Nutrient Composition and Forage Yield, Nutritive Quality of Silage Produced from Maize-Lablab Mixture

Amole[1,2,]*, T.A., Oduguwa[1], B.O., Jolaosho[2], A.O., Arigbede[2], M.O., Olanite[2], J.A., Dele[2], P.A. and Ojo[2], V.O.A.
[1]Institute of Food Security, Environmental Resources and Agricultural Research, [2]Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, P.M.B 2240 Alabata, Ogun State, Nigeria
*Corresponding author: gokeamole@yahoo.com

Abstract

Trials were conducted at the Teaching and Research farm, UNAAB in 2008 and 2009 to evaluate the effect of undersowing Lablab (*Lablab purpureus* cv. Rongai) in maize on grain yield, and to evaluate the nutritive quality of the silage in the dry season using calves. A 2 ha piece of land was used for the experiment. In both years, maize was undersown with Lablab two weeks after planting (2WAP) the maize. At harvest (10WAP), fresh weights and number of cobs, shelling percentage and weight of 1000 grains of maize were determined. Silages of sole maize and maize-lablab in ratio 70:30 were made at harvest in plastic bags. After 4 months of conservation, twelve cross-bred (White Fulani x N'dama) calves weighing 71-72 kg were randomly allocated to three dietary treatments: grazing + sole maize silage, grazing + maize-lablab silage and unsupplemented grazing as control for 84 days. A seven day trial was also conducted to find out the digestibility and utilization of the maize – lablab and sole maize silage fed to cross-bred calves as supplement in the dry season. Undersowing increased grain yield in subsequent year. Nitrogen retention was higher ($P<0.05$) in maize-lablab and lower in natural pasture. Calves supplemented with maize-lablab silage (70:30) had the highest ($P<0.05$) metabolic weight gain (50.03 $g/kgW^{0.75}$) while calves without supplementation had the lowest gain (42.76 $g/kgW^{0.75}$). It was concluded that maize- lablab silage (70:30) could be used as supplements to enhance the growth and survival of calves during the dry season.

Keywords: Undersowing, maize-lablab, silage, calves, supplementation

Introduction

Intercropping cereals with forage legumes has been shown to improve both the quantity and quality of fodder (Umunna *et al.,* 1995). This could improve livestock production considerably in addition to benefits in soil fertility (Nandi and Haque, 1986). The indication from the few time-of-planting studies is that sowing a forage legume simultaneously with a fast-growing cereal has no effect on cereal yield, but more work is required with different crop species. Large-seeded legumes, such as lablab, which germinate faster are likely to compete more with cereals if sown at same time than small-seeded ones such the *Stylosanthes* species.

Feed quality of intercropped species is enhanced especially by the legume component with a consequent increase in livestock production (milk and meat) and reduction in reproductive wastage in females (Khalili *et al.,* 1994). However, when cereal/legume forages alone were evaluated for milk and beef production (Khalili *et al.,*1994; Umunna *et al.,* 1995) results revealed that insufficient intakes of organic matter (OM) and crude protein (CP) contents limited animal performance. Umunna *et al.* (1995) noted that although intercropped cereals were of better quality than their respective pure stand of cereal crop residues, they were still deficient in CP content and energy and should not be used as sole feed. Consequently, protein supplementation is required to improve CP intake, and stimulate dry matter (DM) intake of animals consuming intercropped cereals alone.

It has been reported that the most economical way to improve energy intake and performance of animals feeding on cereal crop residues is to supplement them with good quality forage, including forage legumes (Topps, 1992). Smallholder farmers have also shown increasing interest in the use of forage legume as a sustainable source of limiting nutrients (proteins, minerals and vitamins) in roughage based feeding systems (Butterworth and Mosi, 1986). However, the possibility of improving the productivity of calves through strategic supplementation of feeds generated from cereal - forage legume intercropping systems using on-farm generated protein sources (forage legume), is not established.

There has been considerable debate on whether the surplus forage in early rains can be conserved and used to partly fill the dry season feed gap (Kaiser *et al.*, 1993). Ensiling has been suggested as the preferred conservation option during the period when the surplus exists as climatic conditions are considered unsuitable for haymaking.

There is a need to integrate forage legumes into arable crop-based farming systems of the humid zone to limit the degradation of the natural resource base while sustaining food and feed production. These herbaceous forage legumes have the potential to contribute to both crop and livestock production, hence, factors that will influence farmers' adoption of such species should also be considered. In Nigeria, maize is abundantly available and it is most widely used as energy source for animal feeding. Attempts are being made to integrate forage legumes such as lablab (*Lablab purpureus)* in maize crops. Lablab has a longer growing period than cowpea *(Vigna unguiculata),* and does not interfere with the harvesting of other crops (cereals, cotton). One of the largest feed resources, fresh maize stover, after cob harvest on farmlands is an abundant waste and its proper storage and utilization is lacking in humid zone of Nigeria. This necessitated the attempt to conserve the feed resource as silage which can be fed to ruminant animals during the dry season when the quality of pasture is low and forages are scarce.

Calves are the foundation stock from which the various categories of the adult cattle are obtained; feeding them adequately could bring about significant overall improvement in cattle production. It is therefore necessary to design a study to examine the production and preservation of forage from crop integration and feeding response of calves to the mixed conserved cereal/legume forage that would provide some basic information with application to small and large scale farmers.

Materials and Methods

The experiment was aimed at determining the effect of undersown maize with lablab after two weeks of planting maize on the yield of maize was carried out in the rainy season (May- August) of the year 2008 and 2009 respectively at the Teaching and Research Farm, University of Agriculture, Abeokuta (UNAAB), located on latitude 7^{o}13' 49.46"N, longitude 3^{o}26' 11.98"E of Ogun State, Nigeria (Google Earth, 2011). The research site was located in the derived savanna zone of Southwest Nigeria with monthly rainfall which ranged from 120 mm in May to195 mm in

September and mean monthly temperature ranging from 22.5^o to 33.7^o C. The relative humidity in the rainy (late March-October) and dry (November-early March) seasons ranged between 63-96% and 55-84% respectively. The rainfall data two years of experiments (2008 and 2009) are presented in Figures 1 and 2 for the. An area of 1250 ha was used for the experiment in 2008 and 2009, respectively, with an additional 2 ha planted for silage making in 2009. Three core samples of soil (0 – 15cm) were randomly collected from the site before planting in each year for the two years of planting. These were bulked for each block and analysed for physical (particle size) and chemical properties (pH, total N, organic carbon, C: N ratio, available P, available N, cation exchange capacity and acidity) as presented in Table 1.

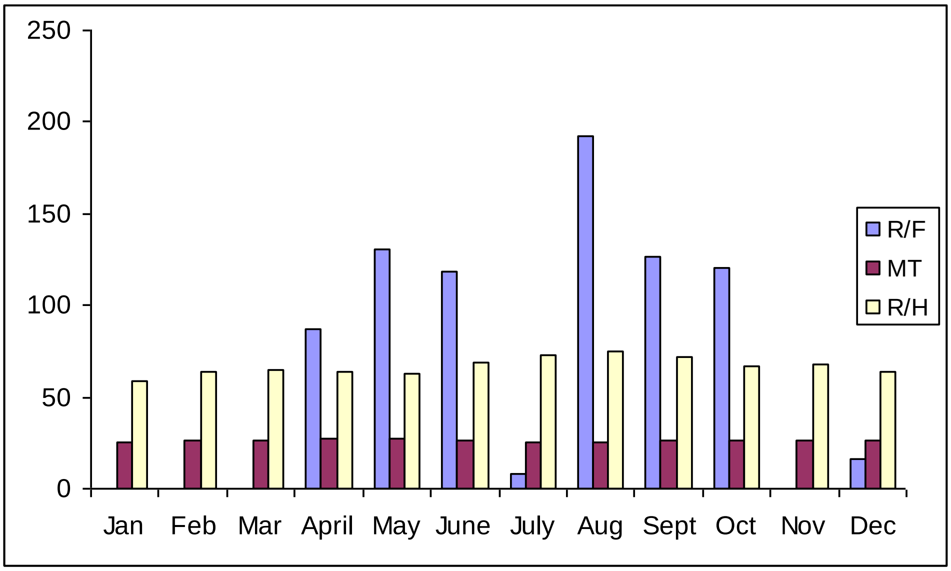

Figure 1: Agrometeorological observation at Ogun-Osun River Basin Development
(OORBD)* in 2008 R/F: Rainfall (mm); MT: Mean temperature (^{0}C); R/H: Relative humidity (%) Source: Ogun-OsunRiver Basin Development, Alabata Road, OgunState. * 5 km from experimental site

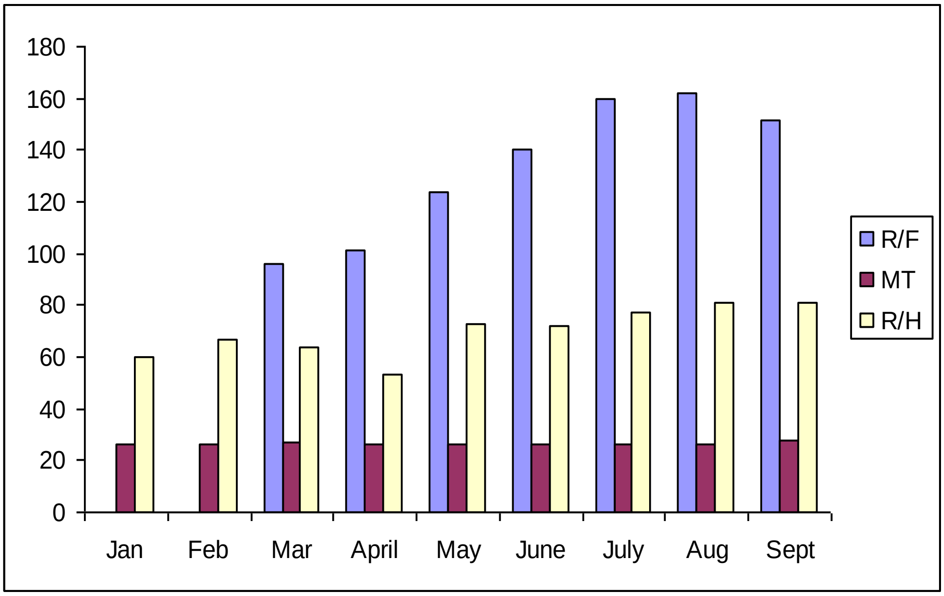

Figure 2: Agrometeorological observation at Ogun-Osun River Basin Development
(OORBD)* in 2009 R/F: Rainfall (mm); MT: Mean Temperature (^{0}C); R/H: Relative humidity (%) Source:Ogun-OsunRiver Basin Development, Alabata Road, OgunState.
*5 km from experimental site

Table 1: Physico – chemical characteristics of the composite soil samples taken from the experimental site at 0-15cm and 15-30cm depths before planting in April 2008 and 2009

Properties	April 2008		April 2009	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Chemical				
pH (H_2O)	6.90	6.90	6.90	6.90
Total Nitrogen (%)	0.21	0.22	0.25	0.29
Organic Carbon (%)	2.83	2.83	2.82	2.81
Organic matter	4.88	5.10	5.00	5.10
Available P (mg kg^{-1})	8.19	8.09	8.39	8.09
Acidity (cmol kg^{-1})	2.00	2.33	1.80	2.31
CEC	1.79	1.75	1.79	1.75
Exchangeable cations (cmol kg^{-1})				
Sodium (Na)	1.40	1.40	1.40	1.34
Potassium (K)	0.20	0.18	0.22	0.18
Calcium (Ca)	0.96	0.81	0.98	0.84
Magnesium (Mg)	1.24	1.00	1.25	1.04
Physical				
Particle size (%)				
Sand	77.8	75.6	77.8	75.6
Silt	14.8	16.8	14.8	16.8
Clay	7.4	6.8	7.4	6.8

The site for planting was cleared and ploughed twice. Thereafter, the land was harrowed and leveled. In both years, a total of 12 plots, each measuring 10 m x 10 m were measured out and demarcated by 1 m spaces between plots and 2 m spaces between blocks for the estimation of yield. The seed of *Lablab purpureus* (Lablab) obtained from National Animal Production Research Institute (NAPRI), Zaria were planted at the rate of 15 kg/ha and spacing of 50x50 cm with one seed per hole. The hybrid maize *(Zea mays)* seeds (SWAN1) was purchased from College of Plant Science, Federal University of Agriculture, Abeokuta (FUANNB) and was planted at 1 m x 0.5 m with two seeds per hole giving an estimated population 67,500 plants/ha.

All the plots except the sole legume plots were sown with maize. Lablab seeds were then undersown into the plots of maize two weeks after planting (2WAP) in mixed plots. Nitrogen was applied to maize at a rate of 26 kg N/ha twice through the compound fertilizer (NPK 20:10:10) two and six weeks after planting. Chemical weed control was carried out using a mixture of herbicides, Premextra Gold® (290 g/l of S-metolachlor and 370 g/l of Atrazine) and Gramoxone® (200mg Paraquat ion per liter emulsifiable concentrate) which was applied pre-emergence one day before sowing using a CP15 knapsack sprayer.

Treatments and Experimental Design

The trial was a total area of 1250 m^2 prepared and laid out as a Randomized Complete Block Design with three treatments namely: sole maize, mixture of maize and lablab undersown after two weeks of planting maize and sole lablab replicated four times which served as blocks.

At harvest (90 days after planting), maize cobs were picked from the experimental plots. The number of cobs per plot was determined. Fresh maize cobs with husk from each plot were weighed (kg) using a weighing balance to determine the cob weight. The cob length (cm) from base to the tip of husk was obtained from 10 selected cobs harvested for the grain yield. These cobs were picked randomly and arranged along a meter rule on a table while the mean value of these cobs was taken as the cob length. Cob circumference was obtained from 10 randomly selected cobs, by winding a tape rule around each cob at the widest part.

Grain yield was obtained from dried maize cobs in each replicate harvested from the four middle rows at 10 weeks after planting. Harvested cobs were shelled winnowed and weighed in kg. Shelling percentage was determined by dividing the weight of grain from the ten randomly selected cobs by weight of cob grain and multiplied by 100.

Fresh maize stovers from the whole plots were harvested and each stand separated into leaf (blade and sheath) and stem (stem, husk and tassel) and weighed. The legumes were harvested at 5cm above ground from the whole plots and weighed. Individual samples weighing 100g of maize stovers and forage legume were oven dried at 60^0C to constant weight for dry matter determination.

In 2009, an area of 2 ha was established with maize undersown with lablab at 2 weeks after planting maize for silage making. At 12 WAP, maize cobs were harvested while maize stover and the lablab were cut, chopped and wilted for 24hours separately. These were later mixed in ratio of 70:30 for maize-lablab and sole maize separately. The 70:30 ratio was selected based on its preferred quality to the 50:50 ratios (Amole, 2008). Polyethylene bags which are sometimes used as refuse sack (15kg capacity) were used as silos.

After four months of storage (September – December 2009), feeding trials to determine the response of grazing calves to feed supplementation with silage during the dry season was conducted at the Cattle Management Technical Committee (CAMTEC) unit of the Teaching and Research Farm, University of Agriculture, Abeokuta, Nigeria.

A total of twelve cross bred calves (White Fulani X N'dama) of ages ranging from 9-12 months old were randomly assigned to three dietary treatments:

Treatment 1: Grazing calves supplemented with sole maize silage at 5% bodyweight/day,

Treatment 2: Grazing calves supplemented with maize –lablab silage (70:30) at 5% bodyweight/day and

Treatment 3: Grazing calves without supplementation (sole grazing).

The cattle pens were thoroughly washed and disinfected. The animals were dewormed (using Albendazole) and dipped to eliminate both internal and external parasites before allotting them to individual pens. At the end of the adaptation period, the animals were balanced for body weight and allocated randomly to the three treatments with four replicates in a completely randomized design. The experimental diets given at 5% of the body weight of the animals were offered from 7:30 to 9:30 am every day with clean water *ad libitum*. The animals were later released to graze in the natural pasture from 10:00 am till 4:00 pm daily. The experiment lasted for 84 days which was December – February, 2010.

Voluntary intake (g) for calves on supplementation was determined as the difference between feed offered and feed refused. Quantities of feeds offered and refused were measured daily to compute feed intake on DM basis. Pre-experimental body weights of the animals were taken after which the animals were weighed weekly prior to feeding. The weight of the animal taken weekly was used to monitor the growth of animals throughout the trial period.

Preparation of Samples for Analysis

Silage samples from each treatment were selected at random throughout the feeding periods and were thoroughly mixed and a sub-sample of 1 kg taken for chemical analyses. The sub-samples were labeled and kept in a deep freezer at -10^oC pending analysis. Samples from natural pasture were taken randomly using quadrat ($1m^2$) from five grazing areas identified by the herdsmen during the dry season throughout the periods of the experiments. These five areas were characterised by the presence of forage grasses (*Pennisetum polystachion, Pennisetum purpureum, Andropogon gayanus, Panicum maximum*) and legumes (*Stylosanthes hamata, Calopogonum mucunoides*) species readily consumed by calves in the location.

Three representative samples of fresh silage and natural pasture were dried, hammer-milled and sieved through a 1 mm mesh and were used for the analysis. Proximate and mineral compositions were determined (A.O.A.C. 1995), metabolizable energy ($MJkg^{-1}$ DM) of the samples was derived from their chemical constituents using the equation of De Boeveret *et al*. (1997). The method of Van Soest *et al*. (1991) was used to determine the neutral detergent fibre (NDF), the acid detergent fibre (ADF) and acid detergent lignin (ADL). Cellulose was taken as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF.

Statistical Analysis

Data obtained were subjected to one-way and two-way analysis of variance (ANOVA) for both yield and performance analysi, respectively, using SAS (1999). Level of significance was taken at 5% probability. Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The influence of undersowing maize with lablab 2WAP maize was a reduction in cob yields from the undersown plots which were 35% and 40% of the yields from the sole maize plot in 2008 and 2009, respectively (Table 2). The number of cobs per plant and cob circumference were similar (P>0.05) in both sole and legume intercropped plots in 2008 cropping years. However, weight of cobs was higher (P<0.05) in the undersown treatment than in the sole maize treatment only in 2009. This implies that legume incorporation enhances grain or kennel formation more than the chaff, woody ring and husk. Undersowing maize with lablab at 2WAP maize in the second year produced shorter cob length (P<0.05) relative to sole maize plot (Table 2). The results of the first year showed that maize undersown with lablab had similar cob length to that produced by sole maize treatment.

Table 2: Effects of undersowing maize with *Lablab purpureus* on cob and grain components of maize sown in different years

Parameter	2008			2009		
	Sole maize	Maize +lablab	SEM	Sole maize	Maize +lablab	SEM
Cob yield (kg/ha)	3500[a]	1330[b]	20.45	3610[a]	1917[b]	22.89
Cob no./plant	3.60	3.20	1.16	3.70	3.60	0.34
Cob weight (g)	128.74	127.88	2.09	148.33[b]	180.67[a]	6.78
Cob length (cm)	24.50	24.94	1.01	26.98[a]	25.51[b]	0.11
Cob circumference (cm)	24.50	15.09	1.05	15.54	15.32	2.65
Weight of 1000 grains (g)	100.02	100.35	1.45	153.07[b]	157.55[a]	1.11
Shelling %	46.12[b]	52.85[b]	1.09	56.70[a]	65.70[a]	0.87

[ab]Means in the same row in each year with different superscripts are significantly different at P = 0.05

The weight of 1000 grains of maize in the first year of planting was not significantly (P>0.05) influenced by the treatments (Table 2). However, when maize was undersown with lablab in the second year, the weight of 1000 grain in sole maize (153.07g) was lower than (P<0.05) in the undersown treatment (157.55g). The values for shelling percentage showed that maize undersown with lablab had higher (P<0.05) values than the sole maize treatment in both years of planting.

The cob yield (3610 kg/ha) in 2009 was higher (P<0.05) than the yield recorded in 2008 (3500 kg/ha) for sole maize which could be as a result of favourable factors which could be increase in rainfall in June and July 2009 (Figures 1 and 2) which coincided to the period of grain formation. Maize undersown with lablab had similar trend with higher cob yield of 1917 kg/ha in 2009 than in 2008. The weight of each cob and shelling percentage of sole maize and maize undersown with lablab were significantly (P<0.05) higher in 2009 than in 2008.

The DM contents of the three diets ranged from 765.7g/kg DM in maize-lablab silage to 871.30g/kg DM in sole maize silage with lowest (P < 0.05) DM recorded in maize-lablab silage while forages from the natural pasture and sole maize silage were similar (Table 3). The crude protein content in sole maize silage was half of that in maize-lablab silage while crude fibre content was higher (P<0.05) in natural pasture but similar to that of the maize-lablab silage.

Table 3: Chemical composition (g/kg DM) of sole maize silage, maize-lablab silage and forage samples from natural pasture

Composition	Treatment			SEM
	Sole maize silage	Maize+Lablab silage	Natural pasture	
DM	871.30^{a}	765.70^{b}	870.45^{a}	2.32
CP	119.38^{c}	235.31^{a}	92.69^{b}	14.30
CF	427.5^{b}	566.0^{ab}	638.5^{a}	2.14
EE	80.5^{b}	116.6^{a}	119.6^{a}	0.43
Ash	20.45	27.30	23.30	9.14
OM	55.18	48.33	52.33	11.17
NFE	75.63^{a}	57.86^{b}	56.19^{b}	1.83
NDF	527.35^{b}	661.05^{a}	670.60^{a}	11.17
ADF	470.40	566.50	433.10	60.45
Lignin	26.80^{b}	39.10^{a}	35.50^{ab}	4.77
GE(kcal/kg)	12.40^{c}	14.80^{a}	13.50^{b}	13.50^{b}
ME(MJ/kg)	11.82	11.45	11.66	2.03

$^{abc:}$ Means in the same row with different superscripts are significant at P < 0.05
*Calculated according to De Boever*et al.* (1997)
DM: Dry matter, NFE: Nitrogen free extract, CP: Crude protein, NDF: Neutral detergent fibre, CF: Crude fibre, ADF: Acid detergent fibre, EE: Ether extract, GE: Gross energy, OM: Organic matter ME:- Metabolizable energy

The mean ether extract contents of maize-lablab and forage samples from the natural pasture were similar but significantly higher than in sole maize silage. The gross energy values of the feed samples varied significantly (P < 0.05) from 12.4 kcal/kg in sole maize silage to 14.8 kcal/kg in maize - lablab silage. There were no significant differences in the OM, ME, ADF and Ash contents of the forage feeds. Lignin content was higher (P<0.05) in maize-lablab silage but was similar to that of the natural pasture.

The mineral composition of the two silage feeds and the forage from the natural pasture as presented in Table 4 indicated that K and P were the most abundant minerals in the feeds. Potassium contents ranged from 25.55 g/kg in sole maize silage to 35.70g/kg in natural pasture which was similar (P>0.05) to 33.55 g/kg in maize-lablab silage.

Table 4: Mineral composition (g/kg DM) of the sole maize silage, maize-lablab silage and forage samples from the natural pasture

Treatment	Calcium	Potassium	Phosphorus	Magnesium	Ca:P
Sole Maize silage	4.50[c]	25.55[b]	26.70[b]	3.15[b]	1:6[a]
Maize-Lablab	8.05[a]	33.55[a]	36.60[a]	6.05[a]	1:4[b]
Natural Pasture	7.00[b]	35.70[a]	33.60[ab]	5.50[a]	1:4[b]
±SEM	1.07	1.15	1.36	0.30	0.11

[abc] Means in the same column with different superscripts are significantly different ($P < 0.05$)
Ca:P: The ratio of calcium to phosphorus

The feeds differed significantly ($P < 0.05$) in content of Ca with values ranging from 4.50 g/kg in sole maize silage to 8.05 g/kg in maize-lablab silage. The values of magnesium in maize-lablab silage and in natural pasture were not different but higher than in sole maize silage. From the result, maize-lablab silage had the highest values for all the minerals determined in the feeds while sole maize had the least values.

The apparent nutrient digestibility of the silage fed to calves as supplement in the dry season are shown in Table 5. The CP digestibility ranged from 71.52% in maize silage to 76.29% recorded for mixed silage. The results showed that mixed silage had higher digestibility in terms CF, EE and NFE than sole maize silage and forages from the natural pasture during the dry season except for ash which was higher ($P<0.05$) in animals fed sole maize silage.

Nitrogen intake (23.78g/day) was significantly higher ($P<0.05$) in calves fed mixed silage than sole maize silage (15.6g/day) and natural pasture (13.44g/day). The animals fed mixed silage also had higher ($P<0.05$) faecal nitrogen and urinary nitrogen but low in proportion to CP digestibility of animals fed sole maize silage and natural pasture. There was higher ($P<0.05$) nitrogen retention and absorption in animals fed mixed silage than other diets.

The average weight gain of 10.33 kg in calves supplemented with maize–lablab silage was similar to the values recorded for the other two treatments (Table 6). Supplementing dry season grazing of calves with maize-lablab silage (70:30) resulted in higher ($P<0.05$) metabolic weight gain (50.03 g/kgW$^{0.75}$) while calves without supplementation had the lowest value. Daily gain (growth rate) followed a similar trend with that of metabolic weight gain. The highest value (184.67g/d) was from calves on maize-lablab silage supplement while the lowest (162.66 g/d) was obtained from calves that were not supplemented.

Table 5: Apparent nutrient digestibility coefficient (%), nitrogen utilization in calves fed ensiled maize – lablab supplement

	Sole maize	Maize -lablab	Natural pasture	SEM
Apparent digestibility				
Crude protein	71.52^{b}	76.29^{a}	72.90^{b}	0.35
Crude fibre	83.71^{b}	93.05^{a}	72.56^{c}	0.35
Ether extract	75.94^{b}	92.30^{a}	71.89^{c}	0.16
Ash	86.05^{a}	83.41^{b}	85.89^{ab}	0.08
Nitrogen free extract	14.58^{b}	25.53^{a}	15.87^{b}	1.56
Neutral detergent fibre	65.74^{b}	67.44^{a}	60.76^{c}	0.03
Acid detergent fibre	73.49^{b}	78.69^{a}	72.71^{ab}	0.22
Lignin	59.02^{b}	74.11^{a}	43.98^{c}	0.12
Nitrogen utilization				
N intake (g/day)	15.6^{b}	23.78^{a}	13.4^{c}	
Nitrogen excretion(g/day)				
Faecal N	6.15^{c}	8.07^{a}	6.54^{b}	
Urinary N	0.48^{c}	0.64^{a}	0.49^{b}	
Total Nitrogen				
N retention (g/day)	8.97^{b}	15.07^{a}	6.41^{c}	
N retention (%)	57.5^{b}	63.34^{a}	47.7^{c}	
N absorbed (%)	60.5^{b}	66.06^{a}	51.3^{c}	

^{ab}means on the same row having different superscript significantly different ($p<0.05$)

Table 6: Growth indices of cross-bred calves on dry season grazing alone or supplemented with sole maize silage or maize-lablab silage supplements

Parameter	Grazing + sole maize silage	Grazing + maize-lablab silage	Sole grazing	SEM
Initial live-weight (kg)	71.00	69.67	72.00	6.18
Final live-weight (kg)	80.33^{b}	80.00^{b}	80.90^{a}	0.16
Live-weight gain (kg)	9.33	10.33	8.90	3.03
Metabolic weight gain ($g/kgW^{0.75}$)	46.23^{b}	50.03^{a}	42.76^{c}	1.23
Growth rate (g/d)	166.67^{b}	184.67^{a}	162.66^{c}	1.76
Silage intake/wk (kg)	9.47^{a}	7.93^{b}	0.00	0.34
Feed conversion ratio	0.99	1.30	0.00	1.40

^{abc}Means in the same column with different superscripts are significantly different ($P < 0.05$)

The differences in the cost of establishing, managing and making of silage from maize and lablab pasture were in the cost of legume seeds, the planting and the purchase of single super phosphate (SSP). The cost of establishing sole maize was lower than that of undersown but with a profit of ₦ 46,00.00 from sale of grains from the undersown plot. The estimated total cost of production for maize and maize-lablab and silage making were the same. The cost of feeding sole maize silage was higher than that of the maize-lablab silage (Table 7). The cost of silage production per live-weight gain for sole maize silage was higher than that of maize-lablab, however, the weight gain by calves on sole maize silage supplement was lower than that of the calves on maize-lablab silage. This led to a higher economic implication in cost per kilogram live-weight of the animals. The cost per kilogram live-weight of calves without supplementation tended to be higher than the supplemented, however, the profit made from the sale of maize compensated for this.

Table 7: Estimated cost of pasture establishment and management and cost kg^{-1}liveweight gain of calves in dry season

Estimated cost of establishment of 2ha land area and silage making (₦)			
	Treatments		
Item/Rate	Sole maize	Maize+lablab	Sole grazing
1. Land preparation			
i.Ploughing (₦2300/ha)	4,600	4,600	-
ii.Harrowing (₦2000/ha)	4,000	4,000	-
2. Pre-emergence herbicides			
i.Grammoxone® (₦1100/L)	2,200	2,200	-
ii.Premextra Gold ® (₦1250/L)	3,750	3,750	-
3. Planting materials			
i.Maize seeds (SWAN1)(₦150/kg bag)	3,600	3,600	-
ii.*Lablab purpureus*(₦ 350/kg)	-	3,500	-
4. Fertilizers			
i.N-P-K (20-10-10)(₦50/kg bag)	10,000	10,000	-
ii.SSP (₦42/kg bag)	-	6,300	-
5. Labour(₦ 800/man-day)			
i.Spraying of herbicides (1 man-day)	4,000	4,000	-
ii.Maize planting (6 man-day)	8,000	8,000	-
iii.Legume planting (6 man-day)	-	3,000	-
iv.Replanting of maize and legume (4 man-day)	1,500	1,500	-
v.Fertilizer application (6 man-day)	1,500	1,500	-
vi.Weeding 6WAP (15 man-day)	15,500	15,500	-
6. Cost of silage production			
i.Harvesting and chopping for silage(15 man-day)	20,600	20,000	
ii.Cost of silage bags	2,000	2,000	
iii.Total number of bags produced	22	22	
iv.Weight of silage produced (kg)	220	220	
7. Total (1+…+.6) (₦)	81,250	94,050	
8. Sale of maize grains (₦)	101,744.00	160,760.00	
9. Economic implication (8-7) (₦)	20,494.00	66,710.00	
10. Cost of 1 kg silage(₦)	103.00	103.00	
11. Cost of feeding for 13weeks(₦)	12,680.33	10,618.27	
12. Live-weight gains (kg)	9.33	10.33	8.90
13. Silage/kg live weight gain(₦)	1,359.09	1,027.90	0
14.Cost kg^{-1} live-weight gain* (₦)	5131.50	5681.50	4895.00
Economic implication (14-13)(₦)	3,772:41	4,653:00	4,895:00

*Prevailing market price (₦ 550:00) for 1kg beef as at the time (March, 2010) of this study
Naira (₦) Nigerian currency (current exchange rate as at the time of the study was 1US$ = 149 Naira)

Maize cob yields in the present study were within the range (2.01- 3.67 t/ha) reported by other authors for most maize varieties in Nigeria (Olasantan *et al.,* 1997; Ogunbodede *et al.,* 2001). However, it was lower than 4 t/ha reported by Kumar *et al.* (1987) in northern Nigeria for sole maize. The range of average cob length recorded in this study (24.53 - 26.98 cm) was higher than values recorded by Ayoola and Makinde (2009) for maize (SWAN1) with or without fertilizer or manure.

The increase in 1000-grain weight and higher shelling percentage in the undersown even in the second year than the sole cropping might be due to the possibility of N accretion from legumes to the companion cereal. Two types of beneficial effects have generally been reported: higher N content and/or higher grain yield of the intercropped cereal in comparison with the cereal alone without addition of N. Reynolds (1982) reported higher N content and uptake in mixtures compared with sole crop system and that the transfer of N from the legume to the maize was equivalent to 45 kg N/ha. This study showed that herbaceous legumes could provide an alternative to the use of commercial N sources for cereal crops and livestock production in low external-input farming systems. Intercropping legume with cereal could compel legume to fix more N than in a situation in which it is growing alone, provided other factors, such as light and water are not limiting.

Crude protein content of the prepared silage in this trial was outstanding as they exceeded the minimum requirement (11-12%) for growth and lactation of a 400-kg cow (NRC, 1989). The two silages were therefore adequate for meeting the protein requirement of growing calves to generate a high level of ammonia in the rumen from degradable protein to ensure an efficient digestion process (Ørskov, 1995). Titterton *et al.* (2000) successfully ensiled mixed cereal-lablab and the CP content reported was comparable to that of commercial feed (17.2% - 18.7%). The CP contents 23% and 11% for the mixed and sole maize stover, respectively, obtained in this trial were similar to the values obtained by Mugweni *et al.* (2001) in Zimbabwe and Muhammad *et al.* (2008) in Nigeria from *Sorghum almum* and lablab silage.

Inclusion of legume in the silages increased the percentages of CP, CF, EE, and ash in all the treatments. This perhaps suggested the need for inclusion of legume to capture the optimum requirement for inclusion in maize silage at maturity. While the increasing trend observed in CP content was in agreement with reports of Azim *et al.* (2001), Mustafa *et al.* (2001) and Mthiogane *et al.* (2001), there are, however, contradicting reports with regards to level of legume required for increasing the quality of grass silages. Muhammad (2008) reported a ratio of 60:40 for grass-legume silage to increase the quality of grass silage. Sibanda *et al.* (1997) reiterated that inclusion of 450g/kg fresh legume increased the volatile nitrogen and total nitrogen content of grass silage. Titterton and Maasdorp (1997) recommended 40% proportion of legumes in grass-legumes silage.

The quality of the mixed silage produced appeared satisfactory in that the DM content was within the recommended range (21-32%) for maize and grass silage. Muhammad *et al.* (2008) recorded a DM content of 508g/kg with *S. almum* and lablab (60:40). This was attributed to the differences in the grass species and the ages at which the forages were ensiled.

While silage prepared with lablab and maize had higher CP content, lablab contributed more to the content of EE in the silage. This could mean that lablab had higher values of some components of nutritive value relative to others. The ash contents of the diets were all within the range recommended for yearling (NRC, 1994). This suggested that there might be no need to add commercial mineral supplements to diet of calves during the dry season if the silage were fed moderately.

The NDF levels of the mixed silage maize-lablab in this trial were within the range for some forage silage in the tropics. Panditharatne *et al.* (1986) reported 69.9-71.9 % for Guinea grass silage in Sri Lanka while Napier grass silage in Thailand had 64.2-70.2% (Shinoda *et al.*, 1999). The ADF of forages and silages should be within the 22-50% range as suggested by Slater (1991). The lower the ADF the higher was the energy level in the forage or silage. The levels found in this study were within the range indicating that the silage has potentials to supply needed energy to the animals during the dry season.

Mineral concentrations of the diets were variable. Calcium concentration (0.4-0.7%) were higher than the recommended critical level (0.30%) (NRC, 1994). Phosphorus concentrations ranged from 2.6 to 3.6% which exceeded the critical level of 0.25% P suggested by McDowell (1997). Potassium concentration met the requirements for various classes of ruminants (0.05- 0.12%). The Ca: P ratios in these diets were above the range 1:2 to 2:1 suggested as desirable by NRC (1994).

The poor N intake and digestibility values obtained for the unsupplemented animals were due to the fact that crude protein levels that were below the recommended minimum values for maintenance. This shows that there is the need for dry season supplementation in calves because the available feeds at that time are limiting in crude protein. Supplementation with legume crop residues contributes fermentable energy to the rumen in the form of available cellulose and hemicellulose which stimulate fibre digestion (Silva and Ørskov, 1985). Concentrations of rumen ammonia had been increased following supplementation with forage legumes (Getachew *et al.*, 1994), the increase being a function of the degradability of the nitrogen in the forage legume.

The total weight gain ranged from 8.90 - 10.33 kg and was lower than (10.8 - 12.0 kg) reported by Ashiru *et al.* (2008) when crossbred heifers were fed cowpea or groundnut hulls as supplement to basal sorghum stover. The variation might be due to differences in the species, nutrient composition of the feed, ages of animals and the season of the experiment. All the calves gained weight, which indicated that the intake of energy and protein was well above maintenance requirements. The daily weight gain (185g) was highest in maize-lablab silage supplement and lowest (170 g) in sole maize silage. Inclusion of legume in the supplement increased feed intake and weight gain of the calves better than sole grazing. Supplementation is necessary in ruminant production because the animals cannot meet their maintenance needs on low quality grass alone during the dry season.

Legumes are considered superior animal feed to grasses because of higher voluntary intake of digested nutrients (Goering *et al*., 1991). In this study, intake of silage increased with addition of lablab. This might be due to increased CP% and digestibility of the rations as a result of the addition of lablab. Supplementation of dairy animals that rely on natural grasses, as basal diet, is inevitable for realization of high milk yields (Kavana *et al.*, 2007). Ibrahim and Olaloku (2000) suggested that feed supplements to roughage were beneficial to cattle because they provided essential nutrients to the rumen micro-organisms and enhanced activity of micro-organisms in the rumen resulting in better digestibility. They provided nutrients for cattle and helped them to maintain their weight during the dry season. Supplementation of pasture in

Zimbabwe with 110 g *Acacia angustissima* per goat per day was found to result in an increase in weight gain of 12 g per day (Ibrahim and Olaloku, 2000). The result from this study showed that increasing the proportion of lablab in the diet appeared to improve acceptability of diets by the animals.

The percentage of empty live-weight and dressed weight of animals were found to be highly correlated with live-weight (Chawla and Nath, 1979). The higher live weight gain of calves supplemented in this trial would sell at higher price. Though, the cost of producing the silage was relatively high, the sale of maize grain from the undersown plot would offset part of the production cost.

Conclusion

Undersowing maize with lablab 2WAP maize resulted in higher herbage production for ruminant feeding. Lablab undersown in maize increased the shelling percentage and weight of 1000- maize grains. Maize-lablab silage (70:30) can be successfully ensiled to produce feed with CP contents of 23% and provide a good supplement for calves during the dry season. Legume inclusion in the supplemented silage increased feed intake and weight gain of the calves. The findings suggest that silage evaluated in this study especially maize–lablab (70:30) could be given as supplements to calves during the dry season to increase the live-weight gain of the animals.

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