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UTILIZATION POTENTIALS OF LABLAB (*Lablab purpureus* (L.) Sweet) AND THE CONSTRAINTS OF FIELD PESTS AND DISEASES IN NIGERIA

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ABSTRACT

In the last one decade and half, lablab was evaluated for its crop-livestock production potentials in Samaru, Kano and Benin City in both the savanna and humid forest zones of Nigeria. Very early, early and intermediate accessions were identified that may be suitable for dry savanna and late growing season of the humid forest while late, very late and extremely late accessions were identified for moist savanna and humid forest. Vegetable-type, grain-type and dual-purpose lablab were identified. Lablab grain ranged from 600-2400 kg ha^{-1} with an average protein concentration of 25.3%. Huge litter of leaves and stems was recorded at the end of production period which extended far into the dry season. Short fallow of one year supported maize-cowpea intercrop with component maize having 13.7% grain yields over that of natural fallow. Following a 2-year lablab fallow, subsequent maize yield was 72.7% higher than that from natural fallow. Lablab had an average of 2600 kg ha^{-1} of biomass and an average of 64.1 kg N ha^{-1}, meaning that lablab has high potential for green manure and soil improvement. Of six herbaceous legumes, lablab was among those that had the highest soil cover. Fresh biomass of 3200 kg ha^{-1} was achieved at eight weeks after planting. Various insect pests, fungal diseases and parasitic plant including Ootheca mutabilis (Sahlb), Podagrica uniforma (Jac.), Nematocerus acerbus (Faust), Anoplocnemis curvipes (F.), Helicoverpa armigera (Hbn), aphids, Colletotrichum sp., Curvularia sp. and Cassytha filiformis (Linn.) were found on lablab plants, causing damage to the crop.

Key words: lablab, fodder, grain yield, pest, disease

INTRODUCTION

Lablab purpureus (L.) Sweet syn. *Dolichos lablab* L., *Lablab niger* medik commonly known as lablab or hyacinth bean is extremely diverse and remarkably adaptable with its various genotypes thriving in different areas and under diverse conditions including arid, semi-arid and humid regions (NAS, 1979; Duke *et al.*, 1981). It is an underutilized but a multipurpose crop used for food, forage, soil improvement, soil protection and weed control (Schaaffhausen, 1963; Grubben, 1977; Kay, 1979; NAS, 1979; Wood, 1983; Yamaguchi, 1983; Shivashankar *et al.*, 1993).

Crop and livestock production are major agricultural enterprises in Nigeria, contributing to household welfare and national economy (Kowal and Kassam, 1978; Ndubuisi *et al.*, 1998). However, in the Nigerian savanna, most soils are naturally of low fertility and the amount of organic nitrogen mineralized annually is often well below the requirement for high crop yields. Due to human population and economic pressures, fallow has been shortened or has entirely disappeared (Kowal and Kassam, 1978; Manyong *et al.*, 1997). This has resulted in continuous cropping or land-use intensification which, in turn, are causing serious soil degradation/erosion and fertility problems, decline in natural species diversity and crop yield, weed problems (Kowal and Kassam, 1978; Webster and Wilson, 1980; Ehui and Jabbar in Jagtap and Amissah-Arthur, 1999; Jabbar, 1995; Tian *et al.*, 1995; Anon, 1997a). In the humid forest of Nigeria, land use has also intensified. There are soil fertility problems and crop yields are low together with increased poverty. Farming systems are changing and fertilizer costs and scarcity make N fertilizer input inadequate. With changes in climate, herding is becoming a common farming activity with its attendant social-economic problems.

The introduction and use of forage legumes are considered an essential part of the process of intensification (Thomas and Sumberg, 1995) and can improve the influence of livestock on soil fertility when used as livestock feed (Tarawali *et al.*, 2001). In fact, Anon (1997b) believes that the most promising opportunity for integration of crop and livestock is improved animal feeding through dual purpose fallow-forage systems and use of crop residues. During the dry season, when the naturally available feed resources are of very poor quality, herbaceous legumes can also produce substantial quantities of better and nutritious fodder for livestock (Schaaffhausen, 1963; Makenbe *et al.*, 1996; IITA, 1997). Other reports have shown that the inclusion of herbaceous legumes in farming

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systems resulted in increased crop yield, reduced weed infestation and prevented soil degradation (Rattray and Ellis, 1953; Vine, 1953; Tian *et al.*, 1995). Herbaceous legumes have also improved soil physical and chemical properties (Vine, 1953; Lal *et al.*, 1978), and can contribute to the control of *Striga hermonthica* (IITA, 1997). Central to crop and livestock production, therefore, is the inclusion of herbaceous legumes in the farming systems of the savanna and rainforest agroecologies.

In 2000 and beyond, both the International Institute of Tropical Agriculture (IITA) and International Livestock Research Institute (ILRI) showed interest in the evaluation of lablab in the northern Guinea savanna of Nigeria for its potential contribution to crop-livestock production systems (Ewansiha *et al*., 2007a,b; 2008; Ewansiha and Chiezey, 2012). Specific activities involved in the lablab research included evaluation of lablab in Samaru in the Nigerian northern Guinea savanna for morpho-phenological variation, potential for crop and livestock production, maize production and drought tolerance. Other experiments involving lablab have also been conducted. In Kano, in the Nigerian Sudan savanna, Ewansiha and Singh (2006) evaluated lablab together with other grain legumes and cereals for drought tolerance. Ewansiha *et al.* (2012), evaluated lablab for its effects on soil properties and subsequent maize-cowpea intercrop in Samaru. The performance of dual-purpose lablab and cowpea was evaluated under maize in Samaru (Ewansiha *et al*., 2016a).

In Benin City, in the rainforest agro-ecology, experiment was conducted to evaluate lablab together with other herbaceous legumes for their potential use in green-manuring (Ogedegbe *et al.*, 2016). During the period of evaluation in Samaru and elsewhere, it was observed that lablab suffered from a complex of pests and diseases (Ewansiha *et al.*, 2016b). Despite control using insecticides and fungicides, it was necessary to determine the type of pests associated with lablab. While the results of these various researches have been reported (Ewansiha and Singh, 2006; Ewansiha *et al*., 2007a,b; Ewansiha *et al*., 2008; Ewansiha and Chiezey, 2012; Ewansiha *et al.*, 2012; Ewansiha *et al.*, 2016a,b; Ogedegbe *et al.*, 2016), this paper highlights the outcomes of these various researches in terms of production niches for lablab, lablab providing grain and pod for food, lablab as a resource for crop production and for soil protection, and lablab as fodder for livestock production as well as the pests/diseases that affect it.

Production Niches for Lablab

Forty-six lablab accessions were evaluated and classified (Ewansiha *et al.*, 2007b; Table 1). Of these accessions, six maturity groups were identified: very early (av. 47 days to 50% flowering), early (av. 54 days), intermediate (av. 72 days), late (av. 98 days), very late (av. 123 days) and extremely late (av. 144 days). The very early, early and intermediate accessions seem suitable for dry savanna with low rainfall or short growing season and the late growing season of the humid forest. These accessions can be grown either as sole crops or in intercrops with cereals. The late, very late and extremely late accessions appear suitable for moist savanna and humid forest with longer growing seasons. These accessions had faster growth and quick soil cover and can therefore provide protection for soils and suppress weeds as well.

Table 1: Classification of *lablab purpureus* according to time of 50% flowering

Accession	Maturity group	Days to flowering	Accession	Maturity group	Days to flowering
PI555670	Very early	42	TLN6	Early	55
PI388019	Very early	42	TLN9	Early	55
PI596358	Very early	47	PI388003	Early	55
PI392369	Very early	47	PI183451	Early	56
PI439586	Very early	47	BARSDI	Early	58
PI346440	Very early	48	Grif1246	Early	58
PI416699	Very early	48	PI532170	Intermediate	68
PI388013	Very early	48	PI345608	Intermediate	76
PI322531	Very early	49	PI401553	Late	91
Grif12293	Very early	50	PI387994	Late	95
PI337534	Early	51	Standard1	Late	97
Grif969	Early	51	ILRI7279	Late	98
PI338341	Early	51	TLN29	Late	99
PI388018	Early	52	TLN7	Late	105
PI388017	Early	52	NAPRI2	Very late	116
PI509114	Early	52	ILRI6930	Very late	116
PI288467	Early	53	ILRI4612	Very late	123
PI284802	Early	53	PI164302	Very late	123
PI388012	Early	54	ILRI730	Very late	125
PI288466	Early	54	Standard2	Very late	126
PI542609	Early	54	NAPRI3	Very late	126
TLN13	Early	54	ILRI7403	Very late	129
PI164772	Early	55	PI195851	Extremely late	144

Lablab as a Quality Food Crop

Of the forty six lablab accessions evaluated, fifteen accessions were suitable for vegetable pods, 11 accessions were suitable for grain-type lablab and three accessions were suitable for food-feed use (Ewansiha *et al*., 2007b; Table 2). With the very early to intermediate accessions, lablab could provide sufficient grain early in the season when food stores would be getting depleted. Grain yield obtained (600-2400 kg ha^{-1}) was comparable with yields obtained with other grain legumes (Ewansiha *et al*., 2007a; Table 3). The lablab grain had an average protein concentration of 25.3% which was comparable with protein contents reported for the dry seeds of the common grain legumes (Table 3), indicating the potential for lablab to contribute to high quality grain nutrition. It also reveals the potential of lablab to fix and supply N since no N fertilizer was applied. As a grain crop, lablab tolerance to drought ensures that food is available even when rains are erratic and when moisture is limiting. Six accessions were identified to be drought tolerant (Ewansiha and Chiezey, 2012), making it possible to develop drought tolerant varieties through breeding and selection. When various herbaceous legumes and cereals were screened for drought tolerance, the most drought tolerant group comprised of lablab (Ewansiha and Singh, 2006). Lablab is drought tolerant because it has a deep taproot system which can penetrate to more than 2 m below the soil surface thus enabling it to sustain growth on residual soil moisture (NAS, 1979; Kay, 1979; Duke *et al.*, 1981).

Table 2: Lablab accessions good for vegetable pod, grain and food-feed use

Vegetable-type	Grain-type	Dual-purpose
PI 555670	Grif 1246	Grif 1246
PI 439586	PI 164772	PI 183451
PI 322531	PI 183451	ILRI 4612
Grif 969	PI 288466	
PI 337534	PI 288467	
PI 509114	PI 388003	
BARSD 1	PI 542609	
PI 345608	NAPRI 4	
PI 532170	ILRI 4612	
Grif 1246	TLN 6	
PI 388019	TLN 13	
PI 392369		
Grif 12293		
PI 416699		
PI 346440		

Table 3: Grain yield and mean crude protein (cp) of some dual-purpose legumes

Crop	Grain yield (kg ha^{-1})	CP (%)
Lablab	600-2400	25.3
Cowpea	200-1400	25.0
Groundnut	800-2700	25.5
Soybean	1700-2600	39.0

Source: Ewansiha *et al.* (2007a)

Lablab as a Resource for Crop Production

Lablab has a potential for up to an average of 2600 kg ha^{-1} of biomass and an average of 64.1 kg of nitrogen ha^{-1} (Ewansiha *et al*., 2007a; Table 4). This means that lablab has high potential for green manure and soil improvement. Moreso, when the biomass is removed as forage to feed livestock, the soil fertility contribution is balanced with the return of the manure and the contribution of the lablab plant roots. With the huge litter of leaves and stems at the end of the growing season which extends into the dry season, high amount of quality crop residue for conservation agriculture is implicated (Fig. 1). In one trial, performance of maize grown following two years of lablab cultivation and incorporation of its plant residues shows that it can support high yield of maize (Ewansiha *et al.*, 2008; Table 5). Lablab fallow supported similar yields of maize across lablab maturity groups from very early to extremely late. Yields of maize for lablab plots were on the average 72.7% higher than for the natural fallow plots. In another trial, yield of maize-cowpea intercrop following one year of lablab fallow and subsequent incorporation of plant residues indicates the ability of lablab to support cereal-legume production systems (Ewansiha *et al*., 2012; Table 6). Lablab and natural fallows compared well for grain yield and seed weight. Lablab fallow, however, favoured higher fodder yield in maize because it improved the supply of soil organic matter, nitrogen, phosphorus and potassium (Ewansiha *et al*., 2012; Table 7). Lablab was able to contribute to the observed improvement in soil fertility because it is a nitrogen-fixing crop with remarkable ability to nodulate even without inoculation (NAS, 1979; Duke *et al.*, 1981).

Table 4: Range and mean values of biomass yield and quality of lablab accessions

Attribute	Range		Mean
	Min	Max	
	kg ha^{-1}		
Root			
Biomass	27.0	303.0	107.0
Nitrogen	0.03	0.52	0.15
Shoot biomass			
Biomass	453.0	7718.0	2640.0
Nitrogen	6.1	184.3	64.1

Table 5: Grain yield of maize following 2-year lablab cultivation and incorporation of lablab residues

Lablab accession	Maize yield (kg ha^{-1})
Very early maturing	5.9a
Early maturing	6.1a
Intermediate maturing	6.2a
Late maturing	6.6a
Very late maturing	6.5a
Extremely maturing	6.6a
Natural fallow	3.7b
$LSD_{0.05}$	0.42

Lablab as Resource for Livestock Production

Sixteen accessions were of good and high quality forage (Ewansiha *et al.*, 2007a; Table 8). These accessions have potential to improve crop and generate residue, which promises to be the dominant feed resource as crop-livestock integration becomes more developed (Smith *et al.*, 1997). Moreover, the various trials recorded huge litter of lablab, lablab biomass and maize stover which provides opportunity for crop and livestock production through sharing of crop residues. Figure 1 show huge litter of lablab leaves and stems at the end of production period which extends far into the dry season. This means that quality fodder can be available for livestock at a time when fodder becomes scarce, natural grasses become less nutritive and animals lose weight. With a dense growth, the lower leaves are shed, which is a potential crop residue for livestock during growing season. Intercrop of lablab and maize gave good grain and fodder yields of lablab relative to that of cowpea (Ewansiha *et al.* 2016a, Table 9). Several other experiments have shown the importance of lablab. The vines when cut with sorghum (*Sorghum bicolor* (L.) Moench) straw gave a mixed fodder of high nutritive values (Shivashankar and Kulkarni, 1989). Selvan *et al.* (1993) found sorghum-lablab intercrop to be superior in grain yield to sorghum-soyabean intercrop. In Zimbabwe, diets based on maize (*Zea mays* L.) stover and lablab could provide adequate nutrients to maintain goat productivity during the cropping season (Makenbe *et al.*, 1996).

Lablab as a Resource for Soil Protection

Evaluation of the performance of six herbaceous legumes in the humid forest region showed that lablab was among the legumes that had the highest soil cover (Ogedegbe *et al.*, 2016; Table 10). Fresh biomass was highest in *Mucuna pruriens* followed by lablab. This was achieved in eight weeks implying that both legumes can provide soil protection, biomass for green manure or fodder for livestock early in the growing season. Ewansiha *et al.* (2008) reported that lablab can be a candidate crop for soil protection, green manure and fodder because it has quick growth combined with high biomass production.

Table 6: Grain and fodder yields (kg ha^{-1}) of intercropped maize/cowpea after one-year lablab cultivation and incorporation of lablab residues

	Maize		Cowpea		Mean
Treatment	Grain	Fodder	Grain	Fodder	
Lablab	3400	3400	400	500	1900
Natural fallow	3000	2800	400	600	1700
Mean	3200	3100	400	500	

Table 7: Lablab effects on organic carbon (OC), total nitrogen (N), available phosphorus (P) and exchangeable potassium (K) after one-year fallow

Treatment	OC (g kg^{-1})	N (g kg^{-1})	P (ug g^{-1})	K^+ (cmol kg^{-1})
Before lablab	5.50	0.50	3.40	0.23
After lablab	5.85	0.55	5.73	0.26
Natural fallow	5.40	0.49	3.70	0.24

Fig. 1: Lablab litter at end of production period and harvest of pods

Table 8: Leaf dry matter yield and quality of lablab

Attribute	Number of accessions	Accession means
Fodder t ha^{-1}	16	>1.5-3.1
	30	<1.5
Fodder quality %		
Crude protein	18	>20-25.2
	28	<20
Phosphorus	46	0.17-0.44

Table 9: Grain yield of dual-purpose lablab and cowpea as sole and when grown together with maize

Crop variety	Sole	Early maize	Late maize	Mean
Grain (kg ha^{-1})				
I4612	983.4	437.3	342.6	587.8b
NAPRI2	999.5	516.0	381.8	632.4b
IT89KD-288	1240.6	638.7	527.7	802.3a
IT99K-241-2	1279.0	710.9	511.7	833.9a
Mean	1125.6a	575.7b	441.0c	
Fodder (kg ha^{-1})				
I4612	4407.0	2426.6	2293.3	3042.3a
NAPRI2	4192.3	2746.0	1968.5	2968.9a
IT89KD-288	2383.5	1454.2	1550.0	1795.9b
IT99K-241-2	2280.3	1675.0	1220.8	1725.4b
Mean	3315.8a	2075.4b	1758.2c	

Means with similar letter are not significantly different at 5% level of probability using LSD.

Table 10: Soil cover and yield of herbaceous legumes at 8 weeks after planting

Legume	Soil cover (score)	Fresh biomass (kg ha^{-1})
Centrosema pascuorum (Mart.) ex Benth	3	240.0
Lablab purpureus (L.) Sweet	5	3210.0
Mucuna pruriens (L.) DC	5	5060.0
Pueraria phaseoloides (Roxb.) Benth.	3	410.0
Stylosanthes hamata (L.) Taubert	4	1070.0
Vigna unguiculata (L.) Walp.	5	1760.0
$LSD_{0.05}$	0.36	1680.0

Table 11: Pests and diseases observed in *Lablab purpureus*

Foliage insects	Pod-sucking insects	Fungal diseases	Parasitic weeds
Ootheca mutabilis (Sahlb)	*Anoplocnemis curvipes* (F.)	*Colletotrichum sp.*	*Cassytha filiformis* (Linn.)
Ootheca bifrons (Labois)	*Cletus notatus* (Thumb.)	*Curvularia sp.*	
Podagrica uniforma (Jac.)	Larvae of *Helicoverpa armigera* (Hbn)	*Rhizoctonia sp.*	
Monolepta goldingi (Bryant)		*Helminthosporium sp.*	
Monolepta nigeriae (Bryant)			
Lema cephalotes (Lac)			
Leaf miners			
Nematocerus acerbus (Faust)			
Silidieus apicalis (Waterh)			
Aphids			

Constraints of Field Pests in Lablab Production

A complex of field pests and diseases were observed on lablab. Insect pests and diseases affected the lablab plants right from the planted seeds through the emerging seedlings and vegetative stage to podding. Young millipedes attacked planted seeds and seedlings. The pests and diseases identified included foliage insects, pod-sucking insects, pod-eating larvae, aphids, fungus and parasitic weed (Ewansiha *et al.*, 2016b; Table 11). Severe damage to pods was caused by the pod-eating and pod-sucking insects that caused pod filling to fail after attack (Ewansiha *et al.*, 2016b). The pest complex observed on lablab was however, similar to that associated with cowpea. Therefore, as with cowpea, lablab can be successfully grown with adequate use of pesticides.

CONCLUSION

Lablab, though an underutilized crop, has the potential to serve as a grain, fodder and resource crop in northern and southern Nigeria. Pests can, however, constitute a setback to its production.

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REFERENCES

Anonymous (1997a). Short fallow systems to arrest resource degradation due to land-use intensification. *Project 1 Annual Report 1997*. Int Inst. of Trop. Agric. (IITA), Ibadan, Nigeria. 67 pp

Anonymous (1997b). Farming systems diversification. *Project 10 Annual Report 1997*. Int. Inst. of Trop. Agric. (IITA), Ibadan, Nigeria. 67 pp

Duke, J.A., Kretschmer, A.E., Jr., Reed, C.F. and Weder, J.K.P. (1981). *Lablab purpureus* (L.) Sweet. In: *Handbook of legumes of world economic importance*. Plenum Press, New York. pp.102-106

Ewansiha, S.U. and Singh, B.B. (2006). Relative drought tolerance of important herbaceous legumes and cereals in the moist and semi-arid regions of West Africa. *J. Food, Agric. Environment*, 4 (2): 188-190

Ewansiha, S.U., Chiezey, U.F., Tarawali, S.A. and Iwuafor, E.N.O. (2007a). Potential of *Lablab purpureus* accessions for crop-livestock production in the West African savanna. *J. Agric. Sci.*, 145: 229-238

Ewansiha, S.U., Chiezey, U.F., Tarawali, S.A. and Iwuafor, E.N.O. (2007b). Morpho-phenological variation in *Lablab purpureus*. *Tropical Grasslands*, 41: 277-284

Ewansiha, S.U., Tarawali, S.A., Odunze, A.C. and Iwuafor, E.N.O. (2008). Potential contribution of lablab residues to maize production in moist savanna of West Africa. *J. Sustainable Agric.*, 32 (3): 393-406

Ewansiha, S.U. and Chiezey, U.F. (2012). Field evaluation of *Lablab purpureus* (L.) Sweet accessions for drought tolerance in the Nigerian moist savanna. *Nigerian J. Life Sci.*, 2(1): 102-114

Ewansiha, S.U., Ogedegbe, S.A. and Chiezey, U.F. (2012). Lablab effect on soil properties and subsequent maize cowpea intercrop. *Agro-Science*, 11 (2): 54-61

Ewansiha, S.U., Ogedegbe, S.A. and Chiezey, U.F. (2016a). Relative yields of dual-purpose hyacinth bean and cowpea when intercropped with maize. *Legume Perspectives*, 13: 35-36

Ewansiha, S.U., Tarawali, S.A. and Chiezey, U.F. (2016b). Observations on pests and diseases in *Lablab purpureus* in Nigerian northern Guinea savanna. *Legume Perspectives*, 13: 23-25

Grubben, G.J.H. (1977). Leguminous vegetables. In: *Tropical Vegetables and Their Genetic Resources*, pp. 70-71

IITA (1997). IITA and ILRI: collaborating for future generations. *Annual Report*. Int. Inst. of Trop. Agric. (IITA), Ibadan, Nigeria. 96 pp.

Jabbar, M.A. (1995). Energy and the evolution of farming systems: The potential for mixed farming in the moist savannas. In: Kang, B.T., Akobundu, I.O, Manyong, V.M., Carsky, R.J., Sanginga, N. and Kueneman E.A. (eds.). Moist savannas of Africa: potentials and constraints for crop production. *Proc. Int. Workshop*, Int. Inst. of Trop. Agric., pp. 87-104

Jagtap, S. and Amissah-Arthur, A. (1999). Stratification and synthesis of crop-livestock production system using GIS. *GeoJournal*, 47: 573-582.

Kay, D.E. (1979). *Crop and product digest* No.3–Food Legumes. Tropical Products Inst., London, 435 pp.

Kowal, J.M. and Kassam, A.H. (1978). *Agricultural Ecology of Savanna*. Oxford University Press, London. 403 pp.

Lal R., Wilson, G.F. and Okigbo, B.N. (1978). No-till farming after various grasses and legumes cover crops in tropical Alfisol. I. Crop performance. *Field Crops Res.*, 1: 71-84

Makembe, N.E.T. and Ndlovu, L.R (1996). *Dolichos lablab* (*Lablab purpureus* cv. "Rongai") as supplementary feed to maize stover for indigenous female goats in Zimbabwe. *Small Ruminant Res.*, 21: 31-36

Manyong, V.M., Makinde, K.O., Sanginga, N., Vanlauwe, B. and Diels J. (1997). Farmers' use of organic and inorganic inputs in the northern Guinea savanna of Nigeria. *Project 1 Annual Report*. Int. Inst. of Trop. Agric. (IITA), Ibadan, Nigeria, pp.5-6

NAS (1979). Lablab bean. In: *Tropical Legumes: Resources for the Future*. National Academy of Sciences (NAS), Washington DC, pp. 59-67

Ndubuisi, A., Zeddies, J., Manyong, V.M. and Smith, J.W. (1998). Crop-livestock integration along the gradient of resource-use intensification in the northern Guinea savanna of Nigeria. *Quarterly J. Int. Agric.*, 37: 105-115

Ogedegbe, S.A., Ewansiha, S.U. and Falodun, E.J. (2016). Relative performance of hyacinth bean and other herbaceous legumes in Nigerian rainforest zone. *Legume Perspectives*, 13: 33-34

Rattray, A. and Ellis B.S. (1953). Maize and green manuring in south Rhodesia. *Rhodesian Agric. J.*, 40: 189-199

Schaaffhausen, R.V. (1963). *Dolichos lablab* or Hyacinth bean: its uses for feed, food and soil improvement. *Economic Botany*, 17: 146-153

Selvan, S.P. and Gopalaswamy N. (1993). Effect of planting pattern and intercrops in sorghum under dry land conditions. *Madras Agric. J.*, 80: 690-692

Shivashankar, G. and Kulkarni, R.S. (1989). *Lablab purpureus* (L.) Sweet. In: van der Maesen, L.J.G. and Somaatmadja, S. (eds.). *Plant Resources of South-East Asia* No 1. Pulses. Pudoc/Prosea, Wageningen, the Netherlands. pp. 48-50

Shivashankar, G., Kulkarni, R.S., Shashidhar, H.E., and Mahishi, D.M. (1993). Improvement of field bean. In: Chadha, K.L. and Kallo, G. (eds.) *Advances in Horticulture*, New Delhi, India, 5: 277-286

Smith, J.W., Naazie, A., Larbi, A. and Agyemang, K. (1997). Integrated crop-livestock systems in sub-Saharan Africa: an option or and imperative? *Outlook on Agric.*, 26: 237-246

Tarawali, S.A., Larbi, A., Fernandez-Rivera, S and Bationo, A. (2001). The contribution of livestock to soil fertility. In: Sustaining Soil Fertility in West Africa. Soil Sci. Soc. Am. (SSSA) & Am. Soc. Agron. *SSSA Special Publ.*, No. 58, pp. 281-303

Thomas, D. and Sumberg, J.E. (1995). A review of the evaluation and use of tropical forage legumes in sub-Saharan Africa. *Agric., Ecosys. Environ.*, 54: 151-163

Tian, G., Kang, B.T., Akobundu, I.O. and Manyong, M. (1995). Food production in the moist savanna of West Africa. In: Kang B.T., Akobundu, I.O., Manyong, V.M., Carsky, R.J., Sanginga, N., and Kueneman E.A. (eds.) Moist savannas of Africa: potentials and constraints for crop production. *Proc. Int. Workshop*, Int. Inst. of Trop. Agric., pp. 87-104

Vine, H. (1953). Experiments on the maintenance of soil fertility at Ibadan, Nigeria. *Empire J. Exp. Agric.*, 21: 65-85

Webster, C.C. and Wilson, P.N. (1980). Rain-fed arable farming systems. In: *Agriculture in the Tropics*. Longman Group Ltd., England. pp. 176-199

Wood, I.M. (1983) Lablab bean (*Lablab purpureus*) for grain and forage production in the Ord irrigation area. *Aust. J. Exp. Agric. Anim. Husb.*, 2: 162-171

Yamaguchi, M. (1983). Hyacinth bean, Lablab bean, Indian and Egyptian bean; *Lablab niger* (*Lablab vulgaris*, *Dolichos lablab*). In: *World Vegetables*. pp. 278-279