AVAILABILITY AND FEEDING QUALITY CHARACTERISTICS OF ON-FARM PRODUCED FEED RESOURCES IN THE TRADITIONAL SMALL-HOLDER SECTOR IN ZAMBIA

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Abstract

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More than 85% of ruminants in Zambia are found in the traditional smallholder sector and their production is limited by inadequate nutrition during the dry-season. This is because these animals depend on fibrous crop-residues and natural pasture which are usually in short supply and of low nutritive value. Inadequate nutrition in the dry season often results in reduced productive and reproductive performance of livestock which culminate in substantial economic losses to the farmers. The approach to improved nutrition of smallholder owned animals in the dry-season may be through increased utilisation of on-farm feed resources. The first approach would be to teach farmers to conserve wet-season fodder for dry-season supplementation of animals. The next step would be to improve the feeding quality of available fodder. This may be done through treatment of crop residues with urea or poultry manure and supplementation of animals with urea/molasses blocks. The quality of dry-season feed materials may also be enhanced through intercropping of cereals with fodder legumes or establishment of fodder gardens. Farmers must also be taught new methods for improving their natural grazing areas through establishment of fodder legumes, selected thinning of browse species, introduction of rotational grazing and reduction of animal stocking rates. These strategies may be successfully implemented after changes to communal ownership of land are made where the farmers are given title to their land.

1. INTRODUCTION

Zambia is endowed with a ruminant population of approximately 2.6 million cattle, 580 000 goats and 65 000 sheep [1]. More than 85% of these animals are in the traditional smallholder sector. Despite the apparently high concentration of ruminant animals in rural areas, there is still a potential to increase livestock production in the traditional smallholder sector. Unfortunately, current government efforts to improve the productivity of animals in this sector are being hampered by a number of constraints, of which inadequate nutrition has been documented as the most important [2]. This is because ruminant animals in the smallholder sector of Zambia are maintained with minimum inputs, and dependent on natural pastures and crop residues for the greater part of the year. In the dry-season, the available pastures and crop-residues are usually in short supply and often poor, and are characterised by low concentrations of energy, protein and other nutrients (minerals and vitamins), which are required to maximise rumen microbial activity [3]. Feeds available in the dry season also have a high content of dietary fibre ranging from 35 to 48%, which has a limiting effect on intake and digestibility of feeds [4]. Associated with dietary fibre are the anti-nutritive factors such as lignin and silica, which are known to inhibit microbial fermentation in the rumen [5].

Inadequate nutrition in the dry-season usually results in reduced body weight and condition scores in adult animals, poor milk yields and long calving intervals in nursing cows, retarded growth and increased mortality rates in calves. Also associated with poor nutrition is the increased susceptibility of animals to stress and disease challenges, which result in these

animals performing below their expected genetic potential [6]. All these factors result in heavy economic losses to the farmer. To improve the productive and reproductive capacity of smallholder-owned ruminant animals, there is a need to develop feeding strategies that will enhance the quality and sustained availability of feed resources produced on-farm.

The objective of this presentation is to give an outline of farm produced feeds that have a potential to be used as dry-season supplements for smallholder ruminant animals in Zambia. An attempt will also be made to point out some of the strategies that may be used to enhance quality and extend availability of feed materials so that they can be used to improve productivity of smallholder ruminant animals in the dry season.

2. CURRENT AGRICULTURAL SITUATION IN ZAMBIA

Zambia has a total land area of about 75.26 million ha of which only 5.27 million ha are currently being utilised for arable and permanent crops [1]. This leaves more than 69 million ha for other activities including tourism and development of ruminant grazing areas. Thus, there is still a lot of potential for increasing ruminant productivity in rural areas, as most of the land is undeveloped. In terms of water availability, Zambia has reserves of ground and surface water compared to other countries within Southern Africa. Thus, most potentially available grazing areas will have access to water.

The potential for increasing animal production may be deduced from the profile of Zambia's population. The majority of Zambian people depend on agriculture for their subsistence (Table I), emphasising the importance of agriculture to this country's economy. It is saddening, however, to note that the agricultural sector which employs more than 70% of the economically active people (Table I) only contributes between 11 and 16% to the country's gross domestic product (GDP). This may be explained by the fact that the agricultural sector in Zambia only uses about 20% of the country's potential arable land and that most small-scale farmers only produce enough for their own consumption, with very little, if anything, left for sale. This again demonstrates that the key to improving the country's economy is by increasing the productivity of small-scale farmers in rural areas. This is a challenge to all working in the agricultural sector and also to the government as a policy making body. The livestock sector already contributes more than 35% of the total agricultural output in the country, but the smallholder contribution should be increased.

TABLE I. DISTRIBUTION OF THE ZAMBIAN POPULATION (MILLIONS) IN RECENT YEARS

	General Population		Economically Active Population		
Year	Total	Agriculture	Total	Agriculture	% of Total
1990	7.2	5.4	2.9	2.2	75
1995	8.1	5.8	3.4	2.4	72
1997	8.5	6.0	3.6	2.5	71

Generated from [1].

3. MAJOR FEED RESOURCES FOR RUMINANT ANIMALS IN ZAMBIA

3.1. Natural Pastures

In Zambia, as in many other parts of sub-Saharan Africa, natural pastures or veld form the basis of ruminant production in terms of nutrition. Natural pastures include annual and perennial species of grasses, forbes and trees [7]. The type and quality of natural pastures found in a given area will depend on local ecological and climatic conditions. Notable among the natural grazing areas of Zambia are the Kafue and Zambezi flood plains of Southern and Western provinces, respectively, which have capacity to support large herds of cattle even in the dry season [8]. Generally, natural pastures are able to support animal productivity in the rainy season without any problems. However, in the dry season these pastures can hardly maintain the animals as most of the feed resources at this time of the year are of very low nutritive quality. This is because the quality of natural pastures, particularly grass species tend to vary with the season (Table II).

TABLE II. NUTRITIONAL QUALITY CHARACTERISTICS (%) OF THE NATURAL VELD AS INFLUENCED BY SEASONAL CLIMATIC CHANGES

Season	Dry Matter	Protein [1] (% DM)	Fibre (% DM)	TDN[2]	Energy[3]
Nov.–Jan.	24.8	8.0	32.6	54	980
Feb.–Apr.	38.7	4.2	38.0	49	865
May–Jun.	51.2	2.1	44.0	26.3	464
Aug.–Sept.	73.3	1.5	47.6	20.0	351

[1]Digestible Crude Protein, [2]Total Digestible Nutrients, [3] in Kcal/kg.

At the beginning of the rainy season, the young succulent grasses have a very high concentration of essential nutrients and have the capacity to support animal growth. But as the rainy season advances, there is a drastic reduction in the content of proteins and other nutrients which is also accompanied with a rapid increase in fibre content. As the quality of natural pastures deteriorates, animals are forced to eat more, in an effort to meet their nutritional requirements. Normally, intake at this time of the year is limited by the rumen capacity of the animal. Levels of vitamins and minerals, which are high at the beginning of the rainy season, are almost non-existent towards the end of the dry season. This again tends to limit animal performance and unless the animals are adequately supplemented they can not perform as may be expected. Other problems, which may be associated with natural pastures as a source of feed for ruminant animals, include:

- Seasonal and low productivity of natural grasslands which may be influenced by prevailing soil conditions. The quality of natural pastures is also influenced by the absence of legume species in communal grasslands. This tends to limit the nutritional quality of available fodder and the animals are thus, unable to meet their protein, energy and mineral requirements.
- In rural areas there are no sustainable range management techniques for smallholder farmers to use in order to improve their communal grazing areas. As a result most of the natural pastures are over grazed and at times degraded due to uncontrolled grazing.

- The communal land tenure system which is practiced in most rural areas, hampers the development or maintenance of communal grazing areas. This has often resulted in over-use of grazing areas resulting in all the problems outlined above. There is also no control of animal numbers, as all the villagers want to compete for available pasture in the communal grazing areas.
- Communal grazing and lack of fencing have also made it impossible for villagers to practice rotational grazing in natural pastures to allow for the regrowth and regeneration of preferred fodder species. This has often resulted in the disappearance of some species, particularly legumes, from these areas.
- Since there is often no supplementation of minerals in the smallholder sector, the mineral content of natural pastures depends on soil fertility. Animals may be adversely affected unless efforts are made to correct these deficiencies.

3.2. Crop Residues

In addition to natural pastures, crop-residues are another major source of feed for ruminant animals in the dry season. Crop-residues are materials generated after the crop has been harvested [4]. Thus, the value of crop-residues produced in a particular area will depend on the amount and type of crops grown in that area. Smallholder farmers usually practice mixed agriculture and, therefore, have crop-residues. Maize is the most important crop grown in Zambia (Table III) and accounts for more than 60% of the total crop-residues produced in the smallholder sector [9]. However, not all the crop-residues produced in the country are used for animal feeding. After harvest, the majority of residues are considered as a nuisance and are simply burnt to clear the fields for the next cropping season. Some of the residues are ploughed under as a way of recycling nutrients into the soil while some are simply left to rot in the fields. Where crop-residues are used for feeding animals, most are grazed *in situ,* often with a lot of wastage from trampling and soiling with animal manure and urine [10].

TABLE III. THE AMOUNT AND TYPE OF MAJOR CROPS CULTIVATED AND PRODUCED ('000 METRIC TONS) IN ZAMBIA TOGETHER WITH THE AMOUNT OF CROP RESIDUES ('000 METRIC TONS) GENERATED FROM EACH CROP

Crop	Cultivated Area ('000 ha)	Amount produced ('000 m tonnes)	Residues generated* ('000 m tonnes)
Cereals and Tubers			
Maize	600	963	1926
Sorghum	45	31	62
Millets	80	61	61
Wheat	18	60	60
Rice	12	13	13
Cassava	106	540	1080
Sugar Cane	13	1420	2840
Legumes and Pulses			
Legumes	30	13	13
Soy Beans	76	29	29
Ground nuts	100	50	50
Cotton seed	66	35	22
Sunflower	48	8	16

Generated from [1]
* Amount calculated from crop yields according to ratios reported by Devendra [3]

The major constraint to using crop-residues as a feed resource, is their high fibre content (Table IV), which tends to limit intake and digestibility in animals. Crop-residues are also associated with low protein and mineral contents, which cannot support adequate microbial growth or meet the host animal's nutrient requirement for increased performance. It should be noted that there are ways for enhancing the feeding value of crop-residues, although most of the techniques developed to date have not yet been adopted in the traditional smallholder sector. Technologies available include the treatment of crop residues with alkaline chemicals such as sodium and ammonium hydroxides. Even though chemical treatment has proved beneficial in increasing the intake and digestibility of residues, its applicability in rural areas is limited due to the cost and availability of these chemicals. There is also the danger of toxicity. The most promising techniques are urea treatment of crop residues or the use of urea/molasses mineral blocks.

Another reason for restricted use of crop-residues in the smallholder sector is the lack of storage facilities for residues for use in the dry season. There is also a lack of knowledge in the traditional sector on methods of improved utilization of crop residues. There is also a shortage of labour for handling and storage of crop-residues on the farm. The distribution of crop-residue production does not often correspond with animal distribution, thereby causing a short fall in some areas and a surplus in others (Table V). Due to their high bulk density, transportation of these materials to needy areas may not be economical.

TABLE IV. NUTRIENT COMPOSITION (%) OF CROP-RESIDUES FROM VARIOUS PLANTS PRODUCED IN ZAMBIA

Residues	Dry Matter	Protein	Fibre	DCP[1]	TDN[2]	Energy[3]
Maize stover	90.6	4.9	35.8	2.3	45	827
Millet straw	88.9	3.7	37.1	0.3	44	1091
Rice straw	91.5	3.8	32.1	1.2	37	639
Sorghum stover	85.1	4.5	27.7	1.5	48	865
Ground nut straw	90.5	10.8	28.0	7.6	60	1053
Beans straw	86.0	4.0	42.8	1.4	40	715
Cassava leaves	90.4	1.2	3.5	0.5	75	2670

[1]Digestible Crude Protein, [2]Total Digestible Nutrients and [3] in Kcal/kg.
Modified from Chimwano [11].

TABLE V. DISTRIBUTION OF RUMINANT LIVESTOCK ('000) AND CROP-RESIDUES ('000 METRIC TONNES) IN DIFFERENT PROVINCES OF ZAMBIA

Province	Cattle	Sheep	Goats	Crop-residues
Central	363	3	195	613
Copperbelt	57	3	6	94
Eastern	251	6	125	670
Luapula	11	8	19	25
Lusaka	75	1	16	138
Northern	11	10	15	202
NorthWestern	5	10	10	34
Southern	1100	11	224	574
Western	500	----	4	73

Adopted from Aregheore [9].

3.3. Agro-Industrial by-products

The agro-industrial by-products are derived from the processing of a crop or animal product, usually by an industrial concern. Included in this category are materials such as molasses, bagasse, oilseed cakes, maize milling products, citrus pulp, and animal by-products including meat and bone meal, fish meal and others. These materials are usually of very high nutritive value and often expensive for the traditional smallholder farmers. The main limitation to increased use of such materials in rural areas is that they are usually produced in urban or peri-urban industrial areas. Thus, if these products are to be utilised by smallholder farmers, they have to be transported back to rural areas. These products are also in high demand by the commercial farmers, who are mostly located in peri-urban areas, thus having an advantage over small-scale farmers, not only in terms of purchasing power but also in transport costs. Due to the nature of these by-products, they often require special transportation and storage facilities (e.g. molasses). It should be noted that, there has been an increase in on-farm processing of agricultural products in recent years. The most notable among these is the processing of oilseeds into cooking oil using the Yenga Press Machine. There is usually a considerable amount of oilseed cake resulting from such processing, which can be used as a source of protein for ruminants. On-farming maize milling has also increased dramatically in recent years and all the by-products including bran and a number of meals can be used as supplements for ruminant animals. Home brewing is another widespread practice in the traditional smallholder sector and by-products of this activity are very high in nutrient content and can be used to supplement animals in the dry season.

3.4. Non-Conventional Feed Resources

Grouped in this category are resources not normally considered as feed by traditional smallholder farmers and yet have potential to be utilised as feed for ruminants. There is no clear demarcation between these materials and the ones outlined above apart from the very fact that these have not yet been accepted as feeds by the majority of smallholder farmers. Included in this category are poultry manure, waste products of animal processing, such as offals from fish or monogastric animals, and feather meal. Most of these have a very high nutrient composition and can be used as a major source of protein, energy and/or minerals [12]. It is important to note that using these materials as feed does not only contribute nutrients and off set feed costs, but also utilises waste materials as these materials are usually considered as a potential environmental hazard. Consumer and cultural considerations may prevent the use of some of the materials available to farmers. To prevent the spread of animal diseases, all animal waste products meant for use as feed must be heat processed before feeding and this can be done by direct sun drying or fermentation in ammonia-silo pits. Fermentation has advantages in that it will de-activate some of the veterinary drug residues and also destroy all pathogenic organisms that may be present in the manure. Fermentation will also eliminate odours, which are often associated with unprocessed manure. Current studies at the Livestock and Pest Research Centre on the use of ammoniated crop-residues with poultry manure have shown that animals respond with better weight gains and condition scores than when fed fertilizer grade urea treated stovers or when supplemented with urea/molasses mineral blocks (Table VI; [13]).

Multi-purpose fodder trees may also be included in this category of non-conventional feed resources as they are not yet widely accepted as a feed resource for ruminant animals in Zambia. More information on their use is needed. Fodder legumes have a very high protein content which can be used to meet both microbial requirements for increased fermentation of the basal diet and amino acids for the host animal [14]. Fodder legumes have advantages over other feed resources in that they are available on the farm and can also be used for other purposes such as fire wood, food, medicines and construction or fencing materials [5].

TABLE VI. WEIGHT GAIN (WG) AND BODY CONDITION SCORE (BCS) OF COWS, HEIFERS AND STEERS ON STOVER SUPPLEMENTED WITH UREA-MOLASSES MULTI-NUTRIENT BLOCKS (UMMB) AND STOVER AMMONIATED WITH POULTRY MANURE OR UREA

	Control		UMMB		Stover ammoniated with urea		Stover ammoniated with poultry litter	
	WG (g)	BCS	WG (g)	BCS	WG (g)	BCS	WG (g)	BCS
Cows								
April	320	5.8	269	5.5	291	5.3	297	5.3
November	244	4.8	224	5.0	230	4.9	250	5.3
Heifers								
April	230	6.0	134	6.0	135	5.5	156	5.8
November	192	5.1	142	5.8	143	5.6	158	5.6
Steers								
April	182	5.8	167	5.3	190	5.8	143	5.5
November	155	5.0	174	5.4	178	5.1	151	5.8

4. STRATEGIES FOR INCREASED UTILIZATION OF FEED RESOURCES PRODUCED ON-FARM

- In order to improve utilisation of natural pastures in rural areas, there is a need to train farmers to embark on fodder conservation techniques so that excess herbage production in the wet season is made available in the dry season.
- Farmers must be encouraged to collect and stack all crop residues after the grain harvest instead of allowing animals to graze them *in situ*. The conserved residues should be used as animal fodder during the latter part of the dry season when there is virtually nothing for animals apart from browse. This will also minimise the problem of trampling and soiling of residues with manure. Farmers need instruction in methods of improving the feeding value of crop residues.
- There is also a need to integrate the production of crops with that of animals. Intercropping of cereal crops with food legumes will not only help in improving soil fertility, but also the quality and quantity of crop residues generated after crop harvest. Intercropping of legumes with cereals will also have the advantage of producing high quality protein foods (often used as vegetables) for the resource poor rural communities.
- Farmers need encouragement to start establishing fodder gardens or legumes, so that they can either graze their animals directly or use the cut and carry system to feed their animals. These may be established in open fallow lands or lands which have not been utilised in the past. Permanent fodder sites may also be established on contour lines or farm boundaries, where they also contribute in controlling soil erosion and protecting arable crops from animals. The fodder legumes established in this manner can be used to provide a valuable feed resource when most needed in the dry season.
- There is a need to introduce rotational grazing in communal grazing areas which will assist in reducing pressure on preferred grass and tree species, thereby reducing the effects of overgrazing and the ultimate effects of water and wind erosion. This may be done through changes to the present land tenure system where individual farmers would be given title to their land, which they can then choose to use more effectively. Improved grazing systems may also be done through chiefs or community participation, where a particular community may come up with a programme, meeting the government's objectives, to maintain or improve their communal grazing areas. Another alternative is for the farmers to start improving their grazing areas through planting of legume species in the natural pastures. This will assist in improving the productivity and quality of feed materials from these pastures.

- Farmers should be encouraged to select suitable stock for production and to match animal numbers to the feed resources, particularly remembering the shortages that will occur in the dry season. The economic benefit of this practice to the farmer will be the sale of excess animals at the end of the rainy season when they are still in good shape and are likely to fetch a better price on the market. The sale of animals at this time of the year will also provide the farmer with cash to purchase feed supplements for his remaining animals.

The other strategy which may be used in rural areas would be through thinning of non-fodder trees and replacing them with browse species. Selected thinning of trees has often resulted in an increase in grass yields.

5. CONCLUSION

Poor nutrition is considered as the main factor limiting animal production in the traditional smallholder sector. The most important sources of feed for smallholder ruminant animals are the natural pastures and the fibrous crop residues. These materials are of low nutritive value in the dry season and do not have the capacity to meet the nutritional requirements of livestock at this time of the year. In order to improve the productive capacity of smallholder animals in the dry season, there is a need to embark on fodder conservation techniques which should not only allow for year-round availability of feed resources but also improve the quality of feedstuffs available to the farmer. A number of technologies have been developed and tried on-station which need to be evaluated on-farm so that they may be adopted by smallholder farmers. In addition to increased processing of crop-residues, the farmers should be trained to improve natural pastures through rotational grazing, planting of legume species, thinning of non-browse species and reducing stocking rates in their communal grazing areas.

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