Original Research Article

Examination of the Breed Preference of Farmers and the Morphometric Characteristics of Sukuma Goats and a Crossbred of Malya and Sukuma Goats in Maswa District, Tanzania

~~Preference by Farmers and Morphometric Characteristics of Sukuma and Crossbred of Malya and Sukuma Goats in Maswa District, Tanzania~~

ABSTRACT

Aims: To study farmers' perception toward performance of crossbreds (Malya x Sukuma) relative to the indigenous Sukuma goats.

Study design: The study was of cross-sectional design employing comparative analysis.

Place and Duration of Study: The study was conducted in Maswa District of Tanzania over a three weeks period.

Methodology: Fifty respondents from household which were previously involved in the crossbreeding program were sampled purposively and interviewed using questionnaires on good and bad attributes of each genotype and ranks of desired breed according to market price, mature body size and age of attaining mature size. Body weights and linear body measurement of mature crossbred (Malya x Sukuma) goats and pure Sukuma goats were also taken after interviewing each household respondent. Interview data were analyzed using frequency distribution and body measurements were analyzed using GLM procedure of SAS.

Results: The most preferred breed was crossbred goats due to their high market price, large mature body size and early age of attaining mature size. Good attributes for Sukuma goats were disease resistance (98%) and drought resistance (94%) while bad attributes were low price in the market (88%), small body size (94%) and slow growth rate (72%). Good attributes for crossbred goats were premium price in the market (92%), high growth rate (80%) and large body size (94%). Bad attributes for crossbred goats had very low frequency. The crossbred goats were larger compared to Sukuma goats. Their mature body measurements were body length (60.6±0.46 cm), heart girth (77.6±0.58 cm), height at withers (66.4±0.42 cm) and body weight (35.1±0.52 kg) for crossbred goats while corresponding mature body

measurements for Sukuma goats were 49.6±0.42 cm, 65.1±0.54 cm, 56.7±0.39 cm and 21.6±0.48 kg, respectively.

Conclusion: Crossbred goats were accepted by farmers due to their beneficial impact to the households' economy.

Keywords: ~~Attributes of breeds~~breed attributes, indigenous goats, ~~meat goats~~goat meat, mature body size

~~1.~~ INTRODUCTION

Goats ~~play an important role in~~have a significant impact on the food and nutritional security of ~~the~~ rural ~~people~~ communities, especially in ~~places~~ areas where there is ~~scarcity~~ lack of pasture for ~~rearing~~ large ~~ruminants~~animals. They are able to ~~role of goats in~~ improv~~e~~ing the income and livelihood of ~~rural people~~ these communities ~~has increased due to the animals' ability to~~ becauss they can thrive ~~by grazing~~ on poor natural pastures in ~~arid and semi-arid~~dry areas without needing additional feed ~~supplementary feeding~~ [1]. As a result ~~Thus,~~ goats are ~~important~~ crucial to ~~poor~~ improverised farming communities in ~~the~~ developing ~~world~~ countries because they offer greater productivity ~~of their higher output as compared to~~ with fewer resources, ~~inputs, small size~~ as well as less space.~~and small space requirements.~~

Sukuma, Masai, Gogo, and Pare are indigenous goat strains commonly found in rural parts of Tanzania. ~~People around many rural parts of Tanzania keep indigenous goats strains like Sukuma, Masai, Gogo and Pare~~ [2]. Thee goats ~~are serve multiple purposes as they~~ valued for their ability to produce ~~a variety of products and by products, such as~~ meat, milk, manure and skin. They are also used ~~, and can be utilized~~ in ~~various~~ traditional functions ~~including~~ and rituals ~~and paying of dowries~~ [3]. ~~Many f~~Farmers prefer keeping goats ~~originating in their~~ from their localities because of their ~~preference to certain traits such as~~ tolerance to ~~prolonged~~ drought, ~~and extreme heat,~~ resistance to diseases, high reproduction efficiency and ~~appreciable~~ growth performance [4,5]. However,~~Despite~~ the productivity ~~people's preference to these strains~~ of indigenous goats has been poor~~, local goats' productivity~~ in terms of growth and reproduction performance ~~has been poor~~ [3, 6, 7]. Indigenous Sukuma goats in particular, ~~are referred to~~ have smallest mature body size ~~among all indigenous strains belonging to Small East African (SEA) goat breed~~ [2] ~~. The small mature size of Sukuma goats has been~~ which lower~~ing~~ market value of their meat. ~~of chevon sourced from indigenous goat flocks due to the tendency of buyers to set prices based on visual body size [8]. This is emanating as a serious~~

~~disadvantage because there is higher demand of goat meat in preference to beef in Tanzania.~~

~~In the effort t~~To improve the market value of goats ~~kept~~ in Maswa district, ~~Tanzania Livestock Research Institute (TALIRI) Mabuki in collaboration with Zonal Agricultural Research Development Fund (ZARDEF) implemented~~ a community-based breeding program was implemented to ~~from 2008 to 2011, which aimed to improve preferable conventional traits namely growth rate, mature body size and ability to produce twins under extensive management system by~~ cross~~ing~~ ~~the~~ indigenous Sukuma goats with Malya goats. However, ~~Information concerning~~ the perception of farmers on the ~~on farm~~ performance of the crossbred progeny ~~, which is a product of improved breed and indigenous breed~~ was not captured, while it is important for planning scalling-up of the breeding intervention. ~~The objective of t~~This study ~~was~~ aimed to investigate the attributes of Sukuma and Sukuma x malya goats in farmers' flocks and compare their ~~with respect to preferred attributes. B~~body measurements ~~of goats of the two genetic groups were also compared in order~~ to ~~investigate if they could have reflection on~~understand preferences.

~~2.~~ MATERIALS AND METHODS

~~2.1~~ Description of ~~the S~~study ~~A~~area

This study was ~~conducted~~ carried out in Mwabayanda and Senani villages ~~of~~ in Maswa District, Tanzania. These were sites for implementation of the project which aimed at improvement of Sukuma goats, which are indigenous to the area, by crossbreeding with Malya goats. Detailed description of the study area is as presented in [8].

Comment [U1]: To be reconstructed

Or it should be:
The purpose of the project was to improve the local Sukuma goats by crossing them with Malya goats

~~2.2~~ Data Collection

Farmers' interviews

The researchers collected information on ~~F~~farmers' perceptions on the performance of the two goat genetic groups ~~under the study were collected through individual farmer interviews by using a~~through structured questionnaire. Data recorded on ~~Information about~~ the composition of the flock ~~structure~~ by sex and age class ~~and farmers',~~ as well as the farmers preference ~~for the breeds~~ and ranking~~s~~ of the breeds. ~~were firstly recorded.~~ They also gather information on the ~~Then, data were collected~~ on ~~farmers~~' perceived ~~ptions regarding good~~ positive and ~~bad~~ negative attributes of each genotype, their mature size, market price and time to reach market size.

2.2.2 Body measurements

Body measurements for mature size for the goats were taken and recorded in order to examine the difference in mature body size between Sukuma goats and crossbred (Malya x Sukuma) goats so that to investigate if the farmers' responses might have reflection on body size of the goats. Selection of animals to be measured was based on age and sex. The following body measurements were taken on mature goats, whereby both sexes of Sukuma and the F_1 crosses (Malya x Sukuma) were involved:

- Body weight (BW), which was measured in kilogram (kg), was obtained by weighing a live goat by using a spring balance,
- Body length (BL), which was measured in centimeter (cm) was obtained by measuring the distance between the prominence of the shoulder and the hind edges of ischium (length from the shoulder to the pin bone) using a tailor's measuring tape,
- Heart girth (HG), which was measured in cm using a tailor's tape as described by [9] from a goat standing on its four legs while restrained, with head maintained in an upright position. Tailor's tape was placed around the goat at the point with smallest circumference just behind the fore-legs and
- Height at withers (HW), which was measured as the distance from the ground to the highest point of the withers using a calibrated ruler. This was recorded in cm.

Comment [U2]: Recast

~~2.3~~ Data analysis

Questionnaire data

The data were coded and analyzed using descriptive statistics option of [10] to generate frequency distributions of the variables under the study.

Comment [U3]: Explain clearly how the data were handled.

Body measurements data

The effects of breed, sex and interaction between breed and sex on body measurements (body weights, body length, heart girth and height at withers) of goats were analyzed by using the General Linear Models of SAS employing the following model [11]:

$Y_{ij} = \mu + B_i + S_j + (B*S)_{ij} + \varepsilon_{ij}$

where:

Y_{ij} = Observation (body measurements) from a goat of i^{th} breed and j^{th} sex.

μ = Overall mean

B_i = Effect of i^{th} breed (1=Crossbred, 2=Sukuma)

S_j = Effect of j^{th} sex (1=Male, 2=Female)
$(B*S)_{ij}$ = Effect of interaction between i^{th} breed and j^{th} sex
ε_{ij} = Random error term

~~3.~~ RESULTS

~~3.1~~ Farmers' goat flock structure characteristics

As shown in Table 1, the total number of goats in the 50 households was 961, of which 289 (30.1%) were males and 672 (66.9%) were females. Sukuma strain goats were 621 (64.6%) while crossbreds (Malya x Sukuma) were 340 (35.4%). On average, each household had only one Sukuma buck and one crossbred buck. The numbers of adult females, which were five (5) for Sukuma strain and three (3) for crossbreds, were higher than the rest of categories. Also in each household the numbers of mature females were higher than other categories, with Sukuma mature females ranging from 0 to 15 and crossbred mature females ranging from 0 to 9. The flock size for goats per household in the area under the study averaged at 12 for Sukuma goats and 8 for crossbred goats.

Table 1: Flock size and structure per household for Sukuma and Malya x Sukuma goats in Maswa

Age class	Sex	Total flock structure			Average flock structure					Flock structure ranges	
		Su	MaxSu	Total	Su	SD	MaxSu	SD	Total	SD	Su	MaxSu
Kids	M	54	34	226	1	1.08	1	0.85	5	3.50	0 – 4	0 – 4
	F	91	47		2	1.70	1	1.38			0 – 6	0 – 6
Weaners	M	73	31	273	1	1.27	1	0.88	5	3.39	0 – 5	0 – 3
	F	113	56		2	1.94	1	1.52			0 – 7	0 – 5
Adults	M	53	44	462	1	0.99	1	0.83	10	4.75	0 – 4	0 – 3
	F	237	128		5	2.59	3	2.19			0 – 15	0 – 9
Total		621	340	961	12	6.13	8	5.74	20	9.98	0 – 15	0 - 9

Su=Sukuma goats, Ma=Malya goats, MaxSu=crossbred goats

~~3.2~~ Preferences for Sukuma and Malya x Sukuma goats

~~Good~~ Positive and ~~bad~~ negative attributes for Malya x Sukuma goats

Results on preferred attributes of the goats under the study are summarized in Table 2. All the farmers interviewed ranked first crossbred goats over the indigenous Sukuma goats. The crosses were preferred because of their large mature size (94%), premium market price (92%) and high growth rate (80%). Other good attributes for crossbred goats which were mentioned by few farmers were production of large amount of milk, resistance to diseases,

high twinning rate, high fertility, appearance attractiveness, large quantity of meat, large size of skin, ability to thrive from eating low quality feeds including kitchen swills and docile temperament. There were a few farmers who mentioned bad attributes of crossbred goats, and these were being prone to diseases (16%), performing poorly under drought conditions (8%) and aggressive temperament of bucks (6%).

~~Good~~ Positive and ~~bad~~ negative attributes for Sukuma goats

Majority (98%) of the farmers preferred drought resistance and others (94) preferred disease resistance of Sukuma goats despite ranking them the second. Other good attributes for Sukuma goats which were mentioned by few farmers were high fertility (12%) and low management costs (8%). The farmers also mentioned bad attributes of Sukuma goats. These were small body size (94%), low market price (88%) and slow growth rate (72%). A minority group of farmers remarked to dislike Sukuma goats from their low production performance for meat, milk and skins, having poor fertility and being destroyers of crops.

Table 2: Good and bad attributes for Sukuma and Malya x Sukuma crossbred goats (n = 50)

Sukuma goats			
Good attributes	**Frequency**	**Bad attributes**	**Frequency**
Diseases resistance	49 (98)	Low price in the market	44 (88)
Drought resistance	47 (94)	Small body size	47 (94)
High fertility	6 (12)	Slow growth rate	36 (72)
Easy to management	4 (8)	Small amount of milk	15 (30)
		Poor fertility	2 (4)
		Low quantity of meat	6 (12)
		Small size of skin	8 (16)
		Destroy crops	8 (16)
Crossbred goats			
Good attributes		**Bad attributes**	
Premium price	46 (92)	Prone to diseases	8 (16)
High growth rates	40 (80)	Perform poorly in drought condition	4 (8)
Large body size	47 (94)	Aggressive especially bucks	3 (6)
Resistance to diseases	8 (16)	Expensive management	1 (2)
Have high amount of milk	15 (30)	Easily captured by predators	1 (2)
High twinning rate	5 (10)		
High fertility	7 (14)		

They are attractive	5 (10)
Large quantity of meat	8 (16)
Large size of skin	11 (22)
Eats everything even kitchen swills	3 (6)
They are docile	6 (12)

NB: Numbers in brackets indicate percentages out of the 50 respondents

~~3.3~~ Body measurements of Sukuma and Mallya x Sukuma goats

Body length

The results for body measurements of mature goats are presented in Table 3. For BL, the overall mean was 53.6±0.25 cm. The measurement varied highly significantly (p<0.001) among breeds and sexes. The BL for Sukuma goats was remarkably shorter (49.6±0.42 cm) than that of crossbreds (60.6±0.46 cm). There was interaction between breed and sex with regard to BL. Mean BL for females (does) was 53.4±0.29 cm while for males (bucks) was 56.7±0.55 cm. The difference in BL between crossbred bucks and Sukuma bucks was bigger than the difference between crossbred does and Sukuma does (Figure 1). The BL for Sukuma bucks (49.8±0.76 cm) and Sukuma does (49.3±0.38 cm) were shorter than those of crossbred bucks (63.7±0.81 cm) and crossbred does (57.5±0.44 cm).

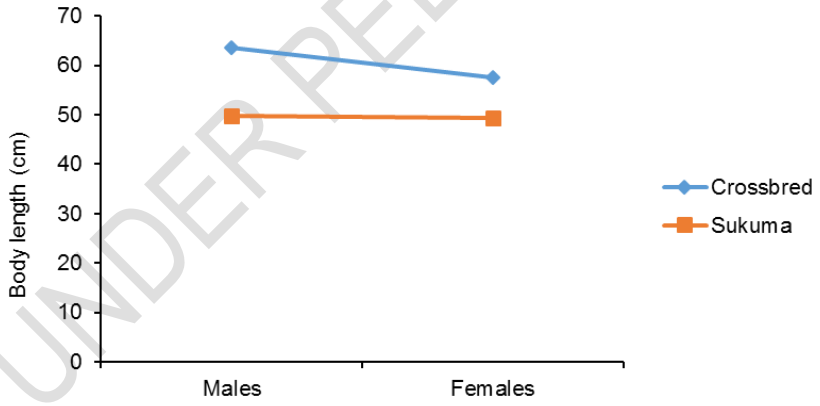

Figure 1: Difference in body length pattern between male and female goats

Heart girth

Heart girths also differed highly significantly (p<0.001) between breeds, sexes and there was interaction between breed and sex. The mean HG for

crossbreds was higher (77.6±0.58 cm) than for Sukuma (65.1±0.54 cm) and the heart girth for bucks (73.6±0.70 cm) was higher compared to the does (69.1±0.37 cm). The HG for crossbred bucks was higher (81.3±1.03 cm) than that of crossbred does (73.9±0.55 cm), but these were higher than those of Sukuma bucks (65.8±0.96 cm) and Sukuma does (64.3±0.49 cm). Heart girths of crossbred bucks were also wider than those of crossbred does, while the difference between HG of Sukuma bucks and those of Sukuma does was small (Figure 2).

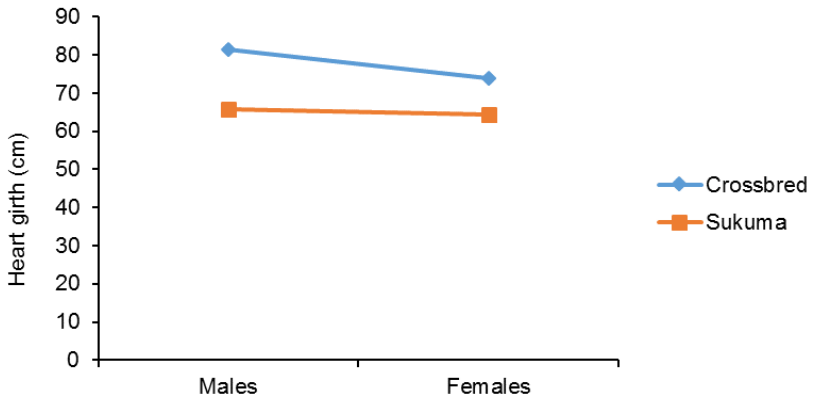

Figure 2: Difference in heart girth pattern between male and female goats

Height at withers

Highly significant (p<0.001) differences were also observed for HW between breeds, sexes as well as for their breed-sex interactions. Crossbred goats had a higher mean HW (66.4±0.42 cm) compared to Sukuma goats (56.7±0.39 cm). Further, bucks showed a higher HW (64.6±0.51 cm) compared to does (58.5±0.26 cm). The HW for crossbred bucks was higher (71.1±0.74 cm) than that of crossbred does (61.6±0.40 cm). As Figure 3 shows, crossbred bucks were also taller by 12.9 cm compared to Sukuma bucks while crossbred does were taller by only 6.24 cm compared to Sukuma does.

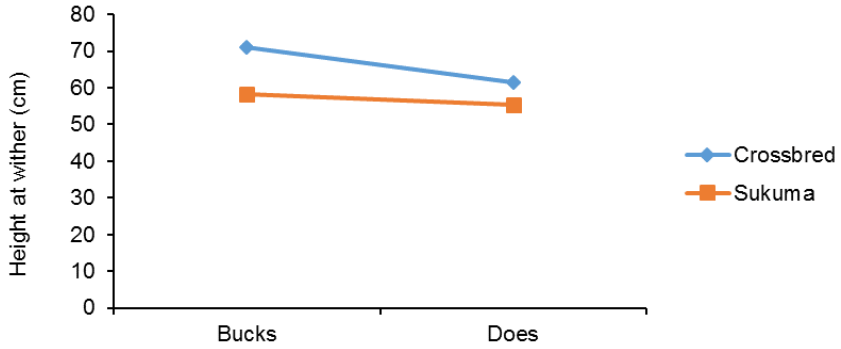

Figure 3: Difference in height at withers pattern between male and female goats

Body weight

Similarly, to other measurements studied, BW showed highly significant (p<0.001) differences between breeds, sexes and interaction of breed and sex. Crossbred goats had a higher mean body weight (35.1±0.52 kg) compared to Sukuma goats (21.6±0.48 kg). For sex groups, bucks had a higher mean body weight (31.0±0.63 kg) than does (25.6±0.33 kg). Moreover, the mean body weight for crossbred bucks was higher by 17.9 kg above Sukuma bucks whereas crossbred does were heavier by 9.07 kg compared to Sukuma does (Figure 4).

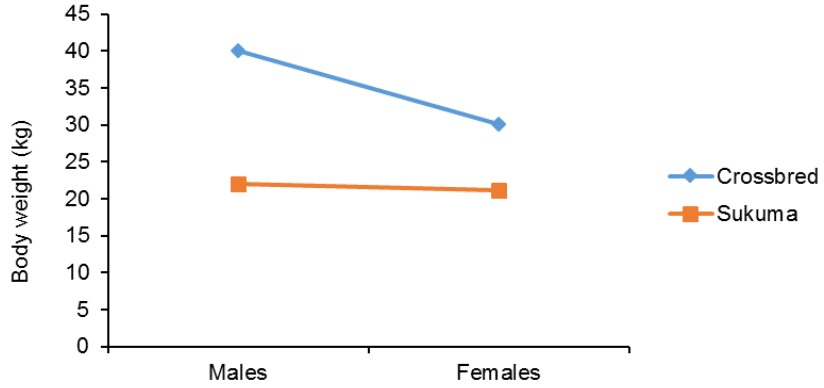

Figure 4: Difference in body weight pattern between male and female goats

Table 3: Least squares means for effect of breed and sex on body length, heart girth, height at withers and body weight of Sukuma and Malya x Sukuma

crossbred goats in Maswa

Factor	N	Body length	Heart girth	Height at withers	Body weight
Overall mean	278	53.6±0.25	69.5±0.32	59.4±0.23	26.2±0.29
Breed		***	***	***	***
Crossbreed	123	60.6 ± 0.46[a]	77.6 ± 0.58[a]	66.4 ± 0.42[a]	35.1 ± 0.52[a]
Sukuma	155	49.6 ± 0.42[b]	65.1 ± 0.54[b]	56.7 ± 0.39[b]	21.6 ± 0.48[b]
Sex		***	***	***	***
Male	60	56.7 ± 0.55[a]	73.7 ± 0.70[a]	64.6 ± 0.51[a]	31.0 ± 0.63[a]
Female	218	53.4 ± 0.29[b]	69.1 ± 0.37[b]	58.5 ± 0.26[b]	25.6 ± 0.33[b]
Breed Sex		***	***	***	***
Crossbred male	28	63.7±0.81[a]	81.3±1.03[a]	71.1±0.74[a]	39.9±0.92[a]
Crossbred female	95	57.5±0 .44[b]	73.9±0.55[b]	61.6±0.40[b]	30.2±0.50[b]
Combined mean	123	60.6±0.46	77.6±0.58	66.4±0.42	35.1±0.52
		NS	NS	***	NS
Sukuma male	32	49.8±0.76	65.8±0.96	58.1±0.69[a]	22.0±0.86
Sukuma female	123	49.4±0.38	64.3±0.49	55.4±0.35[b]	21.1±0.44
Combined mean	155	49.6±0.42	65.1±0.54	56.7±0.39	21.6±0.48

***p<0.001; [a,b]means with different letters within the same factor and column are significantly different at p<0.05; N= Number of observations; ~~NS=Not significant.~~is not shown on the table.

~~4.~~ DISCUSSION

The flock structure displayed a reasonable composition of crossbred goats in farmers' flocks. This indicates that, the desire for transforming indigenous flocks into crossbred goats was partially achieved and the breeding program had impact. The flock size for goats per household in the area under the study averaged at 12 for Sukuma goats and 8 for crossbred goats implying an overall of 20 goats per household. The flock size observed per household therefore lies within the range of 10 – 40 reported by [12] and that of 1 - 22 reported by [13]. The flock size observed for Sukuma goats was higher than the mean flock sizes of 8.8 and 11.6 reported by [14] and [15], respectively but lower than the flock size of 25 obtained by [16] in Chepareria, West Pokot, Kenya. The number of males in each household flock was very low. This is normal and is due to the fact that farmers prefer to sell males rather than females because of their large body size for fetching premium price and retention of only selected breeding male(s). Does are also needed in large number for flock expansion because many of them can be served by one buck according to breeding ratio. An observation similar to this was reported by [7] for Tanzanian EAS goats in agro-pastoral communities of semi-arid and sub-humid areas in the country's central zone.

Formatted: Heading 1, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Good attributes for Sukuma goats as perceived by farmers were found to be disease and drought resistance, while bad attributes were slow growth rate and small body size. It is well known that resistant goats have high survival rates and can be raised easily whereas large sized ones are more marketable and can fetch high prices. Similar observations were made by [5] for goats of South Omo of Ethiopia and [17] for the Small East African goats that have slow growth rate, small body size and poor fertility. On the other hand, the goats were perceived by the farmers to possess good attributes of tolerating drought, diseases and heat as perceived by farmers in the extensive farming systems of Central and Western Kenya. It was also ever explained by [7] that, tolerance of indigenous goats to diseases and drought might be due to the fact that indigenous goats have been naturally selected, through continuous exposure to survive drought and disease challenges in their environments.

In concurrence to the present study, [18] also got similar results for Creole goats and their crossbred in a survey carried out in Guadeloupe where most of farmers considered Creole goats being hardy and resistant whereas some few identified good meat taste as a good attribute for goats. These authors indicated further that, farmers in Guadeloupe prefer keeping crossbred goats from their good conformation, high growth rate and good market price. According to [19], farmers who keep Begait goats in Northern Ethiopia liked goats with large body size, high twinning ability and resistance to drought, which is also a similar observation to that found in this study. Therefore, the farmers' perception towards crossbred goats in this study lied more on possession of good attributes than bad attributes and that has been experienced among other goat crossbreeding programs involving farmers in low input systems of tropical regions. This thereby suggests that, farmers appreciate the performance of improved (crossbred) goats due to the great role they play in boosting their household socio-economy**.**

In the study, crossbred (Malya x Sukuma) goats displayed higher values with regard to all body measurements analyzed (body length, heart girths, height at withers and body weight) than indigenous Sukuma goats and in the respect the results conquered with [20]. The observed values for the body measurements for Sukuma goats in the current study were also comparable to those reported by [2] for the same breed, but were slightly lower than those obtained by [7] for EAS goats in Iramba and Kongwa District of Tanzania Central zone. Crossbred mature body measurements for Sukuma x Malya crossbreds observed in the present study were almost similar to those observed from crossbreds of Creole x Nubian as reported by [21]. Kalahari Red goats as described by [22] were heavier in BW and had longer BL than EAS in current study, while HW was similar to that observed in this study for Malya x Sukuma crossbred goats but higher than that of Sukuma goats. The

body measurements of crossbred goats in the current study were comparable to those of Western lowland goats of Ethiopia while body measurements of Sukuma goats seem to be comparable to those of Abergele goats of Ethiopia [23]. The general observation from overall results is that, farmers' had preference for crossbred over indigenous goats. This was considered valid because crossbred goats appeared to outperform indigenous Sukuma goats in terms of body size at maturity as reflected by body measurements analyzed.

~~5.~~ CONCLUSION

The present study indicated that farmers in the study area appreciated the performance of crossbred goats. The preference for crossbred goats could in part be linked to their ability to grow faster and attain bigger mature size than the unimproved goats, which probably resulted into getting a premium price. The body measurements of crossbreds showed to be superior to those of Sukuma goats reflecting the differential preferences for the studied genetic goat groups.

ETHICAL APPROVAL

This study was approved by the Research Ethical Committee of Sokoine University of Tanzania. Approval Number/Date

REFERENCES

1. Ballal KM, Ahmed MA and Musa LM. Estimates of phenotypic and genetic parameters of growth traits in the Sudanese Nubian goats. Research Journal of Animal and Veterinary Sciences. 2008; 3: 9-14.

2. Nguluma AS, Msalya G and Chenyambuga SW. Phenotypic variation among four populations of small East African goats of Tanzania. Livestock Research for Rural Development. 2016; 28: 36. Available at http://www.lrrd.org/lrrd28/8/ngul 28136.htm.

3. Malole JI, Kifaro GC, Mtenga LA and Chenyambuga SW. The estimate of genetic correlation and heritability of various traits in Small East African Goats. Tanzania Journal of Agricultural Sciences. 2002; 5(1): 59-64.

4. Chenyambuga SW, Komwihangilo DM and Jackson M. Production

performance and desirable traits of Small East African goats in semi-arid areas of Central Tanzania. Livestock Research for Rural Development. 2012; 24:118. Available at http://www.lrrd.org/lrrd24/7/chen24118.htm.

5. Berhanu T, Thiengtham J, Tudsri S, Abebe G, Tera A and Prasanpanich S. Purposes of keeping goats, breed preferences and selection criteria in pastoral and agro-pastoral districts of South Omo Zone. Livestock Research for Rural Development. 2012; 24: 12.

6. Safari J, Mushi DE, Mtenga LA, Eik LO, Kifaro GC, Muhikambele VRM, Ndemanisho EE, Maeda-Machang'u AD, Kassuku AA, Kimbita EN and Ulvund M. A note on growth rates of local goats and their crosses with Norwegian goats at village level in Tanzania. Livestock Research for Rural Development. 2005; 17: 47. Available at http://www.lrrd.org/lrrd17/4/safa17047.htm.

7. Chenyambuga SW and Lekule FP. Breed preference and breeding practices for goats in agro-pastoral communities of semi-arid and sub-humid areas in Tanzania. Livestock Research for Rural Development. 2014; 26: 117. Available at http://www.lrrd.org/lrrd26/6/chen26117.htm.

8. Chavala BC, Kifaro GC, Tungu GB and Chasama GL. Genetic parameters for growth traits of Malya goats and heterosis from crossbreds of Malya and Sukuma goats. Asian Journal of Research in Animal and Veterinary Sciences 2023; 6(4): 492-502.

9. Statistical Package for Social Science (SPSS) (2011). IBM SPSS Statistics for Windows, Version 20.0 Armonk, New York: IBM Corp.

10. Abegaz S and Awgichew K. Estimation of weight and age of sheep and goats. ESGPIP (Ethiopia Sheep and Goat Productivity Improvement Program) Technical Bulletin. 2009; 23. Available at http://www.esgpip.org.htm.

11. SAS. Statistical Analysis System, User's guide, version 8.2. SAS Institute Inc., Cary, NC, USA. 2003

12. Németh T, Branduse L, Ábrahám M and Kukovics S. Factors affecting the profitability of different goat farm sizes in Hungary. South African Journal of Animal Science. 2004; 34(5) supplement 1.

13. Ahuya C O, Okeyo A M and Murithi F M. Productivity of cross-bred goats under smallholder production systems in the Eastern highlands of Kenya. Small Stock in Development. 2005; 54: 54 - 60.

14. Akpa GN, Alphonsus C, Dalha SY and Garba Y. Flock structure and incidence of supernumerary teats in smallholder goat production in Kano state. Continental Journal of Veterinary Sciences. 2010; 4: 9 -15.

15. Boogaard BK, Waithanji E, Poole EJ and Cadilhon JJ. Smallholder goat production and marketing: a gendered baseline study from Inhassoro District Mozambique. NJAS-Wageningen Journal of Life Sciences. 2015; 74: 51-63.

16. Engström F. Breeding and flock structure in livestock based agro pastoralism systems in Chepareria, West Pokot, Kenya. Dissertation for Award of MSc. degree at Swedish University of Agricultural Sciences. 2016; 38 pp.

17. Kosgey IS, Rowlands G, van Arendonk J and Baker R. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Ruminant Research. 2009; 77 (1): 11 – 24.

18. Gunia M, Mandonnet N, Arquet R, de la Chevrotière C, Naves M, Mahieu M and Alexandre G. Production systems of Creole goats and their implications for a breeding programme. Animal. 2010 ; 4(12): 2099-2105.

19. Abraham H, Gizaw S and Urge M. Identification of breeding objectives for Begait goats in western Tigray, North Ethiopia. Tropical Animal Health and Production. 2018; 50(8): 1887-1892.

20. Das SM and Sendalo DS. Comparative performance of improved meat goats in Malya, Tanzania. In: Proceedings of the First Biennial Conference of the African Small Ruminant Research Network held at ILRAD, Nairobi, Kenya, 10-14 December 1990. African Small Ruminant Research Network, ILCA (International Livestock Centre for Africa), Nairobi, Kenya. 1990; pp. 445-452.

21. Vargas S, Larbi A and Sanchez M. Analysis of size and conformation of native Creole goat breeds and crossbreds used in smallholder agrosilvopastoral systems in Puebla, Mexico. Tropical Animal Health and Production. 2007; 39(4): 279-286.

22. Hifzan RM, Idris I and Yaakub H. Growth pattern for body weight, height at withers and body length of Kalahari Red goats. Pakistan Journal of Biological Sciences. 2015: 18(4): 200-203.

23. Abegaz S, Sölkner J, Gizaw S, Dessie T, Haile A and Wurzinger M. Description of production systems and morphological characteristics of Abergele and Western lowland goat breeds in Ethiopia: implication for community-based breeding programmes. Animal Genetic Resources. 2013; 53: 69-78.