The Journal of Animal & Plant Sciences, 24(4): 2014, Page: 1085-1090
ISSN: 1018-7081

PRODUCTION, HARVEST AND CONSERVATION OF *LABLAB PURPUREUS* (L) SWEET FORAGE IN SEMI ARID LIVESTOCK REGIONS: THE CASE OF EAST CENTRAL BOTSWANA

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ABSTRACT

In arid and semi arid regions, marked seasonal fluctuations in nutritional quality of natural pastures compromise livestock productivity and necessitates incorporation of leguminous plants as supplements. To establish the extent of *Lablab purpureus* forage production under extensive livestock systems in Botswana, a survey of randomly selected households was conducted in Central and North East Districts during the 2012/2013 planting season. Farmers were primarily engaged in *L. purpureus* production to produce hay to supplement their livestock during times of feed scarcity while a few sold it as fodder. The main hay storage techniques employed were (1) small rectangular bales, (2) loose piles/bundles of cured forage and (3) cured and chopped forage packed in bags. Some of the highlighted challenges in harvesting, curing and storage of *L. purpureus* included leaf loss, inadequate access to baling machinery, hay damage from direct exposure to sun and rain as well as inappropriate storage facilities. Other challenges were related to seed - inadequate supply, poor quality as well as high cost. To counter these challenges, farmers employed several mitigation measures. Because of the growing popularity of *L. purpureus* among livestock producers, intensified awareness campaigns can accelerate its adoption and thereby alleviate seasonal animal nutritional deficits.

Keywords: curing, forage storage, hay making, leaf shattering, livestock feed, seed quality.

INTRODUCTION

Extensive livestock systems in arid and semi arid regions have been, and continue to be pivotal in supporting rural economies. The very nature of these climatically unpredictable regions, however, presents some sustainability challenges to livestock production. One of these limiting factors relate to animal nutrition. Because vegetation biomass production closely follows rainfall patterns, the natural rangelands provide adequate feed for livestock during rainy/wet seasons. On the contrary, non-rainy/dry periods are characterized by inadequate amount of quality vegetation to maintain livestock body condition while a total lack of feed may occur during extended dry periods or droughts. Subsequently, these pronounced seasonal fluctuations in availability of feed result in low animal productivity, poor fertility and birth rates as well as high mortality rates (Andre-Montemayor *et al*. 2011) - thereby compromising livelihoods dependent on these livestock systems.

In order to alleviate seasonal nutritional deficits, some form of strategic supplementation of livestock therefore becomes a necessity. Of the several alternative supplementation strategies that may be adopted, the use of purchased protein supplements such as oil cakes is restricted in developing countries by non-availability and high cost (Topps, 1971; Smith *et al*. 1988; Maphane and Mutshewa, 1999). Thus for small scale resource-poor farmers, a more sustainable way of improving the feeding value of poor quality pastures and crop residues is through supplementation with forage legumes (Van Eys *et al*. 1986; Murphy and Colucci, 1999). According to Dove (2010), a supplement should preferably be produced in the region, should have good storage characteristics and must offer adequate nutritional characteristics.

Lablab purpureus is the most promising legume forage in Botswana (Tacheba and Moyo, 1988; Aganga and Tshwenyane, 2003), and it is generally seen as a potential substitute for the widely-accepted but expensive, imported Lurcene (*Medicago sativa*) hay. *L. purpureus or* Lablab as it is commonly called is a summer growing, twining herbaceous annual or short duration perennial which is generally resistant to disease and insect attack. Available cultivars in Botswana are the early-flowering Highworth and late-flowering Rongai. Lablab is drought tolerant once established and grows in areas receiving annual rainfall of between 200 and 2500mm (Hendricksen and Minson, 1985; Murphy and Colucci, 1999). It is also tolerant to high temperatures ranging between 18 and 30°C while lower temperatures reduce plant growth; leaves begin to drop at -2ºC but the plant can survive frost for a limited period (Kay, 1979). Lablab grows in a wide range of soils from deep sands to heavy black clays and can tolerate pH ranges of 4.5-7.5

provided drainage is good. The growth period can vary from approximately 75 to 300 days (Kay, 1979), with maximum vegetative growth reached 130 days post germination under conducive conditions (Murphy and Colucci, 1999). Seasonal dry matter yields vary with rainfall, soil condition and time of seeding but averages of 4 t/ha stem and leaf are common in the subtropics. Studies in Botswana have shown crude protein and dry matter digestibility values (stem and leaves) of 14 and 55% respectively, making it a valuable livestock feed.

Though research work on Lablab has been initiated over the past two decades in Botswana, it is only recently that livestock producers have shown keen interest in its planting and subsequent utilization. This study therefore sought to establish the extent to which farmers engage in Lablab production and its storage as well as challenges they encounter. Understanding farmers' perceptions and attitudes towards Lablab forage can lead to better intervention strategies from researchers and extension agents alike, which could ultimately ensure a sustained supply of nutritionally-balanced animal feed and secure rural livelihoods.

MATERIALS AND METHODS

Study Area: The study covered two adjacent Agricultural Districts of Botswana. In Central District the eastern communal farming areas of Mathangwane, Marapong, Natale, Shashe and Tonota were covered. In the other Agricultural District of North East the area surveyed was Mapoka. Selection of areas included in the final survey was mainly based on proximity to extension agents for easy accessibility and other logistical arrangements, as well as willingness of farmers to partake in the study. The area receives an average annual rainfall amount of about 470 mm, which is highly variable in distribution and falls mainly between November and April and there are major ephemeral rivers like Shashe and Tati. While most parts of the country are characterized by deep Kalahari sands, the eastern strip has relatively more fertile soils ranging from sandy loams to sandy clay loams, and are thus mainly alluvial and/or colluvial. The long term maximum temperatures during winter and summer months are ~23 and 35° C, while lows of ~4°C are occasionally observed during winter nights. The area is dominated by *Colophospermum mopane* woody species, while other vegetation associations include species like *Acacia tortilis, A. nigrescens* and *Combretum apiculatum*.

Small scale agriculture is the dominant livelihood strategy in the study area, involving seasonal cultivation of rain-fed crops such as millet, maize, sorghum, groundnuts and melons. In addition, communally-owned rangelands accommodate a number of livestock such as cattle, goats, sheep as well as donkeys which are kept for sustenance.

Sampling Procedure: A questionnaire-based survey was conducted in January and again in June up to August of the year 2013. And because farmers are normally heavily engaged in planting and weeding as well as other related cropping activities during the rainy periods (January to April), very few responses were recorded. As such, the survey was continued during the post-harvest period commencing from the month of June. The Lablab farmers were selected randomly with the aid of extension agents from the Ministry of Agriculture. A total of 26 farmers were interviewed. The number of farmers surveyed was expectedly relatively low because adoption of Lablab forage is still in its infancy in Botswana, thus uptake is still restricted to fewer households. Some of the issues covered by the questionnaire included socio-economic variables in addition to sources of Lablab seed, amount of hectarage planted and planting dates. Also covered were harvesting times of forage, hay storage techniques as well as challenges encountered in Lablab production and related mitigation strategies.

The data were captured using Excel® while open-ended questions were coded before also being captured. Simple descriptive statistics were then used for socio-economic and other related variables, as well as challenges and mitigation measures employed by the respondents and the results were presented in tabular and graphical form.

RESULTS AND DISCUSSION

Socio-economic variables of respondents: The socio-economic variables of the respondents are as reflected in Table 1.

Variable	**Respondents (%)**
1. Gender	
(a) Male, (b) Female	(a) 88, (b) 12
2. Age group	
<21 years	0
21-40 years	12
41-60 years	65
>60 years	23
3. Sources of income	
Arable farming	50
Livestock & livestock products	35
Formal off-farm employment	19
Informal employment	8
Pension	35
Other	8
4. Reasons for growing Lablab	
(a) Feed own livestock, (b) Sell fodder, (c) Sell seed	(a) 85, (b) 27, (c) 0
5. Total planted area of Lablab	
(a) <0.5ha, (b) 0.5-2ha, (c) >2ha	(a) 23, (b) 42, (c) 35

The majority of respondents were elderly males (> 40 years), while the young farmers (<20 years) were expectedly not captured in the surveyed area. Subsistence agriculture has generally been the domain of elderly farmers in Botswana. While a number of reasons can be forwarded for the limited involvement of the youth it is likely that the restricted access to, and lack of control over key productive assets such as land and start-up capital to purchase livestock, seeds and other related inputs as well as borehole equipping and maintenance, hamper the full involvement of youth. Also lately, the subsistence nature of small-scale agriculture is losing appeal to the youth who are interested in 'visible' returns for their investments including time, and will rather look elsewhere for alternative income-generating sources.

While various reasons were advanced for growing Lablab, the majority of farmers did so in order to feed their livestock especially goats, sheep and cattle. Interestingly, none of the respondents solely ventured into production to harvest and sell seed. Several sources of Lablab seed were used by farmers. Commercial retailers (seed merchants) were used by 31% of farmers, 42% purchased seed from other farmers, 23% used seeds from their own harvests from previous seasons while 19% obtained seed through the government seed subsidy program.

Planting of Lablab was done mostly at the same time with other traditional crops following rains in November-December (65%) and January (23%) while only a few (16%) started planting late in February. The legume is a summer growing plant and thus it is susceptible to damage from frost or cold temperatures during Botswana's winter months commencing in May up to August. It is therefore important to plant Lablab ideally in December to maximize biomass production during the rainy period. Harvesting stages of Lablab forage also differed among farmers, but the majority harvested at flowering stage (42%) followed by those who harvested prior to flowering (27%) and at grain filling stage (19%). The reasons for harvesting at these times were; high biomass (19%), high nutritive value (31%), both high biomass and nutritive value (19%) while 8% did so as a recommendation from extension agents from the Ministry of Agriculture. It is widely acknowledged that harvesting forage crops in the transition stage between vegetative and reproductive will produce the best compromise between yield and quality - as beyond this stage they become higher in fibre and lignin content and lower in protein content, digestibility and acceptability to livestock (Perry and Cecava, 1995; Lacefield *et al*. 1999).

***L. purpureus* storage techniques:** Conservation of harvested Lablab forage was through making of hay, which is generally a popular (Henning, 1998), low-cost but high-quality feed (Rayburn, 2002). Generally, four main steps are noted in the hay-making process namely; cutting of forage, curing (drying), baling of cured hay and lastly transfer of bales to storage/sale/feeding points. In this study, the period taken between harvesting and moving hay into storage areas ranged from less than a week (62%), between 1 to 2 weeks and some extending for more than 2 weeks (19% each). It is during this period when dry matter losses and quality changes (increased fibre content and reduced energy content) can occur while the forage is curing in the field through the natural process of plant respiration which converts carbohydrates stored in the plant tissue to carbon dioxide, heat and moisture. According to Rotz and Muck (1994), rapid drying early in the field curing process can reduce this loss since plant respiration ceases when moisture levels drop below 40%.

Afterwards, the cured hay was then stored using 3 main techniques. The first one, which was also used more (65%) involved neatly-stacked small rectangular bales made using a baler (mostly using the manual 'hay box' (DAR, 2006)). The popular use of bales was attributed to significant reduction in leaf loss (47%), ease of handling (24%) and convenience (18%). On the other hand, the second method used was the loose piling of dried forage heaps/bundles (30%) because of better retention of leaves (38%), convenience (25%) and being the cheaper option (25%). The last and least utilized storage technique involved crushing of the dried forage and storing in bags (15%) and it was mainly employed to avoid loss of leaf material (50%). It is interesting to note that most farmers who used one of the three storage methods did so under the impression that the particular method employed was helpful in minimizing leaf loss. But when asked if they would consider any new methods in future, an overwhelming majority (60%) answered in the affirmative while only 12% preferred to continue with their current method. The rest were not sure or adopted the 'wait-and-see' approach. The willingness to even contemplate future adoption of other storage techniques demonstrated by some farmers is in itself partly reflective of the inadequacy of the current methods used. It is possible that some farmers may not have been familiar with other storage methods, or were deterred from utilizing other methods because of limited resources or simply opted to stick with what has worked for them in the past. This further reiterates the fact that despite unfairly being associated with lack of flexibility, farmers in climatically-unpredictable arid and semi arid areas are often astute managers of risk and will continuously reassess their operations and adjust accordingly. Storage of hay was either on a raised home-made wooden deck (58%) or in an enclosed area or warehouse/shed (38%).

***L. purpureus* storage challenges:** Some challenges were experienced in Lablab hay storage, as reflected in Figure 1

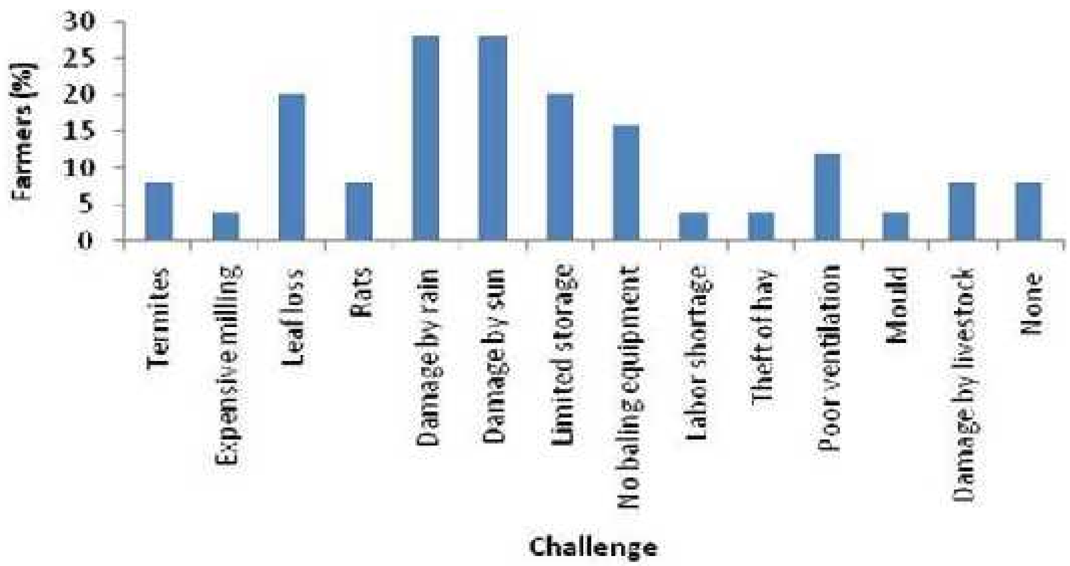

Fig 1. Some challenges encountered by farmers in *L. purpureus* hay storage

While a certain portion of surveyed farmers (8%) did not mention any challenges related to Lablab hay storage, other farmers experienced challenges among which were damage of stored hay through direct exposure to weather elements like rain and sunlight (28% each). While harvesting is ideally done towards the end of the wet/rainy season, there are still unpredictable rainfall events however, that may damage cut forage left to cure in the field leading to loss of leaves and leaching of soluble nutrients from the hay as well as colour bleaching – which all ultimately reduce the value of the forage as an animal feed or a marketable commodity (Rankin and Undersander, 2000; Ball *et al*. 2001). Also, because some farmers store their hay on raised wooden decks out in the open during the dry/non-rainy period, there is still the small possibility of winter rainfall which may catch the farmers unprepared and reduce digestibility of hay. This is more so in today's changing climate, where weather patterns have become even more variable. Studies have shown that rain events during the field curing process does more damage to legume hay when compared to grass hay. Also, the greater the amount of rain and the drier the crop when rain occurs, the greater the loss of dry matter and nutrients (Rotz, 2003). However, it is important to note that delayed harvest due to concern about rain probably results in more forage quality loss than does rain damage (Ball *et al*. 2001). This 'open' storage technique not only left forage susceptible to moisture damage and subsequent moulds (4%) which can reduce palatability, but also left hay prone to damage from sustained excessive heat from the sun. A related challenge of using open spaces involves stray livestock that end up consuming the stored forage (8%), which can be a significant drawback for a farmer with already limited dry season feed options.

The other challenges mentioned by farmers included limited storage space and loss of leaf material (20% each). Under good rainfall regimes, Lablab produces the much-needed above-ground biomass which ironically for small scale resource-poor farmers, requires more space to store. Not only that, but labour is also a possible limiting factor during harvest and transfer of cured forage to storage points. The issue of leaf shattering, this time not due to damage by direct exposure to rain and sun as mentioned earlier, emanates from the differential times of drying required between leaves and stems. While stems take longer to dry, the leaves which are the part of the plant with the highest protein and digestibility quickly dry out and fall off and can easily be lost. The drying rate depends on prevailing environmental conditions like solar radiation, temperature, humidity and wind speed (Rotz, 1995; Orloff and Mueller, 2008), as well as the resources available to the farmer like time and machinery. It is important to strike a balance on when to bale. At very low moisture levels for example, leaf shatter and leaf loss can be quite high. On the other hand leaf loss is reduced at higher moistures but if moisture is too high then mould, discoloration and sometimes spontaneous combustion may occur – resulting in loss or damage of storage structures as well as bales. Normally, moisture content considered safe for baling is 20% or less, but even this can result in some heating and a 5-10% loss of dry matter during storage (Vough, 2004). Conditioning (light physical cracking and crushing of stems) using commercial machinery will allow loss of moisture from the plant more easily and thus shorten curing time (Andrae, 2003). However, some farmers (16%) were ill-equipped in terms of machinery such as tractors, balers and conditioners/crimpers to properly harvest and bale their forage. Pests like termites and rats

(8% each) were also a nuisance to farmers, resulting in direct damage or indirectly rendering the hay unpalatable.

A number of solutions were proposed or already being implemented by farmers to alleviate the preceding problems. To minimize direct exposure to weather elements like rain and sunlight, some farmers covered their stored hay with waterproof tarpaulin such as plastic or canvas (26%) or planned to construct a well-ventilated warehouse/shed or enclosed structure to store their hay (22%). The latter was also a proposed solution for those with limited storage capacity. To minimize the common problem of leaf loss, some farmers advocated for the use of millers to 'grind' the Lablab hay into smaller units and thereafter store it in bags (17%) while only a few opted to hire machinery to make bales (4%). Still in an effort to retain leaves, 13% proposed frequent turning/spreading or raking of the harvested forage to expedite uniform drying through increased air circulation, and also to avoid formation of moulds. While this is undoubtedly helpful, studies have shown that hay which is turned too often or when it is too dry will result in significant loss of leaves, causing a loss in forage quality and yield (Rayburn, 2002). Of particular concern was the proposal to use pesticides (4%) in and around storage areas to deal with pests like termites and rats. Caution should be exercised as indiscriminate use of pesticides can be harmful not only to livestock which may consume the contaminated hay, but in some cases to humans as well.

Other challenges in *L. purpureus* production: Other important challenges encountered in Lablab production in general mentioned by respondents were related to seed availability, quality as well as affordability. Firstly, seeds were not readily available and thus interested farmers had to settle for fewer quantities from commercial retailers (seed merchants) and from other farmers while some regrettably gave up after missing planting dates. It is this very shortage of seed that has partly contributed to high prices of Lablab seed when compared to seeds of other conventional crops. As a result, not all farmers could afford Lablab seed or were restricted to small quantities because of steep prices and shortage of seed on the market. Ferguson and Sauma (1993) also reiterate that the supply of seed to farmers at a reasonable price is one of the key determinants to the successful adoption of improved grasses and legumes by farmers.

Lastly and perhaps more importantly, farmers generally complained about the poor quality of seed. Despite its growing importance as a forage legume, good quality Lablab seed is still a challenge in Botswana, mainly because Lablab has not yet been formally released. This means that it has not benefited accordingly from the current formal seed production system as envisaged by the country's Seed Certification Act (1976), and thus seed is neither tested for purity nor germination – leaving farmers to settle for seed with unverified quality.

Conclusions: Lablab forage is gradually becoming important among livestock producers in semi arid Botswana. This study revealed the extent to which farmers are engaged in Lablab production, which is still at a small scale level. Therefore more should be done to raise awareness of the potential and proper production of Lablab among the farming community. The challenges encountered by farmers during harvesting, curing and hay-making should be addressed as they compromise the quality of animal feed in the end. The seed availability challenge can be addressed through engagement of 'farmer clusters' in informal production of seed while awaiting revision of the seed policy.

Acknowledgements: The authors are grateful to farmers who participated in this survey while the Department of Animal Production (Ministry of Agriculture) assisted with identification of respondents and administration of the questionnaires. The Department of Agricultural Research provided the logistics for this study.

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