South African Journal of Animal Science 2025, Vol 55(2)

Breeding practices and trait preferences of sheep farmers from two villages in Lepelle-Nkumpi municipality, Limpopo Province, South Africa

A.M. Phaladi[1], T.L. Tyasi[1#], O. Tada[1], & S. Mogashoa[2]

[1]Department of Agricultural Economics and Animal Production, University of Limpopo, Private Bag X1106, Sovenga, 0727

[2]Gauteng Department of Agriculture, Rural Development and Environment, 56 Eloff Street, Marshalltown, Johannesburg, 2000

(Submitted 6 May 2024; Accepted 4 January 2025; Published February 2025)

Copyright resides with the authors in terms of the Creative Commons Attribution 4.0 South African Licence.

See: http://creativecommons.org/licenses/by/4.0/za

Condition of use: The user may copy, distribute, transmit and adapt the work, but must recognise the authors and the South African Journal of Animal Science.

Abstract

Despite the large genetic diversity within South Africa's sheep population, average productivity on smallholdings remains low. This study therefore aimed to identify the breeding practices and trait preferences of sheep farmers in the Makurung and Lenting villages, Limpopo Province, for use in the development of a community-based breeding programme. Data were collected from 70 purposively sampled farmers in the two villages using a questionnaire survey method. Descriptive analysis, significance testing, and index ranks using SPSS software were employed to describe and analyse the collected data. Most (48.8%) of the sheep farmers in both villages kept sheep for savings and investment, and meat production purposes. The overwhelming majority (90.0%) of sheep farmers in both villages practised uncontrolled mating, but a significant difference in breeding practices was observed between the villages. Knowledge of castration and culling practices did not significantly differ between the villages. The sheep farmers' preferred traits for breeding rams were mating ability (0.3), body size (0.3), and growth rate (0.2), while for breeding ewes they were twinning ability (0.3), mothering ability (0.2), and lambing interval (0.2). We conclude that farmers should focus more on ewe reproductive anatomy traits (such as udder size and shape, and teat size and placement), and ram reproductive anatomy traits (such as scrotal size and circumference, and testicular size and weight), as these can have an impact on long-term flock productivity. These findings could guide interventions such as the establishment of sustainable community-based breeding schemes to improve sheep production in the study area.

Keywords: breeding ewes, breeding rams, community-based breeding programme, production objectives, purposive sampling

[#]Corresponding author: louis.tyasi@ul.ac.za

Introduction

The diverse sheep population found in the Limpopo Province of South Africa is important for the present and future livelihoods of farmers in this area (Abegaz *et al.,* 2010; Hemacha *et al.,* 2022). Sheep are preferred to other livestock because of their short generation interval, high fertility, ability to adapt to harsh environments, and ability to reproduce with a limited feed supply (Tsedeke, 2007). However,

URL: http://www.sasas.co.za
ISSN 0375-1589 (print), ISSN 2221-4062 (online)
Publisher: South African Society for Animal Science
http://dx.doi.org/10.4314/sajas.v55i2.03

despite the large genetic diversity of the sheep population, average sheep productivity on smallholdings is generally low (Dagnew *et al.,* 2017). There are numerous causes of this low productivity; however, several studies have reported that it is largely related to smallholder farmers' limited knowledge of the concepts of livestock genetic improvement (Gizaw *et al.,* 2013; Dagnew *et al.,* 2017). Several studies have been conducted on smallholder sheep farmers in other countries to determine their production objectives, breeding practices, trait preferences, and selection criteria, with the aim of using this information to design, implement, and review community-based breeding programmes (CBBPs) (Sölkner *et al.,* 1998; Haile *et al.,* 2011; Wurzinger *et al.,* 2011; Mueller *et al.,* 2015). Nevertheless, the breeding practices and trait preferences of sheep farmers from Lenting and Makurung villages in the Limpopo Province are still not well documented.

According to Omore *et al*. (2008), the concept of a CBBP is not new. It was described by Wurzinger *et al.* (2021) as breeding activities that are planned, designed, organised, and implemented by smallholder farmers individually or together with agricultural extension workers. Community-based breeding programmes have long been established as an effective approach, when paired with effective planning, organisation, and implementation (Gutu *et al.,* 2010). A study by De Aguiar *et al.* (2020) reported that Brazil, a developing country, had introduced traditional breeding programmes, but that these programmes had not been effective, as many of the relationships were temporary, inconsistent, and lacked legal contracts. These attempts were consequently discontinued. Mueller *et al*. (2015) reported an analysis of eight CBBPs located in Latin-America, Africa, and Asia, and emphasised the importance of a bottom-up approach and the involvement of local institutions in the planning and implementation stages. They further revealed that a completely self-sustained CBBP seemed to be difficult to attain, as it was necessary to first implement and document formal socio-economic evaluations and provide them to the government and other development agencies before a sustainable CBBP could be created on a larger scale. Sölkner *et al.* (2006) proposed a village breeding programme, which involved breeding activities carried out by communities of smallholder farmers, often at a subsistence level. However, the decisive and most frequently missing step in the design of these programmes has been the definition of breeding objectives.

Breeding objectives can only be formulated when there is a close connection with the target group, and Sölkner *et al.* (2006) suggested using the already existing traditional advisory structure to make this connection, even though traditional advisers do not typically focus on aspects of animal breeding. However, this may not be the best way forward, especially when one specifically seeks to improve animal breeding practices. As such, CBBPs may be a viable option, as they incorporate old and new records, advice from farmers, consider farmers' objectives, and design based on their needs. However, there is limited information available on the breeding practices and trait preferences of sheep farmers from villages in the Lepelle-Nkumpi municipality, in the Limpopo Province of South Africa. This lack of information results in unproductive breeding programmes and limited improvements in sheep productivity.

This study therefore aimed to identify and document the breeding practices and trait preferences of sheep farmers in Makurung and Lenting villages, in the Limpopo Province of South Africa. The study further sought to use this information for the development and implementation of a sustainable, long-term CBBP.

Materials and methods

All procedures were performed following the standards and protocols set by University of Limpopo Animal Research Ethics Committee, under project number AREC/22/2023: PG.

The study was carried out in Makurung and Lenting villages, which are situated in the Lepelle-Nkumpi municipality. The municipality is one of five within the Capricorn district in the Limpopo Province of South Africa. The municipality has a mean annual temperature of 20 °C, with an average temperature of 23 °C in summer and 20 °C in winter (Kuyamandi Development Services, 2006). The area has mild winters and very hot, humid summers, with the mean annual rainfall ranging between 453 mm and 474 mm. The study area falls within the savannah biome, with mixed bushveld vegetation (Lepelle-Nkumpi Local Municipality, 2021). The soil types found within the study area are described as ranging from massive/weakly structured soils with high base status to rocks with limited soil (Lepelle-Nkumpi Local Municipality, 2021).

The study was conducted using a cross-sectional observational design to strike a balance between the depth and breadth of the data collected. Collecting detailed data from a smaller number of villages allowed for a richer understanding of the research questions, while still giving a degree of representation to the other villages. This approach kept the study manageable and feasible. Lepelle-Nkumpi municipality and Makurung and Lenting villages were purposively chosen because of the substantial sheep populations in these areas, as well as the availability of sheep farmers working with the agricultural extension office in this municipality.

Yamane's formula (Yamane, 1967) was used to derive the sample size:

$$n = \frac{N}{1+N(e)^2}$$

where: *n* is the required sample size, *N* is the population size, and *e* is the acceptable error of estimation (0.05). The municipality had a population of 85 farmers on record and Yamane's formula thus suggested that the study use 70 farmers:

$$n = \frac{85}{1 + 85\ (0.05)^2} = 70.10\ \approx 70$$

Furthermore, Admasu *et al.* (2017) suggested that the sample size of a cross-sectional study must be 70 or more farmers. As such, the study used 70 farmers.

Data were collected using a semi-structured questionnaire by six MSc and two PhD students who were familiar with the requirements and protocol to be followed. These students conducted face-to-face interviews with the heads of individual households who were primarily responsible for sheep farming and decision making on their smallholder livestock farms.

Collected data were analysed using the Statistical Package for the Social Sciences (IBM SPSS 2022) version 27. Descriptive statistics, such as frequency and percentage, were used to distinguish the results as percentages for both villages. Rankings were expressed as an index, as described by Zewdu *et al.* (2018):

$$Index = \frac{\sum\big((3 \times rank\ 1) + (2 \times rank\ 2) + (1 \times rank\ 3)\big)\ for\ the\ individual\ trait}{\sum\big((3 \times rank\ 1) + (2 \times rank\ 2) + (1 \times rank\ 3)\big)\ for\ all\ responses}$$

A chi-square (χ^2) statistic was used to contrast the categorical variables for socio-demographic factors and sheep production activities.

Results

The socio-economic attributes of the sheep farmers are presented in Table 1. Most sheep farmers from both villages were males, with no significant difference observed between the villages. All the respondents from Makurung village were married, while in Lenting village, 80.0% were married. The highest education levels in Makurung village were secondary and tertiary education, while in Lenting village, the majority (80.0%) of the sheep farmers had secondary education as their highest education level. Regarding age, most (51.4%) of the sheep farmers from the surveyed villages were between 41 and 49 years old. Lenting village also had a number of farmers (36.7%) older than 60 years of age. The majority of the sheep farmers in both villages had 6–10 years of sheep farming experience. Using the standardised residual value, the source of difference was Makurung village.

The farmers' responses to the questions about the purposes for which they kept sheep are given in Table 2. Most of the sheep farmers in Makurung village reared sheep for the purposes of meat production (25.0%), savings and investment (25.0%), ceremony/rituals (17.5%), and as a source of income (17.5%). Conversely, in Lenting village, the main reasons were for savings and investment (30.0%), as a source of income (20.0%), and meat production (16.7%). However, there was no significant difference between the villages in their responses to this question. Using the standardised residual value, the source of difference was Makurung village.

Table 1 Socio-economic attributes of sheep farmers in Makurung and Lenting villages in the Lepelle-Nkumpi municipality of Limpopo Province, South Africa

	Villages				
	Makurung	**Lenting**	**Total**		
Categorical variables					
	N (%)	**N (%)**	**N (%)**	**Chi-square**	***P*-value**
Gender					
Male	31 (77.0%)	18 (60.0%)	49 (70.0%)	2.5	0.1
Female	9 (22.0%)	12 (40.0%)	21 (30.0%)		
Marital status					
Single	0 (0.0%)	6 (20.0%)	6 (20.0%)		
Married	40 (100.0%)	24 (80.0%)	65 (91.4%)	8.8	0.0
Widow	0 (0.0%)	0 (0.0%)			
Level of education					
Primary	0 (0.0%)	6 (20.0%)	6 (20.0%)		
Secondary	20 (50.0%)	24 (80.0%)	44 (63.9%)	70.0	<0.0
Tertiary	20 (50.0%)	0 (0.0%)	20 (28.6%)		
Age					
≤30	0 (0.0%)	0 (0.0%)	0 (0.0%)		
31–39	16 (40.0%)	0 (0.0%)	16 (22.9%)		
41–49	24 (60.0%)	12 (40.0%)	36 (51.4%)	37.3	<0.0
50–59	0 (0.0%)	7 (23.3%)	7 (10.0%)		
≥60	0 (0.0%)	11 (36.7%)	11 (15.7%)		
Years of farming with sheep					
≤5	13 (32.5%)	12 (48.0%)	25 (35.7%)		
6–10	27 (67.5%)	18 (60.0%)	45 (64.3%)	8.7	<0.0
11–19	0 (0.0%)	13 (43.3%)	13 (18.6%)		
≥20	0 (0.0%)	5 (16.7%)	5 (7.1%)		
Continuous variable					
	Mean ± SE	**Mean ± SE**		**F-value**	***P*-value**
Household size	7.6 ± 0.3	6.6 ± 0.5		2.9	0.1

P <0.05 was adopted as the threshold for statistical significance; N: number of responses, SE: standard error

Table 2 Purposes of keeping sheep in Makurung and Lenting villages in the Lepelle-Nkumpi municipality of Limpopo Province, South Africa

	Villages				
Purpose	**Makurung**	**Lenting**	**Total**	**Chi-square**	***P*-value**
	N (%)	**N (%)**	**N (%)**		
Meat	10 (25.0)	5 (16.7)	15 (21.4%)		
Savings and investment	10 (25.0)	9 (30.0)	19 (27.1%)		
Dowry payment	2 (5.0)	4 (13.3)	6 (8.6%)		
Ceremonial/cultural rites	7 (17.5)	2 (6.7)	9 (12.9%)	4.4	0.6
Income	7 (17.5)	6 (20.0)	13 (18.6%)		
Hides	2 (5.0)	1 (3.3)	3 (4.3%)		
Manure	2 (5.0)	3 (10.0)	5 (7.14%)		
Total	40 (57.2%)	30 (42.9%)	70 (100.0%)		

P <0.05 was adopted as the threshold for statistical significance; N: number of responses

The farmers' responses to the questions about the breeding practices used are presented in Table 3.

Table 3 Breeding practices of sheep farmers in Makurung and Lenting villages in the Lepelle-Nkumpi municipality of Limpopo Province, South Africa

	Villages				
	Makurung	**Lenting**	**Total**	**Chi-square**	***P*-value**
	N (%)	**N (%)**	**N (%)**		
Sheep breeds used					
Dorper	32 (80.0%)	17 (56.7%)	49. (70.0%)	4.4	0.0
Dorper and Meat Master	8 (20.0%)	13 (43.3%)	21. (30.0%)		
Use of breeding practices					
Yes	40 (100.0%)	26(86.7%)	66 (94.3%)	5.7	0.0
No	0 (0.0%)	4 (0.0%)	4 (5.7%)		
Breeding methods used					
Improving indigenous	40 (100.0%)	30 (100.0%)	70 (100.0%)	-	-
Importing exotic	0 (0.0%)	0(0.0%)			
Breed improvement strategy					
Crossbreeding	16 (40.0%)	13 (43.3%)	29 (41.4%)	0.1	0.8
Pure breeding	24 (60.0%)	17(56.70%)	41 (58.6%)		
Mating system used					
Controlled	0 (0.0%)	7 (23.3%)	7 (10.0%)	10.4	0.0
Uncontrolled	40 (100.0%)	23 (76.7%)	63 (90.0%)		
Knowledge of inbreeding					
Yes	40 (100.0%)	19 (63.3%)	59 (84.3%)	17.4	<0.0
No	0 (0.0%)	11 (36.7%)	11 (15.7%)		
Source of knowledge of inbreeding					
Books	16 (40.0%)	14 (46. 7%)	30 (42.9%)		
Farming experiences	16 (40.0%)	4 (13.3%)	20 (28.6%)	37.3	<0.0
From other farmers	8 (20.0%)	12 (40.0%)	20 (28.6%)		
Knowledge of culling					
Yes	20 (50.0%)	26 (86.7%)	46 (65.7%)	5.4	0.5
No	20 (50.0%)	4 (13.3%)	24 (34.3%)		
Reasons for culling					
Low production	0 (0.0%)	4 (13.3%)	4 (5.7%)		
Old age	24 (60.0%)	22 (73.3%)	46 (65.7%)	10.1	0.0
Both old age and low production	16 (40.0%)	4 (13.3%)	20 (28.6%)		
Knowledge of castration practices					
Yes	32 (80.0%)	26 (26.7%)	58 (82.9%)	0.0	0.7
No	8 (20.0%)	5 (16.7%)	13 (18.6%)		
The method of castration used					
Rubber	8 (20.0%)	8 (26.7%)	16 (22.9%)		
Burdizzo	8 (20.0%)	17 (56.7%)	25 (35.7%)	14.6	<0.0
Both rubber and burdizzo	24 (60.0%)	5 (16.7%)	29 (41.4%)		
Breeding season					
Spring	40 (100.0%)	30 (100.0%)	70 (100.0%)	-	-
Other	0 (0.0%)	0 (0.0%)			

P <0.05 was adopted as the threshold for statistical significance; N: number of responses

The farmers' responses about the breeding practices used indicated that farmers in both villages mainly farmed with Dorper sheep (70.0%) and a mixture of Meat Master and Dorper, kept in one flock (30.0%), with a significant difference between the villages. All the farmers in Makurung and 76.7% of the farmers in Lenting village practised uncontrolled mating. The majority of farmers in both villages knew about inbreeding, with only 11 (36.7%) farmers in Lenting having no knowledge of inbreeding. The majority of farmers in both villages knew about the practices of castration (82.9%) and culling (65.7%). In Makurung, the preferred methods of castration were both rubber and burdizzo (60.0%). In Lenting, burdizzo (56.7%) was the preferred method. However, there were significant differences in the mating systems used, knowledge of inbreeding, and castration method used between the two surveyed villages.

Table 4 shows the ram traits, as ranked according to importance by the farmers, and the resultant index values for these traits. Mating ability (0.3) was ranked first by farmers from both villages, followed by body size (0.3), growth rate (0.2), coat colour (0.2), scrotal circumference (0.1), disease resistance (0.0), and sexual maturity (0.0).

Table 4 Ranks and indices of breeding ram traits, indicating the preferences of sheep farmers in Makurung and Lenting villages in the Lepelle-Nkumpi municipality of Limpopo Province, South Africa

Traits	Makurung (n = 40)				Lenting (n = 30)				Overall index
	Rank 1	Rank 2	Rank 3	Index	Rank 1	Rank 2	Rank 3	Index	
Mating ability	7	21	7	0.3	10	10	0	0.3	0.3
Body size	13	6	0	0.2	10	10	0	0.3	0.3
Growth rate	20	0	0	0.3	0	0	20	0.1	0.2
Coat colour	0	13	13	0.2	10	0	0	0.2	0.2
Scrotal circumference	0	0	14	0.1	0	10	0	0.1	0.1
Disease resistances	0	0	0	0.0	0	0	10	0.1	0.0
Sexual maturity	0	0	6	0.0	0	0	0	0.0	0.0
Temperament	0	0	0	0.0	0	0	0	0.0	0.0
Fighting ability	0	0	0	0.0	0	0	0	0.0	0.0

n: number of responses

The ranking of ewe traits by the farmers (Table 5) showed that mothering ability (0.3) was ranked first, followed by mating ability (0.2), lambing interval (0.2), growth rate (0.1), body size (0.3), and disease resistance (0.0).

Table 5 Ranks and indices of breeding ewe traits, indicating the preferences of sheep farmers in Makurung and Lenting villages in the Lepelle-Nkumpi municipality of Limpopo Province, South Africa

Traits	Makurung (n = 40)				Lenting (n = 30)				Overall index
	Rank 1	Rank 2	Rank 3	Index	Rank 1	Rank 2	Rank 3	Index	
Twinning ability	13	6	21	0.3	10	10	0	0.3	0.3
Mothering ability	20	0	0	0.3	0	10	0	0.1	0.2
Lambing interval	7	20	6	0.3	0	0	10	0.1	0.2
Body size	0	7	13	0.1	10	0	0	0.2	0.1
Growth rate	0	7	0	0.1	0	10	10	0.2	0.1
Milk production	0	0	0	0.0	10	0	0	0.2	0.1
Disease resistance	0	0	0	0.0	0	0	10	0.1	0.0
Temperament	0	0	0	0.0	0	0	0	0.0	0.0
Mature body weight	0	0	0	0.0	0	0	0	0.0	0.0
Coat colour	0	0	0	0.0	0	0	0	0.0	0.0

n: number of responses

Discussion

Community-based breeding programmes attempt to achieve the genetic improvement of livestock populations by directly involving the farmers in all stages of these programmes, from the design to the actual breeding actions (Nandolo *et al.,* 2016). The socio-economic attributes of sheep farmers from the surveyed villages in the Lepelle-Nkumpi municipality were documented in this study.

The results indicated that the majority of households in both surveyed villages were male headed. This is consistent with the observations of Mphahlele *et al.* (2019), who found that 73.5% of the resource-poor sheep farmers interviewed in Limpopo Province had male heads of household. This is mainly because of the traditional and cultural customary patterns that exist in rural areas, where men are considered the head of the family and are the main participants in income-generating and livelihood protection activities (Tyasi *et al.,* 2022). However, Zenda & Malan (2024) highlighted that this means that less labour is available for agriculture, because men tend not to be actively involved in agricultural work in these patriarchal social settings, with farming/tending crops being seen as women's work. Agholor (2019) therefore suggested that improving the gender balance may reduce poverty and improve rural economies.

The majority of the sheep farmers interviewed in this study were between 41 and 49 years old, with several being over 60 years old. De Aguiar *et al.* (2020) similarly observed that most sheep farmers in the Hamus region in Ceará, Brazil, were 40–50 years old. Zenda & Malan (2024) observed that only 12.0% of small-scale sheep farmers in the Northern Cape of South Africa were younger than 40 years of age, while the majority were over 61 years old. However, the findings of our study suggest that there is a gradual increase in the number of young people entering agriculture.

Most of the farmers in both villages had secondary and tertiary education as their highest level of education, with a few farmers in Lenting village having only primary education. This implies that sheep farming is practised by highly literate farmers in Makurung, suggesting that it would be relatively easy to train them and engage with them during the development of a CBBP. The low numbers of sheep farmers with only primary education are consistent with the overall age demographic of the sheep farmers in these villages. Only 20.0% were over 60 years old, and this group grew up at a time when education was not easily accessible, resulting in them only being educated at the primary level. Small-stock farming is appealing to this age group, as it is affordable and requires less labour and resources than large-stock farming does.

In this study, we found a higher proportion of married farmers than unmarried farmers, with only 6.0% of the sheep farmers being unmarried. The existence of unmarried farmers could be attributed to social isolation, as sheep farming is practised in rural areas, which could limit social interactions and opportunities to meet potential partners. Furthermore, small-scale sheep farmers typically have fluctuating incomes, and the financial risks associated with sheep farming may discourage farmers from committing to marriage.

The majority of the sheep farmers had six to ten years of sheep farming experience. This agrees with the findings of Yawa *et al.* (2024), who reported that 26.0% of communal sheep farmers in the Eastern Cape Province of South Africa had six to ten years of sheep farming experience. In contrast, Mthi & Nyangiwe (2018) suggested that sheep farmers typically have about 13 years of experience. As experience is gained over time, the sheep farmers in this study are progressively gaining more sheep farming experience, and this will help improve their herd management practices.

Having documented the socio-economic status of the sheep farmers from the two selected villages, it was important to determine the purposes for which the farmers kept small ruminants, as this is a prerequisite for deriving operational breeding goals (Jainter *et al.,* 2001). The primary reason for keeping sheep in the two selected villages was for savings and investment, followed by meat production, income, and ceremonial/cultural purposes. The high dependency of the sheep farmers on keeping sheep for savings and investment purposes observed in this study was attributed to their proximity to urban or peri-urban areas, where they have sources of income other than agricultural activities. In this case, Lebowakgomo township is in close proximity to both study sites. Furthermore, many of the farmers in both villages are educated and thus have formal employment. As such, they invest their money into sheep farming. A similar observation was made by Monau *et al.* (2017), who reported that indigenous Tswana goat farmers in Botswana preferred formal employment as their primary source of income, rather than livestock farming. However, Kosgey *et al.* (2008), who conducted research in the central and western parts of Kenya, and Garcia *et al.* (2013), who studied farmers in Gambia and Senegal, found that livestock farmers primarily kept their sheep as a source of income.

It must be recognised that the different roles that sheep play in the livelihoods of farmers are a direct reflection of the farmers' various objectives for sheep production. Mengesha *et al.* (2012) highlighted that sheep and goats are relatively cheap, and are often the first assets acquired by the community; as such, farmers find it easier to keep them for meat and income, especially at the village level. However, Mthi *et al.* (2020) reported contradicting results, finding that wool production, meat production, and donation were the main production goals of sheep farmers in the Eastern Cape Province of South Africa. The differences in the results of various studies are likely due to the different geographical areas that the farmers occupied and the varying living conditions in these areas. In particular, the climate of the area in which they farm, the type of sheep that thrive there, and the market demand will impact the production goals of the farmers. Furthermore, it is notable that the farmers in this study did not report keeping sheep for milk and wool; this may be because it is uncommon in South African villages to consume sheep milk, as well as because the sheep breeds used were mostly meat breeds.

Despite the differences in rankings, the farmers in this study generally reported that their reasons for keeping sheep were multipurpose. This agrees with the results of Jimmy *et al.* (2010) and Tesfaye *et al. (*2008), who reported that sheep were reared for multiple reasons to maximise the output from an animal that can survive on low-resource input. Given the diversity of reasons for rearing sheep reported in this study, much care is needed when choosing the traits preferred by farmers, as these traits should help them achieve their primary purpose (Kosgey *et al.,* 2008; Jimmy *et al.,* 2010). In rams, mating ability was ranked as the most important trait by sheep farmers in the two surveyed villages in this study, followed by body size, growth rate, and coat colour. This is consistent with the results of Kebede *et al.* (2008), who reported that mating ability was a preferred trait for breeding bucks in the Central Rift Valley of Ethiopia. However, this result contradicts those of Getachew *et al.* (2010), who found that the primary criteria for selecting breeding rams were based on the rams' appearance. These differences in the ranking of preferred traits suggest that sheep farmers in the areas surveyed wanted more production, and hence chose mating ability over coat colour. Moreover, the high ranks assigned to body size and growth rate in this study emphasise that the sheep farmers surveyed are focused on the entrepreneurial side of agriculture, since they participate in informal markets where customers consider body size as their main purchasing point.

In ewes, the most preferred trait was twinning ability, followed by mothering ability, lambing interval, and body size. These results are consistent with the findings of Welday *et al.* (2019), who reported that the preferred ewe trait for sheep owners in Northern Ethiopia was twinning ability. Similarly, Getachew *et al.* (2010) found that mothering ability was ranked second by Menz sheep owners in Ethiopia. Contrary to these findings, body size was reported as being ranked second by Bolowe *et al.* (2022) in Botswana. The variation in traits preferred by farmers is mainly at the level of how much one trait is preferred over the other. The findings of the current study imply that sheep farmers preferred mating ability in rams, as this can increase the size of the herd. Physical traits such as body size and growth rate are associated with high carcass output and thus a higher selling price. Similarly, prioritising twinning ability, mothering ability, and lambing interval should increase flock size and produce ewes with better maternal care, thereby increasing the chances of lamb survival.

According to Kosgey *et al.* (2004), characterising the current production systems and breeding practices of sheep farmers is the first step to improving the small ruminant sector. The findings of this study demonstrated that mating was mainly uncontrolled, with only a few sheep farmers from Lenting village reporting that they used controlled mating systems. These results are consistent with the findings of Getachew *et al.* (2010), Abera *et al.* (2014), and Adimasu *et al*. (2019), who reported that the mating of small ruminants owned by smallholder farmers was predominantly uncontrolled. However, the sheep farmers who practised uncontrolled mating highlighted that they try to identify the sire of the lamb after birth, based on colour and appearance.

Castration was found to be a common practice, with the majority of farmers from Makurung village reporting that they use both a burdizzo and the rubber method to castrate their rams. This could be because of the low cost of these methods, as well as the reduced risk of infection compared to surgical castration. The majority of the sheep farmers in Lenting village used the burdizzo method only, as it is quick and requires less equipment and experience than the other castration methods. These results are consistent with those of Hemacha *et al.* (2022), who found that a large proportion of respondents in Ethiopia practised ram castration. In contrast, Dossa *et al*. (2015) reported the infrequent

use of castration among sheep and goat farmers in Nigeria, Burkina Faso, and Mali. This was mainly because of the small flock sizes owned by the farmers studied.

In this study, most of the sheep farmers had knowledge on the concept of culling. The reasons for culling were old age in rams and a decline in production in ewes. Ejlesten *et al.* (2012) found that sheep were culled when they were considered old and inferior, while Abebe *et al.* (2020) reported that sheep were culled because of their small body size, unfavourable coat colour, old age, and sterility. In the village setting of this study, culling would occur by selling the sheep to other members of the village for ceremonial or meat consumption purposes.

According to Ejlesten *et al.* (2012), farmers who have been keeping sheep for a long time may have more knowledge of issues relating to inbreeding than those who have just started. However, this does not automatically translate into differences in practice. Accordingly, the findings of the current study indicated that while the majority of the sheep farmers surveyed had knowledge of inbreeding, few had any measures in place to control it. Inbreeding is therefore a growing problem among sheep farmers in village settings. The findings of this study also indicated that the sheep farmers are aware of, and are practicing castration and culling, but that these are not necessarily done with the palpation and measurement of the testicles beforehand; rather they are done simply to get rid of sheep.

Conclusions

The results of this study revealed that the socio-economic attributes of sheep farmers in Makurung and Lenting villages in Lepelle-Nkumpi municipality show some differences, particularly in terms of marital status and educational level. However, there are similarities in gender and age distributions. The farmers have small flocks in which females and males are kept together throughout the year, and this free-roaming and herding system makes controlled mating difficult. The farmers prioritise reproductive and growth traits (mating ability, twinning ability, and body size) over ewe reproductive anatomy traits (such as udder size and shape, and teat size and placement) and ram reproductive anatomy traits (such as scrotal size and circumference, and testicular size and weight).

Since the level of productivity is low and little attention is currently given to husbandry and breed improvement, increasing productivity will require the involvement of farmers, researchers, agricultural extension workers, and other stakeholders in designing and implementing a CBBP. This CBBP will need to consider the existing production objectives, trait preferences, and breeding practices that have been documented in this study. Furthermore, researchers and extension workers need to help farmers create a list of criteria for the culling and castration of farm animals if production is to be maximised. Lastly, sheep farmers need to be educated on the importance of reproductive anatomy traits for long-term flock productivity, and the value of a balanced approach for more thorough and sustainable breeding schemes.

Acknowledgements

The authors thank the South African National Research Foundation for financial support, and extend their gratitude to the sheep farmers of Makurung and Lenting villages of the Lepelle-Nkumpi municipality for availing themselves for one-on-one interviews.

Authors' contributions

AMP, TLT, and OT conceptualised the manuscript. AMP, TLT, and SM contributed to the acquisition of data. AMP and TLT analysed the data. AMP drafted and wrote the manuscript. TLT and OT reviewed the manuscript analytically. All authors have read and approved the finalised manuscript.

Conflict of interest

The authors declare that they have no competing interests.

References

Abebe, A.S., Alemayehu, K., Johansson, A.M., & Gizaw, S., 2020. Breeding practices and trait preferences of smallholder farmers for indigenous sheep in the northwest highlands of Ethiopia: Inputs to design a breeding program. PLoS One, 15(5), e0233040. doi 10.1371/journal.pone.0233040

Abegaz, S., van Wyk, J.B., & Olivier, J.J., 2010. Estimates of (co) variance function for growth to yearling in Horro sheep of Ethiopia using random regression model. Arch. Anim. Breed, 53(6), 689–700. doi 10.5194/aab-53-689-2010

Abera, B., Kebede, K., & Gizaw, S., 2014. Indigenous breeding practices and selection criteria of sheep breed in Selale area, Central Ethiopia. Int. J. Livest. Res., 4(7), 49–56. doi 10.5455/ijlr.20140423043726

Admasu, L., Aberra, M., & Sandip, B., 2017. Traditional sheep production systems and breeding practice in Wolayita Zone of Southern Ethiopia. Afr. J. Agric. Res, 12(20), 1689–1701. doi 10.5897/AJAR2016.11940

Agholor, A.I., 2019. Gender gap in sub-Saharan Africa, reminiscence of rural extension and advisory services: Delineation, challenges and strategies. SAJAE, 47(3), 46–60. doi 10.17159/2413-3221/2019/v47n3a514

Bolowe, M.A., Thutwa, K., Monau, P.I., Malejane, C., & Kgwatalala, P.M., 2022. Production characteristics and management practices of indigenous Tswana sheep in southern districts of Botswana. Animals, 12(7), 830. doi 10.3390/ani12070830

Dagnew, Y., Urge, M., Tadesse, Y., & Gizaw, S., 2017. Sheep production and breeding systems in northwestern lowlands of Amhara region, Ethiopia: implication for conservation and improvement of Gumz sheep breed. Open J. Anim. Sci., 7(2), 179. doi 10.4236/ojas.2017.72015

De Aguiar, A.L., da Silva, R.R., Alves, S.M., da Silva, L.P., de Morais, O.R., & Lobo, R.N.B., 2020. Breeding objectives and selection criteria of a participatory community-based breeding programme of goats and sheep. Trop. Anim. Health. Prod., 521, 1933–1943. doi 10.1007/s11250-020-02209-6

Dossa, L.H., Sangaré, M., Buerkert, A.C., & Schlecht, E., 2015. Production objectives and breeding practices of urban goat and sheep keepers in West Africa: regional analysis and implications for the development of supportive breeding programs. SpringerPlus, 4, 281. doi 0.1186/s40064-015-1075-7

Edea, Z., Haile, A., Tibbo, M., Sharma, A.K., Sölkner, J., & Wurzinger, M. 2012. Sheep production systems and breeding practices of smallholders in western and south-western Ethiopia: Implications for designing community-based breeding strategies. LRRD, 24, 117.

Ejlertsen, M., Poole, J., & Marshall, K., 2012. Traditional breeding objectives and practices of goat, sheep and cattle smallholders in The Gambia and implications in relation to the design of breeding interventions. Trop. Anim. Health. Prod., 45, 219–229. doi 10.1007/s11250-012-0194-1

Garcia, L.I.P., 2013. Production objectives and selection criterions of three endemic ruminant breeds in The Gambia and Senegal. MSc thesis, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences. Available at: https://epsilon.slu.se (accessed 15 November 2023).

Getachew, T., Haile, A., Tibbo, M., Sharma, A.K., Sölkner, J., & Wurzinger, M., 2010. Herd management and breeding practices of sheep owners in a mixed crop-livestock and a pastoral system of Ethiopia. Afr. J. Agric. Res, 5(8), 685–691. doi 10.5897/AJAR10.392

Gizaw, S., Komen, H., Hanotte, O., & Van Arendonk, J.A., 2008. Indigenous sheep resources of Ethiopia: types, production systems and farmers preferences. Anim. Genet. Resour., 43(4), 25–39. doi 10.1017/S1014233900002704

Gutu, Z., Haile, A., Rischkowsky, B., Mulema, A.A., Kinati, W., & Kassie, G., 2010. Evaluation of community-based sheep breeding programmes in Ethiopia. International Center for Agricultural Research in the Dry Areas, Addis Ababa, Ethiopia.

Haile, A., Wurzinger, M., Mueller, J., Mirkena, T., Duguma, G., Okeyo Mwai, A., Sölkner, J., & Rischkowsky, B.A., 2011. Guidelines for setting up community-based sheep breeding programs in Ethiopia: Lessons and experiences for sheep breeding in low-input systems. ICARDA tools and guidelines no.1. International Center for Agricultural Research in the Dry Areas, Aleppo, Syria.

Hassen, M., Amentie, T., Abdimahad, K., Ma'alin, A., & Mahamed, A., 2022. Hygienic production and post-harvest handling practices of raw camel milk in Degahbour district of Jarar zone, Somali Regional State, Ethiopia. Open J. Anim. Sci., 12(2), 303–316. doi 10.4236/ojas.2022.122023

Hemacha, S.A., Kebamo, M., & Hailemeskel, D., 2022. Breeding practice, trait preferences and flock structure of local sheep in selected districts of Hadiya zone, Southern Ethiopia. J. Livest. Sci., 13, 171–179. doi 10.33259/JLivestSci.2022.171-179

Jaitner, J., Sowe, J., Secka-Njie, E., & Dempfle, L., 2001. Ownership pattern and management practices of small ruminants in The Gambia—implications for a breeding programme. Small Rumin. Res., 40(2), 101–108. doi 10.1016/S0921-4488(00)00221-2

Jimmy, S., David, M., Donald, K.R., & Dennis, M., 2010. Smallholder goat breeding systems in humid, sub-humid and semi-arid agro-ecological zones of Uganda. Glob. Vet., 4(3), 283–291.

Kebede, T., Lemma, T., Dinka, H., Guru, M., & Sisay, A., 2008. Growth performance and carcass characteristics of Arsi-Bale goats castrated at different ages. JCAB, 2, 187–194.

Kefale, A., Awoke, T., Getu, A., & Abegaz, S., 2017. Herd management and breeding practices of holla sheep owners in south wollo zone, Ethiopia. Int. J. Adv. Geosci., 5(2), 41–47. doi 10.14419/ijbr.v5i2.8333

Kosgey, I.S., 2004. Breeding objectives and breeding strategies for small ruminants in the tropics. Wageningen University and Research. PhD thesis, Wageningen Universiteit. Available at: https://core.ac.uk/download/pdf/132679007.pdf (accessed 27 November 2023).

Kosgey, I.S., Rowlands, G.J., van Arendonk, J.A., & Baker, R.L., 2008. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Rumin. Res., 77(1), 11–24. doi 10.1016/j.smallrumres.2008.02.005

Kuyamandi Development Services, 2006. Goat meat production feasibility study. Available at: http://www.lepelle-nkumpi.gov.za/lepelle nkumpiadmin/pages/sites/lepellenkumpi/documents/strategies/GOAT%20FARMING%20FEASIBILITY.pdf (accessed 18 August 2023).

Mengesha, M. & Tsega, W., 2012. Indigenous sheep production in Ethiopia: a review. Iran. J. Appl. Anim. Sci., 2(4), 311–318.

Monau, P.I., Visser, C., Nsoso, S.J., & van Marle-Köster, E., 2017. A survey analysis of indigenous goat production in communal farming systems of Botswana. Trop. Anim. Health. Prod., 49, 1265–1271. doi 10.1007/s11250-017-1324-6

Mphahlele, M., Tsotetsi-Khambule, A.M., Moerane, R., Mashiloane, M.L., & Thekisoe, O.M., 2019. Risk factors associated with occurrence of anthelmintic resistance in sheep of resource-poor farmers in Limpopo province, South Africa. Trop. Anim. Health. Prod., 51, 555–563 doi 10.1007/s11250-018-1724-2

Mthi, S. & Nyangiwe, N., 2018. Farmers perception on sheep production constraints in the communal grazing areas of the Eastern Cape Province, South Africa. Int. J. Livest. Prod., 9(12), 334–339. doi 10.5897/IJLP2018.0500

Mthi, S., Nyangiwe, N., Thubela, T., Nyalambisa, N., Madyibi, Z., & Yawa, M., 2020. Cattle production and breeding practice in communal farming system in the Eastern Cape Province, SAJAE, 13, 24–54.

Mueller, J.P., Rischkowsky, B., Haile, A., Philipsson, J., Mwai, O., & Besbes, B., 2015. Community-based livestock breeding programmes: essentials and examples. JABG, 132(2), 155–168. doi 10.1111/jbg.12136

Nandolo, W., Wurzinger, M., Mészáros, G., Van Tassell, C., Gondwe, T., Mulindwa, H., & Sölkner, J., 2016. Identification of breeding objectives in community-based goat breeding programmes in Malawi. Acta Agric. Slov., 5(104), 103–108.

Lepelle-Nkumpi Local Municipality, 2020. 2016–2021 Integrated Development Plan. Lepelle-Nkumpi Municipality, Lebowakgomo. Available at: http://www.lepelle-nkumpi.gov.za/lepelle-nkumpi-admin/pages/sites/lepellenkumpi/documents/idp/LNM%20INTEGRATED%20DEVELOPMENT%20PLAN%20 2016-2021.pdf (accessed 26 November 2024).

Omore, A., Kurwijila, L., & Grace D., 2008. Improving livelihoods in East Africa through livestock research and extension: reflections on changes from the 1950s to the early twenty first century. Trop. Anim. Health. Prod., 41(7), 1051–1059. doi 10.1007/s11250-008-9272-9

Sölkner, J., Nakimbugwe, H., & Zárate, A.V., 1998. Analysis of determinants for success and failure of village breeding programmes. In: Proceedings of the 6th World Congress on Genetics Applied to Livestock Production, January 11–16, 1998. Armidale, Australia.

Tesfaye, G., 2008. Characterization of Menz and Afar indigenous sheep breeds of smallholders and pastoralists for designing community-based breeding strategies in Ethiopia, MSc thesis, Haramaya University, Haramaya, Ethiopia. Available at: https://core.ac.uk/reader/132684800 (accessed: 7 October 2022).

Tsedeke, K., 2007. Production and marketing of sheep and goats in Alaba, SNNPR. MSc thesis, Hawassa University, Awassa, Ethiopia. Available at: https://core.ac.uk.download/pdf/132631374.pdf (accessed: 17 August 2022).

Tyasi, T.L., Ng'ambi, J., & Mogashoa, S., 2022. Breeding practices and trait preferences of goat keepers at Lepelle-Nkumpi Local Municipality, South Africa: implication for the design of breeding programmes. Trop. Anim. Health. Prod., 54(1), 68. doi 10.1007/s11250-022-03078-x

Wurzinger, M., Gutiérrez, G.A., Sölkner, J., & Probst, L., 2021. Community-based livestock breeding: coordinated action or relational process? Vet. Sci., 8, 3–7. doi 10.3389/fvets.2021.613505

Yamane, T., 1967. Statistics, An Introductory Analysis (2nd ed.). Harper and Row, New York.

Yawa, M., Mtenjwa, B., Jaja, I.F., Mthi, S., Nyangiwe, N., Tokozwayo, S., Rumosa-Gwaze, F., Stempa, T., & Qokweni, L., 2024. Assessment of knowledge, attitudes, and practices related to the prevalence of sheep scab among communal sheep farmers in Eastern Cape Province, South Africa. Vet. World, 17(3), 558. doi 10.14202/vetworld.2024.558-563

Zenda, M. & Malan, P.J., 2024. Investigation of challenges faced by small-scale sheep farmers in the Northern Cape (Hantam Karoo), South Africa. SAJAE, 52(1), 189–209.

Zewdu, A., Alemayehu, K., & Wondifraw, Z., 2018. Breeding practices and farmers trait preferences on indigenous dairy cattle production in East Gojja Zone, Ethiopia. AJAFS, 6(1), 6.