Estimation of live body weight from the heart girth measurement in KwaZulu-Natal goats

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Abstract

This study was conducted to determine if heart girth measurements can be used effectively in the prediction of live body weights of goats in KwaZulu-Natal (KZN), and to assist in developing a heart girth measuring tape. This is especially aimed at providing a practical solution to determine live weight of goats for those farmers who are not able to purchase their own weighing scales. Data were collected from 1202 goats of different breeds, ages and sexes (55 bucks, 1053 does and 94 castrates) in different areas of KZN. Goats weighed were from research stations, and commercial, communal and emerging farms, thus covering a wide range of farming systems. A regression coefficient of heart girth measurement against body weight of 0.895 was obtained which demonstrated a strong relationship between the two variables. This indicated that the measurement of heart girth can be used in predicting body weight in goats and a tape measure can therefore be developed to assist livestock farmers in managing their goats better.

Keywords: Goats, girth, body weight, scale, communal farmers, emerging farmers
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Introduction

Goats in developing countries are considered one of the most important farm animals for the small-scale farmers, providing them with meat, milk, skins and manure (Peacock *et al.*, 2005). Goats, chickens and cattle are the most frequently kept livestock by people living in the small-scale farming systems in KwaZulu-Natal (De Villiers & Letty, 2001). The scale of interest in goats was observed when more than 700 people attended a Goat Farmer's Day at the Cedara Research Station during May 2006 (De Villiers, J.F., 2008, personal observation). Income derived from livestock production is a major contributor to the livelihoods of rural people. Livestock are a form of capital that is easily converted into cash (Rocha *et al.*, 1991; Nsoso *et al*., 2004).

The importance of goats in KZN is indicated by the fact that KZN, with 14% (937 853) of the national goat population of South Africa (6.6 million), ranks third in the country in terms of goat numbers, after the Eastern Cape (45%) and Limpopo (16%) Provinces (National Department of Agriculture, Agricultural Statistics, 2004). In the Eastern Cape Province of South Africa, Mahanjana & Cronje (2000) reported that 86% of the households in communal areas kept goats, on average 16 goats. In KZN according to the Goat Farmer's day held in Cedara in 2006, 49.9% of the people indicated they keep goats (De Villiers, 2008, personal observation). This reiterates the importance of these animals to the lives of people in rural areas. The main reasons found for keeping goats in the Eastern Cape were for slaughtering during traditional ceremonies (35%), cash sales (23%) and 15% for own meat consumption (Mahanjana & Cronje, 2000). In KZN 71.2% of farmers keep goats for selling, 8.1% cultural purposes and 7.4% for own meat use according to results from a questionnaire completed by goat owners at the Goat Farmer's Day at Cedara in 2006

(De Villiers, J.F., 2008, personal observation). Goats not only play a vital role in South Africa but are of great importance all over the world. In Botswana the indigenous sheep and goats provide income, employment and food security for the resource-poor farmers (Nsoso *et al*., 2004). In Pakistan goats also play a significant role in the economy and nutrition of landless, small and marginal farmers (Khan *et al*., 2006). In Nigeria, goats of the Red Sokoto types are primarily used for meat production. Hassan & Ciroma (2007) observed that in order to increase the meat yield from these goats, breeding selection to improve live weight would be required. Similarly in Pakistan it was observed that to increase the meat yield in Beetal goats genetic improvements in live weight were necessary (Khan *et al.,* 2006).

Internal helminth parasites are an important cause of disease in goats in the rural areas of KwaZulu-Natal (Vatta *et al*., 2002). In order to administer the correct dose of medication whether by injection or orally, it is absolutely essential to know the live body weight of the animal to be treated. Vatta *et al.* (2007) found in an on-farm study with small-scale goat farmers in the Bulwer area of KZN that the improvement in the number of kids suckled per doe year-on-year tended to be greater in the strategically treated anaemic goats than in non-anaemic goats. The routine symptomatic treatment of anaemic goats was considered to be a key factor in this observation (Vatta *et al.,* 2007). This provides an example of the importance of knowing the body weight to assist in health matters. Knowing the body weight of a goat is important for a number of other reasons, such as for breeding, correct feeding and health (Slippers *et al*., 2000). In the small-scale farming communities, people have also indicated that poor reproductive performance of goats is a concern (De Villiers & Letty, 2001; De Villiers, 2005). In the absence of scales, farmers rely on visual inaccurate estimates of the body weight of their goats, and this in turn leads to inaccuracies in decision-making and husbandry. To assist goat farmers to overcome this challenge, the development of a simple, yet reasonably accurate method to predict weight is needed. The heart girth measurement has been used successfully as a predictor of body weight in animals such as cattle and pigs (Dingwell *et al*., 2006).

Many studies have been conducted to investigate the relationship of body weight with linear body measurements in goats (Slippers *et al*., 2000; Badi *et al.*, 2002; Khan *et al*., 2006). In goats the relationship between heart girth and body weight has been studied in many countries such as Botswana (Nsoso *et al*., 2003), Nigeria (Hassan & Ciroma, 2007), Pakistan (Khan *et al*., 2006) and South Africa (Slippers *et al*., 2000). In a study by Badi *et al*. (2002) with 496 Eritrean goats of Barka and Afer types, it was found that heart girth is the best parameter for estimating the body weight and that the height at wither can be used as a supplementary variable that can provide additional information. A linear equation incorporating the heart girth and height at withers accounted for 95% and 91% ($P < 0.01$) of the total variability in body weight. Badi *et al.* (2002) concluded that live body weight of Eritrean goats could be predicted with satisfactory accuracy using heart girth as the sole parameter.

Slippers *et al.* (2000) investigated the relationship between heart girth and body weight in 54 Nguni goats belonging to a small-scale farmer near Impendle, in the KZN Midlands. Slippers *et al.* (2000) concluded that predicting the body weight of Nguni goats from measurement of their heart girth is easy and accurate. The most practical measurement being accepted is the heart girth due to the simplicity of handling the animal when performing this task. Slippers and co-authors suggested, however, that the method needed to be refined, to allow for possible differences in the body weight-heart girth relationship between heavily pregnant does and other does.

The present study was carried out to establish the relationship between live weight and heart girth in goats of different types, gender and ages kept in different agro-ecological farming systems, in different seasons and in different stages of production. The aim was to allow for the development of a heart girth tape to be used by goat farmers under circumstances where for example the production stage and age of the animal are not always known.

Materials and Methods

Goats used in the study were from the following areas in KwaZulu-Natal: Bergville; Table Mountain; Cedara Research Station; Baynesfield; Msinga, Bulwer (Nkwezela, Hlafuna and Njobokazi communities); Colenso and the Owen Sithole College of Agriculture (OSCA) near Empangeni (see locations in Figure 1). The location, farming system, type of breed and number of animals used in the study are summarized in Table 1. The data used in this study were collected from male, female and castrated goats of different ages, but did not include data from milk goats. In total, data from 1202 goats were used.

Of the goats used, 1053 were does, 55 were bucks and 94 were castrates. Goats used in the study were indigenous goats, Boer goats and crosses between indigenous and Boer goats belonging to small-scale, emerging and commercial farmers, to Cedara Research Station and OSCA.

Figure 1 Map showing the study areas where data was collected.

Body weight (kg) was determined with a 100 kg spring balance scale (500 g increments) (Salter Model, Capital Scales - Pretoria, South Africa). The heart girth (in cm) was measured making use of a tailor's tape measure (Khan *et al*., 2006). Heart girth (in cm) represents the circumference of the chest measured at the most dorsal point of the chest in line with the elbow and hence bisecting the chest at the approximate position of the heart (Slippers *et al*., 2000; Khan *et al*., 2006). The age of the animals was determined by counting the number of permanent incisors (Mitchell, 1982) and sex was recorded at the time

of weighing. Production status was not recorded due to the fact that farmers were generally not in a position to provide the information (goats in communal systems are in a continuous mating system.)

Table 1 Number of goats weighed by location, type of system, type of enterprise, breeds and seasons in which goats were weighed

Location	System	Type of System	Breed/type	Total number of goats	Season weighed
Table Mountain (1 owner)	Semi-intensive – veld, mixed grazing	Emerging	Indigenous crosses	118	Spring
Cedara Research Station	Intensive – pastures	Research station	Indigenous	182	Spring
Baynesfield (1 owner)	Semi-intensive, browse	Commercial	Indigenous	137	Spring
Msinga (1 owner)	Extensive, browse	Communal	Indigenous	45	Summer
Nkwezela (3 owners)	Extensive, grazing	Communal	Indigenous	53	Autumn & Winter
Hlafuna (2 owners)	Extensive, grazing	Communal	Indigenous	19	Autumn & Winter
Njobokazi (3 owners)	Extensive, grazing	Communal	Indigenous	45	Autumn & Winter
Bergville (5 owners)	Extensive, browse and grazing	Communal	Indigenous	120	Spring
Empangeni (OSCA)	Semi- intensive, browse	Research Station	Boer goats and Indigenous	92 285	Spring
Colenso (1 owner)	Extensive, grazing and crop residues	Commercial	Indigenous, Boer goats and crosses	106	Winter

Data collected were classified on the basis of sex and age of the goat. Four age groups were used to analyze the data: 0 tooth, less than one year old (no permanent incisors), 1 year old (2-tooth; 1 - 1.5 years old), 2 years old (4-tooth), 2.5 years old (6-tooth) and 3 years and older (full mouth). Body weight was predicted by using the best-fit regression. Goats in the Bulwer areas of Nkwezela, Hlafuna and Njobokazi were weighed and their heart girth measured in March and April 2005 and both data sets were used in the regression analysis. Means and standard deviations were determined for body weight and heart girth for the goats in the different age and sex categories and from the different areas. Regression analysis was used to determine the relationship between live body weight (y) and heart girth (x) using the Genstat programme (GenStat® for Windows® 10th edition, VSN International LTD, 2007). The predicted body weights from the regression equations were tested against the live weights of goats.

Results

The variation in weight between the goats of the different locations and farming systems is summarized in Table 2.

The live body weights and heart girth measurements of the goats by age and sex are summarized in Table 3.

The following non-linear regression was found to fit the data best:

Live weight (kg) = 16.88 + 9.31*exp (- 0.0227*heart girth measurement) $R^2 = 89.4$ ($P< 0.01$)
Standard error = 3.86

The actual average body weight and the predicted weight using the non-linear regression analysis, as found in the study, are summarized in Tables 4 and 5. The values observed show no significant differences, thus indicates how precise the heart girth is in predicting the body weight of goats. The R^2 value of 89.4 acquired, confirms the significant relationship between the body weight and the heart girth.

Table 2 The body weight (kg) and heart girth (cm) of goats in different locations

Area	Age	Does		Bucks		Castrates	
		Body weight (kg)	Heart girth (cm)	Body weight (kg)	Heart girth (cm)	Body weight (kg)	Heart girth (cm)
Baynesfield	0	(21) 20.3	60.3	-	-	-	-
	1	(35) 30.3	68.8	-	-	-	-
	2	(20) 38.0	75.2	-	-	-	-
	2.5	(27) 38.8	76.8	-	-	-	-
	3	(34) 45.6	78.4	-	-	-	-
Cedara	0	(73) 16.9	55.3	-	-	(42) 17.6	56.5
	1	(21) 25.7	68.1	-	-	(1) 26.5	66.0
	2	(5) 36.6	79.6	-	-	-	-
	2.5	(11) 38.0	78.9	-	-	-	-
	3	(29) 44.2	80.4	-	-	-	-
Colenso	0	(38) 23.9	63.1	(16) 21.7	60.3	-	-
	1	(10) 38.8	77.3	(1) 39.0	77.0	-	-
	2	(9) 45.9	78.9	(1) 52.0	86.0	-	-
	2.5	(3) 48.5	81.3	(1) 66	91.0	-	-
	3	(27) 55.7	87.3	-	-	-	-
Hlafuna	0	(1) 38	81.0	-	-	-	-
	1	(1) 34.5	76.0	-	-	-	-
	2	(2) 36.3	80.5	-	-	-	-
	2.5	(8) 36.3	79.4	-	-	-	-
	3	(7) 37.6	78.1	-	-	-	-
Msinga	0	-	-	-	-	-	-
	1	-	-	-	-	-	-
	2	(1) 34.0	73.0	-	-	-	-
	2.5	(15) 34.8	74.2	(1) 36.5	75.0	-	-
	3	(27) 43.7	79.9	(1) 55.5	89.0	-	-
Njobokazi	0	(2) 30.3	76.0	-	-	-	-
	1	(11) 32.4	73.8	-	-	-	-
	2	(7) 36.1	77.3	-	-	-	-
	2.5	(7) 34.5	79.3	-	-	-	-
	3	(18) 38.6	80.8	-	-	-	-
Nkwezela	0	(2) 28.8	70.5	-	-	-	-
	1	(7) 32.0	76.0	-	-	-	-
	2	(10) 32.2	76.1	-	-	-	-
	2.5	(12) 31.5	74.2	-	-	-	-
	3	(22) 34.8	76.7	-	-	-	-
Table Mountain	0	(30) 10.6	47.9	(14) 10.9	48.1	-	-
	1	(7) 28.0	68.6	-	-	-	-
	2	(13) 34.4	73.3	-	-	-	-
	2.5	-	-	-	-	-	-
	3	(52) 39.4	77.0	(2) 60.0	93.0	-	-
Bergville	0	(19) 19.3	60.0	-	-	-	-
	1	(17) 21.0		-	-	-	-
	2	(11) 27.5		-	-	-	-
	2.5	(29) 29.0		-	-	-	-
	3	(43) 35.0		(1) 50.0	84.0	-	-
OSCA	0	(41) 13.2	53.3	(13) 8.9	44.4	(24) 12.9	52.9
	1	(57) 20.7	63.2	-	-	(2) 21.0	64.0
	2	(97) 27.7	69.2	(1) 27.0	68.0	(1) 34.5	74.0
	2.5	(48) 28.8	71.7	(1) 76	99.0	(9) 36.3	78.3
	3	(66) 34.4	76.0	(2) 37	80.8	(15) 41.4	81.9

Table 3 The average body weight (kg) and heart girth measurement (cm), by age and sex of goats in KwaZulu-Natal

Age (years)	Sex	Number of goats	Body weight (kg)	Heart girth (cm)
0	Does	227	17.4	56.5
	Bucks	43	14.3	51.5
	Castrates	66	15.9	55.2
1	Does	166	26.1	67.3
	Bucks	1	39.0	77.0
	Castrates	3	22.8	64.7
2	Does	175	31.3	71.8
	Bucks	2	39.5	77.0
	Castrates	1	34.5	74.0
2.5	Does	160	32.9	74.2
	Bucks	3	59.5	88.3
	Castrates	9	36.3	78.3
3	Does	325	40.2	78.2
	Bucks	6	49.9	86.8
	Castrates	15	41.4	81.9

Table 4 Actual average weight (± s.d.) and predicted weight of goats according to age

Age (teeth)	N	Actual live weight (kg)	Predicted weight (kg)
0	336	16.7 ± 0.41	16.8
1	170	26.2 ± 0.58	26.7
2	178	31.4 ± 0.57	31.5
2.5	172	33.6 ± 0.58	34.6
3	346	40.4 ± 0.41	39.4

Table 5 Actual average weight (± s.d.) and predicted weight of 1200 goats according to breed used in the study

Breed	N	Actual live weight (kg)	Predicted weight (kg)
Boer goat	166	33.6 ± 0.92	32.4
Indigenous	1016	28.8 ± 0.37	29.1
Boer goat x indigenous	18	27.6 ± 2.70	26.5

Discussion

To maintain good animal husbandry, the measurement of live body weight is absolutely essential for breeding, nutrition and health management. A number of studies have been conducted to investigate the relationship between body weight and various linear measurements in goats (Mayaka *et al*., 1996; Slippers *et al*., 2000; Badi *et al*., 2002; Khan *et al*., 2006). Live weight may be estimated through several measurements but the measurement of heart girth seems to be the simplest and most accurate technique.

The nonlinear regression found in this study with a R^2 of 89.4 closely resembled work done elsewhere, with regard to the relationship between heart girth measurement and body weight. Benyi (1997) used linear and geometric regression equations to estimate live weight from measurement of chest girth in 78 West African Dwarf and 73 Sahel cross West African Dwarf goats. The coefficients of variations (R^2) ranged from 0.87 to 0.92 and 0.97 to 0.99 for the linear and geometric equations respectively. Benyi (1997) found no significant breed or sex differences in the R^2 values of the live weight-girth equations. The geometric equations estimated live weight with a high degree of reliability regardless of girth size whilst the linear equations yielded very low and frequently negative live weight estimates where girth measurements were below 30 cm. Mayaka *et al.* (1996) found by regression analysis of the body weight and heart girth that for 95% of the females, the error in predicting the body weight from the heart girth measurement would not exceed 3.5 kg.

The variation in weight between the goats of different locations (as shown in Table 2) could be explained by the different management systems, the differing times of the year at which the study was conducted (See Table 1) especially as this would influence the nutrition of the animals and the type of farming system in practice, whether commercial, subsistence or emerging. As evident, when looking at the adult does, the body weight varies. In communal areas the body weight falls below 40 kg except in Msinga indicating the effect of nutrition as well as the uncontrolled continuous mating that could be the results of these animals not picking up weight. However, the prediction is sufficiently accurate that one girth tape may be used in all systems and throughout the year. An accurate prediction of body weight was obtained from the data collected from goats in different systems with different breeds in different seasons and management programmes.

Conclusion

The study strongly indicates that the heart girth can successfully be used for predicting body weight in meat-type goats in KwaZulu-Natal. The creation of a heart girth measurement tape similar to those used in cattle and pigs would certainly provide communal and small-scale goat farmers with a practical tool to use in determining the live weight of their goats.

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