FEED RESOURCES FOR SUSTAINABLE RUMINANT LIVESTOCK PRODUCTION IN SOUTHERN AFRICA

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ABSTRACT The availability of feed resources for ruminant livestock production in Southern Africa, and how these can be strategically managed and improved for long term economically and environmentally sustainable ruminant animal production, is reviewed. Ruminant livestock production in Southern Africa can be broadly divided into (a) intensive and (b) extensive production systems. Classification of production systems is influenced by the land tenure system and by the level of livestock husbandry and management practices. Within systems, the level of livestock nutrition is a fundamental determinant of productivity. The level of animal nutrition is directly and indirectly influenced by socio-economic and managerial abilities of the farmer and more importantly by pedological, vegetational and environmental factors of the location. The stability and reliability of the livestock nutrition base, which predominantly is the natural pasture, has direct and indirect implications on animal production in Southern Africa.

Key Words: Ruminant production; Feed resources; Southern Africa.

INTRODUCTION

The countries of Southern Africa covered in this paper are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Republic of South Africa, Swaziland, Zambia and Zimbabwe. The total area of Southern Africa is 5,205,663 km^2 (Kapit, 1991). The major ruminant livestock species of Southern Africa are cattle, sheep and goats. Livestock production in Southern Africa can be divided into two sectors (a) communal and (b) commercial livestock production.

Throughout Southern Africa, the communal livestock production is practiced under communal ownership of the grazing land (Lawry et al., 1984; Ndlovu, 1990; Kadzere, 1996) and is predominantly smallholder farming. Conversely, the commercial livestock production is practiced exclusively under private ownership of the grazing land. These constitute the so-called commercial farms and ranches. Ranching in Southern Africa is mainly concentrated in the Republic of South Africa, Zimbabwe, Zambia, and Namibia, with smaller scale ranches found in the other Southern Africa countries. It is evident that throughout Southern Africa the private and communal ownership of land has given rise to different livestock production and management systems.

Whereas agro-ecological zones influence the level of animal husbandry on commercial private properties, livestock production on communal land appears to be less influenced by these zones. Irrespective of the system of land tenure livestock production in Southern Africa depends directly on the utilisation of the natural pasture, as this constitutes the main feed resource base. Exceptions to this are a few specialized, zero-grazing, high technology intensive dairy cattle production enterprises and intensive beef cattle feedlots. Within the privately owned properties, the main determinant between intensive and extensive production systems is the availability, preparation, and utilisation of animal feed resources (Barnes, 1978; Kadzere, 1996).

In intensive livestock production systems, for example, zero grazing dairy systems, feedlots, and station performance testing schemes, feed is grown, harvested and brought to the animal. The farmer controls the quality and quantity of food consumed by his livestock. Often the animals are fed in accordance with their derived level of production. Such systems necessarily record animal feed intake and production (milk, growth, gestation stadium). Extensive ruminant livestock production systems, on the other hand are characterised by the absolute lack of regulation by the farmer of the animal's feed intake. Under private land ownership with extensive livestock production, the Livestock Unit (LU) is allocated to land which is supposed to maintain the animals for a certain period. The LU estimates a standard liveweight of an animal, and this standard may vary from country to country, but usually falls within the limits of 300 to 600 kg live mass. In Southern Africa, the LU denotes an animal live mass of 500 kg. To be able to convert all livestock species to a common unit, the FAO (1974) have used the following conversion factors which have been broadly accepted internationally for general use: the factor 1.1 for camel, factor 1.0 for the buffalo, horse and mule, factor 0.8 for cattle and donkey, factor 0.1 for sheep and goats and factor 0.2 for pigs. To convert x number of animals to LUs, one multiplies the number of animals by the conversion factor. Further, within a species of livestock, similar factors can be used to convert the average liveweight of all age classes of animals to the common LU (Table 1).

The number of LUs that a land area can carry is expressed as the carrying capacity of that land (e.g. one LU to fifteen hectares). The carrying capacity of the land is a theoretical figure that takes into consideration the agro-ecological zone, the climatic and the vegetational production potential of the area, the expected feed intake, and expected production level of the animal. In these systems the animal is virtually always range-borne except when rounded up for husbandry practices such as counting, weighing, dehorning, castrating, dosing, eartagging, vaccinating, dipping, branding *inter alia*. In communal areas, the animals are

Table 1. Conversion factors to calculate LU equivalents for various age classes of cattle.

Class of Cattle	LU Equivalent	
	Males	Females
Calves	0.25	0.25
Weaners and Yearlings	0.34	0.34
2–2.50 years old	0.80	0.75
2.50–3.25 years old	1.00	1.00
3.25–+4 years old	1.00	1.00

Source: Hunting Technical Services (1974) using Baggara cattle in Sudan.

gathered and kraaled near the homestead every night and during the day are let out to graze, accompanied by herd boys in the growing season so as to keep the animals away from the crops in the fields.

Obviously, the availability of feed, and feed resource management, is central in the livestock production systems of Southern Africa. This paper explores the ruminant livestock feed resources for sustainable animal production.

RUMINANT LIVESTOCK FEED RESOURCES IN SOUTHERN AFRICA

I. Natural Pasture/Veld

The quantitative and qualitative nutritive values of natural pastures, or veld, to the grazing ruminant in Southern Africa is predetermined by the prevailing climatic and soil conditions which give rise to the vegetation cover (Okigbo, 1984). Southern African vegetation cover starts with coastal grasslands on the eastern coast of South Africa, Mozambique, and Malawi, and develops into highland savanna in central South Africa, Mozambique, Zimbabwe, Lesotho, Botswana, Namibia, and Angola, and changes to the arid Karoo vegetation of western South Africa and Botswana. Finally, there is the Namib Desert of Namibia and the western coastal regions. Vegetation cover predetermines the carrying capacities of the various veld types of Southern Africa. Higher carrying capacities can be achieved in the high rainfall areas, with (1 LU equal to 500 kg live animal mass) estimates for ranching ranging from 3–4 ha/LU in *Themeda triandra* pastures on fertile soils with rainfall above 700 mm, to 8 ha/LU on mixed *Themeda triandra* pastures in the 500–700 mm rainfall areas. The arid zones carry 1 LU at 10–20 ha (Timberlake & Jordas, 1987).

Further, climatic conditions, especially rainfall, broadly divide the natural pasture of Southern Africa into sweet veld and sour veld (Bonsma & Joubert, 1957; Hahn, 1974; van Niekerk et al., 1986). Sweet veld is more characteristic of the more arid, variable climatic areas particularly on heavier soil types (Bonsma & Joubert, 1957), and is usually dominated by *Themeda triandra*, *Panicum maximum*, and other *Panicum* species (Mcallroy, 1972; Whyte, 1974; Timberlake & Jordas, 1987). Sweet veld can support and provide nutritious grazing for the ruminant throughout the year. In contrast, the sour veld is localised in higher rainfall areas with more than 700 mm/annum (Patzold, 1978; Timberlake & Dionisio, 1984). Dominant grass species in sour veld areas are *Hyparrhenia* spp., *Hyperthelia dissolute*, *Andropogon* spp. and *Heteropogon contortus* (Kennard & Walker, 1973; Whyte et al., 1975). Because of the high rainfall, the sour veld is characterised by high levels of organic matter plant production (Elliot & Croft, 1958; Andreae, 1966; Butterworth, 1967). In between the sweet and sour veld, there are various mixtures of these two veld types. Rapid growth, high protein content and a good nutritive value early in the growing season is typical of natural veld in Southern Africa (Weinmann, 1948; Plowes, 1957). As with tropical grasses, the protein content falls rapidly at flowering as the grasses mature towards the end of the rainy season and beginning of the dry season (Weinmann, 1948; Plowes, 1957; Elliot, 1964). With the advancing seasonal maturity, the veld of Southern Africa becomes less digestible (Du Toit et al., 1940; Plowes, 1957; Kadzere & Tafireyi, unpublished data) and less nutritious, and therefore unable to support high levels of productivity in grazing animals without supplementary feeding. Most researchers in Southern Africa have identified protein as the major constraint to ruminant animal productivity on natural veld in the drier months (Du Toit et al., 1940; Plowes, 1957; Elliot, 1964; Topps & Oliver, 1978). In the rainy season, however, phosphorous deficiency in the young, fast-growing grasses has been identified as a main limiting factor in ruminant animal productivity (Du Toit et al., 1940; Teleni et al., 1977; Read et al., 1986a, b, c). These findings have given rise to animal production systems where protein supplementation in winter and phosphorus supplementation in summer for veld-grazing animals in Southern Africa are standard practice. There is lack of information on the possible deficiencies and toxicities of other nutrients and/or minerals for veld-grazing animals in the Southern African region. In view of the interactions of both protein and phosphorus with other macro- and micro-nutrients in animal metabolism and the consequent influence on livestock productivity, more information needs to be generated in this area if optimum and sustainable production of grazing ruminants is to be achieved in Southern Africa.

1. Natural Pasture Fortification with Legumes

Constraints on the production of grazing ruminants due to both quantitative and especially qualitative deficiencies in the natural veld can be alleviated by fortification of natural pastures with legumes. Research results in Southern Africa, particularly from Zimbabwe, show the potential for improving the nutritive value of natural pastures and thereby increasing the carrying capacity of the veld on a sustainable basis (Clatworthy & Madakadze, 1987). Clatworthy & Holland (1979) and Clatworthy (1984) reported increases in body-mass gains of over 60% per hectare achieved through reinforcing the natural veld with forage legumes (Table 2). Differences in animal productivity between natural- and legume-reinforced pastures were greatest in the dry season (Maclaurin & Grant, 1987). Mufandaedza (1976) reported that steers selected more legumes throughout the year except from October to December, the period after the first rains, when early grass growth was their preferred diet (Fig. 1).

Although veld reinforcement has proved its potential in boosting ruminant

Table 2. Live mass gains of steers on reverted veld and on similar veld reinforced with *Stylosanthes guianensis var. intermedia* (Oxley stylo) over 12 months without winter protein supplement.

	Gains/steer No stylo	(kg) with stylo	Gains/ha no stylo	(kg) with stylo
1973–74	123	152	107	135
1974–75	115	165	103	191
1975–76	139	164	139	205

Source: Clatworthy & Holland, 1979.

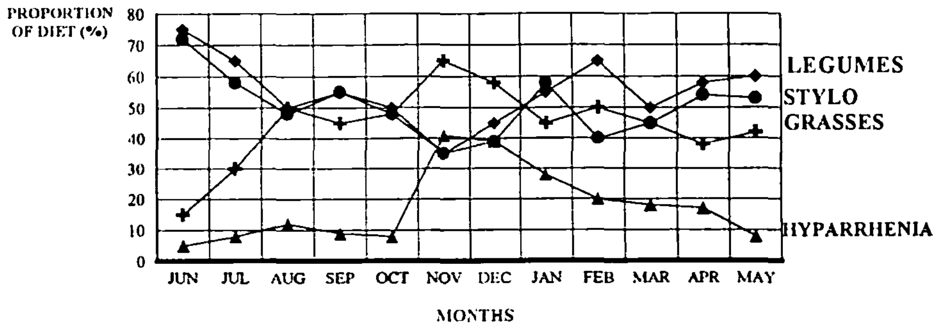

Fig. 1. Selection of grasses and legumes by steers at different times of the year at Marondera Research Station, Zimbabwe (Source: Mufandaedza, 1976).

animal productivity under regulated grazing systems (as is the case on most commercial enterprises), the reinforcement of natural pasture under uncontrolled grazing circumstances (as is the case in all communal lands) may not yield the anticipated effect if the grazing management and ruminant livestock production systems in these areas are not improved. It is necessary to conduct research on livestock production on legume-reinforced natural pastures in communal lands. The improvement of livestock productivity on reinforced natural pastures has been attributed to the increased feed intake and to the increased protein content of the graze, especially during the dry months, when grass protein content is at its lowest. Further research is essential to identify other factors that are necessary to optimize the productivity of animals on reinforced pastures. Most of the legume species used in veld reinforcement experiments in Zimbabwe are of Central or South American and Australian origin (Table 3). It therefore may be significant to iden-

Table 3. Some legume species used in veld reinforcement trials in Southern Africa.

Generic Name	Common Name
Cajanus cajan	Pigeon pea
Cassia rotundifolia	Roundleafed cassia
Desmodium discolor	Horse marmalade
Desmodium intortum	Greenleaf desmodium
Desmodium uncinatum	Silverleaf desmodium
Leucaena leucocephala	Lamtoro
Lotononis bainesii	Beit lotononis
Macroptilium etropurpureum	Siratro
Macrotyloma azillare	Archer
Neonotonia wightii	Cooper glycine
Stylosanthes guianensis	Graham stylo
Stylosanthes guianensis var. intermedia	Oxley fine-system stylo
Stylosanthes hamata	Verano stylo
Stylosanthes humilis	Townsville stylo
Stylosanthes scabra	Shrubby stylo
Trifolium semipilosum	Kenya white clover

tify, select, and experiment with legumes which are indigenous and better-adapted to the various climatic and agro-ecological zones of Southern Africa.

2. Management of Natural Pastures

The sustainable utilisation of both natural and reinforced natural pastures under private, commercial or common ownership depends on good grazing management and good animal husbandry practices. Good grazing aims at improving livestock production, conserving the vegetation cover of rangelands and reducing the risk of irreversible environmental degradation (Cousins, 1987). Presently in Southern Africa, good grazing management is seen in the perspective of rotational grazing or short-duration grazing. Beneficial effects have been demonstrated, both on veld and animal productivity, of short-duration grazing that provides rest periods for portions of the rangelands, especially during the critical growing season (Gammon, 1969, 1984; Savory, 1969, 1984; Froude, 1974; Clatworthy & Barnes, 1975; Parkin, 1981). However, recent research results from the U.S.A. (Hart et al., 1988; Bertelsen et al., 1993) are putting to question the advantages of short-duration over continuous grazing as accepted by the scientific community hitherto.

Most commercial enterprises in the region practice controlled grazing in one way or another. However, the communal grazing areas which cover large areas of Southern Africa have no regulated grazing. As a result, most of the semi-arid savanna lands of Southern Africa have been over grazed and are being encroached by bush (Walker et al., 1981; Walker, 1984). In an effort to counter this development and introduce the principles of rotational grazing, governments and non-governmental organisations have been trying to set up communal grazing schemes. The success of these communal grazing schemes have been very variable. Positively, it can be argued that communal herds in Southern Africa utilise the veld "better" than commercial herds because they are normally composed of a variety of species (cattle, sheep, goats, equines). Strange (1980) observed that (a) cattle graze tops of understorey plants, prefer grasses and forbs, and leave the vegetation patchy. (b) Sheep graze very close to the ground, select nutritious and palatable parts, compete with cattle in areas of grasses and by selective grazing favour the spread of short rhizomatous and stoliferous plants. (c) Goats are part browsers and part grazers, prefer leaves, young shoots and even bark of shrubs, bushes and trees that are ignored by other ruminants and persist in areas where understorey has been over grazed. (d) Donkeys and horses defoliate by biting with upper and lower front teeth, are highly selective and may cause damage when long in one area. To optimally exploit this observation, research is necessary to establish the optimal mixed composition of grazing animal species in the various agro-ecological zones of Southern Africa.

II. Planted Pastures

In Southern Africa, planted pastures are almost always associated with intensive livestock production systems. These are often found in the higher rainfall, better vegetation commercial farming areas, and can either be under irrigation or on

Table 4. Most common plants species used for planted forage production in Southern Africa.

Common Name	Generic Name
Bahaia grass	*Paspalum notatum*
Bermuda or couch grass	*Cynodon dactylon*
Buffel grass	*Urochloa mozambicensis*
Guinea grass	*Panicum maximum*
Hyacinth bean or lablab	*Dolichos lablab*
Kikuyu grass	*Pennisetum clandestinum*
Lamtoro	*Leucaena leucocephala*
Lucerne, alfalfa	*Medicago sativa*
Napier grass	*Pennisetum purpureum*
Oxyley fine-stem stylo	*Stylosanthes guianensis*
Pangola grass	*Digitaria decumbens*
Perennial ryegrass	*Lolium pesenne*
Pigeon pea	*Cajanus cajan*
Rhodes grass	*Chloris gayana*
Sandbur	*Cenchrus ciliaris*
Siratro	*Macroptillium actropurpureium*
Star grass	*Cynodon plectostachyum*
Townsville stylo	*Stylosanthes humilis*
Thin napier grass	*Pennisetum polystachyon*
Velvet bean	*Mucura cochinchinensis*
Weeping lovegrass	*Eragrostis curvula*
White clover	*Trifolium repens*

dryland production systems. Planted pastures are either grazed green by dairy herds or sheep, or are grown to provide grass for silage and for hay making. Often, at such intensive livestock enterprises, crops (mainly maize and sorghum) are also grown for ensiling. Table 4 shows the most common plant species used for forage production on planted pastures of Southern Africa.

III. Browse

Leaves, pods, seeds and edible twigs of shrubs and trees form an invaluable feed resource for browsing animals on natural pastures in Southern Africa (De la Hunt, 1964; Le Houerou, 1980). The longer and more intensive the dry season, when most other feed resources depreciate in quantity and quality, the greater is the degree of dependence of livestock on browse. In Southern Africa, therefore, the importance of browse as a feed resource increases with increasing aridity.

Browse generally has higher protein and mineral contents compared to tropical grasses (Atta-Krah, 1990; Devendra, 1990). Therefore its intake positively influences the digestibility of overall feed intake by livestock (Atta-Krah, 1990). The most common browse in Southern Africa are the *Acacia* and the *Mopane* species (Topps & Oliver, 1978). Using the relationship between feed maintenance requirements of cattle, sheep and goats, and the possibilities of feed ingestion with respect to quality per 100 kg live weight, Sarson & Salmon (1978) concluded that browse alone, the nutritional value of which varies from 0.25 to 0.40 feed units (FU/kg DM), cannot sustain the maintenance requirements of cattle (0.65 FU/kg

DM). The Feed Unit/Fodder Unit (FU) system referred to by Sarson & Salmon (1978) is used in Belgium, France, Holland and Switzerland. The FU system was developed by Van Es (1978) and the FU in calculated as the nutritive value / starch equivalent (SE) of 1 kg of barley. In the FU system, all other feeds are expressed as a proportion of the SE of barley. For most practical ruminant diets and other forages, a mean gross energy (GE) value of 18.4 MJ/kgDM (mega Joules per kg Dry Matter) is commonly accepted. This means that the organic matter of many forages and cereals have a GE of about 18.4 MJ/kgDM. The metabolisable energy (ME) concentration is expressed as q, and it is the ratio of ME to GE. The ME concentration of DM is calculated as 18.4 q (MJ/kgDM). Because of the varying levels of the efficiencies of ME utilisation depending on an animal's production performance, Van Es (1978) calculated the following efficiencies for metabolisable energy utilization:

Maintenance	$k_m = 0.554 + 0.016\ M/D$
Lactation	$k_l = 0.463 + 0.013\ M/D$
Growth and fattening	$k_g = 0.006 + 0.042\ M/D$
Maintenance and Growth	$k_{mf} = \frac{k_m \times k_g \times 1.5}{k_f + 0.5\ k_m}$

whereby: M/D = ME concentration MJ/kgDM

It is worth mentioning that the equations from Van Es (1978) closely follow those of the ARC (1980).

Browse ensures the maintenance of sheep (0.35 FU/kg DM), but does not enhance production. A pure browse diet (0.19 FU/kg) can provide for maintenance and production of goats, thus explaining why goats can survive on depleted rangelands where browse constitutes most of the feed (Sarson & Salmon, 1978). This also explains why goats are less affected by droughts than are sheep and cattle, as during the 1991–92 drought in Southern Africa. Indirectly, browse and other leguminous fodder trees in rangelands have positive effects on grass growing under them (Atta-Krah, 1990). Grass under such trees dry out 3–6 weeks later than in the surrounding veld. Photosynthetic efficiency was 1.4% under shade and 0.3% in the open (Bille, 1978). Working in Botswana, Le Houerou (1978) made similar observations on *Panicum maximum* pastures in which the potential evapotranspiration was reduced by 50–70% under shade and the grass remained green 6 weeks longer into the dry season.

Important to note, though, is that some browse plants contain biochemically active materials such as tannins, goitrogenic, allergenic substances, cyanogenic glycosides, phytates, phenolics as well as other anti-nutritional factors that can negatively influence the animal's metabolism, physiology and performance. Fruits of many *Acacia* species contain polyphenolic compounds that alter carbohydrate and protein use in feed, decreasing urinary loss and increasing faecal N loss (ILCA, 1978), and the seed pods of *Acacia nilotica*, may be harmful to cattle if consumed in large amounts (Pratt & Gwynne, 1977). A classic example of browse toxicity is that of *Leucaena leucocephala* which contains the amino acid derivative mimosine that in ruminants normally degrades into the toxic 2,4 *hydroxy pyridine* (DHP). If consumed in large quantities *Leucaena leucocephala* can be harmful to livestock (Jones & Hegarty, 1984). However, livestock on free range, as is the case in the extensive production systems of Southern Africa, are hardly affected by the toxicity of browse because of the variety of available forage materials. Research is necessary to specifically quantify and qualify the role browse plays in the ruminant livestock production systems of Southern Africa.

IV. Crop Residues

Arable farming produces a variety of straws and other crop residues that form a potential feed resource for ruminant animal production (Table 5). To date, in Southern Africa, crop residues are grazed in the fields after crop harvesting. This makes crop residue grazing (as observed by Bayer & Otchere, 1984) highly seasonal, peaking immediately after harvest. Because of the current mode of utilization, there are no accurate estimates of this feed resource and of its contribution to ruminant livestock production. Only a handful of farmers cut, carry and conserve crop residues to feed livestock strategically in the dry season. With the exception of legume plant stems (peas, groundnuts, soybeans, beans, etc.), the nutritive value of crop residues is limited by their generally low crude protein content and high fibre content (Kadzere & ter Meulen, 1986), and low effective *in vivo* digestibility (Kevelenge, 1978).

Various methods have been developed to treat crop residues and improve their utilization by the animal (Jackson, 1978; Bergner, 1990) (Fig. 2). Adoption of these methods has not been encouraging in Southern Africa, apparently due to two reasons: either (a) the natural grazing still provides an adequate feed resource,

Table 5. Crop By-Products commonly used as ruminant animal feed resource in Southern Africa.

Crop Common Name	Generic Name	By-Product
Maize	*Zea mays*	Maize stover
Rice	*Oryza sativa*	Rice stover/bran
Millet	*Penicicum millaceum*	Millet stover/bran
Sorghum	*Sorghum vulgare*	Sorghum stover/bran
Wheat	*Triticum aestivum*	Wheat stover/bran
Barley	*Hordeum vulgare*	Barley stover/bran
Barley	*Hordeum vulgare*	Brewer's grains
Groundnut	*Arachis hypogea*	Groundnut hulls
Soybean	*Glycine max*	Soybean, stoyer, cake
Sunflower	*Helianthus annus*	Sunflower hulls, husks, cake
Coffee	*Coffea arabica*	Coffee hulls
Oranges	*Citrus sinensis*	Orange wastes
Lemons	*Citrus limon*	Lemon wastes
Pineapples	*Ananas comosus*	Pineapple waste
Sugar Cane	*Saccharum officinarium*	Molasses
Sugar Cane	*Saccharum officinarum*	Suger cane tops
Oats	*Avenue sativa*	Oats stover
Cotton	*Gossypium herbaceum*	Cotton seed cake

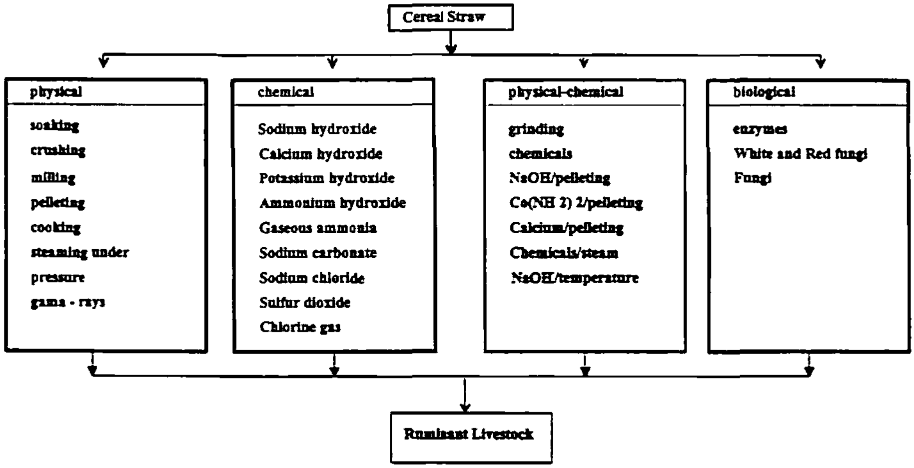

Fig. 2. Methods of treating straw for animal feeds (Source: Doyle, 1983; Ibrahim, 1983).

making the economic and well-planned utilization of straw unnecessary, or (b) propaganda by extension officers on the utilization of treated straw has been ineffective. The latter problem is especially serious with extensive livestock systems. Only in systems where the farmer monitors his animals' intake and has an understanding of the need to have a stable fodder flow throughout the year, has straw treatment and utilization of straw been adopted. With the inevitable future intensification of livestock production in Southern Africa, it is apparent that the utilization of treated crop residues in ruminant animal production will increase.

V. Agro-Industrial By-Products

Table 6. Nutritive value of some Agro-Industrial By-Products available for ruminant livestock nutrition in Southern Africa.

By-Product	Dry Matter	Crude Fibre	Crude Protein	Digestible Protein	Net Energy Lactation (MJ)
	g/kg of By-Product				
Maize stover	852	286	13	6	1.07
Wheat straw	889	399	28	6	3.36
Barley straw	881	387	33	6	3.52
Blood meal	893	3	825	636	5.71
Fish meal	898	6	582	518	6.04
Meat meal	932	8	572	484	6.22
Sunflower cake	912	135	429	380	6.67
Sunflowe extract	901	159	395	349	5.88
Soybean extract	888	32	501	443	6.69
Molasses	773	0	101	84	11.50
Cotton seed cake	913	91	438	374	13.60
Groundnut cake	910	47	495	426	15.30
Brewers grains	234	45	58	41	1.99

Table 7. Basic nutrient and mineral element content of poultry litter in g/kg dry matter.

Type of Poultry	Dry Matter	Organic Substance	Crude Protein	Fat	Crude Fibre	Ash
Laying hens	200	735	305	25	140	265
Laying hens (dehydrated)	250	750	180	20	200	250
Pullets	239	869	329	40	141	131
Broilers	333	821	371	33	152	179
Fattening turkeys	307	852	459	40	125	148
Broiler ducks	120	701	240	29	152	299

Source: Perez-Aleman, 1971; Baschin & Schwarz, 1972; Flaschowsky & Jerock, 1977.

Table 8. Mineral elements and trace elements.

	Ca	P	Na	K	Mg	Cu	Zn	Fe	Mn
	g/kg					ppm			
Broilers	33	19	6	21	7	13	2,900	8,500	296
Laying hens	71	20	8	22	4	23	384	1,659	441

Cereal milling products, brewer's grains, products of animal slaughter houses (animal fat, meat and bone meal, blood meal), fish meal are some of the agro-industrial by-products available as ruminant livestock nutrition in Southern Africa. The nutrient value of some of the products are shown in (Table 6). Most of these agro-industrial by-products are manufactured as concentrate feeds, but due to high costs of production, they are utilized only by commercial farmers in intensive production systems or exported. Chicken manure/waste is an agricultural by-product which is increasingly being utilized by farmers to feed ruminants in Southern Africa (Mutsvangwa et al., 1989). Although its nutrient composition is highly variable, poultry litter provides a high protein and high mineral, cheap feed resource (Table 7 & 8) for incorporation in various ruminant livestock feeding and production systems in Southern Africa.

CONCLUSION

Only under intensive livestock production systems can the use of planted dryland or irrigated pastures be justified in Southern Africa. The cheapest ruminant livestock feed resource in Southern Africa is and will remain the natural veld. However, this important resource is often taken for granted especially in communal livestock production systems. Good grazing management practice and utilization of the natural veld should be encouraged to counter and stop soil erosion and veld degradation, and therefore sustainably increase overall animal productivity. Although rampant uncontrolled fires during the dry season often destroy the natural pasture, it must be mentioned that the proper use of fire is also seen as an important management tool in several veld management systems in the region.

Pasture fortification with legumes helps level out the seasonal quantitative and qualitative fluctuation in the nutritive value of the veld and therefore leads to overall increased grazing ruminant animal productivity. The identification, selection and fortification of natural pastures with locally adapted, indigenous legumes will go a long way towards alleviating deficiencies in the natural veld. Research in this regard needs to be encouraged. On the whole, crop residues are generally grazed after the grain harvest. The treatment of crop residues, especially straw, to improve their nutritive value, has great potential in augumenting ruminant livestock feed requirements in Southern Africa.

The communal land tenure system appears to have negative effects on the natural veld in communal grazing lands. This is especially so because the communal land grazing system does not make the traditional pastoralist accountable for what one's own grazing livestock do to the natural pasture. The veld in this system is perceived as a common resource over which nobody has direct responsibility and whose utilization is open to all members of a community. Education on sustainable natural resource utilization would play a central role in changing such attitudes and thereby contribute to the judicious communal veld utilization by pastoralists. A revisit and analysis of the communal land tenure systems by the policy makers in the region is a worthwhile exercise to consider.

Browse contributes an important protein- and mineral-rich feed resource for ruminants, especially to goats, in Southern Africa. The role of browse in animal nutrition in Southern Africa increases with the increasing aridity of the areas. Research is therefore necessary to quantify and evaluate the role of browse and to establish better production and utilization methods of this natural resource.

If improvements in ruminant livestock production in Southern Africa under the present socio-economic circumstances is to be realized, especially in the so-called communal areas, the question of the over-exploitation of the natural veld as a result of overcrowding of both people and livestock in some areas has to be addressed. Further, the large numbers of livestock on small areas and the resultant overgrazing, soil erosion and concommitant land degradation has to be technically resolved through education and appropriate agricultural extension that will lead to the reduction of the grazing pressure on such areas. Appropriate stocking rates in the various agro-ecological zones have to be adhered to by the rural communities without having to necessarily privatise the communal lands as is often advocated. Experiences in other parts of the world and even in industrialized countries have shown that even on private farms, veld overutilization and subsequent land degradation result, if sound veld and livestock management practices are not followed. Through persuasion, education and effective extension, rather than coercion, the communal pastoralists in Southern Africa should be encouraged to increase the ruminant offtake, which currently averages 3% in communal lands, to near 20% which is the average livestock offtake per annum from commercial livestock enterprises. The low livestock offtake from the communal lands is pivotal to the problem of ever-increasing livestock numbers (except in drought years when due to starvation, the numbers drop) on the finite communal natural resource and the attendant veld overutilization and subsequent erosion, land degradation, and desertification.

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