THE ASSESSMENT OF SOME FACTORS INFLUENCING THE SURVIVAL OF KIDS IN A SMALL-SCALE COMMUNAL GOAT PRODUCTION SYSTEM

By

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DEDICATION:

To all my family members, especially my parents, Mr Maolo Collins Sebei and Mrs Mohube Grace Sebei for their love, encouragement and keen support.

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DECLARATION

I, *Phokgedi Julius Sebei*, hereby declare that the work on which this thesis is based is original and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree at this or any other University.

SIGNATURE DATE

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SUMMARY

THE ASSESSMENT OF SOME FACTORS INFLUENCING THE SURVIVAL OF KIDS IN A SMALL- SCALE COMMUNAL GOAT PRODUCTION SYSTEM

BY

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Abstract:

The aim of this study was to investigate the factors affecting the survivability of goat kids to weaning, in a small-scale communal grazing system. Goat kids are the most vulnerable component of communal goat flocks and increasing their survival could increase productivity. Some of the main factors which contributed towards kid survivability were evaluated and ranked and cost benefit analysis was done.

Initially 20 farmers in Jericho District, North West Province, were subjected to a structured interview. The mean age of farmers was 68.9 years and the mean number of does was 11. Thirteen farmers remained in the trial throughout and were visited once a month. The average number of does for farmers remained in the trial was 13. Body condition scores of does were estimated, kids were weighed, faecal samples were collected and the veld evaluated. Management and socio-economic aspects were observed and informal discussions were conducted with farmers. Goat housing was evaluated using a housing checklist. Monthly precipitation and temperature data were recorded.

Survivability to weaning of 63% of kids was recorded from the total number of kids born (131) from 170 does of the 13 farmers who remained in the trial. The flocks of goats examined were parasitised by *Haemonchus contortus, Trichuris globulosa, Coccidia* as well as *Moniezia.* Although faecal egg counts were relatively low, there was a significant correlation with kid mortalities. Three of the six goats submitted for necropsy also died of internal parasites. The species of ticks were *Amblyoma, Hyalomma and Rhipicephalus* spp. Lice species found were identified as *Bovicola caprae, Bovicola limbatus* and *Linognathus africanus* using scanning electron microscopy. Flea infestation was observed in three flocks, the flea species was identified as *Ctenocephalides felis felis.* Management was found to be suboptimal and in 92.31% of flocks, housing was inadequate. Build-up of faeces and poor drainage probably contributed to internal parasites. Other factors such as climate and feeding could not be correlated to kid mortalities.

Cost benefit analysis suggested that strategic de-worming and improvement of hygiene and drainage in the housing would be the most affordable and effective way to reduce mortalities in kids.

CHAPTER 1

INTRODUCTION

1.1 Motivation

Goat kids are the most fragile and perishable component of a goat flock and any attempt made to ensure their survival is bound to increase productivity and economic returns (Lebbie & Manzini, 1989). By examining the variables in a communal goat farming system it should be possible to develop an appropriate extension message to decrease kid mortalities and increase productivity.

The death of kids before they are weaned is perhaps the single biggest cause of loss experienced by goat farmers. The predisposing factors may be a lack of colostrum at birth, poor mothering, poor nutrition of the dam leading to low milk production, dirty housing and pen areas which allow build up of infective agents, dirty water and failure to vaccinate the dam appropriately (Peacock, 1996).

High mortality among kids and slow growth among those that survive are the major constraints to production. Diseases, inadequate nutrition and poor management are the main underlying causes of the high mortality and low growth rates, especially among young animals (Lebbie & Manzini, 1989). In extensive systems for meat production in tropical areas, mortality rates vary between 12% and 60%. Such high mortality rates may be reduced by improved management methods e.g. treatment against parasites, feeding of dam, vaccination as well as housing (Morand-Fehr *et al.*, 1984).

1.2 Background

Goats are known as the “poor man’s cows” because of their ability to provide sufficient meat, milk and fibre for a subsistence farmer’s own use, with perhaps a little left for sale. This association with poor or small farmers has often meant that goats have been neglected by those involved in research or development in both tropical and temperate countries (Steele, 1996). Although many authors have described the general factors that cause mortalities of young goats, the actual importance of these variables within the communal grazing system used in South Africa is not well understood. It is therefore difficult to choose which extension message would have the greatest impact on the survival of kids in small-scale communal grazing systems.

"*True commercial pastoralism would require maximum profits by maximizing animal production with proper management of the biosphere so that it may yield the greatest sustainable benefits to present generations while maintaining its potential to meet the needs and aspirations of future generations"* (Babi, 1997).

The aim of this study was to examine the factors that influence the survivability of kids. These predisposing factors were used to develop extension messages for use by farmers in communal and small-scale systems. As marketing of goats exists in communal areas, any improvement in the survival of kids will lead to a better financial return for farmers by having more goats available for sale. It has been suggested that goat production systems used in extensive communal areas (area of study) are an economically very low-input, low-output system (Stewart, 1997). It is therefore important that for extension messages to improve output (more goat kids) do not cost more (increased input) than the increased number of kids would bring in after sale i.e. input costs must not be higher than the output costs.

1.3 Problem statement

The traditional system of goat management is mainly characterised by low survivability and high mortalities of kids. There are several factors which affect goat health but feeding, health and general management are possibly the most important.

In a rapid appraisal study conducted by Boomker *et al*. (1997) at Jericho (selected study area) in North West Province, it was found that goat mortalities were mainly in the group younger than two weeks of age and again in kids aged three months. This was substantiated by the low ratio of kids in the flocks as well as the mortalities, weakness and failure to thrive in kids as reported by the owners. The mortality of kids contributes a great economic loss to the goat farmers and if the weaning percentage can be improved there is a possibility of commercial utilisation. If goat kids survive, more goats will be available for marketing at weaning, when there is a good market. However the significance of factors affecting survivability of kids is unknown.

It was indicated by Ademosun (1992) that there is very little veterinary and livestock extension intervention and this is confirmed by the presence of “quacks” in some villages, pretending to administer drugs and vaccines to animals and in the process possibly causing considerable damage. The fact that the farmers are subjected to exploitation by “quacks” underlies their concern for the welfare of their animals. They also use local herbs and medicines for the treatment of diseases, sometimes with temporary relief. Where farmers can not apply treatment to sick animals they prevent total loss by slaughtering or selling the sick animals (Ademosun, 1992). In extensive systems, there may be neither immediate diagnosis of disease nor immediate discovery of loss of the animal. Stress due to poor management or inadequate nutrition may predispose a range of health problems and a high level of inbreeding may reduce viability and resistance to diseases.

Participation by farmers in this study resulted in empowerment, as they learned the technical and management aspects of goat production. This should optimise the productivity of the flock through promoting methods that will increase the survival of kids. Previous extension to goat farmers has often been based on the “top down” model where the farmer is a passive listener. This project was focused on improved ways - who, where, what, how, and when- in which appropriate technical information can be accessed by (rather than transferred to) farmers.

1.4 Research hypothesis

Examination of the factors that influence the survivability of kids in small-scale communal goat production systems, such as nutrition, parasites, infectious diseases, environment and management, will lead to an appropriate extension message to meet the needs of small-scale communal goat farmers in North West Province.

1.5 Research objectives

1.5.1 To assess the demographics of farmers and management practices which affect the health of goats and kids.

1.5.2 To assess and rank the influence of the following factors on goat kid survivability:

- The level of nutrition of adults and kids.
- The importance of parasites (internal and external parasites).
- The importance of infectious diseases.
- To observe farmer's skills and attitudes in relation to environment and management of goats and kids.

1.5.3 To monitor kid births and mortalities over a breeding season

1.5.4 To model different scenarios and evaluate the effects of possible extension messages.

1.5.5 To develop and evaluate the affordability and appropriateness of extension messages for small-scale goat farmers to optimise the survival of kids.

CHAPTER 2

LITERATURE REVIEW

2.1 The demographics of small-scale goat farmers

According to 1997 statistics, the total number of goats in South Africa was estimated to be 6 674 103. Coetzee, (1998) states that 36% of the goats in South Africa are farmed commercially and in North West Province 14% of goats are farmed commercially while 86% of goats are farmed traditionally. Amongst the domestic animals of value to man in the tropics, the goat is perhaps the most important. In comparison with other ruminants, goats are versatile and they display a unique ability to adapt and maintain themselves in harsh environments. It is believed that the goat was the earliest ruminant to be domesticated (Devendra & Burns, 1970).

2.1.1 Indigenous goats and goat production

Goats make up a great potential resource in Africa because they are more numerous than sheep. In South Africa, mainly in rural areas, goats are more common than other ruminant animals. The majority of goats in the tropics are found in part-time, low input: low output, scavenging systems, in herds of 5 to10 animals. They are nevertheless very important as a source of meat and for religious purposes as well as savings. Savings mean that goats provide a way of generating capital and maintaining an acceptable cash flow. They are not a priority enterprise for monetary investment or innovation. Goat farmers therefore have low receptivity for research findings, or extension, in many cases (Fielding, 1987).

The breeds of goats that are kept in rural areas are mainly of indigenous type. The reason behind this is that they are very hardy in terms of diseases and drought tolerance. In the study conducted by Donkin (1998) indigenous goats were shown to have genetic resistance to heartwater, an important tick-born disease. The advantages of farming with indigenous or adapted animals are tolerance to heat stress and water deprivation during drought periods as well as resistance to the many tropical diseases and parasites found in Africa (Maree & Casey 1993; Ramsey *et al.*, 1994). They are generally raised extensively on communal lands with minimal veterinary and other management inputs (Stewart, 1997). Indigenous goats are less prone to stock theft than sheep, as they are more agile and make a lot of noise when handled or slaughtered (Donkin, 1993; McCrindle, 1996; 1997).

Under the traditional production system little attention is paid to adequate feeding, management and health of the animals. These factors result in high mortality and morbidity caused by external and internal parasites, infectious diseases and nutrient deficiencies. The most easily affected groups are young, pregnant and lactating animals (Ademosun, 1987).

Even though it is mentioned that these indigenous goats are hardy and well adapted to harsh environments, fluctuations in the environment, such as seasonal availability of nutrients, can also affect reproduction and this can involve some degrees of reproductive failure. It is known, for example, that many of the indigenous breeds of goats in Africa and the Near East have for years suffered from chronic hunger with consequent prolongation of kidding intervals and fewer and smaller kids (Devendra & Burns, 1970).

Pre-weaning mortality is a major source of loss of the national flock. Under extensive systems a pre-weaning mortality of about 40% has been recorded and this is higher than in intensive systems. In extensive systems the pre-weaning mortalities may still be underestimated as births which occur when the animals are browsing may result in the unnoticed death of the offspring (Ademosun, 1992).

2.1.2 Socio-economics

According to Perry & Mukhebi (1995), socio-economic factors have a strong influence on the distribution, dynamics and the significance of animal diseases, particularly in developing countries where there are great differences in socio-economic status of their inhabitants. The livestock farming system depends on an interaction between humans, animals and diseases. The system is influenced by outside factors such as socio-economics and the environment. Ngategize, (1989) indicated that apparent production constraints such as “high” mortality, “long” birth intervals and “slow” growth rates may not be as critical to the farmer as production scientists think. Therefore recommended technologies may not be adopted in given social, economic and ecological circumstances. In pastoral systems high mortality rates may reflect the management system, lack of permanent settlement and lack of housing and attention to the young (Ngategize, 1989). In communal systems there can be an improvement in land use only with a thorough understanding of all socio-economic and ecological factors that influence productivity, together with the institutional and the political framework in which communal systems have to operate (Bembridge & Tapson, 1993).

Human-animal interaction is influenced by socio-economic variables like infrastructure, political decisions, marketing capacity, level of management required and personal choices (McCrindle, Cornelius & Krecek, 1996). Hunter (1989), indicated the role of small ruminants, namely to provide households with meat and to serve as a store of savings from migrant incomes and as an insurance against retirement. Bosman *et al*. (1997) postulated that when financial and insurance markets are absent or ill-functioning, goat keeping provides benefits in financing and in insurance. This appears to be considered a substantial benefit of goat keeping. The quantifiable outputs of several goat products are important for diversifying production, creating employment, increasing income, building capital; contributing to human nutrition and reducing risk (Payne & Wilson, 1999). The major contributions of goats to human welfare are meat, milk and skins; fibre, mainly as mohair and cashmere, could be an important secondary product (Payne & Wilson, 1999). Like cattle, goats serve as an investment and are used for ceremonial slaughtering and even lobola (Bembridge & Tapson, 1993). In the study contacted by Panin & Mahabile (1997) in Botswana, the contribution of small ruminants to the average annual household income was estimated at 15%. Improvement in production could benefit economic development both at the household and national levels. Livestock products improve the nutritional status of both farm and urban families. Sales of live animals, meat, milk and fibre are often the major source of income for farmers of developing countries (Fitzhugh *et al*., 1992/3).

Brünckner (1995) indicated that there are two self-perpetuating cycles that represent the influence of disease control or eradication on the socio-economic aspects of the society. Those cycles are mentioned as: a negative cycle or downward spiral of decreasing health levels creating steadily worsening socio-economic conditions and, following on successful disease control efforts, a positive cycle or an upward spiral of increasing health levels that results in improvement of socio-economic conditions. Brünckner (1995) further explained the negative cycle, due to the fact that diseased livestock are less productive than healthy animals and lower production results in lowered income and less animal protein and fibre for the producer and for society, therefore resulting in low disposable income.

2.2 Factors influencing survivability

The factors most likely to affect survivability of goat kids are nutrition, parasites and infectious diseases, environment and management (Peacock, 1996).

2.2.1 Nutrition

Animals reared under traditional production systems may experience a shortage of feed. According to Ademosun (1987), in communal systems malnutrition is regarded as the most important cause of high mortality rates and a low production. Goats may also depend on household wastes and browsing that does not provide sufficient levels of nutrition for optimum production. Available browse is of low quality, household wastes are not enough and of low nutritive value and nutrient imbalance is likely to be a feature of feeding under the traditional production system. It was mentioned by Van Niekerk & Schoeman (1993), that in many rural areas of Africa, sheep and goats wander freely around villages and communal veld, scavenging for food, resulting in over-grazing, poor condition of livestock and poor production levels. Communal rangeland is subjected to extreme changes between seasons (Bembridge & Tapson 1993). Fluctuations in nutritional value of these feed resources can result in irregular growth patterns and low milk yield in goats (Das & Sendalo, 1991). The digestibility of herbage is often so low during the winter season that dry matter intakes decline, with a subsequent decline in body weight (Van Niekerk & Schoeman, 1993). A distinct advantage of ruminants over other non-ruminant animals is that ruminants can convert cellulose and other materials that are not suitable for human consumption, into a product of high nutritive value, i.e. goat meat.

O'Brien & Sherman (1993) mentioned that newly born goat kids, like the young of any other livestock species with a maternal syndesmochorial or epitheliochorial placentation, depend on ingesting colostrum, which is rich in antibodies, shortly after birth for passive humoral immunity, until they can actively produce their own antibodies. The results of failure to absorb colostrum soon after birth can lead to infectious diseases and high mortalities in kids. They also mentioned that death of kids at an early stage of life could be attributed to the failure of kids to suckle adequate colostrum at birth. Chen *et al*. (1999), found that the normal suckling and absorption of colostrum seems to be a vital factor in sustaining the health and normal growth during neonatal life and is more important than birth weight.

The viability of kids is also related to their birth size and this is affected by the levels of feeding of the doe in the last trimester of pregnancy. In addition, low levels of feeding during late pregnancy and lactation, may also decrease milk production and the onset of colostrum. This is of primary importance to the survival and performance of the kid (van der Westhuysen *et al.*, 1988).

It was suggested by Sight *et al.* (1991), that the birth-weight of the kid influences its survivability during pre- and post-weaning periods. It was reported that a positive linear relationship existed between birth weight and the survivability of kids during these periods. In addition the survival rate during the post-weaning period could also be improved by improving the birth weight of the kids.

A high level of feed offered for the last two months of pregnancy has the following advantages:

- A low doe and kid mortality,
- Kids have a weight advantage at birth, and

- Milk flow in the doe is increased causing a greater live weight gain in the kid and also a heavier live weight in the adult stock (Devendra & McLeroy, 1982).

Most of the peri-natal deaths (85%) occurred within the first few days after birth. Most frequently these losses result from the inability of the kid to ingest sufficient colostrum or milk, primarily owing to its own weakness, which is often aggravated by low milk production, poor mothering ability or teat deformities of the ewe. In a survey conducted by Morand-Fehr *et al.,* (1984) it was found that 92% of colostrum-deprived kids that died, died when they were 2 days old. Undernourished ewes also tend to have poorer mothering ability and will easily leave their kids unattended for long periods (Van der Westhuysen *et al.*, 1988). Feed supplementation of does during gestation should be according to the intrauterine growth pattern of does to ensure economic production of kids (Osuagwuh, 1992). In the study conducted by Osuagwuh & Akpokodje (1986) it was confirmed that the period of fetal vulnerability in West African Dwarf goats was between 90 and 120 days of pregnancy.

Peacock (1996), has also indicated that contributory factors to the problem of high pre-weaning mortality rate and slow growth rates are seasonal fluctuations in quality and quantity of grazing combined with a general decline in available grazing areas. The amount of milk produced by younger does is usually smaller than the amount produced by more mature ones. Steele, (1996) mentioned that animals that had continuous access to food are less likely to get diseases. Therefore kids born to first kidding does are less well-nourished and less protected against pathogens (Rattner *et al.,* 1993). Many of the mortalities associated with poor mothering can be prevented by giving regular attention during kidding, assisting of weak kids to ingest colostrum and milk or even artificial rearing of weak kids (Van der Westhuysen *et al.,* 1988).

The level of protective immunity offered by maternal antibodies against infectious diseases is relative but not absolute. There are several other factors that determine whether or not individual kids can die of infectious disease. A balance exists between host susceptibility to infectious agents and the potential infectivity of that agent. Management practices such as indoor confinement may multiply potential environmental pathogen loads and tip the balance in favour of infection, even in neonates with maternal antibodies (O'Brien & Sherman, 1993). Ndamukong *et al.* (1989) indicated the importance of better nutrition of kids and does especially during the dry season so as to improve growth rates and reduce disease susceptibility and mortalities.

2.2.2 Parasites (Internal and external)

Per definition of parasitism i.e. the relationship existing between parasites and the host where parasites benefit at the expense of the host, parasitism is detrimental to the host (Oberem & Schroder, 1993; Horak, 1988).

Internal parasitism and some other factors such as poor management and poor nutrition can results in economic losses due to their effect on the productivity of small-scale goat production systems. Livestock in communal grazing systems are prone to parasitic infestation (Bakunzi & Serumaka-zake, 2001; Reinecke, 1983). Impaired productivity in ruminants can be attributed to the presence of gastro-intestinal parasites. These parasites may even be devastating at a sub-clinical level (Holmes, 1986). Wairuiri *et al.* (1993), mentioned that sub-clinical infestation by internal parasites is often neglected. Changes in body condition of the animal can be a visible feature of this effect, reduced growth rate, gradual emaciation and disease susceptibility are also visible features.

Coccidia and helminths are mentioned to be the most common and important gastro-intestinal parasites in ruminants (Maingi *et al.,* 1993 & Waruiri *et al.,* 1993). Helminths and coccidia both tend to infect animals together and have a cumulative pathogenic effect in animals (Chhabra & Pandey, 1991). Gastro-enteritis epidemics associated with small ruminants are more rife during wet seasons than dry seasons (Njau, 1987). The fact that indigenous goats are not immunised against diseases and are hardly dosed against internal and external parasites have led to the natural selection of small, hardy animals that have a high degree of resistance to parasites and diseases (Boomker *et al.,* 1994).

2.2.2.1 Coccicidiosis

Coccidiosis plays a major role in causing enteric disease, especially in young or stressed goats, under certain management conditions (Craig, 1986; Smith & Sherman, 1994). In small stock, coccidiosis is caused by *Eimeria species* which are specific to the host (Levine, 1985). Coccidiosis develops through a contaminated environment and stress-related reduced immunity (van Veen, 1986). Although coccidiosis may prove fatal, especially in young animals, its greater economic importance lies in the unthriftiness and reduced production that it causes (Blood & Radostis, 1989). Coccidiosis in the goat is as much a management and land-use problem, as it is a disease problem (Howe, 1984).

Coccidiosis is a protozoal infection of sheep and goats of worldwide distribution. The principal species are *Eimeria arloingi,* infecting sheep and *Eimeria nina yakimor,* affecting sheep and goats. They are parasitic in the alimentary canal. The *trophozoites* and *schizonts* live in epithelial cells of the small intestine, which they destroy, causing diarrhoea, which may be bloodstained. Death results from dehydration. Young animals are more susceptible than older ones, but the severity of the disease also varies with the condition of the host, species of coccidia and the degree of parasitism (Peart, 1982).

The diagnosis of coccicidiosis depends on the clinical findings of diarrhoea, the presence of a large number of oocyts in the faeces and appropriate signs and intestinal lesions at necropsy (Harper & Penzhorn*,* 1999). Huge numbers of oocyts may occur in the faeces of clinically normal individuals (Blood & Radostits, 1989) and other causes of diarrhoea must be taken into consideration, for example cryptosporidiosis, salmonellosis, enteroxaemia, viral enteritis as well as helminthiasis.

Co-existing nematode or bacterial infections may complicate the enteritis. The transmission is by ingestion of sporulated oocytes in pasture or housing contaminated by the faeces of infected animals. Oocyts are passed in the faeces of infected goats. They are not infective at this stage and they must undergo maturation or sporulation. The maturation time is temperature dependent.

It can be as short as one day during summer or several weeks during winter. Once sporulated, oocysts can persist for a year or longer if protected from sunlight or drying (Howe, 1984).

2.2.2.2 Helminthiasis

In goats helminthiasis is causes by various types of worms. The infective larvae of these worms are ingested individually from the environment. Infected animals contaminate the environment when the eggs of nematodes are passed in faecal matter of the animal. Under favourable conditions these eggs develop to the infective stage (Muenstermann & Tome, 1989). Helminth infestation causes a parasitic gastro-enteritis which results in unthriftiness, several degrees of diarrhoea and death where infection is severe (Wamae & Ihiga, 1990). Helminthiasis can constitute a serious problem under village management conditions, even though the magnitude of the problem is sometimes under-estimated (Wairuri *et al.,* 1983).

(i) *Nematodes*

In the study conducted by Njau (1987) it was found that gastrointestinal nematodes infected small ruminants kept under traditional farming management and the mortalities associated with this infection took place during the wet season. The lifecycle of nematodes may be divided into two stages, viz. "parasitic" and "free living" and two phases, "contamination" and "infection".

The various nematode genera differ with regard to optimal requirements for the free-living stage. However, most of them are present at almost any time. The most important of the nematodes in sheep and goats in South Africa, according to Reinecke (1983) are *Haemonchus*, *Oesophagostomum* and *Trichostrongylus* spp. Haemonchosis has been receiving increased attention as an important cause of mortality in both sheep and goats over the last five years (Connor *et al.,* 1990; Fakae, 1990; Gatongi *et al.,* 1998; Payne & Wilson, 1999; Vatta *et al*., 2001). *Haemonchus* and *Oesophagostomum spp* prefer warm, moist conditions, while *Trichostrongylus spp* prefer cool, or even cold conditions and are prevalent in winter and spring; *Ostertagia spp* is commonly found in autumn and late spring, *Nematodirus spp* survives under moist conditions (Atanasio, 2000; Connor *et al.,* 1990; Fakae, 1990; Gatongi *et al.* 1998; Horak *et al.* 2001; Horak, 1981;Horak & Snijders, 1968; Reineke, 1983).

In the contamination phase, eggs are passed in the faeces of the host and contaminate the pasture. In the infective phase larvae are present on the pasture and can infest the host. Infestation occurs more readily when animals are kept on small-enclosed pastures. It also occurs when over-stocking takes place or if animals are housed in kraals where there is massive accumulation of faeces or on irrigated pastures where moisture stops the larvae and eggs from drying out (Horak, 1981; Horak & Snijders, 1968; Ikeme *et al.,* 1987; Reineke, 1983).

According to Gordon (1948) the three chief epizoological aspects of outbreaks of Helminthosis are the following:

- Introduction of susceptible animals into an already infested community, for example transferring lambs from the dry Karoo to the wetter Eastern Transvaal.
- An increase in the number of infective larvae, brought about by weather conditions, grazing habits, stocking rates and pasture conditions.
- Increased susceptibility due to various stress-factors e.g. malnutrition, repeated pregnancies and diseases such as blue tongue and heartwater.

In the case of *Haemonchus* spp there is a so-called "post partum peak" where egg counts increase in the faeces of ewes shortly after they have given birth (Coop *et al*., 2001).

A complete autopsy and faecal worm counts are necessary for an accurate diagnosis. With large flocks note any soiled breaches ("*vuil broeke*"), anaemia, and bottle jaw. A specific method for diagnosing Haemonchosis in the field has been devised by Bath & Van Wyk (2001). This is known as the FAMACHA© method and is a visual appraisal of the level of anaemia as seen in the conjunctiva of sheep and goats. (Bath *et al.,* 2001; Bath & Van Wyk, 2001; Van Wyk *et al.,* 2001).

(ii) *Cestodes -Tapeworms*

Cestodes are parasites of domesticated animals' worldwide and have a major economic impact. The economic impact of cestodiasis in livestock is due to the contamination of carcasses meant for human consumption, as well as through direct effects upon and growth of infected young animals (Williams & Van Veen, 1985).

The presence and development of the Anoplocephalidae family of cestodes in the small intestine of ruminants can cause helminthoses of the digestive tract. Cestodes require an intermediate host to complete their life cycle (Shar-Fischer & Say, 1989; Williams & Van Veen, 1985). Oribatid mites are always the intermediate host (Horak & Snijders, 1968; Reinecke, 1983; Shar-Fischer & Say, 1989). The mites live on the humus on the soil surface. While feeding on the excreta of infected ruminants, mites ingest embryonated cestode eggs. The infective larval form, called a cysticeroid, develops in 6-16 weeks in oribatid mites, and it remains viable throughout the life period of the mite, which is 1-2 years. Ruminants get the infection while grazing on pastures where mites carrying cysticercoids are present. Mites are prone to be swallowed when they move on the grass blades, in the morning or evening (since they avoid light during the day) or during damp, cloudy weather (Horak & Snijders, 1968; Shar-Fischer & Say, 1989).

Clinical signs of cestodes differ according to the species of parasites, number of parasites, age of the animals, and their general condition. The degree of severity ranges from totally inapparent forms to those producing clinical symptoms. Inapparent infections are the most common form of parasitism that occurs, particularly in adults and healthy carriers of small worm burdens. Clinical infections start as a general weakness. The animal is slow, remains apart, ruminates irregularly and becomes emaciated. Digestive disorders like bloating or alternation of diarrhoea and constipation may also be visible. Finally a slight anaemia occurs. Convulsive disorders and sometimes death are observed in kids. Clinical and laboratory diagnosis can be based on the observation of gravid segments expelled with the excreta and examination of faeces for eggs respectively (Shar-Fischer & Say, 1989).

(iii) *Trematodes - Flukes*

All the parasitic species of domesticated animals belonging to the subclass Digenia require at least one intermediate host. The adult digenetic trematodes, commonly called “flukes” occur in the bile duct, alimentary tract and vascular system (Urquhart *et al.,* 1987). The adults lay many eggs which are excreted in the faeces or urine of the host and larval stages develop in a molluscan (suitable aquatic snail) intermediate host (Reinecke, 1983; Urquhart *et al.,* 1987). The final host is infected when grazing on contaminated pasture.

Clinical signs include anorexia due to discomfort caused by young flukes in the intestine. Loss of weight results because the assimilation of food is decreased by the damage of the intestine. Diarrhoea can also be observed. Death is caused by starvation, exhaustion, pulmonary oedema and hypoxia (Reinecke, 1983).

2.2.2.3 External parasites

Ectoparasites are among the other causes of low productivity in goats and this can account for major losses. The spread of tick, mite and lice infestations is promoted by unhygienic conditions, increased population density and inadequate housing (Pandita & Ram, 1990; Oberem & Schröder, 1993). Ectoparasitic infestation can result in anaemia, hypoproteinaemia, secondary infestation, nutritional deficiencies and reduced vigour as well as bacterial or fungal infections of bite wounds with resultant septicaemia, abscessation, mastitis, and loss of production (Oberem & Schröder, 1993; Pandita & Ram, 1990). The other indirect effect of ectoparasites on productivity is the cost of control methods that include chemicals and vaccines, construction of dip tanks, management and labour costs (Oberem & Schröder, 1993).

(i) Ticks, mites, fleas and lice

There are two families of parasitic ticks, these being the Ixodidae (hard ticks) and the Argasidae (soft ticks or tampans). They differ in appearance, habits and life histories (Oberem & Schröder, 1993; Walker *et al.,* 1978). Most ticks of veterinary importance belong to the family Ixodidae (Howell *et al.*, 1978; Walker *et al*., 1978). All hard ticks have the same life cycle with three stages i.e. a small six-legged larvae, a slightly larger eight-legged nymph and easily recognisable eight-legged adult. Larvae hatch from the eggs that are usually laid on the ground in a cool moist place under a turf of grass or fallen leaves and larvae climb up vegetation such as grass blade and cling to the passing host. Larvae penetrate the host's skin with their mouthparts to suck blood or fluid. Matured female ticks suck more blood, become engorged and drop off the host after 7 days to lay 2 000-20 000 eggs, after which they die (Howell *et al.*, 1978; Oberem & Schröder, 1993; Walker *et al.,* 1978).

There are three differences of this generalised life cycle: one-host, two-host, three-host ticks. The one-host tick is one that does not leave the host from hatching until the engorged female drops off. Two-host ticks are those where the larvae and the nymphs live in one host and the engorged nymphs drop to the ground to moult and then the adult tick will look for the intermediate host to feed on (Howell *et al.,* 1978, Murray, 1982; Oberem & Schröder, 1993). In three-host ticks the larvae, nymphs and adults each feed on separate hosts.

Wild animals like hares, carnivores and even birds or mice may serve as intermediate hosts, whereas all domestic livestock are susceptible to some or other kind of tick (Oberem & Schröder, 1993). There may be adverse effects due to the heavy tick loads on animals unadapted to ticks or already in poor condition or diseased. Some tick species are responsible for severe local lesions, abscesses, lameness and ear infections. It is mentioned that indigenous livestock are poorer tick hosts than exotic breeds and exotic goats are less resistant to ticks (Oberem & Schröder, 1993; Rechav & De Jager, 1991). It was also observed by Rechav & De Jager (1991) that the number of ticks carried by goats was severe mainly during summer. It caused anorexia resulting in loss of weight or reduction of weight gain and abscessation. Ticks are also responsible for the transmission of disease, for example, heartwater (*Cowdria ruminantium*) that causes high mortality in goats in South Africa (Murray, 1982; Mwangi *et al.,* 1985; Oberem & Schröder, 1993).

Mites are tiny, six-legged creatures, generally invisible to the naked eye. They are host-specific in their infection and live permanently on their hosts. Mites of the genus *Psoroptes* cause scab in cattle, sheep and goats (Baker *et al.,* 1956; Murray, 1982). *Sarcoptes scabei* is the exception and can infest many hosts including people. They can survive independently from their hosts for a few days. Their ways of life are different, some feed on dead skin tissue and others suck lymph or blood (Howell *et al.*, 1978; Murray, 1982; Oberem & Schröder, 1993). Diagnosis requires the use of a microscope, as adult stages rarely reach 2 mm in length. Adult female mites lay a few eggs on the hosts and six-legged larvae hatch from the eggs. In southern Africa mites do not transmit disease to livestock. However they cause significant losses in production of meat, milk and fibre. Mites can occasionally cause death in severely infested animals due to blood loss and debilitation. Blood-sucking mites cause irritation that leads to biting and scratching and loss of wool of hair. Alopecia and skin thickening may result in severe cases (Howell *et al.,* 1978, Oberem & Schröder, 1993; Murray, 1982). Irritation can also severely reduce feed intake and performance (Oberem & Schröder, 1993).

The cat flea is the species of flea reported most commonly on cats and dogs worldwide, *Ctenocephalides felis felis (C.f.felis)*, is one of four subspecies of *C.felis* believed to have originated in Africa. The movement of pets around the world has aided the spread of *C.f.felis.* It is a fairly vigorous species and though the cat was its original host, it is not very host-specific. Adult fleas live on their host permanently and lay their eggs on the host. Once an adult flea has located the host, it jumps onto the animal and starts feeding on blood almost immediately. The egg-laying process occurs after the female has taken its first feed and mating. Flea faeces and smooth shelled eggs are voided out into the surrounding environment. They tend to accumulate where the host lies, thus ensuring that a host is likely to be available for the adult flea when it comes out of the pupal cocoon. Once eggs have fallen from the host's coat, they require an environment where temperature and humidity fluctuate more than on the host animal. Fleas are considered to be a pest of both animals and man. A severe flea infestation can cause anaemia. People may develop severe allergic reactions to subsequent flea bites in homes where there is a large emergent flea problem and fleas can convey plague to humans (Fisher, 1999; Howell *et al.,* 1978). McCrindle *et al.* (1999) have described flea infestation of goats in Jericho district.

Lice cause remarkable economic losses to livestock keepers throughout the world. The actual loss resulting from these parasites is not easy to estimate (Steelman, 1976). Lice are relatively tiny, dorso-ventrally flattened, wingless insects varying from less than a millimetre up to ten millimetres in length. They live permanently on the bodies of their hosts and can not survive more than few days off their hosts. They are specific to their hosts. Their eggs are called nits and are attached to the hairs. They hatch after 1-2 weeks into nymphae, which are smaller and paler than the adults and lack genital structures. Nymphae then pass three developmental stages to the adult stage, usually 2-3 weeks after the eggs hatches. Lice generally cause irritation and unthriftness in their hosts. The most vulnerable animals to their adverse effects are young animals and those in poor condition or stressed animals, for instance during droughts or in winter and early spring, when feed is scarce and poor. Lice spread through direct contact, mechanically during handling of animals and to a lesser extend when uninfected animals are brought into premises that were previously occupied by infested animals. Overcrowding and poor hygiene therefore tend to cause the louse problem. Animals infested are restless, do not feed well and continually rub, scratch and bite themselves to try to relieve the irritation.

Linognathus africanus is the blue sucking louse of sheep and goats. It is primarily considered to be a parasite of sheep. It can be confused with *Linognathus stenopsis* but on the basis of collection it was found that *Linognathus africanus* is more common on goats in Africa south of the Sahara (Price & Graham, 1997; Seddon, 1967). Severe infestation may results in severe anaemia, dependant oedema of the legs and if not controlled, it may be fatal, particularly in kids. Horak *et al.* (2001) indicated that kids can be affected from as early as one week of age. Petersen *et al*. (1953), researched an anaemic condition of cattle which were heavily infested with blood-sucking lice, where the destruction of lice was followed by rapid recovery of animals, thus indicating that the anemia was as a result of these blood-sucking lice. The presence of lice resulted in severe skin irritation, causing the hosts to scratch and rub as a result damage their coats (Price & Graham, 1997; Seddon, 1967). Lice infestation also caused stunting in kids and young goats just after weaning (Murray, 1982).

Damalinia (Bovicola) caprae is the red biting louse of goats, which occurs mainly in winter. It is mentioned by Zumpt (1970), that in sheep, infestation increases during the winter season, when the stress of inadequate feed results in the reduction of resistance and increases lice infestation. Lice are cosmopolitan in their distribution. Female *D.caprae* lay their eggs on the goat's hair at the point close to the skin. Their incubation period varies from 7-14 days depending on environmental factors. Nymphs ingest epidermal scales and other skin debris and grow by the process of gradual metamorphosis. Goats become infested through direct contact with infested animals. However, the fact that some stages of lice can survive for short periods of time off the host, makes it possible goats to become infested by occupying pens, trucks, chutes and other facilities that have been previously occupied by other infested goats. The primary host of *D. caprae* is the short-haired goat. *D. caprae* is more abundant during winter. The biting lice of goats feed close to the surface of the skin. When they are present in large numbers they cause irritation and annoy the goats, causing the animals to rub and scratch. Zumpt (1970) also reported that *Damalinia ovis* (the red lice of sheep), injures the skin surface of the host so that the skin produces serum which is utilised by the lice as the source of food. Subsequently this causes loss of hair and a rough hair coat. Nevertheless it is not as harmful as the blue sucking louse.

The U.S. Department of Agriculture (1976) estimated that lice on sheep and goats, caused an average annual loss of 8 million dollars. (Howell *et al.,* 1978, Ledger, 1980, Price & Graham, 1997; Zumpt, 1970).

The other goat-lice species is *Bovicola limbatus* (Angora goat biting lice). Because of the similar appearance and frequent occurrence on the same host *Bovicola limbatus* is often confused with *Bovicola caprae*. Their distribution is believed to be of worldwide. It was mentioned that in South

Africa, *Bovicola limbatus* parasitised all Angora goats including kids. It is also found in Spanish goats where Spanish goats are grazing with Angora goats (Horak *et al.* 2001; Price & Graham, 1997).

Although there have been some reports of biting lice in Angora goats, there is little literature on lice on goats in communal grazing in South Africa. Since 1950, losses from both biting and sucking lice species in Angora goats have probably been reduced by applying insecticides or dips once or twice a year (Price & Graham, 1997).

(ii) Flies and maggots

Myiasis is the infestation by larval (maggot) stages of dipterous flies. The larvae of calliphorid flies (blowflies) and the specialised oestrids (Murray, 1982; Oberem & Schröder, 1993) cause the main nasal bot infestations suffered by goats. The female blowfly lays her eggs on the edge of wounds that may be caused by shearing, castration or tick bites. An important site is the navel of newborn animals and the vulva of the mother. The first stage maggots live in the wounds until they complete the third stage when they drop to the ground to pupate. Infested animals often die if not treated, mainly young animals where the maggots infest the navel (Murray, 1982; Oberem & Schröder, 1993). Nasal bots are often found in sheep in the North West province (personal communication, Mokantla, 2001).

2.2.3 Infectious diseases

2.2.3.1 Heartwater

Heartwater (cowdriosis) is a tick-borne disease caused by a rickettsia, *Cowdria ruminantium*. The "bont" tick (*Amblyoma hebraeum*) transmits infection. Predisposing factors include all factors favourable to the occurrence of the "bont" tick (Bezuidenhout *et al.*, 1994; Monnig & Veldman, 1981). The disease is, therefore, limited to the bush veld and coastal areas.

The symptoms of heartwater include high temperature, listlessness, low appetite, rapid breathing, and even sudden death without noticeable symptoms. Initial symptoms are usually followed within a day or two by nervous symptoms. These include grinding of the teeth, muscular tremors and weakness, and an unsteady or high stepping gait. Immediately prior to death, the animal goes down on its side, makes paddling and chewing movements, blinks eyes continuously, and froths at the nose and mouth (Bezuidenhout *et al.*, 1994).

At necropsy the spleen is enlarged, the lungs are oedematous, and there is froth in the respiratory passages. The heart sac contains a clear to straw coloured fluid and there are haemorrhages on the inner and outer surface of the heart (Van der Westhuysen *et al*., 1988).

2.2.3.2 Pasteurellosis

Pasteurellosis includes various conditions caused by pasteurella organisms such as *Pasteurella multocia* (4 strains) and *Pasteurella haemolytica* (12 strains). These organisms are normal inhabitants of the respiratory system but under certain conditions invade the lungs or other parts of the body. Animals in poor condition are more susceptible and certain stress conditions which include climatic changes, such as spells of cold, rain and drought, exhaustion through driving or transportation over long distances in hot, poor ventilated trucks and lung worm infestation are predisposing factors.

Young kids are more susceptible and heavy losses are often experienced, according to Van der Westhuysen *et al.* (1988). The more common conditions caused by these organisms include pneumonia, inflammation of the liver (bacterial icterus) and mastitis (blue udder). Chronic cases show an obstinate cough, loss of condition, nasal discharge and sometimes swollen joints (Monnig & Veldman, 1981).

Varying degrees of pneumonia and pleurisy will be found at necropsy and the surfaces of the lungs and chest wall are covered with a jelly-like substance. The lungs show smaller or larger areas of consolidation, varying in colour from dark red to grey. Haemorrhages are found in the inner and outer surface of the heart, while the nasal passages have an intense dark red colour. Bacterial icterus is sometimes found and is characterised by a generalised jaundice and enlarged, brittle, greyish yellow liver and swollen spleen (van der Westhuysen *et al.*, 1988; Nestit *et al*., 1994).

2.2.3.3 Salmonellosis

Salmonellosis is an infectious disease of animals caused by organisms of the genus Salmonella. These bacteria are primarily intestinal organisms. *Salmonella typhimurium* is frequently encountered in all species of animals. Salmonellosis is most prevalent in areas of intensive animal husbandry. Under conditions of extensive range husbandry, the disease is most likely to occur when animals are gathered or at parturition. A seasonal incidence associated with the hot rainy season has been described in some countries (Sewell & Brocklesby, 1990).

Salmonellosis can affect all species of domestic animals. Young debilitated and parturient animals are most susceptible to clinical disease. It is an enteric disease and transmitted principally by the faecal-oral route. Salmonellae are excreted in large numbers in the faeces of infected animals with consequent contamination of the environment. In any outbreak, the majority of animals will acquire infection by direct contact with faeces, or food, bedding or water contaminated by faeces (Sewell & Brocklesby, 1990).

Signs vary from acute septicaemia in neonates to acute enteritis, often with dysentery, along with fever and inappetance. Affected kids quickly lose condition, become dehydrated and emaciated. Predominant changes affecting the gastrointestinal tract are seen as a catarrhal to fibrino-haemorrhagic gastro enteritis with acute inflammation of the drainage lymph nodes. Changes are often present in the liver and spleen. Spleenic changes vary from enlargement and congestion to those similar to the liver lesion (Sewell & Brocklesby, 1990).

2.2.3.4 Colibacillosis

Colibacillosis causes severe diarrhoea in young kids infected by the bacterium *Escherichia coli.* Watery diarrhoea, dry mouth, and a stomach full of gas are the main signs. The kid quickly becomes dehydrated and will soon die, unless given fluids. Quick action must be taken to replace the lost fluids with salts, sugar, and clean water and with oral rehydration salts and to kill the bacteria with oral or injectable antibiotics. Kids develop colibacillosis if they have not received enough colostrum immediately after birth and are then reared in dirty environments. This may occur because of the death of the dam or simply through poor management. Kids must be kept in the cleanest possible surroundings (Peacock, 1996).

2.2.3.5 Other diseases

There are other diseases, but these are of lesser importance and will be investigated if they are found in goats e.g. Wesselsbron, Rift Valley fever (RVF), Blue-tongue, Blue-udder, Abscesses.

2.2.4 Environment

The environment in which the goats are kept includes both macro-environment (the housing) and the microenvironment (the climate).

2.2.4.1 Climate

Mellado *et al.,* (1991) reported the relationship between monthly precipitation and the death of kids due to pneumonia during winter and spring. This may indicate the influence of rainfall on the occurrence of death due to pneumonia during the cool weather but not during warm weather. Kulkarni & Deshpande (1986), Mazumdar *et al.* (1980) and Ranatunga (1971) reported the association between mortality, pneumonia and precipitation. Humidity rather than precipitation, *per se*, are believed to contribute to respiratory infections. Ehrlich (1963), indicated that relative humidity prolongs survival of bacterial-colony forming particles, which upon entering the respiratory system, impose severe strain on the animal's clearance mechanism and also allows pathogenic organisms to multiply to the point where clinical pneumonia ensues. Cold weather could further facilitate infection because respiratory rate and pulmonary ventilation is reduced during cold stress. This in turn may reduce both tracheal mucrociliarity rate and alveolar macrophage activity. Again relative humidity could prolong survival of bacteria and influence the death of kids due to enteritis. Muddy udders during the rainy period may have influenced on the occurrence of enteritis in kids (Thomson & Gilky, 1974).

2.2.4.2 Housing

Ficarreli, (1995), mentions that goat keepers in Malawi lose more than 30% of their young stock every year, particularly during the rainy season. This very high mortality rate is the major constraint limiting the productivity of the local flocks and significantly reduces farmers' benefits. Poor and unhygienic housing is one of the causes of these losses and it is in the dung of animals that parasites survive and affect young animals. There is a relationship between the space available per goat in the night housing and kid mortality. A high animal density favours the spread of pathogenic agents among kids and increases the risk of injury (Lancelot *et al*., 1995). According to Ndamukong *et al.*, (1989) adequate housing must protect animals from rain, excessive heat, wind, cold and draughts and provide the opportunity for closer feeding and breeding control.

2.2.5 Management

There are several causes of kid mortality that are directly or indirectly related to management. These include:

- Stocktheft, predators, trauma and motor vehicle accidents
- Daily management of stock
- Managerial practices that restrict the reproductive efficiency
- Poor management of the doe prior to birth and around kidding

2.2.5.1 Stocktheft, predators, trauma and motor vehicle accidents

The fact that in communal systems there is a shortage of labour to herd the goats may be detrimental to goat production. There are changes in rural societies wherein children are now going to school, fathers migrating to urban areas to work and mothers are responsible for everything else: which may be too much. This overburdening of the one remaining adult in the family makes goats vulnerable to stock theft, predators, trauma and motor vehicle accidents. During the kidding period it is also a problem when goats kid on the open veld, as new-born kids fall easy prey to predators and are often abandoned by young, inexperienced dams (Van der Westhuysen *et al.,* 1988).

2.2.5.2 Daily management of stock

Animals under the supervision of a herder can be protected from theft, predators, accidental losses, as well as people who may injure them if they cause damage to crop, fields and properties (Ficarelli, 1995). Toxic plants may also affect the mortality of goats, particularly if they are unsupervised (Kellerman, 1993).

The daily management and supervision of stock is one of the prominent production principles necessary for livestock improvement. In communal systems, farming activities are left to women, old men, and children. There is a low level of literacy among adults, estimated as 33%. Low adoption rates of sound livestock production practices are mainly due to a lack of farming knowledge and poor managerial ability (Bembridge & Tapson, 1993). Labour availability is problematic when children leave home to go to school and many owners are involved in off-farm work which constrains their daily involvement with the management of goats (Ndamukong, 1989).

2.2.5.3 Managerial practices that restrict reproductive efficiency

Managerial practices that restrict the reproductive efficiency of goats include uncontrolled mating, inbreeding, inadequate nutrition for lactating females, unhygienic conditions in sheds and other forms of inadequate disease control and prevention (Ndamukong, 1989). Ademosun (1987) indicated that the prevailing characteristics of the traditional production system must be recognised by any management innovations and provide for improvement in feeding, health and shelter.

2.2.5.4 Poor management of the doe prior to birth and around kidding

Poor management of the doe prior to birth and around kidding (poor nutritional management in particular) can possibly lead to mortality of kids (Van der Westhysen *et al.*, 1988). Kids should remain with their mothers for two days to ensure that they receive adequate colostrum. Colostrum acts as a vital source of antibodies to protect young animals from infections, as well as a laxative to stimulate the alimentary tract to function (Wilkinson & Stark, 1987). The other main problem identified is that the early consumption of colostrum soon after birth is not ensured by small-scale farmers and its value is unknown (Ficarelli, 1995).

It has also been established that resource poor farmers may adopt a partial suckling technique, which produces some milk for family consumption without severely compromising the growth of the offspring. Kids reared by restricted suckling were lighter (at 150 days old) because of poor growth (Restrepo & Preston, 1989). Selection of does for correct conformation (especially the udder, legs and teeth), fertility and mothering ability may also be important as these may affect kid survivability (Ficarelli, 1995).

2.3 Farming systems research and extension (FSR/E)

In order to work out an appropriate extension message, the factors in the farming system must be well understood. The FSR/E approach is described as directed to the problems, situations and the needs in farming; is multidisciplinary by nature; addresses the farming system in its entirety and lastly, is goal oriented and systematic in transfer of new, improved technologies (Fielding, 1987; Stilwell, 1990). It has been mentioned by Van Rooyen *et al.*, (1990) and Tawah (1998), that communal farmers do not use purely technical knowledge given to them by extension services to manage the livestock on their farms. Van Rooyen *et al.*, (1990) and Tawah (1998), indicated that farmers might be willing and ready to accept partial or intermediate solutions because of their managerial limitations and limited resources. A problem with the recommendations given is that they do not consider the socio-economic and ecological situations that dictate farmers' decisions. The appropriate technology for resource-poor production systems in developing areas is still scarce, farming systems research and extension is therefore aimed to improve the well-being of farm families by increasing the overall productivity of the farm. FSR/E aims to achieve the entire range of private and societal goals within the constraints and potentials imposed by the technical and human elements that determine the existing farming systems (Van Rooyen *et al.,* 1990). All FSR/E methodologies involve knowing and understanding the farmer and his or her farming system, and then testing the technology in the farming system using the criteria of that system.

Bembridge & Tapson, (1993) suggested that the development of integrated but decentralised communal livestock production systems, linked to the local markets and agro-industries, forms a framework within which livestock development in communal systems can take place. Fitzhugh *et al.* (1992/3), mentioned that research strategies should include the following concepts:

- adequate economic returns to livestock farmers;
- maintenance of natural resources and productivity;
- minimal adverse environmental effects;
- optimal production with minimal external inputs; and
- satisfaction of human income and food needs as well as rural families' social needs.

The economic aspects of extension messages are probably an important factor determining acceptance and sustainability yet appear to be seldom investigated (Bembridge, 1991)

The above literature review summarises what the research aims of this project hope to achieve and the literature on methods used is reviewed in Chapter 3.

CHAPTER 3

METHODS

The methods in this study are based on participatory rural appraisal (PRA) and farming systems research and extension (FSR/E) (Amir & Knipscheer, 1989; McCrindle *et al.,* 1996; Van Rooyen *et al.,* 1990; Van Vlaenderen, 1995). Goat farmers were visited, a structured interview was done and the variables that influenced the survival of kids were investigated and described over a 12-month period. Thereafter scenarios for impaired productivity were evaluated and compared.

3.1 Model system and experimental design

3.1.1 Model system

The system being modeled is a communal low input/low output extensive goat production system. The variables that were considered in this system are those that have an impact on survival of goat kids. Weaned goat kids are the main outputs. This was a qualitative and quantitative appraisal of management practices that influence kid survivability in a small-scale communal system. Scenarios were done using values obtained from farm visits and FSR methods. A holistic and participatory approach was used (McCrindle *et al.,* 1996, 2001). The intrinsic and extrinsic factors that could play a role in the small-scale goat farming system of the study area were identified. These include extrinsic factors such as environmental, socio-political and economic factors as well as intrinsic factors at the interfaces between people and animal diseases. The approach used for investigation was a holistic resource management (Babi, 1997). Specific inputs and outputs that could impact on the productivity of the system were identified (Figure 3.1).

In the veterinary context, many of these intrinsic factors are related to the epidemiology of particular diseases and parasites as well as nutrition and management. These factors will be ranked in importance so as to identify possible key factors that are likely to have a significant impact on the desired outputs or outcomes such as fertility, number of offspring weaned and number of animals marketed (McCrindle *et al.,* 1996, 2001).

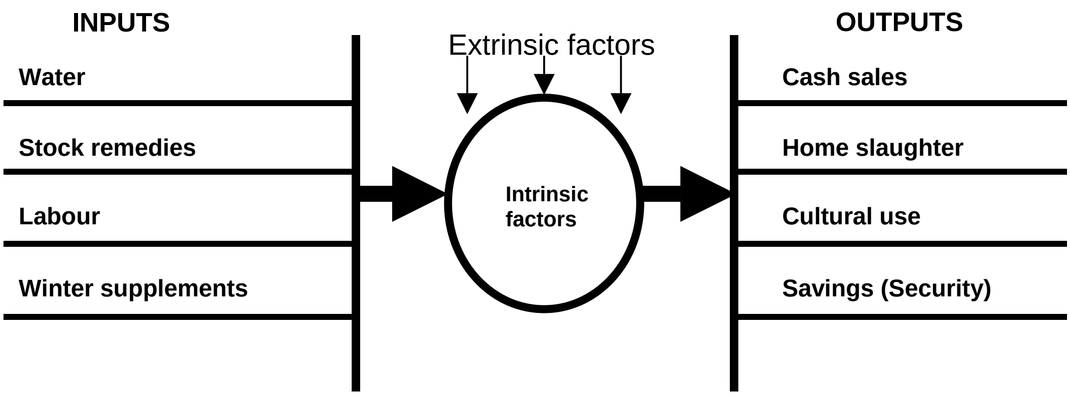

Figure 3. 1: Diagram illustrating input-output analysis of a small-scale goat production system (McCrindle *et al.,* 1996, 2001).

3.1.2 Experimental design

Initially 20 farmers were subjected to structured interview (Appendix 1). Two stage cluster sampling (Thrusfield, 1986) was done where farmers were the primary units and goats were the secondary units. The allocation procedure was based on the purposive selection of goat herds on communal grazing within Jericho (the district falls under North West Province, South Africa). Thirteen farmers remained in the trial and the farms were visited once a month. Body condition score, weighing of kids and collection of faecal samples for evaluation of internal parasites were done. Management was observed and informal discussions conducted during the visits. Monthly precipitation and temperature data was obtained from the Department of Soil, Climate and Water.

3.2 Experimental procedures and observations

The parameters that were measured to study the relationship with mortality rates of the kids were as follows:

- Demographics and socio-economics
- Nutrition
- Parasites (internal and external)
- Infectious diseases
- Environment (including housing scores)

- Management
- Mortalities of goat kids

3.2.1 Demographics and socio-economics

Demographics and the socio-economic information of the farmers and goats were elicited and recorded through the use of a structured interview (Appendix 1). Pfeiffer (1996) described a structured interview as a procedure structured with scientific purpose, by means of which an interviewer asks a series of questions and records the given verbal information from the respondent. The aim of using a structured interview was to obtain measurements of exposure variables necessary for the study.

Because most of the farmers were old and could not read or write and also to explain and translate the questions, as formulated in English, into their language (Tswana) so that questions could better understood by the farmers to get the correct answers. Farmers were visited and interviewed in their homes at the beginning of the survey.

Other relevant information was gathered by means of direct observation, informants and informal interview techniques during visits.

3.2.2 Nutrition

Nutrition was estimated by weighing kids and through the body condition score (BCS) of does using the methods described by Peacock (1996). Kids were weighed on a monthly basis from birth to weaning using a small pocket spring balance and a harness made out of nylon ski-rope, which was passed over the neck and between the front legs (Plate 3.1).

Plate 3.1 Harness made of rope used to weigh goat kid using spring balance

In mature goats nutritional status was measured by recording monthly BCS to make an approximate assessment of the effect of nutrition and season. BCS was assessed by examining the area around the backbone behind the last rib and around the tail area, which are recommended as the best areas for estimating the relative amount of body fat and muscle on a goat. A ranking score ranging from 0-5 was used as described by Steele (1996) as follows:

- Condition scores 0 - is extremely thin nearly dead, no muscle between skin and the bones.
- Condition score 1 - is where the spinous processes are sharp and stick up, transverse processes are sharp and your fingers easily push under their ends, there is a hollow between the end of each process and loin muscle are shallow.
- Condition score 2- is where spinous processes feel less sharp, your finger can be pushed under the transverse processes with a little pressure. Loin muscles are of moderate depth.
- Condition score 3 - is where spinous processes only stick up very slightly, they are smooth and rounded, firm pressure is needed to detect each one separately, transverse processes are smooth and well covered, loin muscles are full.
- Condition score 4 - is where spinous processes can just be felt, with firm pressure, as a hard line and are level with a fresh on either side and the loin muscles are full.
- Condition score 5 - is where spinous process cannot be felt at all, transverse processes can be felt and loin muscles are fully developed.

The nutrition of goats in communal systems is based on the condition of the vegetation, both grass and bushes. The potential nutritive value of the veld was also estimated using veld evaluation during the rainy season and again in the dry season according to the method described by Acocks (1975). The veld was also evaluated using a score of 1-5, where 1 is very poor and 5 is very good, as used by Mamabolo (1999) and Tainton (1981). Photographs of the grazing areas were also taken during the dry and rainy seasons (Plates 4.1 to 4.6 Comparative photographs of dry and rainy season) as described by Bryson (1998).

3.2.3 Parasites

Both internal and external parasites of juvenile and adult goats were collected during farm visits.

3.2.3.1 Internal parasites

Nematode eggs and coccidia (*Eimeria)* oocysts were evaluated by quantitative faecal egg counts per gram by means of a modification of the McMaster slide technique (Reinecke, 1983). Faeces were collected directly from the does and kids of above three weeks of age by inserting a finger covered with a plastic glove into the rectum of the animal with the animal restrained by the farmer. Faeces were transported to the laboratory in a cooler-box. Pooled samples were investigated.

At the laboratory, faeces were mixed thoroughly with a spatula. Then 2 grams of faeces and 58 ml of sugar solution were mixed in a blender for 10-20 seconds, and 4-5 drops of amyl alcohol were added to break up air bubbles in the emulsion. A wide-mouthed pipette was used to transfer the emulsion to two chambers of the McMaster slide which was allowed to stand for two minutes to allow the eggs to float to the surface, and followed by microscopic examination under low power with maximum light. Egg counts were calculated as follows: e.p.g. = total number of eggs counted divided by total number of chambers counted multiplied by 200.

The presence of cestode eggs was also recorded. Reinecke (1983) mentioned that examination of the live animal for cestodes is unreliable, as they do not indicate the severity of the infestation. The presence of *Moniezia* spp. segments in faeces was recorded when nematode egg examinations were carried out. Trematodes were estimated from necropsy of animals found dead and not from living animals. The recommended method of diagnosis where trematodes are involved is through systematic post-mortem examination of the animal (Reinecke, 1983).

3.2.3.2 External parasites

Animals were also examined for external parasites by manual examination of the coat and looking at the coat cover of the animal, as some parasites like lice and fleas can easily be seen with the naked eye close to the skin when the fleece is parted (Zumpt, 1970).

The goats were examined under the tail, around the body, between the hooves, inside and around the ears for ticks. Microscopic parasites were collected for identification using forceps. Live fleas and lice were captured using forceps dubbed with 70% ethanol. Fixed lice specimens with protruding chelicerae were selectively sorted under a dissection microscope. Selected lice were dehydrated through graded series of alcohol, critical-point dried and sputter-coated with carbon and gold after mounting for viewing in a Leica Stereo scan 420 scanning electron microscope (SEM) at 5-7 kV. Scanning electron microscopy (SEM) was used for the identification fleas and lice (Green & Baker, 1996; McCrindle *et al.,* 1999).

3.2.4 Infectious diseases

Infectious diseases were evaluated and recorded through the manifested clinical signs during farm visits, by necropsy of kids found dead and by questioning the farmers about the symptoms shown. The Department of Pathology, at the Faculty of Veterinary Science, of the University of Pretoria did the necropsies on fresh carcasses of kids. A structured interview was done at the beginning of the project, thereafter reports from the farmers were also used to monitor diseases. Farmers were asked about the symptoms shown and the diagnostic lesions in cases where they did necropsies on their own.

3.2.5 Environmental influences

Daily precipitation and maximum and minimum temperatures were obtained from the Institute of Soil, Climate and Water. This was averaged on a monthly basis to show the influence on data recorded monthly during farm visits.

3.2.5.1 Housing

Housing was evaluated using a housing checklist (Table 3.1)

Table 3.1: Housing checklist

CRITERIA	SCORE
Overcrowding co-efficient	
Adequate shelter from prevailing wind and draughts	
Adequate overhead shelter from sun and rain	
Adequate ventilation for goats and kids	
Adequate drainage	
Security against stocktheft and predators	
Easy to manage, repair and clean	
Maternal behaviour considered in design	
Adequate hygiene and regular cleaning of faeces	
Feed and water easily accessible to adults and kids	

Evaluation was done using a qualitative score from 1 to 5 where 1 was very poor and 5 was excellent, in terms of management. The overcrowding co-efficient was calculated as the number of animals divided by the area of the floor of the house measured in square meters (McCrindle, 1995). Flexible measuring tape was also used to measure the area of the kraal. Photographs were taken of the housing used for goats to show the housing materials used.

3.2.6 Management

Both structured and unstructured interviews were used to record socio-economic and management factors. The questionnaire used for the structured interview is included in Appendix I. Mothering ability was evaluated by asking the farmer if the dam accepted the kid within 12 hours after kidding. Abnormalities of the udder such as mastitis, orf, physical damage and warts were examined and recorded during farm visits. Management strategies used by farmers were also observed and discussed during visits to the farms.

3.3 Data analysis

3.3.1 Statistical analysis

Data was entered into Excel and then transferred to SPSS statistical program (SPSS 9.0 for Windows) for multifactorial analysis of variance and covariance. Qualitative data was presented as pie-charts, frequency tables and histograms. Quantitative data was analysed for significant co-relations (Thrusfield, 1995).

3.3.2 Scenario planning

Scenarios for impaired productivity were evaluated and compared by using data from the investigation in a cost benefit analysis. The costs of different extension messages to improve productivity in terms of better kid survival were evaluated using the spreadsheet Excel.

CHAPTER 4

RESULTS AND DISCUSSION

The demography of 20 farmers and their herds were recorded using a structured interview (Appendix 1). This will be discussed in detail in section 4.1. Over the course of two kidding seasons, the goat flocks belonging to 13 farmers were investigated. The observations made over the 12 months trial are shown in section 4.2.

According to the literature surveyed in Chapter 2, several factors were considered important in increasing or decreasing the survival of kids to weaning and will be further discussed in this chapter. These were highlighted as:

- Demographics and management by the farmers
- Nutrition and the grazing and browsing capacity of the surrounding veld
- Endo and ectoparasites
- Infectious diseases
- Environment including rainfall and daily temperature

The effects of each of these factors on the survival of kids were evaluated before their relative importance could be ranked.

4.1 Demography of farmers and animals obtained from questionnaires

The farmers were located mainly in Jericho districts in the following villages: Madinyane, Rietgat, Legonyane, Wilgerkuil, Fafung and Jonathan. The animal health technician located at Jericho serves these areas and they fall under the Odi district of North West Province.

The answers to the questionnaires were grouped into subsections and the results reported in tables, figures or the text.

4.1.1 Names of farmers, numbers of goats in flocks and names of villages

Table 4.1 shows the names of the farmers, the number of goats each farmer owned and the villages in which they were located. Originally there were 20 farmers but 6 farmers were left out of the project along the way for various reasons. Each farmer was allocated a code number that could be used in all the tables. These are shown in Table 4.1.

Table 4.1 Names and locations of farmers and number of goats owned at beginning of trial

Code	Name of farmer	Location (village)	No. does	Comments*
1*	Nthite James	Sephai	15*	Always unavailable
2	Mohlabai Topsy	Jonathan	28	
3	Ditsele Nathaniel	Legonyane	13	
4	Molopyane Alfred	Fafung	22	
5	Mathole Patrick	Madinyane	14	
6	Nyundu Elizabeth	Rietgat	5**	All her goats were stolen at the end of trial
7 *	Tlhwaele Josia	Legonyane	16*	His goats were always unavailable, did not kraal them
8 *	Seboko Dikeledi	Rietgat	12*	Her husband was not interested
9	Nokeri Solomon	Jonathan	16	
10	Menyatso Daniel	Wilgerkuil	14**	Sold all his goats near the end of the trial (most data was collected)
11*	Moche Grace	Sephai	8*	His goats were always unavailable, did not kraal them
12*	Leso Obert	Fafung	15*	Migrated with his goats
13*	Ngobeni Mavis	Jonathan	12*	Her goats were always unavailable
14*	Motswai Monica	Legonyane	8*	She was always unavailable
15	Manonyane Rachel	Wilgerkuil	13	
16	Mohanoe Nathaniel	Madinyane	15	
17	Thobejane Anna	Madinyane	24	
18	Mongobela Maria	Rietgat	22	
19	Moathse Daniel	Wilgerkuil	9	
20	Mashego Morris	Madinyane	20	

*includes reason for leaving trial
**Only few data missing from these farmers as they left at the end of the trial

4.1.2 Age, gender, years of farming, source of income and education

The gender and age of the owner, number of years farming, main source of income and education level are shown in Table 4.2

Table 4.2: Demographics of farmers age, gender, years farming, income and education

Code	Gender of owner	Age of owner	No of years farming	Main source of income	Education level
1	Male	29	15	Parents employed in the city	Std 9 + motor mechanics course
2	Female	78	38	Pension	None
3	Male	65	40	Pension	Std 5
4	Male	67	22	Pension	Teachers course
5	Male	48	3	Self-employed (shop owner)	Std 8
6	Female	68	15	Pension	Std 1
7	Male	65	20	Pension	Std 6
8	Female	44	16	Husband employed and stock sales	Std 6
9	Male	74	10	Pension	None
10	Male	69	1	Pension	Std 1
11	Female	38	7	Husband employed	Teachers diploma
12	Male	78	20	Pension	None
13	Female	38*	10	Pension	None
14	Female	67	10	Pension	Std 5
15	Female	64	3	Pension	Std 4
16	Male	32*	10	Pension	None
17	Female	73	12	Pension	None
18	Female	42	18	Husband employed	Std 3
19	Male	69	40	Pension	Std 3
20	Male	66	25	Pension and selling of cakes (“vetkoeks”)	Std 2

*These are unemployed people supported by the pension of their parents, who are looking after parents goats

The gender distribution was 9 women to 11 men and the mean age was 58.7 years, with a range of 29 to 78 (SD=15.96). There were obviously two main groups, unemployed younger people (n=5) and pensioners whose main income was pension pay-outs (n=14). The average age of pensioners was 69.8 years. One of the farmers was self-employed. The number of those who did not attend school was n=6, attended primary school was n=8, had secondary education was n=3 and had tertiary qualifications was n=3. The average number of years in farming was 16.3 (SD 11.7) with a range of 1 to 40 years.

4.1.3 Flock composition of farmers initially involved in the trial

The initial flock composition, including gender, age and numbers of goats and other animals farmers owned, is shown in Table 4.3. Farmers were asked only to indicate by yes or no if they owned other animals as goats were of primary interest to this study.

Table 4.3: Flock composition

Code	Adult does	Young does	Young bucks	Adult bucks	Castrates	Unweaned kids	Other animals (Yes/No)
1	11	4	0	0	0	4	Yes
2	25	3	2	2	0	12	Yes
3	9	4	2	0	0	4	Yes
4	16	6	0	0	0	8	Yes
5	10	4	0	1	0	5	Yes
6	4	1	0	0	0	3	Yes
7	9	7	0	0	4	0	No
8	10	2	0	1	0	0	Yes
9	9	7	0	2	0	0	Yes
10	9	5	0	0	0	0	Yes
11	8	0	0	0	0	2	Yes
12	11	4	1	0	2	0	Yes
13	10	2	0	0	1	3	Yes
14	5	3	0	3	0	1	No
15	9	4	0	1	0	7	Yes
16	15	0	2	0	0	4	Yes
17	16	8	3	1	0	6	Yes
18	15	7	3	0	0	2	No
19	5	4	1	0	2	0	Yes
20	13	7	2	0	0	0	Yes

It should be noted (Table 4.3, Fig 4.1) that the male to female ratio is not ideal and many of the small flocks had too few or too many adult bucks. This could contribute to the low proportion of kids.

The distribution of the age and gender of the goats is presented in Figure 4.1.

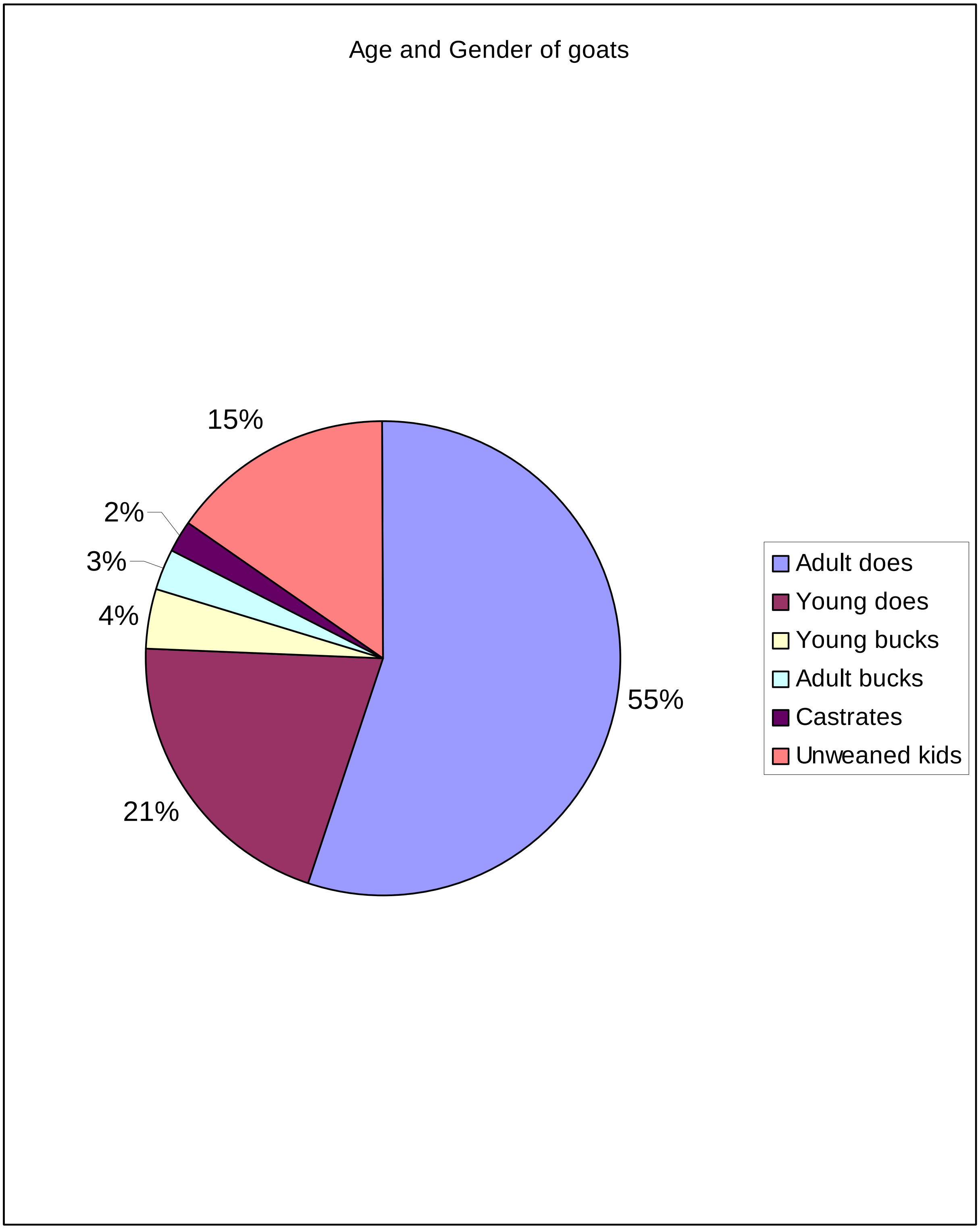

Figure 4.1: Pie chart showing the age and gender of the goats owned by farmers

4.1.4 Nutrition of goats - grazing and browsing data

The goats in this study were all grazed on communal lands owned by the state. Water on the grazing lands was available but not throughout the year. During droughts and in the winter and early spring (June to October), water was bought and given to the goats in the kraal. This water was not always clean. The price of water was 2c per litre. All goats were kept in kraals near the homestead at night. The management in regard to kraals is given in Table 4.4. Kids were kept in the kraals while their mothers grazed the veld.

Table 4.4: Management in respect of kraaling

Code	Are goats herded? Y/N	What hours do they stay in kraal		Hours on grazing
		Let out	Bring in	
1	N	12H00	18H00	6
2	Y	12H00	18H00	6
3	N	12H00	18H00	6
4	N	11H00	17H00	6
5	N	12H00	18H00	6
6	N	13H00	17H00	4
7	N	12h00	18H00	6
8	N	12H00	18H00	6
9	Y	11H00	17H00	6
10	N	10H00	18H00	8
11	N	8H00	18H00	10
12	Y	10H00	18H00	8
13	N	9H00	19H00	10
14	N	9H00	17H00	8
15	N	14H00	18H00	4
16	Y	8H00	18H00	10
17	Y	9H00	18H00	9
18	N	15H00	18H00	3
19	N	12H00	18H00	6
20	N	11H00	18H00	7

These observations may play an important role in kids' survivability because the kids were left in the enclosed kraals without feed and sometimes without water depending solely on their mother's milk. A lack of roughage may have had an impact on rumen development and kids became exposed to heartwater transmitting ticks at a late stage because some farmers let the kids go out with their mothers for the first time at about four months of age. One of the goat kids necropsied (n=6) died of starvation.

The median value for hours of grazing of adult goats (browsing) per day was 6.5 hours with a range of 3 to 10 hours (Fig 4.2)

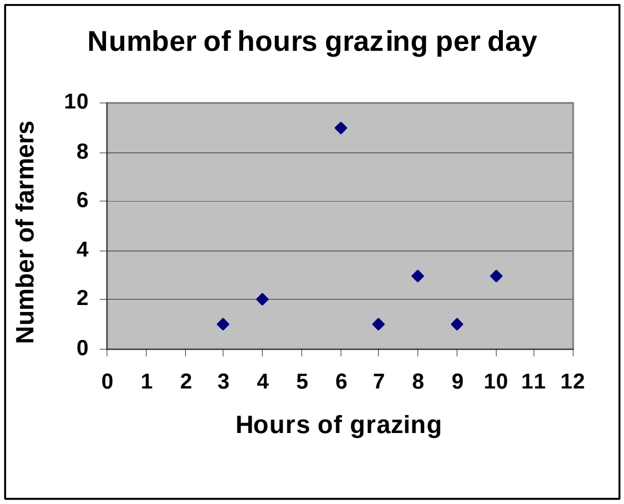

Figure 4.2: Scatter plot showing the number of hours of daily grazing (browsing)

The number of grazing hours measured during farm visits differed from that reported by the farmers. During the farm visits it was observed that when farmers had to collect their pensions or went for shopping or visits their relatives, they released their goats for grazing earlier in the morning. Twelve farmers gave no supplementary feeding, although one mentioned that his goats lost condition in the winter. The reasons for not giving supplements are as follows:

- There is enough grazing land (n=1)
- If supplements are given the goats do not go to the veld and then become troublesome and grazed in the garden (n=1)
- The goats are in good condition (n=3)
- Too expensive and lack of resources (n=7)

Eight farmers gave supplementary feeding on occasion, when their goats lost condition during the winter/early spring or during droughts. They mentioned that it was expensive. Actual words from the farmers are quoted. Supplements fed include the following:

- *"Salt"* (n=1)
- *"Yellow maize meal with salt"* (n=2)
- *"Lucerne"* (n=1)
- *"Cabbage leaves"* (n=1)
- *"Lucerne, vegetable and kitchen refuse"* (n=1)
- *"Licks and concentrates – bonemeal"* (n=2)

The licks and concentrates were given by cattle owners who noticed that the goats could also make use of this supplement. It was observed during the winter that supplementation is not regular or consistent. This may be because of the relatively high cost of supplementation.

Most farmers asked the question " *Is there enough grazing area for your goats",* answered yes (n=18). However when asked: "*Why do you think there is enough grazing area?*" they answer that "*goats are free to graze anywhere*" (n=3) or "*there is enough land*" (n=13) or "*they have good body condition even during winter*" (n=1), or "*they do not destroy home gardens*" (n=1). Only two farmers said they do not have enough grazing area because their goats' body condition declined during winter. This gives the impression that farmers do not measure the feed that is eaten by goats or the amount of bushes and grasses in the browsing or grazing area. It was also observed during the course of the research that the time of letting the goats out to graze was not consistent, during summer most farmers (n= 9) let their goats out for grazing late in the afternoon and during winter late in the morning. This does not agree with the answers they gave when they were questioned (Table 4.4). Reasons given are that during summer if they let their goats out earlier they can walk too far and they can damage crop fields. This makes sense, as most farmers (15 out of 20) did not herd their goats (Table 4.4). It was also observed over the year that even farmers that said they herded their goats seldom herd the goats and just let them out. During farm visits and informal interviews with the farmers it was observed that none of the farmers spent more than one hour per day on their goats. This is not surprising considering the average age of the farmers.

4.1.5 Reasons for keeping goats and methods of identification

Meat was the main use for goats (n=10), however one of the farmers also milked his goats. Five farmers used them for ceremonial purposes, four considered them an investment and only one kept them because he liked keeping animals. Owners used only ear notching and colours to identify the goats. For the trial all goats were ear-tagged (Table 4.5).

Table 4.5: Reasons for keeping goats and methods used for identification

Farmer code	Why do you keep goats *	Methods of identification **
1	C	N and Co
2	I	N
3	Mi, C, I and J	N and Co
4	M and I	N and Co
5	J	N and Co
6	M and C	Co
7	M and C	N and Co
8	P, M and I	N and Co
9	M	N
10	M and I	N and Co
11	C and I	N
12	M	N and Co
13	M	Co
14	M	N
15	M	N and Co
16	C	N and Co
17	M	N
18	J	N and Co
19	M, C and I	N and Co
20	I	Co

* Why keep goats: M= meat, Mi= milk; C= Ceremonial, I= Investment and J= Just like keeping them, P= Prestige
** N= ear notching and Co= Colours

4.1.6 Causes of disease in animals according to farmers

Farmers were questioned about the health and diseases of their stock at the beginning of the trial. Seventeen (17) farmers mentioned they have some problems and three did not have a problem with goat diseases. Farmers could list more than one disease.

The diseases described (in the farmer's own words) were: "rotten kidney" (n=1), heartwater (n=6), anaplasmosis (n=1), mouth sores (n=3), orf (n=2), internal parasites (n=2), bottle jaw (n=1), nasal worm (n=1), lungworm (n=1), plant poisoning (n=1), diarrhoea (n=2), paralysis (n=2), just die (n=2), krimpsiekte (N=1), tick bites (n=2), scab (n=1), flea infestation (n=1), lameness (n=1), plastic bags in the rumen (n=1) and abnormal hooves (n=1). These can be grouped into infectious causes of disease, internal parasites, external parasites, plant poisonings and mechanical causes of disease.

4.1.6.1 Infectious causes

Heartwater is considered to be a common cause of death in goats in this area (Dr Mokantla, 2001, personal communication) and was also found at necropsy in one of the kids (n=6) that died and were necropsied. It is carried by *Amblyomma* spp. ticks, which were also found frequently on all goats examined. The kids were left in the enclosed kraals while their mothers went out to graze. All farmers let the kids go out with their mothers for the first time at about four months of age. This exposes kid to heartwater-transmitting ticks at a late stage and they may not develop immunity. This could result in young goats dying of heartwater, as reported by the farmers and demonstrated in one of the necropsy investigations. Anaplasmosis is a disease found in cattle, not goats. According to a veterinarian working in the area, the rest of the diseases described are found there (Personal communication, Dr E Mokantla, 2001). The term "rotten kidney" is presumably "pulpy kidney", a clostridial disease found mainly in sheep. "Mouth sores" could be "orf" a viral infection, which was also seen on kids (n=10). One of the kids (n=6) that was necropsied showed septicaemia, probably pasteurellosis.

4.1.6.2 Internal parasites

Although farmers seemed aware that sheep could have internal parasites, details were lacking.
The following were listed - " internal parasites (n=2), bottle jaw (n=1), nasal worm (n=1), lungworm (n=1)". *Haemonchus contortus*, *Trichurus globulosa*, *Monezia* spp. and Coccidia were found in necropsies brought to the Medunsa Veterinary Faculty over the last ten years (unpublished observation, Dr E Mokantla, 1999) and these were consequently counted in faecal specimens of goats during the trial (see section 4.2.2.1). Bottle jaw is a common symptom of

Haemonchus infestation. Of the kids necropsied (n=6), two died of Haemonchosis and one died of severe verminosis caused by a mixed infection of *Monezia*, *Haemonchus* and *Bunostomum*. "Nasal worm" infection (caused by nasal bots - *Oestrus ovis*) is easily seen as the animals sneeze out the larvae. It is commonly seen in sheep in the area, however it is not very common in goats (Personal communication, Dr E Mokantla, 2001). Lungworm has not been diagnosed in this area, although it may exist. It is possible that farmers' mistake the coughing caused by pasterellosis or the sneezing caused by nasal bots for lungworm.

4.1.6.3 External parasites

Farmers recognise tick bites (n=2), flea infestation (n=1) and scab (n=1). During the trial ticks, lice and fleas were found on the animals (see section 4.2.2.2). Sheep scab (*Psoroptes ovis*) is found in the area, in sheep, not goats. It is a declared disease of sheep and animal health inspectors actively assist farmers in eradicating it. This is probably why the farmers recognise the disease and presume that goats are also affected.

4.1.6.4 Plant poisonings

Plant poisonings are found in goats, particularly when grazing is poor or they go into the gardens of villagers. "Krimpsiekte" is caused by *Cotyledon spp.,* which are frequently used as decorative plants and are indigenous in this area. The paralysis described by farmers is one symptom of krimpsiekte that may cause a paralysis lasting several weeks. *Nerium oleander*, an exotic plant with very colourful flowers is observed to be common in the gardens and causes rapid death if eaten. Although Crotalaria can cause hoof abnormalities the lesions were not associated with this plant (personal communication, Dr Mokantla, 2002).

Vahrmeijer (1981) lists a large number of poisonous plants in this area that may also affect goats. These include "gousiekte" (*Rubiaceae* family), "gifblaar" (*Dichapetalum cymosum*), "tulp" (*Homeria* spp and *Moraea* spp) and "slangkop" (*Urginea* spp.). These could easily be a cause of sporadic deaths (personal communication, Dr E Mokantla, 2001). Tulp can cause diarrhoea.

4.1.6.5 Mechanical causes of disease

Mechanical causes of disease that were recognised by the farmers included plastic bags in the rumen (n=2), lameness and abnormal hooves (n=1).

Plastic bags in the rumen are found when goats are slaughtered and may also be a cause of symptoms such as bloating, constipation, loss of weight and death. This is not well described in the literature but is considered to be fairly common in cattle as well as goats in Jericho, particularly in winter when phosphate deficiency and lack of grazing leads to pica (personal communication, Dr E Mokantla, 2001). Lameness could be caused by different factors such as footrot, ticks between the toes, abscesses or thorns. This was therefore investigated further during the trial. The deformed hooves farmers described were due to overgrown hooves, as farmers do not cut the hooves of their goats.

4.1.7 Methods described by farmers for treating and preventing diseases

Farmers were asked what they did if one of their animals became sick. The answers are given in Table 4.6 below.

Table 4.6: Details of how farmers handle the diseases of their goats

How do you handle this diseases	Number of farmers (n=17)
Treat goats with home made remedies	1
Treat goats your self with stock remedies	4
Get help from local people who know	1
Get help from animal health technicians	8
Get help from extension officers	0
Get help from local co-operative	0
Do nothing	1
Do not know what to do	2

It was found that out of the 17 farmers who mentioned having problems with goat diseases, one used home-made remedies to treat them, four treated them using stock remedies, one indicated that she gets help from local people who have knowledge, eight get help from the animal health technicians, one did nothing and two did not know how to handle the diseases. None of the farmers consulted veterinarians. The problem of communication between farmers and the state veterinary services is currently being studied (Makgatho, 2002).

Table 4.7: Stock remedies used by farmers

Stock remedy (According to farmer)* * See footnote to Table for manufacturer's details	**Active ingredient (According to IVS)**	**N= 20**
Hi-tet (Hi-Tet 300 LA , Milborrow [1])	300 mg/ml oxytetracycline	2
Terramycin (Terramycin 100, Pfizer[2])	100mg /ml oxytetracycline hydrochloride	5
Dectomax (Dectomax, Pfizer[2]) ; Obermycin (Obermycin LA, Virbac RSA[3]) and Terramycin (Terramycin 100, Pfizer[2])	10 mg/ml doramectin 150 mg/ml oxytetracycline hydrochloride 100mg /ml oxytetracycline hydrochloride	1
Sponsiekte vaccine (Onderstepoort[4]) (Onderstepoort Blackquarter Vaccine)	*Clostridium chauvoei*, formalinised alum precipitated anaculture vaccine	1
Panacur (Panacur BS, Intervet SA[5])	5 mg/ml fenbedazole	1
None	-	10

*** Manufacturer's details**
[1] Hi Tet 300 LA (Milborrow) ® Bayer Animal Health Division
[2] Dectomax ® and Terramycin 100 ® Pfizer Animal Health
[3] Obermycin LA ® Virbac RSA (Pty) Ltd.
[4] Black Quarter vaccine. Onderstepoort Biological Products
[5] Panacur BS ® Intervet SA (Pty) Ltd.

In terms of vaccinations against diseases, nine respondents mentioned they vaccinated their goats and 11 respondents seldom vaccinated. The animal health technician who serves the area, however, said that no farmers asked him to vaccinate their animals and farmers were unable to give the names of vaccines used. It is not essential to vaccinate goats, except perhaps to prevent heartwater so it is possible that farmers did not answer this question correctly. The farmers were also asked what remedies they used for their goats if they became sick. Below are the answers, as given. The actual name used by the farmers (usually the trade name) is given in Table 4.7 above, as well as the main pharmacological ingredient according to the Index of Veterinary Specialities (Swan, 2001/2).

Six of the farmers used some form of oxytetracycline, an antibiotic that is effective against heartwater and footrot and can be used to treat wounds. However it was observed that all (n=6) who were using oxytetracycline were using it as a vaccine against heartwater. Two used some form of dewormer - doramectin is effective against roundworms, including *Haemonchus* and *Trichostrongylus* spp, and fenbendazole is effective against roundworms and tapeworms. Ten of the farmers (50%) used no stock remedies at all.

Farmers were also asked about the frequency of dipping and the types of dips that were used. The results are summarised in Table 4.8.

Table 4.8: Dipping management

Dipping interval	Type of dip used (according to farmers)*	Active ingredient	N=20
After 3 months	Dazzel (Dazzel NF, Milborrow [1])	30% m/m Diazinon	1
When there are ticks	Triatix (Triatix cattle dip, Intervet SA[2])	23.75% m/m Amitraz	4
When necessary	Barricade (discontinued)	Organophosphate	1
When there are ticks	Jeyes fluid	Carbolic disinfectant	2
Once a year	Jeyes fluid	Carbolic disinfectant	1
When there are ticks	Bacdip (Bacdip Plus Aerosol, Bayer[1])	0.2%m/v flumethrin	1
Twice a month when there are ticks	Paracide (Paracide, Pfizer[3])	7% m/v alphamethrin	1
After some years	Disnes dip (discontinued years ago)	Organophosphate	1
Once a month	Tritiax (Triatix cattle dip, Intervet SA[2])	23.75% m/m Amitraz	1
None (no dipping)	-	-	7

*** Manufacturer's details**
[1] Dazzel NF (Milborrow) ® Bayer Animal Health Division
[2] Triatix cattle dip ® Intervet SA (Pty) Ltd.
[3] Paracide ® Pfizer Animal Health

It was observed that farmers who said they dipped when there were ticks and when necessary did not examine their goats for ticks on regular basis. Three farmers mentioned using inappropriate dip (Jeyes fluid). Seven farmers indicated that they hardly dip their goats. Five farmers used Triatix (Amitraz) on their goats.

4.1.8 Farmer's ideas on how they could improve their goat farming

Farmers were asked if they were interested in improving their goats. Three farmers indicated that they planned to buy Boer Goat bucks to improve their goats and 14 farmers indicated that they wanted to improve their goats but they have not yet decided on what to do. One farmer said that he plans to use traditional remedies to improve his goats, he believes that if you can rub the does vulva and tail with sheep fat it will attract bucks and one other farmer mentioned buying more stock remedies so as to improve his goats.

4.1.9 Methods used to wean kids.

All farmers interviewed about the weaning of kids mentioned that they used natural weaning. The doe chases the kid away after a certain period of time, approximately five months (150 days).

4.2 Data gathered by observation during the trial

Certain candidates (n= 7) left the trial after the initial questionnaire had been done (see Table 4.2). In some cases it was impossible to examine the goats as the owners did not cooperate by having them in the kraals for inspection. Mrs Dikelede's husband did not allow her to continue after eight months and Leso Olbert relocated to a more rural area two months after the trial started. Thirteen owners with 215 adult goats completed the trial. Over the course of the year, 32 goats were sold and 26 were slaughtered.

4.2.1 Observations on general goat nutrition

Nutrition of the goats was estimated from three observations. These were actual time spent in the grazing lands (versus time spent in the kraal), seasonal veld evaluation and monthly body condition scores. In kids the nutritional status was estimated using average daily gain i.e. total weight gained per total days weighed. Due to the low level of literacy of farmers and lack of labour to look after the goat kids, it was difficult for the farmers to weigh and keep accurate records of kids. Also due to communication difficulties, it was difficult for us to weigh and record accurate birth weights and monthly weights of kids. Average daily gain over the period birth to weaning therefore was considered in this case to give more accurate weight gain of the kids than the actual monthly weight. It may be seen that farmer 3, who milked his goats, had the highest mortality and second lowest BCS (Tables 4.5 and 4.9).

Table 4.9: Mean body condition score (BCS) of does, average daily gain in gram, standard deviation, range and percentage mortality per farmer

Farmer code	Mean BCS of does	Average daily gain*	Standard deviation	Range	% Mortality
2	2.33	51.82	19.24	10-79	37
3	2.00	36.50	10.60	29-44	75
4	2.00	53.60	16.84	24-65	55
5	2.40	62.00	3.27	58-66	18
6	2.48	33.50	6.36	29-38	67
9	2.22	45.75	13.23	32-63	0
10	2.48	74.00	9.80	66-78	25
15	2.37	82.00	8.87	75-95	29
16	2.10	58.00	14.54	44-72	50
17	2.10	74.86	25.12	48-95	28
18	2.00	74.80	36.50	18-107	50
19	2.34	140.00	39.72	111-185	0
20	2.32	61.25	8.26	53-71	58
AVERAGE	**2.24**	**65.23**	**11.25**	**10-185**	**37.85**

*Average daily gain is the total weight per total days weighed in gram

4.2.1.1 Observed kraaling times

The type of grazing system in the study area was an extensive communal grazing system. The goats were allowed to range freely to their grazing area (bush grazing) and fed household kitchen waste and allowed grazing or browsing of available vegetation without the supervision of the herdsmen. Goats were also allowed to graze during the day and housed during the night. The time that goats were allocated differed seasonally. During the rainy season they were released in the afternoon and expected to come to the kraal shortly before the sun set whereas during the dry season they were released for grazing in the morning and kraaled shortly before the sun set. This is different from the answers given during the questionnaire. The reason given by farmers was that during the rainy season there is plenty of feed for goats to graze enough within a short space of time. Also if they let them out earlier in the day, during the rainy season, they can walk too far and may destroy field crops. Farmers elaborated that they let their goats out for grazing earlier during the dry season because of the scarcity of feed and also due to the fact that during the dry season the day length is short. From Table 4.4, the average grazing time was about six hours. From observation, the average grazing time in winter was about 5.5 hours and in summer about 4.5 hours. In winter they let the goats out at about noon and let them in just before sunset - about

17:30. In the rainy season the goats were let out at about 14:00 and brought in again just before sunset at about 18:30. If the farmers were going to collect their pensions or going shopping, they let the goats out much earlier because there was no one to let them out at lunch-time (13h00). This was the general case among all the farmers observed.

4.2.1.2 Veld evaluation

Veld evaluation was done twice, once in the middle of the rainy season when the veld was at its best and once at the end of the dry season when the veld was at its worst. The veld type was classified using Acocks (1975) descriptions of veld types. It was found that the biome type of all villages was savannah bush veld, the difference was the intensity of bush encroachment. In all villages the dominating tree species was *Acacia* spp. The areas with moderate bush encroachment were Rietgat, Wilgerkuil, Madinyane while there was less bush encroachment at Legonyane, Fafung and Jonathan. Veld condition assessment was based on agronomic features (its capability to sustain livestock production) as mentioned by Tainton (1981).

Table 4.10: Seasonal veld evaluation per village

Village	Veld evaluation in the dry season*	Veld evaluation in the wet season*
Rietgat	2	4
Madinyane	2	4
Legonyane	1.5	3
Wilgerkuil	2	4
Fafung	1	3
Jonathan	1.5	3

*Veld evaluated using score of 1-5, where 1 is very poor and 5 a very good condition

The veld was evaluated considering the fact that goats are mainly browsers. The abundance of *Acacia* thorn trees supplemented the poor veld to a large extent. The grass species that were common in all areas consisted of *Panicum maximum*, *Eragrotis* spp., *Agrostis* spp., *Aristida* spp., *Digitaria eriantha* and *Themeda triandra.* Visual observations of veld were also recorded on film by the author. Plates 4.1-4.8 below illustrate the difference in the veld during the wet and dry season. Note the difference in both the grass and vegetation covers.

Plate 4.1: Legonyane village : grazing area for goats, photographed during the dry season

Plate 4.2: Legonyane village : grazing area for goats, photographed during the wet season

Plate 4.3: Madinyane village: grazing area for goats, photographed during the dry season

Plate 4.4: Madinyane village: grazing area for goats, photographed during the wet season

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Plate 4.5: Jonathan village : grazing area for goats, photographed during the dry season

Plate 4.6: Jonathan village : grazing area for goats, photographed during the wet season

4.2.1.3 Body condition score

When the farmers were visited, all the does were condition scored using the method described by Steele (1996). The average body condition score is recorded per farmer per season in Table 4.11.

Table 4.11: Average Body Condition Score (BCS) of all goats in the flock expressed per farmer per season

Farmer code	BCS during Rainy season	BCS during Dry season
2	2.45	2.00
3	2.72	1.85
4	2.13	1.90
5	2.68	2.38
6	2.94	2.25
9	2.75	2.10
10	2.72	2.40
15	2.38	2.29
16	2.57	1.97
17	2.63	1.97
18	2.00	1.93
19	2.55	2.34
20	2.55	2.19

It may be noted that farmer 18 allowed grazing for only three hours per day. Most (n=17) allowed goats out only for 6-10 hours of grazing. The goats of the two farmers (farmer 6 and 15) who allowed grazing for only 4 hours a day show much better BCS than farmer 18.

4.2.2 Parasites

4.2.2.1 Internal parasites

Faecal counts were done monthly at all the flocks available and pooled faeces were examined for helminth eggs and coccidial oocysts. It was found that the flocks of goats examined were parasitised by gastrointestinal nematodes, cestodes and coccidia.

The types of internal parasites that were found were *Haemonchus contortus, Trichuris globulosa, Coccidia* as well as *Moniezia.* The most common internal parasites in all herds of goats sampled were *Haemonchus contortus*, followed by *Coccidia.* The level of nematode eggs (EPG) and oocysts (OPG) varied from month to month. The mean monthly faecal egg counts (EPG) or oocysts per gram of faeces (OPG) are shown in Table 4.12 below.

Table 4.12: Total monthly egg/ oocyst counts and presence of Monezia segments in faeces

Months	Mean EPG Haemonchus	Mean EPG Trichuris	Mean OPG Coccidia	Monezia: present (Yes/No)
January	1443.75	81.25	3137.5	Yes
February	466.67	133.37	0	No
March	626.3	50	172.78	Yes
April	1053.33	3.13	141.95	No
May	651.51	16	276.92	Yes
June	387.56	13	225	Yes
July	237.5	30.56	655.55	No
August	158.18	52.12	785	No
September	146.53	57.58	409	No
October	399.24	22	209.85	No
November	398.5	11.36	585	No
December	825	25	137.5	No

In Table 4.13 the mean, range and standard deviation is given for Haemonchus EPG.

Table 4.13: Monthly Haemonchus counts (N, Mean and SD deviation) in faeces

Month	*N	Mean	Range	SD Deviation
January	16	1444	0-3300	1109
February	3	467	300-600	152
March	23	657	0-5300	1087
April	24	1087	0-3600	1022
May	54	593	0-4000	643
June	51	384	0-1600	321
July	44	218	0-1500	290
August	40	158	0-800	184
September	47	150	0-1200	259
October	33	403	0-2200	473
November	38	397	0-3000	543
December	27	1124	100-5000	543
Total samples	**400**	**590**	**0 - 5300**	**348.4166**

*N= the number of samples

From the above table it is evident that the highest count was 5300 EPG. However this was seen in only one sample. The majority of samples (n=316, 79%) showed an EPG below 1000. 21% (n=84) of samples showed an EPG of between 1000 and 5300, which might be a possible cause of mortality as found in two necropsed kids. As may be seen from the above, the standard deviation is very high.

According to Prof. Boomker (personal communication, 2001; Reineke, 1983) there is no significant correlation between worm burden and (EPG) because one worm can produce 5 000-10 000 eggs per day. Also there is no significant correlation between egg counts and disease unless the animal infested shows the clinical signs. It may rather be taken as an indication of flock infestation. In Table 4.14, the mean, range and standard (STD) deviation for OPG of coccidia is given.

Table 4.14: Month, mean, range and standard deviation for Coccidia OPG in faeces

Month	*N=	Mean	Range	STD Deviation
January	16	3137	0-14100	4230
February	3	0	0	0
March	23	135	0-1000	225
April	24	148	0-500	181
May	54	293	0-1200	321
June	51	227	0-3000	548
July	44	561	0-14600	2189
August	40	830	0-11800	2012
September	47	396	0-6200	1009
October	33	267	0-3900	678
November	38	621	0-3900	765
December	27	572	0-3300	797.14
Total samples	**400**	**598.92**	**0-14600**	**1203.465**

*N= the number of samples

The highest coccidia OPG counts were 14600 oocysts per gram (Table 4.14). However this was seen in only one animal which was emaciated and having diarrhoea, probably coccidiosis. The majority of animals N=333 (83.25%) showed an OPG of below 1000, N=67 (16.75%) of samples showed an OPG of between 1000 and 14600. Atanásio (2000) mentioned that a minimum count of 3000 oocysts counts per gram is necessary for conformation of clinical coccidiosis. It may be seen from the above that the standard deviation is very high. There is no specific level of coccidia OPG which is regarded as significant (personal communication, Prof. Boomker, 2001).

The mean, standard deviation and range of EPG of *Trichurus globulosa* are given in Table 4.15. From Table 4.15 it may be seen that the highest figure is 700 EPG for *Trichuris*. This is not considered to be clinically significant and rather indicates flock infestation (personal communication, Prof. Boomker, 2001).

Table 4.15: Month, mean, range and standard deviation for *Trichuris Globulosa* EPG in faeces

Month	*N=	Mean	Range	STD Deviation
January	16	81	0-700	176
February	3	133	100-200	58
March	23	30	0-500	106
April	24	4	0-100	21
May	54	15	0-200	45
June	51	14	0-200	45
July	44	27	0-300	66
August	40	25	0-200	59
September	47	34	0-600	109
October	33	30	0-300	64
November	38	11	0-100	31
December	27	36	0-200	63.77
Total samples	**400**	**36.67**	**0-700**	**42.18965**

*N= the number of samples

4.2.2.2 External Parasites

Ticks:

During the survey, goats were examined for external parasites by visual appraisal and palpation of the skin (see Chapter 3, methods). The species of ticks observed on these goats were *Amblyoma, Hyalomma and Rhipicephalus* spp. The distribution of these ticks on the body and over the different seasons was similar to that described in the literature (Pandita & Ram, 1990; Norval, 1994). Lameness was common during the rainy season due to ticks between the claws, however only one goat developed an abscess between the claws. Heartwater, which is transmitted by *Amblyomma* spp., was also a cause of mortality in kids (see Section 4.4.2).

Lice and mites:

No mites were found. Three species of lice were found in the study area during the survey. The lice species found were *Bovicola caprae, Bovicola limbatus* and *Linognathus africanus*. Both sucking and biting lice were found in 11 of the 12 herds of goats examined. In two herds (farmer 2 and 19) goats were clean of lice, it was probably because of regular dipping (Table 4.15). Lice were found on both mature goats and kids. *Bovicola caprae* and *Linognathus africanus* lice were the most common biting and sucking lice in all herds examined (Table 4.16) Fleas were also found on three goats herds (see Appendix 2).

Table 4.16: Distribution of lice on different flocks

Farmer Code	*B. caprae*	*B. limbata*	*L. africanus*	Dipping frequency	Dip used
2	Negative	Negative	Negative	When there are ticks	Dazzel NF
3	Positive	Negative	Positive	none	none
4	Positive	Negative	Negative	When there are ticks	Triatix mixed with old motor oil
5	Negative	Negative	Positive	When necessary	Triatix
6	Positive	Positive	Positive	1 a year	Jayes fluid
9	Positive	Positive	Positive	When there are ticks	Jayes fluid, Triatix
15	Positive	Negative	Positive	None	None
16	Positive	Negative	Positive	After some years	Jayes fluid
17	Positive	Positive	Positive	When necessary	Bacdip
18	Positive	Negative	Positive	After some years	Disnes dip
19	Negative	Negative	Negative	Twice a month when there are ticks	Paracide
20	Positive	Positive	Positive	None, once a month	None, Triatix

Five species of lice have been described on goats throughout the world (Price & Graham, 1997) but no records could be found of simultaneous infestations by two or more species. Collections in this study showed as many as two species of chewing lice (Plate 4.7, 4.8) and one species of sucking lice (Plate 4.9) infesting one herd and while all three species were even collected from the individual goats. For epidemiological studies it was necessary to be able to distinguish these three species easily for counting under a dissection microscope (Plates 4.7-4.18).

Plate 4.7: Ventral surface of *Bovicola caprae* attached to a hair by paired mandibles (*)

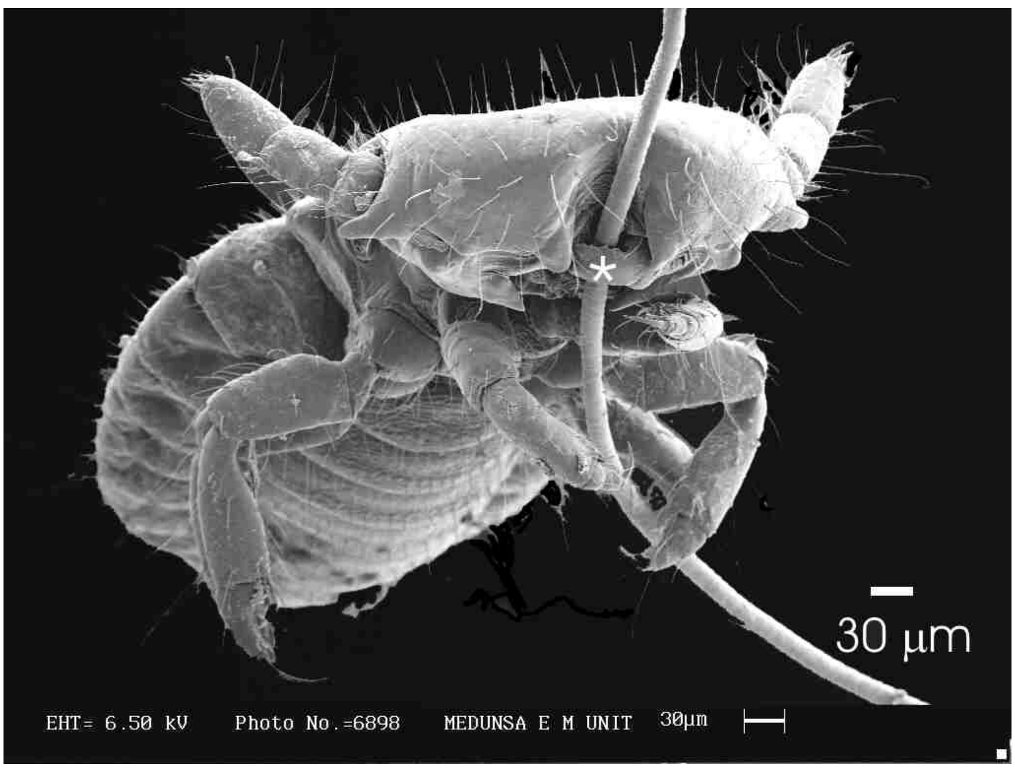

Plate 4.8: Anterioventral surface of *Bovicola limbatus* showing mandibles (*) and tarsal claws

Plate 4.9 Ventral view adult female *L africanus* showing prominent ocular processes (<<) on head, and legs ending in large single claws

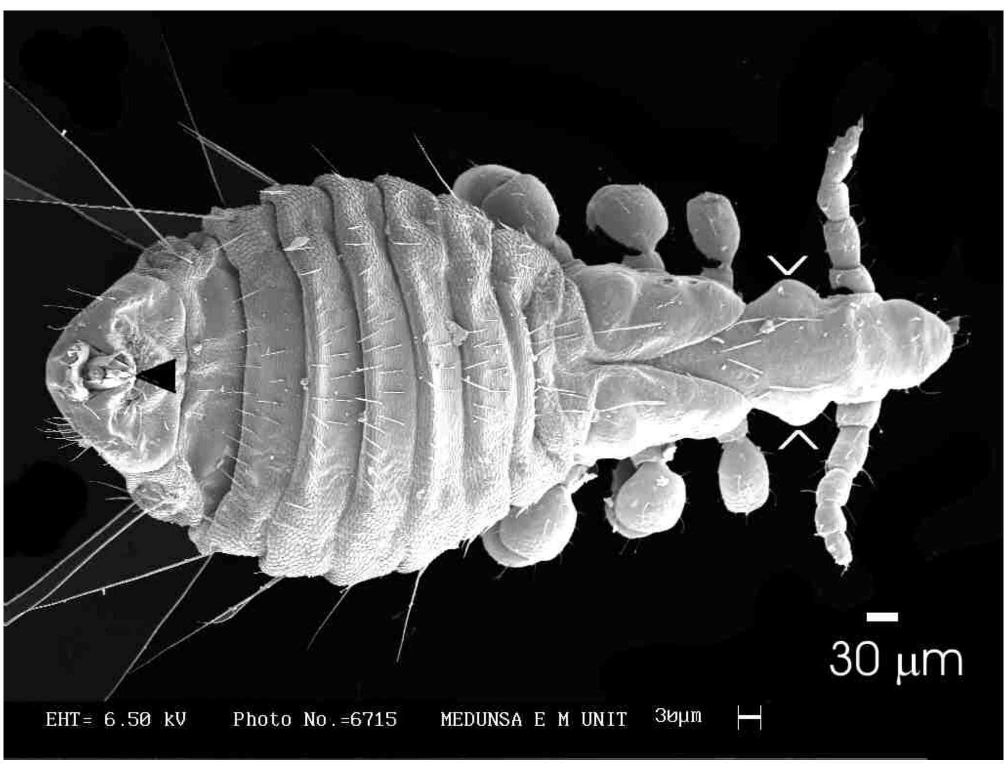

Plate 4.10: Dorsal view of adult male *L. africanus* showing ocular processes (<<) on the head and pseudopenis (black arrow on abdomen)

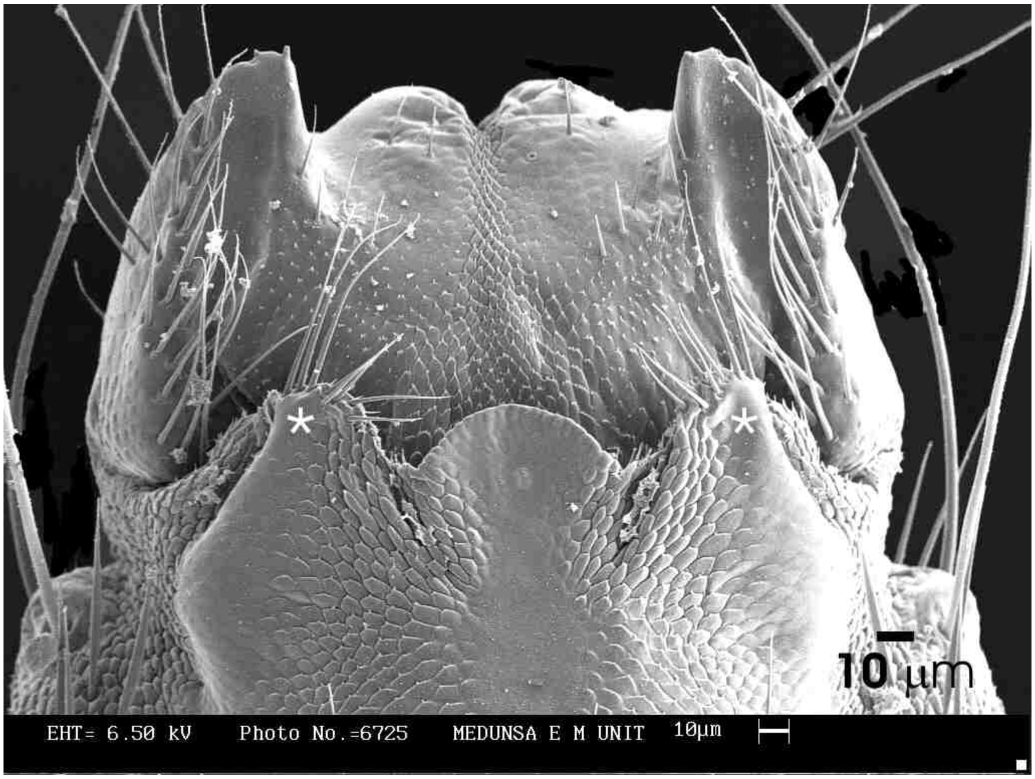

Plate 4.11: **Ventral view of the female gonopods of *L. africanus* not showing the apical tooth at (*)**

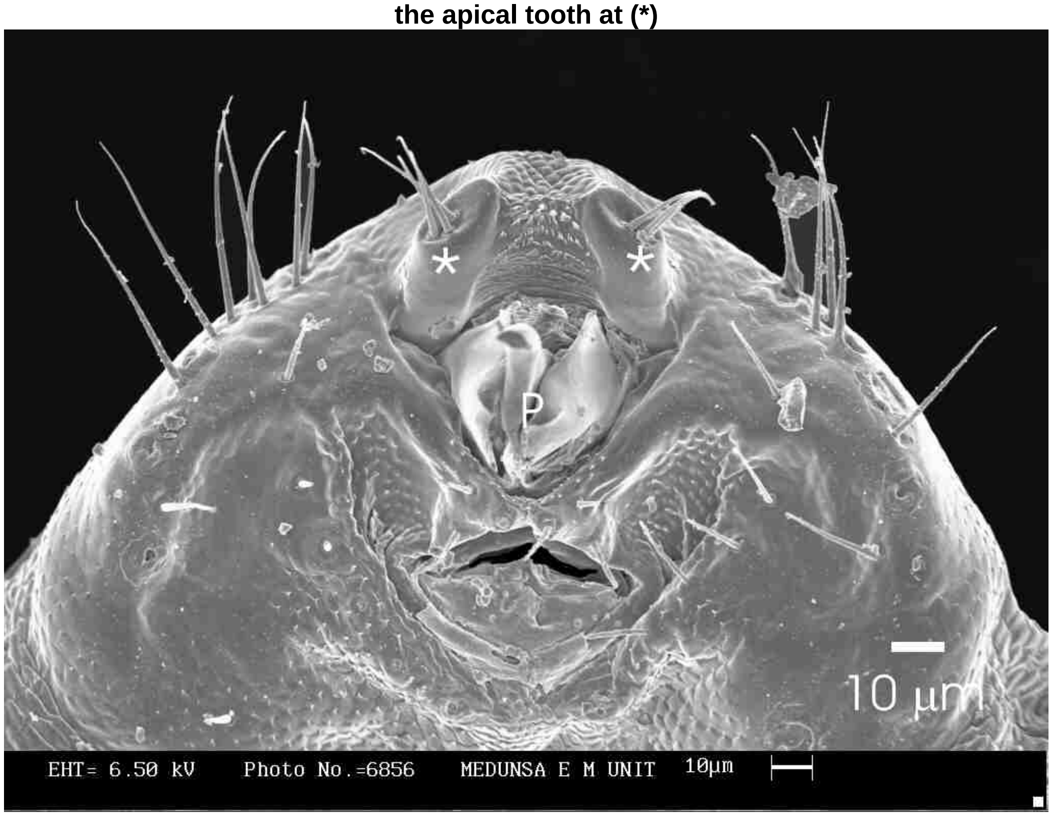

Plate 4.12: **Ventral view of male gonopods of *L. africanus* showing the tubercles (*) and pseudopenis (P)**

Plate 4.13: **Dorsal view of male *B. limbatus* showing the conical male gonopods (G)**

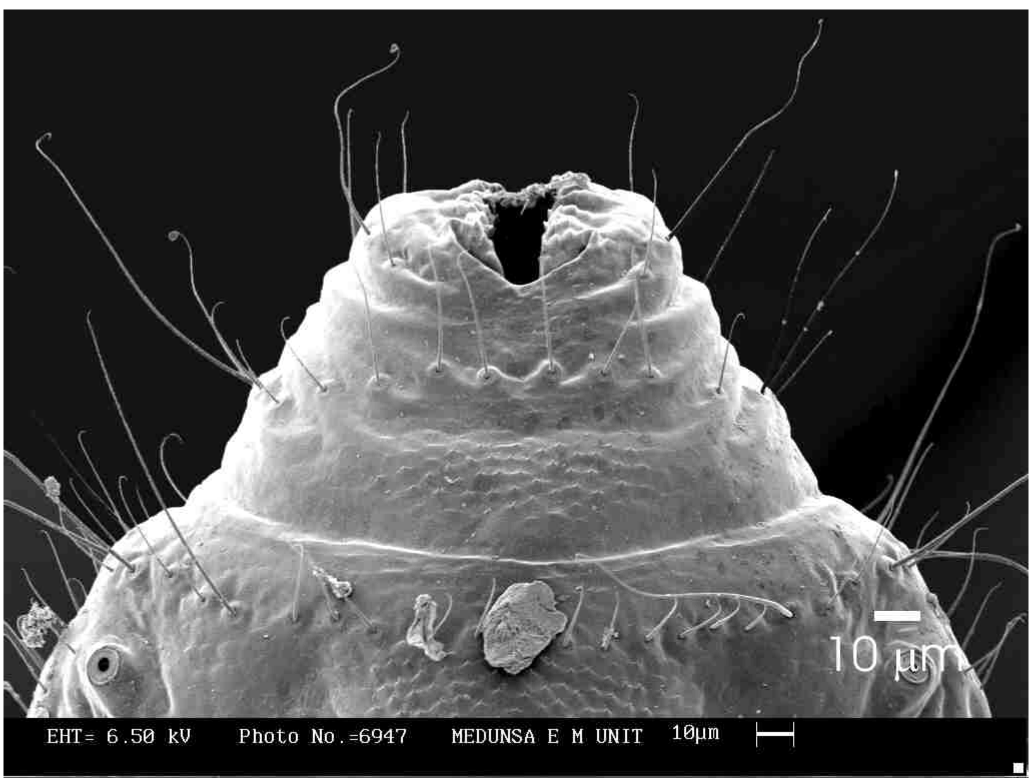

Plate 4.14: **Enlarged view of the conical male gonopods of *B. limbatus* showing the characteristic long setae**

Plate 4.15: **Dorsal view of male *B.caprae* showing the conical male gonopods (G)**

Plate 4.16: **Enlarged view of the conical male gonopods of *B. caprae* showing the terminal flaps (T) covered with short setae closing the genital opening (G)**

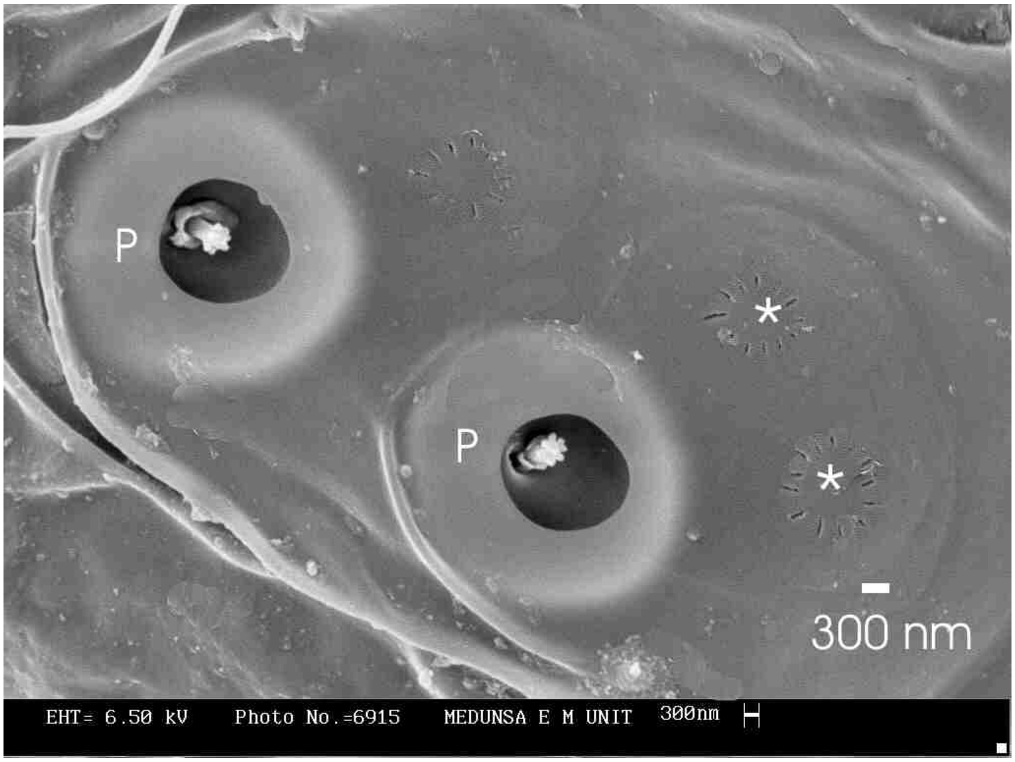

Plate 4.17: **Enlarged view of the antennal sensoria of *B. caprae* showing the two pore organs with the tuft organs (P) and two plates organs enclosed in a single plate (*)**

Plate: 4.18: **Enlarged view of the antennal sensoria of *B. caprae* showing the two pore organs with the tuft organs (P) and two plate organs each enclosed in their own plates (*)**

The goat sucking lice *Linognathus* species are easily distinguished from the *Bovicola* species which are chewing lice. The sucking lice were recognised by their elongated pointed heads and large single tarsal claws (Plate 4.9-4.10) while the chewing lice had broad shovel shaped heads with paired mandibles for attachment to the hair fibres of their hosts (Plate 4.7-4.8).

The sucking louse was identified as *Linognathus africanus* by the following characteristics which distinguish it from *Linognathus stenopsis* (O'Callaghan *et al.*, 1989). The head shape with the prominent bulging ocular points posterior to the antenna, is typical of the African blue sucking louse *Linognathus africanus*. This was confirmed under scanning electron microscope (Plate 4.9) along with the rounded female gonopods (Plate 4.11) which lacked the apical tooth characteristic of *L. stenopsis* (Stojanovich & Pratt, 1965). The gonopods of the male included the pair of terminal tubercles with setae (Plate 4.12) characteristic of *L. africanus* (Price & Graham, 1997).

Distinguishing the *Bovicola* species was more difficult as the adult females of *Bovicola* are difficult to separate (Price & Graham, 1997). None of the *Bovicola* were densely covered with setae or large enough to be identified as *B. crassipes* which is the one of the three *Bovicola* species infesting goats (Ledger, 1980). Under the stereomicroscope the males of *B. caprae* and *B. limbatus* were only distinguishable by the number of sclerotized stemites (Ledger, 1980). However, once positively identified, it was determined that the two species could be distinguished under the dissection microscope. All the para-tergites of *B. caprae* were well-sclerotized and brown in colour while in *B. limbatus* only the anterior two paratergites were sclerotized in both sexes.

According to Price & Graham (1997) these two species of goat lice can be differentiated only by examining the male genitalia. The males of both species showed the male gonopods to be conical in shape (Plate 4.13-4.15) under low magnification. This was confirmed using scanning electron microscopy which revealed further clear differences. The conical gonopods of *B. limbatus* has scattered long setae (Plate 4.14) while the posterior end of the gonopods of *B.*

caprae was densely covered with short setae (Plate 4.16). The distinctive characteristic included the two terminal flaps which closed over the genital opening in *B. caprae* (Plate 4.16). The antennal sensoria were similar in both species with two pore organs each containing a tuft organ (Plate 4.17-4.18). The three adjacent plate organs however showed micro-morphological differences. In *B. limbatus* the anterior two plate organs share one plate (Plate 4.17) while the two plate organs in *B. caprae* are each surrounded by their own plate (Plate 4.18).

Fleas:

During the trial it was also observed that *Ctenocephalides felis felis* was parasitic on goats. Flea infestation was observed in three flocks (2, 17 and 18). The most heavily affected age group was kids and lethargy was the main symptom manifested. This agrees with the findings of McCrindle *et al.* (1999), who described flea infestation in goats in Winterveld, not far from Jericho (Plate 4.19).

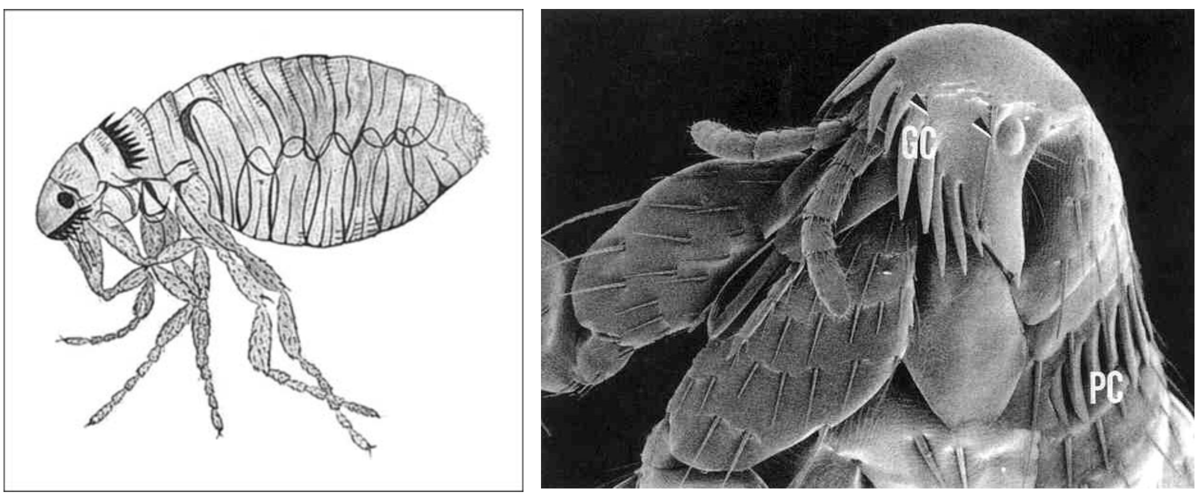

Plate 4.19: Drawing and scanning electron micrograph of *Ctenocephalides felis*

4.3 Mortality and births recorded during the trial

4.3.1 Feedback from farmers on births and mortalities

Mortality refers to all post-natal deaths which occurred during the trial. This refers to the proportion of kids dying as a proportion of the number of kids born during the year (Mamabolo, 1999). Feedback from the farmers was also used to obtain and record the information with regard to the births (Table 4.18) and mortality of the goat kids.

Table 4.17: Causes of kid mortality observed by farmers

Causes of mortality*	**N=
Unknown	16
Suspected fleas	2
Missed	2
Suspected footrot	1
Diarrhoea	4
Suspected malnutrition	4
Suspected heartwater	2
Suspected predators	2
Suspected internal parasites	2
Killed by dog	5
Stillbirth	1
Fell in the toilet pit	1
Total death	42

*excluding necropsied kids (N=6)
**N= number of kids died

Farmers were asked to record the mortality of kids and the cause i.e. the symptoms shown before death (Table 4.17). The total mortality incurred during the survey was 48. This was 37% of the total number of kids born (131) and the survival rate to weaning was 63%. It may be noted from Table 4.18, that farmer 3, who milked his goats had the highest level of kid mortalities (Table 4.5 and 4.9). Prolificacy (number of kids per doe that kidded per year) is a measure of multiple births and does that kidded more than once in a year. Kidding percentage is a measure of the kids born per doe in the flock and is a measure of the doe flock composition - including infertile as well as fertile does (Donkin, 1993; Mamabolo, 1999). From our survey it was found that prolificacy and kidding percentage range is 100% to 160% and 44.4% to 170% respectively.

Table 4.18: Total kids born, prolificacy and mortalities per farmer

Farmer code	**2**	**3**	**4**	**5**	**6**	**9**	**10**	**15**	**16**	**19**	**17**	**18**	**20**
Kids born	19	4	11	17	3	5	8	7	8	5	18	14	12
**** % Prolificacy**	110	130	100	113	100	100	160	140	114	125	128	160	120
***** % Kidding**	76	44.4	69	170	75	55.6	88.9	78	50	100	113	93	92
***Mortality**	7	3	6	3	2	0	2	2	4	0	5	7	7
% Mortality	37	75	55	18	67	0	25	29	50	0	28	50	58

*Kids mortality from birth to weaning **Prolificacy = kids per fertile doe (i.e. those that kidded) per year (indicates multiple births) ***Kidding percentage = kids per does in the flock

4.3.2 Necropsy results

Six goat kids that were found dead were taken for necropsy. These are not included in Table 4.17. The necropsy results for one kid showed that was due to heartwater, one was diagnosed as acute septicaemia (probably pasteurellosis); two kids were diagnosed as haemonchosis, one was diagnosed as severe verminosis (mixed infection) and one was diagnosed as undernutrition (starvation). As the farmers did not have access to communication, did not own refrigerators and could not afford transport, dead kids were not brought for necropsy and only those encountered during monthly visits could be necropsied.

4.4 Environment

4.4.1 Rainfall and temperature

The maximum and minimum daily temperature and rainfall was measured at the Brits weather station. This is the nearest weather station to Jericho District. In Table 4.19, below, the monthly rainfall and average monthly temperatures are given.

Table 4.19: Monthly rainfall, average maximum and minimum temperature

MONTHS	RAINFALL mm *	MAXAVTEMP °C**	MINAVTEMP °C***
January	181.5	26.77	16.77
February	322	27.44	17.48
March	155.5	27.27	17.22
April	45.5	24.04	11.82
May	14	21.42	4.08
June	6.5	20.38	4.37
July	0	19.97	1.11
August	1	23.85	4.62
September	33	26.98	8.23
October	160.5	28.25	14
November	177	27.4	14.64
December	126	29.11	17.08

* RAINFALL = Average daily rainfall in millimetres
** MAXAVTEMP = Average maximum daily temperature in degrees Centigrade
***MINAVTEMP = Average minimum daily temperature in degrees Centigrade

The rainfall is displayed below in the form of a histogram (Figure 4.3) and graph (Fig 4.4).

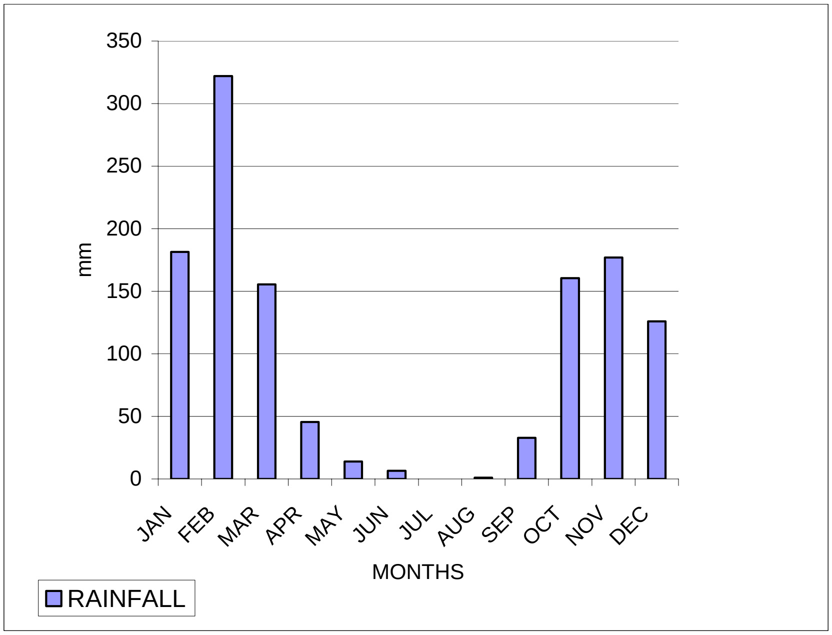

Figure 4.3: Histogram showing the monthly rainfall during the wet and dry seasons

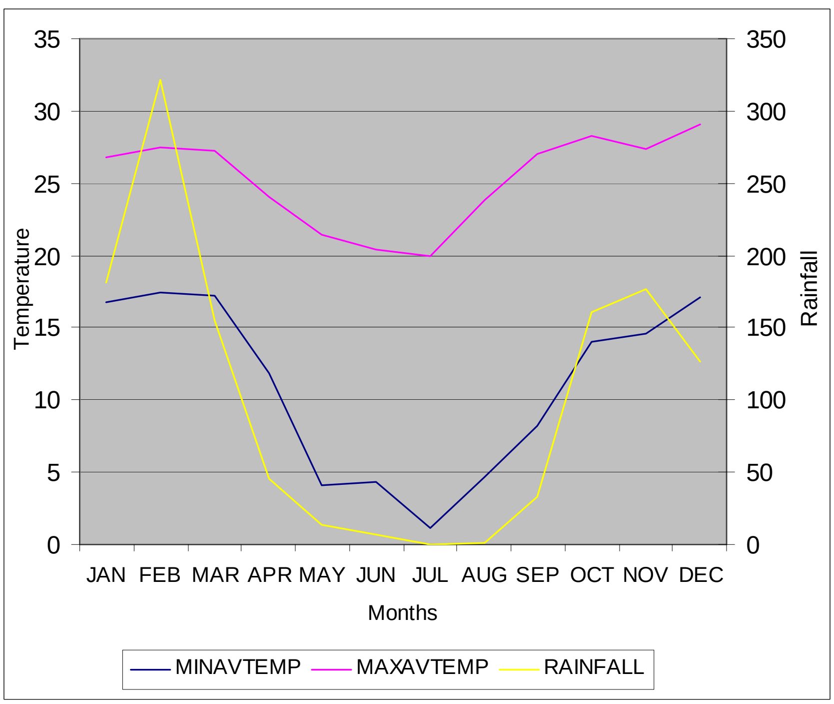

Figure 4.4: Monthly rainfall and average temperatures

4.5 Management

The production system used was an extensive communal goat production system. Goats were mainly managed by older people. Most of the farmers (65%) were pensioners of fairly advanced age (Table 4.2). According to informal interviews, farmers said that able-bodied adults migrated to the cities for better jobs. Goat farming was left mainly to old people and children. Children attend the schools and as a result the old people perform the household chores and look after the animals. It was observed that there was consequently a shortage of man-power to look after the goats.

The economics of keeping goats was a low-input, low-output system. The farmers inconsistently use veterinary products, supplementary feeding or regular cleaning of houses for their goats (Table 4.19). Lack of consistent and regular anti-parasitic measures may be amongst the reasons for low productivity in small-scale communal goats keeping systems (Ademosun, 1987; Boomker *et al*., 1997)

The breeding season was not controlled and the buck was always with the does. The male goats were castrated, slaughtered or sold as kids because uncastrated bucks wander too far. Labour inputs were low. Farmers just let the goats out and put them back in the kraals.

During the structured interview five farmers said that they herded their goats and 15 farmers said that they just let out their goats for grazing on their own. However, over the course of the trial it was observed that no farmers herded their goats. This also makes sense, as most of the farmers (n=14) were pensioners of fairly advanced age. The value of the goats was low and on their pension money they would not be able to pay someone to herd the goats. There was no supervision of kidding during the kidding season and this could also be the reason for the low productivity.

4.5.1 Housing

A housing checklist was used to evaluate goat housing. The results may be seen in Table 4.20. Goat houses in the study area were made of wire, scrap and corrugated iron, thorn bushes and wooden poles. This is in agreement with Payne & Wilson (1999) that goat housing does not need expensive building materials. Bad roofing was common. These results in leakage of water during rainy season and floors become muddy. As mentioned in Devendra & McLeroy (1982) poor housing can cause adverse effects in goats resulting in pneumonia and increased parasitic infestation. It was found that 46% of the houses provided no shelter from the rain and the remaining 54% provided some shelter from the rain. Ficarreli (1995) reported that in Malawi that goat keepers lose 30% of their young stock every year, especially during the rainy season.

Table 4.20: Housing checklist for the farmers and scores (N=13)

Housing checklist	2	3	4	5	6	9	10	15	16	17	18	19	20	Mean
Overcrowding co-efficient	0.76	0.32	0.27	0.77	0.42	0.34	0.3	1.39	1.5	0.86	1.6	0.21	1.22	0.77
Adequate shelter	4	2.5	2.5	3	4	2.5	2	2	3	2	0	0	2	2.27
Adequate ventilation	2	5	5	5	5	5	5	5	2	4	5	5	4	4.4
Adequate drainage	2	2	2	2.5	4	2.5	2	2	2	1	3	2	1	2.2
Adequate security	3	2	2	4	3	3	2	2	1	1	2	2	3	2.3
Easily managed	3	4	3	3	4	3	3	3	3	2	1	3	2	2.8
Maternal behaviour considered	2	1	1	1	0	0	0	0	0	1	0	0	0	0.5
Nutrition accessible	1	1	1	0	0	0	0	0	0	0	0	2	0	0.4
Bedding material	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adequate hygiene	0	0	0	0	3	0	0	0	0	0	0	0	0	0.2
Mean score per farmer (excluding overcrowding)	1.9	1.9	1.8	2	2.6	1.8	1.6	1.6	1.2	1.2	1.2	1.6	1.3	1.7

Table 4.20 shows the scoring of goat housing according to the housing checklist described in chapter three. Plates 4.21 to 4.26 show different types of goat housing used in the study area. In the above qualitative scoring, a score of 2.5 and above is taken as acceptable. In the case of the overcrowding coefficient, 1.0 is taken as the optimal score, below 1.0 is acceptable and above 1.0 is unacceptable. The average score of 0.77 indicates that overcrowding is not a problem. It was found that 69.23% of the houses were not overcrowded and 30.8% of the houses were overcrowded.

In terms of shelter from the prevailing wind it was found that 47% of the houses could not provide shelter from the prevailing wind and 53% could provide shelter from prevailing wind. Only one house had insufficient ventilation, as the owner was worried about stock-theft. One farmer had five kids killed by dogs. These kids used to remain in the kraal when their dams went out for grazing and tended to sneak out of the kraal. It was mentioned by Mowlem (1988) that kids need housing with solid sides all around, as they escape from the house and become prone to adverse environment. In this case it was found to make them susceptible to predation by dogs.

Drainage was measured by using a score of 1-5 where a score of one was regarded as very poor drainage and score of 5 as very good drainage. In this case it was found that 69.2% of the houses had poor drainage and 30.8% of the houses had moderate drainage. It was found that 92.3% of the respondents did not remove faeces from the floor (adequate hygiene) and 7.7% of the respondents removed the faeces from the floors of the kraal twice to three times a year. The mean housing score for 92.3% of the houses evaluated was below 2.5 which is regarded as inadequate housing conditions. It is probable that the general poor housing i.e. wet conditions, lack of shelter from prevailing wind and poor drainage contribute to the mortality of kids due to cold stress.

Plate 4.20: Goat housing made of thorn bushes with tyres to keep goats from the mud during the rainy season and tree for shelter

Plate 4.21: Goat housing made of wooden poles and scrap-iron with tree for shelter

Plate 4.22: Housing for goats made of corrugated iron, scraps and thorn bushes

Plate 4.23: Housing of goats showing lack of hygiene and drainage from accumulated faeces

Plate 4.24: Goat housing of wire and scrap iron, with goats hobbled so that they can not escape, tyres used to keep goats out of the mud during the rainy season. No shelter

Plate 4.25: Goat housing made of wire and wooden poles, with an old iron bedstead and tyres to keep goats from the mud during the rainy season

Ndamukong *et al.* (1989) and Payne & Wilson (1999) recommended that adequate housing must be able to protect animals from rain, excessive heat, wind, cold and draughts and provide the opportunity for better feeding and breeding control.

Kids that died just after birth might be as a result of overcrowding in the case of farmer 6, 11 and 13, as none of these three farmers considered maternal behaviour in the design of their housing. Lack of hygiene and build up of faeces could results in the kids becoming infected with bacterial diseases and internal parasites. It is clear from the initial findings of the survey of housing that extension is required for the improvement of goat housing in the area studied. Payne & Wilson (1999) mentioned that suitable goat housing can result in improved output and productivity.

4.6 Linkages and statistical correlation

Earlier in this chapter the results of the farmers' questionnaire and observations were given. A summary of farmer-linked factors affecting kid mortality is outlined in Table 4.21.

This study was aimed to assess and rank the factors affecting goat kid survivability and develop and evaluate the affordability and appropriateness of extension messages for small scale goat farmers so as to optimise the survival of kids. The factors affecting kid mortality will be discussed and compared. In order to get an effective extension message, cost effectiveness will also be considered (Doll & Orazem, 1984). Statistical analysis, using Pearson correlations and regression (Thrusfield, 1995) was done to investigate correlations between the variables reported and kid mortality. Significant correlation of average and total mortality was found only with the presence of internal parasites.

Table 4.21: Summary of farmer-linked factors influencing kid mortality

Farmer code	2	3	4	5	6	9	10	15	16	17	18	19	20
Age of farmer	78	65	67	48	68	74	69	64	32	73	42	69	66
Income source	P*	P*	P*	SE**	P*	P*	P*	P*	PP*	P*	HE***	P*	P*
Mean BCS of does	2.33	2.00	2.00	2.40	2.48	2.22	2.48	2.37	2.10	2.10	2.00	2.34	2.32
% Mortality	37	75	55	18	67	0	25	29	50	28	50	0	58
Total mortality	7	3	6	3	2	0	2	2	4	5	7	0	7
Housing score	1.9	1.9	1.8	2	2.6	1.8	1.6	1.6	1.2	1.2	1.2	1.6	1.3
Mean EPG *H.contortus*	407	964	748	231	731	318	280	358	551	600	343	283	882
Mean EPG Trichuris	17	25	50	11	133	3	40	3	22	15	36	34	0
Mean OPG	498	390	733	733	706	395	78	740	112	878	527	259	679
ADG of kids	51.8	36.5	53.6	62	33.5	45.75	74	82	58	74.86	74.8	140	61.25
Winter supplement (Yes/No)	Yes	No	No	Yes	No	Yes	No	No	No	No	No	Yes	No
Dipping (Yes/No)	Yes	No	Yes	Yes	No	Yes	No	No	No	No	No	Yes	No
Deworming (Yes/No)	Yes	Yes	No	No	No	Yes	No	No	No	Yes	No	Yes	No
Presence of fleas (Yes/No)	Yes	No	Yes	No	No	No	No	No	No	Yes	No	No	No
Presence of lice (Yes/No)	No	Yes	Yes	Yes	-	Yes	-	Yes	Yes	Yes	Yes	No	Yes
No. of does with udder problems	0	0	0	0	0	0	1	0	0	0	0	1	0
% Prolificacy	110	130	100	113	100	100	160	140	114	125	128	160	120
Kidding %	76	44.4	69	170	75	55.6	88.9	78	50	100	113	93	92
Buck/doe ratio	2:20	0:4	0:16	1:13	0:5	2:10	0:8	1:5	0:13	1:20	0:13	0:6	0:15

*P= Pension, *PP= Parents' pension, **SE= Self-employed, ***HE= Husband employed and EPG= Eggs per Gram, OPG= Oocysts per Gram, ADG= Average Daily Gain

4.6.1 Effect of internal parasites on kid mortalities

Pearson coefficients were calculated to estimate correlations between kid mortalities and faecal counts of *Haemonchus* spp, *Trichurus* spp and *Eimeria* spp. (Table 4.22).

Table 4.22: Pearson correlations between monthly kid mortality (average and total) with monthly EPG *Haemonchus* spp. and *Trichuris* spp. and OPG *Coccidia* in faecal specimens from flocks (n=12).

Variables	Average Haemonchus EPG	Average Coccidia OPG	Average Trichuris EPG	Average kid mortality	Total kid mortality	Kids born
Average Haemonchus EPG	1.000	0.923**	0.918**	0.933**	0.912**	0.899**
Average Coccidia OPG	0.923**	1.000	0.907**	0.961**	0.936**	0.880
Average Trichuris EPG	0.918**	0.907**	1.000	0.893**	0.876**	0.824**
Average kids mortality	0.933**	0.961**	0.893**	1.000	0.987**	0.926**
Total kids mortality	0.912**	0.936**	0.876**	0.987**	1.000	0.954**
Kids born	0.899**	0.880**	0.824**	0.926**	0.954**	1.000

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

It can be seen from the Pearson co-efficients in Table 4.22 that the average coccidial OPG, average *Haemonchus* spp. EPG and average *Trichuris* spp. EPG are significantly correlated to the average and total kid mortalities. This suggests that gastrointestinal parasites played a significant role in kid mortality, which is in agreement with results by Atanásio (2000) that younger goats are more prone to the effect of nematode infection than mature goats. Clinical disease and mortality due to helminth infestation often occurs in young goats (Atanásio, 2000). There was also a significant correlation between the OPG, EPG and the number of kid born. This indicates that eggs might be shed by does in the *post-partum* period, as is described for sheep by Coop *et al.* (2001), resulting in high levels of internal parasites in the entire flock. Adults may also act as carriers of infection for the kids, which are still vulnerable to parasites. *Moniezia* spp. are usually known to infect kids (Atanásio, 2000), however few goats in this study were found to be infected, so this could not be correlated with mortality (Table 4.11).

4.7 Economic evaluation of proposed extension messages

It is suggested that identified key variables form a component of extension messages to improve the outputs (kid survivability) of small scale goat and sheep farmers in South Africa and that economic analysis be done prior to the formulation of extension messages. This agrees with Reynolds *et al.* (1987) that any improved method to be recommended or suggested to farmers must be tested initially, be shown to work and be realistic in the context of the village conditions.

The economic evaluation of the goat farming systems found in this study were estimated, based on prices obtained from the farmers in informal interviews during the trial. The majority of farmers kept their goats for cultural and household use. The average number of adult goats per flock was 13.3, which is greater than the average size of flocks which were observed by Ademosun (1987). Under the same farming system in the villages of South-Western Nigeria he found the average flock size to be five. In an ideal set-up, one of the goats in the herd would be a ram, therefore 12 has been taken as the average number of goats per farmer. If it is considered that improved extension could result in a larger flock where sale of goats improves family income, the following three groups can be used for input/output analysis: 12 does (current farming system), 24 does (sufficient to provide excess goats for family consumption) and 40 does (sufficient to provide excess goats for sale). Under the current management system the average prolificacy of those does that kidded was 123%. Donkin (1998) gave a prolificacy of 150%. The average kidding percentage was 85% and the survival rate to weaning was 63.3% (total kids born less total kids that died before weaning). Survival to marketing (per doe) was 53%. The kidding percentage was less than the figure of 123% which is regarded as achievable for indigenous goats (Donkin, 1998). The large difference found between prolificacy and kidding percentages indicates that there is a high number of infertile does in the flocks, however, this study is concerned with *post partum* mortality. Total kids born were 131 and 48 did not survive to weaning (36.6% mortality). Under intensive conditions, Donkin (1998) described a mortality of 28% in indigenous kids, mainly due to coccidiosis and pneumonia. This he ascribed to overcrowding and poor hygiene.

Goat owners in this study did not treat for internal parasites or heartwater, gave no winter supplements and spent about 1 hour per day of their time letting the goats out of the kraal and putting them in again. Platteeuw & Oludimu (1992) who describe the traditional goat keeping system as deliberately less labour-intensive shared this view. It was also mentioned by Platteeuw & Oludimu (1992) that the intensive goat rearing system is unable to generate a rate of return on labour greater than the traditional goat rearing system, whereas the latter is far below what can be earned by hired labour. These may be contributory to the lack of labour to look after the goats. Ticks were treated with Jeyes Fluid which is not appropriate. Kraals were not cleaned in most cases. According to the farmers, the purchase / selling price of an adult doe was R300.00 and a young goat (after weaning) was R150.00. Water, if purchased locally, costs 2c per litre. The capital value of the goats and kids was taken as the average herd size X average purchase price. An economic evaluation of the system is in Table 5.3.

Weaning age is presumed as 150 days. From informal interviews this was the approximate age at which natural weaning occurred.

For purposes of input-output analysis the total kids weaned per doe in the flock is required (n=0.53). This was calculated by dividing the total number of kids that survived to weaning (n=83) by the total number of adult does that completed the trial (n=156). Under communal conditions it is presumed that the buck mated 100% of does. This could be considered the flock "output". If the work of Donkin (1998) is taken as the achievable output, the output would be 113/128 = 0.88 kids surviving per doe bred.

Replacement of breeding does is taken at 10%. This has no economic impact as the culled does are either slaughtered or sold for the same price as the replacement does.

Table 4.23: Income/Expenditure estimates for three goat farming systems at an estimated kidding percentage of 85% and survival to marketing of 53%

Financial details	Cultural (n =12)	Household (n=24)	Semi-commercial (n=40)
CAPITAL			
Adult goats@R300.00	R3600.00	R 7200.00	R12000.00
Housing	Scrap used (free)	Scrap used (free)	Scrap used (free)
INCOME	(n= 6.36)	(n= 12.72)	(n= 21.2)
(Weaned goat value R150)	R 954.00	R 1908.00	R 3180.00
TOTAL INCOME	R 954.00	R 1908.00	R 3180.00
EXPENDITURE			
Fixed costs			
Labour opportunity cost @ R7.00/hr	R2555.00	R2555.00	R2555.00
Interest opportunity on capital, 10%	R 360.00	R 720.00	R1200.00
SUBTOTAL FIXED COSTS	R 2915.00	R 3275.00	R 3755.00
Variable costs			
Winter supplement, Lucerne @ R22.00	0.00	0.00	0.00
Lick / concentrate @ R70.00/bag	0.00	0.00	0.00
Water @ 5litres/day/goat 2c/litre	R 438.00	R 876.00	R1460.00
Extra water for kids 1 litre/day/kid	R 19.08	R 38.16	R 63.60
Dips 14c/treatment (Dazzel)	0.00	0.00	0.00
Deworming of kids R1.41 (Dectomax)	0.00	0.00	0.00
Deworming of adult goats R3.82	0.00	0.00	0.00
Vaccination (Heartwater i/v) R10.61	0.00	0.00	0.00
Treatment (Terramycin) R6.00	0.00	0.00	0.00
Jeyes fluid @10c/treatment (twice a year)	R 3.67	R 7.34	R 12.24
SUBTOTAL VARIABLE COSTS	R 460.75	R 921.50	R 1535.84
SUBTOTAL INCOME	R 954.00	R 1908.00	R 3180.00
SUBTOTAL Fixed and variable costs	R 3375.75	R 4196.50	R 5290.84
TOTAL (Profit/loss)	-R 2421.75 (loss)	-R 2288.50 (loss)	-R 2110.84 (loss)
Ignore labour opportunity (Costs)	R133.25	R266.5	R444.16
Profit/loss (excluding labour and interest)	R 493.5	R 986.5	R 1644.16
%Return on capital (excluding labour and interest)	13.70%	13.70%	13.70%

Table 4.24: Input output estimates for the current goat farming system, compared to the input output if different extension messages were used

Financial details	A* Output 0.53	B** Output 0.88	C*** Possible output if dewormed eg 0.60
CAPITAL			
Adult doe	R300.00	R300.00	R300.00
Housing	Scrap used (free)	R 100.00	Scrap used (free)
INCOME			
(Weaned goat value R150)	R 79.50	R 132.00	R 90.00
EXPENDITURE (COSTS)			
Fixed costs			
Labour opportunity cost @ R7.00 per hour per goat	R 212.91	R 212.91	R 212.91
Interest opportunity on capital, 10% per goat	R 30.00	R 40.00	R 30.00
Subtotal fixed costs	R 242.91	R 252.91	R 242.91
Variable costs (doe and kid)	N=1.53	N=1.88	N=1.60
Winter supplement, Lucerne @ R22.00	0.00	R 301.93	0.00
Lick / concentrate @ R70.00/ 50 kg bag @ 100g/day/goat	0.00	R 48.03	0.00
Water @ 5litres/day/goat 2c/litre	R 36.50	R 36.50	R 36.50
Extra water for kids 1 litre/day/kid	R 3.87	R 6.42	R 4.38
Dips @ 14c/treatment (Dazzel®) X 2	0.00	R 0.64	0.00
Deworming of kids @ R1.41 (Dectomax®)	0.00	R 1.24	R 0.85
Deworming of adults goats @ R1.41x2	0.00	R 2.82	R 2.82
Vaccination (Heartwater i/v) @ R10.61	0.00	R 9.34	0.00
Treatment (Terramycin) @ R6.00	0.00	R 5.28	0.00
Jeyes fluid @10c/treatment	R 0.31	R 0.00	R 0.32
SUBTOTAL variable costs	R 40.68	R 412.20	R 44.87
SUBTOTAL Fixed and variable costs	R 283.59	R 665.11	R 287.78
Income less fixed and variable costs	-R 204.09 (loss)	-R 533.11 (loss)	-R 197.87 (loss)
Income less variable costs only	R 38.82	-R 280.20	R 45.13

A* =Output calculated using current management
B** =Output achieved by Donkin (1998) using recommended feeding strategies and managing goats
C*** =Estimated output (reduced kid mortality) if only deworming is used

Under the ideal goat rearing system suggested by Donkin (1998), 150% prolificacy and a kidding percentage of 123% is regarded as acceptable with a survival to weaning of 88%. In order to achieve this, feeding must be improved and supplements given during the dry season. It is probable that inadequate nutrition and the presence of internal parasites are the chief reasons for the low prolificacy found in this study, as the average condition score of does was 2.0 and all herds showed high levels of helminthiasis. Strategic deworming with Dectomax® twice a year for adult goats and once a year before weaning for kids, at a dose of 1ml per 50 kg live-weight subcutneously is suggested. Dazzel® is used to control ticks.

Lucerne consumption per goat is estimated at 800g per day supplementation. A bale of 20 kg of lucerne costs R 22.00. Therefore one goat consumes R 0.90 per day of lucerne. Supplementation is required during the dry season, for six months of the year (half a year). For the kid plus doe (1.88), they consume (R 0.88 X 1.88 X 365/2) per day. Then the total cost of lucerne supplement per doe plus kid per year is R 301.93, plus 100g/day/goat of concentrate over six months as winter supplements.

The economic implications of standardised extension messages may be seen clearly from Table 5.3 and 5.4. It is quite important that extension should be adapted to meet the actual conditions of the farming system. This is supported by the work of Doll & Orazem, 1984, however it does not seem to be done in practice by extension workers in developing areas.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

In chapter one, the hypothesis suggested that examination of the factors that influence the survivability of kids in small-scale communal goats production systems, such as nutrition, parasites, infectious diseases, environment and management, will lead to an appropriate extension message to meet the needs of small-scale communal goats farmers in North West Province. It was found that all these factors played a role but the two most important for formulating extension message were internal parasites and housing.

Table 4.21 provides a clear reflection of the general poor management of goats which adversely affects optimum productivity. The majority (n=10) of farmers are pensioners of fairly advanced age who are also performing household chores, this reflects a shortage of labour. Nutrition did not appear to be a major problem. The major problems found during the study were housing and internal parasites. For appropriate and relevant extension message it is on these factors that more emphasis should be placed.

5.1 Effects of internal parasites on kid mortality

From the results there is no doubt that the internal parasites and housing contributed to kid mortalities. It was found that all flocks of goats examined were positive for internal parasites and 92% of the housing was in poor condition. It was shown in Table 4.19 that hygiene and drainage of the housing of the flocks investigated were sub-optimal. Drainage was poor in the majority (69%) of the houses examined. The factors which affect the development and survival of free-living stages of nematodes are mainly environmental, especially seasonal climatic changes, and certain management practices such as the farming system used (Urquhart *et al.,* 1987). Apart from rainfall, other factors which may influence the epidemiology of nematodes include housing, management systems and feeding preferences (Atanásio, 2000). Vercruyse (1982) refers to the importance of sub-clinical cases of coccidiosis which can lead to reduced feed intake, poor weight gain and poor feed utilisation. Atanásio (2000) observed that deaths arising from *Eimeria* spp., particularly in young goats, accounted for about 15% of the total diagnosed causes of death in goats belonging to the family sector in Mozambique. Thamsborg *et al.* (1994) from their study found nutritional stress and wet environments, which favour oocyst development to be the main factors causing clinical coccidiosis in kids. Coccidiosis is also associated with wet, unhygienic conditions and would therefore also be reduced by improved drainage and hygiene. Using advice on improved hygiene and drainage in an extension message would not markedly increase input costs. Also as mentioned by Atanásio (2000), an extension message about parasite control should be directed towards controlling infection in kids.

At the beginning of the trial, (Table 4.7) it appears that only two farmers used appropriate remedies (Dectomax and Panacur) against internal helminth parasites in their goats. From Table 4.21, examination of the trial data gathered through observation and informal interview showed that six farmers appeared to be using deworming remedies. However this does not correlate with EPG and OPG counts. This probably indicated that deworming was not done strategically and consistently or that dosing was incorrect. Also several (n=7) farmers appeared not to understand the use of anthelminthics. This accords with the findings of Nsoso *et al.* (2001), who described the effect of gastrointestinal parasites in kids raised on communal grazing in Southern Botswana. Strategic deworming against *Haemonchus* spp. and *Trichurus* spp. could be considered, despite the suggestion by Nsoso *et al.* (2001) that deworming of kids on communal grazing is not necessary. Nsoso *et al.* (2001) based this conclusion on the EPG levels, that the levels were not high enough to be pathogenic. Even though several authors described indigenous goats as hardy animals, it needs to be taken into consideration that goat kids are less resistant to parasitic infection than adults and even sub-clinical infections can results in fatalities (Atanásio, 2000; Wairuiru *et al.,* 1993).

Vercruysse, (2000) has pointed out that even sub-clinical cases of coccidiosis can lead to deaths in young goats. Purohit (1982) mentioned that herds of goats suffer from several diseases that stay unnoticed because they occur at sub-clinical level. This is confirmed in the present study that the presence of parasites is significantly correlated to kid mortality. Although the monthly use of anthelminthics in communally grazed sheep, as suggested by Bakunzi and Serumaka-Zake (2001), may not be cost effective, Horak *et al.* (2001) has recently suggested that a single strategic deworming can significantly lower the levels of nematodes in angora goats. However Tembely *et al.* (1992) recommended doing strategic deworming of lambs twice (in the middle and the end of rainy season) per year.

5.2 Housing

It was found that 92.3% of houses were below the adequate level (2.5) of housing score (Table 4.20). It is probably poor housing that allows the build-up of pathogens and facilitates the survival of and infection by pathogens and internal parasites. Extension messages should suggest that farmers shift the goat house or remove the faeces from the house shortly before the beginning of every kidding period, as this will reduce the infection of the newly born kids. Removal of faeces and constructing goat housing so that drainage is improved, particularly during the wet season, would probably decrease the levels of internal parasites, and so decrease kid mortality. It is concluded from the cost-benefit analysis that strategic deworming and improved hygiene and drainage in the housing would be the most affordable and effective ways to reduce mortality in kids on communal grazing in Jericho. Further research may be required to accurately estimate the best time for strategic deworming. Further, it is concluded that economic evaluation of any extension should be done prior to implementation and in accordance with the actual farming conditions.

5.3 Effect of other variables on kid mortality

5.3.1 Nutrition

Ademosun (1987) mentioned that bush-grazing cannot provide adequate grazing for browsing animals throughout the year and that household wastes were inadequate and of low nutritive value. This resulted in nutrient imbalances. In the present study it was observed that goats mainly depend on browsing and household wastes.

Flocks studied in this investigation were on average allocated 6.5 hours per day to graze and browse, with a range of between 3-10 hours per day, while Purohit (1982) reported 8-10 hours grazing per day. Farmers never considered the fact that during hot days, flocks rest during midday as they were letting them out at around midday (Purohit, 1982).

Contrary to other authors (Kulkarni & Deshpande, 1986; Mazumdar *et al.*, 1980; Mellado *et al.,* 1991; Ranatunga, 1971) who reported the association between mortality and precipitation, there was no correlation between average rainfall and average mortality in present study. This may be due to nutrition acting as a confounder, as there is better grazing in the rainy season. There was also no significant correlation between condition score of does (considered to be an indicator of nutritional status) and mortalities (Table 4.9). The average BCS of the does over the entire period of study was acceptable (Table 4.21).

Even though there was no correlation between body condition score, which was regarded to be the indicator of nutritional status and kids mortality, nutritional management might have contributed to survivability. The kids were left in the enclosed kraals without feed and sometimes without water, depending solely on their mother's milk. All farmers let the kids go out with their mothers for the first time at about four months of age. From Table 4.9 the kid's average daily gain range was 33.5-140 g, which is less than that found by O'Brien & Sherman (1993), where mean daily gains ranged between 80-200 g in an intensive dairy goat farming system in New England. A lack of roughage might also have had an impact on rumen development. Nutritional needs differ with reproductive state of the does (Brink, 1990) and it was found that the BCS of does varied throughout the year and was generally lower in the dry season. Since there was little supplementary feeding during winter (Table 4.21) when the does' BCS were poor, this might have contributed to kid mortality as result in low milk production.

From the housing checklist (Table 4.20) it can be seen that none of the farmers considered maternal behaviour, which might contribute to the failure of the dam to suckle her kid and provide colostrum immediately after birth. This view is shared by Otesile & Oduye (1993) who said that failure to suckle colostrum shortly after birth exposes young lambs to diseases and can results in fatalities. O'Brien & Sherman (1993) also mentioned that goat kids depend on the ingestion of colostrum to build-up immunity against diseases. Normal growth and health of the neonate is mostly sustained by normal suckling and absorption of colostrum, rather than weight at birth (Chen *et al.,* 1999).

5.3.2 Management

From the results it is clear that the managerial level of goats is poor. It was observed during the trial that goat farming was under the control of old people who were also performing the household chores, and therefore the time allocated to goats was very little. Lack of labour to look after the goats might be one of the major contributing factors to kid mortality. Platteeuw & Oludimu (1992) also observed a lack of labour input in traditional goat rearing systems. This observation about traditional goat keeping systems is shared by Upton (1987) who said that generally, animals under these systems, were given little attention and as a result labour costs are not considered. Purohit (1982) mentioned that in the villages, goat and sheep farming had been mainly allotted to illiterates. In our study it was found that although most of the farmers were literate, the majority were pensioners who were physically unable to do strenuous labour.

There are several causes of kid mortalities that are directly or indirectly related to management. These include:

- Stocktheft, predators, trauma and motor vehicle accidents
- Daily management of stock
- Managerial practices that restrict the reproductive efficiency
- Poor management of the doe prior to birth and around kidding

All of the above were found in the flocks investigated (Chapter 4). The observation of poor managerial practices by small-scale farmers, is shared by Mamabolo (1999). The mortality rate per kid born recorded during the trial was 37%, which is higher than the 28% mortality rate obtained by O'Briem & Sherman (1993) in their trial in New England.

In addition, cold wind, rain, or excessive heat, due to lack of shelter and drainage could play a role in mortality of kids. It was found that 92.3% of the houses had a poor score (score<2.5) when housing was evaluated (Table 4.19). Atanásio (2000) also observed minimal investments in terms of housing, feed and health care for small ruminant production in Mozambique. Ndamukung (1989) and Payne & Wilson (1999) recommended that adequate housing must be able to protect animals from rain, excessive heat, wind, cold and draughts and provide the opportunity for closer feeding and breeding control. Purohit (1982) emphasised adequate ventilation, drainage and ease of cleaning in different types of housing used for goats. None of these criteria were adequately met by the goat houses in this investigation. The fact that kids were kept in the kraal while their mothers went out for grazing might also have played a contributory role in kid mortality. O'Brien & Sherman (1993) pointed out that the intensive confinement might increase potential environmental pathogen build-up which may challenge even newly born kids with acquired immunity.

It is probable that wet conditions, lack of shelter from prevailing wind and poor drainage contributed to the mortality of kids due to cold stress as well as increasing parasite burdens. Lack of hygiene and build up of faeces could result in the kids becoming infected with bacterial diseases and internal parasites. This agrees with the suggestion by Thrusfield (1986), that the structure of bedding materials and surfaces is a determinant of the occurrence of diseases. Kids that died just after birth might be as a result of overcrowding in the case of farmers 6, 11 and 13, as none of these three farmers considered maternal behaviour in the design of the housing. Payne & Wilson (1999) mentioned that suitable goat housing may result in improved output and productivity.

Poor and unhygienic housing is one of the causes of losses as it is in the dung of animals that parasites survive and affect young animals (Ficarreli, 1995). It is therefore concluded from the initial findings of the survey of housing that extension is required for improvement of the goat housing in the area studied. This accords with observation by Specht (1982a) wherein the EPG decreased when animals were moved from wet unclean housing to new clean housing.

5.3.3 Cost benefit analysis

It is concluded from economic analysis that the optimal key variables in the cultural system would be to decrease parasites by better management (e.g. improved housing and strategic deworming) and try to eliminate old and infertile does, as the outputs, even at 140% weaning, cannot support extra feed in the winter. The so-called "semi-commercial herd" – which may be advised by those suggesting job creation at subsistence level, can also not afford winter-feeding of goats (Table 4.23). All three systems would only supplement the income of a low-income family and make good use of available thorn-veld or household garbage. This is in line with Platteew & Oludimu, (1992) who said that the goats contribute very little income to the economy of a household in comparison to the other farm activities.

5.4 Recommendations

As it was found that those internal parasites and poor housing influenced mortality of kids and those changes would be economically viable; these must be used to develop extension messages. In general, however, owners should also be advised on better management.

5.4.1 Internal parasites

Strategic deworming once a year is recommended but the timing of strategic deworming requires further research in order to reduce kid mortalities. This can be used as an extension message for increased output and profitability (Table 4.24).

5.4.2 Housing

According to Table 4.20 , which shows the housing checklist, improvements to current housing would improve the management of goats in the following ways:

- Better shelter from cold wind would be likely to decrease kid mortality.
- Better shelter from rain and better drainage – unweaned kids are susceptible to cold stress
- Better hygiene, according to Table 4.20 faeces were not regularly removed from the current housing. The level of internal parasites would be decreased if faeces was removed or goat kraals were moved before does start kidding.
- Access to some form of roughage may help to develop the rumen of the unweaned kids left in the kraal all day

It is recommended that an extension message be developed, using the housing checklist to monitor housing and suggest improvements. As scrap can be used, this would not have an economic impact or increase inputs. The housing could be improved over a weekend when young, strong family members are at home to assist.

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APPENDIX 1

QUESTIONNAIRE

Questionnaire used in a structured interview with goat farmers.

A. OWNER`S PARTICULARS

NAME:	MALE/FEMALE
Village:	Age:

2. Who owns the goats?

Yourself	
Mother	
Father	
Family	
Uncle	
*Other	

*Specify...

3. How many goats do you have?....................

4. How were they acquired?

Bought	
Inherited	
From lobola	
Present	
*Other	

*Specify...

5. How long have you been involved in goat farming?................years

6. What is your source of income?

Employed	
Pension	
Children	
Livestock sale	
*Other	

*Specify..

7. High education level.
....

B. HERD COMPOSITION

1. What breed of goats do you have?

Boer	
Mohair	
Indigeneous	
Cross-bred	

Specify others...

2. How many:

	Number
Old does	
Young does	
Young bucks	
Old bucks	
Castrates	
Kids	

3. Other animals you own:

	Number
Sheep	
Cattle	
Poultry	
Pigs	
Dogs	
*Others	

*Specify...

C. LAND AND GRAZING

1. Where do your goats graze?

Communal grazing	
Camp	
Trust land	
*Other	

*Specify...

2. Who owns land?

Yourself	
The state	
The Tribe	
*Other	

*Specify...

3. Is there enough space for your goats to graze?

Yes	
No	

Why do you think so?
....
....
....

4. Is there water in your grazing area?

Yes	

No	

5. Is water adequate throughout the year?

Yes	
No	

6. Are you happy with this type of grazing system?

Yes	
No	

Why do you think so?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………

7. In which season do you experience problems with water?

Summer	
Autumn	
Winter	
Spring	

8. Why do you think there is a problem with water?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………

D. MANAGEMENT

1. Are your goats herded?

Yes	
No	

2. Where are your goats kept if they are not grazing?

Never kraaled	
Kraaled at home	
Kraaled in paddock	
*Other	

*Specify………………………………………………………………………………………………

3. If kraaled how long?………………hours

4. Why do you keep your goats?

Prestige	
Meat and milk for home consumption	
Ceremonial	
Investment	
Just like keeping them	
*Other	

*Specify………………………………………………………………………………………………

5. How do you identify your goats?

Ear notching	
Ear tags	
Tattoos	
Names	
*Other	

*Specify...

D. NUTRITION

1. Any supplementary feeding?

Yes	
No	

Why?...
....
....

2. When do you supplement feeding?

Summer		Why
Autumn		Why
Winter		Why
Spring		Why

3. What do you use as feed supplement?

Licks	
Concentrates	
Roughage	

4. Are you happy with the body condition of your goats?

Yes	
No	

5. Any other comments

....
....
....

E. MILKING

1. Do you milk your does?

Yes	
No	

2. Why do you milk your does?

Home consumption	
Sale of milk	
*Other	

*Specify...

3. How many times a day do you milk your does?................times

4. Do kids drink when you milk your does?

Yes	
No	

F. HEALTH AND DISEASES

1. Do you have a problem with any diseases?

Yes	
No	

2. Which diseases? In order of importance:
....
....
....
....
....

3. How do you handle these diseases?

Treat them with home-made remedies	
Treat them with stock remedies	
Get help from local people who know	
Get help from animal health technicians	
Get help from extention officer	
Get help from local cooperative	

If other specify...

What plants do you use to treat sick animals?
....
....

4. Are your goats vaccinated for any diseases?

Yes	
No	

Which diseases?...
....

5. Who does vaccinations?

Self	
Local people who know	
Animal health technitians	
Extention officers	
Veterinarians	
*Others	

*Specify...

6. How often?

Sometimes	
Yearly	
When necessary	
*Other	

*Specify...

7. Do you use stock remedies?

Yes	
No	

Which ones?
....
....
....

8. Do you dip your goats?

Yes	
No	

With what?...

How often?...

9. Any other comment?..
....
....

G. GENERAL

1. Do you want to improve your goats?

Yes	
No	

2. How do you plan to do that?
....
....
....

3. When do you wean your kids? ....months

4. Why do you wean at this age?...
....

5. How do you feel about the death of a young kid?

Not bad	
Bad	
Very bad	

Why?..
....

6. How do you feel about the death of an old goat?

Not bad	
Bad	
Very bad	

Why?...
....

DECLARATION:

I..., declare that I will allow Mr P J Sebei to enter, handle and to collect a data from my herd of goats.

Thanks for your co-operation in this regard.