

The Scope and Potentials of Fodder Trees and Shrubs in Agroforestry

S. Krishnaprabu*

Department of Agronomy, Faculty of Agriculture, Annamalai University - 608 002

*Corresponding Author E-mail: prabu1977krishna@gmail.com

Received: 9.09.2018 | Revised: 15.10.2018 | Accepted: 21.10.2018

ABSTRACT

Fodder shrubs and trees (browse) play a significant role both in farming systems, where they are protected as fallow species, and in livestock production. The importance of browse increases with increasing aridity and is generally most essential in the dry seasons, when most other feed resources depreciate in quality and quantity. Generally, trees occupy a significant niche in the farming systems and overall way of life in animal production. Fodder trees and shrubs are classified into two groups: leguminous and non-leguminous. The leguminous trees and shrubs are often higher in crude protein and other nutrients and play a vital role as dietary supplements of low quality grasses in dry seasons. Livestock depend largely on browse for their dietary protein. Browse intake increases total dry matter intake, increases crude protein intake, and improves the digestibility of low-quality forages. The effect of browse feeding on livestock is shown in increased survivability (i.e., lower mortalities, especially over the dry season) and increased productivity. The processing and conservation of fodder trees and shrubs is increasingly being recognized and explored, while the cultivation is minimal and insignificant. The role and importance of fodder trees and shrubs for livestock production, their nutritional quality and factors which limit their use in livestock production are reviewed. The need for increased cultivation and integration of fodder trees (especially leguminous fodder trees and shrubs) into local farming systems through agroforestry is imperative in order to promote livestock production and also the support of rural livelihoods. It is also important to increased research support for the efficient cultivation, management, processing and use of fodder shrubs and trees for improved livestock production in India.

Key words: Agroforestry, Livestock, Fodder trees, Leguminous, Farming system.

INTRODUCTION

Fodder (browse) is an agricultural term for animal feed, and fodder trees and shrubs are those plants (shoots or sprouts, especially tender twigs and stems of woody plants with their leaves, flowers, fruits or pods) that are raised, used and managed to feed livestock. Fodder plants are plants which are grown in

order to provide the nutritional needs of animals. Babayemi and Bamikole⁵ opined that fodder and shrubs are important components of ruminant diet and they have been found to play an important roles in the nutrition of grazing animals in areas where few or no alternatives are available⁴⁴.

Cite this article: Krishnaprabu, S., The Scope and Potentials of Fodder Trees and Shrubs in Agroforestry, *Int. J. Pure App. Biosci.* 6(5): 1363-1371 (2018). doi: <http://dx.doi.org/10.18782/2320-7051.7260>

In a study conducted by Osemeobo⁴⁰ it was observed that fodder is consumed in the livestock industry and the savannah areas account for about 10-15% fodder as livestock food in the dry seasons. These parts of the country have less rainfall and low biomass production but support over 90% of livestock. Fodder trees and shrubs were noted to support livestock such as-cattle, sheep, goats, donkey and camel in the dry season.

A survey of trees and shrubs in the savannah zones, and found out that most trees and shrubs shed their leaves, the annual grasses die-off and the perennial grasses dry up and the vegetation is burnt thereby leaving the animals with little or nothing to eat. However, the plant parts such as new flush of leaves, flowers and fruits often produced in the dry season are rich in proteins, vitamins and minerals.

Ogunbosoye and Babayemi¹⁴ maintained that inadequate feed supply is a major constraint to ruminant production during the dry season in the tropics and this has been the basic reason for poor performance of livestock. Nevertheless, livestock rearing is considered as an occupation and source of income for the majority of resource-poor farmers in Africa. Sustainable production of livestock usually involves efficient utilisation of available feed resources. However, the low quality and quantity of available forages during the dry season are major constraints for improved livestock production in most savannah areas. In many rural areas, the available grazing is not generally sufficient to meet the maintenance requirements of grazing animals³⁴ during dry periods.

As a major source of animal feeds in Africa, fodder trees and shrubs are highly valued by farmers. Browsers have multiple roles in farming systems such as feed, fuel wood and as human and veterinary medicines³¹. These forage species contain appreciable amounts of nutrients that are deficient in other feed resources such as grasses during dry seasons and dry periods. They have deep root systems enabling the

extraction of water and nutrients from deep in the soil profile⁴². Most browse plants have high crude protein content, ranging from 10 to more than 25% on a dry matter basis³⁸. This reliable protein resource can be used to develop a sustainable feeding system and increase livestock productivity.

Scope and applications of fodder trees and shrubs

Elevitch and Wilkinson¹⁵ pointed out that fodder trees and shrubs have several applications and uses and hence they serve as good sources of Shade, Wind shelter, Living fence, Improved fallow, Improved pasture, Mulch, Bee forage, Human food, Fuel wood, Timber, Fiber, Resins, Dyes, Tannins, Medicine, Food, Fertility enhancement, Soil stabilization, Beauty, Oxygen, Wildlife habitat, Bird habitat, Increased self-sufficiency, Nutrient cycling, Farm diversity.

In a previous study conducted by Komwihangilo *et al.*^{2,8} farmers reported that most browsed species were observed according to their voluntary intake and subsequent performance of browsers on different fodder trees and shrubs. For example, *Dichrostachys cinerea* was reported as the most preferred species by both cattle and goats. Local people generally recognise the trees and shrubs which are well appreciated by ruminants and their nutritive importance.

According to Aganga and Tshwenyane¹ the parts of trees that are commonly used as feed include leaves, tender shoots or twigs, fruits, pods and seeds. In general, leaves are higher in crude protein (almost twice) than twigs, indicating that livestock have access to nutritious feed. Leaves also contain more crude protein on average than pods but the latter were found with higher organic matter and digestibility.

Major fodder shrub and tree species

Several authors have described tree species used to supply animal feeds to different categories of livestock. Emmanuel and Tsado¹⁷ noted that in all fodder development works, legumes play the major role as they enrich the soil with nitrogen and produce

highly digestible and protein rich fodder. The family of legume is one of the biggest in the plant kingdom. Almost all plants are used as

fodder belongs to the sub-family papilionoidese.

Table 1: Some Important Fodder trees and shrubs in Nigeria

| Scientific names | Habitat |
|------------------------------|-----------------|
| <i>Acacia albida</i> | Savannah |
| <i>Acacia nilotica</i> | " |
| <i>Acacia raddiana</i> | " |
| <i>Acacia senegal</i> | " |
| <i>Acacia tortilis</i> | " |
| <i>Adansonia digitata</i> | " |
| <i>Afzelia Africana</i> | " |
| <i>Albizia Zysia</i> | Forest/Savannah |
| <i>Albizia lebbbeck</i> | |
| <i>Anogeissus leiocarpus</i> | Savannah |
| <i>Anona Senegalensis</i> | " |
| <i>Balanites aegyptiaca</i> | " |
| <i>Borassus eathiopium</i> | " |
| <i>Bridelia spp.</i> | " |
| <i>Ceiba pentandra</i> | Forest/Savannah |
| <i>Danellia oliveri</i> | Savannah |
| <i>Detarium Microcarpum</i> | " |
| <i>Ficus capensis</i> | " |
| <i>Ficus polita</i> | Savannah |
| <i>Isobertina doka</i> | " |
| <i>Khaya senegalensis</i> | " |
| <i>Leucaena leucocephala</i> | Forest/Savannah |
| <i>Nauclea latifolia</i> | Savannah |
| <i>Gardenia terifolia</i> | " |
| <i>Gliricidia sepium</i> | Forest/Savannah |
| <i>Parkia biglobosa</i> | " |
| <i>Prosopis Africana</i> | " |
| <i>Prosopis julifera</i> | " |
| <i>Strychnos innocua</i> | Savannah |
| <i>Tamarindus indica</i> | " |

Adopted from: Osemeobo⁴⁰

Nutritional value of some fodder trees and shrubs

Leguminous species were found to contain 25 to 50% more crude protein than non-leguminous plants. Mokoboki *et al.*³⁷ reported the nutritional values, the type and amount of tannins of acacia tree foliage (*Acacia karroo*, *Acacia nilotica*, *Acacia tortilis*, *Acacia galpinii*, *Acacia sieberiana*, *Acacia hebeclada* and *Acacia rhemniana*). Almost all species had crude protein levels above 100 g/kg dry matter (DM), ranging from 103 g/kg DM for *A. rhemniana* to 183 g/kg DM for *A. sieberiana*. Crude protein (CP) levels of this magnitude in a diet are adequate to support the requirements of cattle, sheep and goats at low to medium production levels. Mokoboki *et al.*³⁷ concluded that all the

species except *A. galpinii*, *A. karroo* and *A. tortilis* are of good nutritive value. *Dichrostachys cinerea* is a valuable fodder tree and there are various beneficial effects resulting from supplementing ruminants with *D. cinerea*. Smith *et al.*⁴¹ reported improved performance of goats resulting from supplementation with *D. cinerea* fruits. Basha *et al.* reported *D. cinerea* to have 123.2 g/kg CP, and low tannin content (57.9 g/kg).

The chemical composition of combretum species (*C. apiculatum*, *C. molle* and *C. zeyheri*) was well determined by Lukhele and Van Ryssen²⁹. Mean values CP concentration varied from 92 g/kg DM for *C. molle* to 141 mg/kg DM for *C. mopani*. These values are comparable to those reported for acacia species³⁷. *Ficus*

sycomorus is also among the identified browse species since it provides fruits and leaves. Nutritional status of this species was determined by Nkafamiya *et al.* Results obtained for proximate composition showed protein content of $17.24 \pm 0, 71\%$ and it has a high percentage of crude fibre ($31.54 \pm 0, 11\%$). They concluded that *F.sycomorus* can serve as a good source of nutrients. *Diospyros mesipiiformis* was found to have low levels of CP (5.46 g/kg) but high levels of total carbohydrates (77.21%)¹⁸.

Veterinary uses of some local fodder trees and shrubs

From a study on ethnoveterinary medicine conducted on some local fodder trees and shrubs, it is revealed that many of these plants have both nutritional and therapeutic properties²⁷. For example, *Dombeya rotundifolia* was evaluated for its biological activity. It showed antibacterial and anthelmintics activities³⁶. Aqueous and organic leaf extracts of *C. hereroense* showed good activity in *in vitro* assays against the free-living nematode *Caenorhabditis elegans*³⁵. Members of combretacea have been extensively studied and shown to have broad-spectrum antimicrobial activity^{33,26,16}. Several flavonoids, triterpenoids, and stilbenoids have been isolated from Combretaceae and were shown to be biologically active².

Maphosa *et al.*³² reported that species from Fabaceae family are used to treat various animal diseases, ranging from bacterial diseases to conditions caused by

internal and external parasites. *Peltophorum africanum* was reported by Bizimenyera *et al.*¹⁰ to have anthelmintic and antioxidant activities.

Pattern of utilization of fodder trees and shrub species

Fodder is harvested in the natural environments through: (i) selective cutting of leafy parts, flowers and fruits of shrubs and trees. (ii) Pruning of shrubs and trees which are suitable for livestock. (iii) Pollarding of tree crowns⁴⁰. In a recent survey conducted by Hassen *et al.*²² they observed that parts of the browse species utilized by livestock were leaves, pods, twigs and flowers. In all browses, leaves were the plant parts mostly utilized by livestock. The pods of *Acacia tortilis* and *Dichrostachys cinerea* were important feed resources for goats during the dry season. Dried leaves were found to be more palatable for cattle and goats than wet leaves from broad leaved browse species like *Terminalia brownii*, *Boswellia papyrifera* and *Sterculia africana*.

Also in a study conducted by Javed, *et al.* they found out that fodder tree leaves are an alternative source of livestock feeding in scarcity period, especially in prolonged dry season. The fodder tree leaves are harvested several times during summer and fed to livestock and also stored as hay. They maintained that rangeland grasses are although the main way of procuring feed, yet fodder trees plays an important role in livestock rising.

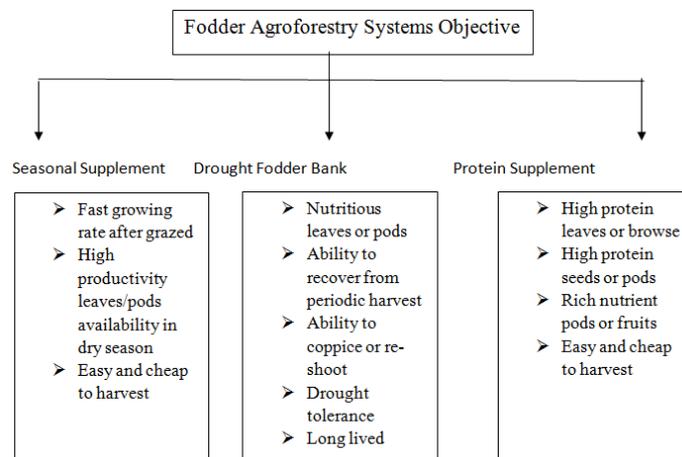


Figure 1: Characteristics of Fodder trees and shrubs in Agroforestry System Objectives, Adopted from Abel *et al.*

Common Agroforestry-Fodder Production Models

According to Calub and Lasco¹¹ a number of fodder production systems designed to produce sufficient foliage for livestock feeding particularly during the dry season were evaluated and a lot of research is still being conducted with several others being refined. These production systems include various types of agroforestry-silvopastoral systems, where trees, animals and pastures are deliberately combined to obtain benefits and services. The integration of these components can vary both in time and in space.

Fodder bank systems

Trees are planted as close as 1m x 1m and are cut regularly to induce maximum herbage production. The cut herbage is usually carried to animal feeding stalls sometimes sheep or goats are brought to the plots and allowed to forage on the cut branches of naturally-growing fodder. The system is called fodder bank, which provides reserve fodder when it is in short supply, usually in the dry season.

Protein bank

This is a type of fodder bank which intentionally chooses trees, shrubs legumes with high protein- containing leaf biomass. Commonly used species include *Leucaena leucocephala*, *Gliricidia sepium*,

Three-strata forage system

This is another type of fodder bank; it involves the planting of forages, shrubs and trees to form three canopy layers or strata in a unit of land. Pasture grasses, vines and herbs occupy the lower strata; shrubs occupy the middle strata and trees occupy the upper strata. The combination of grasses and trees can ensure year-round supply of fodder.

Live fence or boundary systems

Single or double rows of fodder trees are planted along farm boundaries. The trees have the dual purpose of providing fodder and serving as live fence posts. If intended to enclose animals, the trees are usually planted densely, as in hedges, to prevent animals from getting out. In some parts of Africa, thorny species are planted as thick hedges to prevent livestock from straying into crop plots and also to fence them off from wild animals.

Hedgerow intercropping systems

Fodder trees, mostly leguminous are planted as hedges in single, double or triple rows. The spaces in between hedgerows are planted with pasture grasses. As in fodder banks, herbage may be cut and carried to animal feeding stalls. The more common practice is to let the animals forage on the cut tree branches and pasture grasses.

Tree plantation + animal grazing systems

The understory of tree plantations is utilized as grazing area for cattle, sheep and goats. The plantation may be of forest trees, fruit trees, coconuts, oil palms or rubber. The livestock are allowed to graze freely on improved pasture grasses planted under trees.

Indigenous cut-and-carry systems

As the name implies, the fodder is cut and carried to animal stalls. Farmers have long been practicing this system. Indigenous legumes such as *Ficus*, *Acacia*, *Leucaena*, *Gliricidia* and *Albizia* are the most preferred fodder tree species.

Contributions of Fodder trees and Shrubs to food Security

Fodder trees and shrubs form an integral part of ruminant production; feeding browse has become an essential practice especially in the dry season when herbaceous forages are scarce⁷ and low in nutritive value³. Forage legumes, especially browse plants, are important in the maintenance and survival of ruminants. Their relative importance in ruminant nutrition especially during the dry season spell cannot be over-emphasized. Improved animal agroforestry could enhance livestock production in Nigeria through forage production. As a fraction of total fodder intake during the dry season, browse can contribute as much as 30% of cattle's and 60% of goats' fodder. Large number of browse legumes and multipurpose trees have been tried experimentally and subsequently introduced to ruminant farmers.

Fodder legumes are of considerable nutritional importance as livestock feed during the dry season of the year. Their leaves are green all year round and many are well known to herdsmen who frequently cut down their

branches for stock feeding. Most nomads and smallholders know them and therefore use them for their livestock^{4,39}. The fruits of some form an important feed resource during the dry season. Many browses contain high levels of essential elements such as calcium, sodium and sulphur as well as critical micronutrients such as iron and zinc which have been shown to be deficient or borderline for productive purposes in many grass species.

Browse legumes are found from north to south; and west to east in Nigeria. Examples include *Leucaena leucocephala*, *Gliricidia sepium*, *Acacia* spp. (*A. albida*, *A. nilotica*), *Albizia*, *Ficus elasticoides*, *Mangifera indica*, *Musa* sp., *Spondias mombin*, *Cajanus cajan*, *Tamarindus indica*, and *Parkia clappertonian*. *Leucaena* is widely accepted as the best browse legume and has naturalized in some parts of Nigeria. *Leucaena* and *Gliricidia* foliage yields are higher in the wet season^{4,6}. Their leaves provide protein-rich supplements to traditional village diets to increase small ruminant productivity.

Bamikole *et al.*⁸ evaluated the feeding value of *Ficus religiosa* with West African Dwarf goats and the results demonstrated that feed intake, weight gain, digestibility and N utilization can be enhanced by feeding *Ficus religiosa* in mixture with *Panicum maximum* and it can be used in diet mixtures up to 75 % of DM fed. Yahaya *et al.*⁴³ evaluated the nutritive value of three browse trees (*Ficus polita*, *F. sycomorus* and *Acacia sieberiana*) with sheep on dry matter and crude protein digestibility; and degradability of neutral detergent fibre and Acid detergent fibre. Results of the investigation demonstrated that *Acacia sieberiana*, *F. polita* and *F. sycomorus* can sustain sheep on a maintenance diet and could also be used as a supplementary feed during the dry season. Silvopastoral systems that incorporate native trees and shrubs are instrumental for the productive rehabilitation of cattle production and for biodiversity conservation in agricultural landscapes. Silvopastoral systems are a sustainable form of agroforestry for livestock production that combines fodder shrubs.

CONCLUSIONS AND RECOMMENDATIONS

Several studies revealed that fodder trees and shrubs play significant roles within the farming system. The potential of leguminous fodder trees can be seen in their multipurpose nature and their ease of integration into existing farming systems. Leguminous fodder trees can be used for the improvement of both crop and livestock production and thus offer a means of linking livestock production with arable crop production. They are therefore immensely suitable for the improvement of farming systems through soil fertility maintenance (for crop production) and increased availability of high-protein feed for livestock. Generally, the inclusion of leguminous trees in tropical land-use systems offers many advantages at minimum expense. The potentials of fodder trees and shrubs remain vital in the support of rural livelihoods and food security.

Since most works carried out on fodder production are successful in the humid and sub humid regions, fodder trees production should be concentrated in these areas and fodder should be preserved and transported to the major livestock zones in the semi-arid and arid areas. Simple conservation and preservation techniques are required for the operation of such a system and to ensure that quality of forage is maintained. The protection of trees, particularly browse trees, remains a major problem, especially in the dry areas. Governments should educate the local people on the dangers, both to livestock and to the environment, of over-exploitation, and initiate the organization of community-based efforts to improve and properly manage grazing reserves and rangelands.

There is also a need for collaborative efforts between the scientists and farmers. Biggelaar⁹ maintained that most of the work do not have to be done by researchers alone. Many farmers have indigenous knowledge of effective Tree + Livestock + Pasture schemes, which when combined with scientific research can increase the current knowledge on

agroforestry systems and also the general acceptability of the system by the farmers.

Future Research

A lot of work remains to be done in the area of trees and shrubs as browse species. One of the first requirements is a comprehensive list of browse species and their foliar physiology should receive more attention. It could be useful also to select lines of trees which keep their leaves longer than usual on the stem. More should be known on the management of browse species. This would make it possible to avoid the disappearance of some species by over-utilisation, as occurs with *Terminalia avicennioides* in the region of Maradi (Niger).

REFERENCES

1. Aganga, A. A. and Tswenyane, S. O., Feeding value and anti-nutritive factors of forage tree legumes. *Pakistan Journal of Nutrition* **2**: 170-177 (2003).
2. Alves, R. R. N., Barboza, R. R. D. and Souto, W. M. S., Plants used animal health care in South and Latin America. In: Katerere D. & Luseba D. (Eds). *Ethnoveterinary Botanical Medicine: Herbal Medicine for Animal Health*, Life Science Division, CRC Press, Boca Raton, USA (2010).
3. Aregheore, E. M. and Yahaya, M. S., Nutritive value of some browses as supplement for goats. *Malaysian Journal of Animal Science*, **7(1)**: 29-36 (2001).
4. Aregheore, E. M., Natural grassland and ruminant interactions in the dry season in Delta State, Nigeria. *World Review of animal Production*. **31(1-2)**: 74-79 (1996).
5. Babayemi, O. J., Bamikole, M. A., Supplementary value of *Tephrosia bracteolata*, *Leucaena leucocephala*, and *Gliricidia sepium* hay for West African Dwarf goats kept onRange. *Journal Central European Agriculture*, **7(2)**: 323-328 (2006).
6. Balogun, R. O. and Otchere, E. O., Effect of *Leucaena leucocephala* in the diet on feed intake, growth and feed efficiency of Yankasa rams. *Tropical Grasslands*, **29**: 150-154 (1995).
7. Bamikole, M. A., Ikhatua, U. J., Arigbede, O. M., Babayemi, O. J. and Etela, I., An evaluation of the acceptability as forage of some nutritive and antinutritive components and of the dry matter degradation profiles of five species of *Ficus*. *Tropical Animal Health and Production*, **36**: 157-167 (2004).
8. Bamikole, M. A., Babayemi, O. J., Arigbede, O. M. and Ikhatua, U. J., Nutritive value of *Ficus religiosa* in West African dwarf goats. *Animal Feed Science and Technology*, **105(1-4)**: 71-79 (2003).
9. Biggelaar, D. C., Farmer experimentation and innovation. A case study of knowledge generation process in Agroforestry systems in Rwanda. Community Forestry Case Study Series No. 12. FAO. Rome (1996).
10. Bizimenyera, S. E., Swan, G. E., Chikoto, H. and Eloff, J. N., Rationale for using *Peltophorum africanum* (Fabaceae) extracts in veterinary medicine. *Journal of South African Veterinary Association* **76**: 54-58 (2005).
11. Calub, B. M. and Lasco, R. D., Indigenous trees and shrubs as fodder in the drought-prone areas of Batangas. Proceedings of the 36th Annual Convention of the Philippine Society of Animal Science. Manila, Philippines; SAS (1999).
12. CBN (Central Bank of Nigeria). Annual report 1999. CBN, Lagos, Nigeria (2009).
13. Chepape, R. M., Mbatha, K. R. and Luseba, D., Local use and knowledge validation of fodder trees and shrubs browsed by livestock in Bushbuckridge area, South Africa. *Livestock Research for Rural Development*. **23(132)**: Retrieved August 31, 2012, from <http://www.lrrd.org/lrrd23/6/chep23132.htm> (2011).
14. Ogunbosoye, D. O. and Babayemi, O. J., Potential values of some non-leguminous browse plants as dry season feed for ruminants in Nigeria. *African Journal of Biotechnology* **9(18)**: pp. 2720-2726, 3 May, 2010 Available online at

- <http://www.academicjournals.org/AJB>
ISSN 1684–5315 (2010).
15. Elevitch, C. R. and Wilkinson, K. M., *Agroforestry Guides for Pacific Islands*. Permanent Agriculture Resources, P.O. Box 428, Holualoa, HI 96725 (2000).
 16. Eloff, J. N., Katerere, D. R. and McGaw, L. J., The biological activity and chemistry of the southern African Combretaceae. *Journal of Ethnopharmacology* **119(3)**: 686 (2008).
 17. Emmanuel, L. S. and Tsado, D. N., Forage and Fodder Crop Production in Nigeria: Problems and Prospects. *World J Life Sci. and Medical Research* **1(4)**: 88 (2011).
 18. Ezeagu, I. E., Metges, C. C., Proll, J., Petzke, K. and Akinsoyi-znu, A. O., Chemical composition and nutritive value of some wild-gathered tropical plant seeds. *Food and Nutrition Bulletin* **17(3)**: 104 (1996).
 19. FAO, Country Pasture/Forage Resource Profiles Nigeria, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy (2009).
 20. FAO, Agriculture: Towards 2010 Food and Agriculture Organization of the United Nations, Rome, Italy (1993).
 21. FAO, *Bulletin of Statistics*, **2(2)**: Rome, Italy (2001).
 22. Hassen, A., Ebro, A., Kurtu, M. and Treydte, A. C., Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. *Livestock Research for Rural Development*. **22(229)**: Retrieved September 10, 2012, from <http://www.lrrd.org/lrrd22/12/hass22229.htm> (2010).
 23. <http://www.fao.org/docrep/003/T0632E/T0632E04.htm> (access on 28/09/2012).
 24. [http://www.agricultureguide.org/fodder-plants-all-everything-you-want-to-need-know-a-featured-article/\(accessedon28/09/2012\)](http://www.agricultureguide.org/fodder-plants-all-everything-you-want-to-need-know-a-featured-article/(accessedon28/09/2012)).
 25. Sultan, J. I., Rahim, I. U., Nawaz, H., Yaqoob, M. And Javed, I., Nutritional evaluation of fodder tree leaves of Northern grasslands of Pakistan. *Pak. J. Bot.*, **40(6)**: 2503-2512, 2008 (2008).
 26. Katerere, D. R., Gray, A. I., Nash, R. J. and Waigh, R. D., Antimicrobial activity of pentacyclic triterpenes isolated from Africa Combretaceae. *Phytochemistry* **63**: 81-88 (2003).
 27. Kharb, S. and Singh, V., Nutraceuticals in health and disease prevention. *Indian Journal of Clinical Biochemistry*, **19(1)**: 50-53 (2004).
 28. Komwihangilo, D. M., Sendalo, D. S. C., Lekule, F. P., Mtenga, L. A. and Temu, V. K., Farmers' knowledge in the utilization of indigenous browse species for feeding of goats in semi arid central Tanzania. *Livestock Research for Rural Development* **13(6)**: (2001).
 29. Lukhele, M. S. and Van Ryssen, J. B. J., The chemical composition and potential nutritive value of the foliage of four subtropical tree species in Southern Africa for ruminants. *South African Journal of Animal Science* **33(2)**: 132-141 (2003).
 30. Luseba, D., Tshikudo, M. L., Chepape, R. M. and Tshisikhawe, P., Medicinal plant used in the treatment of livestock disease in Vhembe region, Limpopo province, South Africa. *Ethnobotany Research and Applications* (2011).
 31. Luseba, D. and Van der Merwe, D., Ethnoveterinary medicine practices among Tsonga speaking people of South Africa. *Onderstepoort Journal of Veterinary Research* **73**: 115- 122 (2006).
 32. Maphosa, V., Tshisikhawe, P., Thembo, K. and Masika, P., Ethnoveterinary medicine in Southern Africa. In: Katerere, D., & Luseba, D., (Eds). *Ethnoveterinary Botanical Medicine: Herbal Medicine for Animal Health*, Life Science Division, CRC Press, Boca Raton, USA (2010).
 33. Martin, N. D., Katerere, D. R. and Eloff, J. N., Biological activity of five antibacterial flavonoids from *Combretum erythrophyllum* (Combretaceae). *Journal of Ethnopharmacology* **92**: 207-212 (2001).
 34. Matlebyane, M. M., Ng'ambi, J. W. W. and Aregheore, E. M., Indigenous

- knowledge (IK) ranking of available browse and grass species and some shrubs used in medicinal and ethno-veterinary practices in ruminant livestock production in Limpopo province, South Africa. *Livestock Research for Rural Development* **22(3)**: (2010).
35. McGaw, L. J., Rabe, T., Sparg, S. G., Jager, A. K., Eloff, J. N. and Van Staden, J., An investigation on the biological activity of combretum species. *Journal of Ethnopharmacology* **75(1)**: 45-50 (2001).
36. McGaw, L. J., Van der Merwe, D. and Eloff, J. N., In vitro anthelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveterinary medicine. *The Veterinary Journal* **173**: 366-372 (2007).
37. Mokoboki, H. K., Ndlovu, L. R., Ng'ambi, J. W., Malatje, M. M. and Nikolova, R. V., Nutritive value of Acacia tree foliage growing in the Limpopo Province of SA. *South African Journal of Animal Science*, **35**: 221-228 (2005).
38. Moleele, N. M., Encroacher woody plant browse as feed for cattle. Cattle diet composition for three seasons at Olifants Drift, south-east Botswana. *Journal of Arid Environments* **40**: 255-268 (1998).
39. Onwuka, C. F. I., Taiwo, B. B. A. and Adu, I. F., Browse species and supplements utilized for small ruminant feeding in Ogun state of Nigeria. In: Stares, J. E. S., Said, A. N. and Kategile, J. A., (ed). *The complementarity of feed resources for animal production in Africa*. Proceedings of the Joint Feed Resources Networks Workshop held in Gaborone, Botswana, 4-8 March 1991. Africa Feeds Research Network. ILCA (International livestock Centre for Africa). Addis Ababa, Ethiopia. Pp 173-180 (1992).
40. Osemeobo, G. J., Natural Resources Management and in situ Plant Genetic Conservation in Nigerian Arid Zones International Plant Genetic Resources Institute Kenya, 144pp (2006).
41. Smith, T., Mlambo, V., Sikosana, J. L. N., Maphosa, V., Mueller-Harvey, I. and Owen, E., Dichrostachys cinerea and Acacia nilotica fruits as dry season feed supplements for goats in a semi-arid environment. *Animal Feed Science and Technology* **122**: 149- 157. <http://www.sciencedirect.com/science?> (2005).
42. Terefi, A., Solomon, M. and Lisanework, N., Management and utilization of browse species as livestock feed in semi-arid district of North Ethiopia. *Livestock Research for Rural Development*, 20 (2008).
43. Yahaya, M. S., Kibon, A., Aregheore, E. M., Abdulrazak, S. A., Takahashi, J. and Matsuoka, S., The evaluation of nutritive value of three tropical browse species for sheep using in vitro and in vivo digestibility. *Asian-Australasia Journal of Animal Science*, **1494**: 496- 500 (2001).
44. Van, D. T. T., Mui, N. T., Ledin, I., Tropical foliages: effect of presentation method and species on intake by goats. *Animal Feed Science and Technology*, **118**: 1-17 (2005).