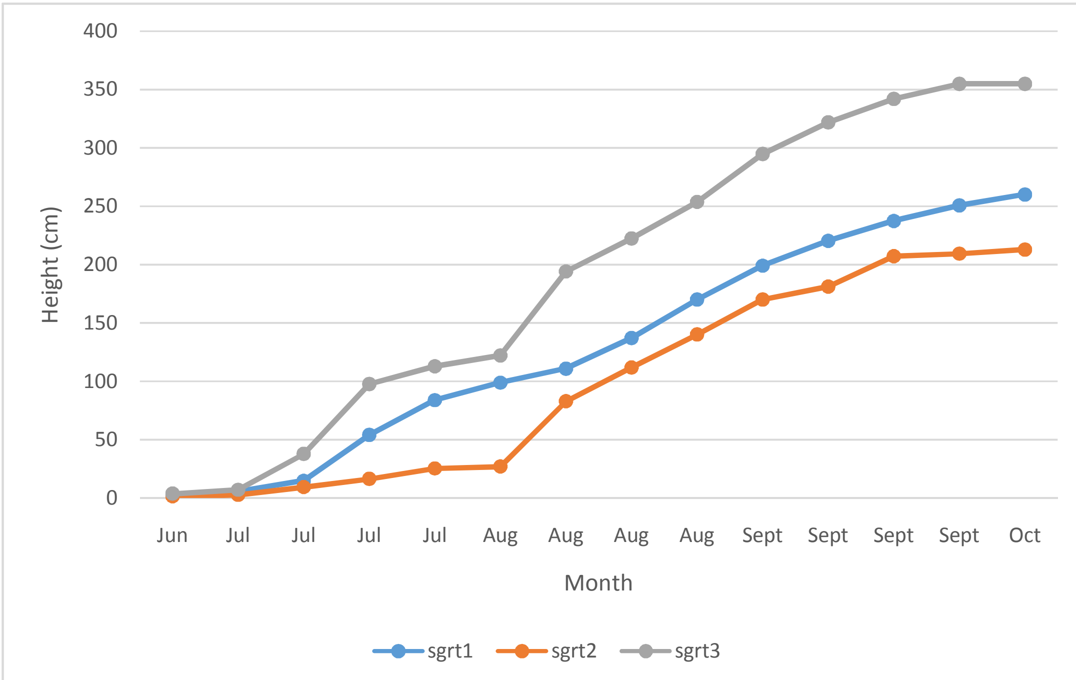
P = amount degraded at time (t)
a =rapidly soluble fraction
b = amount which in time will degrade
c = fractional rate constant at which the fraction "b" will be degraded

The result obtained from the rumen degradation was subjected to analysis of variance according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Growth Pattern of Sorghum

The result of growth measurements of sorghum is presented in Fig.1. The growth in height ranged from 3.3 to 308.7cm, 3.3 to 395.7cm and 3.3 to 441.7cm for T1, T2 and T3 respectively. There were significant differences ($p<0.05$) in growth between treatments. Higher growth was recorded in treatment 3, followed by treatment 2 and least in treatment 1. The higher growth recorded in T2 and T3 could be attributed to the legume intercrop. Though the growth was slow, at early age, but picked up from week 4 and was consistent and increased with age for all the treatments. The trend suggests that nitrogen increase in the soil influenced the growth of the plants. Bibinu *et al*. (2006) reported similar finding with millet in Maiduguri that nitrogen increase in soil influences plant growth. Kwari and Bibinu (2002) and Kwari *et al*. (1998) reported that low productivity of crops could be as a result of low fertility status of the savannah soils. Francis (1989), Ofori and Stern (1987), Rerkaseem *et al.* (1988) and Okigbo (1978) gave similar reports that mixture of cereals and legumes are very advantageous as the legume depends mainly on its own nitrogen fixation and also fixes nitrogen from the free nitrogen in the soil atmosphere provided growing conditions are adequate and reduces competition for nitrogen among the associated crops. Elemo (1989) and Madhiyazhagan *et al*. (1997) observed that increased in plant height could be attributed to vegetative growth of the plant as a result of added nitrogen.



Chemical Composition of Sorghum Forage at Different Stages of Growth.

The chemical composition of sorghum is summarized in Table 1. The dry matter content of sorghum ranged from 30 to 83. 10%, 31.65 to 86. 30% and 32.10 to 89. 0.5% for sole sorghum, sorghum intercropped with lablab and sorghum intercropped with groundnut in 2015. The dry matter increased with stage of growth and was highest with sorghum intercropped with groundnut followed by sorghum intercropped with lablab and lowest with sole sorghum. The sorghum- legumes intercropping significantly increase the dry matter yields of the sorghum. Also, the high dry matter obtained is in agreement with the ealier report by Lamidi *et al.* (1997) who stated that delay in harvest beyond 86 days after planting of crops progressively decreased leaf yield by about 50.48%, 55.77% and 68.71% at 100, 114 and 128 days respectively, but increases the dry matter content, while Fadel Elseed *et al.* (2007) reported higher values of 87.4 to 90.9%, 90.4 to 95.2% for stem and leaves of sorghum without intercropping. A similar higher value of 94.12% was reported by Bogoro *et.al* (2006) with sorghum stover and both of them attributed the difference to sorghum variety and rainfall or soil type. The crude protein content of sorghum ranged from 6.00 to 9.15%, 8.06 to 10% and 8.90 to 11.25% in sole sorghum, sorghum intercropped with lablab or groundnut. The crude protein decreases with maturity and this could be due to the demand for nitrogen during seed production. The higher crude protein content obtained with sorghum intercropped with lablab and groundnut could be due to the N-fixation activity by legume intercrops which were higher than in sole sorghum. This is in agreement with the earlier report by Ofori and Stern (1987) who stated that legumes in intercrops contribute nitrogen to the associated cereal crops through nitrogen fixation. The crude protein content of the sorghum stover obtained is lower than with sorghum values. Bogoro *et al.* (2006) reported higher values of crude protein than obtained in this study with sorghum legume intercrops and this could be due to variety, soil type or stage of harvest. The ash content ranged from 4.15 to 8.10% 4.75 to 9.30% and 5.10 to 10.05% in sole sorghum, sorghum intercropped with lablab and groundnut respectively, the ash content increased with stage of growth and was higher in sorghum with groundnut followed by sorghum with lablab and lowest in sole sorghum. The values obtained are within the range of 8.4% reported by Kiflewahid and Mosimanyana (1987) and 7.33% reported by Bogoro *et al.* (2006). The calcium content of sorghum ranged from 0.28 to 1.30%, 0.48 to 1.55% and0.04 to 1.32% in sole sorghum, sorghum intercropped with lablab and sorghum with groundnut for the respective treatments. The calcium content decreases with stage of growth and was higher in sorghum with groundnut followed by sorghum with lablab and lowest in sole sorghum. The values obtained are similar to the earlier report by Siulapwa and Simukoko (1998) who reported a minimum value of 0.34% for sole sorghum. The phosphorus content ranged from 0.08 0.14%, 0.09 to 0.18%, 0.10 to 0.20% in sole sorghum, sorghum intercropped with lablab and sorghum with groundnut. The phosphorus also decreases with stage of growth. The obtained values are within the range of 0.06 to 11.00% reported by Siulapwa and Simukoko (1998) and attributed the decreases to demand for phosphorus for seed production. The acid detergent fibre (ADF) content ranged from 18.00 to 37.12%, 17.34 to 35.40% and 17.32 to 34.28% and NDF ranged from 25.50 to 58.50%, 23.18 to 53.12% and 17.80 to 48.60% for sole sorghum intercropped, sorghum with lablab and sorghum with groundnut respectively. The neutral detergent fibre content generally was higher than acid detergent fibre in sorghum in all the treatments. The obtained values are both lower than the 73.5% values reported by Fleisher and Tackie (1993) and Bogoro *et.al* (2006) also reported 45.51% ADF which is higher than in this study and the difference could be due to sorghum variety, soil, rainfall, or stage of harvest.

Rumen Degradability Rates

The degradability values of sorghum forage with stage of growth are summarized in Table 2. The mean dry matter degradation at 6, 12, 24, 48, 72 and 96 hours ranged from 0.63 to 0.96% (SS), 0.71 to 0.96% (SL) and 0.83 to 1.12%(SG) respectively. The degradability increased with increase in time of incubation, but decreases with stage of growth from weeks 6 to 14 for all the treatments. There was no significant difference (p>0.05) between all the treatments but SL and SG degraded better than SS. The decrease in degradability with stage of growth could be associated with the high content of structural components (cell wall) and also declined in the ratio of leaves to stem and increase in the level of senescent plant (Crowder and Chedda, 1982; Larbi *et al.,* 1989) and agree with the report by Zerbini *et al.* (2002) that higher degradability can only occur when the NDF, cellulose and lignin content are low. The higher degradability in SL and SG could be due to increase in the nutritive value of the sorghum stover as a result of the legume intercrops. Zerbini and Thomas (2003), Hassan *et al*. (2011) and El-Yassin *et al.* (1991) in separate studies reported that treatment or improving the qualities of sorghum stover normally result into higher degradability. Generally degradability of tropical feeds is lower than that of temperate and subsequently reflected on the performance of the animals as reported by Mortimore *et al.* (1997) and also suggests that improving the cropping systems of cereals and legumes helps in improving both the quality and quantity of the crop residues. The declined in degradability with stage of growth agrees with the earlier report by Akin and Chesson (1989), Crowder and Chedda (1982) who observed that digestibility of tropical forages decline with increase in stage of growth. Nocek and Kohn (1988) reported higher values of degradability with grasses (panicum repens and Brachia mutica) ranging from 32.1 to 70% at maximum of 96 hours than sorghum stover due to higher ADF and NDF content and the nylon bags used could also be a factor which is difficult to standardized. A similar work was reported by Bogoro *et al.* (2006) with sorghum Stover mixed with low to higher protein sources and obtained a range value of 23 to 30% for medium and 27 to 42% for higher protein respectively. They also reported that greater degradability of basal diet may be achieved by increasing the protein content of diets fed to the animals and reported a range of value of 12 to 16% protein levels. The solubility "A" ranged from 0.63 to 0.96% (SS), 0.71 to 0.96% (SL) and 0.83 to 1.12% (SG). The solubility reduces with stage of growth for all the feeds and this could be due to increased in ADF and NDF content of the Stover or increased in structural components (cell wall) and also declined in the ratio of leaves to stem and increase in the level of senescent plant (Crowder and Chedda, 1982: Larbi *et al.,* 1989). The solubility values are higher with the Stover intercropped with legumes and this could probably be that the legumes have contributed nitrogen to the associated sorghum and subsequent enhancement of their solubility. The results obtained are lower than the range values of 6.0 to 29.20% (Bagoro *et* *al.,* 2006; Ndemanisho *et al.,* 2007 and Orskov 1982) and the wide variety in the “A’’ values could be due to the type, particle size, fibre content of the feed or porosity of the nylon bags. The fractional rate constant ‘’C’’ ranged from -0.003 to 0.009% (SS), 0.028 to 0.017% (SL) and 0.02 to 0.03% (SG). The fractional rate constant increased with stage of growth with maximum values for all treatments at week 14. There was significant difference ($p<0.05$) in degradability for all the feed samples with stage of growth and time of incubation. Higher fractional rate constant C in treatments SL and SG could be due to the legume intercrops which most have increased the level of nitrogen content of the associated crops. This is similar to the earlier report by Bogoro *et al.(*2006) who obtained range values of 0.010 to 0.009% for sorghum Stover and groundnut haulms.

Table 2: Chemical Composition of Sorghum Stover as Influenced by Different Legume Species with Stage of Growth (% DM)

WK	STOVER		DM	CP	Ash	Ca	P	ADF	NDF		
6	SS		30.30	9.15	4.5	1.30	0.14	18.00	25.50		
		SL		31.65	10.00	4.75	1.55	0.18	17.34	23.18	
			SG		33.08	11.34	5.60	1.32	0.20	17.32	
17.80				8	SS		37.18	9.80	4.97	1.30	
0.12	22.06	28.10					SL		41.10	10.12	
5.78	1.38	0.14	19.30	25.65					SG		
43.23	10.75	5.99	1.33	0.18	21.82	22.30				10	SS
	54.60	7.88	7.30	0.88	0.15	32.18	37.70				
SL		59.30	9.11	6.45	1.00	0.13	26.15	34.40			
	SG		60.31	9.45	7.13	1.10	0.16	28.31	30.48		
	12	SS		7.65	7.61	6.63	0.55	0.12	35.20	37.70	
			SL		80.10	8.80	7.27	0.78	0.11	30.17	
34.40					SG		82.42	8.65	7.85	0.62	
0.13	30.50	30.48				14	SS		84.23	6.11	
7.95	0.28	0.08	37.12	58.50					SL		

	87.35	8.41	8.10	0.48	0.09	35.40	53.12					SG
		86.82	8.25	8.61	0.40	0.10	34.28	48.60				

KEY: SS = Sole Sorghum Stover.

SL = Sorghum Stover with Lablab Intercrop,

SG = Sorghum Stover with Groundnut intercrop

<u>Table 3: Effect of Legume Intercrop and Stage Growth on Rumen Degradability of Sorghum Stover</u>

WK	TRT	A			TIME	(HOURS)						C
			6	12	24	48		72		96		
6	SS	0.96	82	86	93	108		124		139		-
0.003		SL	0.96	90	94	100	113		125		138	
	0.028		SG	1.12	87	91	97	112		126		140
		0.002										
8	SS	0.89	77	81	88	102		116		130		-
0.002		SL	0.93	78	82	89	103		164		130	
	0.012		SG	1.06	81	84	91	104		117		131
		0.004										
10	SS	0.78	66	69	74	85		96		106		-
0.004												
	SL	0.83	70	72	76	85		96		106		
	0.004		SG	0.99	73	75	80	90		99		109
		0.005										

12	SS	0.74	64	65	66	80		86		90		
	0.011		SL	0.78	68	69	73	88		91		92
		0.008										
	SG	0.91	69	73	77	89		93		94		
	0.019											
14	SS	0.63	53	56	65	72		76		85		
	0.009		SL	0.71	61	67	69	72		76		85
		0.017		SG	0.83	64	70	74	87		90	
	93		0.013									

KEY: SS = Sole Sorghum Stover SL = Sorghum Stover with Lablab intercropped
SG = Sorghum Stover with Groundnut intercropped
A: Rapidly Soluble Fraction
C: Fractional rate Constant at which the Fraction b will be Degraded

Conclusion

The study therefore showed that sorghum–legume intercrop is beneficial in improving the quality of sorghum stover as they degraded better than the sole sorghum stover. The degradability therefore decreases generally with increases in stage of growth for all treatments.

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