

**CHARACTERISATION OF GOAT PRODUCTION SYSTEMS IN SELECTED
COASTAL AREAS OF THE EASTERN CAPE PROVINCE, SOUTH AFRICA**

By

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Declaration

I, Kululeko Dube hereby declare that this dissertation is my original work conducted under the supervision of Professors V. Muchenje and J.F. Mupangwa, submitted for Master of Science in Agriculture, Animal Science Degree at the University of Fort Hare. It has not been previously submitted to any University. Reference has been accorded to other researchers' work and assistance received has been duly acknowledged.

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Abstract

The main objective of the study was to characterise goat production systems by resource limited farmers in coastal areas of the Eastern Cape Province, South Africa. A household survey followed by monitoring of goat flocks was conducted among 100 communal farmers in Port St Johns and Umquma Municipalities. All data was analysed using SAS and simulation models were developed using the DynaMod model. The male household heads (75%) owned most of the goats, followed by female de-jure (16%) and de-facto (6%) heads. Goats were mainly used for ceremonies (38%) and generation of income (37%). The farmers kept mostly indigenous goats together with Boer breed and their crosses. Most farmers controlled internal parasites through regular dosing. The control of external parasites was through dipping. The goat housing was made of wooden poles without any roofing and the kids were kept together with the mature goats in these structures. The goats were marketed through informal channels at an average price of R1500 per goat. Most farmers preferred selling castrated male goats (57%) with peak sales in winter and late summer.

Generally, the reproductive performance was low across all villages. Majola village had the lowest fecundity (68%) and prolificacy (111%) while the other villages showed higher fertility rates (Prolificacy 120-124%; Fecundity 80-88%). Low kid survivability was associated with multiple births as villages with higher fertility rates had the highest infant mortality (31-38%). The villages of Port St Johns Municipality had high goat populations in both current and improved production simulations. Inadequate nutrition supply however restricted the growth potential of the Majola flock while genetic unfitnes limited that of Izibityolo, Mission and Klanisi villages.

Goat class distribution was characterised by a few bucks and high doe proportions across all the villages. Breeding ratio per village was above the recommended 0.04 in all villages despite lack of buck ownership by most households. The effective population sizes were all below 50 hence endangering the existence of indigenous Xhosa lob-eared goats in these populations. The failure to control breeding resulted in high inbreeding rates that surpassed the acceptable threshold level of 0.063 in all villages except Majola. The negative relationship between effective population size and fertility indicators revealed the deleterious effect of inbreeding to flock productivity. This was also further evidenced by the positive relationship between fecundity and kid mortality. These results revealed that there were high levels of genetic unfitness resulting in offspring adaptation failure as shown by high kid mortalities in the flocks. In conclusion, goat production was characterised by ineffective management strategies which led to lower reproductive performance as there were high inbreeding levels across the villages.

Key words: constraints, modeling, population genetics, productivity, small ruminants

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Chapter 1: General Introduction

Agriculture is the source of income for almost 80% of the world's poorly resourced people (FAO, 2005). The majority of these resource-limited people are found in rural areas. They rely mainly on livestock and crop farming systems for livelihoods (Homann *et al.*, 2007). The major challenges faced by these people are food insecurity and low income levels (Peacock, 2005). A gap between food supply and demand has increased as a result of rapid population growth and low agricultural productivity (FAO, 2005). Changes in climatic patterns, which have resulted in recurrent droughts thereby significantly affecting both livestock and crop production (Masikati, 2010). Livestock have a better hedge against climate extremes than crops hence they provide a more sustainable option for effective alleviation strategies. Most resource poor farmers own livestock, especially goats and these can be used as a vehicle for livelihood improvement. Goat production can be considered to be a more relevant and sustainable option to alleviate the communities from poverty as goats are hardy and are drought-tolerant and can subsist on poor quality forage (Lebbie, 2004). Goat production can then be singled out as the most ideal option for Eastern Cape Province, given the abundance of the genetic resource as well as the suitability of the rangelands.

Livestock production in extensive systems is often practised under unstable and detrimental climatic conditions and is further threatened by bush encroachment (Braker *et al.*, 2002). In such conditions, goats become a good option for an ecologically sound way of vegetation control through their ability to both graze and browse (Dziba *et al.*, 2003;

Papachristou *et al.*, 2005). They are the most adaptable animals and also fit well with other livestock species such as cattle, thus they are even used in mixed farming systems to control noxious weeds and bush under controlled pastures (Coffey, 2006). The current rangelands in the Eastern Cape have suffered encroachment from Acacia tree species, as a result of climate change and poor rangeland management. Thus, goat production has become essential in improving the rangelands and this is evidenced by a gradual increase in goat numbers over the years in the Province (NAMC, 2005).

The 2011 census stated that 35.5% of households in the Eastern Cape engage in agricultural activities, of which 30.1% reported livestock ownership. (Statistics South Africa, 2014). Goats are known to be the most popular livestock species among small holder farming enterprises (De Vries, 2008). According to statistics, the Eastern Cape Province constitutes the highest population of goats in South Africa (DAFF, 2014). An estimate of close to 2.3 million goats, from a total population of approximately 6 million goats, is found in Eastern Cape Province (DAFF, 2014).

Goats are vital in improvement of rural livelihood (Peacock, 2005), thus they ensure food security through aiding seasonal food variability and availability (FAO, 2005). Goats are also relatively cheap to acquire and reproduce quickly, hence, have a faster population recovery in an event of severe losses (Peacock, 2005). Most communal goats are hardy (Kouakou *et al.*, 2008) hence are less susceptible to droughts and have low maintenance cost (Iñiguez, 2004). They utilize a variety of feedstuffs, including fibrous crop residues. According to Simela and Merkel (2008), goats are prolific breeders and have short

generation intervals due to the early attainment of maturity. Goat meat has high nutritional attributes due to low quantities of saturated fat and cholesterol (Saico and Abul, 2007).

Although, some research (Ngambu *et al.*, 2011; Marume *et al.*, 2012; Xazela *et al.*, 2012; Moyo *et al.*, 2014) has been done on goats most of it lacked farmer participation as it was mainly researcher-driven, resulting in lack of adoption of technologies. In order to develop technologies that can sufficiently address the problems faced by smallholder farmers, there is a need to conduct baseline surveys to establish current production systems, as well as identify constraints and opportunities. Such an approach helps to establish viable on-station and on-farm research which can be of great use by target smallholder goat farmers.

1.2 Problem Statement

Farmers lack access to technical, as well as market information and their management strategies are not properly defined (Homann *et al.*, 2007). Despite the multiple roles goats exhibit, they are still neglected by sources of credit, with priority given to cattle and crop production (De Vries, 2008).

1.3 Justification

The Eastern Cape Province has a huge potential for goat production through the availability of increased goat numbers and suitable rangelands. Despite the abundance of these resources, this area continues to languish in poverty and malnutrition. Thus, in

order to address food insecurity, it is imperative to increase the availability of animal protein and also develop sustainable income generating options. Improved goat production is a potentially ideal tool to increase food security. There is a need to come up with a detailed analysis of the current goat production systems that illustrates critical gaps existing in the smallholder sector, and to identify opportunities for more focused targeting of interventions. The interventions taken to ensure sustainable development of resource-limited communities need to be directed within the context of farmers' socioeconomic profiles and their priorities in goat production. It is, therefore vital to understand smallholder capacity to invest in management and the relative returns on their investment.

Although some few research efforts (Mahanjana and Cronjé, 2000; Masika and Mafu, 2004; Rumosa-Gwaze, 2009) have been done in the Eastern Cape Province regarding goat production. Most of the research focused on the central and upper inland areas in the Province. Thus, the coastal areas are yet to have their goat enterprises documented so as to assist in designing research programmes that specifically address their problems. It is therefore paramount to generate new information that can be used as a comparison with previous research, while also understanding the changes brought about by different environments.

This study provided a detailed description of the current information on goat production systems and also assisted in determining the influence of socioeconomic factors in production. In addition to information generation, identification of specific constraints

and opportunities in goat production could assist in the formulation of targeted research that improves goat productivity in the area. The results from this study could provide options to direct improved information dissemination among stakeholders in the goat production industry.

1.4 Objectives

The overall objective of this study was to characterise the goat production systems in the coastal areas of Eastern Cape Province.

Specific objective

- to describe goat production systems and identify the existing constraints in the coastal area of the Eastern Cape Province.
- to determine productivity and production potential of the communal goats in the coastal area of the Eastern Cape Province.
- to estimate effective population size and increase in inbreeding co-efficiency and their impact on productivity in the coastal area of the Eastern Cape Province.

1.5 Hypotheses

H₀: There are no constraints and opportunities in the goat production enterprises in the coastal area of the Eastern Cape Province.

H₀: The communal goats have a low production potential in the coastal area of the Eastern Cape Province.

H₀: Inbreeding depression has no impact in the productivity of communal goats in the coastal area of the Eastern Cape Province.

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Chapter 2: Literature Review

2.1 Introduction

Goat farming has often been associated with self-reliance (Morand-Fehr *et al.*, 2004), thus it has significantly improved the social and economic development in impoverished communities (Homann *et al.*, 2007). Goats can adapt well in tropical climates, while exhibiting high productivity potential (Alexandre *et al.*, 2010). The potential of goats, however, remains extremely untapped (Ahuya *et al.*, 2005) due to improper research, as well as poor developmental approaches that exist in their production. According to Boyazoglu (2002), prospects improving goat production are high, however, the difficulties are noted mainly on technology transfer. It is therefore necessary to understand goat management systems according to farmer's interest as this will allow implementation of practical strategies based on factual information hence ultimately improving production (Alexandre *et al.*, 2010). This review explores communal goat management systems in nutrition, housing, breeding and health aspects, as well as the importance of goats to resource limited farmers inclusive of socioeconomic traits.

2.2 Socio-economic characteristics of communal goat farmers.

Livelihoods in the communal areas are complex and generally consist of restricted access to land and income that result in food insecurity (Anseeuw and Laurent, 2007; Berzborn, 2007). They are characterized by mixed farming activities and casual labour agreements (de Sherbinin *et al.*, 2008; Rumosa-Gwaze, 2009). The household economy of communal farmers is often multi-sectoral, with income acquired from non-agricultural activities such as handcrafts, trade, wage labour, remittances and pensions (Bayer *et al.*,

2001). They are also characterised by poor access to conventional knowledge and generally lack mechanization (Boyazoglu *et al.*, 2005; Homann *et al.*, 2007).

2.3 Importance of goats to communal farmers.

Goats have special attributes of importance in communal areas. They are able to utilize low nutritive feed (Lebbie, 2004), and can walk long distances in search of feed during the dry season. They are efficient in utilization of encroached lands and are easy to market given their small carcass (Lebbie, 2004). They have short generation intervals as well as high reproductive rates, that lead to increased turnover hence ensuring reduction in investment risk (Homann *et al.*, 2007). Goats have an inherent ability to flock thus allowing easy herding. It is due to this ability that goats used to lead sheep during herding in some communal areas (Peacock *et al.*, 2005). Goats are highly adaptable and can withstand drought better than cattle (Iñiguez, 2004; Kouakou *et al.*, 2008). In diverse species scenarios, they complement other livestock by avoiding competition on feeding through their ability to utilize low quality forage (Coffey, 2006). Ecological perspective, goats are useful in the biological control of bush encroachment of natural rangelands (Braker *et al.*, 2002). Metabolic waste products from goats are invaluable sources of organic fertilizer. These are essential in improved crop production, while its use also supports the global move towards organic agricultural products (Hansson and Fredriksson, 2004).

Socially goats are of great importance in cultural and ceremonial activities (Kosgey, 2004; Simela and Merkel, 2008). Goats can be used to strengthen social relationships

(Peacock, 2005) and are essential in the provision of protein, organic fertilizer, and hides. The leather is processed into mats, footwear, storage containers and musical drums (Peacock, 2005). In communal areas, goats are an investment and they generate income through live animal and product sales from the animals, to meet emergency needs for cash (Homann *et al.*, 2007; Sweet, 2008). Improvement in goat production coupled with commercialization would create employment. This will greatly improve the rural livelihoods through the income generated hence leading to risk mitigation (Peacock, 2005). Goats can therefore be an ideal option in the alleviation of poverty as well as ensuring food security and improved livelihoods among communal families.

2.4 Communal goat production

Communal livestock farming is very diverse and is linked to poor availability of local resources such as feed and unimproved goat breeds. Communal production systems are mostly similar in that they consist of low livestock numbers, minimal use of technology and high dependence on agricultural by-products for feed (Boyazoglu, 2002).

2.4.1 Characteristics of communal goat production

Extensive goat farming is very common in most communal areas in Southern Africa (Wason and Hall, 2002; Rumosa-Gwaze, 2009), with free ranging, herding and tethering as the main feeding systems. It is practiced where land is not immediately suitable for crop production improvement (McMillin *et al.*, 2012). It is characterized by minimum labour and expenses due to limitations in resources (McMillin *et al.*, 2012). Indigenous goat breeds and their crosses are dominant in this production system (Mahanjana and

Cronjé, 2000; Kosgey, 2004; Mamabolo and Webb, 2005). Flock sizes tend to vary from one to over a hundred per household (Mahanjana and Cronjé, 2000; Bester *et al.*, 2009), and are characterized by large variations in herd structures. The hardiness of the indigenous goat breeds makes them highly suitable for drier areas which are typified with encroached rangelands (Webb and Mamabolo, 2004).

2.4.2 Free ranging

The free ranging system, consists of no mating control therefore community goats interbreed as a single flock (Kosgey *et al.*, 2008; Manyema *et al.*, 2008). This system is common during the dry season when the crops have been harvested and the rangeland feed quality is of low nutritive value (Dziba, 2000; Chikwanda, 2004). The goats are released early in the morning to forage freely without any restrictions. Goats are more prone to predators in this system since they would travel on their own for long distances in search of feed (Kusina, 2000).

2.4.3 Tethering

In this feeding system goats are confined or have their movement controlled. This is mainly meant to prevent them from wandering and damaging the neighbouring crops (Kusina, 2000; Chikwanda, 2004; Rumosa-Gwaze, 2009). Goats are therefore tied/pegged to a 3m rope along roadsides, in crop alleys or on communal rangelands (Chikwanda, 2004; Gizaw *et al.*, 2010). Water is only provided when the goats are shifted which is usually at night when they are returned to their shelter (McMillin *et al.*, 2012). Aggressive animals can be tethered overnight in order to restrain them (Gizaw *et al.*,

2010). In mixed crop and livestock farming systems, tethering allows sparing of labour for other farm activities, especially cropping (Kusina, 2000; Rumosa-Gwaze, 2009). However, some studies have cited that tethering in goats resulted in loss of body condition (Chikura, 1999; McMillin *et al.*, 2012). Additionally there is less exposure for mating in breeding animals, hence there is a reduction in reproductive performance of the does (Chikwanda, 2004).

High incidences of vegetation degradation have been noted in areas where tethering is practiced mainly due to overgrazing as a result of over utilization of tethering spots (Chikura, 1999; Gizaw *et al.*, 2010). This would create bare patches on the ground eventually leading to soil erosion on the onset of the rains. It can therefore be recommended that the tethering spots be frequently changed so as to allow vegetation regrowth as well as nematode control (Chikwanda, 2004).

2.4.4 Herding

In most communal areas, herding is conducted by women and school children (Kusina, 2000; Chikwanda, 2004; Homann *et al.*, 2007; Rumosa-Gwaze, 2009) or employed shepherds (Wason and Hall, 2002). Herded goats have access to freely select a variety of plants and pods unlike the tethered goats (Chikwanda, 2004). Goat movement is, however, controlled by the attendant through guiding them into preferred grazing areas (Gizaw *et al.*, 2010). This system is generally popular during the cropping season goats are prevented from straying into cropping fields or vegetable gardens (Kusina, 2000; Rumosa-Gwaze, 2009). As a result of commitment of labour to other activities such as

school and cropping, goats are often penned for longer periods awaiting availability of labour (Kusina, 2000; Chikwanda, 2004; Rumosa-Gwaze, 2009). This situation leads to reduced foraging time, that translates into poor body condition (Chikura, 1999).

2.5 Nutrition

The natural veld is the major source of feed for communal animal production (Mbiriri *et al.*, 2012). Livestock browse and graze on communal rangelands throughout the year and receive little or no supplements during the dry season period (Ndebele *et al.*, 2007). Seasonal variation in both the quality and quantity of feed as a result of climate change has led to failure of animal production sustenance by rangelands (Masikati, 2010; Mbiriri *et al.*, 2012). Despite these prevailing conditions, goats have proven to better withstand this situation compared to other livestock species. Goats are known to utilize diverse plant feed resources on rangelands (Bakare, 2009). The trees can either be deciduous or evergreen, thus their availability in the rangeland as feed for goats also vary with season (Dziba, 2000). In addition the plant species chemical composition differ across these seasons, thereby resulting in selective feeding behavior in goats (Tainton, 1999; Bakare, 2009).

2.5.1 Feed management and availability

In addition to the seasonal variability in the rangelands, availability of feed in the communal sector is limited by poor management of rangelands (Papachristou *et al.*, 2005), inappropriate grazing management (Quinn *et al.*, 2007), rangeland fires and seasonal droughts (Ben Salem and Smith, 2008). It is then paramount to preserve feed

during the period of its abundance to ensure a sustained goat production as well as survival during the dry season (Ben Salem and Smith, 2008). Classes with higher nutrient requirement should be prioritised in supplementation so as to maintain high goat productivity. The levels of supplementation in the communal areas may vary depending on the local availability of the feed resource. The most commonly used supplements are crop residues (Garcia-torres *et al.*, 2003; Ben Salem and Smith, 2008; Masikati, 2010), leguminous tree pods (Sikosana *et al.*, 2008; Maphosa *et al.*, 2009), silage and hay (Ben Salem and Smith, 2008). It should be noted that nutritional deficiencies, especially during pregnancy lower the reproductive performance of goats and in some cases result in kid mortality (Kusina *et al.*, 2001). High pre-weaning losses have also been attributed to poor nutrition during lactation as well as inappropriate housing conditions among other factors (Sebei *et al.*, 2004)

2.5.2 Effect of nutrition on reproductive performance of does.

Nutritional stress limits the reproductive performance of female goats. Donkin and Boyazoglu (2004) reported that nutritionally related fluctuations in body weight of does temporarily disrupted ovarian activity as shown by low conception during the dry periods. Ovarian activity was observed to be sensitive to nutrient availability and tended to decrease as feed became scarce (Kusina *et al.*, 2001), as reflected by low conception rates of 60% as compared to 100% observed in does on high plane nutrition related to such periods.

Severe feed restriction impairs the hypothalamic gonadotropin pulse generator (Ismail *et al.*, 2008; Hefnawy *et al.*, 2010). Improvement of doe nutrition increases systemic

luteinizing hormone secretion which restores ovulation rate. This observation agrees with finding that the abundance of feed was associated with breeding that resulted in peak kidding (Kusina *et al.*, 2001). Chikura (1999) found that in the dry season goats had longer kidding intervals of 382 ± 90 days as compared to 265 ± 48 days in the wet season.

2.5.3 Effect of nutrition on growth performance of goats.

Nutrition is one of the most important factors affecting growth performance of goats. Underfed does take long to attain the critical body weight (two-thirds of mature weight) at which puberty occurs (Rhind, 1992). Delay in puberty ultimately delays the age at which first kidding occurs (Jainudeen and Hafeez, 1993; Madibela *et al.*, 2002). Does that are on low plane of nutrition have suppressed early occurrence of first estrus hence reducing their ability to conceive (Madibela *et al.*, 2002).

2.6 Housing management

In the communal areas, goat housing is generally characterized by open or roofed kraals made of locally available resources, especially wood poles. Goats are penned during the night for protection against theft, predation and straying among other reasons. It has been observed that farmers with smaller flock sizes normally afford to roof their kraals compared to those with bigger flocks (Homann *et al.*, 2007). An appropriate goat housing structure should offer a good drainage during the rainy season. According to Chikura (1999), Chikwanda (2004), Sebei *et al.* (2004) and Chikwanda *et al.* (2013) most of the goat kid mortalities are as a result of inappropriate housing structures which expose goats to adverse weather conditions, such as wind, cold, rain and mud (Shumba, 1993;

Chikwanda, 2004). As a result, there is a high incidence of pneumonia, foot rot and internal parasites. Parasitic infection in goat houses is further exacerbated by unhygienic conditions. Most parasites may be harbored in the animal dung; hence failure to remove the dung as well as maintain good hygiene may lead to the transfer of the parasitic pathogens.

2.7 Breeding Management

Communal goat production is mostly done without any structured breeding seasons hence the breeding animals flock together throughout the year (Tefera *et al.*, 2004). This often results in mating closely related individuals leading to inbreeding (Masika and Mafu, 2004; Rumosa-Gwaze, 2009). Inbreeding depression results in poor growth rates and miscarriage among other negative effects (Saico and Abul, 2007). This condition is further worsened by the small goat population sizes, tethering during the summer and late culling of old bucks within a flock (Masika and Mafu, 2004; Webb and Mamabolo, 2004). The buck exchange between farmers can be a sustainable way to reduce inbreeding in communal goat production.

2.7.1 Indigenous goat breeds in the Eastern Cape.

The Eastern Cape Province has several goat genotypes which dominate the region. These mainly include Nguni, Xhosa lob-eared, Boer and their crosses. The Nguni goat is a small framed, hardy breed and is highly adapted to the local environment (Dziba *et al.*, 2003; Nyamukanza and Scogings, 2008). The Xhosa lob eared breed, were originally found in the medium to lower rainfall area of the Province. The breed is now endangered as a

result of introduction of Boer goats and its crosses in most communal areas. Only a handful of breeders in South Africa preserved some of these original multi-coloured, lob eared goats. Boer goats are large to medium framed and commonly have white bodies and distinctive brown heads.

2.7.2 Breed selection in the communal goat production systems

Selection and maintenance of own breeding stock vary from one household to another (Kosgey, 2004; Kosgey *et al.*, 2006; McMillin *et al.*, 2012). The retention of young bucks is seldom practiced and there seems to be negative selection of this class of animals (Kosgey *et al.*, 2006; Webb and Mamabolo, 2004). Farmers tend to select and castrate faster growing animals for sale (Gizaw *et al.*, 2010). Selection criteria in the communal areas includes conformation (Kosgey, 2004; Gizaw *et al.*, 2010), colour (Mahanjana and Cronjé, 2000; Rumosa-Gwaze, 2009; Gizaw *et al.*, 2010) and performance history (Kosgey, 2004; Gizaw *et al.*, 2010). In most households, selection through the use of performance history is generally not effective since most farmers rarely keep animal performance records of their animals (Kosgey *et al.*, 2006; Gizaw *et al.*, 2010). Fertilisation success in communal goat production depends on a range of factors; including semen quality and mating behavior. Therefore, testis and semen characteristics can be of great value in the selection of the animals (McMillin *et al.*, 2012). A huge research gap still remains in this area as fertility status of goats is not well documented.

2.7.3 Reproductive performance of different indigenous breeds in Southern Africa.

Reproductive and growth performances are important measures of productivity in animal production. Productivity levels for most indigenous breeds in Southern Africa are still low. The age at first kidding ranges between 15 months as noted in Malawi goats by Kamwanja *et al.* (1985) to 23 months as according to the findings of Sibanda (1988) from the Matebele goats. A gestation length of 145-148 days was documented by Webb and Mamabolo (2004) on indigenous goats in Mpumalanga Province. Kidding interval as low as 258 days was also recorded by Webb and Mamabolo (2004) in the same study; while a high length of 394 days was recorded for the Landim goats (DAGRIS, 2007). There is a paramount need to review the current productivity indices of indigenous goats as much of the available information is now outdated. In light of ever changing climatic conditions, the generation of new information on reproduction will guide in precise goat improvement strategies.

2.8 Health Management

Communal farmers rarely have the resources to purchase veterinary inputs, essential to sustain the animal and reduce the constraints imposed by the environment (Sebei *et al.*, 2004). They depend mostly on government funds for veterinary services. Despite significant parasite and disease outbreaks (Githiori *et al.*, 2006); disease control measures by the African governments has only been aimed at major and only fatal diseases. According to Alexandre and Mandonnet (2005), veterinary and small ruminant improvement programmes are very minimal. This current state is further worsened by the inflated cost of animal health service delivery as well as its unavailability (De Vries,

2008). Diseases have resulted in the major production losses for goat farmers, despite huge gains obtained through high prolificacy rates. Goat production remains low due to high disease incidence (Masika and Mafu, 2004; Rumosa-Gwaze, 2009). Huge financial burdens are incurred by farmers in an effort to manage diseases within their flocks (Mahusoon *et al.*, 2004; Sissay *et al.*, 2006). Within the goat flock, kids are more susceptible to diseases compared to other classes (Sebei *et al.*, 2004; Homann *et al.*, 2007). In addition to high pre-weaning mortality; diseases are responsible for still births and abortions that occur in goat flocks.

There is a wide range of causes of disease in a goat enterprise, but the major ones are as a result of nutritional deficits, extremely harsh environment and unhygienic kraaling conditions. The most common goat diseases include pulpy kidney, helminthiasis, mange, heart water, pustular dermatitis (orf) and foot rot (Homann *et al.*, 2007). Heart water and helminthiasis were reported to be highly common in most communally reared South African goats (Vatta *et al.*, 2001; Masika and Mafu, 2004; Bester *et al.*, 2009). There is less information available on the prevalence of diseases under communal conditions. In addition, most farmers find it difficult to identify some of the disease hence there is need for them to be educated in this area.

2.9 Marketing

Urbanisation, population and income growth all have resulted in increased demand of animal protein consumption (Delgado *et al.*, 1999). This has created a huge market demand for livestock products hence ensuring expansion of market opportunities (Lapar

et al., 2002). The interventions aimed at improving goat productivity need to consider the market aspects simultaneously (Endeshaw, 2007). Improved production is best sustained by an efficient marketing system. Improved market access facilitates a more commercial orientation in goat production (KIT *et al.*, 2006). There is need for farmer awareness on market product preference as well as its price trends (Ehui *et al.*, 2000) . This would assist them to plan for breed selection and fattening programs consistent with consumers' preferences as well as profitable seasonal periods (Ehui *et al.*, 2000). Small holder producers would definitely increase their profits margins with alleviation of challenges in goat marketing. This would also increase variety of meat products to the urban consumers (Ayele *et al.*, 2003).

Potential goat production and marketing has not been fully utilised due to little information on demand trends (Ehui *et al.*, 2000). Goat market development would drive farmers to increase technology uptake, resulting in improved goat production (Homann *et al.*, 2007). Improved goat production and marketing program would eradicate poverty at the same time building a sustainable food security option for communal communities.

2.10 Summary

Communal goats are vital in the livelihoods of resource limited communities in developing countries. They significantly contribute to household food security and also assist in seasonal food variability and availability. Their ability to graze and browse a wider diversity of plants, withstand arid conditions and reproduce quickly gives them a better chance to survive in harsh environments. Despite the potential goats possess in

transforming the livelihoods of the communal areas, their utilization still remains low in most communities. There is a dire need to develop strategies that would ensure sustainable development of this resource while improving the rural livelihoods.

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Chapter 3: Production characteristics of communal area goats in coastal regions of the Eastern Cape Province, South Africa.

Abstract

The objective of this study was to describe goat production systems and to identify existing constraints faced by communal goat farmers in the Eastern Cape Province, South Africa. Data was collected from 100 households through a questionnaire. Male household heads (75%) owned most of the goats, followed by female de-jure (16%) and de-facto (6%) heads. The goats were mainly used for ceremonies (38%) and generation of income (37%). The farmers kept mostly indigenous goats together with the Boer goat breed and its crosses. The goat flocks mainly consisted of does (58%), kids (19%), castrates (19%) and bucks (4%). Low reproductive performance of does was evidenced by a low birth rate (43%). Kid mortality at 22%, was mainly attributed to tick-borne diseases and the harsh environment. Most farmers controlled internal parasites through regular dosing while dipping was used to control of external parasites. There were no controlled breeding systems, hence high inbreeding possibilities. The housing consisted of wooden poles without roofing. The kids were kept together with the mature goats in kraals. The goats were marketed through informal channels at an average price of R1500 per animal. Most farmers preferred selling castrated male goats (57%). Sales peaked in winter and late summer. The major management constraints identified included poor nutrition, absence of market linkages and inadequate knowledge for husbandry. The study established the existence various production challenges if addressed could result in improved goat productivity in these communities.

Keywords: communal, constraints, farming, management, smallholder, small ruminants.

3.1 Introduction

Goat production plays a major role in the livelihoods of communal farmers. In addition, they also contribute significantly to the household socio-economic development (Homann *et al.*, 2007; Rumosa-Gwaze, 2009). The hardiness of goats enables them to adapt easily in extreme conditions which are prevalent in most communal areas. As a result goats have been the most common livestock species in these impoverished communities (Alexandre *et al.*, 2010).

Most researchers regard goat production as an ideal vehicle to mitigate against poverty (Peacock, 2005; Ahuya *et al.*, 2005; Alexandre *et al.*, 2010). In most communal areas goat enterprise remains unexploited (Ahuya *et al.*, 2005), yet the communities still languish in poverty. Sustainable livelihood development has remained a high priority as regards to global poverty eradication (Dubeuf *et al.*, 2014). Improved goat production is one of the most viable, sustainable development options for communities. It should be noted however that goat productivity has remained low in most communal areas as a result of poor research consequently leading to ineffective development strategies (Boyazoglu, 2002). It is therefore necessary to engage farmers prior to development of improved mitigations. This will assist in clarity in addressing the major challenges and utilization of opportunities which exist in communal goat production. This study was therefore conducted to generate new knowledge in communal goat production that will assist in the development of improved intervention and policies to enhance productivity in this enterprise.

3.2 Materials and Methods

3.2.1 Description of study sites

The study was conducted in Port St. Johns and Umnquma local municipalities. Port St. Johns is located under the O.R Tambo District municipality. It is characterised largely by Savanna and Indian Ocean Coastal Belt biomes and some few patches of the grassland (SANBI, 2012). It receives mean rainfall of 1250 mm, mainly in summer with a mean summer temperature of 22.5°C and mean winter temperature of 14.5°C (South African Explorer, 2014). It is characterised by a moderate, humid and subtropical coastal climate. The villages selected for this study in this municipality were Majola and Bizana. The Umnquma local municipality is located under the Amathole District Municipality. It is characterised largely by Savanna and Grassland biomes and some few parts of the Indian Ocean Coastal Belt and Albany thicket (SANBI, 2012). It receives mean rainfall of 596 mm, mainly in summer with a mean summer temperature of 25.6°C and mean winter temperature of 19.2°C (South African Explorer, 2014). The villages selected for this study in this municipality were Izibityolo, Klanisi and Mission. Figure 3.1 gives a more detailed description of the vegetation types in both these municipalities.

3.2.2 Sampling Procedure

The households were randomly selected to participate in the survey. Villages with high goat populations were selected as suggested by the extension staff from each Municipality.

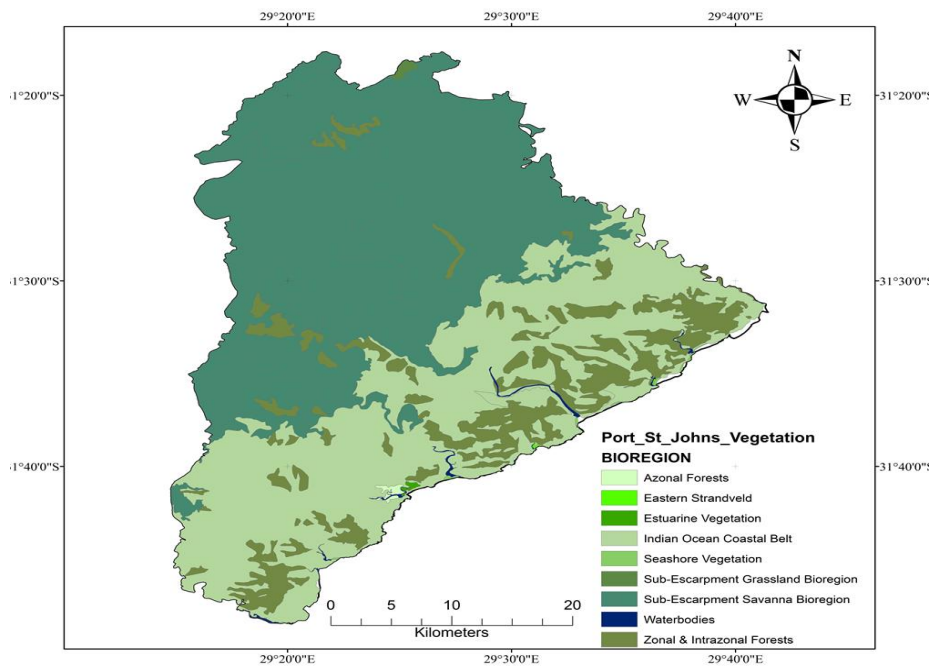
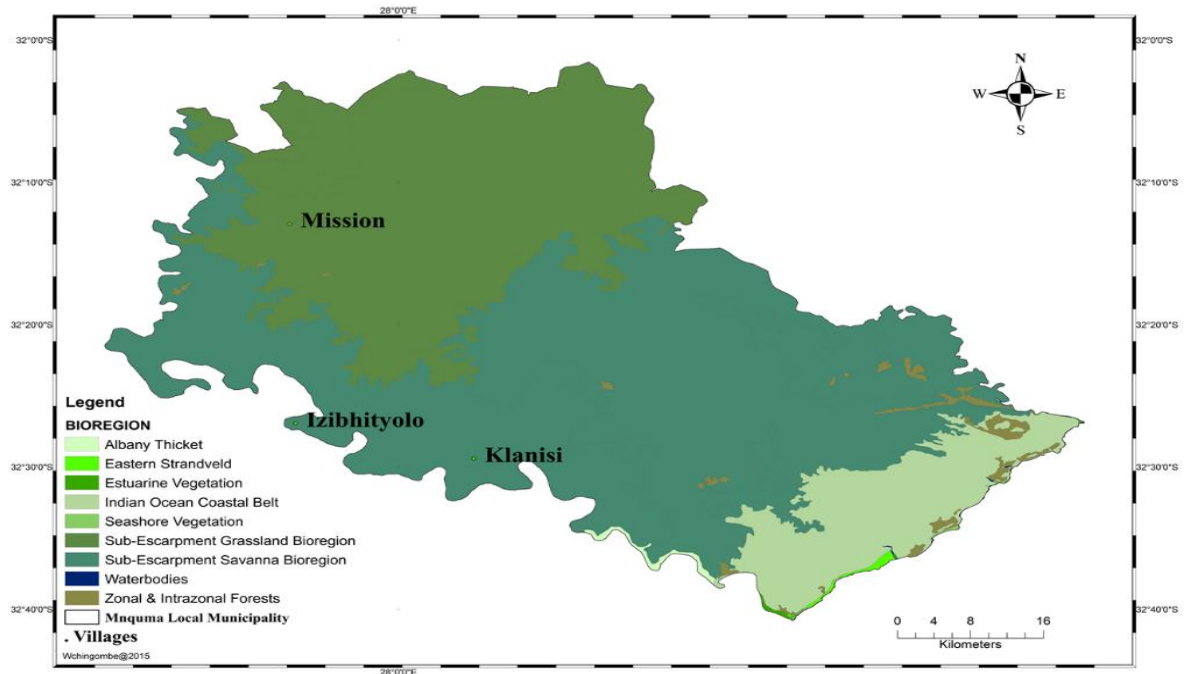


Figure 3. 1 Location and vegetation mapping of the villages in the studied Municipalities. *Map data obtained from SANBI (2012)*

The respondents were sampled as follows in the villages; Majola (34), Bizana (16), Izibityolo (15), Mission (18) and Klanisi (17). A total of 100 households participated in the study.

3.2.3 Data collection

Data collection was done through an in-depth household survey and key informant discussions were held to complement the information gathered. The household survey was conducted through the use of a tested structured questionnaire with open and closed questions. A group of five trained enumerators with fluency in Xhosa participated in the data collection. The questionnaire covered the following areas:

- ✓ Socioeconomic household characteristics
- ✓ Inventory and flock dynamics
- ✓ Goat management strategies (feeding, health, breeding, and housing)
- ✓ Goat marketing
- ✓ Constraints to goat production

Ethical clearance was granted by the University of Fort Hare ethics committee and a certificate (Reference number: MUC201SDUB01) was issued. All ethical considerations were observed during and after the data collection period. Feedback and verification sessions were also conducted with the communities.

3.2.4 Data analysis

Data was analysed using SAS (2003). Descriptive statistics were computed using PROC FREQ to interpret qualitative data. The Krustal-Wallis Test (NPAR1way procedure) was used to rank means of the farmers' responses. An ordinal logistic regression model

(PROC LOGISTIC) was used to determine the odds ratios. The logit model used for analysis was:

$$\ln[P/1-P] = \beta_0 + \beta_1X_1 + \beta_2X_2 \dots + \beta_5X_5 + \varepsilon$$

Where:

P = probability of a household breed choice based on a certain factor;

[P/1-P] = odds ratio, which referred to the odds of a household breed choice according a certain factor;

β_0 = intercept;

$\beta_1X_1 \dots \beta_5X_5$ = linear regression coefficients of household headship (HH), Age of household head and education;

ε = random residual error.

3.3 Results

3.3.1 Socioeconomic household characteristics

3.3.1.1 Demographic characteristics

The majority of the households were male headed (75%) followed by female-dejure (19%) and female de-facto (6%) headships. The most dominant age group within these heads was ≥ 60 years (55%), followed by those in 41-59 years category (36%) with a few younger household heads below 40 years (9%). Their educational levels consisted mainly of primary (61%), secondary (25%) and tertiary (3%) education whilst only 11% were not educated. Animal production was ranked as the overall most important income source as shown in Table 3.1. Port St Johns municipality depended mostly on grants and child maintenance as main income sources in its selected villages. The villages in Umnquma municipality all ranked animal production as their major income source.

3.3.1.2 The reasons for keeping goats

The major reasons for keeping goats cited by the farmers were mainly cultural ceremonies and selling to raise income. Figure 3.2 illustrates farmers' reasons for keeping goats, according to the different villages as well as the consolidated overall perception. Some of the farmers (43%) showed interest to participate in goat milk development projects with the rest (57%) not willing to be engaged.

Table 3. 1 Mean score (rank) of main sources of incomes in selected villages of Port St Johns and Umquma Municipalities.

Sources of Income	Villages					Overall N=200	Significance
	1 N=68	2 N=32	3 N=30	4 N=36	5 N=34		
Salaries	49.4(3)	51.4(3)	45.3(3)	61.4(6)	44.9(2)	50.5(4)	NS
Pension	44.2(2)	62.4(5)	48.0(5)	53.0(4)	51.5(4)	51.8(5)	NS
Child maintenance	54.9(5)	39.6(1)	40.7(2)	49.0(3)	62.2(6)	49.3(2)	*
Grants	40.2(1)	52.0(4)	73.7(6)	46.4(2)	53.5(5)	53.2(6)	***
Home industry	51.4(4)	45.5(2)	45.5(4)	56.6(5)	51.4(3)	50.1(3)	NS
Crop production	51.4(4)	45.5(2)	45.5(4)	56.6(5)	51.4(3)	50.1(3)	NS
Animal production	59.6(6)	62.4(5)	40.5(1)	40.5(1)	40.5(1)	48.7(1)	***

NB: The lower the mean rank score of an income source, the greater is its importance. Significance level (***= p<0.001; **=p=0.01; * = p < 0.05; NS Not Significant. Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi.

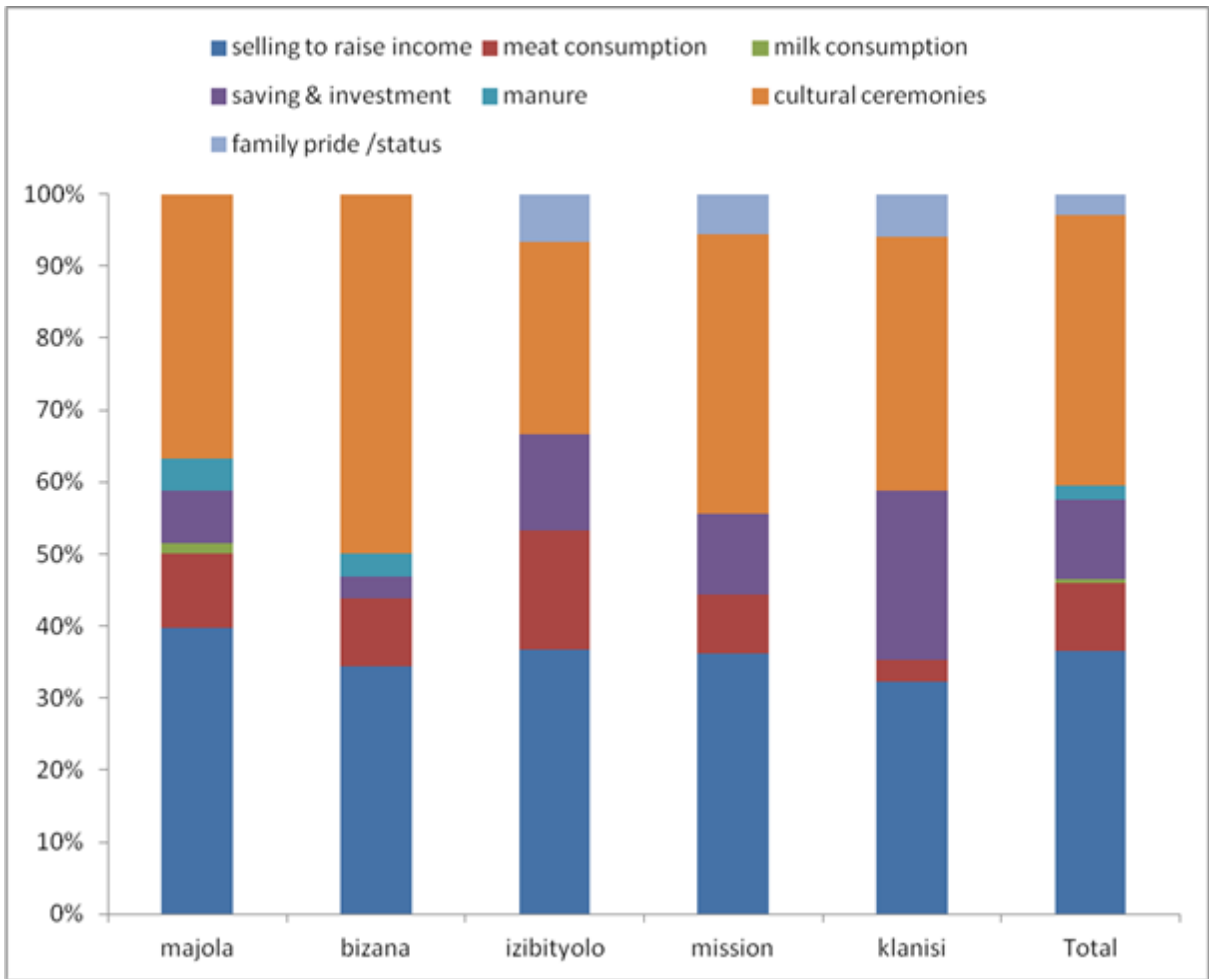


Figure 3. 2 Reasons for keeping goats by farmers in Port St Johns and Umquma Municipalities

3.3.2.1 Goat distribution and ownership.

In order to differentiate investment patterns by flock sizes, goat ownership was categorized. Thus, owners were separated into three classes consisting of those with less than 9 goats, 9 to 20 goats and more than 20 goats. Figure 3.3 shows the distribution pattern of goats among the households for Port St Johns and Umquma Municipalities. The majority of households in Port St Johns owned more than 20 goats, while those in Umquma had between 9 to 20 goats.

3.3.2.2 Goat flock composition and dynamics

3.3.2.2.1 Flock composition and reproductive performance

The flocks mainly consisted of does (58%) followed by kids (19%), castrates (19%) and bucks (4%). The reproductive performance of the does was very low, as shown by the average kidding rate of 43% while kid mortality (22%) was significantly high.

3.3.2.2.2 Flock dynamics

Seasonal inflows and outflows were reported from April 2013 to July 2014. The inflows (Figure 3.4) were mainly through births with the peaks reported to be in winter and summer in both Municipalities. Umquma Municipality had highest entries in winter while Port St Johns inflows were greater in summer. The detailed total outflows (Figure 3.5) were characterised by high mortality and sales, during winter and summer for both Municipalities.

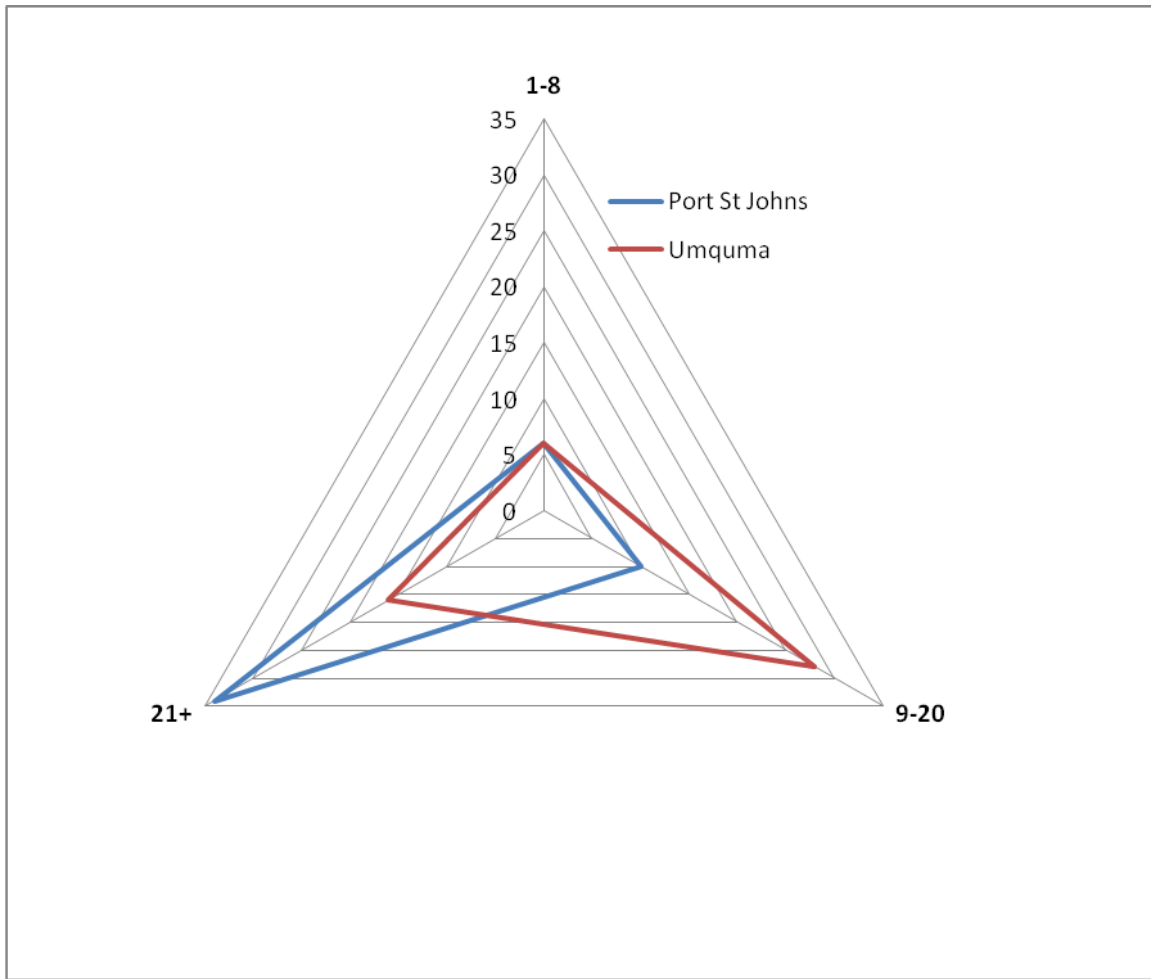


Figure 3. 3 Distribution (%) of households and goats by flock size categories in Port St Johns and Umnquma Municipalities.

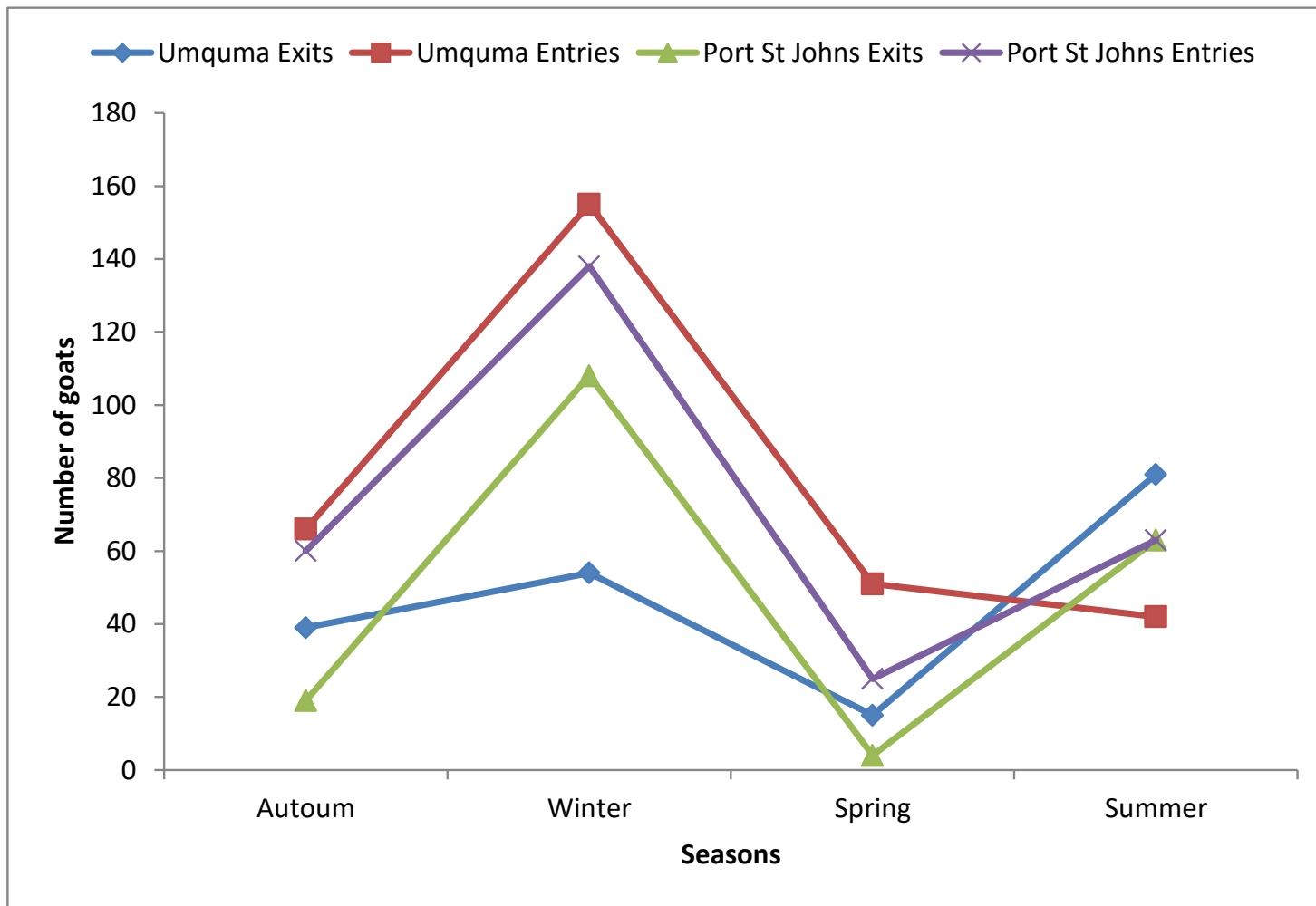


Figure 3. 4 Flock dynamics by seasons in Port St Johns and Umquma municipalities from April 2013 to July 2014.

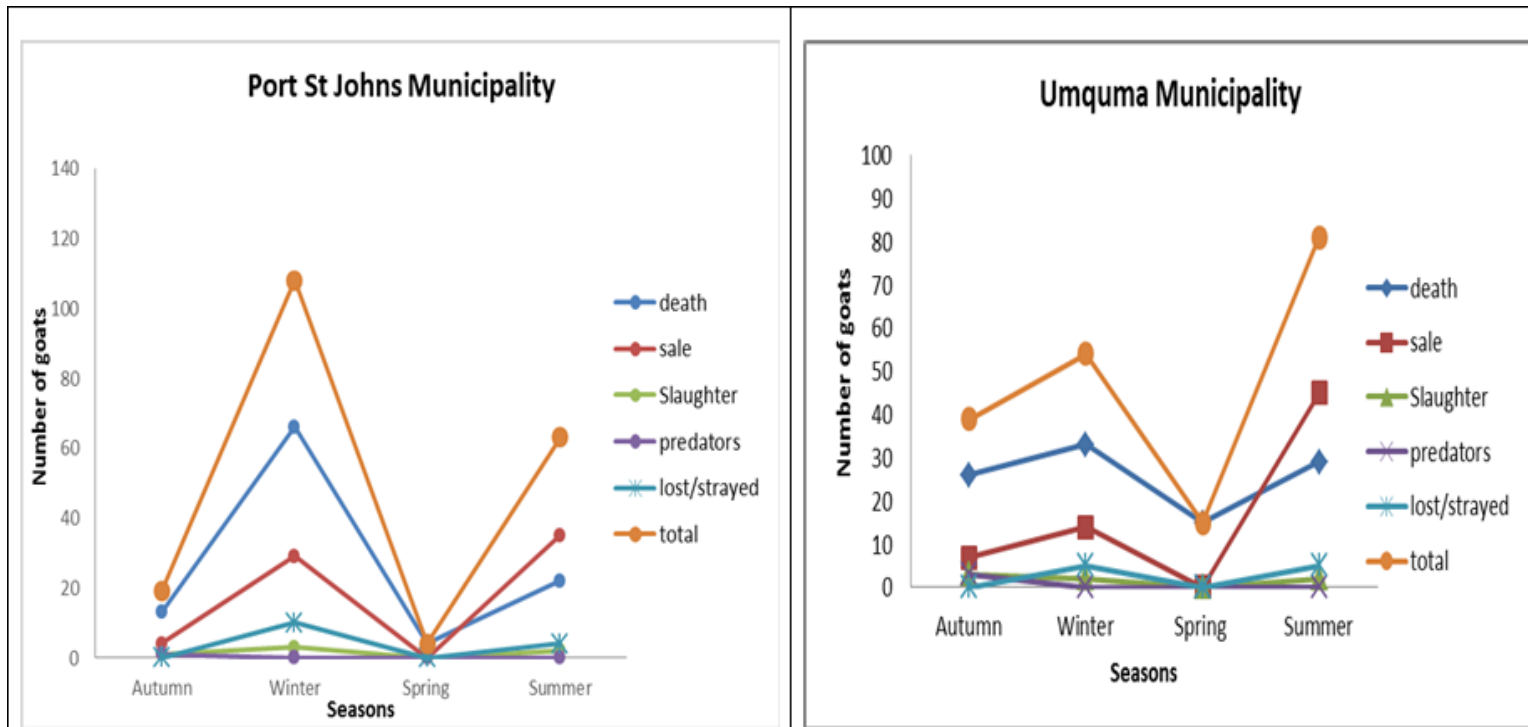


Figure 3. 5 Flock outflows by seasons in Port St Johns and Umnquma municipalities from April 2013 to July 2014

3.3.3 Health Management

3.3.3.1 Causes of mortalities and common diseases

All farmers cited that they experienced mortalities within their flocks. The major causes of mortality were reported to be diseases (69%), parasites (18%), predators (10%) and bad weather (3%). However the causes of mortality did not show any significant difference across the district municipalities. Gall sickness was ranked as the common disease in the goat flocks as illustrated in Table 3.2 below. Foot rot was significantly different across the villages and ranked as the second common disease. It was highly common with the Port St Johns flocks (villages 1 and 2).

3.3.3.2 Disease control

Farmers made use of both traditional and conventional methods in preventing and controlling diseases in their flocks. Conventional methods were often used in dipping and deworming of their flocks. The government through the extension department sometimes assisted in drug procurement. Forty six percent of the total households dipped their flocks. The majority of these farmers dipped their animals whenever they deemed necessary (36%) while 10% indicated dipping in winter and summer. Most of the farmers indicated that they were deworming their flocks (79%). Amongst these, 53% cited that they deworm whenever they find it necessary, while 17% conducted the activity at the beginning of summer, with 9% only deworming in winter.

Table 3. 2 Mean score (rank) of the common diseases in selected villages of Port St Johns and Umquma Municipalities.

Common Diseases	Villages					Overall N=200	Significance
	1 N=68	2 N=32	3 N=30	4 N=36	5 N=34		
Pneumonia	47.1(1)	60.9(4)	39.8(1)	48.7(2)	58.9(4)	51.1(4)	NS
Heart water	51.2(3)	47.5(2)	55.0(3)	54.4(4)	43.8(1)	50.4(3)	NS
Foot rot	47.9(2)	45.0(1)	61.7(4)	50.6(3)	50.9(3)	50.2(2)	*
Gall sickness	56.3(4)	49.1(3)	46.0(2)	46.0(1)	48.9(2)	49.3(1)	NS

NB: The lower the mean rank score of a disease, the greater is its importance.

Significance level (***)= $p < 0.001$; (**)= $p = 0.01$; * = $p < 0.05$; NS Not Significant. Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi.

3.3.4 Feeding and housing management

3.3.4.1 Feeding management

The rangeland was cited as the only source of feed. The majority of the households grazed their goats for 7 hours (79%) while the rest (21%) grazed for 4-6 hours. The major water sources were rivers in all the district municipalities. All households did not supplement their goats, despite a few (10%) acknowledging feed shortages during the dry season period.

3.3.4.2 Housing management

The majority of the farmers (98%) indicated that they housed their goats mainly for protection against straying and theft. The housing structures were mainly kraals made of wooden poles.

3.3.5 Breeding management

3.3.5.1 Breeds, breeding traits, source, and use of bucks

The farmer kept mostly indigenous goats as well as some Boer goats and their crosses. Farmers' reasons for breed preference (Table 3.3) showed significant differences for availability, quality of meat and colour. Farmers from villages with small flock sizes (Umquma Municipality) choose their goats based on availability. Farmers with high flock sizes (villages 1, 2 and 3) preferred their breed based on colour. Quality of meat was the major preferential reason in Majola while it was not prominent in other villages. The odds ratio estimates for socio-economic factors influencing farmers' reasons for breed choice are illustrated in Table 3.4. They showed that household headship had a major influence in the farmers' reason for breed preference. Most farmers indicated that they did

not have bucks hence relied on other farmers' bucks for breeding. The bucks were either bred from their own flocks (49%) or bought from other farmers (3%) while 48% did not have any male breeding goat. Those with bucks cited that they kept mature bucks for more than 3 years (46%) while the rest (6%) kept them for at least 2 years.

Table 3. 3 Mean score (rank) on factors considered for breed preference in selected villages of Port St Johns and Umquma Municipalities.

Factors	Villages						Significance
	1 N=68	2 N=32	3 N=30	4 N=36	5 N=34	Overall N=200	
Fast growth	49.0(3)	50.5(2)	58.8(5)	47.7(2)	49.0(2)	51.0(3)	NS
Quality of meat	41.8(1)	64.3(5)	56.3(4)	49.7(3)	50.6(4)	52.5(5)	*
Feed cost	51.7(4)	41.5(1)	51.5(3)	55.4(4)	50.3(3)	50.1(2)	NS
Availability	63.3(5)	51.5(4)	43.2(1)	43.2(1)	38.3(1)	47.9(1)	**
Colour	43.0(2)	50.9(3)	48.2(2)	55.4(4)	62.1(5)	51.9(4)	*

NB: The lower the mean rank score of a factor, the greater is its preference. Significance level (***= p<0.001; **=p=0.01; * = p < 0.05; NS Not Significant. Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi

Table 3. 4 Odds ratio estimates lower and upper confidence interval of a household preference on a breed.

Predictors	Availability-Rank 1			Feed cost-Rank 2			Fast growth-Rank 3			Colour-Rank 4			Quality of meat-Rank 5		
	Odds ratio	Lower CI	Upper CI	Odds ratio	Lower CI	Upper CI	Odds ratio	Lower CI	Upper CI	Odds ratio	Lower CI	Upper CI	Odds ratio	Lower CI	Upper CI
Household Head (HH)	1.101	0.516	2.353	0.097	0.387	0.062	1.03	0.504	2.12	0.980	0.335	2.871	1.212	0.530	2.773
Age of HH	0.864	0.441	1.693	- 0.146	0.343	0.182	0.789	0.424	1.466	1.269	0.537	2.997	1.051	0.526	2.100
HH Level of Education	0.814	0.475	1.397	- 0.205	0.276	0.555	0.801	0.498	1.289	1.127	0.466	2.725	1.117	0.630	1.981

NB: Higher odds ratio estimates indicate a greater difference in preference between levels of predictors.CI Confidence Interval (set at 95%).

3.3.5.2 Breeding management practices

Farmers did not use any other husbandry management techniques to control inbreeding other than castration. Almost all the households (94%) castrated their goat mainly to improve meat quality (45%), to reduce temperament (24%), control breeding (20%) and to avoid straying (5%). All the farmers indicated that they did not have any production records of their flocks.

3.3.6 Marketing management and production constraints

3.3.6.1 Marketing management

The main marketing channel was through informal markets, within their communities. The goat sales peaked during winter and summer seasons as shown in Figure 4.5. Most of the farmers (93%) sold their animals; with most sales consisting of castrates (57%), all mature goats (36%) while only (7%) did not have any sales. However, farmers cited that they may sell their goats at any time of the year, depending on whether a need arose at that particular time. The majority of the farmers (74%) sold their goats, for at least R1 500 while the rest (26%) sold for at least R1 000.

3.3.6.2 Production constraints and opportunities

The major constraints faced by farmers were lack of adequate technical knowledge in goat husbandry and marketing management. Table 3.5 shows the mean ranks of farmers' responses on the production constraints they experience in their enterprises.

Table 3. 5 Mean score (rank) on goat production constraints in selected villages of Port St Johns and Umquma Municipalities.

Constraints	Villages					Overall N=200	Sig
	1 N=68	2 N=32	3 N=30	4 N=36	5 N=34		
Marketing	52.6(5)	47.6(1)	52.0(4)	51.4(4)	46.7(1)	50.1(2)	NS
Housing	51.9(4)	49.0(3)	52.3(6)	49.0(3)	49.0(3)	50.2(3)	NS
Diseases	51.6(3)	48.3(2)	51.2(2)	51.7(5)	48.6(2)	50.3(4)	NS
Capital	47.0(1)	55.0(6)	52.2(5)	48.3(1)	54.3(6)	51.4(6)	NS
Professional knowledge	53.0(6)	51.5(5)	43.2(1)	48.7(2)	53.0(5)	49.9(1)	NS
Theft	47.9(2)	51.3(4)	51.7(3)	53.3(6)	50.9(4)	51.0(5)	NS

NB: The lower the mean rank score of a constraint, the greater is its importance.
Significance level (NS Not Significant. Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi)

3.4 Discussion

In this study the demographic characteristics were almost similar to those reported in the previous communal goat research in the Eastern Cape (Mahanjana and Cronjé, 2000; Rumosa-Gwaze, 2009). The finding that the majority of farmers were old showed a critical gap which may exist in the future prospects of goat farming in these communities. This would potentially result in future erosion the available goat management knowledge. Agriculture training should therefore target younger generations for them to appreciate the benefits and ensure its future continuity.

Goat production was considered to be the main income source contrary the findings by Masika and Mafu (2004), Bester *et al.* (2009) and Rumosa-Gwaze (2009) where its contribution was minimal. This may have been due to the selection criteria used in this study which focused mainly on areas with high goat ownership and populations. This finding justifies the need to address farmers' production constraints so as to improve and sustain their livelihoods. The goats were however kept mainly for cultural purposes and to aid in generation of income during financial distress. These results were consistent to those by Masika and Mafu (2004), Bester *et al.* (2009) and Rumosa-Gwaze (2009). The use of goats for milk production was unpopular as also reported in previous studies (Masika and Mafu, 2004; Tefera *et al.*, 2004). This is because most farmers considered the consumption of goat milk to be highly associated with poverty. It is therefore essential to educate farmers on the rich nutritional attributes of goat milk which can assist in reducing malnutrition in these communities.

The overall mean flock sizes were higher than those reported by Mahanjana and Cronjé (2000), with the similar flock composition. Majority of the households had more than 20 goats compared to 8 goats as reported by Homann *et al.* (2007) in Zimbabwe. This result signified a high potential for commercialization of communal goat production in the Eastern Cape municipal communities. Despite these significantly high flocks farmers depended entirely on the rangelands for feed supply for their goats. As a result of erratic changes in nutritional value of the veld, low kidding rates were also observed as reported by Sebei *et al.* (2004) in the North West Province. This could have been due to nutritional stress which is known to cause long kidding intervals, delayed estrus and silent heat periods thereby significantly reducing doe productivity (Kusina *et al.*, 2001; Ismail *et al.*, 2008; Hefnawy *et al.*, 2010)

Despite most of the households providing shelter for their goats, a major concern arose from their housing structures which were not roofed. These inappropriate structures do not help under harsh weather conditions hence this proliferates diseases in the goat flocks. This perception can be justified by the finding that most of the outflows were due to kid mortalities. Exposure to extreme environmental conditions was found to reduce their kids' survivability (Sebei *et al.*, 2004). However, the mortality figures reported in this study were relatively lower compared to those of Sebei *et al.* (2004), Webb and Mamabolo (2004) and Homann *et al.* (2007) which were between 30%-50%. This might be due to a significant number of farmers dipping and deworming of their goats in the current study. The ability of farmers to acknowledge these basic health strategies, illustrates their efforts in reducing production losses. In addition to conventional disease

control methods farmers used traditional medicine as cited also by Setlalekgomo and Setlalekgomo (2013).

The most common diseases illustrated in Table 3.2 showed that tick-borne diseases were a major setback in goat production. In their studies Masika and Mafu (2004) and Slayi *et al.* (2014) observed that there was a high prevalence of heart water and gall sickness, in the Central Eastern Cape. The erratic dipping programs coupled with failure to mix chemicals properly may have resulted in tick resistance. Therefore, despite farmer efforts in controlling ticks, the ticks still had a significant effect in the flocks. The finding that foot rot was more prominent in Port St Johns may be arguably justified in that this Municipality receives relatively higher annual rainfall compared to Umnquma (South African Explorer, 2014). The moist and muddy conditions that occur as result of increased precipitation would then amplify the incidence of footrot (Masika and Mafu, 2004).

Farmers kept mostly indigenous goats as well as Boer crosses and this was in agreement with the findings of Slayi *et al.* (2014). The general response of reasons for breed preference among farmers was based on its availability. The mean rank scores (Table 3.3) revealed that farmers from villages with high goat numbers preferred to select their breed based on colour rather than availability. This concurred with findings that farmers preferred the white coloured goats for use during traditional ceremonies (Rumosa-Gwaze 2009). The odds ratios (Table 3.4) showed that education had the greatest influence on the probability of the farmer choosing a breed based on its colour. This result shows the farmers intent to produce their animals according to market demands. Goats bred

throughout the year as also observed by Mamabolo and Webb (2005) in Mpumalanga. There was little to no efforts of controlling inbreeding as farmers kept bucks for more than three years in the flock. This was in agreement with Kosgey *et al.* (2008), McMillin *et al.* (2012) on the description of communal goat breeding systems. Although most of the farmers castrated their goats, it was mainly done to improve meat quality and reduce aggressiveness this was in agreement with findings by Simela and Merkel (2008). It is therefore, imperative to educate farmers about breed management techniques as this will ensure effective use of the available genetic resources, this is sufficient to cater for improved outputs.

The finding that peak sales were prominent during winter and summer was also reported by Mahanjana and Cronje (2000), Masika and Mafu (2004) and Rumosa-Gwaze, (2009). This is the time when most traditional ceremonies and festivals occur in the Eastern Cape Province. It was highlighted that goats were sold regardless of their class, however, most sales were dominantly for castrates and this was in agreement with the findings by Homann *et al.* (2007) and Gizaw *et al.* (2010). The informal market provided a competitive price of between ZAR 1000-1500 (\$83-\$120 USD) per live animal. The formal market prices are often undesirable since they are charged according to carcass weight. The average carcass of an indigenous goat is 13.5kg, with the formal market offering ZAR 22 (\$1.83 USD) per kg (NAMC, 2005). Therefore, if farmers would participate in the formal market, there would be a need to have high off takes to realize significant profits.

3.5 Conclusion

Goat production can be a viable option to ensure food security of resource limited households. This study gave a detailed description of the current state of goat production in the investigated areas according to perceptions of farmers. Despite considerably high goat numbers for the majority of the farmers, a number of production constraints still exist in these households. The major constraints identified in the study are inadequacy of goat management knowledge, low off takes (due to poor marketing) high mortalities (due to diseases) and low reproductive performance (due to poor nutrition).

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Chapter 4: Productivity and production potential of indigenous goats in the selected coastal areas of the Eastern Cape Province.

Abstract

This study was conducted to determine productivity and production potential of communally owned indigenous goats. Data was obtained through an annual flock monitoring survey of the selected baseline households in five different villages. Frequencies were generated by SAS and a DynaMod model simulated future trends of both current and improved goat production scenarios. Majola village had the lowest fecundity (68%) and prolificacy (111%) while the other villages showed higher fertility rates (Prolificacy 120-124%; Fecundity 80-88%). Low kid survivability was associated with multiple births as villages with higher fertility rates had the highest kid mortality (31-38%). The villages of Port St Johns Municipality had high goat populations in both current and improved production simulations. Inadequate nutrient supply however restricted the growth potential of the Majola flock while genetic unfitness limited that of Izibityolo, Mission and Klanisi villages. Bizana village had the greatest production potential although all villages had a low reproductive performance. All the villages showed significant potential increase in their flocks despite limitations by inadequate nutrition supply and inbreeding.

Key words: Coastal, modeling, productivity, small ruminant

4.1 Introduction

Sixty percent of goats in the Eastern Cape Province are communally owned by resource poor farmers (Shabalala and Mosima, 2002) and play a pivotal role in ensuring household food security (Peacock, 2005). The goats contribute to improved nutrition through the consumption of their meat and milk (Lebbie, 2004; Homann *et al.*, 2007). Economically, they are used in wealth storage, hence they provide immediate income through their sales during the periods of financial distress (Lebbie, 2004; Rumosa-Gwaze *et al.*, 2008). Their ability to browse trees and shrubs is important in the control of bush encroached rangelands thus availing grass for other livestock species (Braker *et al.*, 2002). In addition goats are the most adaptable livestock species in the arid and semi-arid areas that characterise the majority of the resource poor farmers.

Goat production has often been used in various instances to develop poor rural communities. However the success of most of these programmes has been poor (Dubeuf *et al.*, 2014). One of major concern in the use of goats to ensure sustainable food security is low production potential of communal goats (Masika and Mafu, 2004; Rumosa-Gwaze *et al.*, 2010). The lack of current productivity information of the goats has often led to implementation of wrong improvement strategies hence leading to failure of most developmental programmes (Boyazoglu, 2002; Kosgey *et al.*, 2006; Dubeuf *et al.*, 2014). Reproductive performance remains an integral component in determining productivity of any livestock enterprise (Mellado *et al.*, 2006). According to Mukasa-Mugerwa *et al.* (2002) and Assan (2015) reproduction performance is an initial indicator of reduced flock productivity in small ruminants. Prolificacy and fecundity are important measures of

flock fertility while kid mortality and weaning are essential in the determination of the viability of the small ruminant enterprises (Mellor and Stafford, 2004; Konyalı *et al.*, 2007; Nunes and Salgueiro, 2011).

Verbeek *et al.* (2007) mentioned that there are often improper assumptions that goat production is the same across all communities, rangelands and economies. As a result some methods were developed to measure productivity and potential of indigenous goats under the communal production systems (Ahuya *et al.*, 2007; Gwaze *et al.*, 2010). The degree of the estimation however varies due to the complex nature of these production systems, hence simulation models have since been adopted due their ability to project the future production trends. It is, however vital that a simulation model be as simple as possible for it to give more accurate results (Kamalzadeh, 2005). The productivity information is critical in the development of improvement strategies that seek to increase production efficiency in these communities. It is then against this background that this study used the DynaMod model to determine the productivity and production potential of the goats in Port St Johns and Umquma Municipalities.

4.2 Materials and Methods

4.2.1 Study site

The study was conducted in Port St Johns and Umnquma local Municipalities. The sites are described in Section 3.2.1

4.2.2 Data collection

A detailed data sheet was used to collect information on flock inventory after the baseline survey. The farmers were trained in filling out the sheet with assistance from the agricultural extension staff. Each of the selected farmers in the baseline study was issued

a data template to capture monthly inflows and outflows in and from their flocks. The goat flocks were monitored for a period of 12 months with occasional monthly visits by the researcher as well as the extension staff.

4.2.3 Data analysis

PROC FREQ of SAS (2007) was used to generate frequencies for the productivity data.

The DynMod model (Lesnoff 2007) was used to simulate population size and its growth rate in the goat flocks of the selected villages.

4.2.3.1 Description of the model

The DynMod model is a Microsoft Excel spreadsheet that simulates livestock population dynamics over a given time period based on parameters like reproduction rates or mortality rates. The model parameters used for this study were flock sizes at the beginning of the observation period and reproduction rates (parturition, prolificacy) as inflows and mortality rates as outflows during the 12 month observation period.

4.3 Results and Discussion

To establish the productivity of the goats in each village, prolificacy, fecundity, weaning and mortality was computed (Figure 4.1). Within the villages Majola had the lowest prolificacy (111%) and fecundity (68%). This could be attributed to limited forage availability as a tea estate occupy about 400ha of land in this village (ERCDA, 2012). Effect of reduced fertility due to inadequate nutrition was also reported in communal goats by Chikwanda (2004), Kumsa *et al.* (2011) and Slayi *et al.* (2014). The mortality rate for Majola (21%) was relatively lower compared to the other villages (30-40%) hence it produced high weaning. This result was consistent with the findings by Lehloenya *et al.* (2005) that multiple births had lower survivability. This is due to physiological starvation of multiple fetuses during pregnancy, which results in the birth of weak kids. Their death is accelerated by depletion of the already diminished energy reserves since they struggle to suckle and also suffer from abandonment by does.

The low prolificacy of Majola goats could have increased the chances of the kids to survive. Generally the goats across all the villages had showed a low reproductive performance. The overall average prolificacy was lower than was reported by Ahmadua and Lovelace (2002) and Webb and Mamabolo (2004). Mortality rates were however relatively lower compared to studies by Masika and Mafu (2004), Sebei *et al.* (2004) and Homann *et al.* (2007).

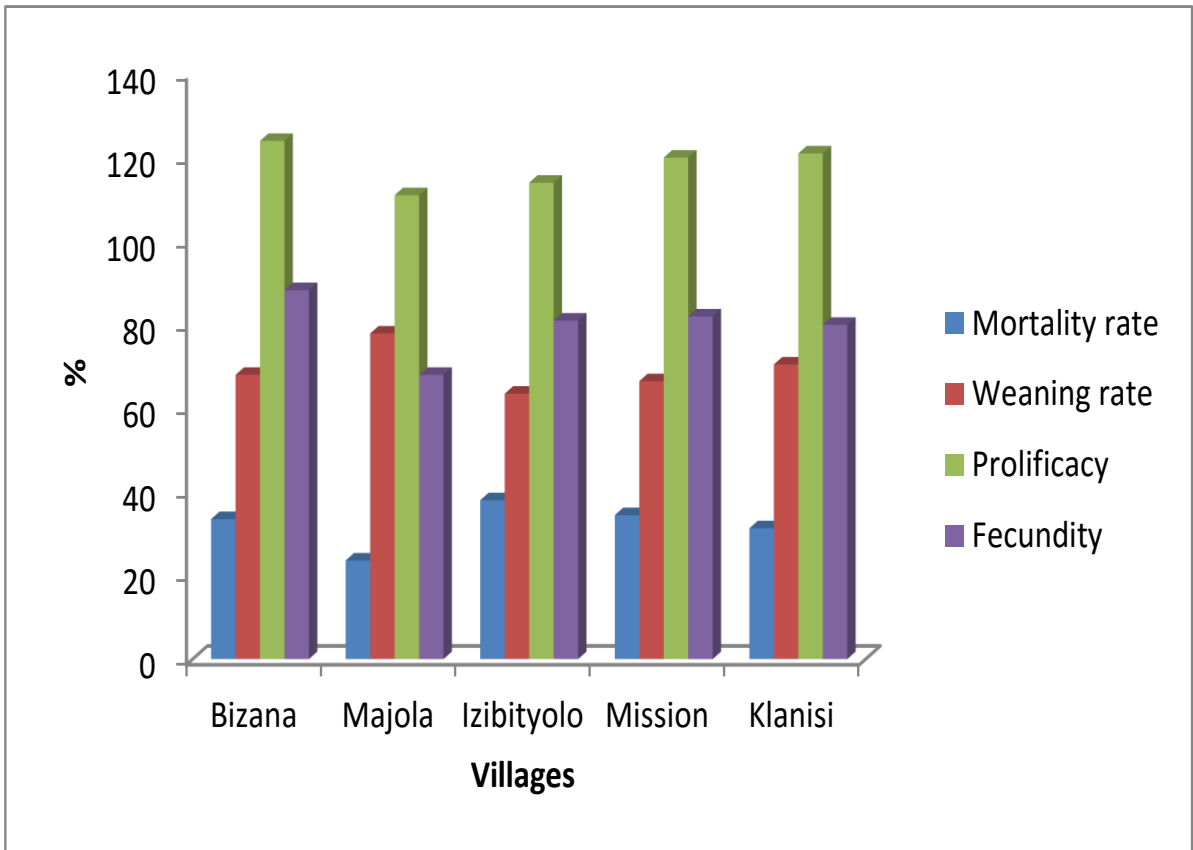


Figure 4. 1 Reproductive performance of goat flocks in the selected villages of Port St John's and Umnquma Municipalities.

A simulation of both the current and improved productivity was conducted to determine the future population size and growth trends within a 20 year period. The assumptions of the improved productivity were that mortality was to reduce by 5% after every 5 years through practicing good husbandry techniques e.g. routine dipping and dosing, improved housing structures.

In Port St Johns Municipality the current production potential showed that the population size of Majola flock (Figure 4.2) was declining while that of Bizana (Figure 4.3) was increasing over time. This observation further highlights on the effect of limited forage in this village. The already low capacitated rangeland could not sustain further flock increases thus an inadequate nutritional supply would result in reduction of reproductive performance. Studies by Dwyer (2008), Ismail *et al.* (2008) and Hefnawy *et al.* (2010) reported on the effect of under-nutrition in the disruption of the female endocrinology thereby lowering the overall flock productivity. Bizana had a high growth rate, which was declining over time while that of Majola showed a steady rise from the negative zone. This could be as a result of low mortality and high weaning rates observed in Majola village (Figure 4.1) while the same fact is true for Bizana. The improved production simulation showed an increase in goat populations in both villages; however Bizana had higher goat numbers in comparison to Majola. This result further supports the finding that Bizana rangeland had a high capacity to accommodate flock increases as compared to that of Majola. This then further highlights the ability of Bizana to sustain high growth rate under improved management.

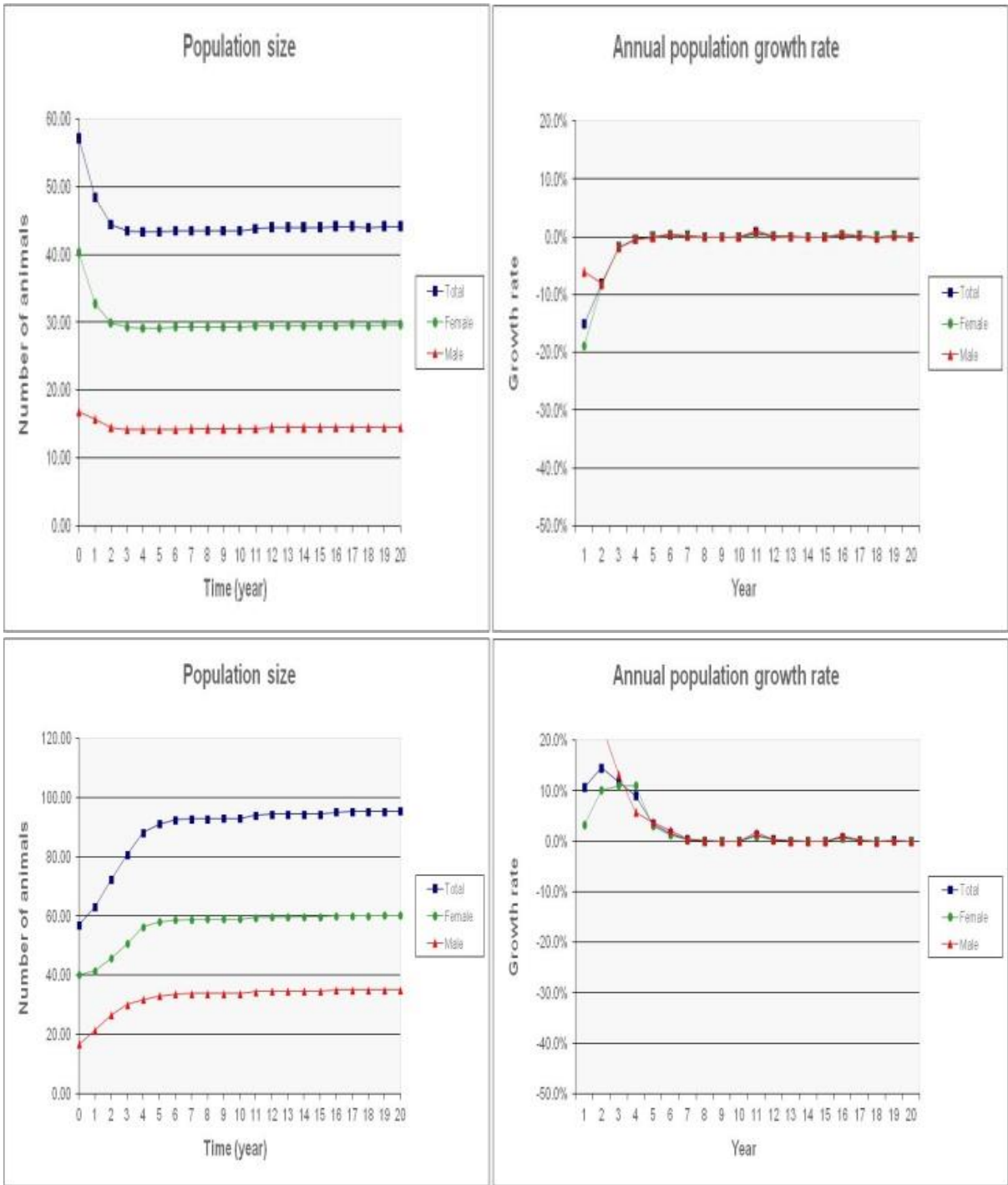


Figure 4. 2 Simulated goat population size and growth rate in Majola village of the Port St John’s Municipality. **The first two upper graphs illustrate the current scenario while the bottom shows expected improved productivity after intervention.*

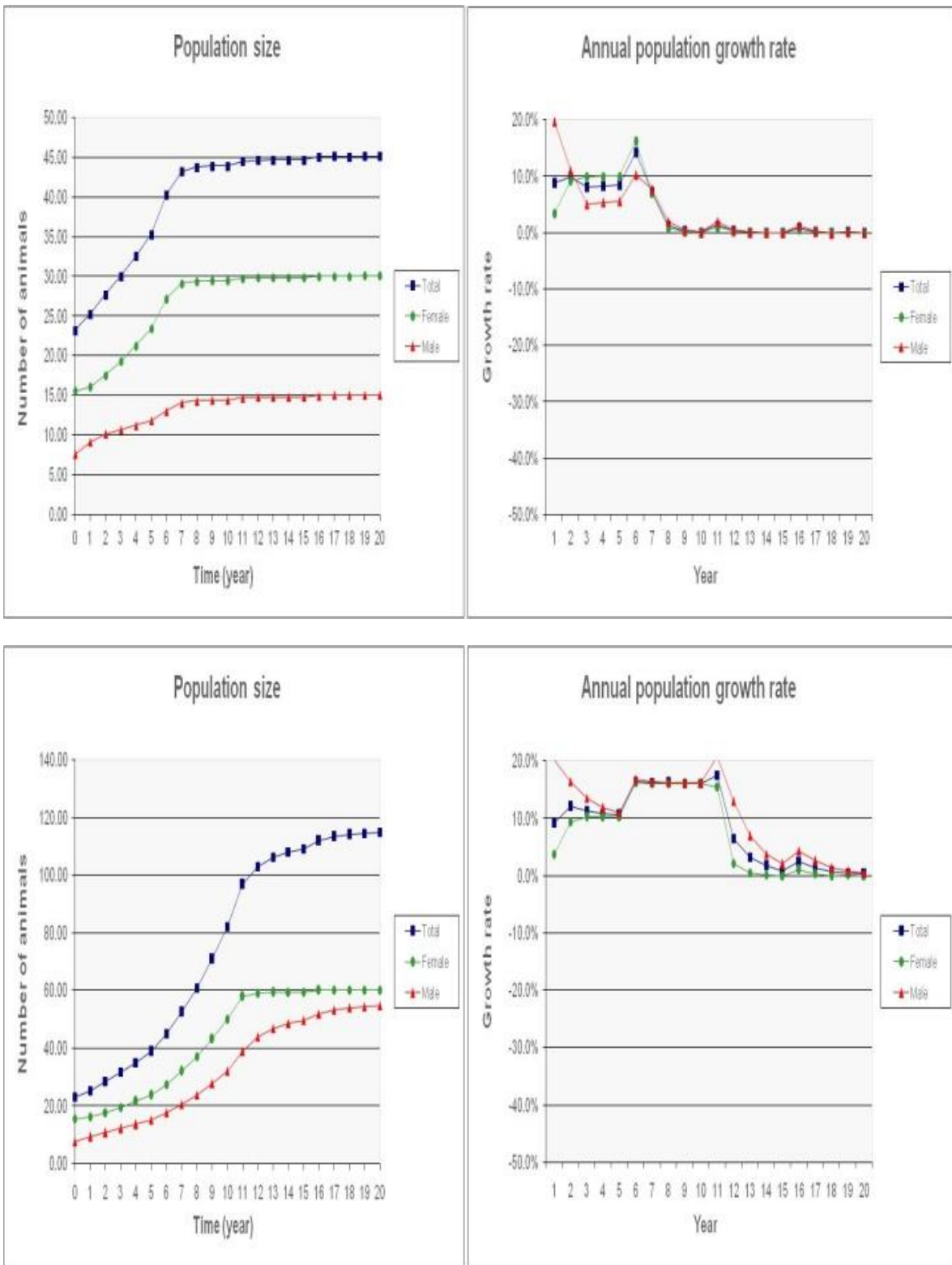


Figure 4. 3 Simulated goat population size and growth rates in Bizana village of the Port St Johns Municipality. **The first two upper graphs illustrate the current scenario while the bottom shows expected improved productivity after intervention*

In Umnquma Municipality the current production potential was typified by an increase in flock population sizes of Izibityolo (Figure 4.4), Mission (Figure 4.5) and Klanisi (Figure 4.6). Growth rates in all the villages had a more similar decline pattern over time. This was consistent with the earlier findings on productivity parameters (Figure 4.1 above) where these villages showed similar results. The decline in population growth patterns gave an insight of the impact of high mortality and reduced weaning rates as commonly experienced in flocks under extensive production systems (Rumosa Gwaze *et al.*, 2009; Zewdie and Welday, 2015). Improved productivity almost doubled the population sizes of all the villages. This finding was in agreement with Sebei *et al.* (2004) and Homann *et al.* (2007) who in their studies mentioned that good husbandry practices have a potential to improve productivity of communal goats. There was however no clear differences in population growth of both the improved and current scenarios. A similar observation is noted if all these villages are compared to Bizana (Figure 4.3), despite having almost similar current production trends the latter shows very different results under improved conditions. This finding indicates a possibility of genetic unfitness in the Umnquma villages as their growth and population size is far below that of Bizana village. This assumption could be supported by the facts established in Chapter 3 that farmers did not have any breed management strategies hence mating was not controlled with situation further worsened by failure to cull old bucks. These results were also reported by Masika and Mafu (2004) and Rumosa-Gwaze (2009) in the communal owned goats of the central Eastern Cape Province. There is a need to validate this finding using small population genetics parameters to determine the extent of inbreeding in these flocks.

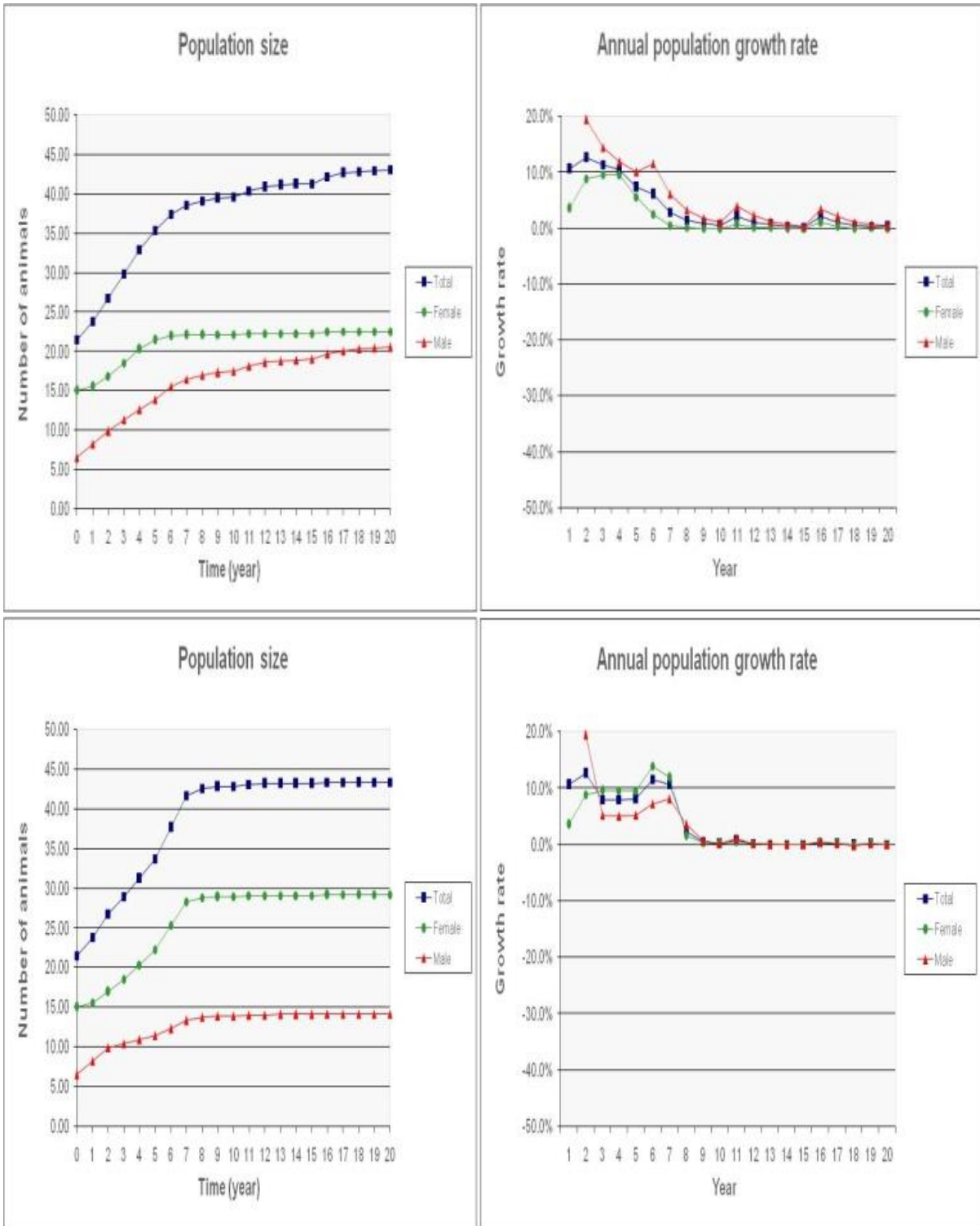


Figure 4. 4 Simulated goat population size and growth rate in Izibityolo village of the Umquma Municipality. **The first two upper graphs illustrate the current scenario while the bottom shows expected improved productivity after intervention*

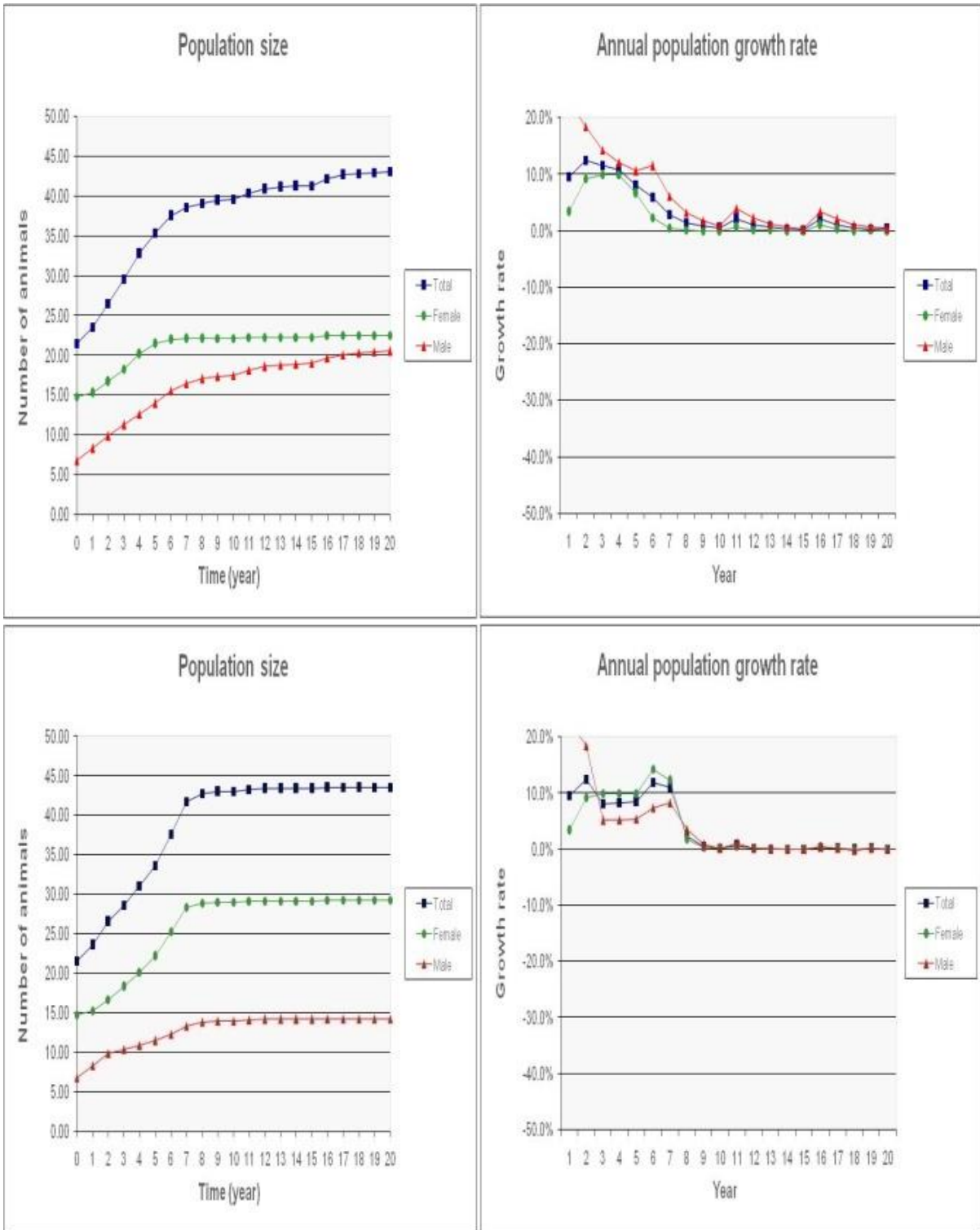


Figure 4. 5 Simulated goat population size and growth rate in Mission village of the Umnquma Municipality. **The first two upper graphs illustrate the current scenario while the bottom shows expected improved productivity after intervention*

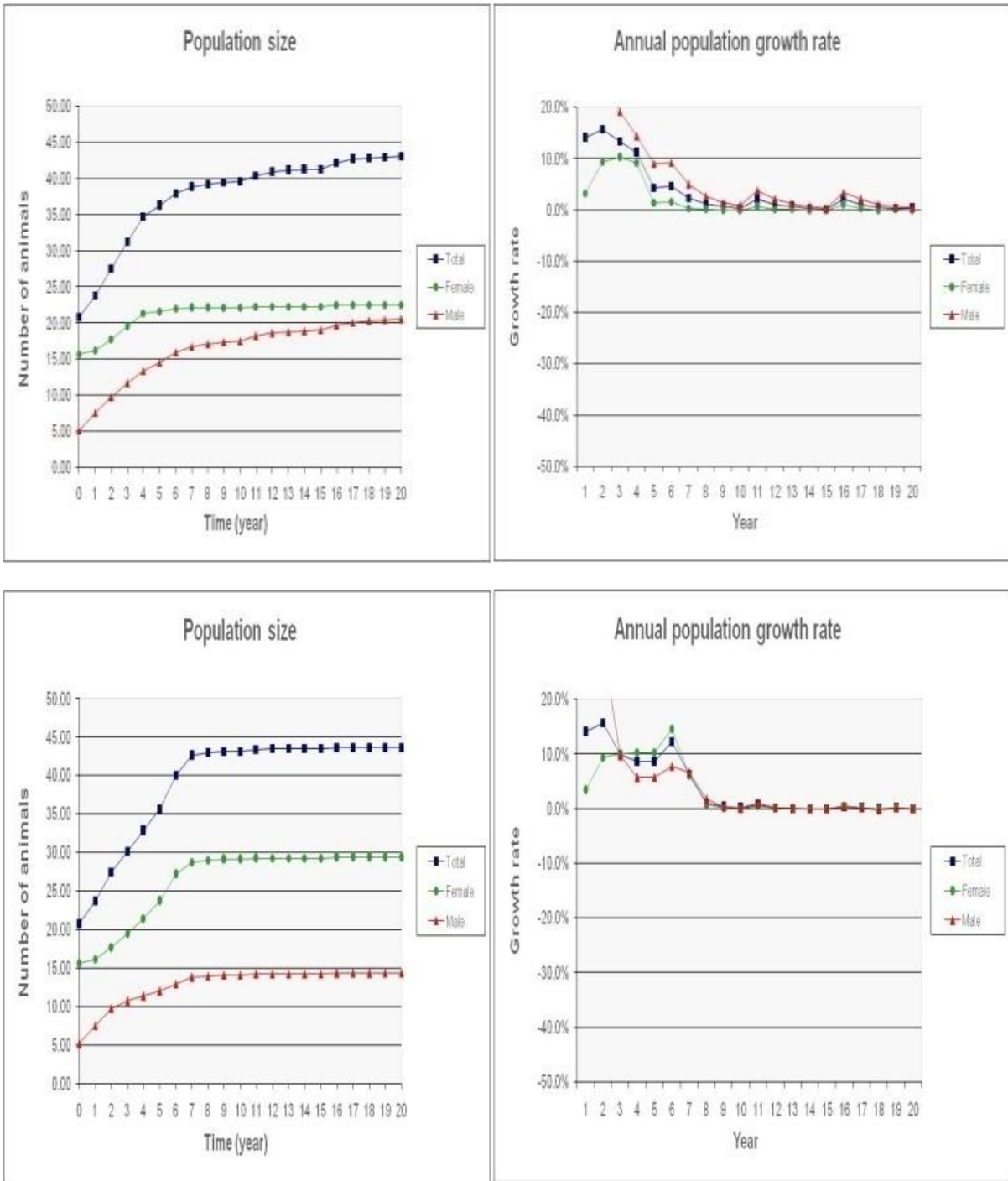


Figure 4. 6 Simulated goat population size and growth rate in Klanisi village of the Umnquma Municipality. **The first two upper graphs illustrate the current scenario while the bottom shows expected improved productivity after intervention*

4.5 Conclusion

The study showed that the productivity of goats was generally low in all the villages. Port St Johns Municipality had higher population sizes in both current and improved production scenarios as compared to Umnquma Municipality. The current production scenarios did not show any clear distinctive patterns as almost all villages had similar trends except for Majola village. Improved management simulations, however, showed that Bizana village had the greatest potential compared to the rest of the village. The study also revealed that despite improving management there would be little change in population growth; hence this highlighted a possibility of genetic unfitness as one of the limiting factors in goat productivity. In order to fully develop viable intervention strategies to ensure improved goat production there is a need to explore the levels of inbreeding in these flocks and determine their impact on productivity.

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Chapter 5: Inbreeding depression and its impact on productivity of indigenous (Xhosa lob eared) goats in the coastal areas of Eastern Cape Province.

Abstract

The objective of the current study was to estimate inbreeding levels and its impact on goat productivity. The data were collected from a monitoring survey consisting of 100 households in five villages and was subjected to an analysis by SAS. Goat class distribution was characterised by few bucks and high doe proportions across all the villages. Breeding ratio per village was above the recommended 0.04 in all villages despite lack of buck ownership in most households. The effective population sizes were all below 50 hence this indicated a possible threat to the existence of indigenous Xhosa lob eared goats in these populations. The rate of inbreeding was also above the acceptable threshold of 0.063 in all villages except for Majola. The negative relationship between effective population size and fertility indicators signaled existence genetic unfitnes in the flocks. This also further evidenced by the positive relationship between fecundity and kid mortality. It can then be concluded that there were high inbreeding levels in the studied village flocks that significantly contributed to a low overall goat productivity.

Key words: population genetics, productivity, small ruminants.

5.1 Introduction

The Eastern Cape Province has about 2.3 million of the estimated 7 million goats in South Africa (DAFF, 2014). Despite this huge goat population the numbers have remained static over the past decade. Although these statistics are merely estimates due to absence of viable farm records by goat farmers. Current research in goat production in the province has shown that production is characterized by poor reproductive performance and high mortality rates (Masika and Mafu, 2004; Rumosa-Gwaze, 2009). This could be attributed to genetic deterioration and inadequate nutrition supply.

Communal goat populations are considered to be small, they range from 2-100 goats (Mahanjana and Cronjé, 2000; Simela and Merkel, 2008). Farmers do not control breeding in their flocks hence resulting in the mating of closely related individuals. This situation is further worsened by prolonged stay of older breeding males and failure to retain young bucks (Masika and Mafu, 2004; Kosgey *et al.*, 2006). In an effort to improve productivity the introduction of genetically superior breeds e.g. Boer goat, has increased genetic corrosion of the indigenous goat breeds. The reproductive performance of cross breeds (non-descript) is generally lower in comparison to the natives. This is attributed to failure in environmental adaptation as often exhibited by high kid mortalities.

Indiscriminate crossbreeding and inbreeding pose a major threat to the existence of local indigenous breeds (Tada *et al.*, 2013). It is crucial to control inbreeding and conserve genetic diversity of these indigenous genotypes (Shrestha and Soysal, 2010; Rashidi *et*

al., 2014). Small population genetics parameters are therefore essential in determining genetic drifts and threats to the genetic health of small populations (Nomura *et al.*, 2000; Neel *et al.*, 2013). They have been used before in community-based management of Nguni cattle in the Eastern Cape Province (Tada *et al.*, 2013). The objective of this study was to estimate the effective population size (N_e) and inbreeding co-efficiency of communally owned goats as well as their impact on productivity. This information is necessary in the optimization of breeding programs for additive genetic response to inbreeding depression.

5.2 Materials and Methods

5.2.1 Study Site

The study was conducted in Port St Johns and Umnquma local Municipalities. The sites are described in Section 3.2.1.

5.2.2 Data Collection

Data was collected through information sheets indicating flock inventory of the selected farmers. The non-Fisherian sex-ratio effective population size (N_e) was calculated using a formula by Wright (1931) (Equation 1) and the levels of inbreeding per generation were calculated using the formula by Wright (1977) (Equation 2).

$$N_e = 4 * N_m * N_f / (N_m + N_f) \dots\dots\dots \text{Equation 1}$$

Where N_m and N_f are the number of breeding males and females respectively.

$$F = 1 / (2 * N_e) \dots\dots\dots \text{Equation 2}$$

5.2.3 Statistical Analysis

The general linear model (GLM) procedure of SAS (SAS Institute, 2005) was used to determine the goat class distribution and small population genetics parameters across five villages. The following model was computed:

$$Y_{ij} = \mu + \alpha_i + e_{ij}$$

Where;

Y_{ij} = (different goat classes; Breeding ratio, N_e , ΔF)

μ = the common mean,

α_i = the village effect (1..and 5)

e_{ij} = the random error.

Differences between means were separated according to the Least Significance Difference (LSD) test of SAS. Correlations were used to establish the relationship between small population genetic parameters and the productivity indicators.

5.3 Results and Discussion

5.3.1 Goat flock class distribution

Flock class distribution (Table 5.1) across the villages was characterised by high breeding and non-breeding does, followed by kids, castrates and the least numbers being breeding and non-breeding bucks. The finding that breeding males were fewer as compared to castrates was also observed by Jaitner *et al.* (2001), Kosgey, (2004) and Nigussie *et al.* (2013). This finding might be attributed to the farmer preference to sell castrates while giving less priority to male breeding animals. This scenario also supports the finding that extensive goat farming has a huge reliance on community bucks (Webb and Mamabolo, 2004; Gizaw *et al.*, 2010). The does had higher numbers compared to other classes as

also observed by Chikagwa-Malunga and Banda (2006), Dossa *et al.* (2007) and Gwaze *et al.* (2010). This could be attributed to the fact that farmers consider retention of does as a way to enhance flock growth through increased births (Ahmadu and Lovelace, 2002; Rumosa-Gwaze *et al.*, 2010).

Table 5. 1 Animal class distribution in goat flocks of Port St Johns and Umnquma Municipalities.

Animal Class	Village				
	1	2	3	4	5
BB	1.1 ^{ac} ±0.05	1.0 ^b ±0.09	1.0 ^b ±0.11	1.0 ^a ±0.09	1.0 ^{ab} ±0.27
Non BB	2.5 ^a ±0.45	2.3 ^a ±0.85	3.0 ^a ±1.7	-	-
BD	17.8 ^a ±1.66	7.9 ^b ±2.42	7.3 ^b ±2.5	7.0 ^b ±2.28	7.2 ^b ±2.35
Non BD	15.8 ^a ±1.94	7.4 ^b ±3.74	5.1 ^b ±3.31	4.5 ^b ±2.75	4.7 ^b ±2.75
Kids	15.6 ^a ±1.53	6.6 ^b ±2.24	5.0 ^b ±2.31	6.1 ^b ±2.24	5.9 ^b ±2.17
Castrates	10.0 ^a ±1.08	4.6 ^b ±1.61	4.4 ^{bc} ±1.73	4.4 ^{bc} ±1.56	3.0 ^c ±1.56

^{abc} Values with the same superscript letter in each row are not significantly different (P >0.05). – means data could not be calculated
 BB-Breeding Buck; BD=Breeding Doe; Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi.

5.3.2 Small population genetics parameters

The breeding ratios for the villages Bizana, Izibityolo and Mission were significantly higher than that of Majola and Klanisi. This was attributed to a high proportion of does in the Majola and Klanisi goat population thereby lowering the breeding ratio. The breeding ratios in all villages (Table 5.2 below) was higher than the recommended standard of 0.04 per flock (Rumosa-Gwaze *et al.*, 2010). This was in agreement with several studies conducted on communal goat production (Webb and Mamabolo, 2004; Bester *et al.*, 2009; Gwaze *et al.*, 2010; Tesfaye *et al.*, 2012). Mission village had a significantly lower effective population size (N_e) compared to the other villages. This was due to the fact that Mission village had the smallest proportion of breeding animals in its flock (Table 5.1). Effective population sizes of all the studied villages were very low as a result of most households' reliance on community bucks. This showed that there was increased vulnerability of the goat flocks to genetic drift and inbreeding depression (Falconer and Mackay, 1996; Baldursdottir *et al.*, 2012). Since the flocks had a N_e below 50 they could be at risk of extinction, according to FAO (2006). Therefore the Xhosa lob eared goats should be considered for *in situ* conservation of indigenous animals similar to Nguni cattle (Tada *et al.*, 2013) and Zulu sheep (Mavule *et al.*, 2005).

The Umnquma villages had significantly higher inbreeding levels as compared to those of Majola but were not that different from Bizana. This may have due to the fact that Majola had significantly higher flock sizes compared to other villages in almost all the goat classes (Table 5.1). Change in inbreeding co-efficiency (ΔF) for all villages with exception of Majola was higher than 0,063 which is considered to be acceptable by

Armstrong (2006). This could have been due to the recurrent use of related breeding males, uncontrolled mating, failure to cull old bucks and small flock sizes. This finding also validated the perceived assumption of inbreeding possibility in Umquma Municipality reported in Chapter 4. The levels of inbreeding levels were in the same range as reported by Bahmani *et al.* (2011) in Makhoz goats, Tesfaye *et al.* (2012) in Arsi-Bale goats and Kunene *et al.* (2014) in Zulu sheep.

Table 5. 2 Small population genetics parameters of pooled data in selected villages of Port St Johns and Umnquma Municipalities.

Parameter	Villages					Pooled data (Overall)
	1	2	3	4	5	
Breeding ratio	0.1 ^a ±0.01	0.2 ^{bcd} ±0.02	0.2 ^c ±0.03	0.2 ^d ±0.23	0.1 ^{abc} ±0.07	0.63
Ne	14.9 ^a ±2.03	10.3 ^a ±3.52	8.3 ^a ±4.31	5.0 ^b ±3.34	-	6.01
ΔF	0.06 ^a ±0.007	0.08 ^{ab} ±0.013	0.09 ^b ±0.015	0.11 ^b ±0.012	0.08 ^{ab} ±0.049	0.39

^{abcd} Values with the same superscript letter in each row are not significantly different (P >0.05). – means data could not be calculated
 Ne-Inbreeding effective population size; ΔF-Increase in inbreeding per generation;
 Village 1-Majola; 2-Bizana; 3-Izibityolo; 4-Mission; 5-Klanisi.

5.3.3 Impact of inbreeding on the productivity of goats.

In order to ascertain the impact of inbreeding in these flocks, correlation coefficients were computed to determine the relationship between N_e and productivity indicators discussed in Chapter 4. There was a negative relationship of N_e with both prolificacy and fecundity (Table 5.3). This relationship would mean that an increase in the number of breeding animals concurrently, resulted in reduction of flock fertility. This finding was contradicted the fact established by Shrestha and Soysal (2010) that an increase in N_e should lower levels of inbreeding hence improving flock productivity. This therefore highlights the possible incidence of genetic unfitness in these goat populations. To further lament on this finding was also the positive relationship between fecundity and kid mortality clearly shows adaptation failure a key indicator of population genetic drift (Primack, 2000; Gherardi *et al.* 2009; Harmon *et al.* 2009). Genetic unfitness in goats due to inbreeding has been also reported by (Mainguy *et al.* 2014). The negative relationship between fecundity and weaning could be attributed to non-genetic factors. This shows that goats were failing to reach their production potential due to limitations such as inadequate nutrition since these animals solely relied on the rangeland for feed supply.

Table 5. 3 Correlations of reproductive performance indicators and effective population size of goats in Port St Johns and Umnquma Municipalities.

	Fecundity	Prolificacy	Weaning	Kid Mortality
Effective population size	-.305 ^{***}	-.004 ^{NS}	.238 [*]	-.238 [*]
Fecundity		.432 ^{***}	-.029 ^{NS}	.029 ^{NS}
Prolificacy			.052 ^{NS}	-.052 ^{NS}
Weaning				-1 ^{***}
Kid Mortality				

Significance level (***= p<0.001; **=p<0.01; * = p < 0.05; NS Not Significant).

5.4 Conclusion

The lack of prioritisation of breeding males in almost all villages led to a reduction of the effective population sizes. The low N_e increased vulnerability to the mating of closely related animals, hence increasing inbreeding co-efficiency. The ΔF in almost all villages surpassed the threshold value confirming the occurrence of inbreeding assumed in Chapter 4. The study also revealed a possible endangerment of the indigenous Xhosa lob eared goats due increased genetic erosion shown by low N_e . Although there was a low ΔF the impacts on productivity were detrimental thus they led to poor fertility and increased kid mortality of the goats. There is a need to genetically characterise this breed through a molecular study. This study, also recommends buck exchange among farmers of different communities to reduce mating of relatives. Farmers should also maintain the breeding ratios in their flocks as well culling of old bucks and does.

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Chapter 6: General Discussion, Conclusion and Recommendations

6.1 General Discussion

The importance of goats in these communities has since been realised and well documented (Lebbie, 2004; Gwaze *et al.*, 2009). Despite the immense contribution of these goats to the household economies, they remain underutilised and undeveloped compared to other livestock (Ahuya *et al.*, 2005; Alexandre *et al.*, 2010). Most of the efforts made to improve their productivity lacked farmer involvement hence the recommended strategies fail in both implementation and adoption (Boyazoglu, 2002; Alexandre *et al.*, 2010).

The Eastern Cape Province has the largest goat population in South Africa (DAFF, 2014). The potential of these goats to meet household food security is yet to be recognised. The main objective of this study was to characterise goat production systems so as to understand farmers' management strategies and their current production constraints with a view to formulate current practical mitigation strategies to generate new knowledge pertinent to the improvement of communal goat production.

A detailed description of the current goat management systems was given in Chapter 3. The study revealed that the majority of the households were male headed, with most of the farmers having acquired at least primary level of education. The farmers indicated that they own mostly indigenous goats together with Boer breed and their crosses as also reported by Masika and Mafu (2004), Rumosa-Gwaze (2009) and Slayi *et al.* (2014). Kid mortality was low compared to other studies by (Sebei *et al.*, 2004; Homann *et al.*, 2007). This could have attributed to farmers ability to control internal and external parasites through dosing and dipping goats. Farmers response ranks showed that tick borne

diseases were a major health constraint. Similar findings were reported by Masika and Mafu, (2004) and Slayi *et al.* (2014). Poor housing structures proliferated disease incidents and exposed goats to harsh weather conditions resulting in increased kid mortalities (Sebei *et al.*, 2004). The goats were marketed through informal channels at an average price of R1500 per goat. Most farmers preferred selling castrated male goats with peak sales in winter and late summer. This is because goats are essential in cultural ceremonies such as circumcision, which coincide with these seasons (Masika and Mafu, 2004; Rumosa-Gwaze, 2009; Bester *et al.*, 2009). Goats were also mainly used in generation of immediate income to assist during financial bottlenecks. Farmers' responses indicated their major constraint was inadequate goat management information this may have been due to ineffective knowledge transfer as a result of limited interactions of extension staff with these farming communities. It is often impossible for these technocrats to attend promptly to farmers' problems. The other reported constraints were low goat off-takes due to limited market access, high kid mortalities and a low reproductive performance.

In Chapter 4 the productivity and production potential of the studied goats were determined. The productivity was measured through fecundity, prolificacy, and weaning and mortality rate. The study showed that the productivity of goats was generally low. Port St Johns Municipality had higher population sizes in both current and improved production scenarios compared to Umquma Municipality. The current production scenarios did not show any clear distinction patterns as almost all villages had similar trends except for Majola village. Inadequate availability of nutrition was the major

growth limiting factor for Majola as shown by low prolificacy and fecundity rates. This was due to the fact that a larger land portion was used for tea production in this village. Improved management simulations, however, showed that Bizana village had the greatest potential compared to the rest of the village. The study also showed that despite improving management there was little change in population growth in Umquma villages hence a possibility of genetic unfitness was perceived to limit goat productivity.

Chapter 5 aimed to validate the possibility of inbreeding depression as previously reported. The population genetics parameters were used to estimate the effective population size and the inbreeding co-efficient as well as their impact on overall productivity. It was established that despite having relatively high breeding ratios the studied goats had very low effective population sizes. This increased vulnerability of these goat flocks to genetic drift and inbreeding depression (Falconer and Mackay, 1996; Baldursdottir *et al.*, 2012). Thus the indigenous goats were threatened by the risk of extinction hence it is vital to consider them for situ conservation. The negative relationship between effective population size and fertility indicators indicated genetic unfitness in the flocks. In addition the positive relationship between fecundity and kid mortality further illustrated on offspring adaptation failure (Primack, 2000; Gherardi *et al.*, 2009; Harmon *et al.*, 2009).

6.2 Conclusion

Goat production can be a viable livelihood option in coastal areas of the Eastern Cape Province. There is however a need to improve management strategies through effective knowledge transfer by extension staff to enhance goat husbandry practices. The

simulation study illustrated that improved management can increase the productivity of these indigenous goats. The current levels of inbreeding are however unacceptable hence there is a need to develop mitigation strategies that will lower ΔF and increase N_e . There is also a need to consider indigenous Xhosa lob eared goats for situ conservation as they are currently at risk of genetic erosion.

6.3 Recommendations

Community engagement activities would assist in smooth transfer and adoption of proven research technologies which may improve productivity. Need to identify and utilize naturally available feed resources to supplement goats during periods of nutritional bottlenecks. Farmers' should practice buck exchange programmes to minimize breeding of related animals. There is a need to cull old bucks and does to reduce the inheritance of recessive genes. Farmers should improve the construction of their housing structures and maintain good hygiene so as to reduce disease proliferation.

6.4 Areas to consider for further research:

- Development of low cost feedstuffs to supplement goats using locally available resources.
- Genetic characterisation of the Xhosa lob eared goats using molecular techniques.
- *In situ* conservation of the indigenous Xhosa lob eared goats.
- Assessment of possible market value chain linkages and development.

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Appendix 1-Household Questionnaire

Questionnaire number	
Name of respondent	
Enumerator's name	

District	
Village	
Date:	

A. Demographic information

A. 1. What is the status of headship in the family?

a. Male headed (___) b. De-jure female (___) c. De-facto female (___) d. Child headed (___)

A.2. What is the age of household head?

a. ≤ 18 (___) b. 20-40 (___) c. 41-59 (___) d. ≥ 60 (___)

A.3. What is the marital status of household head?

Single (___) Married (___) Divorced (___) Separated (___) Widowed (___)

A.4. Is head of the household resident on the farm? Y/N (___)

A.5. What is the size of the household?

Age group	Male	Female
Adults (>15 years)		
Children (< 15 years)		

A.6. Level of education for person responsible for management of goats.

a. Primary (___) b. Secondary (___) c. Tertiary (___)

A.7. What are your main sources of income rank according to importance?

Source	Salaries	Pension	Child maintenance	Grants	Home Industries	Crop Prdtn	Animal Prdtn	Other/ Specify
Amnt of								

income/yr								
Rank								

1. ≥R4999 2. R5000-R9999 3. R10000-R14 999 4. R 15 000- R20000

B. Livestock production Inventory

B.1. What are your reasons for keeping goats?

Reason	Tick	Rank according to Importance
a. Selling to raise income		
b. meat consumption		
c. milk consumption		
d. Form of saving & investment		
e. Manure		
f. Social function (specify)		
g. Cultural function (specify)		
h. Family pride & status		
i. Others (specify)		

B.1.1 Would you want to participate in a goat milk yield improvement and value addition programme. Y/N (___)

B.2. Which livestock species do you own?

Type of livestock	Size of Flock/herd	Number Rank according to importance

Cattle		
Goats		
Sheep		
Chicken		
Pigs		
Ducks		
Donkeys		
Others (specify)		

B. 3. What is the composition of your goat flock?

Class	Number
Buck	
Doe	
kid	
castrates	
total	

B.3. Who owns the goats? a. Father (___) b. Mother (___) c. Children (___) d. Other (specify).....

B.4. Please provide information on ways by which your goat herd size might have increased over the last 1 year (April 2013-May 2014, you may split into clusters of months)

Inflows (code)	Month when obtained ? (code)	Number of animals obtained	Main animal type (code)	If purchased, from whom (code)	Purpose of purchase (code)	Average price per animal (Rands)

INFLOWS	1=Birth, 2=Bought, 3=Gift, 4=Exchange, 5=Others (specify)
MONTHS	1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec
ANIMAL TYPE	1=Breeding Doe, 2= Young females, 3= Breeding Buck, 4= Male castrated, 5=kids,
PURCHASED FROM	1= large private farm, 2= government farm, 3= smallholder farm, 4=individual trader/broker, 5= Other (specify)

PURPOSE OF PURCHASE	1= Replace animal that died, 2= Increase herd size, 3= For breed improvement, 4= Speculation, 5= Other (specify)
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B.5 Please provide information on ways by which your goat herd size might have reduced in the last 1 year (April 2013-May 2014, you may split into clusters of months)!

Outflows (code)	Month when disposed (code)	Number of animals	Main animal type (code)	Comments

OUTFLOWS	1=Death, 2=Sale, 3=Exchanged 4=slaughter, 5= Gift 6= Lost, strayed, 7=Predators, 8=Stolen, 9=Others (SPECIFY!)
MONTHS	1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec
ANIMAL TYPE	1=Breeding does, 2= Young females, 3= Breeding Buck, 4= Male castrated,

	5=kids
--	--------

C. Health Management

C.1. Are you experiencing any goat mortalities/ deaths in your flock? Y/N (___)

C.1.1. If yes, tick and rank the main causes of mortality in your flock

Cause	Tick	Rank
a. Bad weather calamities		
b. Parasites		
c. Diseases		
d. Predators		
e. Others (specify)		

C.2. What are the common diseases and parasites in your area?

Local/ Scientific name	Symptoms	Season of prevalence	Control

C.3. Are you experiencing some kid mortalities? Y/N (___)

C.3.1. If yes is it caused by a. Dystocia (___) b. Starvation (___) c. Mismothering (___)

C.4. Do you dip your flock? Y/N (___)

C.4.1. If yes how many times?

Period	In winter per month	In summer per month	Other/ specify
# of times			

C.5. Do you deworm your flock? Y/N (___)

C.5.1. If yes when do you dose and how many times?

Beginning of rain season	Mid rain season	After rain season	Other /specify

D. Feeding & Housing Management

D.1. How long do you graze your goats?

a. 0-3hrs () b. 4-6hrs () c. ≥7hrs ()

D.2. What source of water do you have for animal watering?

A .Borehole () b. Dam () c. River () d. Windmill () e. Others (Specify).....

D.3. Do you experience feed shortages? Y/N () , when.....

D.4. Do you provide supplementary feeding for your goats? Y/N ()

D.4.1. If yes, please provide the following information:

Class	Type of feed	Source of feed	Priority
Buck			
Does			
Kids			
Castrates			

D.4.2 What are the reasons for feeding goats?

Reason	Tick	Rank
a. Improve reproduction		
b. Improve growth rate		
c. Improve body condition		
d. Improve lactation		

e. Others (specify)		
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D.4.3 If no, why? a. Expensive feed (___) b. Not necessary (___) c. Other (specify).... ..

D.5. Do you house your goats? Y/N (___)

D.5.1. If yes, what type of housing are you using?

a. brick walls with roofing (___) b. Wooden poles with roofing (___) c. brick walls without roofing (___) d. Wooden poles with roofing (___) e. Other (specify).... ..

D.6. Are kids kraaled separate from adults at night? Y/N (___)

D.7. Why do you house your goats.....

E. Goat Breeding

E.1. Which breeds of goats do you keep?

a. Indigenous breeds (___) b. Exotic breeds (___) c. Cross breeds (___)

E.2. Which breed do you prefer?.....

E.3. Reasons for breed preference?

Reason	Rank
a. Fast growth rate	
b. Quality of meat	
c. Low feed cost	
d. Resistance to diseases	
e. Availability	
f. Colour	
g. Others (specify)	

E.4. What mating system do you practise? a. Hand mating (___) b. Flock mating (___) c. Group

Mating (___)

E.5. Which season do you prefer to mate your does?.....

E.6. Where do you source your buck?

a. Own flock(bred) (___) b. Own flock (bought) (___) c. donated (___) d. communal area (___)

E.6.1 How long do you use your buck?

a. 1-2yr (___) b. 3-4yrs (___) c. \geq 5yrs

E.7. Do you castrate your goats? Y/N (___)

E.7.1 If yes state reason for castration

a. To control breeding (___) b. Improve meat quality (___) c. For better temperament (___) d.

Other.....

E.7.2 How do you control inbreeding in your flock beside castration.

a. Buck exchange (___) b. Culling of old bucks (___) c. Other specify.....

E.8. Do you keep records? Y/N (___)

E.8.1. If yes, why?.....

E.8.2. If no, why?:.....

E.9. Do you think government has done enough in improving communal goat production?

Y/N? (___)

E.9.1. If no, what do you think should be done?.....

G. Marketing management

G.1 What are the major marketing channels available close to you?

a. Abattoir (___) b. informal markets (communities) (___) c. stock sales (___) d. butcheries (___)

e. others (specify)

G.1.1 On average, how many goats do you sell per annum?.....

G.1.2 Which class of goats do you usually sell?

Class	All goats	Bucks	Does	Kids	Weaners	Castrates
Tick						
Price						

G.1.3. At what time of the year do you usually sell goats?

a. Summer (___) b winter (___) c. spring (___) d. autumn (___) e. anytime (___)

G.1.4. How much income do you derive from sell of goats per season?.....

G.1.5 What major constraints do you usually encounter in your goat flock?

Constraints	Comments	Rank according to importance
a. Marketing		
b. Housing		
c. Diseases		
d. Feed cost		
e. Capital		
f. Professional knowledge		
g)Thefts		
h. Others (specify)		

G.1.6. Which organisation has helped you in the production & marketing of your goats?.....

Appendix 2- Recording template for flock inventory

Name of household.....Month..... Village.....

	Numbers	Comments
Entries		
Births (Ezizelweyo)		
Purchases (Ezithengiweyo)		
Gifts-in (Izipho)		
Exchange –in (Ukutshintshisa)		
Entrusted –in (Ukunjoma/Ukusisa)		
Exits		
Sold (Ezithengisiweyo)		
Slaughtered (Ezixheliweyo)		
Died (Ezifileyo)		
Predated upon/stolen/lost		
Gifts out (Ekuphiswe)		
Entrusted out (Ukungonywa/ukusiselwa)		
Flock Composition		
Female kids (amathokazi angamatakane)		
Male kids (inkunzi ezingamatakane)		
Adult non breeding female (ithokazi elidala)		
Adult breeding female (imazi)		
Adult non breeding males (inkunzi engakasebenzi)		
Adult breeding males (inkunzi esebenzayo)		