Fodder trees and shrubs in range and farming systems in dry tropical Africa

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INTRODUCTION

Dry tropical Africa refers to about 38% of the continent and is characterized by an average annual rainfall of less than 600 mm. About 45% of the area is desert while the remainder constitutes the arid and semi-arid zones which are actually the portions capable of supporting plant, animal and human life. The regional distribution of this climatic zone is 9% in Central Africa, 34% in East Africa and 20% in Southern Africa (Le Houérou and Popov, 1981).

Fodder trees and shrubs constitute a vital component in livestock productivity in the arid and semi-arid zones where about 52% of the cattle, 57% of the sheep, 65% of the goats and 100% of the camels in tropical Africa are found (Von Kaufmann, 1986). They supply goats and camels with the bulk of their nutritive requirements and complement the diet of cattle and sheep with protein, vitamins and minerals in which bush straw is deficient during the dry season. Nutrition of game animals also greatly depends on them. To people, they serve useful purposes such as the provision of food, drugs, firewood and building materials.

Despite this importance, research and development efforts with regard to trees and shrubs have been minimal until the occurrence, in recent years, of prolonged droughts which adversely affected the fragile ecosystem of the area. Consequently, increased interest has been shown by policy makers and researchers in the maintenance, and even expansion of, tree populations and the evaluation of the role and potential of fodder trees and shrubs in grazing systems.

FODDER TREES AND SHRUBS IN RANGE AREAS

A tree or shrub is classified as fodder if it is browsed by animals.

Palatability depends upon a number of interacting factors linked to animals as well as environment. The animal factors include species, physiological status and previous experience with specific vegetation, while the environmental variables comprise botanical composition, plant structure, forage quality and grazing pressure. Trees and shrubs recognized as fodder vary from region to region and an exhaustive inventory of them is difficult to make.

Main fodder trees and shrubs

Table 1 lists 124 fodder trees and shrubs found in dry tropical Africa. The inventory was based on the extensive reviews and reports made by Edwards (1948), Baumer (1983), Dicko (1980), Dicko and Sayers (1988), Keya *et al.* (1991), Lamprey *et al.* (1980), Le Houérou (1980), McKay and Frandsen (1969) and Walker (1980).

TABLE 1. **List of main fodder trees and shrubs**

Mimosaceae:	*Albizia anthelmintica, Acacia albida (Faidherbia albida), A. benthamii, A. brevispica, A. erioloba, A. ehrenbergiana, A. karoo, A. laeta, A. mellifera, A. nilotica, A. nubica, A. raddiana, A. senegal, A. seyal, A. tortilis, Prosopis africana, Parkia biglobosa.*
Combretaceae:	*Anogeissus leiocarpus, A. schimperi, Combretum aculeatum, C. apiculatum, C. denhardtiorum, C. eleagnoides, C. exaltatum, C. fragans, C. ghazalense, C. glutinosum, C. micranthum, C. mossambicense, Guiera senegalensis, Terminalia holstii, T. ruspolii.*
Caesalpiniaceae:	*Afzelia africana, Bauhinia petersiana, B. reticulata, B. rufescens, Cassia sieberiana, C. tora, Colophospermum mopane, Cordeauxia edulis, Piliostigma reticulatum, P. thonningii, Tamarindus indica.*
Capparidaceae:	*Boscia albitrunca, B. angustifolia, B. salicifolia, B. senegalensis, Cadaba farinosa, C. glandulosa, Capparis decidua, C. tomentosa, Crateva adansonii, Maerua angolensis, M. crassifolia, M. parvifolia, M. tricophylla.*
Papilionaceae:	*Baphia massaiensis ssp obovata, Dalbergia melanoxylon, Indigofera garckeana, I. spinosa, Lonchocarpus capassa, Pterocarpus lucens, P. erinaceus, Rhychosia flavissima.*
Tiliaceae:	*Grewia bicolor, G. flava, G. flavescens, G. kakothamnos, G. tenax, G. villosa.*

TABLE 1. List of main fodder trees and shrubs (continued).

Acanthaceae:	*Barleria eranthmoides, B. proxima, Disperma kilimandscharica, Justicia Caeruleir, J. pinguor.*
Convolvulaceae:	*Ipomea hardwickii, I. eriocarpa, I. acanthocarpa, I. coccinasperma.*
Rubiaceae:	*Feretia apodanthera, Gardenia americana, G. spatulifolia, Mitragyna inermis.*
Anacardiaceae:	*Lannea stuhlmannii, Sclerocarya birrea, S. caffra.*
Labiatae:	*Leucas neufliziana, Hoslundia opposita, Plectranthus iginansus.*
Verbenaceae:	*Avicennia africana, Clerodendron myricoides, Premna viburnoides.*
Burseraceae:	*Commiphora africana, C. boiviniana.*
Euphorbiaceae:	*Acalypha fructicosa, Securinega virosa.*
Rhamnaceae:	*Ziziphus mauritiana, Z. mucronata.*
Simaroubaceae:	*Balanites aegyptiaca, B. maughamii.*
Amaranthaceae:	*Sericocomopsis hilderbrandtii.*
Annonaceae:	*Annona aremaria.*
Asclepiadaceae:	*Oxystelma bournouense.*
Bombaceae:	*Adansonia digitata.*
Boraginaceae:	*Heliotropium albohispidum.*
Cyperaceae:	*Croton dichogamus.*
Ebenaceae:	*Diospiros mespiliformis.*
Erythroxylaceae:	*Erythroxylum zambesiacum.*
Hypocratheaceae:	*Hypocrathea africana.*
Liliaceae:	*Asparagus spp.*
Loganiaceae:	*Strychnos innocua.*
Lythraceae:	*Hypocratea africana*
Lythraceae:	*Lawsonia inermis.*
Malvaceae:	*Hibiscus micranthus.*
Moraceae:	*Ficus gnaphalocarpa.*
Moringaceae:	*Moringa oleifera.*
Ochnaceae:	*Ochna stuhlmannii.*
Oleaceae:	*Ximenia americana.*
Plumbaginaceae:	*Plumbago zeylanica.*
Salvadoraceae:	*Salvadora persica.*
Sterculiaceae:	*Cola laurifolia.*
Ulmaceae:	*Celtis integrifolia.*
Umbelliferae:	*Steganotaenia araliacea.*

This list should certainly be longer, particularly if one considers the fact that severe forage scarcity in dry tropical Africa can make herbivores eat anything including pieces of paper and plastic material. Whyte's (1947) assertion that 75% of trees and shrubs in Africa are browsed to a greater or lesser extent by game and domestic animals is surely applicable to dry tropical Africa.

BROWSE PRODUCTION

Browse production is influenced by many environmental factors such as climatic, edaphic and topographic conditions and management background involving exploitation by animals, lopping and burning forested areas.

The foliage and fruit production of some fodder trees and shrubs in the Sahel is given in Table 2. Noticeable is the wide variation in the browse production of the different species, particularly in the proportion of fruit which represents 3 to 55% of the deciduous biomass.

Browse productivity (production per unit area) has been found to be linked to habitat and soil texture. For instance, in a study carried out by Cisse and Wilson (1984) at Niono in Mali, the number of *Pterocarpus lucens* trees found on clay, loamy-clay and sandy soils was 845, 100 and 94 per hectare, respectively. The corresponding foliage production was 3.5, 0.9 and 0.4 tons DM/ha. In the same zone, an open woodland with *Sclerocarya birrea* and *Guiera senegalensis* produced only 0.02 ton DM/ha.

Regarding the effect of management, pruning is found to ensure better browse production than lopping and for both, the operation should preferably be carried out during the cold dry season rather than during the hot period (Le Houérou, 1980). Excessive lopping in dry areas often results in the death of the trees. Fires have adverse effects on trees and shrubs in arid and semi-arid zones where low soil moisture balance prevails. In sandy soils, however, plants with deep root systems are less affected than those on shallow and heavy soils. Also, fires at the end of the dry season can be detrimental to trees and shrubs which have already flushed (Walker, 1980).

TABLE 2. **Foliage and fruit production per individual per year.**

Species	Country	Rainfall (mm)	Diameter (cm)	Leaves (g DM)	Fruit (g DM)
Acacia senegal	Senegal	250	15.9	3840	1340
Adansonia digitata	Senegal	250	140.0	22000	2400
Balanites aegyptiacum	Senegal	250	16.8	1850	1030
Commiphora africana	Senegal	250	16.5	290	80
Guiera senegalensis	Senegal	250	10.2	2850	-
Acacia laeta	Burkina Faso	440	15.0	2500	-
Acacia seyal	Burkina Faso	440	15.0	1700	-
Acacia tortilis	Burkina Faso	440	15.0	700	-
Balanites aegypticum	Burkina Faso	440	15.0	2500	-
Acacia albida	Mali	600	14.3	3100	-
Pterocarpus lucens	Mali	600	14.3	3980	-
Ziziphus mauritiana	Mali	600	14.3	3600	-

Adapted from Bille, 1980

NUTRITIVE VALUE

The main features of browse plants are their high crude protein (CP) and mineral contents. The concentration of CP in the leaves and fruit of the majority of fodder trees and shrubs is above 10% even in the dry season when it tends to decrease. Generally, calcium and potassium contents are higher than those of other minerals. The role of trees and shrubs in the supply of vitamins is indirectly demonstrated in dry tropical Africa by the fact that browsers such as goats and camels seldom contract photophobia or eye inflammation which many cattle are prone to during the dry season.

The dry matter digestibility, which is related to nutrient composition, varies widely among tree and shrub species. A range from 38 to 78% was given by Skarpe and Bergstrom (1986) working in Botswana with Kalahari woody species. Similar findings were reported by McKay and Frandsen (1969) and Walker (1980). However, digestibility alone gives a poor assessment of the nutritive value of fodder trees and shrubs. This is because there is often no relationship between digestibility and intake.

Low intake and digestibility of browse may have some connection with the deleterious substances that it may contain. For instance, some browse species reported in Table 1, such as *Acacia albida, A. tortilis, A. erioloba* and *Ximenia americana*, contain substances such as cyanogenic glucosides, fluoroacetate or tannins which may considerably reduce their nutritive value or even be toxic to animal. However, toxicity depends upon the concentration of the deleterious compound in the fodder and the rate at which the forage is eaten. "An amount of the plant eaten quickly, say in one hour, could be fatal, whereas the same amount of plant material eaten slowly over, for example, a five hour period, would be harmless" (Storrs, 1982). On the range, the chances of animals getting poisoned are remote because they actually eat a combination of species and browse slowly, particularly when the plant is armed with defensive structures such as hairs and thorns.

For most of the fodder trees and shrubs identified in dry tropical Africa, knowledge of browse production and chemical composition is still lacking. Overcoming this constraint would ensure maximization of the use of this fodder by livestock.

FODDER TREES AND SHRUBS IN FARMING SYSTEMS

Exploitation of fodder trees and shrubs on rangelands

In addition to the exploitation *in situ* by domestic ruminants, rangeland fodder trees and shrubs are used for marketing purposes. They are also invaluable as consumable goods, drugs. Additionally, they are considered as embodiments of supernatural power.

In the Sahelian zone of West Africa, selling fodder is quite lucrative, as shown by the study of Dicko and Sangare (1981) (Table 3).

Table 3 indicates the predominance of browse in terms of types of fodder presented (4 out of 7) as well as quantity (522 out of 674 tons DM). The highest weight (458 tons) was recorded for *Pterocarpus lucens*. If one assumes a leaf off-take of 0.2 tons DM per hectare from woodlands of *Pterocarpus lucens* whose productivity ranges from 0.4-3.5t DM/ha, one arrives at exploited areas totalling about 23 Km^2.

TABLE 3. **Estimated quantities (in tons DM) and values (in US dollars)* of browse and crop residues presented for sale at Niono market, Mali, 1981.**

Fodder from	Quantity		Value	
	tons	%	US dollars	%
Pterocarpus lucens[a]	458	67.9	10734	36.7
Pterocarpus erinaceus[a]	4.5	0.7	292	1.0
Mixture of *Ipomea* spp.[a,b]	51.6	7.6	3033	10.4
Hypocrathea + *Oxystelma*[a,c]	8.1	1.2	238	0.8
Ischaemum rugosum	94.2	14.0	3157	10.8
Arachis hypogea	17.2	2.6	3936	13.4
Vigna unguiculata	40.0	6.0	7883	26.9

* 1 US dollar = 500 Mali franc in 1981

[a] leaves of shrubs and trees

[b] mixture of *Ipomoea eriocarpa, I. acanthocarpa* and *I. coccinosperma*

[c] mixture of *Hypocrathea africana* and *Oxystelma bourbouense*

Source: Dicko and Sangare, 1981

The results also demonstrate that to farmers, browse leaves are not as valuable as the hay from cropped legumes. The browses were 8 to 10 times cheaper than the hays of groundnut (*Arachis hypogea*) and cowpea (*Vigna unguiculata*). However, despite this low cost, the leaves of shrubs and trees had an estimated value of 14,297 US dollars (Table 3).

Assuming that about 20 farmers were involved in the transactions[1] and that three quarters of the browse presented was sold, the average cash income per fodder trader would be about 45 US dollars per month. This is 50% more than the monthly salary of a casual worker in the zone. In dry West Africa, selling fodders is a specialized activity in its own right. The trade flourishes mainly during the 2 to 3 months preceeding the Muslim celebration of "Tabaski".

INTRODUCTION OF TREES AND SHRUBS IN FARMING SYSTEMS

Traditional agroforestry system

Agroforestry is a long-standing practice among certain groups in Africa (Boudet and Toutain, 1980). Trees and shrubs are protected or grown on-farm primarily because they provide shade and edible leaves, fruit and seeds. They are also used for marking farm boundaries, controlling erosion, improving and stabilizing soils. Farmers therefore have policies regarding bush clearing. Their strategy considers the needs of both crop and livestock production, as testified by the words of an old couple from Zimbabwe talking about clearing Acacia woodlands: "It is a good idea to cut tall muvunga (*Acacia* sp), because the ground will be shaded and there will be no grass and the tree will be too tall for the goats to eat. We should cut some old ones and leave the young ones. It is also best to cut those trees that do not produce pods" (Scoones, 1988). In West Africa, bush clearing policies advocate keeping reasonable tree densities in order to reduce crop damage which may be caused by birds using trees for perching.

A traditional agroforestry system based on *Acacia albida* is found throughout the semi-arid zones. *Acacia albida* is a leguminous tree which enriches the soil, particularly with nitrogen and calcium. It also has the advantage of providing shade and valuable browse during the dry season. Jung (quoted by Charreau and Nicou, 1971) reported annual production of 97 and 125 kg of leaves and pods respectively from a tree

[1] The actual number is lower than that. There are a limited number of people specializing in the marketing of fodders.

which had a crown surface of 230m².

In the semi-arid highlands of Ethiopia, *Acacia albida* was integrated on farmers' fields at a rate of 20 trees per hectare. Economic analysis of this intervention arrived at an additional income of 230 US dollars per hectare from cereal grain, stover, fodder and fuel wood (CTA, 1991).

Another traditional agroforestry system, especially in Niger and Sudan, is the one incorporating *Acacia senegal* in crop rotation (Boudet and Toutain, 1980). In addition to browse, this species also produces gum which brings important income.

Modern agroforestry systems

The expression "modern" is used here to qualify the agroforestry recently introduced in farming systems by government services, alone or in conjunction with non governmental or international organizations. The actual development of the discipline occurred after the prolonged droughts of the early 70's which resulted in manifest desertification particularly in the Sahel.

In the projects[2] that were created in agricultural zones, erosion control and wood production were the primary objectives (Kerkhof, 1990). Pastoral zones were given little consideration as regards woodland management, probably because of the transhumant and nomadic style of life of pastoralists.

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[2] Agroforestry projects in operation.
Projects in agricultural zones:
- Burkina 1 = village woodlands project in Burkina (rainfall 400-1000 mm).
- Burkina 2 = Burkina Faso agroforestry project (rainfall 400-600 mm).
- Kenya 2 = East Pokot agricultural project (rainfall 600 mm).
- Mali 1 = Village woodlot project in Mali (rainfall 600 mm).
- Mali 2 = Koro village agroforestry project (rainfall 300-600 mm).
- Niger 1 = Majjia valley wind break project (rainfall 400-600mm).
- Niger 2 = Guesselbodi forest land use project (rainfall 500 mm).

Projects in pastoral zones:
- Kenya 1 = Turkana rural development project (rainfall 180-400 mm).
- Senegal 1 = project on reforestation round wells in N. Senegal (rainfall 300-400 mm).

To realize the set objectives, the projects used indigenous and exotic trees which mostly have potential for fodder production as well. These trees are:

- *Acacia albida*: Mali 2, Senegal 1
- *Acacia nilotica*: Kenya 1, Niger 1
- *Acacia raddiana*: Mali 2
- *Acacia senegal*: Senegal 1
- *Acacia tortilis*: Kenya 1
- *Azadirachta indica**: Burkina 1, Burkina 2, Kenya 1, Kenya 2, Mali 1, Mali 2, Niger 1.
- *Atriplex nummilaria**: Kenya 2
- *Balanites aegyptiaca*: Kenya 1, Kenya 2, Niger 2.
- *Dobera glabra*: Kenya 1
- *Salvadora persica*: Kenya 1
- *Tamarindus indica*: Kenya 1
- Various *Acacia, Combretum* and *Bauhinia* species: Niger 2
- Various *Prosopis**: Kenya 1, Kenya 2, Mali 2.
- *Ziziphus mauritiana*: Kenya 1, Kenya 2.

(* introduced species)

The technical packages involved the use of seedlings and also direct seeding, the latter having limited success mainly with indigenous species. *Acacia* were often planted in rows with spacing varying from 5 x 5m to 10 x 20 m (Senegal 1), but a dispersed intercropping which is preferred by farmers was also tried out. The design for windbreaks in Niger 1 and Mali 2 consisted of double rows of trees (4 x 4 m spacing) over 2 km. The trees were planted perpendicularly to the prevaling wind direction. Microcatchments were used with success in Burkina 2, Kenya 1 and 2, Mali 2 and Niger 2. However the high cost of their establishment is a drawback to their extension. Mulching consisting of leaving branches and other organic materials improved natural regeneration in Niger 2 (Kerkhof, 1990).

After 8 to 15 years of operation, modern agroforestry has had little impact on farming systems. One of the major reasons is the top-down

approach at the initial stage of most of the projects, with objectives which often do not match farmers' needs. For instance, woodland projects for producing building poles and fuel-wood rarely succeed in zones where people live in clay-brick houses and believe that firewood has to come from rangelands. Another reason is the difficulty of growing trees in harsh conditions of arid and semi-arid zones. The slow growth rate, poor survival rate and high labour input for protecting seedlings do not foster enthusiasm for adopting tree planting on a medium or large scale. Poor adoption is also due to the communal land tenure system and acquisition of land on a loan basis. In neither of the systems, do users consider themselves as owners and hence they are not willing to spend money on the land, particularly when the trees have a life span of about 30 years. Another important reason is that tree crops come into economic production after 6 to 7 years, while poor-resource farmers (who are in the majority) are interested in interventions which give profit within a year.

Fortunately, many projects have drawn lessons from past experience and now match intervention packages to farmers' needs and circumstances.

In addition to the indigenous fodder trees and shrubs used in modern agroforestry, the following species are interesting for further introduction: *Boscia senegalensis, Bauhinia rufescens, Cadaba glandulosa, Combretum aculeatum, Grewia bicolor* and *Pterocarpus lucens*.

At research level, tests of some Australian *Acacia*'s have also been carried out in many countries of dry tropical Africa (including Burkina Faso, Mali, Mauritania, Niger and Senegal) (Cossalter, 1986). *Acacia holosericea, A. trachycarpa* and *A. tumida* were found to have high fodder potential and to be adapted to a variety of soils. Their main drawback is sensitivity to prolonged droughts. According to Cossalter (*loc. cit.*) other interesting fodder species for further investigations are: *Acacia stenophylla, A. ampliceps, A. maconochiena* and *A. pachycarpa*.

CONCLUSION AND RECOMMENDATIONS

Dry tropical Africa is endowed with indigenous fodder tree and shrub species which are an important feed source for livestock in the area. Unfortunately, details of browse production and nutritive value are still lacking for most of the species identified.

Over the years, woody plants have increasingly become subjected to intense exploitation pressure aggravated by prolonged droughts, thus posing a serious threat to the ecosystem of the area. This resulted in the initiation of Agroforestry projects involving indigenous and exotic species. However, the impact of these projects on farming systems has been limited by ecological, social and cultural factors.

Tests have shown that there is potential for introducing into the area fodder tree species from other regions of the world such as Australia.

For optimum utilisation of fodder trees and shrubs, it is essential that details of browse production, palatability and nutritive value of the prominent species are measured. Knowledge of deleterious substances in the various fodders is equally important.

To safeguard sustainability and protect the fragile ecosystem of dry tropical Africa, there is a need to develop appropriate range management packages for the region.

Due to the potential of fodder trees and shrubs from other regions of the world, it is recommended that deliberate efforts be made to expand the adapted species, while continue to test new ones. However, this expansion should considers farmers' needs and circumstances.

Bibliography

Baumer, M. 1983. *Notes on trees and shrubs in arid and semi-arid regions*. EMASAR, Phase II. FAO, Rome, Italy.

Bille, J.C. 1980. Measuring the primary palatable production of browse plants. In: *Browse in Africa, the current state of knowledge*. H.N. Le Houérou (ed.), ILCA, Addis Ababa, Ethiopia.

Boudet, G.C. and Toutain, B. 1980. The integration of browse plants within pastoral and agropastoral systems in Africa. In: *Browse in Africa, the current state of knowledge*. H. N. Le Houérou (ed.), ILCA, Addis Ababa, Ethiopia.

CTA. 1991. Integration of trees and livestock in tropical Agriculture. *Spore*, 32.

Charreau, G. and Nicou, R. 1971. L'amélioration du profil cultural dans les sols sableux et sablo-argileux de la zone tropicale sèche ouest-africaine et ses incidences agronomiques. *Agronomie tropicale* 26: 566-625.

Cisse, M.I. and Wilson, R.T. 1984. Status and use of *Pterocarpus lucens* Lepr. in Sahelian eco-systems. Paper presented at *Savanna Symposium*, 28-31 Mai 1984, Brisbane, Australia.

Cossalter, C. 1986. Introducing Australian *Acacias* in dry, tropical Africa. In: *Australian Acacias in developing countries*. Proceedings of an international workshop held at the Forestry Training Centre, Gympie, Queensland, Australia, 4-7 August, 1986.

Dicko, M.S. 1980. *Digestibilité in vivo de quelques résidus de culture et de fourrages ligneux en zone sahélienne*. Rapport interne ILCA-Mali.

Dicko, M.S. and Sangare, M. 1981. *Les aliments du bétail vendus sur le marché de Niono*. Rapport interne, CIPEA-Mali/ILCA, Addis Ababa.

Dicko, M.S. and Sayers, R. 1988. *Recherches sur le système agropastoral de production de la zone semi-aride du Niger: étude de la composante animale*. CIPEA-Niger/ILCA, Addis Ababa. 140pp.

Edwards, L.C. 1948. Some notes on the food of goats in a semi-arid area. *The East African Agricultural Journal* 13(4).

Kerkhof, P. 1990. *Agroforestry in Africa: a survey of project experience.* Panos Publications Ltd. London, UK. 216pp.

Keya, G.A., Woie, B.M. and Cheruiyot, H.K. 1991. Utilization of rangeland resources by the camels in the arid zones of Kenya. *4th International Rangeland Congress.* Montpellier, 22-26 April 1991, France. 18pp.

Lamprey, H.F., Herlocker, D.J. and Field, C.R. 1980. Report on the state of knowledge on browse in East Africa in 1980. In: *Browse in Africa, the current state of knowledge.* H.N. Le Houérou (ed.), ILCA, Addis Ababa, Ethiopia.

Le Houérou, H.N. 1980. Role of browse in the sahelian and sudanian zones. In: *Browse in Africa, the current state of knowledge.* H.N. Le Houérou (ed.), ILCA, Addis Ababa, Ethiopia.

Le Houérou, H.N. and Popov, G.F. 1981. *An eco-climatic classification of intertropical Africa.* Plant production and protection paper No. 31. FAO, Rome.

McKay, A.D. and Frandsen, P.E. 1969. Chemical and floristic components of the diet of zebu cattle (Bos indicus) in browse and grass range pastures in a semi-arid upland area of Kenya : I. Crude protein. *Tropical Agriculture* 46(4).

Scoones, I. 1988. *Community management of indigenous woodland project.* ENDA-Zimbabwe.

Skarpe, C. and Bergstrom, R. 1986. Nutrient content and digestibility of forage plants in relation to plant phenology and rainfall in the Kalahari, Botswana. *Journal of Arid Environments* 11: 147-164.

Storrs, A.E.G. 1982. *More about trees.* Forest Department Ndola, Zambia. 126pp.

Von Kaufmann, R. 1986. An introduction to the sub-humid zone of West Africa and the ILCA sub-humid zone programme. In: *Livestock systems research in Nigeria's sub-humid zone.* Proceedings of the second ILCA/NAPRI symposium held in Kaduna, Nigeria, 29 Oct. - 2 Nov. 1984. ILCA, Addis Ababa, Ethiopia.

Walker, B. H. 1980. A review of browse and its role in livestock production in Southern Africa. In: *Browse in Africa, the current state of knowledge.* H.N. Le Houérou (ed.), ILCA, Addis Ababa, Ethiopia.

Whyte, R.D. 1947. *The use and misuse of shrubs and trees as fodder.* Commonwealth Agricultural Bureau, Publication No. 10.