FEED RESOURCES FOR GOATS: RECENT ADVANCES IN AVAILABILITY AND UTILISATION IN AFRICA

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Paper 2

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ABSTRACT

Available feed resources for ruminants in general, and goats in particular were reviewed, and identified to include natural grasses and rangelands, cultivated pastures, crop residues,by-products and browse. Factors affecting not only the quantities but also the quality of these resources were discussed, and include regional and agro-ecological differences, goat breed and production systems.

Although the vegetation in natural pastures and rangelands play a major role in the nutrition and feeding system of goats, seasonal fluctuation in both quantity and quality limit its ability to meet their requirements for acceptable levels of production,hence the need to broaden the feed resource base and to enhance utilisation.

Strategies suggested to achieve these include feed complementarity and the exploitation of inherent attributes of the goat. A number of feeding systems based on such strategies was suggested, and the future role of research in further expanding the feed resource base and enhancing its utilisation was stressed.

1. INTRODUCTION

The availability, quality,and cost of feeds have been identified as the major constraints to acceptable livestock productivity across the various regions(northern, southern, western, eastern and centra),and agro-ecological zones of Africa(Devendra, 1986;Ademosun et al 1988). Thus, in the humid zone of central, western and eastern Africa, where rainfall is high(>1500mm), herbaceous forages grow luxuriously, providing the much needed nutrients in near adequate amounts for livestock, but only for a short period, because early maturity is the norm in this ecozone.

The process of early maturity leads to a rapid change in the stem to leaf ratio, in favour of the less nutritive stems. Feed constraints are therefore mainly qualitative, and could be alleviated by judicious supplementation. In the arid and sahelian zones of northern and western Africa where rainfall is low(<600mm) and soils poorer, both qualitative and quantitative feed constraints act in concert, calling for a different feeding stategy.Regional and ecological differences in the availability and utilisation of feed resources by goats in Africa will be highlighted in this review. More importantly,recent advances in the development of feeding strategies with the potential to improve feed utilisation and goat productivity will be presented.

2. LIVESTOCK RESOURCES AND PRODUCTION SYSTEMS

Goats are the focus of this paper. Livestock population figures presented, will therefore be limited to ruminants with emphasis on the contribution of goats to African livestock resources and products. Ecozones and regionally based population figures presented in Tables 1 and 2 respectively, show that about 65% of the goat population is concentrated in the arid and semi-arid zones, where qualitative and quantitative feed constraints are most acute. This is a testimony of the ability of the goat to adapt to a variety of ecological conditions and management systems.

The most important goat producing areas are the eastern and western regions. In both regions as in others, goats form an integral part of the small scale farming systems producing meat, milk, manure, fuel and fertiliser, at levels that require improvement. Thus, while 31% of world goat population was located in Africa in 1989, Africa's share of chevron and goat milk production the same year were 26.7 and 23.9% respectively.

An important component of any production system is the utilisation of appropriate and adapted goat breeds. The literature abounds with unsuccessful livestock production projects attributable to the utilisation of inappropriate breeds. Shkolnick et al., (1980) described the desert Bedouin goat as being more suitable for the transhumant production system compared to several other breeds. The former can apparently withstand water deprivation for long periods, and digest low quality roughages better. More significantly, it can ingest large amounts of water when available, without adverse effects on the rumen functions. The exploitation of suitable, well adapted breeds within specific production systems is important, if feed resources associated with the production systems are to be optimally utilised.

2.1 ***Goat Production systems.*** Goats are managed under a variety of production systems ranging from the complex to the relatively simple. Five major types found in Africa as summarised in Table 3, which additionally shows the predominant ecosystems, the major objective and major source of feed of the systems. According to Johnson and Van Eys (1987) and Morand-Fehr (1988), the major objective of the extensive management system is not to maximise livestock productivity, but to optimally exploit the rangeland and pastures vegetation. In other words, management of rangeland to reduce excessive animal pressure and minimise degradation must feature prominently in strategies designed to improve rangeland utilisation. Devendra (1986), suggested a stocking rate of 1 to 4 goats/Ha.

Resource inputs including labour requirement for both the semi intensive and intensive systems increase in consonance with the main objective of optimising productivity. Both systems rely on natural or cultivated pastures grazed, or cut and carried. Stocking rates of 16-60 goats/Ha. are apparently feasible, depending on the types and quality of forage(Devendra,1986),as well as the ecological zone. The feed base - pastures - is subject to seasonal vagaries as well as management know-how. Improvement strategies must therefore focus on forage management as well as appropriate supplementation with crop residues or concentrates.

All of the factors discussed above - production systems, agro-ecological zones and breeds - acting alone or in concert , have significant effects on feed availabilty, and or, utilisation, and must be considered when designing strategies to improve feed utilisation.

3. FEED RESOURCES AND UTILISATION

The variety of feeds available across the major ecological zones and production systems can be classified as: ***natural grasses and rangelands, cultivated pastures, crop residues and by-products and browse.***

3.1 Natural grasses and rangelands. In the humid and sub-humid zones, natural pastures comprise a variety of grasses and broad leafed plants which except for a high moisture content are good nutritive materials at least for a short period during the growing season. According to Onim et al.,(1986), the crude protein contents of common weeds and grasses eaten by small ruminants in western Kenya were 23.6 and 16.3% respectively.

In this high rainfall area, rapid forage growth is accompanied by lignification which leads to a decline in nutritional quality that accentuates as the dry non growing season progresses.Goats grazing such a material are therefore not likely to meet their requirements for acceptable growth.Ademosun et al.,(1988) confirmed the suggestion that unless well fertilised and harvested young, these grasses would not supply required nutrients for a reasonable production level.

Natural pastures in the semi-arid zone comprise a grass-tree complex typical of a savannah type vegetation. Thairu and Tessema(1985) identified 14 grass species, 5 broad leafed weeds and 4 shrub species in a recent survey of the Katamani area of Kenya. They reported a forage biomass yield of 2.3 tons/Ha under controlled conditions, but noted that yields may be 25 to 50% lower under common grazing conditions. A striking feature of their findings was a seasonal variation in crude protein content of the vegetation, which ranged from 10.9 % early in the rains to 4.4% at the peak of the dry season.

Palatable perennial grasses are scarse in the natural ecosystem of the arid Mediterranean zone of north Africa and west African sahel, which are dominated by shrubs. Browse therefore constitute an important component of arid rangelands, making up 40% of livestock feeds(Le Houérou,1980). According to Morand-Fehr(1988), rangeland vegetation of the arid Mediterranean is no better than poor quality hay with about 600 to 900 kcalNE/KgDM. This energy value could however be doubled, by reducing stocking rate by one third(Rouaissi and Majdoub,1987).

The major points highlighted above are low and seasonal fluctuation in grasses and rangelands productivity, seasonally variable nutritive value, agravated by poor management techniques such as overgrazing. Several strategies have been suggested to improve the utilisation of this major feed resource.

Abou Akkada(1989) proposed a five-point strategy for the improvement of rangelands: rain water harvesting and distribution, provision of water points, feed and range reserve establishment, establishment of livestock cooperatives and range revegetation programmes. While some of these solutions may be difficult to effect, it is clear that improved rangelands and pastures utilisation depends essentially on good grazing management and control such as rotational grazing, temporary closures and proper stocking rates. Such controls and appropriate management techniques are, however, difficult to apply under the present communal land tenure systems in many of countries.

Other measures which would be equally effective in both the more humid and dry areas include: the introduction of more productive pastures, fodder conservation during periods of surplusses for use during critical periods of shortages, and supplementation with crop residues, by-products and even concentrates, where economically justifiable. Morand-Fehr(1988), however, cautioned that supplementation could have adverse effects on the intake of the basal feed, reducing it to such a point as to increase the overall cost of the diet. It should therefore be used judiciously, restricted in quantity, and duration, and targeted to goats whose capacity enables them to accomodate the supplements.

3.2 Cultivated pastures/fodder. Natural pastures which are mainly grasses in the humid amd sub-humid zones, but interspersed with badly managed shrubs and trees in the arid and semi-arid zones, are nutritionally inadequate for a greater part of the year. The period of nutritional adequacy is usually directly related to the length of the dry season. One of the corrective strategies suggested is the cultivation of leguminous and non-leguminous pastures and fodder plants. These pastures show promise of providing better quality feed and in larger amounts (Table 4), to meet the nutritional requirements of the animals. Leguminous pastures have the added advantage of restoring soil fertility depleted by intense cropping or grazing.

Although the history of research on planted improved pastures is fairly old in Africa, the adoption and utilisation of the technology has been slow and rather unsuccessful for a number of reasons: lack of management expertise, lack of labour which is usually concentrated on cropping, the practice of communal grazing and insecure land tenure, rampant annual bush burning and uneconomic returns.

Nevertheless, research continues to look for solutions to some the pertinent questions : appropriate type of plant for the various ecological zones, effect of management input on the yield and quality of such plants, the economics of the system, and transfer of the technology. The solutions found todate, extension efforts and adoption rates, vary according to ecological zone and countries.

In east and southern Africa, Napier grass(Pennisetum purpureum), Guatemala grass, Setaria(Setaria splendida) and lablab(Lablab purpureus), have been found suitable and are been used by smallholder farmers. In Kenya, Napier grass is extensively cultivated and used by all categories of farmers.In the humid and sub-humid zones of west Africa, several species of grasses and legumes have been tested, and Onifade and Agishi(1990) gave a long list of suitable and recommended species. Adoption has,however, been limited to a few leguminous browses such as Leucaena, Gliricidia and Cajanus cajan, probably because of ease of maintenance. Successful reports of adoption and use of gliricidia by smallholder.goat farmers have been published (Ademosun et al., 1988). In general, however, one could conclude that planted pastures and fodder play a limited role as a feed resource for goats in Africa, and where adopted extensively (Kenya), has been targeted towards dairy cattle.

3.3 CROP RESIDUES AND BY-PRODUCTS

An important component of the farming system in Africa is the cultivation of various food crops(cereals, grain legumes,roots and tubers,fruits...) and tree crops(cocoa, oil palm, rubber....). These crops generate residues after harvest and primary on-farm processing, and/or by-products after secondary processing elsewhere. Smith(1989) made a distinction between residues and by-products. The former, are usually fibrous, low in nitogen and widely spread geographically, because they are produced on-farm(wheat and barley straws) or at homesteads(cassava peels,maize cobs), and are more suitable as basal feeds. The latter, on the other hand, could be rich in nitrogen(oilseed cakes, brewery and flour milling by-products)low(rice mill feed) or high in fibre(sugar cane bagasse,palm press fibre), and to a large extent,are more suitable as supplements.A list of major residues and by-products is shown on Table 5.

Quantitative and qualitative studies have been carried out on these feed resources in several parts of Africa, and in general the evidence is that large amounts are available for ruminant feeding. Sansoucy and Emery(1982) suggested that if all available residues were fed to livestock, each livestock unit would receive up to 3kg dry matter daily. Poor nutritional value has often been cited as the major reason for a much lower level of utilisation.

Many of the crop residues are highly fibrous, low in fermentable carbohydrates and nitrogen(Table 6), and therefore can not maintain an efficient rumen ecosystem. It has been suggested that the characteristics of a maintenance diet for adult ruminants are: a crude protein level of 6-7%, a dry matter intake of about 1.7% of body weight, and a dry matter digestibility of 50-55% (Devendra, 1985). Many crop residues rarely meet these requirements, and may require upgrading through physical, chemical or even biological means to improve their value and usefullness. Such treatments may, however, be unsuitable for the majority of goat owners who are small scale and subsistent producers.

Nevertheless, advantage could, and should be taken of the legendary selective ability and high digestive capabilities of the goat, as well as certain characteristics of the residues to evolve a viable and productive feeding system.

On the basis of simple parameters such as crude protein and fibre contents and in situ degradability, crop residues could be classified into potential supplements (to be fed with poor quality forages) and potential basal feeds(to be supplemented with better quality materials such as browse). Table 7 shows such a classification for some crop residues in the forest belt of humid west Africa.

The selective ability of the goat should also be exploited by increasing the amount of basal residue offered from the usual ad libitum refusal rate of 10-20% to a higher level. Owen et al (1989) reported that barley straw dry matter and digestible dry matter intake by goats increased by 47 and 78% respectively, simply by increasing the amount of feed offered to allow a 50% refusal rate.

The application of such basic nutrition principles should lead to the formulation of a number of practical feeding strategies that will maximise the utilisation of available feed resources. The choice must be guided by season, number of animals to be fed, available resources and ecological zone. A non exhaustive list of feasible feeding systems for goats in the humid zone of West Africa is presented in Table 8.

3.4 Browse The vegetation of arid range land is dominated by browse, in form of shrubs, bushes and sub-shrubs(van

Duivenbooden,1989), and they form an integral part of the farming system in the humid zone, particularly of west Africa(Atta-Krah et al 1986). They therefore merit a special interest,particularly as evidence exist that goats relish browse(Devendra,1986),and probably utilise them more efficiently. In terms of utilisation, browse currently play an important , albeit non-strategic role in goat nutrition, as animals under confinement in the humid zone often receive one type or the other of browse, from fallow lands or around the homestead,forming up to 25% of their diet.

In the arid and semi-arid zones, browse constitute the main feed resource during the extended dry periods of the year(Le Houérou,1980) and play a similar role in the sub-humid savannah zone,to the extent that Stuth and Kamau (1990) suggested that when contemplating bush removal in the savannah zone(for tse-tse control), consideration should be given to the role trees and shrubs could play in stabilising protein intake of goats. They concluded that tree cutting is particularly detrimental to the nutritional ecology of goats.

The nutritional value of several browse species and the complimentary role they could play in pasture or crop residue based diets have been well documented(Reynolds, 1989; Smith et al.,1989). They are therefore assumimg an important role in the nutrition of goats, and a number of viable feeding systems built around this feed resource are currently being developed and refined.

4. RECENT ADVANCES IN THE DEVELOPMENT OF FEEDING SYSTEMS

Most notable advances in recent years have been in the area of the development of feeding systems built around the use of browse. As indicated earlier, browse consitute the main feed resource during the extended dry periods of the year in the semi-arid zones, Even in the humid and sub-humid zones, goats are often fed browse from fallow lands with occasional supplemntation with kitchen wastes. Weight losses varying from mild to severe are the results of this feeding regime. Efforts are currently being made, however, to develop this model - browse only - into a viable feeding system, through appropriate management of cultivated browse species for year round production on the one hand, and judicious mixtures of different browse on the other hand.

Ademosun et al.,(1988) compared several diets in which Gliricidia was fed alone, or as basal feed, supplemented with varying levels of Leucaena. These diets were compared to a concentrate based control diet, on which goats grew at a rate of 60g/day considered optimal for West African Dwarf Goats. The browse only diets provided enough digestible organic matter not only for maitenance, which Zemmelinck et al.,(1984) estimated at 26g/kg of metabolic weight, but also for a reasonable growth rate ranging from 39 to 60% of the optimum. This feeding system therefore appears feasible. Although Leucaena constituted 50% of the diet at the highest level

of supplementation, no symptoms of toxicity were observed during the more than 6 month long trial. Similar trials need to be carried out to with local browses currently being used by farmers, to work out optimum combinations.

The nutritional value of browse has also been exploited in feeding systems using them as supplements to low quality tropical forages and crop residues. In general, many of the common browse species contain high levels of protein and energy in the range of 14 to 26% and 11 to 14 MJ of ME/kg of dry matter respectively. In addition, they are fairly well digested, 50 to 65% of organic matter digestibility, and contain reasonable levels of both macro and trace minerals required for efficient rumen function.

Recent studies have shown that when fed as supplements to cereal straws at the optimum dietary level of 30 to 50% of ration dry matter, browse have consistently increased total dry mattter intake, feed digestibilty and animal performance as summarised in table 9. A more detailed result of one specific study in Tanzania is shown in table 10.

Browse are also being used as protein banks, particularly in humid tropical Africa. Umder this system, suitable browse are planted as tree only plots,or tree-grass combinations. In the former, leguminous browse such as Leucaena or Gliricidia are planted in rows with 0.5m interrow spacing, while in the latter, they are spaced 4 or 2.5 m apart, with 4 or 2 rows of grass respcetively in in the alleys.

With yields of 30t dry matter/ha (Atta-Krah and Reynolds,1989), and a protein content of 22%, Leucaena only plots supply over 6.5t of high quality proteins for supplementary feeding. When targeted to the smallholder farmer with only 0,1ha of land and 3 to 4 goats, the tree only protein bank provides sufficient browse to meet about 12.5% of the daily dry matter requirement of the animals.(Atta-Krah and Reynolds,1989).

5. FUTURE DIRECTIONS

A number of issues need to be addressed more systematically and in depth, in order to increase available feed resources and improve their utilisation by goats. These include:

a. *Fodder conservation* Fodder conservation technologies need to be developed to ensure a year round good quality feed supply. A large part of fairly good quality herbaceous, tree and shrub fodder as well as crop residues available during the crop growing season is often left unutilised and allowed to deteriorate during this period of abundance. These feeds should be preserved either as hay or silage for dry season feeding. Some interesting work along this line and targeted towards smallholders is going on in Kenya. Onim et al.,(1988) described a simple grass and legume hay making

technique that was described as effective and accepted by smallholder farmers.

More recently, Otieno et al.,(1990) demonstrated the technical feasibility of ensiling maize stover, sugarcane tops, sorghum stover and bana grass (Pennisetum purpureum x Pennisetum typhoides) with or without molasses in gunny bags. These bags, normally used for industrial packaging of sugar, salt etc. are readily available in the market, and cost about 0.25$ each. The technique is flexible enough to allow farmers ensile small quantities of material as and when available, and to feed equally small amounts without much wastage.The workers reported that the technique improved feed availability and monthly distribution year round.

b. *Expansion of feed resource base* The full range of potential feed resources available for goat feeding are yet to be fully tapped. Aquatic plants, which in some areas (river banks of sahel zones) constitute a major feed resource, fall into this category. A number of studies have shown that they could constitute viable feed resources. El-Serafy et al.,(1984) reported high digestibility values in goats fed water hyacinth (Eichornia crassipes) as hay or when ensiled with other feeds such as maize stalks rice straw and molasses. Similar results were reported by Adebowale(1988) who fed the Bourgu plant (Echinochloa stagnina) to goats and reported that the plant could maintain the animals year round. Harvesting and feeding systems that could maximise the value of such plants need to be developed.

Other research issues that need to be addressed in order to meet the objectives of increasing the feed resource base and develop efficient year round feeding systems are: management of grasslands, identification of suitable pasture species for various ecozones, and the development of tree crop-grazing systems.

In attacking these problems, it is suggested that researchers should take into account the socio-economic and environmental context of the target population (i.e. farmers), as well as their main goals, objectives and aspirations, so that solutions suggested,and technologies developed are relevant and readily adopted.

5. CONCLUSIONS

The foregoing discussion has highlighted the fact that vegetation in natural pastures/rangelands play, and will continue to play an important role in the nutrition and feeding systems of goats in Africa. This feed resource, as indicated earlier, is subjected to quantitative and qualitative seasonal fluctuations, that limit its capacity to cover livestock requirements. Indeed, feed budgets in Africa always show a deficit on the supply side. Thus, according to Abou Akkada(1989) only 48% of energy requirements of livestock in

Libya,Tunisia,Algeria,Morocco and Mauritania is covered by available pasture vegetation. In other words, other feed resources must be utilised to ensure acceptable production levels.

A number of potential feeds were discussed, and suggestions made as to how to how to exploit certain attributes and feed preferences of goats to maximise their utilisation. In this respect, emphasis was laid on the utilisation of browse and generous offers of the more fibrous materials to take advantage of their selective ability. Research has a big role to play in increasing available feed resources and their utilisation by goats. Some of the pressing issues that need attention have been highlighted.

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TABLE 1. RUMINANT LIVESTOCK POPULATION IN AFRICA BY ECOLOGICAL ZONE (Jahnke, 1982)

ECOLOGICAL ZONE	GOATS (10^6)	GOATS % OF TOTAL	SHEEP (10^6)	CATTLE (10^6)
ARID	48.3	38.5	37.1	31.5
SEMI-ARID	33.2	26.5	23.1	45.5
SUB-HUMID	20.3	16.2	14.2	32.8
HUMID	11.6	9.3	8.2	8.8
HIGHLANDS	11.9	9.5	21.4	29.0

TABLE 2. RUMINANT LIVESTOCK POPULATION IN AFRICA (Oau/Ibar,1989)

REGION	GOATS (10^6)	GOATS % OF TOTAL	SHEEP (10^6)	CATTLE (10^6)
EASTERN	72.5	45.1	68.6	87.2
WESTERN	53.1	33.0	38.9	41.2
NORTHERN	12.6	7.8	43.7	7.0
SOUTHERN	11.3	7.0	35.2	28.1
CENTRAL	11.3	7.0	5.4	23.1

TABLE 3. GOAT PRODUCTION SYSTEMS IN AFRICA (Adapted from Devendra, 1986)

SYSTEM	PREDOMINANT ECOZONE	SYSTEM MAIN OBJECTIVE	MAJOR FEED SOURCE
Extensive/pastoral	Arid/Sahel	Rangeland and pastures Exploitation	Rangeland/ pastures
Subsistent village based/agro-pastoral	Humid, sub-humid, semi-arid	Maintenance plus minimum growth	Fallow and road side vegetation kitchen wastes, crop residues
Tree-crop-small ruminants Integration/Agricultural	Humid Sub-humid	Medium level Productivity	Pastures, crop residues
Semi-intensive/pastoral	Sub-humid, humid	Medium level Productivity	Pastures, crop residues By-products
Intensive small-holder/ Agropastoral/periurban	Humid, sub-humid, semi-arid	High level productivity	Cut and carry pastures crop residues, concentrates

TABLE 4. YIELD AND PROTEIN CONTENT OF SELECTION PASTURES
(Munthali and Dzowela, 1985; Onifade and Agishi, 1990)

TYPE OF FORAGE	DRY MATTER PRODUCTION (T/Ha/Annum)	CRUDE PROTEIN CONTENT (%)
NATURAL GRASSLAND		
-Dryland pasture	1.1	2.0 - 11.0
-"Dambo"grass	3.2	3.2 - 6.0
IMPROVED CULTIVATED PASTURES		
-Guinea grass	8.0 - 14.0	4.0 - 14.0
-Rodes grass	7.0 - 12.0	4.2 - 13.8
-Napier grass	21.9	
-Stylosantes	3.6	13.6 - 19.4
-Siratro	9.7	12.1 - 19.4
-Leucaena		13.6 - 19.4

TABLE 5. SOME MAJOR CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS IN HUMID WEST AFRICA

CROP	RESIDUE	BY-PRODUCT
Maize	Stover Cob	Bran
Rice	Straw	Bran Husks Rice mill feed
Sorghum	Stover	Bran
Wheat	Straw	Bran, offals
Barley	Straw	Spent grains
Groundnut	Haulms Husks	Groundnut cake
Cowpea	Vines	-
Cocoa	Pod	-
Coconut	Husk	Copra cake
Oil palm/date palm	Empty fruit bunch Palm oil mill effluent	Palm press fibre Palm kernel cake
Rubber	-	Rubber seed meal
Banana/Plantain	Leaves Pseudo stems Peels and rejects	-
Sugar cane	Tops	Molasses Bagasse
Cassava	Leaves Peels and rejects	-
Sweet potatoes	Vines and peels	-
Pineapple and citrus fruits	Rejects	Pulps

TABLE 6. NUTRIENT CONTENT OF SELECTED CROP RESIDUES (% OF DM)

RESIDUE	CRUDE PROTEIN	CELL WALL	CELL CONTENT
Maize	2 - 8	70 - 80	25
Sorghum stover	3 - 6	70 - 75	26
Rice straw	2- 9	60 - 80	20
Sugar cane tops	5 - 8	65 - 75	30
Cocoa pods	2 - 9	75 - 80	20

TABLE 7. NUTRITIONAL ROLE OF COMMON CROP RESIDUES IN HUMID WEST AFRICA

CROP RESIDUE CLASSIFICATION	CRITERIA OF CLASSIFICATION (% DM)			
	CRUDE FIBRE	ACID-DETERGENT FIBRE	CRUDE PROTEIN	IN SITU DEGRADABILITY (% DM)
A. BASAL FEEDS				
Rice straw	20 - 45	45 - 55	2 - 9	30 - 34
Cocoa pods	20 - 45	55 - 59	6 - 8	38 - 40
Sugar cane tops	28 - 34	43	5 - 8	10 - 20
Sorghum cane tops	31 - 35	45 - 50	3 - 6	25 - 30
Corn stover	28 - 46	46 - 50	2 - 8	50 - 65
B. SUPPLEMENTS				
Cassava peels	10 - 22	15 - 18	3 - 7	70 - 75
Yam peels	5 - 8	10 - 12	5 - 8	75 - 80
Sweet potato peels	-	15 - 18	6 - 10	80 - 90
Cowpea husk	40 - 45	38 - 40	6 - 10	70 - 75
Maize bran	-	8 - 10	15 - 20	75 - 80

TABLE 8. SUGGESTED FEEDING SYSTEMS FOR SMALL GOATS IN HUMID WEST FOR AFRICA

FEEDING SYSTEM	TARGET BELT	SEASON
A. FORAGE BASED		
Forage + browse	Forest, Savanna	Wet
Forage+browse+crop residue	Forest, Savanna	Wet
Forage+Highly fermentable Crop residues	Forest, Savanna	Wet
B. BROWSE BASED		
Browse alone	Forest, Savanna	Dry
Browse+fermentable crop residues	Forest, Savanna	Dry
CROP RESIDUE BASED		
Fibrous crop residues+browse	Forest, savanna	Dry
Fibrous+fermentable crop residues	Forest, Savanna	Dry
D. NOVEL SYSTEMS		
Under tree crop grazing+ supplement	Forest	Wet
Alley farm foliage+crop residue	Forest	Dry
Foder banks	Savanna	Dry

TABLE 9. RESPONSE TO BROWSE SUPPLEMENTATION OF FIBROUS FORAGES AND CROP RESIDUES

BASAL FEED	BROWSE SUPPLEMEMENT	RESPONSE	REFERENCE
Guinea grasshay	Gliricidia (20g/kg mw)	- Doubling effect on digestible dry matter intake	Ademosun et al., 1988
	Leucaena (30g/kg mw)	- 66% increase in digestibale dry matter intake	
Guinea grass plus cassava peels	Gliricidia : leucaena (1 : 1)	- 45% increase in growth rate of offspring of nourished dams from birth to weaning	Reynolds and Adediran 1988
Guinea grass	Sesbania (100g/day)	26% increase in dry matter intake and 23% increase in nitrogen digestibility	Ash 1990
Maize stover	Leucaena (30g/day)	135% increase in dry matter intake, and 164% increase in digestible dry intake	Banda and Aysade 1985