Sheep production and reproduction in a communal environment of the Eastern Cape Province

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Abstract

The study was conducted in Gwaba village, Buffalo City Metropolitan Municipality, Eastern Cape Province. The study provides information that can be utilized to track change over time with respect to the livelihood status, livestock asset ownership and the production and reproduction profile of a communal sheep flock. Results from a structured farmer livelihood and agricultural productivity questionnaire indicated that the sheep owners are reasonably educated but old. They list farming enterprises as their main source of income. Animals are managed as one flock and an autumn mating season is followed. Theft is a concern forcing them to kraal their animals at night. Their biggest constraints are veld and animal production management followed by financial aspects and infrastructure needs. Four of the owners own more than 47% of the sheep in the communal flock. Animal production and reproduction status were recorded bi-annually. The 3 to 4 year old ewes were heaviest with average weight of 38.0 ± 6.4 kg in winter and 33.1 ± 3.8 kg in summer. Female animals experienced weight loss during the winter and weight gain during the summer months. Estimated annual pregnancy percentage was high at 86.5% in the first season, however declined to 64% the following season. Average ewe milk solid composition was 4.45%, 4.83% and 8.74% for protein, lactose and fat respectively. The amount of greasy wool marketed through the formal market increased and improved classing techniques improved the total income annually over the study period.

Keywords: small scale, livelihood, husbandry, productivity, reproduction status, body weight, wool production; milk solids
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Introduction

The Eastern Cape hosts 29% of the country's sheep (National Livestock Statistics, 2019). This represents 6.5 million sheep of which an estimated 32-40% are found in the developing areas (Statistics South Africa, 2016). These numbers emphasize the fact that sheep production and the promotion thereof should be a high priority (Tapson, 1982; Tapson, 2015). The combination of climatic, topographic and geological features in the Eastern Cape limits crop production (Scholtz *et al.*, 2008). As a result, 90% of the province consists of rangeland used for communal grazing, commercial livestock production, nature conservation and game ranching (De Wet & Van Averbeke, 1995; CSIR, 2004). The developing agricultural livestock sector is faced with a number of serious limitations. These limitations range from inadequate resources, ineffective productions systems and inadequate market access. The efficiency of meat, wool and milk production from communal livestock is estimated to be only a quarter of that in commercial farming due to low levels of nutrition and management in communal grazing areas (Bembridge & Tapson, 1993). There are an estimated 100,000 small-scale wool producers in the former Ciskei/Transkei area of the Eastern Cape of which 1224 wool growers are grouped into wool growers associations, with access to shearing sheds (CAPEWOOLS S.A., 2007). In many rural communities, livestock is often the only asset of the poor who is furthermore highly vulnerable to climate variability and extremes.

The study aims to contribute to baseline information that places the households at the centre of inter-related impacts that affect how households create a livelihood for themselves. The purpose of baseline studies is, firstly, to help livestock owners identify what they need to change to improve their livestock's performance. Secondly, it should provide a model or principles to guide the implementation of practices and bridge the gap between goals and aspirations (Jack & Boone, 2012). Livestock development, without formal planning and

unassisted by organized development efforts, has in the past largely resulted in the numeric expansion of traditional systems without any productivity improvement (Jahnke, 1982).

The study seeks to provide information that can be utilized to track change over time with respect to livelihood and gender indicators, agricultural production and changes made in sheep farming practices over time (adaptation/innovation). The specific objectives of the study are to determine the livestock asset ownership and the production and reproduction profile of a communal sheep flock.

Materials and Methods

The study was conducted in Gwaba village, Buffalo City Metropolitan Municipality, Eastern Cape Province.

Initially, baseline information on livestock owners were collected regarding livestock owner demographics, livelihood status and general livestock husbandry practises using a structured farmer livelihood and agricultural productivity questionnaire. These questionnaires were administered on an individual basis. The study was completed over a 3 year period from 2014 to 2016 (2014 Winter1, 2014/2015 Summer1, 2015 Winter2 and 2015/2016 Summer2). Animals were kept on Eastern Cape Thornveld and False Thornveld (Acocks, 1988). Each animal was identified individually and the owner name, the gender and estimated age of the animal recorded. The approximate age of animals were determined by inspecting their incisor teeth. The reproduction statuses of all post pubertal females were assessed by using a real-time ultrasound scan. The sheep owners were consulted to establish an inventory of the facilities and resources available to them and a veld assessment of the grazing resources was completed by assessing the basil cover material (grass) on site considering species composition and standing hay material.

Thereafter, animals were observed bi-annually to record information regarding production and reproduction statuses. Any births were recorded together with the identity of the dam. Similarly, any deaths were recorded and all animals weighed. Although data was recorded on individual animals, reporting is done on a total communal flock basis. The total sample size observed varied from 138 to 562 sheep representing 15 sheep owners and 1367 weights measured over the study period.

Milk samples were collected from lactating ewes with lambs from different age groups, during June and July of 2016. The lamb age groups were one (born during June), two (born during May) or three (born during April) months old lambs. During the June sampling there were few ewes suckling three month old lambs and ewe milk sample collection quantity was small, resulting in a pooled milk sample available for analysis. During July there were no ewes suckling 1 month old lambs, indicating that lambing was completed by June 2016. Milk samples were analysed after heating to 40ºC using the Milko Scan 104 (Foss Electric) to determine the milk solid composition. The Milko Scan 104 was calibrated using store bought full cream UHT dairy milk.

Data was statistically analysed with StatSoft, Inc. (2013) using Restricted Maximum Likelihood (REML) stepwise regression and variance component estimation models.

Wool production data was obtained from the annual wool sale account issued by the broker.

Results and Discussion

The Gwaba community has fair internal organizational structures within the community. Livestock owners expressed willingness to participate and they understood the objectives of the study. There was access to cattle handling facilities in the form of a dipping race. There are however no camps and water access in drier months can be limited.

Data on veld condition was collected from three surveys done in separate areas on the communal grazing area. The average carrying capacity, for the specific veld types, was 5.73 Ha/LSU under ideal conditions. However, the veld surveys in the grazing area show poorer carrying capacity figures with an average veld condition score of 43.89%.

The results from the livelihood and agricultural productivity questionnaire are presented in Figures 1 to 6. Figures 1 to 3 depicts results from the questions related to demography and livelihood. Figure 1 shows the age distribution per gender of the livestock owners where Figure 2 indicates the literacy level per age group. Lastly, Figure 3 indicates the income source of the livestock owners.

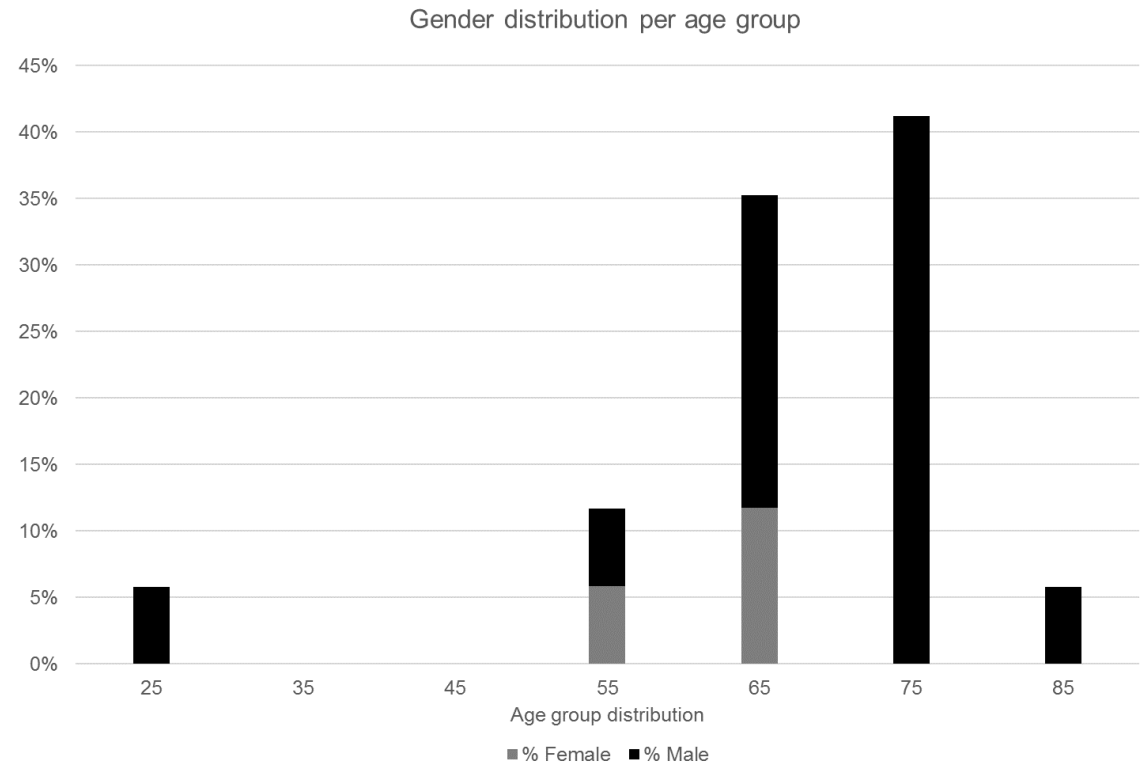

Figure 1 The gender distribution per age group of livestock owners from Gwaba village

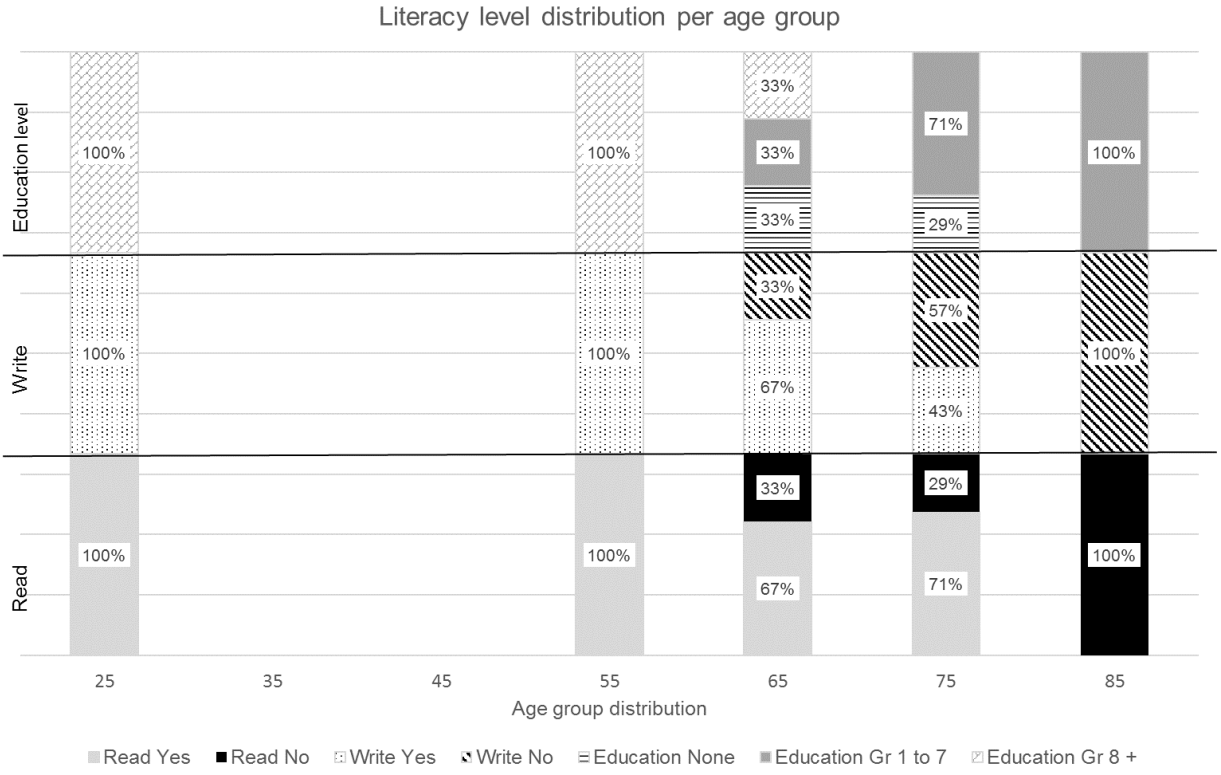

Figure 2 The literacy level distribution per age of livestock owners from Gwaba village

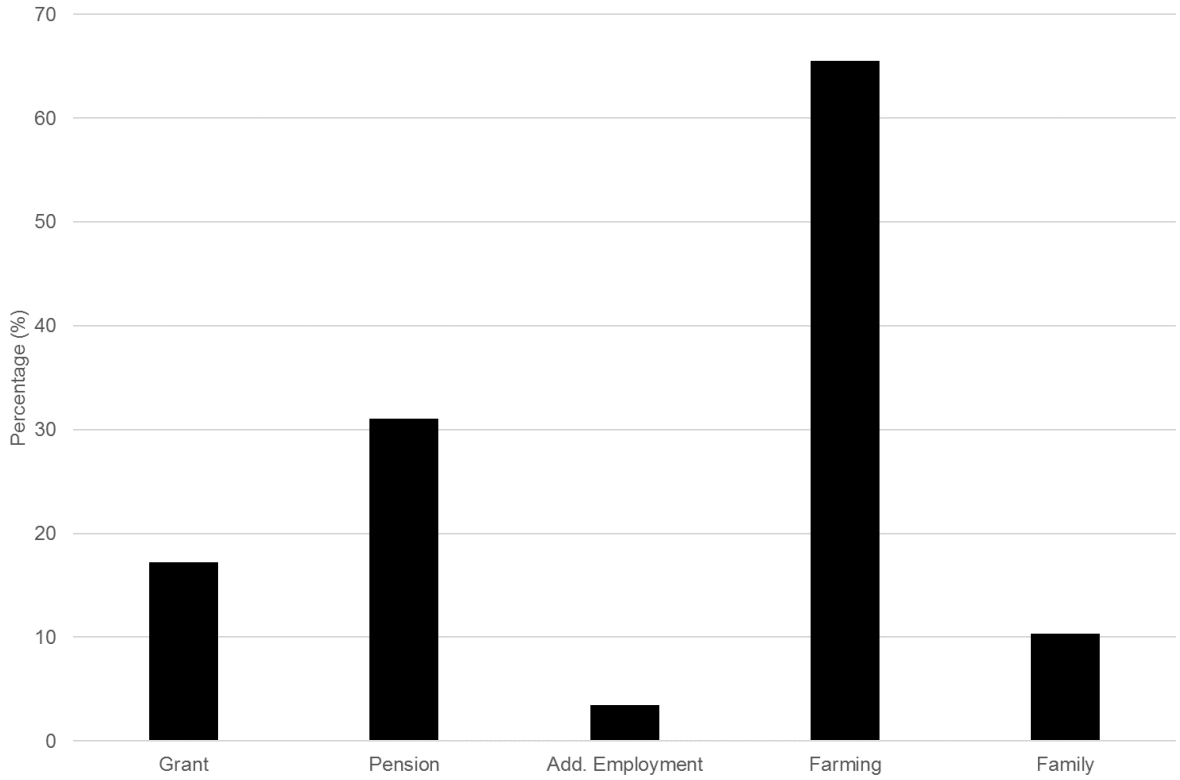

Figure 3 The distribution of the income sources of livestock owners from Gwaba village

The livestock owners are older and are mostly in the 56 to 75 year age range (Figure 1). Female livestock owners represent only 17.6% of the livestock owners and are in the 46 and 65 age groups. This is in agreement with studies done by Ainslie (2002) and Marandure (2015). Most livestock owners indicated that they can read and write and 41.2% completed schooling at a tertiary level. This is in agreement with the findings of Marandure (2015) and Molefi (2015) but much higher than the 10% reported by Ainslie (2002) for the Pedie district. However, the level of education reduced as the age of the livestock owners increased (Figure 2). All livestock owners participating in the questionnaire older than 75 years did not have any formal schooling and indicated that they cannot read or write. The livelihood and agricultural productivity questionnaire responses indicate that the nature of farming for most of the communal livestock owners participating in the study is subsistence level in order to support their household. Farming is the main source of income (65.5%) for sheep owners followed by pensions (31%) (Figure 3). This differs from the findings in Mpumalanga of Molefi (2015) who recorded that approximately 48% of the respondents relied on pension income, while 28.5% reported that the main source of income in their households came from a combination of livestock production and pension.

Figures 4 and 5 highlight the livestock owner's perceptions on sheep husbandry and productivity. A large percentage (67%) of the sheep owners in Gwaba rank sheep farming as the second most important priority after beef production. Figure 4 depicts general husbandry practises regarding sheep farming with regards to where they obtain mating rams, mating seasons, where they keep their rams and the reasons why they kraal their animals at night. Lastly, Figure 5 depicts the perception of the most common livestock diseases owners experience arranged in decreasing order of importance.

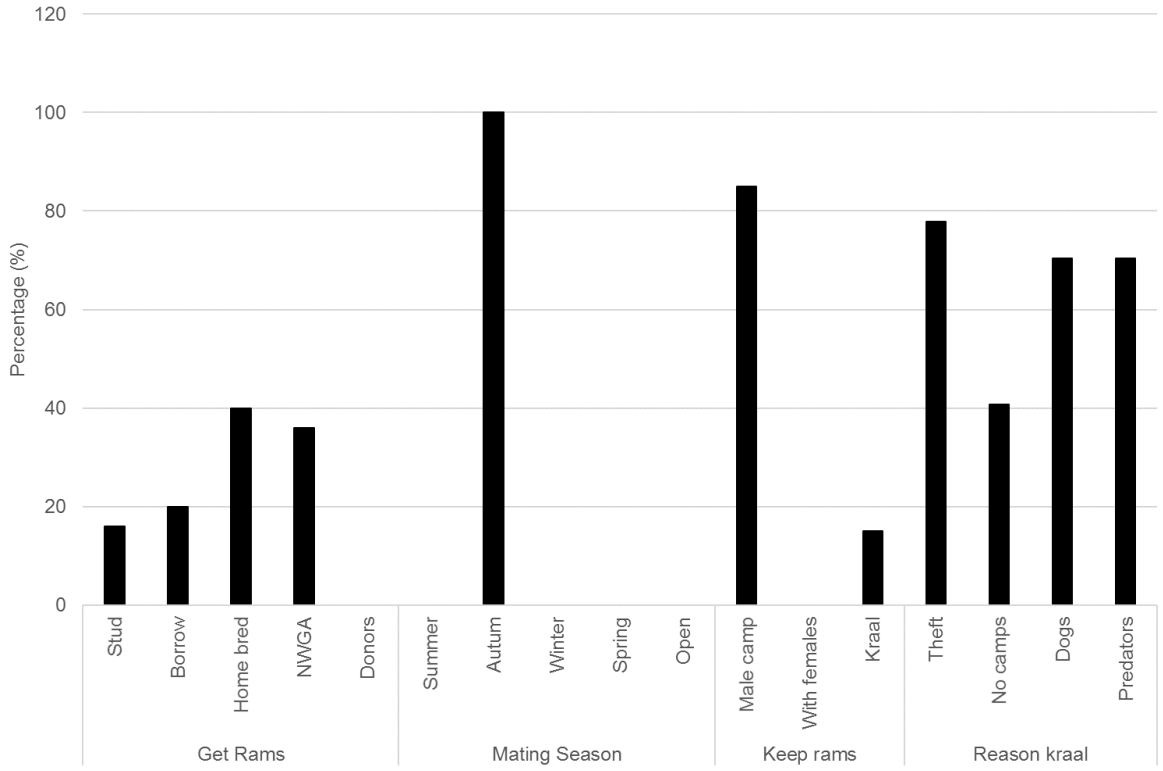

Figure 4 General husbandry practises of sheep owners from Gwaba village

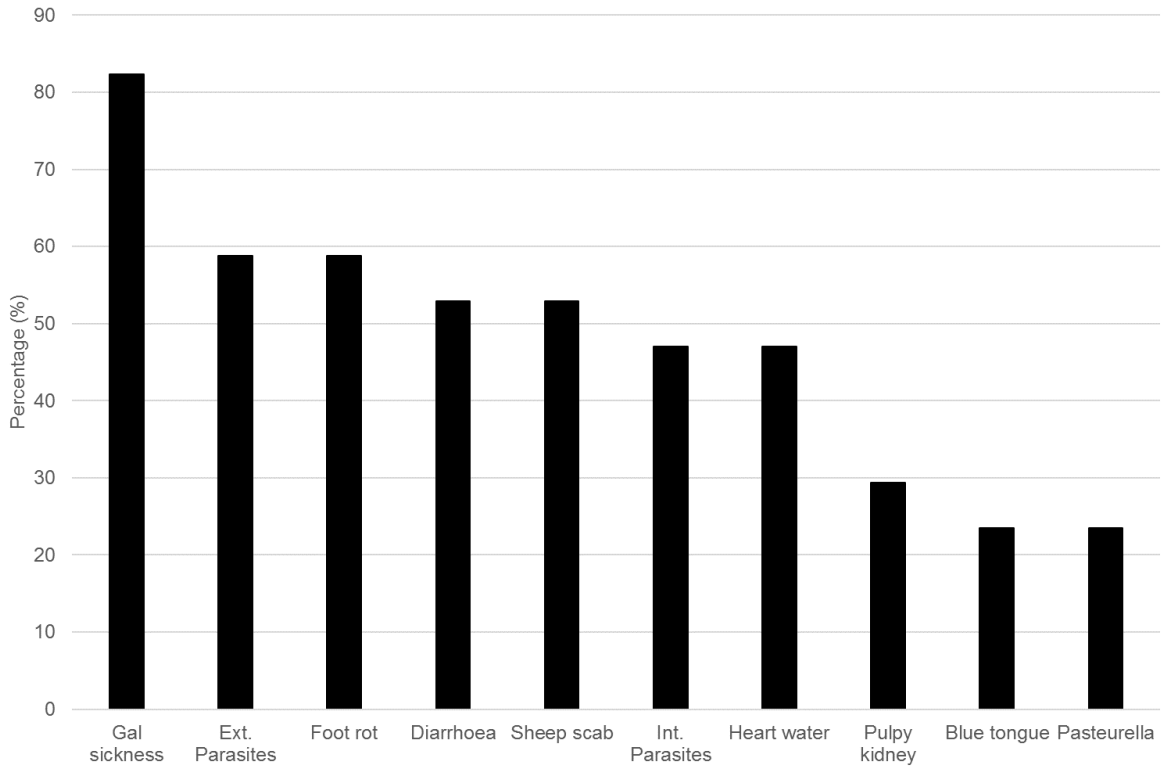

Figure 5 The distribution of most important diseases the livestock owners experience ranked in order of importance

Rams for mating are obtained through the NWGA ram scheme (59%) or are homebred (29%). Rams are, for the most part, kept with the females. Mating is observed during autumn. Animals are kraaled at night to prevent stock theft (71%) or losses due to dogs and predators (Figure 4). The livestock owners indicated diseases they experience problems with as gal sickness (82%), external parasites (59%), foot rot (59%) and diarrhoea (53%). Mapiye *et al*. (2009) found tick-borne diseases to be one of the greatest limitations to livestock productivity in rural areas.

Lastly, Figure 6 depicts the most important constraints as indicated by livestock owners, in decreasing order of importance, as indicated by the livestock owners.

The biggest constrains livestock owners experience are veld management (77%), followed by production aspects (71%), financial issues (59%) and poor infrastructure (59%).

Supplementary to the questionnaire, sheep owners were questioned on the use of preventative disease treatment, supplementary feeding and marketing of their wool and meat. If animals get sick, the livestock owners treat them, but do not always take preventative steps. Only one of the livestock owners indicated that he provide extra feed for his animals during the winter months. Most livestock owners indicated that they market their wool through the formal wool market (88%) but market meat in the informal market. Tapson (1982) estimates off-take of livestock in the former Transkei area as 5.4 % and Bembridge, (1987) estimated it slightly higher at around 6.8 %.

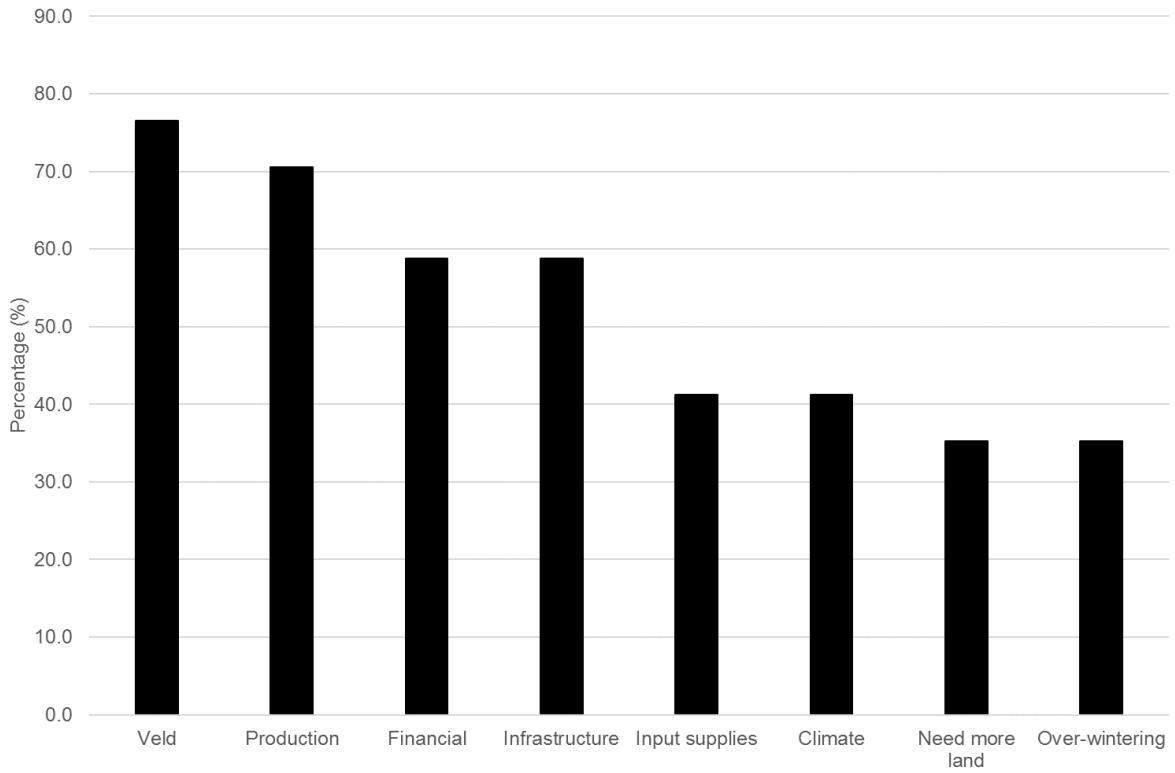

Figure 6 The most important constraints raked by owners in order of importance

Enthusiasm to participate in the trial declined over time. This is similar to the results obtained by Rust *et al.*, 2015. The average owner flock size was 21.3 ewes and the numbers varied between 49 and 7 ewes per owner. This is in agreement with flock sizes observed by Rust *et al*., 2015. Recorded data is presented in Tables 1 to 4. Table 1 gives the number of female and male animals (including castrates) per age group as well as expressed as a percentage of the total flock size.

Table 1 Number of sheep per estimated age group

	Estimated age group (years)						
	< 1	1	2	3	4 and < 7	7 and older	Total
Recording period	Number of female sheep (% of total flock)						
Winter1	117(21)	98(17)	31(6)	48(9)	92(16)	32(6)	418(74)
Summer1	35(9)	76(20)	19(5)	29(8)	114(30)	22(5)	295(79)
Winter2	17(5)	33(10)	68(21)	24(8)	85(27)	18(6)	245(77)
Summer2	0	0	20(14)	37(27)	61(44)	3(2)	124(90)
	Number of male sheep (% of total flock)						
Winter1	74(13)	61(11)	5(1)	1(0.1)	3(0.5)	0	144(26)
Summer1	19(5)	45(12)	8(2)	4(1)	4(1)	0	80(21)
Winter2	12(4)	18(6)	38(12)	3(1)	2(1)	0	73(23)
Summer2	0	0	10(7)	3(2)	1(0.7)	0	14(10)

The average number of sheep owned by each owner varies significantly with the average 32±15.3 sheep. Four of the owners own more than 47% of the sheep in the communal flock. This is similar to results observed by Rust *et al.*, 2015 where almost 50% of the farmers owned less than 5% of the animals representing ownership of less than 20 sheep with 24% owners owning less than 10 sheep. Bembridge (1984) found that 76% of farmers owned less than 20 and 50% less than 10 sheep. This indicates that the nature of farming for most of the communal farmers participating in the study is substance level farming in order to support their household.

The flock structure observed is more or less consistent with the females on average making up 78 % of the adult flock. However, 31% of the females in the flock are older than 4 years with 5% ewes older than 7 years. Furthermore, the number of ewes born decline rapidly from the 1 year (15% of total flock) to 3 year age group (9.9% of total flock). This in agreement with the results of Rust *et al.* (2015) in a study done in the Ngqolowa community of the Eastern Cape Province. Lam mortalities were high and estimated at 35 to 40%. This corresponds with the findings of Bembridge (1984), Steyn (1982) and Rust *et al.* (2015) that found high lamb mortalities in the communal farming system.

Due to the high lamb mortality rates, milk samples were collected to establish the quality of the milk produced by lactating ewes. The results are presented in Figure 7.

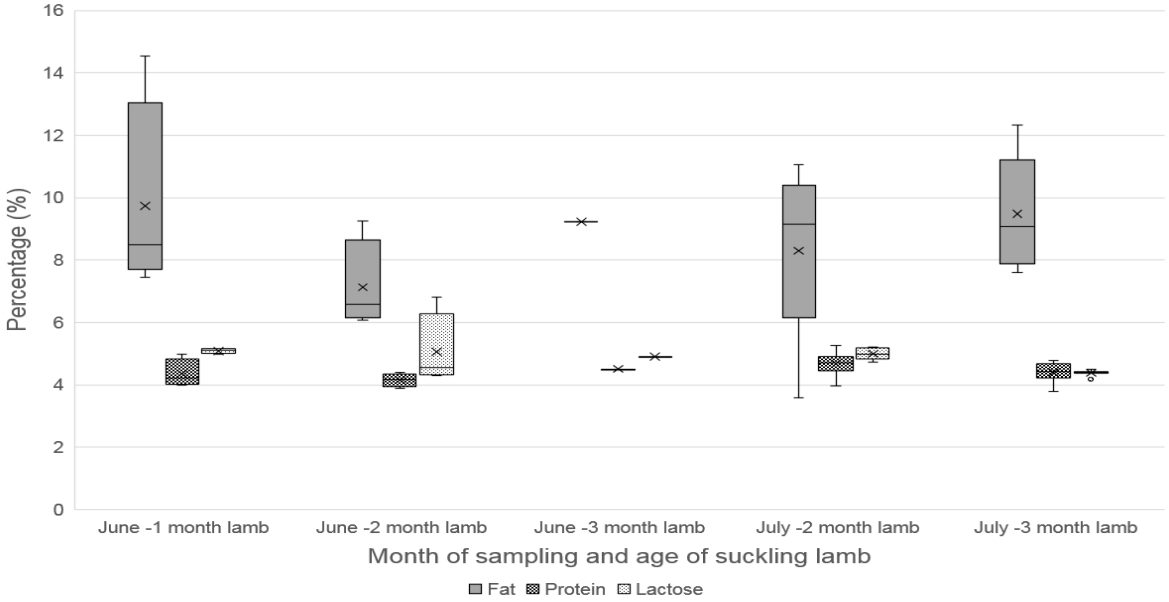

Figure 7 Milk solid percentages. Samples collected from ewes in different months sucking lambs of different age groups

When considering the standard deviations, the variation measured for both protein percentage (3.78% vs. 5.26%) and lactose percentage (4.37% vs. 6.82%) was small over all lamb age groups. Fat percentage showed variation of a high of 14.5% to a low of 3.6%. Most of the variation (11.1% vs. 3.6%) was observed for ewes suckling two month old lambs. However, there was no significant difference ($P<0.05$) between the fat percentages for different age groups or months measured. The milk solid percentages observed in communal sheep are in line with the percentages observed in commercial sheep as reported by Torres-Hernandez & Hohenboken, 1979; Wohlt *et al.*, 1981; Bencini & Purvis, 1990; Merlin Junior, 2015.

The average weight per age group and gender, over all the seasons are presented in Table 2. Castrates are included in the male group.

Table 2 Average weight of female and male sheep per age, as measured in the respective seasons

	Winter1	**Summer1**	**Winter2**	**Summer2**
Age (yr)		**Weight ± SD (kg)**		
Female				
<1	7.3 ± 3.1	17.2 ± 3.0	*	*
1	29.7 ± 5.8	29.8 ± 4.9	28.0 ± 3.2	*
2	38.8 ± 5.0	32.1 ± 4.0	36.7 ± 4. 5	29.6 ± 4.7
3	39.0 ± 5.2	33.8 ± 3.6	39.6 ± 5.0	31.6 ± 3.8
4-6	37.7 ± 6.3	33.4 ± 3.9	38.9 ± 6.7	32.0 ± 3.5
7+	35.1 ± 5.8	32.2 ± 5.1	38.1 ± 5.4	32.3 ± 2.0
Male/ Castrate				
<1	7.5 ± 2.5	16.5 ± 3.5	*	*
1	31.8 ± 7.5	31.0 ± 6.1	29.3 ± 4.0	*
2	52.4 ± 10.7	43.8 ± 6.6	39.0 ± 7.5	36.6 ± 7.2
3	*	56.0 ± 12.1	Na	*
4-6	*	48.9 ± 8.8	Na	*
7+	Na	Na	Na	Na

*Too few animals represented in age group

The estimated ADG (average daily gain) for the adult ewes were calculated by pooling the winter and summer weights for the respective age groups. The average grams gained or lost between recording dates were used to estimate the average ADG (Table 3).

Table 3 Pooled estimated ADG (kg gained/days observed) for adult ewes per age group

	Age (years)	ADG (g)
Winter to Summer	1	0.0
	2	-38.66
	3	-36.55
	4-6	-30.93
	7+	-24.15
Summer to Winter	1	-9.85
	2	25.89
	3	32.06
	4-6	30.33
	7+	32.58

The average weight of both female and male animals increased with age, however the weights of females begin to decline at the age of 4 years. The weight of young females is comparable to their male contemporaries up to the age of 1 years when the females begin to reproduce. The average weight of an adult productive ewe is 38.0 ± 6.4 kg in winter and 33.1 ± 3.8 kg in summer. The male animal numbers were small and too few to calculate weight averages in most instances (see Table 1).

All adult female age groups lost weight from winter to summer. The adult females lose on average 30.93g per day during the winter months and gain on average 30.33g per day during the summer months. Young two-toothed ewes showed no weight gain in their first year after replacing their milk teeth with

permanent teeth. The number of weights recorded for adult male/castrates were small (Table 1) and average ADG was not calculated for them.

The reproduction status of the female flock as determined from the real-time ultrasound scans are presented in Table 4. Observations recorded were: Pregnant (P) and Not Pregnant (NP). Real time ultrasound scans during the winter seasons (May 2014, Winter1 and May 2015, Winter2) indicated a pregnancy percentage of 86.5% and 60.6%, with ewes on average being 3.2 and 3.1 months pregnant, respectively. Additional reproduction status observations were done during August 2015 to verify the results recorded during May 2016.

Table 4 Reproduction status for ewes observed using real-time ultrasound scans

Season	Pregnant (P)	Average gestation, Months ± SD	Not Pregnant (NP)	Pregnancy %
Winter1	148	3.2 ± 0.8	23	86.5%
Summer1	10	1.5 ± 1.0	229	4.2%
Winter2	63	3.1 ± 0.7	41	60.6%
*Add. scan August 2015	93	3.7 ± 0.4	51	64.6%
Summer2	2	1.0	108	1.8%

The stepwise regression analysis indicated that the fixed effect of season of observation had the largest significant effect ($P<0.05$) on pregnancy status, followed by year of observation ($P<0.05$) and age of the ewe at observation ($P<0.05$). The REML variance component analysis indicated a significant interaction ($P<0.05$) between fixed effects season and year of observation. The month of real-time ultrasound scan had a significant effect ($P<0.05$) on gestation stage. When considering data recorded during May, year of observation and ewe weight at observation significantly ($P<0.05$) explained the variation in gestation stage. Age classes 2 and 3 years old both differed significantly ($P<0.05$) for gestation stage from age class 5 years and older.

Wool sheared annually in Gwaba village are sold in the formal wool market and auctioned through a wool broker. The results of the wool sales for the study period are presented in Table 5 and Figure 8 gives a breakdown of the weight of the different producer lot classes presented at the annual wool auction.

Over the study period the number of producer lot bales increased while the bin bales stayed constant. In the second year classing improved and AA wool was classed separately, influencing the total income.

Table 5 Formal wool production in Gwaba village in years 2014–2016

Year	**2014**	**2015**	**2016**
Producer lots (number)	11	20	22
Binned bales (number)	5	6	6
Bags	3		
Kg greasy producer lots	1729.6kg	2747.3kg	3787.8kg
Kg greasy bin lots	934.2kg	634kg	716.5kg
R value producer lots	R80 445.39	R221 869.50	R263 209.00
R value bins bags	R18 587.11	R19 319.26	R29 614.96
Total Income	R99 405.48	R241 784.50	R293 410.20

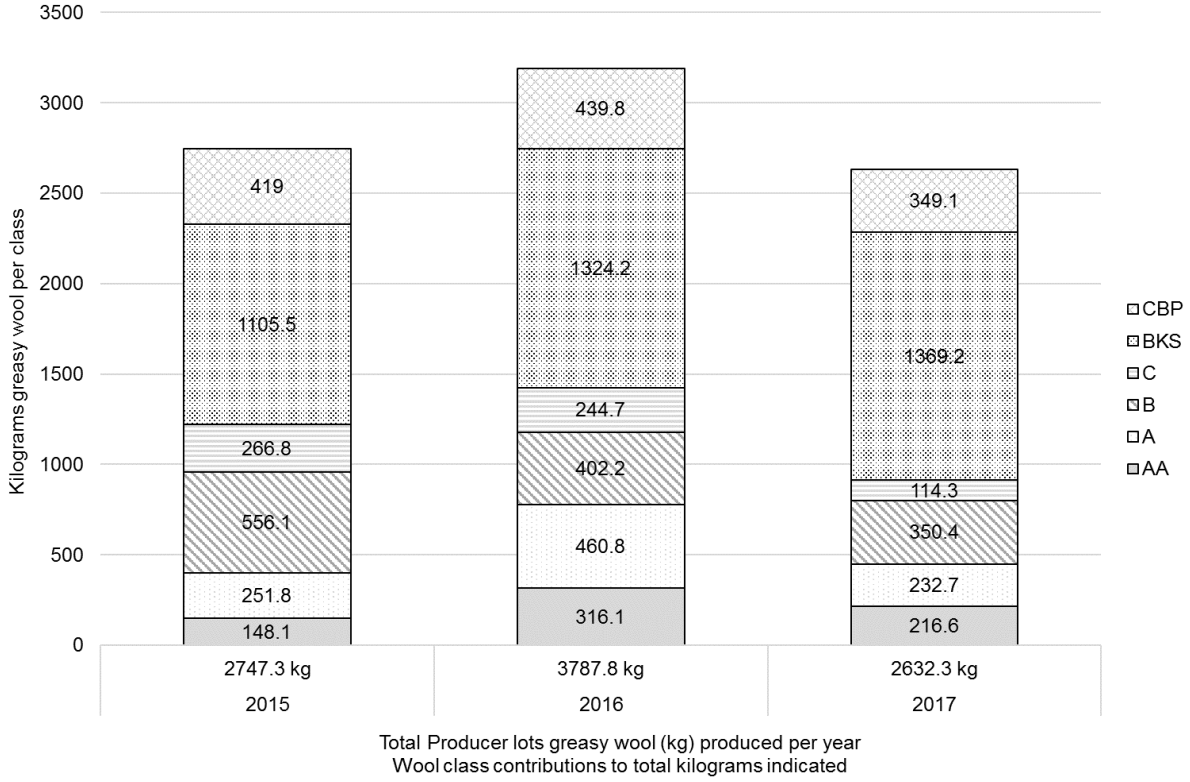

Figure 8 Greasy wool production (kg) of the different producer lot classes presented at the annual wool auction

The amount of greasy wool marketed through the formal market increased with a 1 000kg annually. This, together with improved classing techniques as seen by the increase in the kilograms classed as AA and A, improved the total income annually.

Conclusions

It must be noted that the measurements and observations were recorded in a communal environment under semi-controlled conditions. The livestock owners had complete authority regarding the management of their animals. Livestock owners were not prescribed to, and continued for the duration of the study, to follow their own preferred animal husbandry system. Exact measurements and observations in such circumstances are difficult to obtain. Many of the conclusions made are based on probabilities.

From the livelihood and agricultural productivity questionnaire, it is clear that the livestock owners are reasonably educated but are old. They list their main income source as farming enterprises and pension. Animals are kept as one flock and an autumn mating season is followed. Theft is a concern, forcing them to kraal their animals at night. Their biggest constraint is veld management followed by production aspects. It is clear that the livestock owners over utilize the grazing resource. Extensive restoration of old lands is necessary to improve the productivity of the communal farming area.

Most of the ewes, (86.5 % in winter 1 and 60.6% in winter 2) were on average 3.2 (winter 1) and 3.1 (winter 2) months into their gestation. At this stage in gestation ewes are expected to gain 6 – 7 % in weight due to foetal weight plus placenta (Rattray, 1974; McCann, 2002). At this stage of gestation ewes are expected to weigh approximately 2 kg heavier in winter compared to their summer weight. Gestation stage can to some extent explain the higher weights as well as the larger standard deviation recorded in winter. However, improved veld conditions after the summer rains and into early autumn, is probably the main reason why the ewes in this study were on average 5 kg heavier in winter compared to summer.

The average weight of both female and male animals increased with age. Females are at their heaviest at ages 2 to 4 years old after which they slowly start losing weight as they grow older and struggle to eat efficiently due to teeth wear. Pregnancy percentage was high, with ewes lambing during the winter months. There is a clear trend that the ewes lose weight from winter to summer and then gain weight in late summer

when the veld condition is good after the summer rains. Estimated lambing percentage is high and season of observation had the largest significant effect ($P<0.05$) on pregnancy status. Year of observation and ewe weight at observation significantly ($P<0.05$) explained the variation in gestation stage. Lamb mortality is estimated at 35 - 40%. The quality of ewe milk just after, and up to three months after lambing, is adequate and agrees with what is reported in the literature. It is hypothesised that the high mortality rates measured in communal flocks are not necessarily due to the quality of the milk the ewes produce and investigations should be extended to investigate the quantity of milk produced. Furthermore, the effect of the low nutritional level of ewes during pregnancy as well as the occurrence of diseases on the mortality of lambs, should be investigated.

The amount of greasy wool marketed through the formal market increased and improved classing techniques over the study period improved the income from wool.

Due to the nature of the trial and the unpredictability of communal livestock husbandry practises, the results cannot explicitly represent the situation as far as sheep production is concerned. However, it is a good indicator of the trends to be expected regarding sheep production in a typical communal farming setup.

Author contributions

Conception: TR and JMR; Design: TR; Data collection and analysis: TR and JMR; Milk analysis: AMR, Data collection: NSN, CHDR, NAF, SM and MM; Critical revision: JMR; Critical revision and final approval of version to be published: all authors.

References

Acocks, J.P.H., 1988. Veld Types of South Africa. Memoirs of the Botanical Survey of South Africa, 57. SANBI, Pretoria.

Ainslie, A., Kepe, T., Ntsebeza, L., Ntshona, Z. & Turner, S., 2002. Cattle ownership and production in the communal areas of the Eastern Cape, South Africa. Programme for Land and Agrarian Studies, Research Report 10, School of Government, University of the Western Cape.

Bembridge, T.J., 1984. A systems approach study of Agricultural Development problems in Transkei. PhD dissertation, University of Stellenbosch.

Bembridge, T., 1987. Aspects of cattle production in Transkei. S. Afr. J. Anim. Sci., 17 (2), 74-78.

Bembridge, T & Tapson, D., 1993. Communal livestock systems. In: Livestock Production Systems – Principles and Practice. Eds. Maree, C. and Casey N.H., Agri-Development Foundation, Brooklyn, Pretoria. pp. 361-373.

Bencini, R. & Purvis, I.W., 1990. The yield and composition of milk from Merino sheep. 18th Biennial Conference of the Australian Society of Animal Products, 1990, 18. Wool Technol. Sheep Breeding. June/July 1990. 71–73.

CAPEWOOLS SA., 2007. Regional Analysis of Wool Production in Southern Africa 1999/00. CAPE WOOLS SA, Port Elizabeth, South Africa.

CSIR, 2004. Eastern Cape state of the environment report. CSIR, Division of water, environment and forestry technology. Durban, South Africa. Available at: http:/www.environment.gov.za/soer/ecpae/Download_report.htm.

De Wet, C. & Van Averbeke, W. (eds), 1995. Regional overview of land reform related issues in the Eastern Cape province. ARDRI/BRC/ISER, University of Fort Hare, Alice and Rhodes University, Grahamstown.

DAFF, 2018. Abstract of Agricultural Statistics. Department of Agriculture, Forestry and Fisheries. Resource Centre Directorate: Knowledge and Information Management, Private Bag X144, PRETORIA, 0001.

Jack, L. & Boone, J., 2012. Chapter 1: Sustainable Change and Benchmarking in the Food Supply Chain In: Benchmarking in Food and Farming. Creating Sustainable Change. Gower Publishing, Ltd., 28 Sep 2012.

Jahnke, H.E., 1982. Livestock production systems and livestock development in Tropical Africa. Kieler Wissenschafsverlag Vauk.

Mapiye, C., Chimonyo, M., Dzama, K., Raats, J.G. & Mapekula, M., 2009. Opportunities for improving Nguni cattle production in the smallholder farming systems of South Africa. Livest. Sci. 124: 196-204.

Marandure, T, 2015. Sustainability of smallholder cattle production and its vertical integration into the formal beef market value chain in South Africa. Master of Science in Sustainable Agriculture at Stellenbosch University, 2015.

Mccann, M.A., 2002. Body Condition Scoring Ewes and Late Gestation. Animal and Poultry Sciences, Virginia Tech. https://www.apsc.vt.edu › dam › sheep › programs › shepherds-symposium.

Merlin Junior, I.A., Dos Santos, J.S. Costa, L.G., Costa, R.G, Ludovico, A., De Almeida Rego, F.C. & De Santana, E.H.W., 2015. Sheep milk: Physical-chemical characteristics and microbiological quality. Abstract. Arch. Latinoam. Nutr., Vol. 65 (3), 193–198.

Molefi S.H., 2015. Utilization and management of beef cattle farming as a contributor to income of households in communal areas of Chief Albert Luthuli Local Municipality in Mpumalanga Province. Master of Science, University of South Africa, 2015.

National Livestock Statistics (NLS), 2019. National Department of Agriculture, Pretoria, South Africa.

Rattray, P.V., Garrett, W.N., East, N.E. & Hinman, N., 1974. Growth, development and composition of ovine conceptus and mammary gland during pregnancy. J. Anim. Sci., 38(3), 613-626.

Rust, T., Goosen, W.J. & Mbatha, Z., 2015. Characterization of production outputs and ewe flock structure of communal wool sheep in Ngqolowa, Eastern Cape. Appl. Anim. Husb. Rural Develop. 8, 6-18: www.sasas.co.za/aahrd/.

Scholtz, M.M., Bester, J., Mamabolo, J.M., & Ramsay, K.A., 2008. Results of the national cattle survey undertaken in South Africa, with emphasis on beef. Appl. Anim. Husb. Rural Develop., 1: 1-9. Accessed on 18 December 2014.

Statistics South Africa, 2016. Community Survey 2016 Agricultural households, Statistics South Africa, Pretoria, Private Bag X44, Pretoria, 0001. Report no. 03-01-05

StatSoft, Inc. (2013). Hill, T. & Lewicki, P., 2007. STATISTICS: Methods and Applications. StatSoft, Tulsa, OK.

Steyn, G.J., 1982. Livestock production in the Amatola basin. MSc. Dissertation, University of Fort Hare.

Tapson, D., 1982. Population dynamics in the Transkei cattle herd and implications for production. University of Fort Hare, Alice: Agriculture and Rural Development Research Institute (ARDRI).

Tapson, D., 2015. National Wool Growers Association Support Programme: 2015 survey. 34a Pickering Street, Port Elizabeth.

Torres-Hernandez, G. & Hohenboken, W., 1979. Genetic and environmental effects on milk production, milk composition and mastitis incidence in crossbred ewes. J. Anim. Sci., Vol. 49, (2), 410–417.

Wohlt, J.E., Kleyn, D.H., Vandernoot, G.W. & Selfridge, D.J., 1981. Effect of Stage of Lactation, Age of Ewe, Sibling Status, and Sex of Lamb on Gross and Minor Constituents of Dorset Ewe Milk. J. Dairy Sci., 64, 2175-2184.