AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT (ATIP)

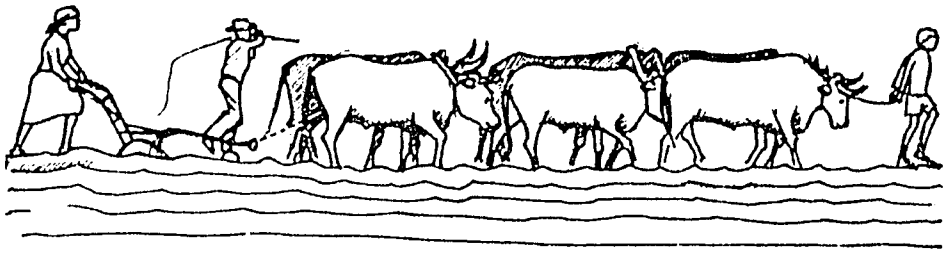
HEART GIRTH MEASUREMENT AS AN ESTIMATE OF WEIGHT FOR TSWANA GOATS

BY

F. D. WORMAN, T. R. THEDFORD, K. M. KELEMOGILE AND J. A. BAATHODI

ATIP WORKING PAPER

ATIP WP-30



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A GOB / MIAC /USAID Project

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MINISTRY OF AGRICULTURE
BOTSWANA

MID-AMERICA INTERNATIONAL
AGRICULTURAL CONSORTIUM
(MIAC)

JUNE 1990

PRINTED: June 26, 1990

ADDRESSES:

P/BAG 0033
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TATITOWN (FRANCISTOWN)

PREFACE

ATIP working papers are prepared and circulated to make ATIP research findings easily available to Government of Botswana personnel and researchers interested in Botswana Framing Systems. This paper has been reviewed by ATIP staff and by the Chief Animal Production Research Officer, DAR, Dr. L. Setshwaelo.

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ACKNOWLEDGEMENTS

The authors of this paper wish to acknowledge the invaluable assistance of the following people.

The cooperating farmers of the villages of Mathangwane, Marapong, and Matobo in the Tutume Agricultural District.
ATIP Village Staff at Mathangwane, Marapong, and Matobo.
ATIP office staff.
ATIP Drivers.

HEART GIRTH MEASUREMENT AS AN ESTIMATE OF WEIGHT FOR TSWANA GOATS

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ABSTRACT

This paper presents information on a researcher managed, researcher implemented (RMRI) study to investigate the relationship of the heart girth measurement to the body weight (mass) of Tswana goats. The variables of age and sex were also included in the collection and analysis of the data. This project was conducted in the villages of Mathangwane, Marapong, and Matobo, in the Tutume Agricultural District. Based on the data collected a table was constructed for the estimation of body weights, which may be used when scales are not available and a rough estimate of body weight will be adequate for the purpose at hand. The estimation is done by measuring the heart girth circumference and finding the estimated weight for that measurement from the table presented. The estimates are subdivided by:

(a). Kids -- Birth To Three Months Old
(b). Females Over Three Months Old
(c). Males Older Than Three Months
(d). Male Castrates Older Than Three Months.

INTRODUCTION

When conducting research on livestock, one of the common parameters used is body weight (mass). However, weighing animals in the villages is often a difficult task because of a shortage of scales, especially those that are reasonably accurate. Systems exist in western countries to estimate the weight for several species of farm animals including dairy goats by using heart girth measurements. Tswana goats, however do not have the body conformation of dairy goats and so the existing tables for estimating goat weight based on heart girth measurements do not seem to correlate very well for the Tswana goat. If a heart girth weight table could be developed for the Tswana goat, it would simplify and speed up data collection. Since goat herds in Marapong, Matobo and Mathangwane were being handled for other reasons, it was a relatively easy task to measure and weigh the animals to collect the data for this analysis.

OBJECTIVE

The objective of this data collection and subsequent mathematical exercise was to develop a table of body weight estimates for Tswana goats based on heart girth measurement. Age and sex were considered as additional variables.

JUSTIFICATION

It is nearly impossible to find accurate scales in a village. Farmers cannot afford to purchase them and almost never weigh animals when deworming or treating for disease, or for that matter, when animals are sold! As a result, the ability to accurately guess animal weight is poor. With the Botswana Meat Commission starting to purchase smallstock for slaughter in Francistown and with the research on smallstock being done, especially at the farm level through ATIP and APRU, it was felt that a simple and reasonably accurate method of estimating body weight was needed. This is an attempt to fulfill that need.

DESIGN

During the months of December 1988 and January 1989 all of the goats belonging to the farmers cooperating in the ATIP goat studies in Marapong, Matobo and Mathangwane were being identified by ear tag and ear tatoo, and were being bled for a serological disease study. It was decided that very little additional time and effort would be required to age

them by tooth eruption, measure their heart girth with a plastic sewing tape measure (cost of about P1.50), and weigh each individual. December and January was decided on because animals were in reasonable physical condition at that time of the year, not too poor, yet not at their peak which occurs later on in the wet season.

Each animal was weighed using a 100 kilogramme scale with 0.5 kilogramme graduations. They were turned on their back and suspended from the scale, upside down, in a sling made from a hessian bag. The weight of the sling was subtracted from the gross weight.

Each animal was sexed and aged. Age determination was by permanent incisor tooth eruption, both central incisors indicating a one year old, two sets of teeth a two year old, and three sets a three year old. Four sets of incisor teeth indicated a full mouth and the animal was considered as four years old or older. Goats with no permanent incisors were aged as kids. The data on birth weight and subsequent monthly weighing, and corresponding heart girth measurements, were taken from another experiment and added to the data set.

Heart girth measurements were obtained by taping the circumference of the body over the back and around the chest just behind the elbow of the front leg. This was done with the animal standing and in a relaxed condition. If the animal were tense or fighting, the measurement was delayed until the desired degree of relaxation was obtained. The tape was pulled firmly and held between the tips of the thumb and forefinger of the left hand, measuring the animal from the side. The measurement was taken as the animal exhaled. If there were a doubt about the reading, another one or two measurements were made and the most common measurement was used. The reading was made to the nearest 0.5 cm.

The data were entered into a computer and analyzed using the SPSS multiple linear regression programme. The resulting regression equations were used to construct a table of estimated weights based on one centimeter heart girth increments.

RESULTS

Records used in this analysis were divided into two data sets. There were 647 records in the set of data for goats older than three months, while the set of data for kids from birth to three months contained 86 records. Each record included the heart girth measurement, weight, sex and age.

Plots of the data sets indicated a curvilinear relationship for both sets of data. Several models were estimated for the data sets combined and separated. Age appeared to be an important factor for dividing the kids data, but not for the older group of goats. The opposite was true of sex, it was important for older goats but not for kids. Tables of predicted weights and actual weights were constructed using the various models, and comparisons were made. In addition to considering the coefficient of determination (R^2), the actual and predicted weights were examined looking for the closest patterns of predicted weights to actual weights. Based on this examination, the estimated weights reported in Table 1 were developed.

The weight estimates were broken into the following four subgroups:

(a). Kids -- Birth To Three Months Old
(b). Female Goats Over Three Months Old
(c). Male Goats Over Three Months Old
(d). Male Castrate Goats Over Three Months Old

TABLE 1: ESTIMATED WEIGHTS FOR TSWANA GOATS BASED ON HEART GIRTH MEASUREMENTS

HEART GIRTH	0 TO 3 MONTHS	GOATS OVER 3 MONTHS		
	WEIGHT	FEMALE WEIGHT	MALE WEIGHT	MALE/CAST WEIGHT
CM	KG	KG	KG	KG
25	1.8			
26	1.9			
27	2.1			
28	2.2			
29	2.4			
30	2.6			
31	2.9			
32	3.2			
33	3.6			
34	3.9			
35	4.2			
36	4.5			
37	4.8			
38	5.1			
39	5.4			
40	5.7			
41	6.0			
42	6.3	6.7	9.7	8.8
43	6.6	7.3	10.0	9.1
44	7.4	7.9	10.3	9.4
45	7.9	8.5	10.7	9.7
46	8.3	9.2	11.0	10.0
47	8.7	9.8	11.4	10.3
48	9.1	10.5	11.8	10.7
49	9.5	11.2	12.3	11.1
50	10.0	11.9	12.7	11.6
51	10.4	12.6	13.2	12.0
52		13.3	13.7	12.5
53		14.0	14.3	13.1
54		14.8	14.9	13.6
55		15.5	15.5	14.2
56		16.3	16.1	14.8
57		17.1	16.7	15.4
57		17.1	16.7	15.4
58		17.9	17.4	16.1
59		18.7	18.1	16.8
60		19.6	18.8	17.5
61		20.4	19.6	18.2
62		21.3	21.4	19.0
63		22.3	21.2	19.8
64		23.0	22.0	20.7
65		23.9	22.8	21.5
66		24.9	23.7	22.4
67		25.8	24.6	23.3
68		26.7	25.6	24.3
69		27.7	26.5	25.2
70		28.7	27.5	26.2
71		29.7	28.5	27.3
72		30.7	29.6	28.3
73		31.7	30.6	29.4
74		32.7	31.7	30.5
75		33.7	32.8	31.6
76		34.8	34.0	32.8
77		35.9	35.1	34.0
78		37.0	36.3	35.2
79		38.1	37.6	36.5
80		39.2	38.8	37.8
81		40.3	40.1	39.1
82		41.4	41.4	40.4
83		42.6	42.7	41.8
84		43.8	44.0	43.2
85		44.9	45.4	44.6
86		46.1	46.8	46.0
87		47.4	48.3	47.5
88		48.6	49.7	49.0

For the estimation of weight of kids, the data were broken into age groups and the resulting estimates were combined to approximate the actual observed weights. The following equations were used for estimating kid weights (coefficients in parentheses are t-values):

(a). ***For Heart Girths 25-29 cms***

$$WT = -1.932 + 0.148HG \quad (8.59)$$

$R^2 = 0.52$

Cases = 71

(b). ***For Heart Girths 30-43 cms***

$$WT = -6.415 + 0.302HG \quad (10.67)$$

$R^2 = 0.63$

Cases = 68

(c). ***For Heart Girths 44-51 cms***

$WT = -11.048 + 0.420HG$
(10.27)

$R^2 = 0.69$
Cases = 50

Where:
WT = weight in kilograms
HG = heart girth in centimeters

For estimating weights of goats older than three months, the following equations were used:

(a). ***For Females***

$WT = -5.625 + 0.007HG^2$
(56.12)

$R^2 = 0.87$
Cases = 469

(b). For Males

$WT = 21.283 - 0.821HG + 0.013HG^2$
(-1.81) (3.48)

$R^2 = 0.85$
Cases = 68

(c). ***For Male Castrates***

$WT = 23.921 - 0.947HG + 0.014HG^2$
(-3.51) (7.20)

$R^2 = 0.95$
Cases = 102

Appendix A contains a listing, by the four animal categories, of predicted weights, mean recorded weights, standard deviations, and number of cases for each included hearth girth measurement.

CONCLUSIONS

Additional data collection and analysis to validate these equations should be done. Estimation of weight by heart girth measurement should never be used when actual weight can be obtained, especially when research results are being collects. This procedure was designed for use by farmers when scales are not available and when an estimated weight will suffice for the purpose at hand.

It was concluded that Table 1, could be used to estimate body weight, based on a heart girth measurement, for Tswana goats when scales are not available. Additional testing of the formulas could cause the tables to be revised. The following precautions need to be

followed:

(a). The tape measure used to estimate heart girth should be placed around the rib cage just behind the elbow of the front legs.

(b). The tape should be snug but not loose or pulled tightly.

(c). If the animal is not relaxed, allow it to do so and take several measurements using the most consistent one for the estimation.

(d). Animals in very poor condition or very heavy condition may not be accurately estimated by this technique.

(e). Animals in advanced pregnancy may be heavier than the estimated weight in the table.

(f). If animals have just consumed feed and/or water, estimates will be low. It is best to use this technique after they have been kept away from feed and water for several hours.

(g). The extremes for each range of estimated heart girth measurements and the corresponding weight estimates, i.e., smallest and largest heart girths, will not be as accurate as those near the middle.

(h). One-half centimeter measurements were ignored in the processing of the data. If half centimeter measurements are to be used in estimating weight, it can be done by splitting the difference between the two weights indicated on the table.

APPENDIX A1: PREDICTED AND MEAN ACTUAL WEIGHTS FOR KIDS LESS THAN THREE MONTHS, HEART GIRTH STUDY, TUTUME AGRICULTURAL DISTRICT, 1989

GIRTH	PREDICTED WEIGHT	ACTUAL MEASUREMENTS		
		MEAN	STD DEV	CASES[a]
25.0	1.8	1.7000	0.4761	4
26.0	1.9	1.9571	0.1813	7
27.0	2.1	1.9000	0.4796	7
28.0	2.2	2.1667	0.2317	9
29.0	2.4	2.4400	0.3534	10
30.0	2.6	2.6235	0.2611	17
31.0	2.9	2.6353	0.3707	17
32.0	3.2	3.0538	0.6091	13
33.0	3.6	3.1769	0.6673	13
34.0	3.9	3.6056	1.0833	18
35.0	4.2	4.2000	0.5533	6
36.0	4.5	4.3455	1.2739	11
37.0	4.8	4.8500	0.8888	12
38.0	5.1	4.6444	1.0772	9
39.0	5.4	5.3846	0.9831	13
40.0	5.7	5.4429	1.5873	14
41.0	6.0	5.5875	1.0789	8
42.0	6.3	6.1313	0.8154	16
43.0	6.6	6.5286	1.6849	7
44.0	7.4	7.4100	0.7593	10
45.0	7.9	7.6800	0.8871	5
46.0	8.3	7.8400	1.2260	5
47.0	8.7	8.7500	0.6455	4
48.0	9.1	9.1000	0.8485	2
49.0	9.5	9.5500	1.1387	4
50.0	10.0	10.2667	2.5325	3
51.0	10.4	10.7500	0.3536	2

a. Each case is a monthly weight reading from zero to three months of age. There were 86 kids in the study but not all were weighed each month, thus there were a total of 246 cases.

APPENDIX A2: PREDICTED AND MEAN ACTUAL WEIGHTS FOR FEMALES OLDER THAN THREE MONTHS, HEART GIRTH STUDY, TUTUME AGRICULTURAL DISTRICT, 1989

GIRTH	PREDICTED WEIGHT	ACTUAL MEASUREMENTS		
		MEAN	STD DEV	CASES
42.0	6.7	6.5000	0.0000	1
43.0	7.3	11.0000	0.0000	1
44.0	7.9	9.2500	1.0607	2
45.0	8.5	11.0000	0.0000	1
46.0	9.2	12.5000	0.7071	2
47.0	9.8	10.5000	0.7071	2
48.0	10.5	11.5833	1.6857	6
49.0	11.2	11.8750	1.9311	4
50.0	11.9	12.1000	2.0125	5
51.0	12.6	13.0000	0.0000	2
52.0	13.3	12.7500	0.3536	2
53.0	14.0	14.3750	1.6008	4
54.0	14.8	14.6667	2.0817	3
55.0	15.5	17.0000	1.8257	4
56.0	16.3	16.0000	1.1547	4
57.0	17.1	17.1000	3.3615	5
58.0	17.9	17.5000	1.0801	7
59.0	18.7	17.8125	1.7513	8
60.0	19.6	19.0000	3.1168	8
61.0	20.4	19.3333	1.0897	9
62.0	21.3	20.8889	2.0733	9
63.0	22.2	21.0714	3.0609	7
64.0	23.0	23.3333	3.9131	9
65.0	23.9	22.4000	2.4850	5
66.0	24.9	24.6250	4.1812	8
67.0	25.8	24.5625	4.7316	8
68.0	26.7	28.6250	2.7195	4
69.0	27.7	27.3182	2.6765	11
70.0	28.7	29.8846	3.4715	13
71.0	29.7	29.2308	2.7127	13
72.0	30.7	33.0588	3.3952	17
73.0	31.7	35.4706	3.5420	17
74.0	32.7	32.8235	2.9997	17
75.0	33.7	34.6667	4.0252	15
76.0	34.8	36.4189	3.4203	37
77.0	35.9	35.6000	3.5681	30
78.0	37.0	37.9038	4.6734	26
79.0	38.1	39.4130	4.1194	23
80.0	39.2	39.4545	4.6475	33
81.0	40.3	41.1944	5.3196	18
82.0	41.4	42.7826	4.1061	23
83.0	42.6	44.0357	4.8416	14
84.0	43.8	44.1429	4.8573	14
85.0	44.9	44.2000	4.5908	5
86.0	46.1	45.7857	1.6547	7
87.0	47.4	47.3333	2.3629	3
88.0	48.6	44.5000	2.1213	2

APPENDIX A3. PREDICTED AND MEAN ACTUAL WEIGHTS FOR MALES OLDER THAN THREE MONTHS, HEART GIRTH STUDY, TUTUME AGRICULTURAL DISTRICT, 1989

GIRTH	PREDICTED WEIGHT	ACTUAL MEASUREMENTS		
		MEAN	STD DEV	CASES
42.0	9.7			
43.0	10.0	11.5000	0.7071	2
44.0	10.3			
45.0	10.7			
46.0	11.0	13.0000	0.0000	1
47.0	11.4			
48.0	11.8	11.2500	1.7678	2
49.0	12.3	12.2500	0.3536	2
50.0	12.7	11.7500	0.3536	2
51.0	13.2	14.8333	1.1547	3
52.0	13.7	14.5000	0.0000	1
53.0	14.3			
54.0	14.9	14.0000	0.0000	1
55.0	15.5	15.5000	1.5000	3
56.0	16.1	19.0000	0.0000	1
57.0	16.7	16.2500	1.7678	2
58.0	17.4	17.5000	2.1794	3
59.0	18.1	13.2500	3.8891	2
60.0	18.8	20.5000	1.5000	3
61.0	19.6	19.0833	1.4634	6
62.0	20.4	21.0000	1.2583	7
63.0	21.2	24.8750	4.7148	4
64.0	22.0	21.7500	1.0607	2
65.0	22.8	23.1000	1.4748	5
66.0	23.7	24.5000	0.0000	1
67.0	24.6	23.7500	1.7678	2
68.0	25.6	25.2500	0.3536	2
69.0	26.5	23.5000	0.0000	1
70.0	27.5	31.1667	5.8381	3
71.0	28.5	30.7500	1.0607	2
72.0	29.6	31.5000	0.0000	1
73.0	30.6			
74.0	31.7			
75.0	32.8	32.0000	0.0000	1
76.0	34.0			
77.0	35.1	31.0000	0.0000	1
78.0	36.3			
79.0	37.6			
80.0	38.8	39.5000	0.0000	1
81.0	40.1			
82.0	41.4			
83.0	42.7			
84.0	44.0			
85.0	45.4			
86.0	46.8			
87.0	48.3			
88.0	49.7			

APPENDIX A4: PREDICTED AND MEAN ACTUAL WEIGHTS FOR MALE CASTRATES OLDER THAN THREE MONTHS, HEART GIRTH STUDY, TUTUME AGRICULTURAL DISTRICT, 1989

GIRTH	PREDICTED WEIGHT	ACTUAL MEASUREMENTS		
		MEAN	STD DEV	CASES
42.0	8.8			
43.0	9.1	9.5000	0.0000	1
44.0	9.4	12.0000	0.0000	1
45.0	9.7	10.0000	0.0000	1
46.0	10.0	10.0000	0.0000	1
47.0	10.3			
48.0	10.7			
49.0	11.1			
50.0	11.6			
51.0	12.0	11.7500	1.0607	2
52.0	12.5	13.5000	0.0000	1
53.0	13.1	16.0000	0.0000	1
54.0	13.6	15.3750	1.4361	4
55.0	14.2	15.5000	0.0000	1
56.0	14.8	15.5000	0.7071	2
57.0	15.4	17.0000	0.0000	1
58.0	16.1			
59.0	16.8	18.1250	2.1171	8
60.0	17.5	20.0000	0.0000	2
61.0	18.2	18.8333	1.7559	3
62.0	19.0	19.0000	0.0000	2
63.0	19.8	21.5000	0.0000	1
64.0	20.7	21.7000	0.9083	5
65.0	21.5	25.2500	1.7678	2
66.0	22.4	23.4000	2.1036	5
67.0	23.3	25.3333	2.0817	3
68.0	24.3	24.7500	1.0607	2
69.0	25.2	23.5000	0.7071	2
70.0	26.2	24.7500	2.4749	2
71.0	27.3			
72.0	28.3	28.0000	4.5826	3
73.0	29.4	33.5000	0.0000	1
74.0	30.5	29.5000	2.1213	2
75.0	31.6	36.3333	2.0207	3
76.0	32.8	37.7500	4.5552	4
77.0	34.0	36.6667	3.6856	3
78.0	35.2	37.6000	3.1105	5
79.0	36.5	39.5000	3.3417	4
80.0	37.8	41.7500	1.9365	4
81.0	39.1	40.3333	1.1547	3
82.0	40.4	43.3333	1.0408	3
83.0	41.8	43.0000	2.7749	6
84.0	43.2	45.6250	3.3260	4
85.0	44.6	44.5000	3.5355	2
86.0	46.0	47.0000	0.0000	1
87.0	47.5			
88.0	49.0	51.0000	0.0000	1