Forage from cropping systems as dry season supplements for sheep

J. AKINLADE[1], J.W SMITH[2], A. LARBI[2], I.O. ARCHIBONG[2] AND I.O. ADEKUNLE[2]
[1]*Department of Animal Production and Health, Ladoke Akintola University of Technology, Oghomoso, Nigeria*
[2]*International Livestock Research Institute (ILRI), Humid/Subhumid Zone Program, Ibadan, Nigeria*

Abstract

Information on the utilisation of legume hays from an intercropping system as a feed supplement is limited. Three forage legume hays (*Stylosanthes guianensis, Lablab purpureus* and *Aeschynomene histrix)* were compared by feeding them as supplements for yearling West African dwarf rams (LWt 18.0±2.2kg) fed a basal diet of mature guinea grass (*Panicum maximum*). The performance of the rams was evaluated in a 60-day growth trial, using a completely randomised design with 6 rams per treatment. Organic matter digestibility and nitrogen retention were assessed in a separate trial using the same design, but with 4 animals per treatment. In the growth trial, rams supplemented with *S. guianensis* and *A. histrix* gained more weight (P<0.05) than those on the *L. purpureus*-supplemented diet. Average total weight gains were 33.3, 13.2 and 31.2 g/d for *S. guianensis-*, *L. purpureus-* and *A. histrix*-supplemented diets, respectively.

Organic matter digestibility was 643, 568 and 523 g/kg for *S. guianensis-, A. histrix-* and *L. purpureus*-supplemented groups, respectively. All treatments resulted in positive nitrogen balance.

We concluded that feeding forage legumes from cereal-based cropping systems as a supplement can maintain liveweight in sheep and even achieve modest weight gains during the critical dry period when feed quality is poor.

Correspondence: J. Akinlade, Department of Animal Science, University of Ibadan, Ibadan, Nigeria. e.mail: Akinlade_Adeyemi@yahoo.com

Introduction

Poor nutrition is a major constraint to livestock production in small-holder crop-livestock farming systems, especially during the dry season when available feed quantity is low and quality extremely poor (Alhassan 1987). Integration of forage legumes into the cropping system could improve soil fertility as well as providing better quality forage for supplementation of low quality cereal residues during the dry season (Nnadi and Hague 1985). The legume can be sown as pure stands in protein banks or undersown in food crops. In small-holder crop-livestock systems where land is scarce, undersowing of a forage legume in a crop could be advantageous. Several studies on the effect of a supplement of forage legume on feed intake, digestibility and utilisation of low quality crop residues have been reported (Butterworth and Mossi 1985; Owen 1985). In most of these studies, however, the forage legumes were harvested from pure stands which does not represent on-farm conditions in small-holder systems (ILCA 1988).

We are currently studying different cropping systems, which aim at improving crop-livestock integration. This study was undertaken to compare the supplementary effect of cereal-based intercropped legume hays on feed intake, digestibility, nitrogen balance and weight changes in West African dwarf sheep fed a basal diet of guinea grass (*Panicum maximum).*

Materials and methods

Forages

The forages tested were *Aeschynomene histrix, Lablab purpureus* and *Stylosanthes guianensis*. Seeds of legumes were sown at the recommended rate for 90% viability: 6 kg/ha for stylo; 3 kg/ha for all other genera (Humphreys 1980). Inoculum was not used but all legumes received 150 kg/ha single superphosphate fertiliser at sowing. Plots were not fertilised after this, but were hand-weeded throughout the trial. Maize was planted at a spacing of 25 cm within rows and 100 cm between rows with an estimated population of 40 000 plants/ha. Legumes were intercropped when maize was 4 weeks old at the rate of 1 row of legume to 3 rows of maize. The legumes were harvested at the end of the cropping season (18 wk after undersowing), dried under shade and mechanically chopped to 5–10 mm lengths and stored in a cool dry place. *Panicum maximum* regrowth was about 5 weeks old at the start of the trial. Fresh guinea grass was manually harvested daily at 25 cm above ground, chopped by hand into 3–5 cm lengths and fed to the animals.

Experimental animals and management

Eighteen West African dwarf yearling rams (LWt 18.0±2.2kg), 9–15 months old, were divided into 3 groups of 6 animals each, balanced for weight and age. Each group was randomly assigned to a basal diet of fresh guinea grass supplemented with one of the forage legume hays: *Aeschynomene histrix, Lablab purpureus* and *Stylosanthes guianensis.* The sheep were dewormed and dipped to control external parasites before the start of the experiment, and were housed in individual pens with a concrete floor covered with wood shavings. The basal diet and supplements were offered in separate troughs at a ratio of 70:30. The feed was offered at the rate of 50 g DM per kg liveweight, at 08.00h daily, after removal of the feed refused the previous day. Fresh drinking water and a mineral block were available to each ram at all times.

Growth trial

The growth study lasted for 60 days including an initial 14-day adjustment period. The animals were weighed weekly and the liveweight gain over the experimental period was calculated by subtracting the initial weight from the final weight. Feed offered was adjusted each week according to liveweight. The amounts of basal diet and supplement offered and refused were recorded daily to calculate feed intake. Samples of feed offered were taken weekly while refusals were taken daily and bulked for each animal and oven dried at 60°C for 48h to determine dry matter (DM) concentration.

Digestibility trial

After the growth trial, a digestibility trial was conducted using the same treatments and same feeding regime as in the growth trial. Four rams were assigned to each treatment. Animals were housed in individual metabolic cages equipped with feed and water troughs with facilities for separate collection of faeces and urine. The trial consisted of a 14-day adaptation period followed by a 7-day collection period. Animals were weighed at the beginning and end of the collection period. The amounts of feed offered and refusals were recorded daily and sampled for each animal during the collection period. Daily faecal output of each animal was weighed and sampled. Total daily urine produced was collected over 10 ml concentrated sulphuric acid. Samples of faeces and urine were frozen and stored for later analysis.

Chemical and statistical analyses

Sub-samples of the feed offered and refused and faeces were oven- dried at 60°C for 48h to determine dry matter (DM) concentration. The oven-dried samples were ground to pass a 1-mm screen for NDF analysis (Goering and Van Soest 1970). N was determined by the Kjeldahl method (AOAC 1990) and converted to crude protein as N × 6.25. Ash was obtained by placing samples in a muffle furnace at 600°C for 18h. Data were analysed using a completely randomised block design with animals as replicates using General Linear Model (GLM) procedures (SAS 1988). Means were separated assuming a probability level of 0.05.

Results

Chemical composition of forages

The chemical composition of the basal grass and the supplementary legume hays is shown in Table 1. *Panicum maximum* had the highest ash concentration (83 g/kgDM) and was low in crude protein (CP) (25 g/kgDM) compared with the legumes (65–110 g CP/kgDM). The NDF concentration in the basal diet (665 g/kgDM) was higher than in the legume hays (469–573 g/kgDM).

Table 1. Chemical composition of *Panicum maximum* and 3 supplementary legume hays fed to West African dwarf sheep.

	DM[1]	OM	CP	NDF
	(g/kg)	(g/kg DM)		
Panicum maximum	234	917	25	665
Stylosanthes guianensis	934	980	65	469
Lablab purpureus	933	943	80	573
Aeschynomene histrix	938	973	110	513

[1]DM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fibre.

Voluntary intake

There were significant (P<0.05) differences among treatments in OM intakes of the basal diet (Table 2) but no differences in intake per unit metabolic weight (P>0.05). OM intakes of the supplements were significantly (P<0.05) different (*S. guianensis* > *L. purpureus* > *A. histrix*-supplemented group). The total organic matter intakes per head were in the order LP>SG>AH (P<0.05) while intakes per unit metabolic weight were SG>LP>AH (P<0.05).

Digestibility

Animals on the *L. purpureus*-supplemented diet had significantly lower OM digestibility than animals on *A. histrix*- and *S. guianensis*-supplemented diets (Table 2). Organic matter digestibility and intakes of digestible organic matter were in the order SG>AH>LP and SG>LP>AH, respectively (P<0.05).

Nitrogen balance

Yearling rams supplemented with *A. histrix* or *L. purpureus* consumed more total N but lost more N in urine (both treatments) than sheep supplemented with *S. guianensis* (P<0.05) (Table 2). All rams were in positive nitrogen balance with most N retained (P<0.05) by sheep supplemented with *L. purpureus*.

Growth trial

Weight gains of rams supplemented with *L. pupureus* were significantly (P<0.05) lower than for those supplemented with *S. guianensis* and *A. histrix* throughout the study period (Table 2; Figure 1).

Table 2. Liveweight, liveweight gain, voluntary intake, digestibility and nitrogen balance in West African dwarf sheep fed a basal diet of *Panicum maximum* supplemented with *Stylosanthes guianensis* (SG), *Lablab purpureus* (LP) and *Aeschynomene histrix* (AH).

	SG	LP	AH	SEM
Organic matter intake				
P. maximum				
g/hd	277.9c[1]	299.9a	286.5b	0.1
g/kg $W^{0.75}$	32.3a	32.9a	33.5a	1.7
Supplement				
g/hd	157.8a	142.7b	114.5c	0.7
g/kg $w^{0.75}$	18.3a	16.2a	13.4c	2.5
Total intake				
g/hd	435.7b	441.5a	401.1c	2.9
g/kg $w^{0.75}$	50.6a	49.1b	46.9c	0.4
OM digestibility (g/kg)	643a	523c	568b	4.6
Intake of DOM (g/hd/d)	280.2a	230.9c	227.8b	32.2
Total N intake (g/hd/d)	2.9b	3.2a	3.3a	0.14
Nitrogen output (g/hd/d)				
Faecal	0.6a	0.5b	0.6a	0.17
Urinary	0.2b	0.4a	0.4a	0.12
Nitrogen retention (g/hd/d)	2.2b	2.4a	2.3b	0.79
Liveweight (kg)	17.9a	18.8a	17.4a	9.56
Liveweight gain (g/d)	33.3a	13.2b	31.2a	7.8

[1]Means within rows followed by the same letters are not significantly different (P>0.05).

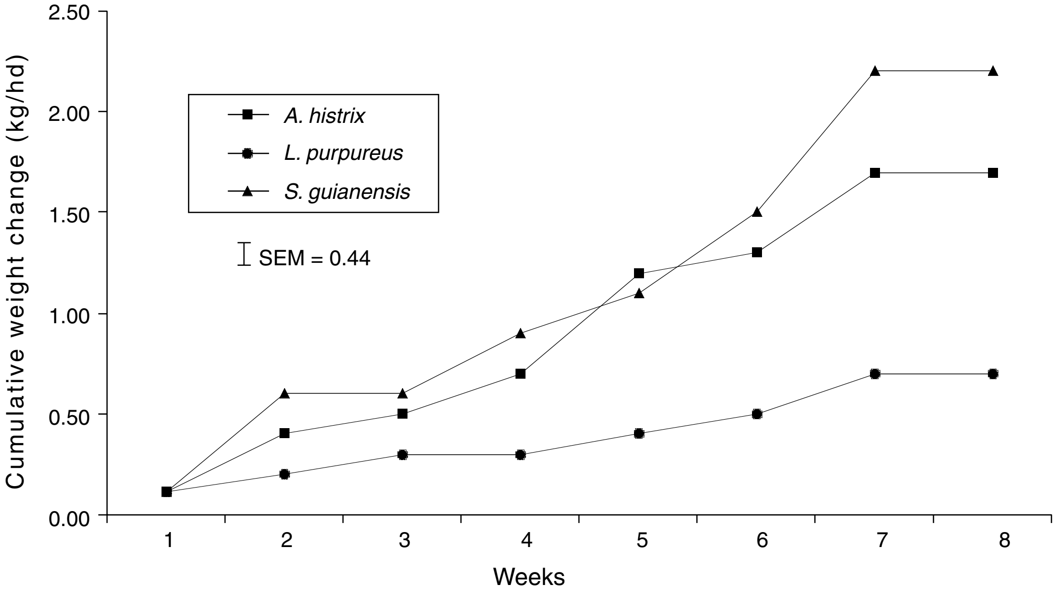

Figure 1. Weight gains of West African dwarf sheep fed a basal diet of *Panicum maximum* supplemented with *Stylosanthes guianensis*, *Lablab pupureus* and *Aeschynomene histrix* hays.

Discussion

This study has shown that all three legumes provided an above-maintenance level of nutrition to sheep when used as supplements to guinea grass regrowth containing 2.5% crude protein. These CP levels are typical of levels in mature tropical grasses (Olubajo 1977) and would limit voluntary feed intake (Milford and Minson 1968). It would be expected that supplementing with the legumes would have improved voluntary feed intake (Said and Tolera 1993). However, we are unable to quantify any responses which might have occurred in our study as we did not include a treatment incorporating guinea grass only.

The liveweight gains we obtained were similar to the 19.7 g/lamb/d reported by Said and Tolera (1993) when feeding *S. guianensis* (250–450 g/hd/d) as a supplement to a basal diet of maize stover. Gains of this order would sustain sheep over the dry season. However, the gains may have been elevated by the level of selection we allowed. We offered feed at 50 gDM/kg liveweight and consumption was about 24–25 gDM/kg liveweight. This allowed the sheep to select a higher quality diet than the feed on offer which was confirmed by the lower nutrient levels in the refusals. In a practical situation, animals would be expected to consume more than half of the available forage.

The liveweight gains would suggest that *S. guianensis* and *A. histrix* were superior to *L. purpureus* as supplements. Despite a much higher intake of digestible organic matter on the *S. guianensis* treatment, animals gained no more than on the *A. histrix* treatment. *A. histrix* appeared to retain a higher CP level than the other species at the stage of growth when they were harvested. Our data do not allow us to state which legume was superior to the others for sowing into a crop. Other factors such as dry matter yields, crude protein levels, ability to retain leaf and pod materials, drought tolerance, pest and disease resistance and impacts on current and subsequent crop yields would need to be considered in selecting which species to sow.

Intercropping of legumes into cereal crops can benefit both current and subsequent crops (Tarawali and Peters 1996). An improvement in animal performance on the crop stubble would provide an additional benefit to the small-holder farmer. Our results suggest that such an improvement in animal performance would occur, but it needs to be demonstrated. Further studies are warranted to examine the differences in utilisation of and animal production from crop residues both with and without undersown legumes, especially when grazed *in situ.* It is essential that the comparative studies are conducted to quantify any benefits in animal performance from legume inclusion.

Conclusion

Stylosanthes guianensis and *Aeschynomene histrix* were the most promising of the 3 forage legumes as both promoted modest weight gain in West African dwarf rams fed on poor quality grass. The results suggest that an additional benefit from the cropping system could be achieved by allowing animals access to the hay after crop harvest. This will further enhance the expected merits of integrated crop-livestock farming systems. However, further studies should examine performance on the basal diet as well to ensure that the benefits of the intercropped legume hays are quantified.

Acknowledgement

The authors gratefully acknowledge the support of the International Livestock Research Institute (ILRI), Ibadan, Nigeria for providing the facilities.

References

ALHASSAN, W.S. (1987) Studies on untreated crop residues utilization in red Sokoto (maradi) goat. In: Smith, O.B. and Boymen, H.C. (eds*) Goat production in the humid tropics. Proceedings of workshop at O.A.U., Ile-Ife, Nigeria. 20–24 July 1987.*

AOAC (1990) *Official methods of analysis*. (Association of Official Analytical Chemists: Washington, DC).

BUTTERWORTH, M.H. and MOSSI, A.K. (1985) Practical evaluation of crop residues and agro-industrial by products for ruminants in developing countries with emphasis on East Africa. *FAO Animal Production and Health Paper 50*. pp. 15–20. (FAO: Rome).

GOERING, H.K. and VAN SOEST, P.J. (1970) *Forage Fibre Analyses (Apparatus, Reagents, Procedure and some applications). Agricultural handbook*. No 379. (US Department of Agriculture: Washington, DC, USA).

HUMPHREYS, L.R. (1980) *A Guide to Better Pastures in the Tropics and Subtropics.* 4th Edn. (Wright Stephenson and Co (Australia): Australia).

International Livestock Centre for Africa (1988) *Annual reports 1998, ILCA, Addis Ababa, Ethiopia.*

MILFORD, R. and MINSON, D.J. (1968) The digestibility and intake of six varieties of Rhodes grass (*Chloris gayana*). *Australian Journal of Experimental Agriculture and Animal Husbandry*, **11,** 18–25.

NNADI, L.A. and HAGUE, I. (1985) Forage legume — cereal systems: Improvement of soil fertility and agricultural production with special reference to sub Saharan Africa. In: Haque, I., Jutzi, S. and Neate, P.J.H. (eds) *Potential of forage legumes in farming systems of sub Saharan Africa. Workshop Addis Ababa, Ethiopia, 16–19 September 1995.*

OLUBAJO, F.O. (1977) The nutritive value of hay from four grass species cut at three stages of growth at Ibadan. *Nigerian Journal of Animal Production,* **96**, 176–180.

OWEN, E. (1985) Crop residues as animal feeds in developing countries, use and potential use. In: Wanapat, M. and Devendra, C. (eds) *Relevance of crop residues as animal feeds in developing countries. Proceedings of an International Workshop held in Khon Kaen, Thailand, November 28–December 21, 1984.* pp. 25–42. (Funny Press: Bangkok).

SAID, A.N. and TOLERA, A. (1993) The supplementary value of forage legume hays in sheep feeding: feed intake, nitrogen retention and body weight change. *Livestock Production Science,* **33,** 229–237.

SAS Institute Inc. (1988) *SAS/STAT User's guide*. 8-1 Release, 6.04 Edn. (Statistical Analysis Systems Institute Inc.: Cary, NC, USA).

TARAWALI, S.A. and PETERS, M. (1996) The potential contribution of selected forage legume pastures to cereal production in crop-livestock farming systems. *Journal of Agricultural Science (Cambridge),* **127,** 175–182.

(Received for publication September 28, 1999; accepted March 26, 2002)