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PERFORMANCE AND COST BENEFIT OF GROWING RED SOKOTO GOATS FED VARYING LEVELS OF *SORGHUM ALMUM* AND *LABLAB PURPUREUS* HAY MIXTURES WITH CONCENTRATE SUPPLEMENTATION

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ABSTRACT

An experiment was conducted at Feeds and Nutrition Research Programme, National Animal Production Research Institute, Shika, Zaria, Kaduna State, Nigeria. To investigate the performance of growing Red Sokoto goats fed varying levels of *Sorghum almum* and *Lablab purpureus* hay mixtures with concentrate supplementation. Twenty growing Red Sokoto goats (bucks) aged between 8 -10 months with average body weight of 12.55 ± 2.63 kg were randomly allotted to one the following four dietary treatments containing *S. almum* and *L. purpureus* hay mixtures of 100:0, 90:10, 80:20 and 70:30 inclusion levels as basal diets respectively and supplemented with concentrate. The bucks were individually pen-fed at 3 % body weight (1.5 % forage mixtures and 1.5 % concentrate) with allowance of 200g/day for a period of 12 weeks in a Randomized Complete Block Design (RCBD) in five replicates. Proximate composition of the experimental diet showed that Dry matter was between 91.11- 93.40%, Crude protein was 12.62 - 13.75%, Organic matter was 86.00- 88.48%, Crude fibre was 14.86- 17.01%, Metabolizable Energy was 12.16- 12.20MJ/kg, Relative Feed Value was 107.48- 129.35, Acid Detergent Fibre, Neutral Detergent Fibre, Acid Detergent Lignin, Hemicellulose and Cellulose were within the range of 26.66-31.15%, 48.98-55.72%, 9.80-12.02%,20.75-24.77% and 16.86-18.63% respectively. Total feed intake were significantly the same (P>0.05) across treatments. Average body weight gain (3.70kg) and daily weight gain (44.05 g/day) were significantly (P<0.05) higher in bucks fed 70:30 *S. almum* and *L. purpureus* hay mixtures than other treatments. Feed Conversion Ratio (10.09) was significantly (P<0.05) lower and better in bucks fed 70:30 hay mixtures as compared to other treatments. Higher value of gain (₦1, 665.00k) and Net benefit (₦1, 171.25k) was obtained for feeding bucks with *S. almum* and *L. purpureus* hay mixtures at 70:30 compared to other treatments. Therefore, feeding growing Red Sokoto bucks with *S. almum* and *L. purpureus* hay mixtures at 70:30 improves their performance, increased cost benefit of the farmer by 34.37 %, reduce the cost of feeding concentrate and hence, the utilization of *S. almum* and *L. purpureus* hay mixtures at 70:30 in the diets of small ruminants is hereby recommended.

Keywords: Red Sokoto goats, *Sorghum almum*, *Lablab purpureus*, Hay, Concentrate

INTRODUCTION

The major challenge to livestock production in Nigeria is ensuring adequate feed supply throughout the year in terms of quality and quantity (Kallah et al., 1997). During the dry season forage quality declined to 3 % crude protein which is below the critical level of 7 % crude protein recommended (Alalade et al., 2014). Ruminants rely heavily on low quality roughages (Thorpe et al., 2000) without supplementation. Consequently, this results in poor growth and low animal productivity. These feeds are fibrous and devoid of most essential nutrients especially protein and energy, which are required for increased rumen microbial fermentation and performance of host animals (Lanyasunya et al., 2007a). Therefore, the declaration to improve the quality of grasses through crop-livestock production systems in different parts of the world is well recognised (Caballero et al., 2001). In Kenya, high performance of Dorper sheep was reported when fed with Sorghum almum based diets and Commelina benghalensis as protein supplement (Lanyasunya et al., 2007b). The contribution of Lablab purpureus L. Sweet legume as versatile crop which permits diverse utilization as either ruminant feed or green manure is well recognised and produces high quality conserved fodder (Amodu et al., 2003). It serves as a dual purpose legume producing both food for farmers as well as forage for livestock. Its high value as protein supplement for ruminants especially goats on low quality diets (Hassan et al., 2014).

MATERIALS AND METHODS

Description of experimental site

The study was conducted during the 2015/2016 rainy season at the Experimental Farm of the Feeds and Nutrition Research Programme, National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State, Nigeria. Shika is located on Latitude 110 12'W. Longitude 070 33'E with an altitude of 660 m above sea level, along Zaria-Funtua Road in the Northern Guinea Savannah zone of Nigeria (Ovimap, 2016). The climate of the study area is characterised by a defined wet and dry season. Wet season starts from April to early May and ends in late September to early October while the dry season last from October to April. The total annual rainfall ranges from 748.6 – 1156.7 mm with a long-term average of 1058.60 mm, with a maximum air temperature of 370C in May and minimum air temperature of 11.50C recorded in December/January and relative humidity of approximately 70% (IARMS, 2016).

Preparation of Sorghum almum and Lablab purpureus hay mixtures

Forage materials were harvested at 12 weeks after sowing S. almum with a forage harvester attached to a tractor machine and conveyed to the drying shade in a trailer attached to the tractor. The harvested forage materials were chopped to 2 cm with cutlasses and allowed to wilt for 5 days under the shade and stored in jute bags in a well ventilated room until ready for feeding trial with growing Red Sokoto bucks. S. almum and L. purpureus hay mixtures was prepared after a week by weighing the forages using a weighing balance and mixing them in the following S. almum: L. purpureus hay mixture ratios of 100

:0, 90:10, 80:20 and 70:30 respectively as presented in Table 1 as shown below, the concentrate supplement was prepared to contain; maize, wheat offal, cotton seed cake, bone meal and salt as presented in Table 2.

Experimental animals and their management

The experiment was conducted at the Small Ruminant Research Programme experimental unit of the National Animal Production Research Institute (NAPRI) Shika, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Twenty (20) growing Red Sokoto bucks aged between 8-10 months with average body weight of 12.55 + 2.63 kg were used in the study. The animals were initially prophylactically treated

against internal and external parasites during the acclimatization period. All animals received 0.1ml/10kg body weight of Ivermectin (10ml) injection and 0.1mg/kg body weight of Tetranor (Oxytetracycline Dehydrate, 20 % weight/volume injectable solution). Other routine management practices carried out was deworming against intestinal parasites using Albendazole® 10% solution administered orally. Amitics® solution was also sprayed on the animals using knapsack sprayer against external parasites twice a week prior to the commencement of the study.

Experimental design and Animals feeding

The bucks were initially balanced for their weights and allotted to four dietary treatments with five bucks per treatment in a Randomized Complete Block Design (RCBD). The experimental treatments contain S. almum and L. purpureus hay mixtures in the ratios of (100:0, 90:10, 80:20 and 70:30) which were fed as basal diets respectively, with concentrate as supplement. The bucks were pen-fed separately with S. almum and L. purpureus hay mixtures and concentrate supplement at 3 % body weight (BW) (1.5 % forage mixture and 1.5 % concentrate) for a period of 12 weeks. During the feeding trial, concentrate diet was offered once in the morning (8.00am) then the S. almum and L. purpureus hay mixtures immediately after they finish the concentrate. Daily records of feeds offered (concentrate and S. almum and L. purpureus hay mixtures) and left over were recorded to determine the voluntary feed intake. Water and mineral salt-licks were provided ad libitum to the bucks. During the experiment the bucks were also weighed fortnightly to determine their live weight changes and to adjust for the feed offered.

Chemical analysis

Samples of the forages harvested, feed offered and faeces were analysed for dry matter (DM), crude protein (CP = N x 6.25), crude fibre (CF), ether Extract (EE) and ash contents according to the procedure described by AOAC (2005). Nitrogen Free Extract was calculated by difference NFE = 100 - (CF + CP + EE + Ash). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according to the method of Van Soest (1991). Mineral contents (Calcium and Phosphorus) were determined by the standard laboratory procedure of AOAC (2005) using the Atomic Absorption Spectrophotometer. Urine was analysed for nitrogen using Kjeldahl Procedure (AOAC, 2005). Samples of experimental diets, orts and faeces were burnt to ash by charring in Muffled furnace at 5000 C for 6 hours. Organic matter (OM) was obtained as the difference between the dry matter and ash content. Metabolizable energy of the diets was calculated by the equation of Alderman, (1985) as: ME (MJ/Kg DM) = 11.78 + 0.0064 CP + (0.00065EE) 2 – CF (0.00414EE) – 0.0118A. Where ME = Metabolizable energy, DM= dry matter, CF = crude fiber, CP = crude protein, EE= ether extract and A = Ash.

Cost benefit analysis of the experimental diets

The value of gain and net benefit for each treatment was calculated based on the value of weight gain by each buck and cost of feed consumed throughout the experimental period. The total cost of feed per kilogramme (kg) was determined by addition of costs of concentrate and hay mixtures per kg. Total feed consumed was recorded as the total feed intake from each treatment for hay and concentrate. Cost of feeding each buck was calculated as total cost of feed multiplied by total feed consumed divide by 5 (number of bucks). The value of gain was determined as live weight gain of each buck multiplied by N450.00 (cost per kg of live weight experimental period). Cost per kg gain was calculated as cost of feeding divided by live weight gain. Net benefit was determined value of gain minus cost of feeding each buck (Hassan, 2014; Hassan et al. 2016).

Statistical analysis

Data collected on daily voluntary and nutrient intake, average daily gain, initial and final weights, coefficients of digestibility and cost

analysis were analysed by ANOVA using the General Linear Model Procedure of (SAS, 2005). Significant treatment means were separated using the Post Hoc Test (Dunnet's test).

Experimental model:

$Yij = \mu + Tj + eij$

Where: Yij = dependent variables

μ = Overall mean

Tj = Effect of the jth treatment diet (j = 100:0, 90:10, 80:20 and 70:30)

eij = Random error

RESULTS

Chemical composition, Metabolizable energy and Relative Feed Value (RFV)

The proximate composition of S. almum and L. purpureus hay mixtures, concentrate supplement and lablab hay were presented in Table 3. The concentrate supplement had crude protein content of 15.75 %, dry matter of 92.68 %, organic matter content of 86.02 %, crude fiber content of 7.58 %, nitrogen free extract content of 64.92 %, metabolizable energy of 11.67 MJ/kg and relative feed value of 105.45. The L. purpureus hay in mixtures with S. almum had crude protein, metabolizable energy and relative feed value of 22.53 %, 12.13 MJ/Kg and 120.03 respectively. The dry matter contents of experimental diets containing S. almum and L. purpureus hay mixtures were greater than 91.0 % across the treatments. The organic matter was above 80.0% but less than 90.0%, the metabolizable energy was between 12.16 – 12.20 MJ/kg across treatments. The crude protein content ranged from 12.62 % in 100:0 diet to 13.88 % in 80:20 diet. The crude fiber and nitrogen free extract contents were statistically similar in all the treatments and range from 4.90 % in 100:0 diet to 5.11 % in 90:10 % diet and 63.43 % in 70:30 diet to 94.45 % in 90:10 diet respectively. However, the highest values of 31.15 % acid detergent fiber and 55.92 % neutral detergent fiber, 24.77 % hemicellulose and 19.13 % cellulose were observed in 90:10 diet. The acid detergent lignin were within the range of 9.80 % in 100:0 diet to 12.02 % in 90:10 diet. The relative feed value of experimental diets were above 100 with the highest value of 129.35 in 100:0 diet and lowest value of 107.47 in 90:10 diet.

Growth performance

The result on performance characteristics of growing Red Sokoto bucks is presented in Table 4. Voluntary feed intake of forage hay mixtures are significantly ($P<0.05$) different across the treatments. Hay intake of (185.75 g/day) for bucks fed S. almum and L. purpureus hay mixture of 80:20 and (184.52 g/day) for 70: 30 were not significantly ($P>0.05$) different from (177.92 g/day) of the control group. There was significantly ($P<0.05$) lower (160.73 g/day) hay intake for bucks fed (90:10) diet than the other treatments. However, the total dry matter intake across treatments compared to the control were not significantly ($P>0.05$) different. The final body weight of the bucks fed 70: 30 diet was significantly ($P<0.05$) higher (16.30 kg) than (15.10 kg) of those fed the control (100:0) diet. The average body weight gain and daily weight gain of bucks fed with 80:10 and 70:30 diets differed significantly ($P<0.05$) from the control (100:0). The highest average body weight gain (3.70 kg) and daily weight gain (44.05 g/day) was observed in bucks fed with 70:30 diets while the lowest average body weight gain of 2.30 kg and daily weight gain of 27.38 g/buck/day was obtained in bucks fed with 90:10 diet. The feed conversion ratio was significantly ($P<0.05$) better (10.09) in bucks fed 70:30 diet compared to the control (17.77).

Cost benefit analysis

The result on cost benefit analysis is shown in Table 5. An increase in total cost per kilogram feed with increase in L. purpureus hay ratios in the diet from N 62.80k/kg to N 67.0k/kg of feed. The total feed consumed also follows similar trend for 35.77kg to 36.85kg as the inclusion of L. purpureus increased from 100:0 to 70:30 hay

mixtures. The cost of feeding each buck was comparably higher (N 493.74k) in bucks fed 70:30 hay mixtures than all the other treatments. The cost per kilogram weight gain higher (N223.24k) in the control diet with progressive decrease across treatment groups and lowest (N135.25k) in bucks fed 70:30 hay mixture. The value of gain followed a similar pattern of progressive increase as the ratio of L. purpureus was increased in the diets. The value of gain was higher (N1, 665.00k) in bucks fed 70:30 and lowest (N1, 035.00k) in bucks fed 90:10 hay mixtures. However, the net benefit derived from feeding Red Sokoto bucks with S. almum and L. purpureus hay mixtures was higher (N1, 171.25k) in 70:30 diet compared to the values obtained in the other treatment groups. This represents 34.37 % higher net benefits obtained when 70:30 was fed to the bucks.

Table 1: Ratios of experimental based diets fed to growing Red Sokoto bucks

Ratios	100:0	90:10	80:20	70:30
Sorghum almum	100	90	80	70
Lablab purpureus	0	10	20	30
Total	100	100	100	100

Table 2: Composition of concentrate supplement fed to Red Sokoto bucks

Ingredients	Percentage (%)
Maize	40.0
Wheat offal	31.5
Cotton seed cake	25.0
Bone meal	2.5
Salt	1.0
Total	100.0
Calculated analysis (%)	
Crude protein	13.63
Ether extract	17.53
Crude fibre	10.28
Ca	0.74
Available P	0.81
Ca:P	0.90
Metabolizable energy (Kcal/kg)	2679.0

Table 3: Chemical composition of the experimental diet fed to growing Red Sokoto bucks *Sorghum almum and Lablab purpureus* hay mixtures

Parameter (%)	100:0	90:10	80:20	70:30	Concentrate	Lablab hay
Dry matter (DM)	92.5	91.11	93.4	91.56	92.68	94.47
Organic matter (OM)	87.60	86.00	88.48	86.70	86.02	83.15
Crude protein (CP)	12.62	13.13	13.88	13.75	15.75	22.53
Crude fibre (CF)	17.01	15.12	14.86	16.2	7.58	22.14
Either extract (EE)	2.03	2.19	2.01	1.76	5.09	6.37
Ash content (A)	4.9	5.11	4.92	4.86	6.66	10.32
Nitrogen free extract (NFE)	63.44	64.45	64.33	63.43	64.92	38.64
ME (MJ/kg)	12.17	12.16	12.19	12.20	11.67	12.13
Relative feed Value (RFV)	129.35	107.48	114.16	123.42	105.45	120.03
Acid detergent fiber (ADF)	26.66	31.15	30.02	29.13	28.68	27.82
Neutral detergent fiber (NDF)	48.98	55.92	53.36	49.88	58.69	52.08
Acid detergent lignin (ADL)	9.8	12.02	11.68	10.5	10.54	14.22
Hemicellulose	22.32	24.77	23.34	20.75	30.01	24.26
Cellulose	16.86	19.13	18.34	18.63	18.14	13.60

RFV= {88.9-(0.78 x ADF%)) x (120/NDF%)}/1.29) (Agric –facts 2006), ME (MJ/kg DM) = 11.78 + 0.00654CP + (0.000665EE)2 – CF (0.00414EE) – 0.0118A

Table 4: Growth Performance of Red Sokoto Bucks fed *Sorghum almum* and *Lablab purpureus* hay mixtures with concentrate supplement *Sorghum almum* and *Lablab purpureus hay*

Parameters	100:0	90:10	80:20	70:30	SEM
Concentrate DM intake g/day	216.45	211.18	218.08	219.77	11.34^{NS}
Hay DM intake g/day	177.92^{a}	160.73^{b}	185.75^{a}	184.52^{a}	11.51*
Total DM intake g/day	394.37	371.91	403.82	404.29	22.68^{NS}
Initial body weight (kg)	12.60	12.60	12.40	12.60	0.59^{NS}
Final body weight (kg)	15.10^{b}	14.90^{b}	15.60^{ab}	16.30^{a}	0.60^{*}
Average body weight gain (kg/buck)	2.50^{b}	2.30^{b}	3.20^{a}	3.70^{a}	0.28*
Daily weight gain (g/buck/day)	29.76^{b}	27.38^{b}	38.10^{b}	44.05^{a}	3.30*
Feed conversion ratio (FCR)	17.77^{c}	15.21^{c}	13.19^{b}	10.09^{a}	1.54*

^{abc*}Means with different superscripts within columns differed significantly (P<0.05). SEM= Standard Error of Mean, DM= Dry Matter, NS= Not significant.

Table 5: Cost benefit analysis of Red Sokoto Bucks fed *Sorghum almum* and *Lablab purpureus* hay with concentrate supplement

	Sorghum almum* and *Lablab purpureus hay			
Parameters	**100:0**	**90:10**	**80:20**	**70:30**
Cost/kg of concentrate (N)	50.80	50.80	50.80	50.80
Cost/ kg of Hay (N)	12.00	13.40	14.80	16.20
Total cost/kg of feed (N)	62.80	64.20	65.60	67.00
Total feed consumed (kg)	35.77	33.96	36.47	36.85
Live weight gain (kg)	2.50	2.30	3.20	3.70
Cost of feeding (N/buck)	449.33	436.03	478.49	493.74
Cost/kg gain (N)	223.24	195.34	173.04	135.25
Value of gain (N)	1125.00	1035.00	1440.00	1665.00
Net benefit (N)	675.67	598.97	961.51	1171.25

SEM= standard error of mean, Concentrate = a, Hay = b, Total= a+b=c, Total feed consumed = d, Cost of feeding (N/buck) = (c x d) = e, live weight gain = f, Value of gain = f x N450 = g, Cost/kg gain = (e/f) = h, Net benefit = g-e, (1US$= N395.0k as at June, 2016)

DISCUSSION

The Chemical composition, Metabolizable energy and Relative Feed Value (RFV)

The dry matter (DM) content of S. almum and L. purpureus hay mixtures were above 91.00 % this might be due prevailing edaphic factor and stage of growth at harvest. The value of DM observed was similar to 929.1 g/kg (92.91 %) reported by Lanyasunya et al. (2007c). The crude protein content of S. almum and L. purpureus mixtures increases with increase in the inclusion levels of lablab hay in the mixtures. The crude protein (CP) ranged from 12.62 – 13.75 %. This increase could be associated with increase in the levels of lablab hay in the diet. The CP content of lablab and S. almum (control) hay observed in this study are 22.53 % and 12.62 % respectively. The crude protein is one of the quality parameters used in pasture evaluation (Muhammad and Halim, 2014). However, The % CP value of all the treatments were greater than the bench mark recommended for efficient rumen function in matured beef cattle of 7 % but fell short of the requirement of high producing dairy cows of 19 % as reported by Sebahattin et al. (2011). The CP values reported in this study met the requirement of 10 – 12 % CP for sheep and goats (Wada et al., 2016). Tessema and Baars, (2006) also, reported higher protein concentration in legumes than in grasses. The crude fibre (CF) and its fractions of the basal diets were inconsistent though, lower than the previous report of Hassan et al. (2016) probably due to variations in experimental periods. The cell wall fractions were found to compare well with earlier reports on tropical grasses (Aganga, et al., 2000). The nutrient detergent fibre (NDF) was below 60.0 % suggested by Muia, (2000) as critical for limit for efficient utilization of roughages. The metabolizable energy obtained ranged from 11.67 – 12.20 MJ/kg above the range of values 10.85 – 11.16 MJ/kg reported by Sani et al. (2015) for fattening bulls. The relative feed value (RFV) obtained in this study is above 100 which indicated a good quality feed (Agric- fact, 2006). Lablab is a protein rich legume with RFV value of 120.03 which is an indicator of prime quality fodder (Canbolat et al., 2006). The RFV index is used to rank cool

season legumes, grasses and mixtures by potential digestible dry matter intake and it enables allocation of forages to the proper livestock class with a given level of expected performance (Lanyasunya et al., 2007c).

Growth performance

Dry matter intake is an important factor in the utilization of feeds and a critical determinant of energy and performance in small ruminant (Devant et al., 2000; Abdu et al., 2015). It appears that the mixture of S. almum and L. purpureus hay of 70:30 was probably more palatable and acceptable to the bucks. The variations observed in feed intakes could be as a result of improvement in the protein status of the feed which enhances rumen micro-organism profile and encourage a more rapid and thorough digestion of ingesta leading to assimilation. Hassan et al. (2016) reported that inclusion of lablab hay in the diet can help to increase the efficiency of utilization of roughages by the rumen microbes which resulted in improved weight gain. Lanyasunya et al. (2007b) in a study in China, reported that increase in intake is attributed to increase in nitrogen in the diet and available fermentable fiber. The authors added that, if the basal diet have such a low nitrogen content as to constrain rumen microbial activity, the addition of a forage legume will increase the nitrogen content of the total diet, which in turn will likely increase the rate of degradation of basal diet in the rumen and so, increase feed intake. They further suggested that beneficial effect of the incorporation of highly digestible legume in an otherwise low digestible basal diet could be that, its exert a large effect on digestibility by providing a highly colonised fiber source to "seed" bacterial onto the less digestible fibre. According to Olafadehon et al. (2014) reported that nutrient intake is a function of dry matter intake in small ruminants. The result of this study also, indicated an increase in body weight when S. almum and L. purpureus hay mixtures (70:30) of 3.7 kg and a daily weight gain of 44.05 g/day, this could be as a result of higher feed intake which are likely to have consumed more nutrients and more energy available for tissue development. This is in agreement with the report of Njidda, at al. (2014) and Wada et al. (2016) that efficient utilization of feed supply adequate energy and protein is required for optimum growth and performance in ruminants. The average daily weight gain followed similar pattern as feed intake, this implies that, the lower average daily gain of the control diet compared diets containing 80:20 and 70:30 of S. almum and L. purpureus hay mixture is due to lower feed intake by the animals. The values of average weight gain and daily weight gain observed were similar to 3.98 kg and 44.22 g/day respectively reported by Hassan et al. (2016). The feed conversion ratio (FCR) obtained in this study (10.09) for 70:30 of S. almum and L. purpureus hay mixtures was similar (10.72) report by Hassan et al. (2016). Better FCR observed in 70:30 hay mixtures might be attributed to better utilization of feed and hence improved body weight gain.

Cost benefit analysis

It was observed from the result of this study (Table 5) that, the combination of S. almum and L. Purpureus hay mixtures in the diet of Red Sokoto bucks resulted in a positive net benefit and income (Table 4). Higher economic returns of N1171.25k (1US$ = N 395.00k) compared to the control (N 675.67k) resulted from the addition of lablab hay with S. almum at 70:30 mixtures. This is in agreement with previous reports by Yusufali (2005); Kabirizi et al. (2006) and Hassan et al. (2016) that, inclusion of lablab hay in the diet of Red Sokoto bucks resulted into high profit margin compared to other forage legumes and Sani et al. (2015) also reported a positive net benefit derived from fattening bulls with rice offal up to 30%. The study showed that a mixture of S. almum and lablab hay at 70:30 can increase the income of a smallholder farmers by 34.37 % compared to when sole S. almum was fed to Red Sokoto bucks.

CONCLUSION AND RECOMMENDATION

The utilization of S. almum and L. purpureus hay mixtures in smallholder livestock system will promote the conservation of these two crops as traditional crops for food and fodder in Nigeria and help in diminishing its threat of genetic eroding fodder crops. Therefore, the result of these study indicated that mixture of Sorghum almum and L. purpureus hay in the diet of Red Sokoto goats (bucks) at 70:30 increases dry matter intake, body weight gain, FCR and net benefits indicating their potential as small ruminant livestock feed and will provide the farmer with 34.37 % higher net benefit. It could be recommended that smallholder farmers, stock owners and feed millers can adopt S. almum and L. purpureus hay mixtures at 70:30 for better performance and higher net benefit.

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