



Relationship between body measurement traits, udder measurement traits and milk yield of Saanen goats in Capricorn district of South Africa



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Abstract:

The association between body measurements and udder measurements can be used towards the improvement of milk yield. The objective of the study was to investigate the correlation between udder measurement traits and milk yield. The study was conducted at Sikline village in Mankweng, Capricorn district of Limpopo province, South Africa where a total number of 30 lactating Saanen goats were used. Pearson's correlation technique was used for data analysis. The results showed a significant ($P<0.05$) correlation between distance between teats and milk yield ($r= 0.45$) and a highly negative significant ($P<0.01$) correlation between teat diameter and milk yield ($r= -0.57$). Body weight and milk yield ($r= 0.54$) had a highly positive significant correlation ($P<0.01$). The finding of the current study implies that body weight and distance between teats can be used to improve the milk yield in Saanen goats. The finding of the study might be used to predict the milk yield of Saanen goats. However, further studies need to be conducted on relation of body and udder measurements and milk yield using higher sample size.

Keywords: Correlation, Body weight, Teat diameter, Udder circumference, Milk yield.

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Saanen goats can adapt to different climatic conditions, and they are characterised as medium to large sized goats with high milk yield⁽¹⁾. Body and udder measurements of an animal are of importance to the farmers as it can be used for feeding, administering of medication, selection for breeding and management on the farm⁽²⁾. Kouri *et al*⁽³⁾ reported that body weight and udder measurements play a significant role on milk yield. Saanen goats are docile with high milk yield of about 2.2 kg/d⁽⁴⁾. There is lack of knowledge on communal farmers to which traits can be used to improve milk yield⁽⁵⁾.

The relationship between the udder and body measurements of different animals have been investigated; Arcos-Alvarez *et al*⁽⁶⁾ reported that there is a correlation between udder measurements, the volume of the udder, and the daily milk yield of Pelibuey ewes. Adewumi *et al*⁽⁷⁾ highlighted that in a traditional rearing system of small stock, results revealed that partial milk yield could be determined based on udder size and teat length in extensively reared does and ewes and heart girth of kids could be used to indicate the doe's milk production. Therefore, milk yield can be predicted from body measurement traits and udder measurement traits. However, as far as known, information on using body measurement traits and udder measurement traits to improve the milk yield of Saanen goats in South Africa is limited and not conclusive. Hence, the objective of this study was to determine the correlation between body measurement traits, udder measurement traits, and milk yield of Saanen goats. The outcomes of this study will help communal farmers to identify body measurement traits and udder measurement traits that can be used to improve milk yield of Saanen goats.

The study was conducted at Sikline village in Mankweng situated at 23°53'24"S latitude and 29°45'25"E longitude, Capricorn district of Limpopo Province, South Africa. The ambient temperature around the study area ranges between 16 and 27 °C in summer while in winter it ranges between 8 and 22 °C. The area receives a mean annual rainfall of 450 mm⁽⁸⁾. A total of 30 lactating Saanen goats reared under an extensive farming system between the ages of 3 to 5 yr were used.

The animals were kept under an extensive farming system. Whereby, they were released into the veld to browse in the morning and collected back to their kraal in the evening. Clean water was provided *ad-libitum*.

A cross-sectional design was used for measuring body measurement traits and udder measurement traits in this study. Milking records for 2 wk that took place 7 d after kidding were collected by the farmer.

Body measurements were recorded using a tape measure calibrated in centimeters while body weight was taken using a weighing scale once in the morning before grazing. Body measurement traits were taken as described by Pesmen and Yardimci⁽⁹⁾. Briefly, Wither's height (WH) was measured as the distance from the surface of a platform to the withers, Body length (BL) was measured as the distance from the occipital joint to the first caudal vertebra, Heart girth (HG) was measured behind the scapula, Sternum height (SH) was measured as the distance between the floor and the ventral surface of the sternum, and Rump height (RH) was measured as a distance between the floor and the dorsal edge of the pelvic girdle.

The following external udder measurement traits: Udder length before milking and after milking (ULB & ULA); Udder width before milking and after milking (UWB & UWA); Udder circumference before milking and after milking (UCB & UCA); Distance between teats before milking and after milking (DBTB & DBTA); Teat diameter before milking and after milking (TDB & TDA); Teat length before milking and after milking (TLB & TLA) were measured using a tape measure (cm)⁽¹⁰⁾. The milking of goats was performed twice a day for 2 wk, in the morning and afternoon. The udder measurements were collected before and after milking.

Statistical Package for Social Sciences (IBM SPSS, 2020) version 27.0 software was used for analysing the data. Descriptive statistics including mean, standard deviation, standard error, and coefficient of variance were calculated. Pearson's correlation was used to determine the relationship between measured traits. A probability of 5% was used for significance and 1% for high significance between traits.

Descriptive statistics of body measurement traits, udder measurement traits, and milk yield of Saanen goats are shown in Table 1. The mean value of MKY was found to be 47.69 L, the highest mean value was displayed by HG and BL, while TDA had the lowest mean value. The highest coefficient of variation was recorded by TLB whereas WH recorded the lowest value. The results highlight that the Saanen goats had an average of 74.27 kg BW; the results are higher than the results that were obtained by Adewumi *et al*⁽⁷⁾ where average body weight was 19.20 and 23.09 kg for goats and sheep respectively.

Table 1: Descriptive statistics of measured traits (cm)

Traits	Mean	SD	SE	CV
BL	76.13	7.92	1.45	10.40
RH	75.37	5.43	0.99	7.20
WH	74.80	4.37	0.80	5.84
SH	49.03	3.85	0.70	7.84
HG	86.47	7.97	1.46	9.22
BW, kg	74.27	15.30	2.79	20.60
ULB	24.40	1.89	0.34	7.73
ULA	20.07	3.53	0.64	19.60
UWB	26.60	1.96	0.36	7.36
UWA	20.77	2.96	0.54	14.23
UCB	57.43	4.01	0.73	6.97
UCA	37.17	5.40	0.99	14.52
DBTB	11.27	2.07	0.38	18.34
DBTA	9.43	1.41	0.26	14.91
TDB	3.77	1.45	0.27	38.62
TDA	3.17	1.20	0.22	37.74
TLB	5.27	2.55	0.46	48.33
TLA	4.20	1.58	0.29	37.72
MKY, L	47.69	11.21	2.80	23.50

Body length (BL), Rump height (RH), Withers' height (WH), Sternum height (SH), Heart girth (HG), Udder length before milking (ULB), Udder length after milking (ULA), Udder width before milking (UWB), Udder width after milking (UWA), Udder circumference before milking (UCB), Udder circumference after milking (UCA) Distance between teats before milking (DBTB), Distance between teats after milking (DBTA), Teat diameter before milking (TDB), Teat diameter after milking (TDA), Teat length before milking (TLB), Teat length after milking (TLA), Milk yield (MKY).

Phenotypic correlation between body measurement traits and udder measurement traits is presented in Table 2. The body measurements showed a significant relationship with udder measurements in Saanen goats. The highest significant correlation coefficient between body measurement and udder measurements was recorded between BL and UWA, HG and UWB, WH and ULB at ($P < 0.01$). The lowest correlation coefficient was highlighted between BL and DBTB, WH and UCB, SH and ULA, BW and ULA at ($P < 0.05$). There was a negative significant correlation between RH and TLB ($P < 0.05$). The findings of this study suggest that body length can be used to improve distance between teats and udder width whereas Rump height can be used to improve udder width, distance between teats and teat length. The findings are similar with the study conducted by others⁽⁷⁾ who stated that there was a significant correlation between body measurement traits and udder measurement traits such as distance between teats, udder width, udder length, and udder circumference that had a significant correlation with body measurement traits such as body length, rump height,

withers height, and sternum height respectively in ewes and does in Nigeria. Other studies conducted in sheep indicated that body measurements such as body weight, withers height, body length, heart girth, neck length, and neck circumference had a significant correlation with udder circumference, udder width, teat length, and distance between teats in West African Dwarf sheep⁽⁵⁾.

Table 2: Phenotypic correlation between body measurement traits and udder measurement traits

Traits	BL	RH	WH	SH	HG	BW	ULB	ULA	UWB	UWA	UCB	UCA	DBTB	DBTA	TDB	TDA	TLB	TLA	
BL																			
RH	0.40*																		
WH	0.44*	0.23 ^{ns}																	
SH	0.28*	0.29*	-0.10 ^{ns}																
HG	0.57**	0.46*	0.45*	0.37*															
BW	0.29*	0.15 ^{ns}	0.05 ^{ns}	0.22 ^{ns}	0.23 ^{ns}														
ULB	0.13 ^{ns}	0.06 ^{ns}	0.50**	-0.13 ^{ns}	0.04 ^{ns}	0.06 ^{ns}													
ULA	0.11 ^{ns}	0.15 ^{ns}	0.12 ^{ns}	0.28*	0.10 ^{ns}	0.27*	0.48*												
UWB	0.16 ^{ns}	0.25*	0.20 ^{ns}	0.20 ^{ns}	0.63**	0.21 ^{ns}	0.48*	0.43*											
UWA	0.72**	0.08 ^{ns}	0.06 ^{ns}	0.07 ^{ns}	-0.10 ^{ns}	0.02 ^{ns}	0.58**	0.71**	0.66**										
UCB	-0.11 ^{ns}	0.12 ^{ns}	0.35*	-0.07 ^{ns}	0.21 ^{ns}	0.20 ^{ns}	0.39*	0.25*	0.19 ^{ns}	0.10 ^{ns}									
UCA	0.14 ^{ns}	0.10 ^{ns}	0.24 ^{ns}	0.06 ^{ns}	0.07 ^{ns}	0.23 ^{ns}	0.57**	0.61**	0.36*	0.46*	0.10 ^{ns}								
DBTB	0.38*	0.26*	0.17 ^{ns}	0.23 ^{ns}	0.24 ^{ns}	0.18 ^{ns}	0.12 ^{ns}	0.25*	0.31*	0.32*	0.26*	0.05 ^{ns}							
DBTA	0.08 ^{ns}	0.03 ^{ns}	-0.07 ^{ns}	-0.07 ^{ns}	-0.15 ^{ns}	0.05 ^{ns}	-0.13 ^{ns}	0.18 ^{ns}	0.27*	0.38*	0.09 ^{ns}	0.14 ^{ns}	0.59**						
TDB	-0.18 ^{ns}	-0.05 ^{ns}	-0.07 ^{ns}	-0.02 ^{ns}	-0.21 ^{ns}	-0.12 ^{ns}	-0.03 ^{ns}	-0.14 ^{ns}	-0.13 ^{ns}	-0.39*	0.12 ^{ns}	0.13 ^{ns}	-0.43*	-0.34*					
TDA	0.00 ^{ns}	0.01 ^{ns}	0.23 ^{ns}	-0.02 ^{ns}	-0.17 ^{ns}	0.07 ^{ns}	0.26*	0.04 ^{ns}	-0.03 ^{ns}	-0.14 ^{ns}	0.11 ^{ns}	0.33*	-0.10 ^{ns}	-0.36*	0.61**				
TLB	-0.23 ^{ns}	-0.29*	-0.08 ^{ns}	-0.03 ^{ns}	-0.03 ^{ns}	-0.17 ^{ns}	-0.09 ^{ns}	-0.29*	-0.23 ^{ns}	-0.26*	0.10 ^{ns}	-0.16 ^{ns}	-0.18 ^{ns}	-0.30*	0.36*	0.44*			
TLA	-0.04 ^{ns}	-0.09 ^{ns}	0.16 ^{ns}	0.03 ^{ns}	0.12 ^{ns}	-0.14 ^{ns}	-0.07 ^{ns}	-0.23 ^{ns}	-0.11 ^{ns}	-0.11 ^{ns}	0.10 ^{ns}	-0.16 ^{ns}	0.17 ^{ns}	-0.10 ^{ns}	0.02 ^{ns}	0.37*	0.81**		

Body length (BL), Rump height (RH), Withers' height (WH), Sternum height (SH), Heart girth (HG), Udder length before milking (ULB), Udder length after milking (ULA), Udder width before milking (UWB), Udder width after milking (UWA), Udder circumference before milking (UCB), Udder circumference after milking (UCA) Distance between teats before milking (DBTB), Distance between teats after milking (DBTA), Teat diameter before milking (TDB), Teat diameter after milking (TDA), Teat length before milking (TLB), Teat length after milking (TLA), Non-significant (^{ns}), Correlation is significant at 0.05 level, (*), Correlation is significant at a 0.01 level (**).

Phenotypic correlation between udder measurement traits and milk yield is shown in Table 3. The udder measurements traits had no statistical significant correlation with MKY except for DBTA that showed a positive correlation at ($P<0.05$). There was a highly negative significant correlation between MKY and TDB ($P<0.01$) and a negative significant correlation with TLB ($P<0.05$). Results indicated that all udder measurement traits had no significance correlation with milk yield except for the DBTA, TLB, and TDB. The study is in agreement with other study⁽¹¹⁾ who stated that the correlation coefficients between milk yield and udder measurement traits were not significant in White Bornu and West African Dwarf of Southern Nigeria. There current findings imply that udder measurements such as distance between teats, teat length and teat diameter can be used in improving milk yield. Similarly, Žujović *et al*⁽¹²⁾ highlighted a relationship between breast width, breast depth, and milk yield of domestic Balkan goat breed that is reared in the mountain range Sharplanina. However, the study conducted in Pelibuey ewes⁽⁶⁾ disagrees with the current study and stated that there was no correlation between teat length and teat diameter in the relationship between udder measurement and milk yield in Pelibuey Ewes. These results may differ due to differences in the breed of animal used and environmental factors.

Table 3: Phenotypic correlation between udder measurement traits and milk yield

Traits	ULB	ULA	UWB	UWA	UCB	UCA	DBTB	DBT A	TDB	TDA	TLB	TLA	MKY
ULB													
ULA	0.48*												
UWB	0.48*	0.43*											
UWA	0.58**	0.71*	0.66*										
UCB	0.39*	0.25 ^{ns}	0.19 ^{ns}	0.10 ^{ns}									
UCA	0.57**	0.61*	0.36*	0.46*	0.10 ^{ns}								
DBTB	0.12 ^{ns}	0.25 ^{ns}	0.31*	0.32	0.26*	0.05 ^{ns}							
DBTA	-0.13 ^{ns}	0.18 ^{ns}	0.27 ^{ns}	0.38*	0.09 ^{ns}	0.14 ^{ns}	0.59**						
TDB	-0.03 ^{ns}	-0.14 ^{ns}	-0.13 ^{ns}	-0.39*	0.12 ^{ns}	0.13 ^{ns}	-0.43*	-0.34*					
TDA	0.26*	0.04 ^{ns}	-0.02 ^{ns}	-0.14 ^{ns}	0.11 ^{ns}	0.33*	-0.10 ^{ns}	-0.36*	0.61**				
TLB	-0.09 ^{ns}	-0.29*	-0.23 ^{ns}	-0.26 ^{ns}	-0.10 ^{ns}	-0.16 ^{ns}	-0.18 ^{ns}	-0.30*	0.36*	0.44*			
TLA	-0.07 ^{ns}	-0.23 ^{ns}	-0.11 ^{ns}	-0.11 ^{ns}	0.10 ^{ns}	-0.16 ^{ns}	0.17 ^{ns}	-0.10 ^{ns}	0.02 ^{ns}	0.37*	0.81*		
MKY	-0.18 ^{ns}	0.07 ^{ns}	0.25 ^{ns}	0.19 ^{ns}	0.04 ^{ns}	0.12 ^{ns}	0.28 ^{ns}	0.45*	-0.57**	-0.29 ^{ns}	-0.48*	-0.13 ^{ns}	

Udder length before milking (ULB), Udder length after milking (ULA), Udder width before milking (UWB), Udder width after milking (UWA), Udder circumference before milking (UCB), Udder circumference after milking (UCA) Distance between teats before milking (DBTB), Distance between teats after milking (DBTA), Teat diameter before milking (TDB), Teat diameter after milking (TDA), Teat length before milking (TLB), Teat length after milking (TLA), Milk yield (MKY), Non-significant (^{ns}), Correlation is significant at 0.05 level, (*), Correlation is significant at a 0.01 level (**).

Table 4 present the correlation between body weight and milk yield. The results of correlation between milk yield and body measurements revealed that there was no significant correlation between the five body measurements taken. Only BW showed a highly positive correlation with MKY ($P<0.01$). On evaluation of relationship between body measurement traits and milk yield, results recognized that all body measurement traits had no significance correlation with milk yield except body weight which had highly positive statistical significance correlation with milk yield. The study is in harmony with the findings of Kouri *et al*⁽³⁾ who stated that milk yield was positively correlated with body weight of Damascus and Zaraibi goats. However, it disagrees with other study⁽²⁾ who stated that body length had a positive significance correlation with milk yield in Damascus and Zaraibi goats in Egypt. The environmental factors and the breed morphological structure may factor for the difference in the outcome of results obtained.

Table 4: Phenotypic correlation between body measurement traits and milk yield

Traits	BL	RH	WH	SH	HG	BW	MKY
BL							
RH	0.40*						
WH	0.44*	0.23 ^{ns}					
SH	0.28 ^{ns}	0.29*	-0.10 ^{ns}				
HG	0.57**	0.46*	0.45*	0.37*			
BW	0.29*	0.15 ^{ns}	0.05 ^{ns}	0.22 ^{ns}	0.23 ^{ns}		
MKY	0.06 ^{ns}	0.24 ^{ns}	0.09 ^{ns}	0.15 ^{ns}	0.18 ^{ns}	0.54**	

Body length (BL), Rump height (RH), Withers' height (WH), Sternum height (SH), Heart girth (HG), Milk yield (MKY),

Non-significant (^{ns}), significant at 0.05 level, (*), significant at a 0.01 level (**).

The current study concludes that the following udder measurement traits had a relationship with body measurement traits: udder width with body length, rump height and heart girth; distance between teats with body length and rump height; teat length with rump height; udder length with withers height and body weight; and udder circumference with withers height and sternum height. Distance between teats, teat length, and teat diameter has a relationship with milk yield. The body weight of Saanen goat showed a relationship with milk yield. This finding can be used by communal farmers to improve the milk yield of the Saanen goats. There is a need for more investigation on the relationship between body measurement traits and udder measurement and milk yield to assist in the improvement of milk yield.

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Conflict of interests

The authors declare that they have no conflict of interest.

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