Nigerian J. Anim. Sci. 2013, vol. 15:179-190

Effect of Planting Pattern and Irrigation Frequency on Forage Yield and Chemical Composition of Lablab (*Lablab Purpureus* (L.) *Sweet*) in Combination with Maize (*Zea mays* L.)

***M. R. Hassan[1], I.R. Muhammad[3], G.E. Jokthan[1], J.T. Amodu[2], S. B. Abdu[1], B. Abdullahi[1], H.Y. Adamu, [1] S. Yashim[1], M.S. Tamburawa[4], U. Ado[1] and S.A. Abubakar[2]**

[1]Department of Animal Science, Ahmadu Bello University, PMB 1044 Zaria [2]National Animal Production Research Institute, Shika, Ahmadu Bello University, Zaria
[3]Department of Animal Science, Bayero University, Kano [4]Department of Animal Science, Kano University of Science and Technology, Wudil

*Corresponding author: mohammedrabiu92@gmail.com

Target audience: Animal scientist, Forage agronomist, Farmers, Extension workers

Abstract

A study was conducted at Kadawa Experimental Research Station of the Institute for Agricultural Research Kano during the 2010/2011 dry season to determine forage yield of lablab, nutritive quality of lablab forage and maize grain yield using five (5) different planting patterns and three (3) irrigation frequencies. A 5 x 3 factorial experiment in a complete randomized block design with a split plot arrangement was used. The results indicated that there was a positive correlation between weeks after sowing lablab and plant height (R^2 = 0.88). Alternate rows showed 35% increase in forage yield ($P<0.05$) compared to sole maize (control). The 9 days irrigation interval showed 10% increase ($P<0.05$) in forage yield compared to 3 and 6 days intervals. However, sole maize produced 39% higher ($P<0.05$) grain yield compared to intercrops. Irrigation interval at 6 days produced 13% higher ($P<0.05$) maize grain yield compared to 3 and 9 days intervals. The highest ($P<0.05$) crude protein (CP) content of 21% was observed in sole lablab treatment. Intercropped lablab had the lowest ($P<0.05$) crude fibre (CF) compared with the control. It was therefore recommended that smallholder farmers in Nigeria could introduce lablab as a relay crop with irrigated maize for improved livestock performance, income generation and environmental control.

Key words: Forage, irrigation, lablab, maize, Nigeria

Description of Problems

In Nigeria, the agricultural system comprised of mixed crop-livestock system with very low external inputs such as chemical fertilizers, improved seeds, agro-chemicals, livestock feeds and drugs (1). To attain optimum productivity of both crops and livestock under this system may be difficult considering the fact that most of the farmers are subsistence. The livestock sector in Nigeria is growing very fast just like in other developing countries (2) perhaps due to increasing human population, income level and urbanization which help to elevate the demand for livestock products (3). Hence, there is a market for livestock products in both rural and urban areas of Nigeria (4). However, a major constraint to livestock production in the country is lack of qualitative feed supply especially during the dry season period. In order to meet up with increasing demands of animal protein in Nigeria, there is a need to integrate high quality forage legumes that will assist in supplementing livestock with fresh and qualitative feed for better performance (5). Lablab (*Lablab purpureus*) is one of such forage legumes that have the ability to be used as food for humans and forage for livestock (6, 7).

Farmers in Nigeria have been planting cereal crops such as maize and leguminous crops such as soybeans under rain-fed condition for commercial purposes (8). However, the practice of integrating forage legumes into cereal based cropping system under irrigation is not a common practice in Nigeria. Although lablab is a popular forage legume in many tropical and sub-tropical countries (7), it is still not being utilized to its full potential under irrigation by smallholder farmers in Nigeria. It was against this background that this research was carried out to investigate the possibility of integrating lablab with maize under irrigation. The objectives of this study were to (i) investigate the chemical composition of lablab (whole plant) under irrigation and (ii) investigate the effects of planting pattern and irrigation frequency on growth and yield of lablab and maize grown in mixture.

Materials and Method

Experimental site

The experiment was conducted at the Institute for Agricultural Research Farm Kadawa Experimental Station, Kano. The area is located at $11^0$39'N latitude and $8^0$27' E longitude at an elevation of 500m above sea level. The area is characterized by high water table with clay soil representing one of the typical soil types of the region. The mean annual rainfall of the area ranged from 500mm to 1000mm with about 140 rainy days per year. There is one main rainy season extending from June to October. The mean annual temperature, ranged between 29^{o}C to 38^{o}C with higher temperatures during the dry months. The soils are reddish-brown rogosols with mainly sandy to clay loam texture and slightly to moderately alkaline. Humidity is high during the wet season and very low during the dry season (9). Routine soil analysis of the study area indicated that the soil was made up of 71% sand, 20% silt, 9% clay, pH (6.5), organic carbon (0.24%), total nitrogen (0.053%), available P (27.79 ppm), Ca (6.00 mg/kg), Mg (2.80 mg/kg), K (0.11 mg/kg), Na (1.30 mg/kg) and H-Al (0.10 mg/kg) (10). Soil pH, available P and total nitrogen were moderate while the level of exchangeable calcium was high.

Experimental design and cultural practice

The experiment was laid in a randomized complete block design (RCBD) with split plot arrangement. It was replicated four times. The experiment consisted of factorial combination of five planting patterns (T_1 = Sole maize, T_2 = Sole lablab, T_3 = 1:1 alternate rows, T_4 = 1:2 alternate rows and T_5 = 2:1 alternate rows) and three irrigation intervals (I_1 = 3 days interval, I_2 = 6 days interval and I_3 = 9 days interval). The maize variety used was SAMMAZ 14 obtained from the Seed Unit of the Institute for Agricultural Research, Samaru while the lablab variety was Rongai white purchased from the National Animal Production Research Institute (NAPRI) Shika, Zaria. The potential grain yield of SAMMAZ 14 variety is 7 t/ha while that of lablab is 3 t/ha. The plot sizes were 4.5m x 4.5m with maize and lablab spacing of 75cm x 30cm. Inter row spacing between plots was 0.5m. Three maize seeds were planted per hill which was later thinned to two plants per hill when the crop was 10-14 days after sowing (DAS). Two legume seeds were planted per hill. Irrigation treatment was imposed at 3 weeks after sowing (WAS). Manual weeding was done twice at two and five weeks after sowing. Compound fertilizer (N.P.K. 15:15:15) was applied on maize crop only in the maize pure stand at the rate of 60 kg NPK ha^{-1} at 2 weeks after sowing (WAS) and later top dressed with 60 kg N ha^{-1} using urea at 6 WAS respectively using the method of Sani *et al.* (11).

Harvesting, measurements and chemical analyses

Leaf area index (LAI) was calculated from five random plants selected from the net plot. Fodder yield was estimated from each plot using a 1m x 1m quadrat and cutting the forage at 15cm above ground level using sickle. The lablab forage harvested from each plot was weighed fresh in the field using a hanging scale before sub-sampling 250-300g. The samples were taken to the Biochemical Laboratory in the Animal Science Department, Ahmadu Bello University, Zaria and oven dried at 65^0C to constant weight. The dried samples were weighed before grinding and later ground to pass 1.0mm sieve using hammer milled screen. The ground samples were then used for the determination of dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash following the method of A.O.A.C. (12). Nitrogen free extract (NFE) was determined by calculation. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were analyzed using Van Soest *et al.* (13) methods.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using a General Linear Model (GLM) Procedure for Randomized Complete Block Design (RCDB) using SPSS (14). Regression analysis was used to determine the optimum plant growth components (plant height and leaf area index) under varying weeks of sowing and irrigation intervals.

Significantly different means were separated using Dunnet's test.

Results and Discussion

Plant growth components

Plant height

Figure 1a shows the trend of maize/lablab plant height as influenced by weeks of sowing. At 6 weeks after sowing (WAS) the result indicated that the height of maize was 71% higher than that of lablab. This result was expected because of differences in growth habits of maize and lablab plants (15). The growth pattern showed a linear trend up to 11 weeks after sowing when the height of lablab exceeded that of maize. This may be explained by the fact that lablab has a twining growth habit which facilitates its growth by entwining round the maize plant for optimum light reception and photosynthesis (16). However, beyond 11 weeks after sowing, the height of maize continued to decrease. Our value for maize plant height was however lower than the value (132 cm) reported by (11) when maize plant was irrigated under full consumptive use requirement at Samaru. The regression lines show the relation between weeks of sowing and plant height which elucidate a high positive correlation between both variables. The high R^2 values for lablab (R^2 = 0.88) and maize (R^2 = 0.99) indicated that farmers could successfully predict heights of maize and lablab plants when grown in mixtures under irrigation. This will further assist farmers to predict the amount of forage to be harvested for silage making thereby avoiding unnecessary loses due to poor management.

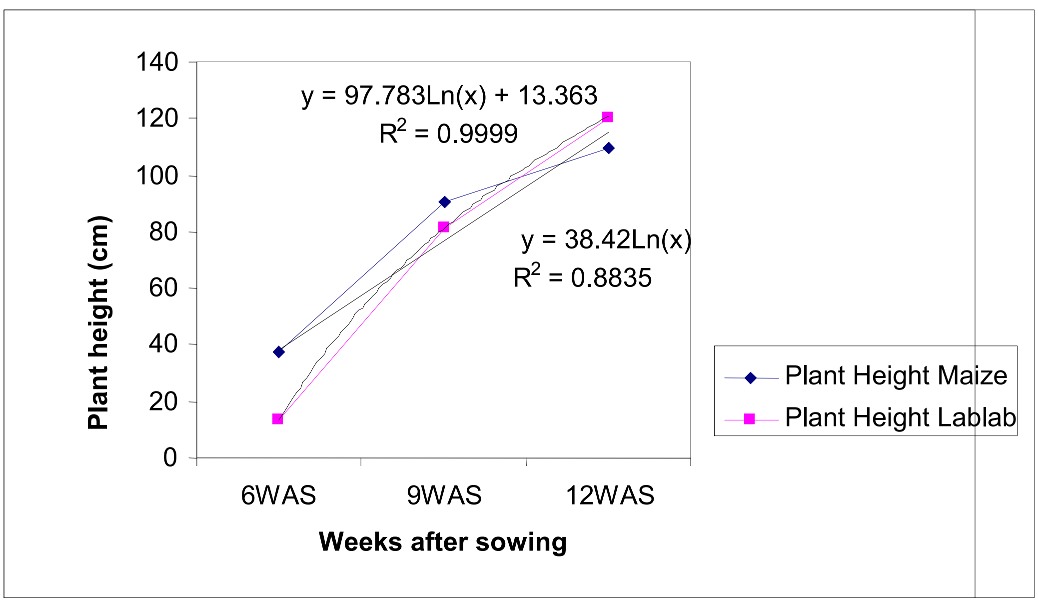

Figure 1a: Trend of maize/lablab plant height as affected by weeks of sowing during the 2010/2011 dry season at Kadawa

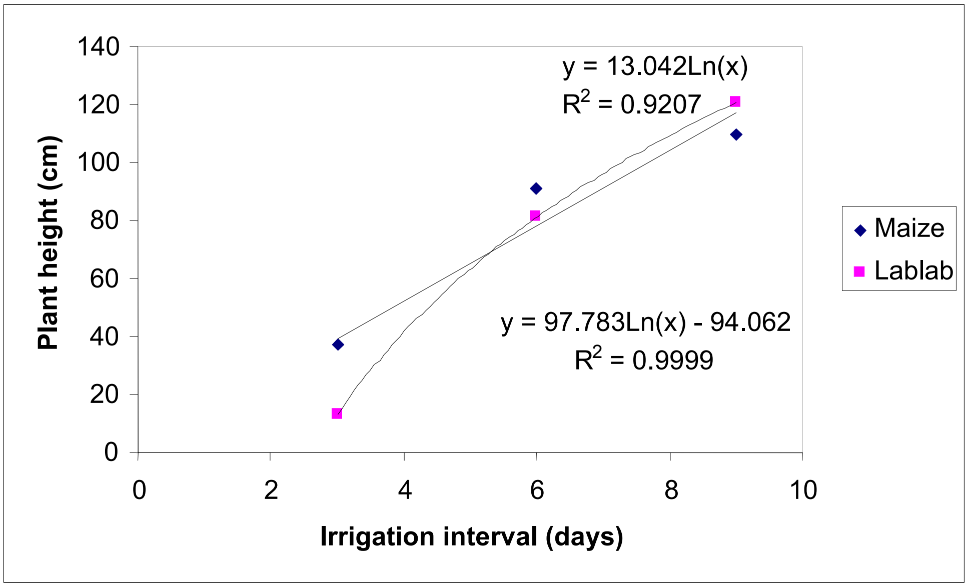

Figure 1b: Trend of maize/lablab plant heights as affected by irrigation interval during the 2010/2011 dry season at Kadawa

Figure 1b shows the effect of irrigation interval on plant height. There was a strong and positive correlation between plant height and irrigation interval. The result indicated that at 3 days irrigation interval, the height of lablab was 40% lower than that of maize. At 6 days irrigation interval, maize plant height was 19% higher than that of lablab. This result indicates that moisture availability within the root zone of maize under irrigation during the first six weeks after sowing might have facilitated maize growth components. Vishwanatha *et al.* (17) reported a similar result in India. However, at 9 days irrigation interval, the height of lablab was 20% higher than that of maize. This result can be explained by the fact that lablab is a drought tolerant plant and therefore tend to resist the dry spell imposed by the irrigation scheduling compared to maize (18). Also, the vigorous growth habit of lablab might have affected maize growth due to entwining and coverage of the maize leaves. Birteeb *et al.* (19) observed a lower mean maize height in Ghana when lablab was intercropped with maize. Hussaini *et al.* (20) showed that maize plant height was significantly affected by irrigation.

Leaf area index

Figure 2a shows the relationship between weeks after sowing and leaf area index (LAI) of maize and lablab plants. There was a strong and positive correlation between weeks of sowing and LAI. Maize plant showed 84% (R^2 = 0.74) increase in LAI compared to lablab at 9 weeks after sowing. This result indicates that the LAI of maize increased with increase in light interception and moisture before it finally decreased at maturity. However, the LAI of lablab increased steadily at slower rate of 2% (R^2 = 0.99) compared to maize. Gangwar and Kalra (21) found a similar result when maize was grown in mixtures with legumes under rain-fed condition. Khapre *et al.* (22) reported a strong correlation between LAI and seed yield of sorghum and pigeon pea intercrops at 45 days. Also, (23) attributed high yield of intercropped sorghum with legumes under irrigation to high LAI and number of leaves.

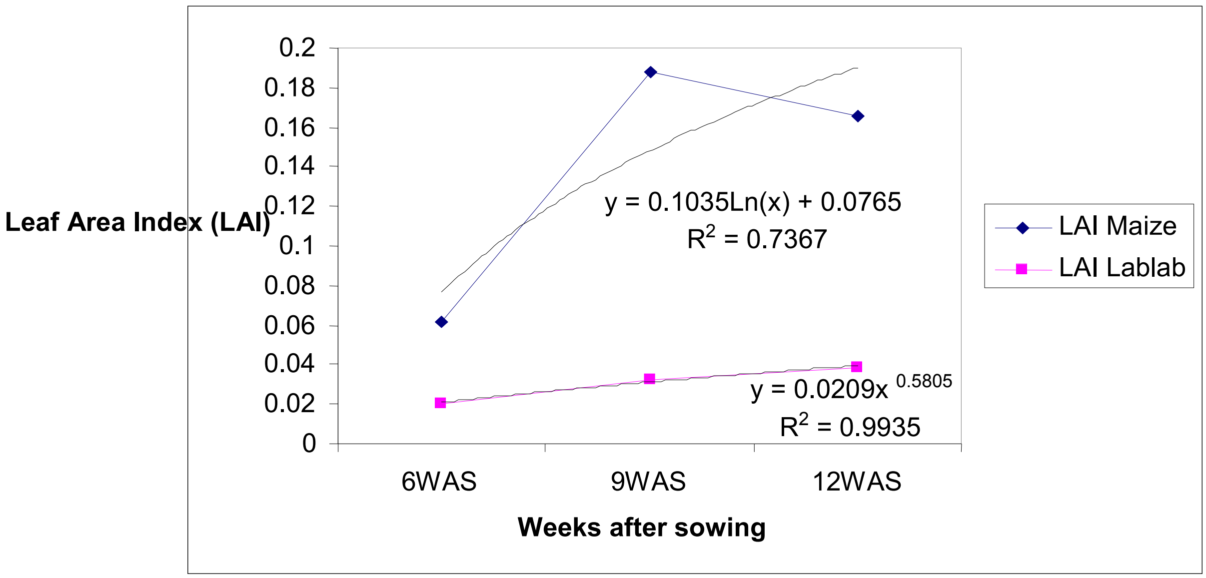

Figure 2a: Trend of maize/lablab leaf area index as affected by weeks of sowing during the 2010/2011 dry season at Kadawa

Irrigation interval had a strong and positive correlation with LAI (Figure 2b). This result is in agreement with the report of (11). This indicates that 6 days irrigation interval is the most appropriate interval for the growth of maize at Kadawa since it translated into higher maize grain yield (Table 1) compared to 3 and 9 days intervals. Similar results were observed by (24). However, our LAI values were lower than the values of (11). This might be due to the effect of intercropping with lablab which might have reduced the photosynthetic ability of maize plant as a result of entwining nature of lablab crop. At 9 days irrigation interval, lablab showed 50% increase in LAI which indicates that the variety used in this study could tolerate water stress beyond 9 days under irrigation without adversely affecting performance.

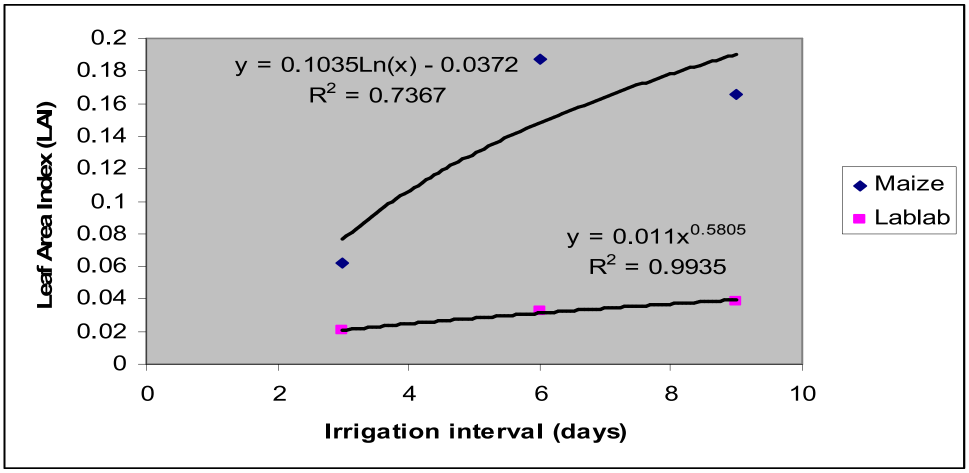

Figure 2b: Trend of maize/lablab leaf area index as affected by irrigation interval during the 2010/2011 dry season at Kadawa

Forage yield

Table 1 shows the effect of planting pattern and irrigation on forage yield and maize grain yield. Alternate rows showed 35% increase in forage yield ($P<0.05$) compared to sole maize (control). However, sole maize did not differ ($P>0.05$) from sole lablab. Our values are however higher than the values reported by (25, 15) but are comparable to the value of (26). The significant high forage yield of intercrops compared to sole maize may be related to good establishment and persistence of the intercrops which could have resulted in high dry matter accumulation (27). The 9 days irrigation interval showed 10% increase ($P<0.05$) in forage yield compared to 3 and 6 days intervals. This result may be due to the good management which might have facilitated the growth of lablab thereby contributing to high forage yield (25).

Maize grain yield

Sole maize produced 39% higher ($P<0.05$) grain yield compared to the intercrops. The significant reduction in maize grain yield in the intercrops may be related to the competitive ability of lablab when grown in mixtures (19, 28). Irrigation interval at 6 days produced 13% higher ($P<0.05$) maize grain yield compared to 3 and 9 days intervals. The implication of this is that farmers should avoid subjecting maize plants to water stress or logging conditions under irrigation because physiological activities of the plant may be impeded thereby reducing potential grain yield (11).

Table 1: Effect of planting pattern and irrigation and their interaction on forage yield, maize grain yield, cob length and cob size during the 2010/2011 dry season at Kadawa.

Treatment	Forage yield (kgDMha-1)	Maize Grain yield (Kgha-1)	Cob length (cm)	Cob diameter (cm)
Sole Maize	5162.15[b]	6143.11[a]	14.29	9.03
Sole Lablab	5548.54[b]	ND	ND	ND
1:1 alternate rows	7962.31[a]	4151.25[c]	13.57	9.02
1:2 alternate rows	7297.05[a]	2834.75[d]	12.89	8.98
2:1 alternate rows	6752.35[a]	5540.08[b]	12.78	8.47
Overall	6544.48	3733.84	10.88	7.22
SEM (±)	365.25	420.35	0.85	0.51
Irrigation regime				
3 days interval	6460.58[b]	3383.42[b]	11.10	7.28
6 days interval	5989.56[c]	4292.75[a]	10.38	6.88
9 days interval	7183.31[a]	3525.35[b]	11.18	7.53
Overall	6544.48	3733.84	10.88	7.22
SEM (±)	365.25	420.35	0.75	0.48
Interaction				
T × I	6544.48	3733.84	10.88	7.22
SEM (±)	365.25	420.35	0.75	0.48

Means with different superscripts along the column differed significantly ($p < 0.05$); ND = not determined.

Table 2: Chemical composition of lablab (whole plant) at 18 weeks after sowing under irrigation at Kadawa during the 2010/2011 dry season.

	Treatments						
Parameters	1	2	3	4	5	Overall	SEM
Crude Protein	7.46[c]	21.02[a]	17.44[b]	17.40[b]	16.56[b]	17.98	0.680
Crude Fiber	11.78[d]	14.42[a]	13.78[b]	12.92[c]	11.18[d]	12.82	0.714
Ether Extract	0.82[b]	0.96[a]	0.94[a]	0.85[b]	0.99[a]	0.91	0.037
NFE	61.78[a]	52.55[c]	57.13[b]	58.67[b]	63.18[a]	58.66	1.795
ASH	8.22[b]	11.05[a]	10.71[a]	10.16[a]	7.98[b]	9.62	0.774
Neutral Detergent Fiber	62.38[a]	61.91[a]	59.75[b]	62.23[a]	52.41[c]	59.74	1.205
Acid Detergent Fiber	22.39[a]	22.77[a]	21.62[a]	22.10[a]	18.59[b]	21.49	0.583

Means with different superscripts along the row differed significantly ($p < 0.05$), T_1 = sole maize, T_2 = sole lablab, T_3 = 1:1 alternate rows, T_4 = 1:2 alternate rows and T_5 = 2:1 alternate rows.

Chemical composition of Lablab

Table 2 showed the result of chemical composition of lablab. Although sole lablab showed a higher percentage of crude protein (CP) ($P<0.05$), but intercropped lablab was generally 57% higher in quality compared to sole maize (control). This result therefore suggests that intercropping lablab with maize under irrigation could assist smallholder farmers to minimize costs of purchasing expensive concentrate feeds during the dry season. Ngongoni *et al.* (15) found a similar result and they concluded that legumes improve the protein content of the diet to meet maintenance and production requirements of smallholder dairy cows in Zimbabwe. The significantly lower ($P<0.05$) crude fibre (CF) content of the intercropped lablab indicates that including lablab in the diet may further facilitates better performance through high intake and digestibility (29). The ether extract (EE) content ranged from 0.99% in T_5 to 0.82% in T_1. This value was however lower than the value reported by (30). The nitrogen free extracts (NFE) content ranged from 63% in T_5 to 53% in T_2. Ash values ranged from 11% in T_2 to 8% in T_5. Neutral detergent fibre (NDF) ranged from 62% in T_1 to 52% in T_5. Acid detergent fibre (ADF) values ranged from 23% in T_2 to 19% in T_5 respectively. The values of CF, NDF and ADF obtained in this study were in agreement with previous findings (18, 28).

Conclusion and Application

This study revealed that:

1. Smallholder farmers in Nigeria can introduce lablab as a relay crop with irrigated maize for increased maize grain yield and forage production.
2. In order to improve the performance of our livestock as well as the quality of their products particularly during the dry season period, lablab forage can be used to supplement the low quality hay for better live weight gain.
3. Maize and lablab can be relayed using 1:1 alternate rows arrangement at 6 days irrigation interval for optimum forage and grain yields.

References

1. Bourn, D., Wint, William, Blench, R. and Woolley, E. (1994). Nigerian livestock resources survey. *World Animal Review,* 78(1):49-58.

2. Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S., and Courbois, C. (1999) “Livestock to 2020 – The Next Food Revolution”. *Food, Agriculture and the Environment Discussion Paper* 28. IFPRI/FAO/ILRI.

3 FMEN (Federal Ministry of Environment of Nigeria) (2001). National Action Programme to combat desertification. http://www.uncd.int/action programmes/Africa/national/2001 /Nigeria-eng.pdf

4 Andrew, W.S. (2003). Global Production and Consumption of Animal sourced Foods. *Journal of Nutrition*, 133:4048S-4053S.

5. Nuru, S. (1996). Agricultural development in the age of sustainability: Livestock production. In: *Sustaining the Future - Economic, Social, and Environmental Change in Sub-Saharan Africa* (Edited by George Benneh, William B. Morgan, and Juha I. Uitto). The United Nations University, 1996.

6. Onifade, O.S. and Agishi, E.C. (1988). A review of forage production and utilization in Nigeria Savanna. In: Utilization of Research Results on forage and Agricultural by-products materials as animal feed resources (B.H. Dzowela, A.N. Said, Aarat Wendem Ageneh and J.A. Kategile Eds.). *Proceedings of the First Joint workshop held in Lilongwe, Malawi, by the Pasture Network for eastern and Southern Africa (PANESA) and African Research Network for Agricultural by-products (ARNAB). International Livestock Centre for Africa (ILCA).* 5-9 December, 1988. pp. 114-125.

7. Khalid, A., Ibrahim, Elsiddig A.E., Elsheikh, Ahmed M., El Naim and Elbasri, A . Mohammed (2011). The Effects of Bradyrhizobium Inoculation on Yield and Yield Components of Hyacinth Bean (*Dolichos hyacinth* L.). *Australian Journal of Basic and Applied Sciences*, 5(6): 303-310.

8. Olufajo, O.O. (1995). Sorghum/Soyabean intercropping as affected by cultivar and plant arrangement in a sub humid tropical environment. *Samaru J. Agric. Res.* 12:3-11.

9. Onyibe, J.E. (2010). Effect of irrigation regime on growth and development of two wheat cultivars (*Triticum aestivum* L.) in the Nigerian savanna. *Journal of Agriculture and Rural Development in the Tropics and Sub-Tropics* 106 (2): 177-192.

10. Institute for Agricultural Research (IAR) (2011). Biochemical Laboratory, Soil Science Department, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria.

11. Sani, B.M., Oluwasemire, K.O., Mohammed, H.I., (2008). Effects of Irrigation and Plant Density on the Growth, Yield and Water Use Efficiency of Early Maize in the Nigerian Savanna. *ARPN Journal of Agricultural and Biological Science.* 3(2):33-40.

12. Association of Official Analytical Chemists (AOAC) (1999) Official Methods of Analysis. Washington DC, USA

13. Van Soest, P.J., Robert, J.B. and Lewis, B.A. (1991). Method for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci* 74:3583-3597.

14. SPSS (2009). Statistical Procedure for Social Sciences. Pc version 17.0, Michigan Avenue, Chicago IIIinois, USA.
15. Ngongoni, N.T, Mwale M, Mapiye, C., Moyo, M.T., Hamudikuwanda, H. and Titterton, M. (2007). Evaluation of cereal-legume intercropped forages for smallholder dairy production in Zimbabwe. *Livestock Research for Rural Development. Volume 19, Article No.129.* Retrieved , from http://www.lrrd.org/lrrd19/9/ngon19129.htm
16. Jiang, H. and Egli, D.B. (1993). Shade induced changes in flower and pod number, and flower and fruit abscission in soybean. *Agronomy Journal* 85:221-225.
17. Viswanatha, G. B., Ramachandrappa, B. K. and Nanjappa, H. V. (2000). Effect of drip irrigation and method of planting on root and shoot biomass. Tasseling, silking interval, yield and economics of sweet corn (*Zea mays* Cv. Saccharata). *Mysore Journal of Agricultural Sciences*., 34: 134-141.
18. Andrea, M.M. and Pablo, E.C. (1999). A tropical forage solution to poor quality ruminant diets: A review of *Lablab purpureus*. *Livestock Research for Rural Development. Volume 11, Article No. 2*. Retrieved July 8, 2011, http://www.lrrd.org/lrrd11/2/colu112.htm
19. Birteeb, P.T., Addah, W. Jakper, N. and Addo-Kwafo, A. (2011). Effects of intercropping cereal-legume on biomass and grain yield in the savannah zone. *Livestock Research for Rural Development. Volume 23, Article No. 198.* Retrieved December 23, 2011, from http://www.lrrd.org/lrrd23/9/birt23198.htm
20. Hussaini, M. A., Ogunlela, V. B., Ramalan, A. A. and Falaki, A. M. (2001). Growth and development of maize (*Zea mays* L.) in response to different levels of nitrogen, phosphorus and irrigation. *Crop Res*., 22 (2): 141-149.
21. Gangawar, B. and Kalra, G. S. (1982). Intercropping of rainfed maize with different legumes. *Indian J. Agric. Sci.*, 52(2): 113-116.
22. Khapre, P. R., Nerkar, Y.S. and Salunke, M. R. (1993). Relationship between physiological parameters and grain yield in pigeonpea under different systems. *International Pigeonpea Newsletter*, 18: 18-19.
23. Singh, S. P. and Ahuja, K. N. (1990). Intercropping of grain sorghum with fodder legumes under dryland conditions in north-western India. *Indian J. Agron.*, 35(3): 287-296.
24. Rajshekhar, M.G. (2001). Effect of maize plant geometry, row proportion and time of planting on maize-lucerne intercropping

system. *M. Sc. (Agri.) Thesis*, Uni. Agric. Sci. Dharwad (India).

25. Gbaraneh, L.D., Ikpe, F.N.; Larbi, A; Wahua, T.A.T., Torunana, J.M.A. (2004). The Influence of Lablab (*Lablab purpureus)* on Grain and Fodder Yield of Maize (*Zea mays*) in a Humid Forest Region of Nigeria. *J. Appl. Sci. Environ. Mgt.* 8 (2) 45-50.
26. Nworgu, F.C. and Ajayi, F.T. (2005). Biomass, dry matter yield, proximate and mineral composition of forage legumes grown as early dry season feeds. *Livestock Research for Rural Development. Volume 17, Article No.121.* Retrieved December 23, 2011, from http://www.lrrd.org/lrrd17/11/nwor17121.htm
27. Ramakrishna, K., Krishnappa, K.S. and Umamaheswarappa, P. (2000). Dry matter production, nutrient accumulation and uptake of primary nutrients in french bean (*Phaseolus vulgaris* L.) as affected by genotypes, spacings and fertilizer levels. *South Indian Horticulture*, 50(1-3): 105-112.
28. Armstrong K. L., Albrecht K. A, Lauer J. G. and Riday H. (2008). Intercropping Corn with Lablab Bean, Velvet Bean, and Scarlet Runner Bean for Forage. *Crop Sci* 48:371-379
29. Maasdorp, B. V. and Titterton, M. (1997). Nutritional improvement of maize silage for dairying: mixed-crop silages from sole and intercropped legumes and a long-season variety of maize. 1. Biomass yield and nutritive value. *Journal of Animal Feed Science and Technology* 69: 241-261.
30. Ajayi, F. T., Akande, S. R., Adegbite, A. A. and Idowu, B. (2009). Assessment of seven under-utilized grain legume foliages as feed resources for ruminants. *Livestock Research for Rural Development. Volume 21, Article No.149.* Retrieved December 23, 2011, from http://www.lrrd.org/lrrd21/9/ajay21149.htm