# CHARACTERISATION OF GOAT PRODUCTION SYSTEMS AND PRODUCTIVITY IN RUSHINGA COMMUNAL AREA, ZIMBABWE


**BY**

**CHIKWANDA ALLEN T.**

(BSc. Agric. Hons, UZ)


A thesis submitted in fulfillment of the requirements for the degree of

**MASTER OF PHILOSOPHY**


**Department of Animal Science**

**Faculty of Agriculture**

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**Approved as to style and content by:**

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**ABSTRACT**

One monitoring and 2 on-farm experimental studies were undertaken using goats that belonged to smallholder farmers in Rushinga communal area, Zimbabwe. The objectives of these studies were to investigate the effect(s) of management system, supplementary feeding, provision of housing and antihelminthic treatment on overall flock productivity, doe fertility, pre-weaning kid mortality and worm burden, respectively.

The effects of tethering or herding on flock productivity were investigated, from March 2001 to March 2003, using 24 goat flocks which were selected from 3 flock sizes (i.e. 1 to 5, 6 to 10 and > 10 goats/flock). Productivity was analysed in terms of kidding pattern, kidding rates, prolificacy, kidding interval, off-take and death rates. The major findings were that kidding patterns were similar under both management systems with two major peaks from March to April and from September to December and kidding rates were low and were not affected by management system ($P > 0.05$). Prolificacy was also not affected by management system ($P > 0.05$). Kidding intervals were long but similar ($P > 0.05$) between the 2 management systems. The sales, slaughters and death rates were low for both systems. It was concluded that the productivity of goats reared under herding or tethering was similar. However, there was a need to reduce reproductive wastage and form goat marketing centres so as to increase sales.

In the second study, the effect of supplementary feeding, with sunflower cake, on doe fertility was investigated using 36 goat flocks which were randomly allocated to 3 treatment groups (i.e. Group 1 no supplementary feed, in Group 2 the does were offered 270 g/ day of hand pressed sunflower cake during the first 60 days of lactation and in Group 3 the does received 270 g/ day of the sunflower cake from late pregnancy and continued through the first 60 days of lactation). Fertility was analysed in terms of kidding rate, kidding interval, prolificacy and age at first kidding. The major findings were that kidding rates were low and not affected by the treatments ($P > 0.05$). The kidding rates ranged from $2.84 \pm 1.21$ to $5.08 \pm 1.21$ and from $1.61 \pm 1.21$ to $5.60 \pm 1.40$ parturitions/100 does/doe year in the control and supplemented flocks, respectively. Age at first kidding was not affected by treatment group ($P > 0.05$). Prolificacy was significantly affected by the interaction of flock size and season of mating ($P < 0.05$). It was concluded that the level of supplementary feed that was offered during pregnancy and lactation resulted in minor improvements in the reproductive performance of the does.

In the third study, the effect of the type of goat housing and provision of antihelminthic treatment on kid mortality and the prevalence and predominance of internal parasites was investigated. Thirty six goat flocks were selected from the 3 flock sizes and were randomly allocated to 2 types of goat housing (i.e. pole walled and an improved housing) and were further put on 2 antihelminthic treatments (untreated and de-wormed with Valbazen). The major findings were that death rate of kids was low across all treatments and was not affected ($P > 0.05$) by type of housing or the antihelminthic drug. Low egg numbers of *Coccidia, Strongyle* and occasionally *Moniezia* species were observed in the faecal samples. The most prevalent nematode larvae in the faecal cultures were *Haemonchus contortus*, *Cooperia, Trichostrongylus* and *Strongyloides*. The prevalence of *Haemonchus contortus* was significantly affected ($P < 0.05$) by a three- way interaction of type of housing, antihelminthic treatment and season. It was concluded that kid death rate and the prevalence of internal parasites was low and not affected by type of housing. In addition, the use of antihelminthics in the area was not necessary.

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DEDICATION

**To my wife Denice and son Wallen Alexander Tadiwanashe Chikwanda**

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| ADF | = | Acid detergent fibre |
| AFK | = | Age at first kidding |
| Ca | = | Calcium |
| CP | = | Crude protein |
| CTs | = | Condensed tannins |
| $^{o}C$ | = | Degrees Celsius |
| DM | = | Dry matter |
| EE | = | Ether extract |
| Epg | = | Eggs per gram |
| GLM | = | General linear models |
| KI | = | Kidding interval |
| NDF | = | Neutral detergent fibre |
| OM | = | Organic matter |
| P | = | Phosphorus |

# CHAPTER 1

## 1.1 INTRODUCTION

Optimum goat management has the potential to reduce levels of malnutrition and improve income generation among rural communities through increased consumption of animal protein and goat sales, respectively. This is possible because of the abundance of goats in communal areas, i.e. 97 % of the total goat population of 4.7 million (Central Statistics Office, 2000). The goats require minimum levels of management during the greater part of the year except during the rainy season where, if not properly tended, they damage cultivated crops (Shumba, 1993). In order to reduce disputes between households over crops damaged by goats and also competition for labour between cropping and livestock management, some communal area farmers resort to tethering of goats while they tend to crop fields (Shumba, 1993; Chikura, 1999). This is, however, only feasible with small flock sizes. The farmers, who own large flocks and have sufficient labour or those who can afford to hire labour, engage shepherds to look after their goats.

Most of the goats that are owned by communal area farmers are the indigenous Mashona and Matebele breeds (Chikura, 1999). These breeds have been reported to be hardy and prolific, with an average litter size of over 1.5 (Nyamangara, 1991; Kusina and Kusina, 2000). However, despite their high prolificacy as demonstrated on research stations, high reproductive wastage under traditional systems of management is a limitation to increased productivity (Kusina and Kusina, 1998). This loss in production has been attributed to a number of constraints namely poor nutrition, poor health care and low management input (Kusina, Kahiya, Mukaratirwa, Chikura and Sibanda, 1999).

The goats are generally given little veterinary care and are subjected to inadequate feeding

(Kusina, 2002). The farmers rarely call veterinarians when their animals fall ill or die. In most cases unwell goats are treated using traditional medicines whose effectiveness has not been proven (Kusina and Kusina, 2000). The general health of goats is affected by a fluctuating plane of nutrition and insufficient foraging time. In addition, the pens in which the goats are housed overnight are poorly constructed (Matika and Sibanda, 1993), and as a result they expose the animals to wind, cold, predators and rainwater (Shumba, 1993). Such poor management practices and inappropriate shelter result in high kid mortality (Pandey, Ndao and Kumar, 1994), increase the incidence of diseases (Obwolo, 1991) and reduce the reproductive performance and overall flock productivity (Mtenga, Kifaro and Belay, 1994).

This study, therefore, evaluated the goat management systems and types of housing that are used in communal areas and investigated possible interventions that may ensure optimum productivity, which may in turn benefit the resource poor, communal area farmers.

**1.2 OBJECTIVES**

The main objective(s) of this study were to assess production systems, evaluate opportunities and constraints in goat rearing with the aim of improving goat production in Rushinga District of Zimbabwe. Improvements in goat production were expected to increase protein consumption (meat and milk), increase soil fertility through manure and control bush encroachment through multi- species utilisation of forages. The specific objectives of the study were:

a) to characterise the goat production systems and identify constraints to goat productivity through a continuous monitoring study,
b) to investigate the effect of strategic supplementary feeding with sunflower cake on doe reproductive performance, and

c) to investigate the effects of goat housing and antihelminthic treatment on pre- weaning kid mortality rate and the incidences of gastro- intestinal helminthes.

## 1.3 NULL HYPOTHESES

a) There is no difference in flock productivity between goats that are tethered or those that are herded.
b) Supplementary feeding of goats during pregnancy and lactation does not improve their reproductive performance.
c) Provision of improved housing and antihelminthic treatment does not reduce pre-weaning kid death rate or worm burden.

# CHAPTER 2

## 2.0 REVIEW OF LITERATURE

### 2.1 Goat Production in Zimbabwe

Goat production in Zimbabwe forms an integral and important component of the smallholder farming system (Kusina, Chinuwo, Hamudikuwanda, Ndlovu and Muzanenhamo, 2001). Over 97 % of the 4.7 million goats in Zimbabwe are found in the smallholder farming sector (Chikura, 1999). Most of the smallholder farmers live in agro- ecological regions IV and V, which are characterised by poor rainfall, which only permits low cropping activities. Livestock rearing, especially goat production, predominate in such arid and semi- arid regions (Chikura, 1999; Masunda, 2001).

Five breeds of goats have been identified in Zimbabwe and these are the Mashona, Matebele, Boer, Saanen and Angora goats (Kusina, 2000). The Boer, Saanen and Angora goats are kept for meat, milk and mohair production, respectively. Mature weights of Boer does and bucks are 80 kg and 130 kg respectively, and those of the Saanen does and bucks are 65 and 75 kg, respectively. However, the dominant breeds are the indigenous Mashona and Matebele goats. The Matebele goat is a large meat breed. The females and males have mature live weights ranging from 30 to 40 kg and from 50 to 55 kg, respectively (Mhlanga, Khombe, and Makuza, 1999). This breed is similar in size to the Boer and Nguni breeds of South Africa and the Tswana breed of Botswana (Sibanda, Ndlovu and Bryant, 1997[a]). The breed is found on smallholder farms in Matebeleland North and South Provinces of Zimbabwe. Smallholder farmers in other parts of the country keep the Mashona goat which has a low mature body weight ranging from 25 to 30 kg (Nyamangara, 1991).

### 2.1.1 Tethering

It is common practice among the farmers to tether or herd the goats during the rainy season so as to control their access to cultivated crops, thus preventing crop damage (Kusina and Kusina 1998). Such management practices lead to limited grazing time, which reduces feed intake and, consequently, lower the productivity of the animals. Tethering is the restriction of goat movement by attaching them with ropes or chains to either pegs or trees (Steele, 1996). The restraining is done on road-sides, in crop alleys or on communal rangelands (Ogebe, Ogwu, Mustafa and McDowell, 2000). The advantage of tethering is that labour that is normally used for herding the flocks can be used on other farming activities (Chikura, 1999). Overnight tethering of goats in pens is done to restrain aggressive animals and prevent them from charging and inflicting injury on other goats (Steele, 1996).

There are several methods of tethering and these include the use of a wobbling rope, a running lead or a centre peg (Staniland, 1980; Bayer and Zemmelink, 1998). However, the majority of farmers prefer to use ropes attached to a centre peg or a tree.

#### *2.1.1.1 Effect of tethering on goat production*

There are conflicting views on the effect of tethering on goat performance and on the environment (Karua and Banda, 1994; Ogebe, Ogwu, Mustafa and McDowell, 2000). According to Karua and Banda (1994), tethering was the major cause of loss of body condition in goats. They attributed the loss in body condition to the low nutrient intake that resulted from restricted foraging behaviour of the tethered goats. Heat stress on exposed tethered goats during hot weather also reduced the grazing time (Ogebe *et al.,* 2000). In addition, the authors reported that tethered bucks often got injured or killed when attempting to free themselves. Tethered does also had limited or no exposure to bucks and this reduced female reproductive performance (Ikwuegbu, Tarawali and Njwe, 1994).

Chikura (1999) reported that the vegetation where tethering was done was destroyed through overgrazing. He indicated that over-utilisation of the tethering spot lead to soil erosion due to the creation of bare patches on the ground. Steele (1996) recommended that goats should be moved to a fresh tethering spot once the current patch had been well grazed, in order to enhance animal productivity and conserve the environment. The frequency of changing the tethering spots is similar in principle to rapid rotational grazing systems which have been found to be effective in the control of nematodes.

### 2.1.2 Herding

In a herding management system, a goat attendant controls the movements of the grazing goats by guiding the animals to preferred grazing areas (Bayer and Zemmelink, 1998). The attendant also prevents goats from entering into crop fields, vegetable gardens or places where harvested crops or thatch grass are being preserved. However, herded goats are able to select a variety of plants and pods compared to goats that are tethered.

Shumba (1993) observed that foraging goats moved very fast and in situations where fences existed, they easily jumped over the fences and strayed into crop fields. Because of this, goats were usually confined in pens until late in the afternoon during the rainy season before they were released for herding when labour had been freed from cropping activities or school (Kusina and Kusina, 2000). This prolonged penning reduced the time goats were allowed to feed and consequently, had a negative effect on the productivity of the animals (Chikura, 1999).

### 2.1.3 Free ranging

In the free ranging management system, goats are released in the morning to feed on veld forages and crop residues without any restriction on their movements (Bayer and Zemmenlink, 1998). This system is mostly practised during the dry season after crops have been harvested and stored in secure places. Although there is more access to feeding by the goats, the forages during this time of the year are of poor quality (Mandibaya, Mutisi and Hamudikuwanda, 1999). In addition to the poor nutrition, goats are more vulnerable to predators when they are free ranging.

### 2.1.4 Confinement

Goats under confinement are housed in pens all the time (Devendra and Burns, 1983**.** They are offered concentrates and forages, which are harvested and brought to the pens. Confinement of goats is normally practised on intensive goat production farms. This production system requires high inputs in terms of labour, feed, veterinary drugs and management and it results in high milk production and carcasses of good quality.

## 2.2 CONSTRAINTS TO GOAT PRODUCTION

In addition to the type of management practices adopted, there are several other factors that limit goat production in the communal areas of Zimbabwe and these include nutrition (Ndlovu, 1992), health (Obwolo, 1991; Pandey *et al*., 1994; and Kusina *et al*., 1999) and type of housing (Chikura, 1999).

### 2.2.1 Nutrition

The mobile upper lip and prehensile tongue of goats enable them to graze short grass swards and browse even those shrubs and trees that have mechanical deterrents such as thorns

(Nyamangara, 1991; Devendra and Burns, 1983). Goats are also capable of assuming a bipedal stance that allows them to utilise overhead branches of trees and shrubs (Devendra and Burns, 1983). However, despite having these advantages, goats still face a nutritional challenge that limits their productivity.

#### *2.2.1.1 Effect of nutrition on the productivity of goats*

Goats in the communal areas of Zimbabwe depend mostly on veld forages and crop residues to meet their nutritional requirements (Nyamangara, 1991). The poor nutritive value of the forages, especially during the dry season, has been reported to affect ruminant livestock production (Mandibaya *et al*., 1999). Sarwatt, Kapange and Kakengi (2000) reported that crop residues were low in crude protein and high in lignocellulose contents which led to low digestibility, low rates of passage and therefore low voluntary feed intake of the residues by the goats. As a result, the energy and nitrogen intake from the residues could not sustain optimum levels of performance in goats. Indigenous goats that were not offered dietary supplementary feeding lost weight during the dry season (Sikosana, Mangena and Vela, 1993).

Loss of liveweight in animals grazing unimproved veld forages during the dry season is common in Zimbabwe. However, Chikura (1999) observed that goats compared to other ruminants performed better during the dry season than during the rainy season. Hatendi (1991) explained that the unique survivability of goats during the dry season was dependent on their ability to utilise a variety of forage species and to select plant parts of high nutrient concentration. However, the author highlighted that the dependence on veld grazing in any ruminant production system was susceptible to the seasonal fluctuations in the quantity and quality of the veld forages.

### *2.2.1.2 Effect of nutrition on reproductive performance of does*

Nutritional stress limits the reproductive performance of female goats. Kusina and Kusina (1998) reported that nutritionally related fluctuations in body weight of does temporarily disrupted ovarian activity as shown by low conception rates during dry periods. Ovarian activity was observed to be sensitive to nutrient availability and tended to decrease when feed became scarce (Wilson, 1989), as reflected by low conception rates related to such periods. Chronic or severe feed restriction impairs the hypothalamic gonadotrophin pulse generator. However, improvement of doe nutrition increases systemic luteinising hormone secretion which restores ovulation rate (Kusina *et al.,* 2001). This leads to seasonal patterns in kidding in goats reared on natural pastures that are subjected to seasonal fluctuations in nutrient quantity and quality (Llewelyn, Ogaa and Obwolo, 1991). This observation agrees with the finding that the abundance of feed was associated with breeding that resulted in peak kidding (Kusina and Kusina, 2000). Chikura (1999) found that goatskidding in the dry season had longer kidding intervals (382 ± 90 days) than those that kidded during the wet season (265 ± 48 days) and he attributed the low kidding rate to the nurtitional stress experienced during the dry season.

### *2.2.1.3 Effect of nutritional stress on the pregnant doe*

Nutritional stress has been reported to cause abortions or metabolic disorders such as pregnancy toxaemia in does (Steele, 1996). The abortions are caused by low levels of glucose in the maternal blood, which trigger hyperactivity of the foetal adrenal gland (National Research Council, 1981). The foetal adrenal gland then releases oestrogen precursors that induce the expulsion of a live foetus. Low maternal blood glucose also stimulates the adrenal glands of the doe to release oestrogen precursors, which lead to the expulsion of a dead oedamatous foetus (National Research Council, 1981).

Pregnancy toxaemia is a condition characterised by mobilisation of body reserves by an undernourished pregnant doe, which are channeled to the growing foetus. Sometimes the mobilisation of body reserves continues to an extent that causes severe loss of body condition or death of the doe (Steele, 1996).

### *2.2.1.4 Effect of nutrition on kidding interval*

In situations where an underfed pregnant doe manages to kid, the nutritional stress experienced by the doe has an effect on her subsequent reproductive performance. Ndlovu (1992) reported that the high energy demands of lactation caused a high negative energy balance which delayed resumption of post-partum oestrus in lactating does. The late resumption of post-partum oestrus prolonged the service period, i.e., the period between one kidding and the next conception (Devendra and Burns, 1983). Since gestation length is fixed within and across goat breeds, the service period is, therefore, an important determinant of kidding interval (Jainudeen and Hafez, 1993). Ndlovu (1992) showed that post-partum anoestrus period, which is usually over 150 days in underfed Zimbabwean indigenous goats, was reduced to 50 days under good nutritional management. Proper feeding of does resulted in mean kidding intervals of 180 days (Devendra and Burns, 1983).

### *2.2.1.5 Effect of nutrition on productivity indices*

Table 2.1 presents some productivity indices of on-farm and on-station performances of the two main breeds of goats in Zimbabwe. The difference in the performance of goats on the different sites was attributed to the adequate feeding and better management of goats that were reared on the research stations (Chikura, 1999). Sibanda, Ndlovu and Bryant, (1997[b]) advocated for the culling of poor performing goats in order to improve the amount of feed available to the productive stock, thus promoting flock productivity.

**Table 2.1 Productivity indices of two main goat breeds in Zimbabwe**

| | Mashona | Matebele | | |
|---|---|---|---|---|
| Trait | On-farm | On-farm | On-station | Source |
| Litter size | 1.19-1.4 | 1.06-1.34 | 1.7 | Chikura (1999), Mhlanga *et al.* (1999). Kusina and Kusina, (2000) |
| Weaning percentage | 55.0 | 56.2 | 82.1 | Sibanda, Ndlovu and Bryant (1997[a]) |
| Growth rate (g/ day) | 30-56 | 30-65 | 94.2 | |
| Weaning weight (kg) | 8.8-10 | 8.8-11.9 | 15.2 | Mhlanga *et al.* (1999) |
| Age at first kidding (days) | 418-914 | 354-727 | N/A | Chikura (1999) |
| Kidding interval (days) | 182-883 | 266-434 | 363 | Sibanda, Ndlovu and Bryant (1997[b]) |

N/A stands for information not available

#### *2.2.1.6 Prolificacy*

A survey by Kusina and Kusina (2000) revealed twinning rates ranging from 1.5 to 1.6 for goats in the Guruve District of Mashonaland Central Province in Zimbabwe. These rates were higher than the 1.19 to 1.40 prolificacy range that was reported by Chikura (1999) on work done in Wedza communal area. According to Kusina and Kusina (2000), nutritional stress limited the number of foetuses carried to term by the goats under smallholder management.

Parity was also reported to affect prolificacy, with multi-parous does having higher litter size than the first or second parity does (Sibanda *et al.,* 1997 [b]). Jainudeen and Hafez (1993) stated that the principal determinant of litter size was ovulation rate, which affected the number of potentially fertilisable ova. These authors reported that increasing the level of nutrition of small ruminants before mating resulted in increased ovulation rate. On the other hand, restriction of energy intake during the pre-mating period caused a loss in body weight of the does and reduced the incidence of twin births (Kusina *et al*., 2001). Sibanda *et al.* (1997[b]) reported that does in good body condition give twin births in subsequent parturitions.

#### *2.2.1.7 Weaning percentage*

High kid mortality is one of the major constraints to goat production. Pandey *et al*. (1994) reported that pre-weaning kid mortality in Zimbabwe was as high as 65 %. Exposure to cold, rain, starvation, diseases, internal parasites and predation were among the factors that caused high kid mortality (Shumba, 1993). The kids normally succumbed to heavy worm burden within the first four months after birth. According to Mtenga *et al.* (1994), kids of low birth weight had low energy reserves and were vulnerable to harsh environments. Conversely, high birth weights were associated with low mortality (Devendra and Burns, 1983). Inadequate milk supply to twin kids, due to poor dam nutrition and competition for milk between the twins, predisposed the kids to diseases.

#### *2.2.1.8 Effect of nutrition on growth rate*

In addition to affecting the survival of kids during the period between birth and weaning, nutrition also affects their growth rate, which is important in subsequent reproductive performance of female kids. Rhind (1992) stated that puberty was delayed in kids reared by underfed goats. This was a result of a delay in the attainment of a critical body weight (two-thirds of mature body weight) at which puberty occurred. Jainudeen and Hafez (1993) explained that the age at which puberty was attained determined the age at which first kidding occurred. The Mashona and Matebele goats normally attained puberty at seven months of age. Devendra and Burns (1983) reported that the earliest time at which kidding occurred after first oestrus was five months. This implies that indigenous goats, which are non-seasonal breeders, can kid when they are one year old. However, a fluctuating plane of nutrition suppresses early occurrence of first oestrus in tropical goats, thereby increasing age at first kidding (Rhind, 1992).

Early nutritional intervention using solid feed was reported to be difficult since kids depended entirely on milk during the first 7-8 weeks after birth (Devendra and Burns, 1983). Therefore, any nutritional interventions during the first eight weeks of life should be directed towards increasing milk production from the doe through supplementation. However, Sibanda and Ndlovu (1990) observed that supplementing indigenous goats with conventional supplements was unprofitable and also the smallholder farmers did not have the cash to buy the supplements (Francis and Ndlovu, 1995).

#### *2.2.1.9 Supplementary Feeding*

Francis and Ndlovu (1995) reported that it was possible for smallholder farmers to formulate home produced supplements for cattle using locally available feed resources e.g. maize stover, sunflower cake and silage. Chimonyo (1998) used sunflower cake and maize stover (three parts sunflower cake to one part maize stover on DM weight basis, since sunflower was widely grown by smallholder farmers) as supplements for draught cows and he found that supplementary feeding improved the fertility of the draught cows. Mixing of crop residues with oil seed cakes was reported to improve the protein content of the poor quality forages (Mirgani, Nasir and Nasir, 1993). Mandibaya *et al*. (1999) formulated calf rations, using sunflower cake and various roughage sources and found that the rations promoted faster growth rates of calves compared to the growth rates achieved by feeding a commercial calf starter meal. Kadzere, Charuma and Jingura (1991) used hand-pressed sunflower cake to supplement sheep rations. However, they warned that the inclusion of fat to ruminant rations to levels above 5 % of the dry matter of the total diet was not recommended as it interfered with the functions of rumen cellulolytic bacteria. There appears to be no research work that has been done on formulating homegrown supplements for goats in Zimbabwe. Based on the work cited above, it should be possible to formulate home produced supplements for goats.

### 2.2.2 Health

Despite the hardiness of Zimbabwean indigenous goats, their mortalities are very high in communal areas (Chikura, 1999). Flock mortalities have been reported to be in excess of 50 % (Kusina *et al*., 1999), with kids being the most vulnerable group (Pandey *et al*., 1994).

According to Kusina *et al*. (1999), lack of proper health care was the major cause of such high mortalities. Obwolo (1991) reported that 39 % of all deaths were due to diseases. He identified infections and nutritional inadequacies as the major causes of goat diseases. Kusina *et al*. (1999) reported that infectious diseases, particularly those caused by gastro-intestinal parasitism, were the dominant cause of losses in the goats in communal areas.

Goats have limited resistance to nematodes due to limited exposure to these parasites. These animals normally browse well above the ground, whereas parasites are deposited on the ground. Veld characteristics, such as overgrazed forages, which compel the goats to graze close to the ground resulted in parasitic infestations. Financial losses from gastro-enteritis were mainly incurred through mortality and reduced liveweight gain (Temberly, Lahlou-Kassi., Sovani, Rege, Baker and Mukasa- Mugerwa, 1996).

The dominant internal parasites affecting goats were *Haemonchus contortus*, *Oesophagostomum colombiunum*, *Trichostrongylus spp* and *Bunostomum spp* (Obwolo, 1991; Chikura, 1999; Kusina *et al*., 1999). In Zimbabwe, high levels of infestations by parasites were observed during the rainy season (Kusina *et al*., 1999). The increase in the infestations was attributed to the rainy conditions that enabled the eggs of the parasites that were passed in faeces to develop into infective larvae (Kusina *et al*., 1999). The gastro-intestinal parasites have been observed to reduce growth rate and body condition of the infested animals (Vatta, Krecek, Letty, Van der Linde, Motswatswe and Hansen, 2002). In addition, heavy worm burden caused diarrhoea, anaemia and in acute cases death occurred, particularly in kids (Obwolo, 1993). Howlader, Captain, Edyardo, Roxas and Sevilla (1997) reported that the adult and fourth larval stages of *Haemonchus contortus* sucked blood and caused haemorrhage in the abomasal lining of goats, which lead to anaemia. The authors also reported that the reproductive performance of does and their offspring was negatively affected by *Trichostrongylus* infestation.

Nfi and Ndamukong (1997) noted that poor nutrition aggravated the parasitic damage in small ruminants as a result of lowered resistance. Malnourished kids infested with parasites suffered from severe weight loss and bottle jaw (Nfi and Ndamukong, 1997). Infestation of does by *Ostertagia circumcinta* or *Haemonchus contortus* reduced milk production and severely reduced liveweight gains of the kids (Howlader *et al.,* 1997). The authors also reported that dam infestation did not affect the birth weight of the kids but it affected the growth rates of the kids when they were three weeks old and above. Maphosa (1993) found mixed nematode infestation in goat faeces and suggested the use of anthelmintics to control strongyle worms. Similarly, Temberly *et al*. (1996), recommended dosing the breeding females towards parturition in order to reduce pasture contamination and prevent the newly born kids from being exposed to heavily contaminated pastures. Waghorn and Shelton (1995) suggested the feeding of tannin-rich plants to goats in order to control gastro-intestinal parasitism. On the other hand, provision of improved goat housing aimed at reducing contact of goats with worm eggs was recommended by Kusina *et al*. (1999).

### 2.2.3 Housing

In Zimbabwe, over 50 % of all kid deaths were reported to be a result of the lack of appropriate housing (Chikura, 1999). The poor housing offered little or no protection against wind, cold, rain and muddy conditions (Shumba, 1993). Shumba (1993) cited lack of knowledge on the adverse effects of inappropriate goat housing, as the main reason behind construction of poor goat housing structures. Lack of appropriate shelter resulted in the prevalence of diseases such as pneumonia, foot rot and internal parasites. According to Obwolo (1993), foot rot caused lameness. This condition was associated with painful swollen legs (Linklater, 1993) and reduced the foraging ability of the affected animals. Consequently, the animals lost body condition and were more susceptible to other diseases. Improvement of goat housing in addition to prophylactic treatment and better nutrition were observed to reduce pre-weaning kid mortality (Matika and Sibanda, 1993; Mtenga *et al.,* 1994).

### 2.2.4 Conclusion of the Literature Review

Traditionally managed goats relied mostly on communal rangelands and crop residues to meet their nutritional requirements (Nyamangara, 1991). However, the seasonal fluctuation of rangeland forages impaired the reproductive performance of does (Kusina and Kusina, 1998). Supplementary feeding using farm by- products such as sunflower cake improved the fertility of cows (Chimonyo, 1998) and sheep performance (Kadzere *et al*., 1991) but there is little information on their use as a goat supplement.

The viability of smallholder goat production has also been threatened by lack of proper health care of the goats (Kusina *et al*., 1999). As a result, diseases and poor housing of the goats caused worm infestations, reduced liveweight gains, poor reproductive performance and high kid mortality (Obwolo, 1991; Pandey *et al*., 194; Kahiya, 1997). A holistic approach in research towards finding solutions to the problems of goat management systems, nutrition and goat health is, therefore, necessary.

# CHAPTER 3

## 3.0 THE EFFECT OF TETHERING AND HERDING MANAGEMENT SYSTEMS ON THE PRODUCTIVITY OF MASHONA GOATS REARED BY SMALLHOLDER FARMERS IN RUSHINGA COMMUNAL AREA OF ZIMBABWE

### 3.1 Introduction

In Zimbabwe, over 97 % of the goat population is kept by smallholder farmers (Central Statistics Office, 2000) under traditional extensive or semi extensive systems of management. The goats play an integral but secondary role on the smallholder farms (Kusina *et al.*, 2001). In general, the farmers give little or no veterinary care to the animals and they rarely provide supplementary feeding and as a result, the productivity of the goats is low. Most of the farmers have small goat flocks with numbers varying from 2 to 10 goats per flock (Chikura, 1999).

The goats are normally herded or tethered during the cropping season so as to prevent them from damaging field crops but after harvesting, the goats are allowed to forage freely. Goats are very agile animals and this makes them difficult to herd (Shumba, 1993). Herding is normally done by children of school going age. As a result, most of the goats are released from pens for foraging late in the afternoon when the children have finished school. The late release of the goats limits the time that they spend grazing and this results in low daily forage consumption.

Farmers who own small flocks and whose farm labour is usually tied up in other farming activities either tether their goats by the roadside, or in crop alleys or on communal rangelands during the rainy season. However, the effects of tethering or herding on the performance of goats are not well known. Most of the research work that has been done on goats has concentrated on improving the reproductive performance and health of the goats (Obwolo, 1991; Kusina *et al*, 2001) and has over-looked the management aspect of goat production. As a result, there is limited information on the effect of traditional goat management systems on goat performance. The objective of this study was, therefore, to investigate the productivity of goats reared under tethering and herding management systems in a communal area of Zimbabwe with the view to improve efficiency of production.

## 3.2 Materials and Methods

### 3.2.1 Study site

This study was carried out in Kamanika Ward, Rushinga East District of Zimbabwe over a period of two years, i.e. from March 2001 to March 2003. Kamanika ward is located in Natural Region IV and it lies between 27 $^{o}$ S and 33 $^{o}$ E latitude and longitude, respectively. The area has erratic rainfall patterns with a mean annual rainfall ranging from 400-600 mm per annum. The precipitation is normally received during the months of November to April. The mean monthly minimum and maximum temperatures are 14.1 $^{o}$C and 28.6 $^{o}$C, respectively.

The vegetation is characterised by sparse baobab trees and thorn bushes scattered on the communal rangelands. The leaves and/ or pods of the thorn bushes contribute significantly to the browseable component of the diet of the goats. The common thorn trees include, *Acacia tortilis, Acacia gerrardii, Acacia nilotica* and *Dichrostachys cinerea*.

The landscape of the area is characterised by a hilly and rocky topography, which is not suitable for cropping, although some cultivation of cotton and maize was done on the rough terrain and also along stream banks. However, some of the stream banks are littered with holes dug up by gold panners in search of gold.

### 3.2.2 Animals, Management and Study Design

The study was a randomised complete block design where twenty-four flocks of Mashona goats, belonging to 24 local smallholder farmers, who were willing to participate, were used. The flocks were selected from three flock size groups (1-5, 6-10 and more than 10 goats per flock). The blocking was done by flock size and the flock sizes were chosen based on the ownership patterns of goats, with most farmers having goats that were within those numbers. In addition, the attention given to individual goats by farmers varied depending on flock size, hence, flock size was expected to influence the performance of goats. The selected flocks were then randomly allocated to either the tethering or herding management systems in equal numbers such that there were 4 flocks per management system per flock size group (Table 3.1). All the goats in the study flocks were ear-tagged for identification. The kids were ear-tagged within 48 hours of birth. The smallholder farmers retained ownership of their goats and they were free to decide on when to sell, slaughter or change flock management from free ranging to tethering or vice versa according to the season. However, the farmers were required to record all the events related to goat management.

### 3.2.3 Records and measurements

The farmers were given books into which they recorded incidences and types of diseases occurring in their flocks, birth type, birth weight and liveweights of the rest of the flock, causes of change in flock sizes and the time the goats were allocated for foraging (see Appendix 1). In addition, the farmers recorded the length of the tethering ropes, the criteria that they used to select particular herding or tethering sites (see Appendix 2), the

**Table 3.1: Allocation of flocks to tethering and herding management systems**

| Management System | Flock size groups | | |
|---|---|---|---|
| | **1 to 5** | **6 to 10** | **+10** |
| Herding | 4 | 4 | 4 |
| Tethering | 4 | 4 | 4 |
| Total | 8 | 8 | 8 |

frequency of changing tethering spots per day and watering periods. The farmers also supplied information on how the kids were managed. Every evening, the farmers inspected their goats to check for injuries caused by tethering or those that were incurred during foraging.

The liveweight measurements were done in the morning before the goats were let out for grazing. The weighing was done by means of a canvas sling, which was strapped around the ventral part (i.e. abdomen and chest area) of the goat and hung onto the hook of a spring balance (100 kg Class 2 Spring Balance Scale, Kattleway, Marondera, Zimbabwe) at each farmer's goat pen.

The flock inventory data explained changes in flock composition and also gave an insight into the economic contribution of goats to household income. All exits or withdrawals (e.g. deaths, sales, thefts) from flocks and inflows (e.g. purchases, gifts in, and births) were recorded by each farmer as they occurred. The withdrawals and inflows were computed into incidence rates which were defined as the intensity of change by which goats in dynamic flocks assumed the event of interest, for example the number of goats that were born, sold, slaughtered or those that died (Toft, Agger, Houe and Bruun, 2002). Incidence rates, for example death rate, were calculated as follows:

$$\text{Death rate} = \frac{\text{Number of goats that died during the study period}}{\text{Time at risk}}$$

The time at risk was the number of time units i.e. goat days, from when the goat was introduced into the study up to the time when it died or when the study came to an end.

$$\text{Time at risk (goat days)} = \frac{\text{(Number of goats at start + Number of goats at end)}}{2} * \text{Time period}$$

The time period was the number of days between successive visits to the study site. In the calculation of kidding rate, only the breeding females contributed to the goat days. The rearing females contributed to goat days (breeding female days) at the time of first parturition (Chikura, 1999).

Kidding interval was obtained from 14 does that kidded twice during the study (from March 2001 to March 2003). Kidding interval was calculated as the number of days between successive kiddings of each doe during the study period. Prolificacy was calculated as the number of kids born per kidding (Alexandre, Matheron, Chemineau, Fleury, and Xandé, 2001).

### 3.2.4 Data Analysis

The General Linear Models procedure (GLM) (SAS, 1996) was used to analyse incidence rates, the effects of flock management, flock size and season of birth on birth weight and liveweight at six months, kidding interval (KI) and age at first kidding (AFK). Seasons were grouped by rainfall pattern, i.e. the rainy season (November to April) and the dry season (May to October). Regression equations on kid growth rate were derived using the PROC REG procedure of SAS (SAS, 1996). The linear statistical model used was as follows:

$$Y_{ijkln} = \mu + S_i + Y_j + F_k + M_l + FS_{ki} + MS_{li} + FM_{kl} + MFS_{lki} + E_{ijklm}$$

Where,

$Y_{ijkln}$ = dependent variable under analysis (e.g. birth weight),

$\mu$ = overall mean common to all observations,

$S_I$ = effect due to season (i = 1 to 2),

$Y_j$ = effect due to year of birth (j = 1 to 2),

$F_k$ = effect due to flock size (k = 1 to 3),

$M_l$ = effect due to management system (l = 1 to 2)

$FS_{ki}$ = interaction of flock size and season,

$MS_{li}$ = interaction of management system and season,

$FM_{kl}$ = interaction of flock size and effect of management system,

$MFS_{lki}$ = interaction of management system, flock size and season, and

$E_{ijkln}$ = random residual error distributed as $\sim N(0; I\delta e^2)$.

### 3.4 Results

The time that was allocated for grazing under both management systems ranged from 5 to 10 hours per day. The goats that were tethered were grazed in crop alleys, just outside homesteads, by the road side, near vegetable gardens and also in the communal grazing areas. The tethering spot had to be close to where the farmer was doing his or her farming activities for ease of changing the tethering sites once the current spot had been well grazed. The tethering rope varied in length from 2 to 5 m. The goats under herding management foraged in the communal grazing areas or in hills close to homesteads.

#### 3.4.1 Reproductive Performance

A total of twenty-one, and forty-eight births were recorded for does that were reared under tethering and herding management systems, respectively. In 2001, most of the kiddings by goats under both management systems occurred in the months of March to April and September to December (Figure 3.1). However, in the year 2002, most of the kiddings in

flocks that were tethered were spread from March to June compared to that of flocks that were herded which occurred mainly in April.

Kidding rates ranged from 3.11 ± 3.37 to 8.58 ± 2.75 and 4.18 ± 2.13 to 5.75 ± 2.75 kiddings/100 does/doe-year in flocks that were herded and those that were tethered, respectively (Table 3.2). Overall prolificacy values ranged from 1.0 to 2.33. The season of conception and the management system that was practised had no effect on prolificacy ($P > 0.05$). Out of a total of 69 does that kidded in this study, only 14 does kidded twice between March 2001 and March 2003. Ten of the does were from the flocks that were herded and the remaining four where from flocks that were tethered. Kidding interval ranged from 251.5 ± 15.7 to 365.5 ± 26.6 and 344.9 ± 22.1 to 499.4 ± 27.8 days in flocks that were herded and in those that were tethered, respectively. The kidding interval was not affected by the management system, flock size group, litter size in previous parturition or season of previous parturition ($P > 0.05$).

Out of a total of 58 female kids that were born, only four kidded during the two years of the monitoring study. All the four goats were from the 1 to 5 flock size group. Two of the goats were from the tethering and the other 2 from the herding management systems. The mean age at first kidding was 484.5 and 366.5 days for the tethered and herded flocks, respectively.

### 3.4.2 Off-take

Slaughter rates (see calculation in Section 3.2.3) were low and they ranged from 0.46 ± 2.52 to 10.51 ± 3.09 and 0.83 ± 2.51 to 0.92 ± 1.95 cases/100 goats/goat year in the herded and tethered flocks, respectively (Table 3.3). The slaughter rates were not influenced by the management system that was practised by the farmers ($P > 0.05$). The breeding females were

the preferred class of animal for slaughter (contributing 28.57 %; i.e. 8 out of 28 animals). Although slaughters were spread throughout the study period, there were distinct peak slaughter periods, which occurred in December 2001 and 2002 when 21.4 % (6 out of 28 animals) were slaughtered.

Goat sales were not significantly affected by management system (P > 0.05). Approximately 91.7 % (11 animals out of 12 ) of the sales were from flocks that were herded. About 83 % (10 out of 12 animals) of the total sales occurred in 2002. Most animal sales occurred in January, May, July and September.

### 3.4.3 Goat Losses

The farmers lost a few goats and the losses were a result of deaths and animals that went missing. The goats that went missing and were never recovered were presumed dead. Death rate was low (i.e. 0.19 ± 0.59 to 2.34 ± 0.73 cases/100 goats/goat year) in both management systems. Fifty eight percent (7 out of 12 animals) of the goats that died were kids. The majority of the deaths were due to predation by baboons or injuries inflicted by aggressive goats on the young and weak goats.

### 3.4.4 Flock Dynamics

The numbers of goats per flock were significantly influenced by the interaction of the goat management system with flock size group (P < 0.05). The mean number of goats in the flocks that were herded in the flock size group with > 10 goats were initially more than those in the flock size group of 6 to 10 goats. However, as the study progressed, the goat numbers in the 6 to 10 flock size group rose above that in the flocks size group of > 10 goats (Figure 3.2). On the other hand, the number of goats in the 6 to 10 flock size group of goats that were tethered

was higher than that in the 1 to 5 flock size group for most part of the study period.

### 3.4.5 Growth Rate

The birth weight and liveweight of kids at six months of age were significantly affected ($P < 0.01$) by the interaction of the management system, flock size and season of birth (Appendix 3). The kids that were born during the dry season had higher birth weights and live weight at six months than those born during the rainy season.

## 3.5 Discussion

### 3.5.1 Kidding Pattern

Most of the kidding occurred during months that coincided with the harvesting of crops (March to June) and the onset of rains (November to January) in both 2001 and 2002. The kidding pattern observed in this study was in agreement with the results obtained by Chikura (1999) in Wedza communal area of Zimbabwe. The months in which peak kidding occurred were characterized by improved nutritional availability. The delay in peak kidding that was observed in 2002 was attributed to the erratic nature of rainfall received in the 2001 to 2002 rain season. The delay in peak kidding was similar to the observations made by Sibanda *et al.* (1997[b]), who noticed that peak kidding was delayed by the late onset of rains.

The does that kidded between March and June and between November and January in 2001 and 2002 had conceived between November to January and June to September of the previous year, respectively. The conception periods coincided with the onset of the rainy season and the period of free ranging, respectively. The farmers in the study area switched from tethering or herding management system to free ranging management system between the months of May and June. This switch in management practice allowed the goats to have free access to veld forages and promoted mating. In addition, the free ranging offered a flushing period to does which may have improved conception rates.

Kusina *et al.* (2001) reported that the diminished nutritional supply during the dry periods of the year resulted in poor ovarian activity which led to seasonal patterns of peak kidding. Alexandra *et al* (2001) added that the sudden exposure of does to bucks increased the reproductive activity in seasonally anovulatory does which synchronized breeding activity. The increased reproductive activity due to the presence of a male is thought to have occurred to does in flocks that were tethered but did not have bucks, when management was switched to free ranging.

### 3.5.2 Kidding Rate and Prolificacy

Kusina *et al.* (2001) reported kidding rates that ranged from 73 to 93 % in goats that were managed on a research station and were offered feed at varying energy levels. These kidding rates were higher than those obtained in this study. The kidding rates obtained in this study were also lower than those reported by Chikura (1999) who recorded kidding rates as high as 106%. The wide variation between the kidding rates observed in this study compared to those obtained by other scientists may have been due to differences in the computation of kidding rates. For example, Chikura (1999) defined kidding rates as a percentage of the number of parturitions per number of animal days multiplied by 365 and presented the results as risk rates. However, the results in the current study were presented as risk rates and the derivation of the animal days were also different from the author's. Kidding rates were thought to be increased by the culling of infertile does (Sibanda *et al.,* 1997[b]).

The lack of a significant effect of management system on the prolificacy of goats meant that the farmers could switch from one management system to another, depending on the availability of labour, without compromising prolificacy. The prolificacy values obtained in this study were similar to those reported by Kusina and Kusina (2000) who recorded values ranging from 1.50 to 1.60. Other researchers (Ndlovu and Simela, 1996; Mhlanga, Khombe and Makuza, 1999) observed lower prolificacy values which ranged from 1.2 to 1.32 in Mashona goats.

Wilson (1989) mentioned that the ovarian activity was sensitive to nutritional stress and tended to decrease when feed became scarce. An increase in the level of nutrition of small ruminants before mating resulted in increased ovulation rate, which translated to an increase in prolificacy (Jainudeen and Hafez, 1993). The high prolificacy obtained in this study was probably a result of the occurrence of peak conceptions during periods of adequate nutrition. Most of the goats under both management systems in this research work conceived during periods of free ranging and at the onset of rains when the animals had access to high levels of nutrition.

### 3.5.3 Kidding Interval

The kidding intervals in tethered goats tended to be longer than in flocks that were herded, although the differences were not significant. These kidding intervals were similar to the values of 403 and 304 days reported in Matebele goats that kidded during March to April and September to December periods, respectively (Sibanda *et al.,* 1997[b]). The later kidding interval was a result of conceptions that occurred between April an July i.e. free ranging period. The kidding intervals observed in the current study were long and could not support a breeding programme which would result in three kiddings in two years (Alexandre *et al*., 2001). Although the season of previous kidding had no significant effect on kidding interval, there was a tendency of a longer kidding interval in does that had kidded during the previous dry season compared to those that kidded during the rainy season. This observation was consistent with the results obtained by other researchers. Ndlovu (1992) suggested that the long kidding intervals in does that kidded and lactated during the dry season was due to nutritional stress. Nutritional stress during lactation resulted in a high negative energy balance in does that delayed the resumption of post-partum oestrus, and this prolonged the kidding interval (Devendra and Burns, 1983).

The lack of a significant effect of prolificacy in previous parturition on the kidding interval was in contrast to the findings by Okello (1993) who noted that does with twin births were associated with longer kidding intervals. The observations made in the current study could be due to the small sample size.

Out of the 58 female kids that were born during this study, only four of the kids gave birth when they were on average 366.5 and 484.5 days old for the herded and tethered flocks, respectively. There is, therefore, a need to improve the management of goats in order to promote the young does to kid early.

### 3.5.4 Off-take

The slaughter rates and sales that were recorded in this study were low in both goat management systems. Most of the slaughters occurred in December, which was a festive season. However, most of the sales were done in January, May, July and September. These periods coincided with the reopening of Zimbabwean schools, a time when farmers had to sell goats to raise school fees. This observation was consistent with other reports that goats were mostly kept as a form of a savings account which was only liquidated to meet immediate and compelling financial needs (Chikura, 1999). However, this marketing strategy prejudiced the producers in that buyers took advantage of the desperate need for cash by the farmers by offering low prices for the goats.

### 3.5.5 Goat Losses

The death rate that was observed in this study was low compared to the high mortality levels that were generally reported in goats managed under the traditional systems of production (Pandey *et al.*, 1994). This difference was probably due to the hot and dry conditions experienced in the study area during the greater part of the study period. Such dry and hot conditions reduced the prevalence of parasites and diseases which promoted good health.

### 3.6 Conclusions and Recommendations

The current study revealed that rearing goats under either the tethering or herding management systems resulted in no significant differences in the productivity of the goats. However, there was a low off- take and high reproductive wastage as indicated by the low sales and slaughters, a small percentage of kids that kidded at a young age, long kidding intervals and low kidding rates for both management systems.

The low overall mortality rate observed in this study and the above average prolificacy signified a high productive potential that could be used to increase goat production in the communal areas. However, more studies are needed to promote goat marketing, high growth rate of the kids and the reduction of reproductive wastage so that goat production can be viable in the communal areas. Strategic supplementary feeding methods need to be considered to offset nutritional stress which occurs during lactation and periods of dry spells. Cheap antihelminthic methods to ease the worm burden during the rainy season need to be developed. Such interventions are likely to enhance goat production in the communal areas.

## CHAPTER 4

## 4.0 EFFECTS OF SUPPLEMENTARY FEEDING USING SUNFLOWER CAKE ON THE FERTILITY AND OVERALL FLOCK PRODUCTIVITY OF MASHONA GOATS

### 4.1 Introduction

Improving the reproductive performance of goats is important in increasing meat production from smallholder farms (Alexandre *et al*., 2001). The goats that are kept by most smallholder farmers in the tropics are not influenced by photo-period to reproduce and are, therefore, expected to kid throughout the year (Llewelyn *et al.*, 1995). However, Chikura (1999) observed that although the indigenous goats in Zimbabwe kidded throughout the year, they exhibited two main kidding periods, which were March to April and August to November. Sibanda and Ndlovu (1999) noted that the conceptions that were related to the peak kidding occurred during periods of improved nutritional availability.

In their study, Sibanda and Ndlovu (1999) reported that nutritionally stressed pregnant does mobilised body reserves to provide nutrients to their foetus. However, a prolonged mobilisation of body reserves by the pregnant does caused severe loss of body condition, which was followed either by birth of weak kids that had little chance of survival or, in extreme cases, the death of both the dam and the foetus. Nutritional stress was, therefore, the major cause of low productivity (Ndlovu, 1992), especially during late pregnancy and lactation when energy and protein requirements were high.

The objective of this study was, therefore, to improve the reproductive performance of does by offering them sunflower cake as supplementary feed during pregnancy and lactation. Sunflower cake was selected as an ideal supplement since over 30 % of arable land owned by some smallholder farmers was used for the cultivation of sunflower (Chimonyo, 1998). The majority of the smallholder farmers extracted oil from the sunflower seeds on-farm, leaving behind a residue that could be used as supplementary feed.

## 4.2 Materials and Methods

### 4.2.1 Study site

A detailed description of the study site was given in Section 3.2.1

### 4.2.2 Animals and Experimental Design

The design of the study was a randomised complete block design where thirty-six goat flocks belonging to local smallholder farmers were used in this study which started in March 2001 and ended in March 2003. Flock size was used as the blocking factor. The flocks were selected from three flock size groups (1 to 5, 6 to 10 and more than 10 goats/flock). The experimental flocks were then randomly allocated to three treatment groups (Section 4.2.3), in equal numbers (Table 4.1 explained in Section 4.2.3). Pregnancy diagnosis was not done because the available techniques (i.e. laparascopy, laparatomy and ultra- sound) are expensive and were not appropriate for the nature of the study and would not be well received by the communal area farmers. All the goats in the study flocks were ear-tagged for identification. The kids were ear-tagged within 48 hours of birth. The smallholder farmers retained ownership of the flocks and they freely decided on when to sell or slaughter the goats. However, the farmers were required to record any sales or slaughters.

### 4.2.3 Treatments

Foraging from communal rangelands formed the primary source of goat diet in all the three treatment groups. No supplementary feed was offered to the does in Group 1 (i.e. control

**Table 4.1: Allocation of flocks to the dietary treatment groups**

| Treatment group | Flock size groups | | |
|---|---|---|---|
| | **1 to 5** | **6 to 10** | **+10** |
| Group 1 (Control) | 4 | 4 | 4 |
| Group 2 | 4 | 4 | 4 |
| Group 3 | 4 | 4 | 4 |
| **Total** | **12** | **12** | **12** |

**Table 4.2: Chemical composition of the hand pressed sunflower cake**

| | g/ kg DM | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Feedstuff** | **DM** | **OM** | **CP** | **EE** | **NDF** | **ADF** | **Ca** | **P** |
| Sunflower cake | 904 | 868 | 176 | 115 | 448 | 449 | 0.3 | 4.3 |

DM: Dry matter

OM: Organic matter

CP: Crude protein

EE: Ether extracts

NDF: Neutral detergent fibre

ADF: Acid detergent fibre

Ca: Calcium

P: Phosphorus

group). The does in Group 2 were individually offered 270 g of hand pressed sunflower cake in the morning before they were let out for grazing, during the first 60 days of lactation. Those in Group 3 were offered the same amount of sunflower cake per day starting from late pregnancy and for the first sixty days of lactation. Table 4.2 shows the chemical composition of the sunflower cake.

### 4.2.4 Records and measurements

Farmers were given record books into which they recorded kiddings, abortions, sales and purchases of goats, deaths and diseases as they occurred in their flocks. Data on births captured the date of parturition, prolificacy, sex of kids, birth weight, month of conception and identity of the dam. The female kids were monitored from birth up to their first parturition in order to determine the age at first kidding and, later, kidding interval. The month of conception was estimated by subtracting five months from day of parturition on the basis of an average gestation length of 150 days in goats. The initial weight of kids was measured and recorded within 48 hours of birth. Thereafter, weighing of kids was done twice a month at two-week intervals to assess growth rate from the start (March 2001) up to the end (March 2003) of the experiment. The weighing process and the calculation of sales rates, slaughter rates, death rate, kidding rate and prolificacy were as described in Section 3.2.3.

### 4.2.5 Data Analysis

The General Linear Model Procedures (GLM) (SAS, 1996) were used to analyse the effects of supplementary feeding, flock size and season of birth on birth weight and liveweight at six months, kidding interval (KI), age at first kidding (AFK) and off- take and death rates. Seasons were grouped into the rainy season which extended from November to April and the dry season extending from May to October. Regression equations on kid growth rate were derived using the PROC REG procedures of SAS (SAS, 1996). The linear statistical model used was as follows:

$$Y_{ijklm} = \mu + S_i + Y_j + F_k + T_l + FS_{ki} + ST_{il} + FT_{kl} + TFS_{iki} + E_{ijklm}$$

Where,

$Y_{ijklm}$ = dependent variable under analysis (e.g. birth weight),

$\mu$ = overall mean common to all observations,

$S_I$ = effect due to season (i = 1 to 2),

$Y_j$ = effect due to year of birth (j = 1 to 2),

$F_k$ = effect due to flock size (k = 1 to 3),

$T_l$ = effect due to feed treatment (l = 1 to 3)

$FS_{ki}$ = interaction of flock size and season,

$ST_{il}$ = interaction of season and feed treatment,

$FT_{kl}$ = interaction of flock size and feed treatment,

$TFS_{iki}$ = interaction of feed treatment, flock size and season, and

$E_{ijklm}$ = random residual error distributed as ~N(0; $I\delta e^2$).

**4.3 Results**

**4.3.1 Reproductive Performance**

A total of 227 births was recorded from the experimental does. Only one doe in supplementary Group 3 aborted. The pattern of kidding by month and year of birth is shown in Figure 4.1. Kiddings occurred in all months of the study period. The highest number of births during the first year occurred in March and December (29.03 %), October and November (38.38 %) and April and September (16.67 %) for Group 1, Group 2 and Group 3

does, respectively. During the second year, peak kidding occurred in March and October (9.68 %), April and November (13.13 %), and January and October (18.18 %) in Group 1, Group 2 and Group 3, respectively.

The results on kidding rates, age at first kidding, kidding interval and prolificacy are shown in Table 4.3. There was no significant effect of supplementary feeding on kidding rates ($P > 0.05$). The kidding rates were low in all the three groups and ranged from 1.61 ± 1.21 to 5.60 ± 1.40 (LS Mean ± SE) kiddings per flock of 100 does per doe year in flocks in the control group and the flocks that were offered supplementary feed.

A total of 47 kidding intervals were calculated. Flock size had a significant effect on the interval between successive kiddings ($P < 0.05$). Generally, the kidding interval decreased with increase in flock size (Table 4.3). Supplementary feeding and season of previous kidding did not have a significant effect on the interval between successive kiddings ($P > 0.05$). However, there was a tendency of lower kidding intervals in supplemented flocks compared to non- supplemented flocks.

The age at first kidding was also not affected by supplementary feeding, season of birth or number of kids born at parturition ($P > 0.05$). However, there was a tendency of younger age at which first kidding occurred in kids born in Groups 2 and 3 compared to those born in Group 1 (Control).

Prolificacy was significantly affected by the interaction of flock size and season of mating ($P < 0.05$). In Groups 1 and 2, high prolificacy values were observed in does that were bred during the rainy season and were reared in flocks with goat numbers that ranged from 1 to 5

and those with more than 10 goats per flock. However, Group 3 does that were bred during the dry season had consistently higher prolificacy compared to does in the same group that conceived during the previous rain season.

### 4.3.2 Off-take

The off- take (slaughters and sales) rates were low and were also not significantly affected by supplementary feeding ($P > 0.05$). The slaughter rates ranged from 0.46 ± 0.46 to 1.36 ± 0.46 and from 0.00 to 0.59 ± 0.53 slaughter incidences per flock of 100 goats per goat year in the control and supplemented flocks, respectively (Table 4.4).

The sales rates ranged from 0.14 ± 0.36 to 0.71 ± 0.36 and from 0.00 to 0.97 ± 0.42 (Table 4.4) sale incidences per flock of 100 goats per goat year in the control and supplemented flocks, respectively.

### 4.3.3 Death Rate

The death rate per flock of 100 goats per goat year was very low in all the three groups. Death rate ranged from 0.19 ± 0.17 to 0.39 ± 0.15 and from 0.00 to 0.32 ± 0.21 (Table 4.4) mortality incidences per flock of 100 goats per goat year in the control and in the flocks that were offered supplementary feed, respectively. However, mortality rate was not significantly affected by supplementary feeding ($P > 0.05$).

## 4.4 Discussion

### 4.4.1 Reproductive Performance

Supplementary feeding of does with sunflower cake had no effect on the kidding pattern of the goats. This was possibly due to the fact that the sunflower cake was offered only to the does that had either already conceived or were in lactation. The supplementary feed was, therefore, expected to take effect on the kidding pattern in subsequent parturitions by does in Groups 2 and 3. In addition, a few does that had been offered sunflower cake were either sold, slaughtered or died and did not remain in their respective flocks long enough to be monitored during subsequent kiddings.

The kidding rates per flock of 100 goats per doe year that were obtained in this study were very low. Low kidding rates are mainly caused by either the occurrence of a high proportion of infertile does within flocks (Sibanda *et al*., 1997[b]), an inadequate number of bucks (Ndlovu, 1992), poor nutrition (Kusina *et al.,* 2001) or reproductive diseases. In this study, some farmers did not keep mature bucks in their flocks and relied on random mating on communal rangelands for their does to conceive. Kusina *et al.* (2001) achieved high kidding rates in indigenous goats by providing supplementary feed as well as synchronising oestrus through hormonal treatment. However, the use of hormonal treatment by resource poor farmers is not recommended since they cannot afford the hormones.

In this study, the observed young age at first kidding in supplemented flocks was due to the early attainment of puberty in the kids. Jainudeen and Hafez (1993) explained that the age at which puberty was attained was influenced, to a greater extent, by the liveweight of the kid, which was affected by nutrition and growth rate before and after weaning. It is possible that the kids that were born in supplemented flocks received sufficient milk from their dams, which promoted early attainment of a critical body weight that was necessary for puberty to be reached early. Lebbie and Manzini (1989) explained that early kidding was important since it increased economic turnover rates, created replacements and lead to rapid improvements in flock productivity.

The generally shorter kidding intervals that were observed in the supplemented flocks were an indication of some improvements in the reproductive activity. This observation indicated that the supplementary diet was able to reduce the energy deficit that was normally experienced by lactating does. Ndlovu (1992) reported that the high energy demands of lactation delayed the resumption of *post- partum* oestrus in lactating does. Devendra and Burns (1983) reported that the delayed resumption of oestrous activity prolonged the period between one kidding and the next conception. However, Ndlovu (1992) showed that it was possible to reduce *post- partum* anestrous period to below 50 days by feeding the animal adequately. In the current study, the kidding intervals appeared to be long in non-supplemented flocks which relied on communal rangelands to meet their nutritional requirements. The kidding intervals that were observed in supplemented flocks were similar to the 240 days interval that was required for three kiddings per doe in two years (Sibanda and Ndlovu, 1990).

The frequency of multiple births (twins or triplets) in Groups 1 and 2 was high for the does that had conceived at the onset of the rainy season. Conversely, Group 3 does that had conceived during the dry season had higher prolificacy compared to their counterparts that were bred during the rainy season. These observations were consistent with the findings that reproduction in nutritionally stressed and traditionally managed goats improved at the onset of rains and during the immediate post-rainy period (Lebbie and Manzini, 1989). At these times, there is an improvement in the quality and quantity of forages in the communal rangelands (Kusina and Kusina, 2000). Jainudeen and Hafez (1993) noted that increasing the level of nutrition that was available to goats just before mating resulted in an increase in ovulation rate which led to multiple births. This study demonstrated that supplementary feeding during pregnancy increased prolificacy in the subsequent conception in does that were later bred immediately during the following dry season.

#### 4.4.2 Off-take

The off- take per flock of 100 goats per goat year was low in all the three groups. This was in contrast to reports by Ndlovu (1992) who recorded very high slaughters and sales. In the current study, goats were only sold to meet immediate financial needs, especially school fees. The flock sizes were too small (i.e. 77 % of the flocks had goat numbers that ranged from 3-10 and the largest flock had a maximum of 15 goats) to promote regular sales or slaughters. In addition, the lack of established markets that paid satisfactory prices to the farmers may also have been a disincentive to sell goats. As a result, the farmers resorted to selling their goats only when an emergency that required the use of money arose.

#### 4.4.3 Death Rate

Low death rates were observed across all treatment and flock size groups. This observation was in contrast to the high mortality rates that were reported by other researchers (Pandey *et al*., 1994). It is possible that the hot conditions and low rainfall that prevailed in the study area, and improved nutrition created improved disease resistance and an environment that reduced disease incidences and parasitic challenge. Chikura (1999) noted that the wet season promoted infestation by parasites and diseases in goats. In addition, Shumba (1993) explained that exposure to cold and muddy conditions made the goats susceptible to diseases which led to high mortality rates in flocks.

### 4.5 Conclusion

Supplementary feed resulted in minor improvements in the reproductive performance of the does. In addition, some farmers did not have mature bucks in their flocks and were, therefore, encouraged to keep bucks so that does could be mated whenever they came on heat. It is also possible that there could have been some chronic internal parasitic infestations that masked expression of the benefits of supplementary feeding. There is, therefore, a need to carry out further studies aimed at establishing the prevalence and predominance of internal parasites and possible ways of controlling them.

## CHAPTER 5

## 5.0 THE EFFECT OF GOAT HOUSING AND ANTIHELMINTHIC TREATMENT ON PRE-WEANING KID DEATH RATE AND THE INFESTATION WITH GASTROINTESTINAL HELMINTHS

### 5.1 Introduction

Five types of goat housing have been identified in the communal areas of Zimbabwe (Monicat, Borne and Meron, 1991). The majority of these houses have earthen floors with walls that consist of poles or bricks and have either open roofs or are roofed with thatch grass or corrugated iron sheets. The goat houses vary in shape, size and the type of construction materials used. Most of them are poorly constructed and, therefore, expose goats to predators, windy weather, cold, rain and muddy conditions (Shumba, 1993). Exposure to these harsh conditions predisposes the goats to diseases such as pneumonia, foot rot, and internal parasites (Mtenga *et al.,* 1994).

Internal parasites are a major health problem in the livestock industry. They cause retardation in animal growth, poor reproductive performance, condemnation of goat carcasses at abattoirs and high kid mortality (Temberly *et al.,* 1996). Kid mortality depresses goat production at both commercial and smallholder levels (Singh, Singh and Lal, 1996). Mtenga *et al*. (1994) recommended the provision of appropriate shelter, de- worming against internal parasites and adequate nutrition as possible ways to reduce kid mortality. However, most smallholder farmers cannot afford to purchase antihelminthic drugs. Some of the farmers administer incorrect dosages to their animals and this often leads to drug resistance.

This study was carried out to determine the effect of goat housing and minimum antihelminthic treatment on the diversity and predominance of nematode infestation and pre-weaning kid mortality of goats reared in Rushinga communal area. The main objective of this study was to promote the survival of kids from birth to weaning.

## 5.2 Materials and Methods

### 5.2.1 Study site

A detailed description of the study site was given in Section 3.2.1.

### 5.2.2 Animals and Design of the Study

The design of the study was a 2 * 2 factorial experiment in an RCBD, where there were two housing treatments (improved and pole walled), two antihelminthic treatments (de-wormed and untreated) and flock size was used as the blocking factor. Thirty-six flocks of goats belonging to 36 local smallholder farmers who were willing to participate were used in the experimental study. The experimental study began in December 2001 and ended in May 2003. The flocks were randomly selected from three flock sizes (1 to 5, 6 to 10 and more than 10 goats/flock). The experimental flocks were then randomly allocated to 2 housing and 2 antihelminthic treatments at the rate of 3 flocks per type of housing per antihelminthic treatment per flock size group (Table 5.1). All the goats were ear-tagged for identification and the kids were closely monitored from birth until they attained six months of age in order to determine the kid death rates.

### 5.2.3 Treatments

The two housing treatments were pole walled houses and an improved goat house that was designed by the research team (Appendix 4). The pole houses were the original structures that were constructed by the farmers. These pole houses were built on earthen floors and had roofs that often leaked when it rained. The improved house had slated wooden floors, a grass thatched roof and well ventilated walls built from thin wooden poles. The goats were penned

**Table 5.1: Allocation of flocks (number of flocks per treatment) for the housing and antihelminthic treatments**

| Type of housing | Antihelminthic treatment | Flock size | | |
|---|---|---|---|---|
| | | **1 to 5** | **6 to 10** | **> 10** |
| Improved | Untreated | 3 | 3 | 3 |
| Improved | De- wormed | 3 | 3 | 3 |
| Pole | Untreated | 3 | 3 | 3 |
| Pole | De- wormed | 3 | 3 | 3 |
| **Total** | | **12** | **12** | **12** |

every evening in the respective housing treatments. One half of the flocks in each housing type and flock size group was treated against internal parasites with Valbazen (manufactured by Pfizer, Registration Number 54/00781/07, South Africa) and the other half was not treated. The antihelminthic drench was administered in measured amounts using a graduated syringe once every six weeks during the rain season (i.e. November to April) and once every three months during the dry season (i.e. May to October). The quantity of the antihelminthic drug that was administered to each animal was based on the liveweight of the animal.

### 5.2.4 Records and Measurements

The farmers were given record books into which they recorded all births, birth weights of kids, birth type, abortions, sales and purchases of goats, slaughters, diseases and deaths as they occurred in the experimental flocks. Initial liveweights of kids were measured and recorded within 48 hours of birth as handling of kids was only permitted by the farmers after the kids appeared strong enough to be handled and amniotic fluids had dried-off. The kids were closely monitored from birth to six months of age in order to determine pre- weaning kid mortality. The death rate of the kids and prolificacy of the does were calculated as described in Section 3.2.3. In addition to the reported or confirmed deaths, the pre-weaning death rate also included the young animals that disappeared from the flock and were never recovered. These kids were, therefore, assumed to have died.

### 5.2.5 Parasitological Examination

Rectal samples of faeces were collected from the goats and kids once every month from December 2001 to May 2003. The faecal samples were placed in labeled plastic bags and stored at 4 $^{o}$C until they were processed for nematode faecal egg counts and identification of nematode larvae.

The number of eggs per gram (epg) of faeces was determined using the modified McMaster technique (Hansen and Perry, 1994). Composite larval cultures were prepared from the faecal samples of each antihelminthic treatment for the determination of the composition of the genera of *Trichostrongylids* affecting the goats.

**5.2.6 Data Analysis**

The data on eggs per gram (epg) of faeces was transformed to log(epg + 1) in order to conform it to the normal distribution, and the transformed data were analysed using SAS General Linear Models procedures (Proc GLM) (SAS, 1996). The results were back-transformed by taking anti- logarithms of the Least Square Means and presented as geometric means (Baker *et al.,* 1998). The General Linear Models procedures (Proc GLM) were also used to analyse the effect of type of housing and antihelminthic treatment on birth weight, prolificacy and pre-weaning kid death rate (Appendix 5). The linear statistical model used was as follows:

$$Y_{djkno} = \mu + S_d + F_j + H_k + M_n + HS_{kd} + HF_{kj} + SM_{dn} + FM_{jn} + HMS_{knd} + HMF_{hnj} + E_{djkno}$$

Where,

$Y_{djkno}$ = variable under analysis (e.g. eggs per gram of faeces),

$\mu$ = overall mean common to all observations,

$S_d$ = effect due to season (d = 1 to 2),

$F_j$ = effect due to flock size (j = 1 to 3),

$H_k$ = effect due to type of goat housing (k = 1 to 2),

$M_n$ = effect due to antihelminthic treatment (n = 1 to 2),

$HS_{kd}$ = Interaction of type of housing and season,

$HF_{kj}$ = Interaction of type of housing and flock size,

$SM_{dn}$ = Interaction of season and antihelminthic treatment,

$FM_{jn}$ = Interaction of flock size and antihelminthic treatment,

$HMS_{knd}$= Interaction of type of housing and antihelminthic treatment by season

$HMF_{knj}$= Interaction of type of housing, antihelminthic treatment and flock size, and

$E_{djkno}$ = Random residual error distributed as ~N(0; I$\delta e^2$).

## 5.3 Results

### 5.3.1 Births

There were two distinct periods of peak kidding during the study which were from March to July in 2002 and from October 2002 to January 2003 (Figure 5.1). The former kidding period coincided with the end of the 2001/2002 rainy season and the latter kidding period with the beginning of the 2002/2003 rainy season.

Birth weights were significantly affected by the interaction of type of goat housing and flock size ($P < 0.05$) (Table 5.2). Birth weights increased with an increase in flock size in goats that were sheltered in improved housing structures. On the contrary, mean birth weights decreased with an increase in flock size in goats kept in pole houses. However, there was no significant effect of season of birth, birth type and sex of the kid on mean birth weights ($P > 0.05$).

Mean prolificacy values ranged from 1.00 ± 0.37 to 1.67 ± 0.30 and 1.00 ± 0.37 to 2.00 ± 0.26 in goats sheltered under improved housing and wooden pole houses, respectively (Table 5.3). The prolificacy was not significantly affected by type of housing or by antihelminthic treatment ($P > 0.05$).

### 5.3.2 Pre-weaning Kid Death Rate

The pre-weaning death rate of the kids was low across all the treatments (Table 5.4) and was not affected by the type of housing or the antihelminthic drench ($P > 0.05$). Of the 35 deaths of kids that were recorded, 54 % were due to predation, 29 % resulted from diarrhoea, 14 % were due to unknown causes and 3 % were due to respiratory problems.

### 5.3.3. Faecal Worm Egg Counts

The eggs of *Coccidia, Strongyle* and occasionally *Moniezia* species were observed in the faecal samples. The excretion of *Coccidia* eggs in faeces was not influenced by type of housing or by the antihelmintic treatment ($P > 0.05$). However, the number of *Strongyles* eggs per gram of faeces was significantly affected by the type of housing and the interaction of antihelminthic treatment by month of the year ($P < 0.05$) (Figure 5.2). The mean number of *Strongyles* eggs per gram of faeces was $1.45 \pm 1.09$ and $1.91 \pm 1.10$ in goats housed in the improved and pole houses, respectively. The *Strongyle* egg per gram of faeces of goats sheltered in the improved housing were significantly lower than those in the traditional pole houses ($P < 0.05$).

### 5.3.4 Larval Cultures

The most prevalent nematode larvae in the faecal cultures were *Haemonchus contortus*, *Cooperia, Trichostrongylus* and *Strongyloides* (Table 5.5). Occasionally, some *Oesophagostomum* and *Bunostomum* species were also found. The prevalence of *Haemonchus contortus* was significantly affected ($P < 0.05$) by a three-way interaction of type of housing, antihelminthic treatment and season. The highest proportion of *Haemonchus contortus* larvae was in the faeces of untreated goats sheltered in pole houses and this

occurred during the rainy season (Table 5.6). Conversely, the least proportions of *Haemonchus contortus* were obtained in the faeces of untreated goats in the improved houses during the rainy season. The season of faecal collection significantly affected ($P < 0.05$) the prevalence of *Cooperia, Trichostrongylus* and *Strongyloides* species in the larval cultures. The faecal levels of these species were lower during the rainy season compared to the levels recorded in the dry season.

## 5.4 Discussion

Prolificacy was not significantly affected by the type of housing or the antihelminthic treatments. The lack of significant effects of treatments on prolificacy in this study was probably due to the fact that most of the does were already pregnant when the treatments were imposed in December 2001 as shown by births that occurred between December 2001 and May 2002. Unfortunately, pregnancy diagnosis had not been carried out before the study commenced due to the lack of relevant equipment and expertise (i.e. laparatomy, laparascopy and ultra sound techniques). The low prolificacy rates and their large treatment variation show that there is a potential in improving prolificacy. However, it was paradoxical that a tendency for lower prolificacy and birth weights was observed in de-wormed goats compared to what was recorded in the untreated flocks.

In this study, kid mortality was low and the mortality was not influenced by the type of housing or the antihelmintic treatment offered to the animals. Most (56 %) of the deaths occurred during the dry season. Fifty-four percent (n=19) of the deaths were due to predation by dogs and baboons and they occurred when kids were allowed onto the communal rangeland with their dams without supervision by shepherds. Similar observations were made by Sibanda *et al.* (1997[a]) who reported that lack of attention to kids immediately after birth resulted in most of the kid deaths that occurred within the first month of birth. All the diarrhoea related kid deaths (29 %) that were recorded in this study occurred in one flock and were, therefore, suspected to have been a result of poor management by the farmer.

There were generally low levels of infestation of goats by *Strongyle* species in the current study. The goats that were sheltered under the improved housing had low faecal egg counts compared to those under the pole housing. This observation supports the reports by Mukasa-

Mugerwa (1996) that goats maintained on slated floors had low levels of nematode infection. The raised and slated floors, in this study, could have reduced the chances of re- infestation by third stage larvae since the faeces carrying the infective agent were beyond the reach of the goats.

The infestation rate by *Trichostrongylides* of *Cooperia, Trichostrongylus* and *Strongyloides* species was unexpectedly higher during the dry season compared to the rain season. However, the magnitude of the difference in seasonal infestation rate by these parasites was small. On the contrary, the prevalence of *Haemonchus contortus* was high in the faeces voided during the rainy season. A similar pattern of *Haemonchus contortus* infestation by season was noted by Kusina *et al*. (1999) who reported that rangeland conditions during the dry season destroyed the free-living stages of the parasite. In order to ensure its survival, *Haemonchus contortus* underwent a period of arrested development during the dry season and the adult worm formed a long part of the parasite's life cycle (Jackuiet, Cabaret, Thiam and Cheikh, 1998). The third stage larva was the infective stage and was mostly common in the rainy season, hence the high prevalence of infestation. These survival strategies resulted in low infestation rates by the parasite during the dry season.

Mukasa-Mugerwa (1996) reported that *Haemonchus contortus* was the most important species of the helminth parasites that caused parasitic gastro-enteritis and resulted in high kid mortality that occurred during the rainy season in many countries. It is probable that the effects of worm burden, in this study, were minimised by the low rainfall that was received in Rushinga and the availability of the browse component in the natural rangelands during the rainy season (Vatta, Krecek, Letty, van der Linde, Motswatswe and Hansen, 2002). In the current study, goats in all the treatment groups had access to *Acacia* trees, some of which have been reported to contain condensed tannins (CTs). Kahiya (2002) reported that goats fed *Acacia karroo* and *Acacia nilotica* leaves showed low infestation levels when they were inoculated with *Haemonchus contortus*. The finding was attributed to the antihelminthic effect of condensed tannins that were present in the *Acacia* spp leaves. Therefore, nutrition may have contributed to the low levels of infestation that were observed in the current study.

**5.5 Conclusion and Recommendations**

The study showed low internal parasite infestations in both treated and untreated goats and it was concluded that the use of antihelminthics in the study area was not necessary. Infestation rates were lower in the improved houses than those observed in the traditional pole goat-housing structures. Smallholder farmers were, therefore, encouraged to construct cheap and appropriate shelters, and to allow goats access to *acacia* browse forage as a means of reducing infestations by helminthes.

Pre-weaning death rate was low and was not influenced by type of goat housing. The major cause of kid deaths in this study was negligence of goats by the farmers when goats were allowed to forage without the attention of shepherds. This type of management exposed the kids to predators. Such losses could easily have been avoided if the young kids were restricted to the homesteads until they were old enough to outrun the predators.

Prolificacy was low but showed a potential to improve in untreated goats, which had the highest rates. There is need to carry out investigations on reduced ovulation rate or the possibility of loss of embryos in early pregnancy and reduced foetal growth resulting from antihelminthic treatment.

# CHAPTER 6

## 6.0 GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

### 6.1 General Discussion

Three systems of goat management were operational in Rushinga communal area. The management systems were either herding or tethering of goats during the rainy season and free ranging during the dry season. These management systems were similar to those done by other rural farmers in most African countries (ILRI, 1998).

Three hypotheses were stated at the beginning of this study and these were: goat management systems did not affect goat productivity, which was generally viewed as sub-optimum (Kusina, 2000), and that supplementary feeding, provision of housing and antihelminthic drugs did not improve doe fertility and kid survival from birth to weaning. The results from this study confirmed the first hypothesis. However, supplementary feeding and provision of housing and antihelminthic drugs had little effect on fertility, kid death rate and the prevalence of parasitic infestations.

#### 6.1.1 Management Systems

The tethering or herding of goats was mostly done from November up to May of the following year. Similar to earlier observations (Shumba, 1993), restriction of goat movement through these management systems was done to prevent crop damage. In the current study, the choice of which management system to use, between tethering or herding, depended mainly on the availability of labour. In another study, Mahanjana and Cronje (2000) observed that a considerable amount of labour and time was expended under the herding management system to guide grazing goats and return the flocks to the pens each night in order to protect them against harsh weather, predators and theft. Chikura (1999) reported that the farmers who had insufficient labour were forced to tether their animals. In this study, first priority in the allocation of labour was given to the cotton and maize fields. This was because the farmers expected to generate more cash and achieve food security from these crops. The general finding was that there were no differences in productivity between goats that were tethered or herded. It is possible that the long foraging periods (5 to 10 hours per day), frequent changing of tethering spots and the long tether which varied from 2 to 5 m in length allowed the tethered goats to eat same amounts of feed to the goats that were herded. The access to similar amounts and or types of feed is thought to have promoted similar levels of productivity among goats that were either tethered or herded in this study.

### 6.1.2 Kidding Pattern

In all the three studies (Chapters 3, 4 and 5), the kidding pattern of goats showed two distinct peak kidding periods, i.e. March to May and October to December. This was similar to earlier findings by Chikura (1999). The goats that kidded from March to May had conceived between the previous November to January period and those kidding in October to December were bred between the previous June to August months. The November to January conception period marks the beginning of the rainy season and hence establishment of new grass shoots (Kusina and Kusina, 1998). The improvement in the quantity and quality of forages available in the communal rangelands may have promoted ovarian activity in goats. During the June to August period, goats were allowed to forage freely in the grazing areas. This enabled the goats to select the more nutritious browse and also allowed the flocks that had no bucks to get access to mature fertile males. In addition, the presence of a male could have activated ovarian function of does in such flocks when they were suddenly exposed to bucks during free ranging (Alexandre *et al.,* 2001).

It was expected that supplementary feeding would promote uniform kidding throughout the year. However, supplementary feeding did not change the kidding pattern of goats. This finding was in contrast to reports by Kusina *et al*. (2001) who observed that supplementary feeding promoted ovarian activity which was expected to cause uniform breeding activity throughout the year. It is probable that the supplementary feed was not sufficient enough to effect uniform kidding pattern or some of the supplemented does did not stay long enough (i.e. due to sales, slaughters and deaths) to be monitored throughout the study period, or the two year study period was not long enough to allow shifts in kidding pattern to be observed.

### 6.1.3 Kidding Interval

The study established that, on average, the period between successive kiddings of a doe ranged from 211 ± 33 days to 499 ± 27 days. The longest kidding interval was observed in tethered goats (Chapter 3), whereas the shortest was in goats that received sunflower cake during pregnancy and lactation (Chapter 4). Nutritional stress on unsupplemented and lactating does most likely prolonged their kidding interval. Ndlovu (1992) reported that the energy demands of lactation could delay resumption of *post-partum* oestrus if the lactating does are subjected to severe nutritional stress. Therefore, supplementary feeding in Chapter 4 may have promoted early resumption of *post-partum* oestrus and reduced the kidding interval (Devendra and Burns, 1983; Ndlovu, 1992).

### 6.1.4 Prolificacy

The prolificacy of above 1.5 observed in this study (Chapters 3, 4 and 5) was higher than the 1.2 for Matebele goats reared in Southern Matebeleland (Sibanda *et al*., 1997[b]) and the 1.32 for Mashona goats in other parts of the country (Mhlanga *et al.,* 1999). Most of the does in Chapters 3 and 4 were bred at the onset of the rainy season and at the beginning of the dry season. These periods were characterised by an improvement in forage availability in the communal rangelands and crop residues on harvested fields, respectively. The improvement in the availability of forages in communal rangelands and access to crop residues from harvested fields provided improved nutrition which may have promoted multiple ovulation. Jainudeen and Hafez (1993), reported that nutritional adequacy enhanced ovarian activity which resulted in multiple births.

In Chapter 5, the goats that received the antihelminthic treatment tended to have lower prolificacy than the untreated does. It was envisaged that antihelminthic treatment would reduce worm burden, thereby making nutrients more available to goats so as to improve their body condition. It is probable that the worm remedy that was used resulted in early embryonic loss which reduced prolificacy in treated goats. The manufacturers of Valbazen, the worm remedy that was used, warned that an overdose of the drug could result in abortion. There is, therefore, a need to carry out investigations on the possibility of embryo loss even when the appropriate dosage is given.

**6.1.5 Age At First Kidding**

In Chapter 3, only 4 kids out of 58 female kids, that were born during the study period, gave birth. The finding indicated high reproductive wastage since the majority of the female kids took too long to reach puberty. Supplementary feeding of the dam (Chapter 4) resulted in most of the kids kidding within 332 ± 66 days to 357 ± 47 days from birth. The disparity in age at first kidding between kids in Chapter 3 and those in Chapter 4 indicates that it is possible for goats to kid at a young age, under smallholder management systems, by improving dam nutrition. Both supplementary feeding during lactation alone or pregnancy and lactation reduced the age at first kidding. The supplementary feeding provided the extra energy and protein which prevented weight loss in does, promoted milk production, increased growth rate of kids and resulted in early attainment of puberty. Early attainment of puberty was reported to promote young age at first kidding (Jainudeen and Hafez, 1993). A study by Lebbie and Manzini (1989) showed that young age at first kidding was important in that it produced replacements and resulted in rapid improvements in flock productivity.

### 6.1.6 Parasitic Infestations

A low rate of parasitic infestation was found in the current study and the use of antihelminthics in the study area was not necessary. It is probable that the hot and dry conditions which were experienced in the study area were not favourable for the proliferation of internal parasites. In addition, the access to *Acacia* trees by goats on communal rangelands may have had an antihelminthic effect due to the presence of condensed tannins which suppressed proliferation of nematodes (Kahiya, 2002). The improved housing was also able to reduce the infestation of goats by *Strongyle* parasites. The finding confirmed reports by Mukasa- Mugerwa (1996) that goats maintained on slated floors had low levels of nematode infections. However, the finding of a high proportion of *Haemonchus contortus* in the current study was a cause for concern. The parasite has been reported to cause high kid mortality, especially in parts of the country that receive high rainfall (Pandey *et al*., 1994; Mukasa-Mugerwa, 1996). There is, therefore, a need to monitor infestation rate by the parasite during the rainy season especially in view of the fact that *Haemonchus contortus* can be very pathogenic to young kids (Kusina *et al*., 1999) and can interfere with protein nutrition.

### 6.1.7 Off-take

This study established that farmers rarely sold or slaughtered their goats (i.e. less than 3.6 slaughter or sale incidences per flock of 100 goats per goat year). The few slaughters took place during the December festive season for Christmas celebrations, and also at funerals to feed mourners. On the other hand, sales were done mainly in January, May, July and September. The farmers confirmed that the main reason for selling their goats at those times was to generate school fees for their children. The low contribution of goats to household income was explained by the fact that most of the farmers who participated in the experimental studies grew cotton, a cash crop and at times ventured into gold panning along the nearby Mazoe River. Cotton sales were the main source of cash, especially in the immediate post harvest period (i.e. May to July). Thereafter, almost all households would leave their homes and go to camp along the Mazoe River for days or weeks panning for gold which they claimed paid them well.

In a different study that was done in South Africa, Mahanjana and Cronje (2000) reported that although goats performed multiple roles within communities, they were mainly used to accumulate and store wealth as a hedge against emergencies, and this attitude lowered sales. Sibanda *et al*. (1997[b]) postulated that regular sales of goats by culling old animals would promote off-take as well as improve flock productivity. Similar to the current study, Kusina and Kusina (2000) also observed that goat sales were few and irregular. The goat sales were not planned, but were driven by the need to generate immediate cash. Unfortunately for the producers, the buyers took advantage of their desperate need for cash and offered low prices which prejudiced the farmers.

### 6.2 Conclusion and Recommendation

In this study, there were no differences in productivity among flocks that were managed either through tethering or herding. It was, therefore, concluded that farmers could safely switch from either tethering or herding management practices without affecting the level of goat performance. However, the reproductive performance of the goats under all the experimental studies was low possibly due to a high proportion of infertile females or an inadequate number of mature bucks. The farmers are, therefore, urged not to castrate all their male kids but to keep at least a buck in their flocks in order to promote mating. In addition, infertile female goats need to be identified and culled as soon as possible so that resources can be channeled to productive goats with the aim of improving flock productivity.

It would appear that initiatives aimed at improving kidding rate and kidding interval of the goats could improve the consumption of animal protein by rural communities as well as increase goat sales. The preservation of forages during the rainy season for use during the dry season and the planting of high protein herbaceous or shrub forages may improve the plane of nutrition and, therefore, fertility of goats. However, several factors may limit the success of such initiatives and these include labour constraints and the lack of ready markets that pay fair prices for goats. The establishment of goat markets may encourage the farmers to invest more time and resources in goat production as well as sell their goats. The farmers are encouraged to come up with marketing centres that periodically sell goats on the hoof with prices based on goat liveweight.

The level of parasitic infestations was low and kid mortality was also not a major problem in the study area. The improved housing was, therefore, thought to be more appropriate in protecting goats as well as reducing mortality in areas that received high annual rainfall.

# CHAPTER 7

## 7.0 REFERENCES


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