

Phenotypic Characteristics And The Factors Causing Effects On The Phenotypes Of *Capra Hircus* Populations In Kajiado And Makueni Counties, Kenya

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Summary :The aim of this project was to study the phenotypic characteristics and the factors causing effects on the phenotypes of *Capra hircus* (Galla and Small East African goats) populations in Kajiado County in Rift valley province and Makueni County in Eastern province. Data were obtained through personal observations of the goats between 1st September, 2013 and 2nd December, 2013. This study covered characteristics of goats majorly quantitative and qualitative traits. The Galla goats weighed more than the Small East African goats as least square mean for the Galla goats was $46.33 \pm s.e 0.36$ kg while the Small East African goats had $32.41 \pm s.e 0.41$ kg. The males were superior in weight than the females as the males had a least square mean of $45.75 \pm s.e 0.43$ kg while the females had a least square mean of $32.99 \pm s.e 0.30$ kg. Breed and sex had high significant effect on weight. County also had high significant effects on weight and heart girth length while flock size had significant effects weight. Weight, height, heart girth length and back length were highly correlated at $p < 0.001$ which means that by measuring one of the four traits, one is able to get information concerning the other three traits. 6% and 67% of the female SEA in Kajiado and Makueni respectively had black pigmented skin 2% and 11% of the male SEA in Kajiado and Makueni respectively also had black pigmented skin The trait of the black pigmented skin is a trait which is specific to Galla goat breed but it appeared in goats which were more of SEA goats. This was due to a lot of cross breeding between the Galla and SEA goat breeds. These are clear indications that in the two Counties of Kenya there are no pure Galla goats nor pure SEA goats.

KEY WORDS: Phenotypic characteristics, *Capra hircus*, Kajiado and Makueni Counties, Kenya

I. MATERIALS AND METHODS

Sampling

Random sampling was used in this study. Morphological trait measurements were taken from total of 360 goats in the two Counties; 180 animals per County (**Commission on genetic resources for food and agriculture**, 2011). Three goats per flock across the different areas were sampled, (Halima, 2012). Visiting the homesteads was done in the morning hours because, first it was during the dry season and animals were driven out early to start feeding. Secondly, the data collection was done in the morning to avoid taking wrong values on weight (Yakubu *et al.*, 2010)

Data were obtained from direct observations and recording of physical appearance of the selected goats including qualitative traits like, coat colour, sex, ear orientations and, presence or absence of mane, tassel presence or absence of beards, presence or absence of horns, and horn orientation, head orientation, rump profile, and measurements of quantitative traits like back length, weight, heart girth width, height, ear length, udder circumference, hair length, chest girth length, body length, horn length and horn length, amongst other attributes were recorded and questions related to the management of goats were also asked.

Quantitative traits measurements involving weight was done using a weighing balance of (0-100 kg), while the measurements involving length was done using a tape measure of (0-100 cm) (Yunusa, 2013).

GPS was used to record specific locations/co-ordinates where the specific data/information was collected.

Identification of Small East African and Galla goats.

Goats were identified using description by (NAFIS, 2009), thus all Galla goats must be white haired with black skin, nose, feet and under tail. The colour of fur of SEA goat ranges from pure white to black over a variety of spotted and reddish brown colour. The males often have a pronounced mane running the full length of the back.

Statistical data analyses and processing

The data collected was entered in excel and later exported to the statistical package (SAS V 9.0) (Snedecor and Cochran, 1967) for analysis. Different models in the SAS software were used to analyse the data. The effects of factors affecting weight, height, heart girth length and back length was analysed using proc GLM (Generalised Linear Model) for ANOVA (Analysis of variance) and LSM (Least Square Means) and weight, height, heart girth length and back length as the variables.

Correlation analysis was done using the model proc corr data with the variables being weight, height, heart girth length and back length.

Frequencies were done using proc freq model in the SAS system software. Chi-square and fisher`s test was also used to find significant effects of variables (Snedecor and Cochran, 1967). Univariate description graph was drawn using SAS software using proc univariate data.

Map was drawn using arc view GIS (Global Information System) software.

II. RESULTS

The spatial distribution of the flocks of the Galla goat breed, the SEA goat breed and the mixed Galla and SEA

There was even distribution of the flocks of Galla, SEA and mixed Galla and SEA in Kajiado and Makueni. The co-ordinates are shown in appendix ii. This was caused by crossing of the Galla goats and the SEA goats (Figure 3)

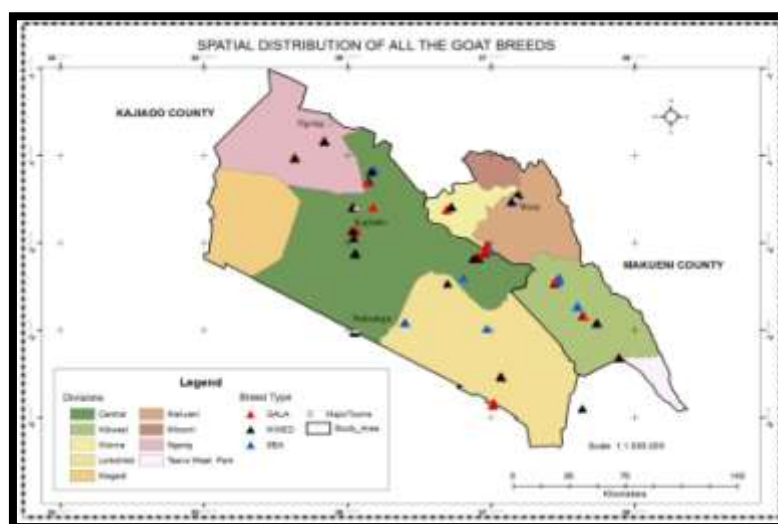


Figure 1: Spatial distribution of the flocks of Galla goat breed, SEA goat breed and the mixed Galla and SEA

Goat breeds descriptions in Kajiado and Makueni

The mean and the standard deviation for linear measurements including weight, height, ear length, back length, heart girth length, hair length, horn length, udder circumference and amount of milk are well illustrated for the Galla and the SEA and for both females and males. The mean weight for the Galla goats breed was higher than that of the SEA. The height of female Galla is a mean of 68.42 cm \pm std 2.60 cm in Kajiado and 66.72 cm \pm std 5.2 cm in Makueni, a significant difference of $p < 0.05$. Female SEA is 59.81 cm \pm std 3.41 cm in Kajiado and

58.00 cm \pm std 4.04 cm in Makueni, a significant difference of $p < 0.05$. The male Galla is 76.04 cm \pm std 3.80 cm in Kajiado and 74.17 cm \pm std 4.76 cm in Makueni, no significant difference as $p > 0.05$. The male SEA goats have 66.20 cm \pm std 4.23 cm in Kajiado and 62.49 cm \pm std 6.03 cm in Makueni, a significant difference at $p < 0.05$ (table 1).

The ear length also showed significant differences. The ear length of a female Galla goat is 8.78 cm \pm std 1.31 cm in Kajiado and 7.41 cm \pm std 0.72 cm in Makueni. The female SEA is 8.00 cm \pm std 0.93 cm in Kajiado and 7.34 cm \pm 0.75 cm in Makueni. The ear length of the male Galla is 13.71 cm \pm std 1.87 cm in Kajiado and 15.91 cm \pm std 1.44 cm in Makueni. The male SEA is 13.29 cm \pm std 2.34 in Kajiado and 15.43 cm \pm std 1.59 cm in Makueni (table 1).

A female Galla has a back length of 59.46 cm \pm std 1.99 cm in Kajiado and 59.65 cm \pm std 1.84 cm in Makueni. The female SEA is 54.49 cm \pm std 2.33 cm in Kajiado and 54.61 cm \pm std 2.20 cm in Makueni, no significant difference of $p > 0.05$. The male Galla is 68.73 cm \pm std 3.23 cm in Kajiado and 69.47 cm \pm std 2.19 cm in Makueni. The male SEA is 61.60 cm \pm std 4.35 cm in Kajiado and 60.68 cm \pm std 3.06 cm in Makueni (table 1).

Heart girth length of the males showed significant difference. A male Galla is 18.36 cm \pm std 0.82 cm in Kajiado and 17.17 cm \pm std 2.17 cm in Makueni. The SEA is 16.54 cm \pm std 0.99 cm in Kajiado and 14.88 cm \pm 1.40 cm in Makueni (table 1).

The average amount of milk production per Galla goat was a mean 0.75 \pm std 0.00 liters per lactation and 0.52 \pm std 0.07 liters for SEA per lactation in Kajiado. In Makueni, the average amount of milk per lactation was 0.72 \pm std 0.08 litres for Galla goats and 0.51 \pm std 0.05 litres for SEA goats (table 1).

Table 2 shows the factors causing significant effects on weight, height, heart girth length and back length while table 3 shows the least square means for the factors. County has highest significant effect on weight at $p < 0.001$ and Least square mean of 43.20 \pm 0.49 kg in Kajiado and 35.54 \pm 0.48 kg in Makueni. It also has higher effect on heart girth length at $p < 0.01$ and a least square mean of 18.80 \pm 0.36 cm in Kajiado and 17.81 \pm 0.19 cm in Makueni. Breed and sex had the highest significant effects on weight, height, heart girth length and back length at $p < 0.001$. Farming type had effects on back length at $p < 0.01$ with the goats kept under pastoralism showing highest least square mean of 62.69 \pm 0.51 cm. Interaction between County and sex caused highest significant effect on weight at $p < 0.001$ with the males in Kajiado showing highest least square on weight of 51.68 \pm 0.70 kg while the female SEA goats in Makueni showed the smallest least square mean of 31.25 \pm 0.52 kg. Interaction between breed and sex caused the highest significant effect on weight at $p < 0.001$ with the male Galla goats in Kajiado recording highest least square mean of 54.87 \pm 0.58 cm and the female SEA in Makueni had the smallest least square mean of 28.19 \pm 0.45 cm. In height, male Galla goats in Kajiado had the highest least square mean of 75.44 \pm 1.18 cm while female SEA in Makueni had the least of 59.39 \pm 1.11 cm ($p < 0.01$). The interaction of breed and sex also caused highest significant difference in heart girth length and high significant difference in back length at $p < 0.01$ with the male Galla goats having the highest least square mean.

Qualitative traits description of the Galla goats and SEA goats in Makueni is shown in appendix i.

Weight, height, heart girth length and back length were highly correlated at $p < 0.001$ according to analysis done using the Pearsons correlation coefficient model. The correlation co-efficient for all the variables was higher than 0.76 (table 4).

Table 1: The mean and the standard deviation of the measurements on quantitative traits of Galla and SEA in Kajiado and Makueni

TRAIT	KAJIADO					MAKUENI				
	Breed	Galla		SEA		Galla		SEA		
		mean	std	mean	std	mean	std	mean	std	
Weight (kg)	Female	40.78	3.18	30.18	2.77	30.63	6.04	28.32	5.3	
	Male	62.11	6.79	42.07	7.30	44.04	11.88	30.14	4.08	
Height (cm)	Female	68.42	2.60	59.81	3.41	66.72	5.2	58.00	4.04	
	Male	76.04	3.80	66.20	4.23	74.17	4.76	62.49	6.03	
Ear	Female	8.78	1.31	8.00	0.93	7.41	0.72	7.34	0.75	

length (cm)									
	Male	13.71	1.87	13.29	2.34	15.91	1.44	15.43	1.59
Back length (cm)	Female	59.46	1.99	54.49	2.33	59.65	1.84	54.61	2.20
	Male	68.73	3.23	61.60	4.35	69.47	2.19	60.68	3.06
Heart girth length (cm)	Female	18.36	0.82	16.54	0.99	17.17	2.17	14.88	1.40
	Male	21.71	1.79	18.80	1.01	21.22	2.29	17.68	2.07
Hair length (cm)	Female	0.80	0.04	0.79	0.04	0.79	0.07	0.80	0.06
	Male	0.93	0.90	0.80	0.00	0.82	0.04	0.76	0.27
Horn length (cm)	Female	6.80	2.80	7.30	2.15	7.49	2.24	7.02	2.45
	Male	11.15	7.90	18.00	2.05	15.05	5.80	16.27	4.75
Udder circumference (cm)	Female	51.23	4.23	46.78	2.16	51.47	2.61	47.62	2.57
Milk amount (l)	Female	0.75	0.00	0.52	0.07	0.72	0.08	0.51	0.05

Table 2: ANOVA description showing the effects of fixed and variable factors on weight, height, back length, heart girth length

ANOVA	C	B	S	FT	FS*FM	S*C	B*S	FS
WT (kg)	***	***	***	—	—	***	***	**
HT (cm)	NS	***	***	—	*	—	**	—
BL (cm)	NS	***	***	**	—	—	***	—
HGL (cm)	**	***	***	—	—	—	**	—

* significant at P<0.05; ** significant at P<0.01; *** significant at P<0.001; NS-Not _significant; * interactions, WT – weight, HT – height, BL – back length, HGL – heart girth length

County (C), Breed (B), Sex(S), Farming type (FT), Flock size (FS), interactions between; Flock size (Feeding method) FS*FM, Sex (County) S*C, Breed*Sex (B*S)

Table 3: Least square means (LSM) for the factors causing significant differences on weight, height, back length and heart girth length

LSM		MEAN	SE
Weight (Kg)			
County	Kajiado	43.20	0.49
	Makueni	35.54	0.48
Breed	Galla	46.33	0.36
	SEA	32.41	0.41
Sex	Female	32.99	0.30
	Male	45.75	0.43
Breed*Sex	Galla Female	37.78	0.42
	Galla males	54.87	0.58
	SEA Female	28.19	0.45
	SEA male	36.63	0.67
Sex*County	Kajiado Female	34.72	0.53
	Kajiado Male	51.68	0.70
	Makueni Female	31.25	0.52
	Makueni Male	39.82	0.68

Height			
County	Kajiado	67.55	1.18
	Makueni	66.00	1.14
Breed	Galla	71.65	1.12
	SEA	61.90	1.10
Sex	Female	63.62	1.09
	Male	69.93	1.12
Breed*Sex	Galla Female	67.85	1.14
	Galla Male	75.44	1.18
	SEA Female	59.39	1.11
	SEA Male	64.41	1.20
Back length			
County	Kajiado	61.19	0.55
	Makueni	62.28	0.52
Breed	Galla	65.02	0.48
	SEA	58.45	0.44
Sex	Female	57.81	0.44
	Male	65.66	0.47
Farming type	Semi-commercial	61.38	0.51
	pastoralism	62.69	0.51
	Mixed farming	61.14	0.61
Breed*Sex	Galla Female	60.26	0.50
	Galla Male	69.79	0.54
	SEA Female	55.36	0.46
	SEA Male	61.54	0.51
Heart girth length			
County	Kajiado	18.80	0.36
	Makueni	17.81	0.19
Breed	Galla	19.61	0.25
	SEA	17.00	0.26
Sex	Female	16.75	0.24
	Male	19.85	0.26
Breed*Sex	Galla Female	17.80	0.26
	Galla Male	21.41	0.28
	SEA Female	15.70	0.26
	SEA Male	18.29	0.31

Table 4: Pearson's correlation for weight, height, heart girth length and back length

	Weight	Heart girth length	Height	Back length	Significant level
Weight	1.00	0.78	0.81	0.77	***
Heart girth length	0.78	1.00	0.81	0.76	***
Height	0.81	0.81	1.00	0.77	***
Back length	0.77	0.76	0.77	1.00	***

The values in the table × (multiplied) by 100% shows the percentage correlation, *** significant at p<0.001.

III. DISCUSSION AND CONCLUSION

Breed description in Kajiado and Makueni

Colour of the skin and fur

The colour of the skin (appendix i) was such that; 82 (98.80%) of the female Galla goats in Kajiado had pigmented black skin, 1.20% had their skin colour not pigmented. The female Galla goats in Makueni had 35 (76.09%) having black pigmented skin. The male Galla goats in Kajiado had 43 (95.56%) of their number

having black pigmented skin while the male Galla goats in Makueni had 18 (78.26%) having black pigmented skin colour. Six (16.22%) female SEA in Kajiado, 67 (50.00) female SEA in Makueni, 2 (13.33%) male SEA goats in Kajiado and 11 (29.73%) male SEA in Makueni had black pigmented skin. Over 90% of the Galla goats had white colour of fur, some had white patchy black colour. The SEA goats had a variety of colours with over 50% of the population being white; others were white patchy black, white patchy brown, brown and grey. These results were totally different from what is supposed to be a typical Galla and SEA goat as the findings were different from (NAFIS, 2009). The white colour of fur was still the dominant in Galla goats. The appearance of white patchy black colour in some of the Galla goats indicates the introduction of genes for black colour into the population of the Galla goats. This was as a result of cross breeding between the Galla and the SEA. According to this research there were many white coloured goats in Kajiado than in Makueni (appendix i). This was because the Maasai farmers in Kajiado preferred white coloured goats since they had higher market value. The findings by (Kisiangani's, 2008) that the Maasai's liked spotted animals for dowry and uniformly coloured animals for sacrifices never featured in this research.

The average amount of milk per lactation of the SEA and the Galla goats

The average amount of milk produced by the female Galla goats and the female SEA goats in Kajiado was 0.75 ± 0.00 litres and 0.52 ± 0.07 litres for respectively (table 1). In Makueni, the average amount of milk produced by a female Galla goat was 0.72 ± 0.08 litres and 0.51 ± 0.05 litres by the SEA. The results indicate that Galla goats produced a lot of milk than SEA goats. These findings were same to (Joy, 2013) who noted that SEA goats in Uganda produced 0.75 litres of milk or less and that they were predominantly kept for meat in Uganda.

Factors causing effects on quantitative traits

County caused the highest significant effect on weight of goats at $p < 0.001$ (table 4). This is explained by the difference in the methods of selection by the farmers in the two Counties. Kajiado goats had higher least square mean of 43.20 ± 0.49 kg (table 3) because the farmers considered large body size when doing selection of breed while Makueni recorded as low as 35.54 ± 0.48 kg because the farmers did not consider body size when selecting breed. Breed had effect on weight. The Galla goats weighed heavier at a least square mean of 46.33 ± 0.36 kg than the SEA goats at a least square mean of 32.41 ± 0.41 kg, same to (NAFIS, 2009). Sex had effects on weight and height with the males giving a high least square mean weight which was 45.75 ± 0.43 kg while females had 32.99 ± 0.30 kg and in height, the males had 69.93 ± 1.12 cm while the females had 63.62 ± 1.09 cm. This means that the males grew to a bigger size than the females. The result on the effects of sex was same to (Zahraddeen, 2008).

Farming types caused significant effects on back length ($p < 0.01$). Goats kept under pastoralism had longer back length with least square mean of 62.69 ± 0.51 cm. The semi-commercial feeding type had a least square mean of 61.38 ± 0.51 cm and mixed farming type had 61.14 ± 0.61 cm. The longer back length of goats kept under pastoral situation could be because of the adaptation to walking for longer distances; they had to adapt to speed and also to climbing hilly places to get browse from hills during dry season. This result was same to (Safari and Hashemi, 2014). Sex also affected back length as the males recorded a longer back length of least square mean of 65.66 ± 0.47 cm and the females had 58.81 ± 0.44 cm. the results were same to (Ikpeze and Ebenebe, 2004).

Sex had significant effect on heart girth length with the males having higher least square mean of 19.85 ± 0.26 cm and the females 16.75 ± 0.24 cm. Different from (Aghaali *et al.*, 2010). The effect of sex on heart girth length could be explained by the difference physiological characteristics and endocrine system type and measure of hormone secretion, especially sexual hormones.

Flock size caused significant effect on weight at $p < 0.01$ while interaction between flock size and feeding method caused significant effect on height at $p < 0.05$. This was because goats fed under free ranging system especially in Kajiado County were kept in large numbers and this encouraged competition and efficiency on feed use; they therefore had higher weight on average (table 1) than the goats kept in Makueni that were constantly tethered at one point continuously regardless of season and this made the goats in Makueni to have low mean weight. This was different from (Lee *et al.*, 2008).

Interaction between sex and County caused significant differences in weight ($p < 0.001$) while interaction between breed and sex caused significant differences in weight, height, heart girth length and back length. These were so because of the general effects on County, breed, and sex.

The results on *table 4* shows that weight, wither height, heart girth length and back length were highly correlated at ($r < 0.001$). This means that live weight of goats in Kajiado can be reasonably estimated using wither height, heart girth length and back length. This result was same to (Kunene *et al.*, 2009).

I then conclude that the existing population have a lot of similar traits so that some Galla goats have traits that are specific traits of SEA goats while some SEA goats have traits which are specific for Galla goats. This result has been encouraged by a lot of cross breeding between the two breeds. Therefore, there are no pure SEA or Galla goats in Kajiado and Makueni Counties.

REFERENCE

- [1] Aghaali – Gamasae *et al.*, 2010: Genetic and phenotypic aspect of the body measured traits.
- [2] Yunusa A.J., A. E. Salako and O.A Oladejo 2013: Morphometric characterization of Nigerian indigenous sheep using multifactorial discriminant analysis
- [3] Commission on genetic resources for food and agriculture (CGRFA)-13/11/inf.19(April 2011): Draft guidelines on phenotypic characterization of animal genetic resources.
- [4] Halima Hassen¹, Michael Baum¹, Barbara Rischkowsky¹ and Markos Tibbo, (2012): Phenotypic characterization of Ethiopian indigenous goat populations
- [5] Joy (2013):Goat Development Programme. Local types of Ugandan goats
- [6] Kunene, A.E Nesamvuni, I.V Nsahlai (2009): Determination of prediction equations for estimating body weight of Zulu (Nguni) sheep.
- [7] NAFIS (2009): Local Breeds .The Small East African Goat. http://www.go.ke/livestock/dairy_goat-production/breeds/
- [8] Ikepeze O.O and C.I Ebenebe (2004): Factors affecting growth and body measurements of the grass-cutter (Rodentia : Thryonomyidae)
- [9] Snedecor, G.W and Cochran, W.G. (1967): Statistical Methods. 6thed.Ames, Iowa The Iowa State University Press.
- [10] Lee Sung Ki, Panjono, Sun Moon Kang, Youn Bok Jung, Tae Sil Kim, Ik Sun Lee, Young Han Song and Chang-Gie Kang (2008): Effects of Tethering and Loose Housing on the Meat Quality of Hanwoo Bulls.
- [11] Yakubu A, Salako AE, Imumorin I.G. (2010b): Multivariate analysis of spatial patterns of morphological traits in West African dwarf goats in three agro-ecological zones of Nigeria. J. Appl. Anim. Res. 38:257-260.
- [12] Zahraddeen D, ISR Butswat and S.T Mbap (2008): Evaluation of some factors influencing growth performance of local goats in Nigeria.

APPENDICES

Appendix I: Qualitative traits frequencies

Colour of fur	Frequency	Percent
Female Galla in Kajiado		
white	80	96.39
white patchy black	3	3.61
Female Galla in Makueni		
white	42	91.30
white patchy black	4	8.70
Male Galla in Kajiado		
White	44	97.78
white patchy black	1	2.22
Male Galla in Makueni		
white patchy black	21	91.30
Female SEA in Kajiado		
White	23	62.16
White patchy black	8	21.62
White patchy brown	6	16.22
Female SEA in Makueni		
white	40	54.05
white patchy black	17	22.97
white patchy brown	12	16.22

brown	4	5.41
grey	1	1.35
Male SEA in Kajiado		
white	10	66.67
white patchy brown	5	33.33
Male SEA in Makueni		
white	50	67.57
White patchy black	14	18.92
White patchy brown	4	5.41
brown	4	5.41
grey	2	2.70
Skin colour-black pigmented skin		
Female Galla in Kajiado	82	98.80
Female Galla in Makueni	35	76.09
Male Galla in Kajiado	43	95.56
Male Galla in Makueni	18	78.26
Female SEA in Kajiado	6	16.22
Female SEA in Kajiado	67	50.00
Male SEA in Kajiado	2	13.33
Male SEA in Makueni	11	29.73
Ear orientation		
Female Galla in Kajiado		
erect	78	93.98
drooping	5	6.02
Female Galla in Makueni		
erect	43	93.48
drooping	3	6.52
Male Galla in Kajiado		
erect	43	95.56
drooping	2	4.44
Male Galla in Makueni		
erect	22	95.65
drooping	1	4.35
Female SEA in Kajiado		
erect	36	97.30
drooping	1	2.70
Female SEA in Makueni		
erect	72	97.30
drooping	2	2.70
Male SEA in Kajiado		
erect	15	100.00
Male SEA in Makueni		
erect	34	91.89
drooping	3	8.11
Mane-presense		
Female Galla in Kajiado	1	1.20
Female Galla in Makueni	1	2.17
Male Galla in Kajiado	43	95.56
Male Galla in Makueni	17	73.91
Female SEA in Kajiado	37	100.00
Female SEA in Makueni	1	1.35
Male SEA in Kajiado	13	86.67
Male SEA in Makueni	36	97.30
Tassel-presense		
Female Galla in Kajiado	13	15.66
Female Galla in Makueni	7	15.22
Male Galla in Kajiado	7	15.56

Male Galla in Makueni	6	26.09
Female SEA in Kajiado	4	10.81
Female SEA in Makueni	14	18.92
Male SEA in Kajiado	2	13.33
Male SEA in Makueni	5	13.51
Horn orientation-frequency missing refer to hornless goats		
Female Galla in Kajiado		
Straight	57	87.69
Curved backward	2	3.08
Curved forward	6	9.23
Frequency Missing = 18		
Female Galla in Makueni		
Straight	41	100.00
Frequency Missing = 5		
Male Galla in Kajiado		
straight	27	90.00
curved backward	2	6.67
curved forward	1	3.33
Male Galla in Makueni		
straight	19	95.00
curved forward	1	5.00
Frequency Missing = 3		
Female SEA in Kajiado		
straight	11	34.38
curved backward	13	40.63
curved forward	8	25.00
Frequency Missing = 5		
Female SEA in Makueni		
straight	43	69.35
curved backward	6	9.68
curved forward	13	20.97
Frequency Missing = 12		
Male SEA in Kajiado		
straight	6	50.00
curved backward	6	50.00
Frequency Missing = 3		
Male SEA in Makueni		
straight	16	48.48
curved backward	17	51.52
Frequency Missing = 3		
Beard-presence		
Female Galla in Kajiado	19	22.89
Female Galla in Makueni	19	82.61
Male Galla in Kajiado	19	42.22
Male Galla in Makueni	19	82.61
Female SEA in Kajiado	9	24.32
Female SEA in Makueni	21	28.00
Male SEA in Kajiado	5	33.33
Male SEA in Makueni	29	78.38
Udder shape		
Female Galla in Kajiado		
oval	59	71.08
circular	24	28.92
Female Galla in Makueni		
oval	39	84.78
circular	7	15.22
Female SEA in Kajiado		

oval	28	75.68
circular	9	24.32
Female SEA in Makueni		
oval	57	77.03
circular	17	22.97
Twinning rate-produces twins		
Female Galla in Kajiado	39	30.23
Female Galla in Makueni	11	23.91
Female SEA in Kajiado	24	47.06
Female SEA in Makueni	21	28.38

Appendix II: The co-ordinates for places where sampling was done and flocks of Galla goat breed,

SEA goat breed and mixed Galla and SEA

<u>Division</u>	<u>Location</u>	<u>Sub- location</u>	<u>Village</u>	<u>breeds in flocks</u>	<u>SOUTH</u>	<u>EAST</u>
mashuri	poka	emali	maroloi	Galla goat breed	S02°.12752'	E037°.43051'
mashuri	poka	emali	maroloi	Galla goat breed	S02°.08944'	E037°.47145'
mashuri	poka	emali	maroloi	Mixed Galla and SEA goat breed	S02°.09912'	E037°.46046'
mashuri	poka	emali	maroloi	Galla goat breed	S02°.08947'	E037°.45997'
mashuri	poka	emali	maroloi	Mixed Galla and SEA goat breed	S02°.12740'	E037°.43030'
mashuri	nkama	nkama	samulei	Galla goat breed	S02°.12917'	E37°.42775'
mashuri	nkama	nkama	samulei	Mixed Galla and SEA goat breed	S02°.13198'	E037°.42687'
mashuri	nkama	nkama	samulei	Galla goat breed	S02°.12787'	E037°.41628'
mashuri	nkama	nkama	samulei	Mixed Galla and SEA goat breed	S02.13139'	E037°.40228'
mashuri	nkama	nkama	samulei	Galla goat breed	S02°.12904'	E37°.40155'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02°.95567'	E037°.50090'
loitokitok	ololoopon	kuku	loitokitok	Galla goat breed	S02°.94538'	E037°.50863'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02°.94328'	E037°.50909'
loitokitok	ololoopon	kuku	loitokitok	Galla goat breed	S02°.94106'	E037°.50885'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02°.93939'	E037°.50733'
loitokitok	kimana	kimana	kimana	Galla goat breed	S02°.79827'	E037°.55246'
loitokitok	kimana	kimana	kimana	Mixed Galla and SEA goat breed	S02.79268'	E037°.54582'
loitokitok	kimana	kimana	kimana	Galla goat breed	S02°.79286'	E037°.54496'
loitokitok	kimana	kimana	kimana	Mixed Galla and SEA goat breed	S02°.79301'	E037°.54361'
loitokitok	kimana	kimana	kimana	Galla goat breed	S02°.79405'	E37°.54149'
kajiado	suguta	eldamat	ndagorikajo	Mixed Galla and SEA goat breed	S01°.83699'	E036°.77424'
central	suguta	eldamat	ndagorikajo	Galla goat breed	S01°.84202'	E036°.77496'
kajiado	suguta	eldamat	ndagorikajo	Mixed Galla and SEA goat breed	S01°.84149'	E036°.77286'
central	suguta	eldamat	ndagorikajo	Galla goat breed	S01°.84609'	E036°.77299'
kajiado	suguta	eldamat	ndagorikajo	Mixed Galla and SEA goat breed	S01°.84228'	E036°.77361'
central	enkaroni	kumpa	kumpa	Galla goat breed	S01°.97810'	E036°.78236'
kajiado	enkaroni	kumpa	kumpa	Mixed Galla and SEA goat breed	S01°.97610'	E036°.77080'
central	enkaroni	kumpa	kumpa	Galla goat breed	S01°.97701'	E036°.79400'
kajiado	enkaroni	kumpa	kumpa	Galla goat breed	S01°.97630'	E036°.76467'
central	enkaroni	kumpa	kumpa	Mixed Galla and SEA goat breed	S01°.97550'	E036°.77350'
central	enkaroni	kumpa	kumpa	Mixed Galla and SEA goat breed	S01°.97550'	E036°.77350'
namanga	loronguswa	libisil	orinei	Galla goat breed	S01°.09852'	E036°.78489'

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namanga	loronguswa	libisil	orinei	Mixed Galla and SEA goat breed	S02°.01420'	E036°.77869'
namanga	loronguswa	libisil	orinei	Mixed Galla and SEA goat breed	S02°.10211'	E036°.78269'
namanga	loronguswa	libisil	orinei	Mixed Galla and SEA goat breed	S02°.09777'	E036°.78635'
namanga	loronguswa	libisil	orinei	Mixed Galla and SEA goat breed	S02°.10400'	E036°.77936'
namanga	namanga	loinyorok	meto	Mixed Galla and SEA goat breed	S02°.54566'	E036°.78189'
namanga	namanga	loinyorok	meto	Galla goat breed	S02°.54087'	E036°.78020'
namanga	namanga	loinyorok	meto	Mixed Galla and SEA goat breed	S02°.54090'	E036°.78020'
namanga	namanga	loinyorok	meto	Mixed Galla and SEA goat breed	S02°.54124'	E036°.78262'
namanga	namanga	loinyorok	meto	Mixed Galla and SEA goat breed	S02.54314'	E036°.78492'
ngong	keekonyokie central	oltepesi	oltepesi	Galla goat breed	S02°.01558'	E036°.46794'
ngong	keekonyokie central	oltepesi	oltepesi	Galla goat breed	S01°.56101'	E036°.46884'
ngong	keekonyokie central	oltepesi	oltepesi	Galla goat breed	S01°.56059'	E036°.46785'
ngong	keekonyokie central	oltepesi	oltepesi	Galla goat breed	S01°.56482'	E036°.47580'
ngong	keekonyokie north	oltepesi	oltepesi	Mixed Galla and SEA goat breed	S01°.56686'	E036°.46984'
ngong	keekonyokie north	keekonyokie	keekonyokie	SEA goat breed	S01°.46879'	E036°.62375'
ngong	keekonyokie north	keekonyokie	keekonyokie	Galla goat breed	S01°.46731'	E036°.62303'
ngong	keekonyokie north	keekonyokie	keekonyokie	Galla goat breed	S01.46444'	E036°.62202'
ngong	keekonyokie north	keekonyokie	keekonyokie	Mixed Galla and SEA goat breed	S01°.47028'	E036°.62532'
ngong	keekonyokie	keekonyokie	keekonyokie	Mixed Galla and SEA goat breed	S01°.47345'	E036°.62629'
isinya	ototo	ototo	kisaju	SEA goat breed	S01°.63331'	E036°.88163'
isinya	ototo	ototo	kisaju	Mixed Galla and SEA goat breed	S01°.63928'	E036°.86581'
isinya	ototo	ototo	kisaju	Mixed Galla and SEA goat breed	S01°.63983'	E036°.86780'
isinya	ototo	ototo	kisaju	SEA goat breed	S01°.64112'	E036°.86615'
isinya	ototo	ototo	kisaju	Mixed Galla and SEA goat breed	S01°.64099'	E036°.87091'
isinya	isinya	isinya	isinya	Mixed Galla and SEA goat breed	S01°.69243'	E036°.85577'
isinya	isinya	isinya	isinya	Galla goat breed	S01°.69213'	E036°.85350'
isinya	isinya	isinya	isinya	SEA goat breed	S01°.69509'	E036°.85350'
isinya	isinya	isinya	isinya	Mixed Galla and SEA goat breed	S01°.70088'	E036°.85379'
isinya	isinya	isinya	isinya	Galla goat breed	S01°.10221'	E036°.84823'
wote	wote	kamunyulu	kavati	SEA goat breed	S01°.77301'	E037°.63769'
wote	wote	kamunyulu	kavati	Mixed Galla and SEA goat breed	S01°.77068'	E037°.63004'
wote	wote	kamunyulu	kavati	Mixed Galla and SEA goat breed	S01°.77219'	E037°.63445'
wote	wote	kamunyulu	kavati	SEA goat breed	S01°.77257'	E037°.63579'
wote	wote	kamunyulu	kavati	Mixed Galla and SEA goat breed	S01°.76996'	E037°.63554'

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wote	unoa	unoa	malavani	goat breed	S01°.80938'	E037°.60082'
wote	unoa	unoa	malavani	SEA goat breed	S01°.800759'	E037°.60132'
wote	unoa	unoa	malavani	Galla goat breed	S01°.80529'	E037°.60193'
wote	unoa	unoa	malavani	SEA goat breed	S01°.81199'	E037°.59694'
wote	unoa	unoa	malavani	Mixed Galla and SEA goat breed	S01°.80872'	E037°.60277'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01°.23549'	E037°.84906'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01°.23665'	E037°.84919'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01°.25694'	E037°.84957'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S02°.23731'	E037°.34787'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S02°.23634'	E037°.84559'
makindu	makindu	manyatta	manyatta	SEA goat breed	S02°.26959'	E037°.82537'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02°.26966'	E037°.82622'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02°.26739'	E037°.26739'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02°.26739'	E037°.82633'
makindu	makindu	manyatta	manyatta	Galla goat breed	S02°.26064'	E37°.82655'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02°.40063'	E037°.94302'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02°.40050'	E037°.94639'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02°.40018'	E037°.94570'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02°.39887'	E037°.94550'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02°.39772'	E037°.94267'
kibwezi	masongaleni	masongaleni	masongaleni	Mixed Galla and SEA goat breed	S02°.49143'	E038°.04183'
kibwezi	masongaleni	masongaleni	masongaleni	Mixed Galla and SEA goat breed	S02°.49201'	E038°.04275'
kibwezi	masongaleni	masongaleni	masongaleni	SEA goat breed	S02°.49927'	E038°.04453'
kibwezi	masongaleni	masongaleni	masongaleni	Mixed Galla and SEA goat breed	S02°.49126'	E038°.04633'
kibwezi	masongaleni	masongaleni	masongaleni	SEA goat breed	S02°.47149'	E038°.04781'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02°.45006'	E037°.97352'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02°.45139'	E037°.97352'
mtitoandei	utiithi	mashinani	usalama	SEA goat breed	S02°.97299'	E037°.96963'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02°.45196'	E037°.97099'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02°.45497'	E037°.97841'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Galla goat breed	S02°.68367'	E038°.16004'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Galla goat breed	S02°.68486'	E.38°.15875'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Mixed Galla and SEA goat breed	S02°.68670'	E038°.15946'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Mixed Galla and SEA goat breed	S02°.68835'	E038°.16164'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	SEA goat breed	S02°.68946'	E038°.16269'
mbitini	mulala	katuni	iteta	Mixed Galla and SEA goat breed	S02°.05134'	E037°.47193'
mbitini	mulala	katuni	iteta	SEA goat breed	S02°.05217'	E037°.47554'
mbitini	mulala	katuni	iteta	Mixed Galla and SEA goat breed	S02°.05317'	E037°.46985'
mbitini	mulala	katuni	iteta	SEA goat breed	S02°.05477'	E037°.46902'
mbitini	mulala	katuni	iteta	SEA goat breed	S02°.05628'	E037°.46788'
mbitini	sultan hamud	hamud	sultan	Galla goat breed	S02°.08532'	E037°.48826'
mbitini	sultan hamud	hamud	sultan	Galla goat breed	S02°.08532'	E037°.48826'
mbitini	sultan hamud	hamud	hamud	SEA goat breed	S02°.08532'	E037°.48644'
mbitini	sultan hamud	hamud	hamud	SEA goat breed	S02°.08532'	E037°.48644'
mbitini	sultan hamud	hamud	hamud	Galla goat breed	S02°.08509'	E037°.48826'
mbitini	sultan hamud	sultan	sultan	SEA goat breed	S02°.08481'	E037°.48730'

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mbitini	sultan hamud	hamud sultan hamud	hamud sultan hamud	SEA goat breed	S02°.08482'	E037°.48501'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01°.85417'	E037°.26193'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01°.85619'	E037°.26170'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01°.85640'	E037°.26293'
kilome	mukaa	mtaingo	kithata	Galla goat breed	S01°.85607'	E037°.26456'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01°.85459'	E037°.26347'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01°.83900'	E037°.28777'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01°.83802'	E037°.28706'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01°.83759'	E037°.28600'
kilome	kiimakiu	kiimakiu	kiimakiu	SEA goat breed	S01°.83850'	E037°.26819'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01°.84022'	E037°.28849'