academicJournals

Vol. 8(26), pp. 1226-1238, 11 July, 2013
DOI 10.5897/SRE2013.1872
ISSN 1992-2248 © 2013 Academic Journals
http://www.academicjournals.org/SRE

Scientific Research and Essays

Full Length Research Paper

Characterization of Zulu sheep production system: Implications for conservation and improvement

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Accepted 25 June, 2013

Understanding the production environment under which Zulu sheep are raised is essential in strategizing the breed's conservation and improvement programme. Ninety-six farmers across 11 rural areas of KwaZulu-Natal, South Africa, were interviewed using structured questionnaires to describe traditional Zulu sheep production system, evaluate its sustainability and identify some constraints limiting production. Sheep were the least owned livestock species amongst interviewed farmers after cattle and goats. Farmers began sheep production with sample stock of fewer than four animals, either bought from other farmers or inherited through patrilineality. Sheep flock sizes were 39.8±7.5 (±SD) on average, with each flock constituting of 3.12±0.31 rams, 21.81±5.61 ewes, 4.98±0.87 yearlings and 9.92±2.05 lambs. About 43.7% of the flocks interacted with 2 or fewer neighbouring flocks during grazing time. Rate of flock size decrease was estimated at 7.4% in the past 5 years. Drought and diseases were identified as leading causes of sheep loss. Methods to controlling external and gastro-intestinal parasites were only practised when sheep showed a need. Zulu sheep were used mainly as a source of meat, income and manure and were preferred over their exotic counterparts because they were regarded tolerant to diseases and drought and for their tasty meat. The information obtained in this study is crucial in planning suitable conservation, improvement and extension programs for the breed.

Key words: Production environment, animal genetic resources, socio-economic, production systems.

INTRODUCTION

Zulu sheep are a type of Nguni breed found with the communal people of KwaZulu Natal, South Africa. They primarily serve as a source of meat and income to the poor rural farmers, at the same time providing a source of livelihood and means of utilising marginal environments not suitable for cultivation (Ramsey et al., 2000). Rural farmers recognise Zulu sheep for its high adaptation to the prevalent harsh environmental conditions and the ability to tolerate both external and gastro-intestinal parasites as well as tick-borne diseases. In addition they can walk longer distances and have good foraging ability (Ramsey et al., 2000).

Nevertheless, the existence of the breed is threatened (Kunene et al., 2009). Its place is being taken up by less adapted exotic breeds, either by replacement or crossbreeding (Kunene et al., 2009, Mavule et al., 2013). This change is being driven by the perception, held by most farmers, that indigenous livestock show poorer performance compared to their exotic counterparts. This line of thinking has been receiving political backing over the years in many African countries (Scholtz et al., 2008). Thus breeding programmes put in place in Africa have been geared towards improving this presumed low productive performance through crossbreeding (Köhler-Rollefson, 2001).

Many researchers have however urged that such

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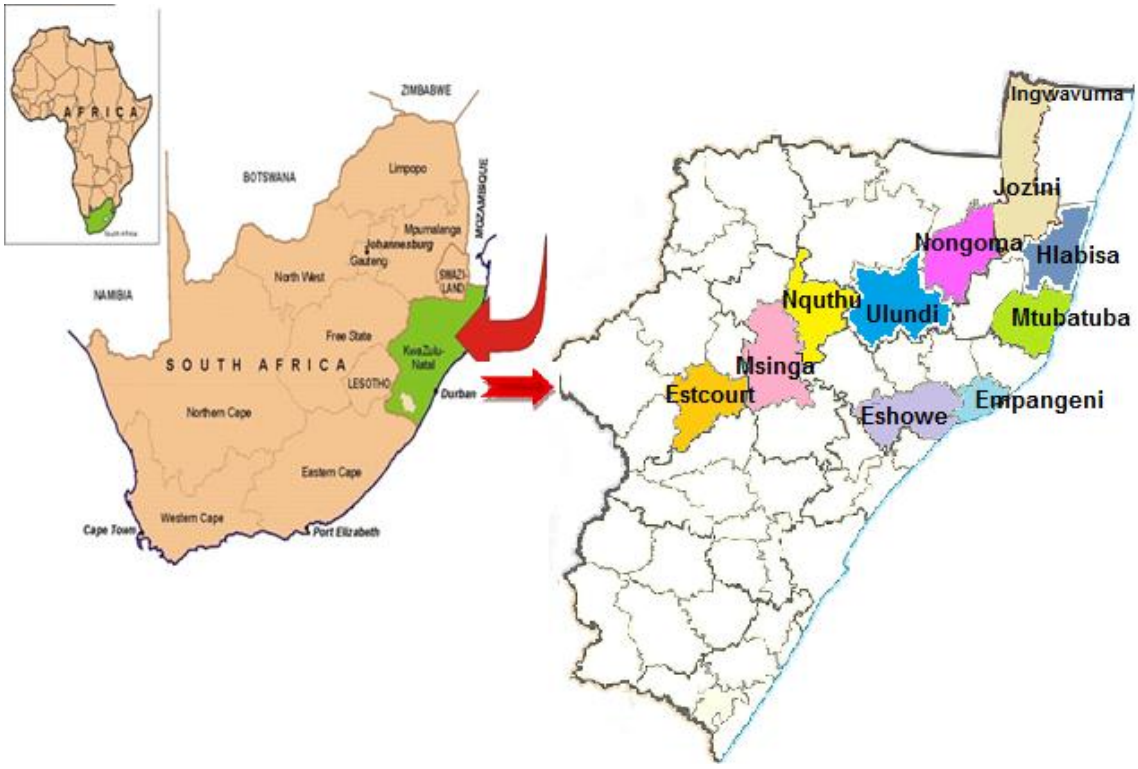

Figure 1. Map illustrating municipality boundaries of KwaZulu-Natal and the rural areas from which the study was conducted.

upgrading efforts are futile due to farmers' inability to meet management requirements for crossbred offspring or their exotic parents since the imported breeds have high feed maintenance requirements (Köhler-Rollefson, 2001; Rege and Lipner, 1992). The predicament makes raising indigenous livestock, by the resource poor rural farmers, advantageous over the exotic ones in that the livestock are adapted to local conditions and will give some level of production even under adverse conditions (FAO, 2007).

Lately farmers and government have begun to realise that high productivity is not necessarily more important than the ability of livestock to survive natural calamities (Köhler-Rollefson, 2001). This has aroused the need to characterise indigenous animal genetic resources (Kosgey et al., 2008; Kunene and Fossey, 2006; Taye et al., 2010). However, many rural farmers no longer possess this valuable heritage that has endured and adapted for hundreds of years. Moreover, production systems are being altered to suit the new upcoming types of breed that require intense care to produce and survive. Consequently knowledge and skills gained over years on the management of indigenous genetic resources is being lost to posterity without characterisation and documentation.

FAO (2012) has indicated that a comprehensive description of the production environment is essential to make use of performance data and to understand the special adaptations of breeds/populations. Understanding the production environment of Zulu sheep would enable a better comparative understanding of the adaptive fitness and performance of the breed. Adaptive fitness of the breed can thus be characterized indirectly by describing the primary variables (criteria) which have affected an animal gene pool (breed) over time, and have probably maximized its adaptive fitness for that environment.

The current study provides a better understanding of the traditional Zulu sheep production system, evaluate its sustainability, and identify some constraints limiting its productivity. This information can be useful for policy makers and extension services in devising strategies to improve the productivity and sustainability of the farming system, more importantly strategizing conservation and improvement programmes of the breed.

MATERIALS AND METHODS

Study area

An on-farm survey was conducted in 11 rural communities of KwaZulu-Natal, South Africa, namely: Empangeni, Eshowe, Hlabisa, Jozini, Ingwavuma, Mtubatuba, Nongoma, Ulundi, Msinga, Nqutu, and Estcourt (Figure 1). The communities occur between latitudes 27° 07' and 29° 00' S and longitudes 29° 52' and 32° 04' E with an altitude range of 90 to 1900 m above sea level and annual rainfall ranging from 600 mm to over 1400 mm.

Table 1. Number of selected households in each area studied in KwaZulu-Natal.

Areas	Number of farmers sampled per area
Empangeni	4
Eshowe	1
Hlabisa	8
Jozini	14
Ingwavuma	2
Mtubatuba	6
Ulundi	10
Nongoma	14
Nqutu	15
Msinga	21
Estcourt	1
Total number of farmers sampled	96

Sampling procedure, Study design and data analysis

The survey was conducted during the period of June to August 2011. Selection of respondents was based on farmers' possession of Zulu sheep and willingness to participate in the study. The Department of Agriculture officials in the selected areas assisted in identification of farmers who still possessed Zulu sheep. Data were collected from 96 households (Table 1) from either the household head or the main caretaker of the sheep. Farmers were interviewed individually at their homesteads. The questions covered aspects on the general household characteristics and livestock ownership, breeding, feeding, housing and marketing. Sheep mortalities on the farms was quantified by collecting retrospective information on the number of sheep owned and the number of deaths in each age and sex category (rams, ewes and lambs) within 12 months before the study. The numbers of households sampled per area are shown in Table 1. Ranking of sheep production objectives and selection creteria for breeding rams given by farmers was done as implemented by Kosgey et al., (2008). All Statistical analysis was carried out using SPSS (SPSS, 2010). Chi-square tests of association were carried out to determine associations of age and gender of farmers with sources of income, sheep ownership and perceptions on conservation of animal genetic resources. The results are presented mainly in the form of descriptive tabular summaries.

RESULTS

Household characteristics

The proportion of male headed households was higher (86.5%) than the proportion of female headed households (13.5%). Fifty four percent of the interviewed farmers were aged between 55 and 80, 32.3% were aged between 35 and 55 and 13.7% were aged between 20 and 35. The greatest proportion (67.4%) of respondents had household sizes within the range of 5 to 10 members, 21.6% had fewer than five members and only 1% had more than sixteen members. A large percentage (60.6%) of farmers identified livestock as their major source of income. However the association between age groups of farmers and the dependence upon livestock as major source of income was not significant (χ^2 (2) = 3.77, p > 0.05). Other sources of income identified apart from livestock production were formal employment (19.4%), government grant (22.6%), pension (18.3%) and self-employment (39.8%).

Livestock ownership patterns

Table 2 shows weighted herd sizes of livestock species. A large proportion (45.3%) of respondents owned less than 10 cattle, 43.0% owned less than 10 goats and 48.5% owned less than 20 sheep. Farmers owning between 41 to 50 sheep were 7.4% of the total number of interviewees. The association between sheep ownership and age category (X^2 (10) = 9.865, P > 0.05) of interviewed farmers was not significant. The overall proportion of farmers that owned sheep as their major livestock species was lower (21.9%) than that of farmers owning cattle (54.2%) or goats (24.0%) as major livestock species. Nqutu was the only area, amongst studied areas, where sheep were identified as the major livestock species. Table 3 shows estimated livestock trends in the past five years (2007 to 2011). Cattles were estimated to have increased by 25.1% in the past five years. Goats and sheep on the other hand decreased by estimates of 3.4 and 7.4%, respectively.

Sheep flock sizes and composition

Sheep flock sizes were 39.8±7.5 on average, with each flock constituting of 3.12±0.31 rams, 21.81±5.61 ewes, 4.98±0.87 yearlings and 9.92±2.05 lambs. Nqutu (110.4±18.4) had the largest average flock size while Mtubatuba (8.0±2.6) had the smallest. Ram to flock ratio was as high as 20% in Eshowe and as low as 2.9% in Estcourt. Ewes constituted the greatest percentage of the flocks. The percentage of mature ewes per flock was

Table 2. Weighted herd sizes of livestock species kept by interviewed Zulu sheep farmers in KwaZulu-Natal.

Livestock	Flock sizes	Number of farmers	Percentage of farmers
Cattle	<10	39	45.3
	11-20	20	23.3
	21-30	11	12.8
	31-40	10	11.6
	41-50	1	1.2
	>50	5	5.8
Goats	<10	37	43.0
	11-20	20	23.3
	21-30	16	18.6
	31-40	5	5.8
	41-50	4	4.7
	>50	4	4.7
Sheep	<10	24	25.3
	11-20	22	23.2
	21-30	20	21.1
	31-40	14	14.7
	41-50	7	7.4
	>50	8	8.4

Table 3. Estimated livestock trends in the past five years (2007 to 2011) in KwaZulu-Natal.

Trend	Number of farmers	Percentage of total farmers	Overall percentage increase
Cattle			
Decrease	22	25.9	25.1
Increase	63	74.1	
Goat			
Decrease	91	95.8	-3.4
Increase	4	4.2	
Sheep			
Decrease	93	96.9	-7.4
Increase	3	3.1	

highest in Nqutu (79.8%), followed by Estcourt (71.4%) and the lowest in Mtubatuba (26.1%). In total the percentage of yearlings (29.2%) was lower than that of mature ewes (59.2%). Lambs constituted 15.7% of the average flock.

Perceptions on conservation of animal genetic resources

Farmers were questioned concerning their awareness to the national call to conserve animal genetic resources (AnGR) and how important they regarded the conservation of these AnGR (Table 4). Also shown in the same table is how farmers valued Zulu sheep and why they preferred them over their exotic counterparts. There was no significant association between Age (χ^2 (6) = 1.520, $p > 0.05$) or gender (χ^2 (5) = 2.343, $p > 0.05$) of farmers and their perceptions on conservation of animal genetic resources.

Uses of Zulu sheep

Table 5 shows the ranking of sheep production objectives given by farmers. Keeping sheep for meat obtained the highest ranking followed by ‘sale’ and then ‘manure’. ‘Skin’ and ‘rituals’ received the lowest ranking.

Table 4. Farmers' perceptions on conservation, importance of animal genetic resources (AnGR) and utilisation of Zulu sheep.

Parameter	Number of farmers	Percentage
Awareness to global call for conservation of AnGR		
No knowledge	37	38.5
Minimal	30	31.3
Average	26	27.1
Well informed	3	3.1
The value of conservation of AnGR		
Not important	10	10.4
Important	70	72.9
Extremely important	16	16.7
The value of Zulu sheep to farmers		
Not important	18	18.8
Important	55	57.3
Extremely important	23	24.0
Reasons for preferring Zulu sheep		
It is tolerant to harsh conditions	58	60.4
It is a Rare breed	28	29.2
It has Tasty meat	9	9.4

Table 5. Importance-ranking of uses of Zulu sheep sheep by rural farmers in KwaZulu-Natal.

Production objectives	Rank 1	Rank 2	Rank 3	Index
Meat	85	8	0	0.537
Sale	11	55	0	0.283
Manure	0	18	50	0.170
Skin	0	0	3	0.006
Rituals	0	0	2	0.005

Housing, feeding and watering of Zulu sheep

Sheep grazed on communal grazing land during the day and were enclosed in kraals in the evening. Ninety-eight percent of the flocks were housed in separate open kraals adjacent to or within the owner's homestead while 2% were kept in sheds. The majority (82.3%) of farmers interviewed released their flocks for grazing between 0730 and 0830 h whilst 17.7% released them between 0900 and 1100 h. The percentage of farmers who released their flocks from 0900 to 1100 h was higher in Ulundi (60.0%) and Nqutu (63.1%). All studied farmers interviewed enclosed their sheep at sunset (between 1700 and 1800 h).

Seventy-six percept of farmers interviewed did not offer supplementary feed to their sheep. Farmers who gave supplements to their sheep used mainly mineral concentrates. Other feed supplements used were beer residues, lucerne and maize grains (Table 6). A greater proportion of the interviewed farmers produced crops (69.8%). Maize was the most common crop produced (89.6%). Vegetables (9.0%) and rye grass (1.5%) were grown by just but a few farmers. Most flocks (65.7%) owned by crop producing households had access to crop residues.

Watering of sheep

The majority of farmers in studied areas sourced water from rivers (68.8%). Dams provided water to 24% of the farmers. Tap water and boreholes were less common sources of water for sheep (6.2 and 1.0%, respectively). Some flocks had water fetched and brought home while others would be driven to or would find their way to the water source. The proportion of flocks which travelled to water sources was higher (91.7%) in summer than in winter (81.3%). Some farmers (18.8%) in winter fetched water and brought it home for their sheep to drink. Incidences of this practice were less frequent in summer

Table 6. Feed supplementation and use of crop as stock feed amongst sheep farmers in KwaZulu-Natal.

Response	Frequency	Valid percent
Type of feed supplements		
Beer residue	3	14.3
Mineral Concentrates	15	71.5
Lucerne	2	9.5
Maize grain	1	4.8
Any form of crop production		
No	29	30.2
Yes	67	69.8
Type of crops produced		
Maize	60	89.6
Ryegrass	1	1.5
Vegetables	6	9.0
Sheep feeding from crop residues		
No	23	34.3
Yes	44	65.7

(8.3%).

Figure 2 presents percentages of respondents in different distances travelled by flocks to the water source in winter and summer. The proportion of farmers who reported that their sheep travelled shorter distances (<1 km) in summer was higher (72.9%) than in winter (45.8%). More flocks travelled longer distances (>1 km) to the water source in winter (45.8%) than in summer (25%). Low percentages of flocks drank water that was fetched and provided at home in both winter (8.3%) and summer (2.1%).

Establishment of flocks and breeding management practices

The analysis of flock origin indicated that most (61.9%) respondents started rearing sheep with initial stock purchased from other farmers (Table 7). Thirty two percent were obtained through inheritance and 6.2% as gifts. The possibility of relationships within initial stock was estimated by asking farmers to indicate if their stock were; 'bought from the same flock', 'bought from different flocks in the same community' or 'bought from different communities' (Table 7). Some farmers were able to recall the number of sheep that was used to establish their flocks. More than seventy percent of the respondents started off with fewer than 3 sheep while 19.4%, 6% and 3% started with 4 to 6, 7 to 9 and more than 10 sheep, respectively. The overall mean size of the founder flock was 3.5±3.8 (±s.e). Fifty-eight percent of the sheep flocks had not been crossbred with exotic breeds. Twenty-eight percent of the flocks did not interact with other flocks; that is, they existed in isolation from neighbouring flocks. More than 70% interacted with at least one flock. Flocks interacting with 2 flocks were modal; followed by those interacting with 1 flock. Farmers were also asked if they understood inbreeding and its deleterious effects on livestock productivity and also if they had any methods in place to control inbreeding (Table 7).

Table 8 shows proportions of sources of rams, reasons for keeping rams and methods of mating by Zulu sheep farmers in KwaZulu Natal. Rams were used for breeding purposes by all farmers interviewed. No socio-cultural use was mentioned in the entire survey. Mating was uncontrolled in all flocks surveyed.

The questionnaire was complemented by the interviewee's preference for traits he/she considered important in selecting rams. Free answers were possible, however, each farmer had to rank his/her preferences with the trait ranked first as the most important. Indices were then calculated to estimate the relative importance of traits in selecting rams. The indices obtained are presented in Table 9.

Access to veterinary services and control of gastro-intestinal and external parasites

The access to veterinary services and veterinary methods adopted by owners of sheep are presented in Table 10. More than eighty percent of farmers obtained medication for their sheep through private drug suppliers. Only 3.1% each indicated that they sourced help from extension services and government veterinary, with 12.5% stating that they had no access to veterinary help. Most farmers did not follow routine systems in controlling gastro-intestinal and external parasites. Animals received treatment for external (58.3%) and gastro-intestinal (60.4%) parasites when showing ill health. Ten percent and 17.7% did not use any medication to control external and gastro-intestinal parasites, respectively. Most interviewed farmers used a spray (53.1%) in controlling external parasites. Gastro-intestinal parasites were predominantly controlled by drenching (70.8%).

Causes of sheep mortalities and mortality rates

Tables 11 and 12 show causes of mortalities and mortality rates reported by farmers, respectively. The most common cause of sheep death was drought (43.8%) followed by diseases (28.2). Mortality rates were determined by asking farmers to give estimates of the number of sheep, within different groupings (mature males, mature females and lambs), that had died within the year 2010/2011. Farmers were not keeping any records, thus numbers of these mortalities were recalled

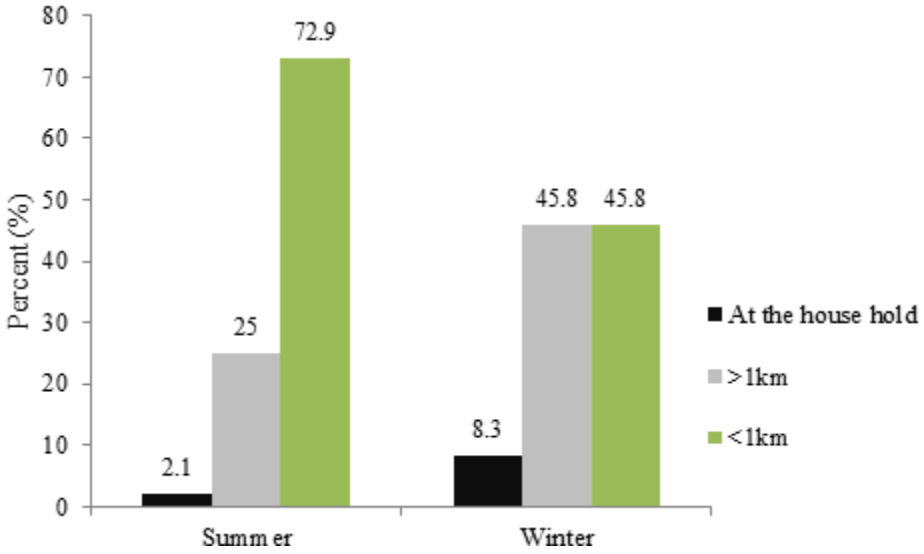

Figure 2. Percentages of responses by farmers on distance travelled to the water sources by sheep in winter and summer in KwaZulu-Natal communal areas.

from memory. Mortality rates were highest in lambs (69.4%).

Marketing of Zulu sheep in rural communities of KwaZulu Natal

The proportion of farmers who sold their sheep (57.3%) was greater than that of farmers who did not sell sheep (42.7%). Most farmers were compelled by need to sell sheep and only a few had defined systems of marketing (e.g. selling rams when their numbers have increased). The greater proportion of farmers selling sheep were not specific in the type of animals they sold (70.9%), while other farmers indicated to sell old rams, unproductive ewes and weaners (Table 13).

DISCUSSION

There is an increasing interest in the characterisation of African native animal genetic resources (Kunene et al., 2009; Traoré et al., 2008; Yakubu et al., 2010) because of their valuable contribution towards livestock biodiversity and adaptive attributes to fulfil the multifaceted roles they are allocated to by the poor livestock keepers in the region (Ali, 2011; Köhler-Rollefson, 2001). Zulu sheep have become a stable part of KwaZulu Natal ecosystem through hundreds of years of adaptation to the production environment in which they are raised (Ramsey et al., 2000). The current study described and documented Zulu sheep production systems in the traditional sector of KwaZulu-Natal as an essential step towards the development of a sustainable breed improvement programme.

The findings that households were predominantly headed by males and that most livestock farmers are old aged are common phenomena in most developing countries (Oladele, 2001). The present study confirmed findings of Kunene and Fossey (2006) who reported that the proportion of older people is predominant in rural communities of KwaZulu-Natal. Bembridge (1984), Mahanjana and Cronjé (2000) and Mapiliyao (2010) reported similar findings in the Eastern Cape. Meanwhile, Oladele (2001) in Nigeria echoed that older people are custodians of tradition. This implies that young people are less involved in livestock production in developing countries. The migration of younger people to urban areas might be a contributing factor to the high proportion of elderly people found in these areas.

Though livestock farming was identified as the major activity in most areas studied, farmers had alternative means to source income. Seemingly, farm produce alone could not sustain the household upkeep. Sokhela and Bembridge (1991) attributed this to unreliable food crop yield in the province. ‘Even in good years’, the authors highlighted, ‘maize crop yield is not enough to guarantee the respondents sufficient food and income for one year’. Hence, other sources of income (self-employment, formal employment, grant and pension) reported in the current study, seemed to serve as supplements to farming income. This phenomenon presents an opportunity for sustainable utilisation of indigenous livestock; which can withstand drought and can produce under conditions of low input and low level management, thus requiring less input and availing farmers time to conduct other activities. Kosgey et al. (2008) assert that flock composition in terms of sex and age classes is an indicator of the

Table 7. Flock establishment, interaction with other flocks, inbreeding awareness and methods employed to control inbreeding by communal farmers in KwaZulu-Natal.

Parameter	Number of respondents	Percentage
Ways of establishing foundation stock		
Bought	59	61.9
Gift	6	6.2
Inherited	31	32.0
Relatedness of the foundation stock		
Obtained from the same flock	42	65.6
Obtained from different flocks, but the same community	10	15.6
Obtained from different communities	12	18.8
Number of founders		
<4	48	71.6
4-6	13	19.4
7-9	4	6.0
10>	2	3.0
	N=67	Mean=3.52±3.8
History of cross breeding		
No	55	58.3
Yes	41	42.7
Interaction with other flocks		
Yes	68	71.6
No	27	28.4
Number of neighboring flocks with which the flocks interacted		
0	27	28.4
1	12	12.8
2	29	30.9
3	10	10.4
4	5	5.2
5	6	6.3
6	7	7.3
Inbreeding awareness		
No knowledge	12	14.1
Minimal	24	28.2
Average	42	49.4
Well informed	7	8.2
Methods used to control inbreeding		
Borrow rams	15	15.6
Buy rams	6	7.2
None	63	65.6

management system, because it reflects to some degree the management objectives, flock productivity and constraints on the system. Overall, the mean flock size (39.8) reported in the current study was higher than that reported by Mapiliyao (2010) in the Eastern Cape of 18.3 and 19.0 for the villages of Sompondo and Gaga, respectively. However, the fact that Nqutu (110.4) and Estcourt (350.0) had high mean flock sizes is an

Table 8. Sources of rams, reasons for keeping rams and methods of mating of Zulu sheep in KwaZulu-Natal.

Parameter	Number of farmers	Percentage
Source of ram		
Borrowed	1	1.2
Communal area ram	6	5.9
Donated	1	1.2
Bought	8	8.2
Own bred	80	83.5
Total	96	100.0
Reason for ram		
Breeding	96	100
Socio-cultural	0	0
Mating		
Uncontrolled	96	100
Hand mating	0	0

Table 9. Ranking of selection criteria for breeding rams by Zulu sheep farmers in KwaZulu-Natal.

Selection criteria	Rank 1	Rank 2	Rank 3	Index
Colour	8	5	51	0.195
Conformation	17	51	6	0.226
Size	68	40	0	0.525
Horns	2	1	39	0.051
Tail Type	1	0	0	0.003

influencing factor towards a higher figure obtained in this study. Large flocks in Nquthu can be attributed to good pastures combined with semi-intensive management and crossbreeding with exotic germplasm whereas in Estcourt sheep are kept under improved management practices. A mean (19.1) similar to that of Mapiliyao (2010) would be obtained if Nqutu and Estcourt were excluded from the calculation. The high percentage of mature breeding ewes (59.2%) in the current study was similar to that reported by Mapiliyao (2010) in Eastern Cape. Taye et al. (2010) also gave a similar figure of 58.8% in Ethiopia. Kosgey et al. (2008) ascribed this to the fact that farmers maintained breeding ewes for long periods and that the importance of culling was not fully recognized. The removal of rams for sale or family consumption is another possible factor contributing to the high proportion of ewes per flock in this study.

One aim of this study was to document information that would be useful in the future when formulating a breeding programme for Zulu sheep. The following findings are important, particularly in designing a breeding programme for Zulu sheep in KwaZulu Natal. Firstly, individual sheep flock sizes were quite small (48% of the flocks were made up of fewer than 20 animals; Table 2). Secondly a high proportion (28.4%) of these flocks existed in isolation from other neighbouring flocks or interacted with only a few flocks (72% interacted with 3 or fewer flocks, Table 7). Bias (2006) highlights the fact that when a population is divided into isolated subpopulations it tends to lose more heterozygosity than it would if the population was undivided. Thirdly, most breeding rams were sourced locally (either own-bred or bought from neighbouring farmers). This rendered the genetic diversity within a flock and even within a village to be potentially narrow and increased inbreeding (Gill and Harland, 1992). Also, high incidence of uncontrolled mating noted in surveyed areas predisposes flocks to loss of genetic diversity (Bias, 2006). The importance of maintenance of genetic variability in small populations and the effect of inbreeding has been discussed by several authors (Bias, 2006; Mendelsohn, 2003). Breeding between individuals sharing common ancestors tends to reduce the rate of allelic variation in the next generation which then reduces the genetic diversity of the population (FAO, 2007). The accumulation of deleterious recessive alleles may threaten the fitness of the population and negatively affect reproductive rates, thereby increasing the risk of extinction (Gandini et al., 2004; Woolliams, 2004).

Furthermore, though a majority of farmers (85.9%) showed awareness of inbreeding and its deleterious effects, the effort put forth to address the implication did not seem to correspond with their knowledge. Sixty five percent of the interviewed farmers did not put into practice any measures to control inbreeding. The few who introduced new rams into their flocks did so by either borrowing or buying rams from neighbouring farmers. Communal herding, which allows breeding females to mix with breeding males from other flocks, can minimise inbreeding (Kosgey et al., 2008), but this appears to be rarely practised among the farmers because distances are longer between neighbouring flocks.

Over 71% of the respondents in this study established their flocks by three or fewer breeding animals sourced mainly from a single flock (through gifts, inheritance or purchase) or from different flocks but in the same village, implying high chances of close relationships amongst foundation stock. This tends to narrow the genetic constitution of the progeny flock, because the primary constraint on the genetic profile of a breed/flock is the genetic constitutions of its founders (Gill and Harland, 1992). Founder effects acting on different demes generally lead to subpopulation with allele frequencies that are different from the larger population (Bias, 2006). Thus each subpopulation developing from different genotypic constitution from that of the larger population would develop into a unique strain, which in this case would have been built on a narrow gene pool. According to Gill and Harland (1992), the greater the genetic

Table 10. Access to veterinary services and veterinary methods adopted by owners of sheep in surveyed areas of KwaZulu-Natal.

Parameter	Number of farmers	Percent
Access to veterinary services		
Extension service	3	3.1
Government vet	3	3.1
None	12	12.5
Veterinary drug supplier	78	81.3
External parasite control		
Done routinely	30	31.3
Done when need arises	56	58.3
None	10	10.4
Gastrointestinal parasite control		
Done routinely	21	21.9
Done when need arises	58	60.4
None	17	17.7
Methods of external parasite control		
Dip	9	9.4
Hand dressing	9	9.4
Injection	17	17.7
Spray	51	53.1
None	10	10.4
Methods of gastro-intestinal parasites control		
Drench	68	70.8
Injection	11	11.4
None	17	17.7

Table 11. Causes of Zulu sheep mortalities reported by farmers in KwaZulu-Natal.

Reasons for mortalities	Number of farmers reporting reason	Percent
Unfavourable weather conditions	3	4.7
Diseases	18	28.2
Drought	28	43.8
Predation by dogs	3	9.4
Gastro-intestinal parasites	5	3.1
Road accidents	4	6.3
Predators	3	4.7
Theft	3	4.7
Too much rain	2	3.1
Total	64	100.0

diversity the greater the potential of a breed to respond to changing environmental conditions. A good breeding programme for Zulu sheep will serve well if it adequately addresses these constraints.

Inadequate feeding and poor quality feed are often regarded as major factors limiting sheep production (Kosgey et al., 2008). The current study revealed that most (76%) interviewees did not offer supplementary feeding to their flocks; animals depended entirely on veld for their nutritional requirements. This finding concurs with the results of Kunene and Fossey (2006) and other studies in areas where extensive livestock production is practised (Sölkner et al., 1998; Taye et al., 2010). This study, as did Kosgey et al. (2008), revealed that farmers

Table 12. Total number and percentage of Zulu sheep mortalities reported to have occurred between June 2010 and June 2011 in KwaZulu-Natal.

Mortalities	Total number of mortalities	Average mortalities per flock	Std. Deviation	Percentage (%)
Mature males	39	0.76	1.37	8.9
Mature females	95	1.83	2.76	21.8
Lambs	302	6.29	11.16	69.4
Total mortalities	435	8.37	11.43	100.0

Table 13. Sheep marketing in Northern KwaZulu-Natal by Zulu sheep farmers.

Aspects of sheep marketing	Response	Frequency	Percent
	No	41	42.7
Does the farmer sell his/her sheep	Yes	55	57.3
	Total	n=96	
	Prevalence of need	49	89.1
What determines your selling of sheep?	System of production	6	10.9
	Total	n=55	
	Mature rams	7	12.7
	Not specific	39	70.9
Which animals do you sell?	Unproductive ewes	7	12.7
	Weaners	2	3.6
	Total	n=55	

who supplemented diets of their animals provided them with mineral concentrates. Supplementary feeding amongst famers in the present study can be ascribed to unreliability of roughage production especially during drought periods.

Most animals were released for grazing in the morning (0730-0830 h) and brought back for enclosure in the evening (1700-1800 h). The proportion of farmers who released their animals later (0900-1100 h) was higher in Ulundi and Nqutu. Although not presented in the current study it was generally observed that these areas had good pastures when compared to the rest of the areas studied. Late release of animals by farmers therefore might be attributed to the fact that animals graze to their satiety in shorter grazing time due to high pasture availability. Late release of animals allows farmers to carry out other household chores before they lead their flocks for grazing.

Understanding the reasons for keeping small ruminants is a prerequisite for deriving operational breeding goals (Kosgey et al., 2008). Ignorance of this aspect has been a major constraint in the lack of success in genetic improvement programmes attempted in the tropics (Rewe et al., 2002; Sölkner et al., 1998). The reasons for keeping sheep identified in the present study reflect multiple objectives by the farmers and are consistent with the findings of Kunene and Fossey (2006) in KwaZulu Natal and Mapiliyao (2010) in Eastern Cape. Sheep were commonly used as a source of meat, family income and manure, in the present study. Together these accounted for 99% of the total usage. The other use mentioned by farmers was skins. Only two farmers, in Ingwavuma, used sheep for rituals (Table 5). FAO (2007) mentions fibres, hides, skins and pelts as other important products used in other sheep breeds. These could be possible opportunities which farmers can exploit to better utilise their sheep.

In spite of all the socio-economic advantages mentioned by farmers, this study showed that sheep flock sizes are declining, concurring with earlier studies of Kunene and Fossey (2006). The continued decline shows that more damage has occurred to this important genetic resource over the years. Inaction might lead to total eradication of the breed. It is therefore imperative that emergent measures be put in place to hold in check the genetic decay. The prospects for a breed depend to a great extent on its present and future function in livestock systems (FAO, 2007). Some breeds are lost due to the emergence of new circumstances that change the lifestyle of their keepers and are thus set aside to face the danger of extinction. Several reasons have been given by Oldenbroek (1999) as to why the implement-tation of conservation measures for a particular breed might be considered important: genetic uniqueness; a high degree of endangerment; traits of economic or scientific importance (unique functional traits); and

ecological, historical or cultural value. If identified and understood by the keepers of Zulu sheep, these will, to some extent, improve the effectiveness of the conservation programme.

Though most farmers recognised the breed for its tolerance to local prevalent harsh environmental conditions, the major cause of loss of sheep identified in this study was drought. This sounds equivocal, but drought intensity in some parts of the province can be so high that its effects override the sheep's adaptive attributes. Disease was identified as the second major cause of sheep mortality in the present study. This concurred with findings by Kosgey et al. (2008) who ascertained that poor health is the key limiting factor to the productivity of sheep raised by most rural farmers in developing countries. Most farmers interviewed depended on drug suppliers for veterinary help; this raises some doubts on the accuracy of the diagnosis of diseases. Maximum productivity in a given system of production emerges when disease control is optimal (Gatenby, 1986). Thus, healthcare is an important problem to consider before genetic programmes can be seriously contemplated. Community-based animal health programmes may be one way forward and wider utilisation of indigenous breeds tolerant to disease another (Njoro, 2001). Other causes of sheep loss such as road accidents and theft identified in the present study were less significant (Table 12) - a finding similar to that of Mapiliyao (2010).

Zulu sheep were preferred over their exotic counterparts by most farmers studied. Reasons given for their preference concurred with those of Kunene and Fossey (2006) that the breed is tolerant to diseases and drought and that it has tasty meat. These results are indicative of the fact that Zulu sheep can live and produce under low management levels of resource-poor farmers who would do well with disease resistant multipurpose animals with low-maintenance feed requirements and relatively good mutton output. This therefore renders the breed a cost effective tool in alleviating poverty, improving food security and livelihoods of the resource-poor farmers in KwaZulu Natal. The reasons for breed preference should be investigated further because it may have a bearing on the implementation of a breeding programme. Farmers who are not satisfied with their breed might not be willing to put effort into improving the animals.

The survey revealed that there was no formal market in which farmers sold their sheep. Sheep were sold primarily to other farmers, but hardly ever to abattoirs, suggesting the possibility of non-competitive prices. Also noted in the present study is the non-specificity of the type of animals sold by farmers and a high proportion of farmers selling to meet emergent family needs. This was a result of the fact that farmers did not have stipulated guidelines in selling their sheep. This suggests a necessity to explore if organised marketing can improve the benefits reaped by farmers from their investments. Kosgey et al. (2008) indicated that farmers would likely not adopt improved management practices whilst proceeds from sale of animals are low. Thus sheep marketing would have to be addressed in order to win the hearts of farmers towards the conservation and improvement of Zulu sheep.

ACKNOWLEDGEMENTS

The field research was fully financed by the Department of Agriculture, Forestry and Fisheries (DAFF) and the University of Zululand (project number: 5509/04). The National Research Foundation (NRF, GUN number: 76352) also provided financial assistance to the first author while undertaking his MSc study.

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