PN-AAU-656
44287

ESTIMATING LIVE-WEIGHT AND CARCASS WEIGHT IN GAMBIAN N'DAMA CATTLE

by

W.Spencer, J.Eckert, P.Jakus

Technical Report No. 8
March 1986

ESTIMATING LIVE-WEIGHT AND CARCASS WEIGHT IN GAMBIAN N'DAMA CATTLE

by

W.P. Spencer
J.B. Eckert
P. Jakus

Prepared with support of the United States Agency for International Development. All expressed opinions, conclusions and recommendations are those of the authors and not of the funding agency, the United States Government or the Government of The Gambia.

MIXED FARMING PROJECT

March 1986

MIXED FARMING PROJECT
TECHNICAL REPORTS

1. Alers-Montalvo, Manuel, Fasainy Dumbuya, Glen Fulcher, Baboucar Gai, John Haydu, 1983. Farming Activities in The Gambia, A Survey (Preliminary Report).

2. Hedrick, Don and Musa Bojang, 1983. Final Report of the Forage Agronomist.

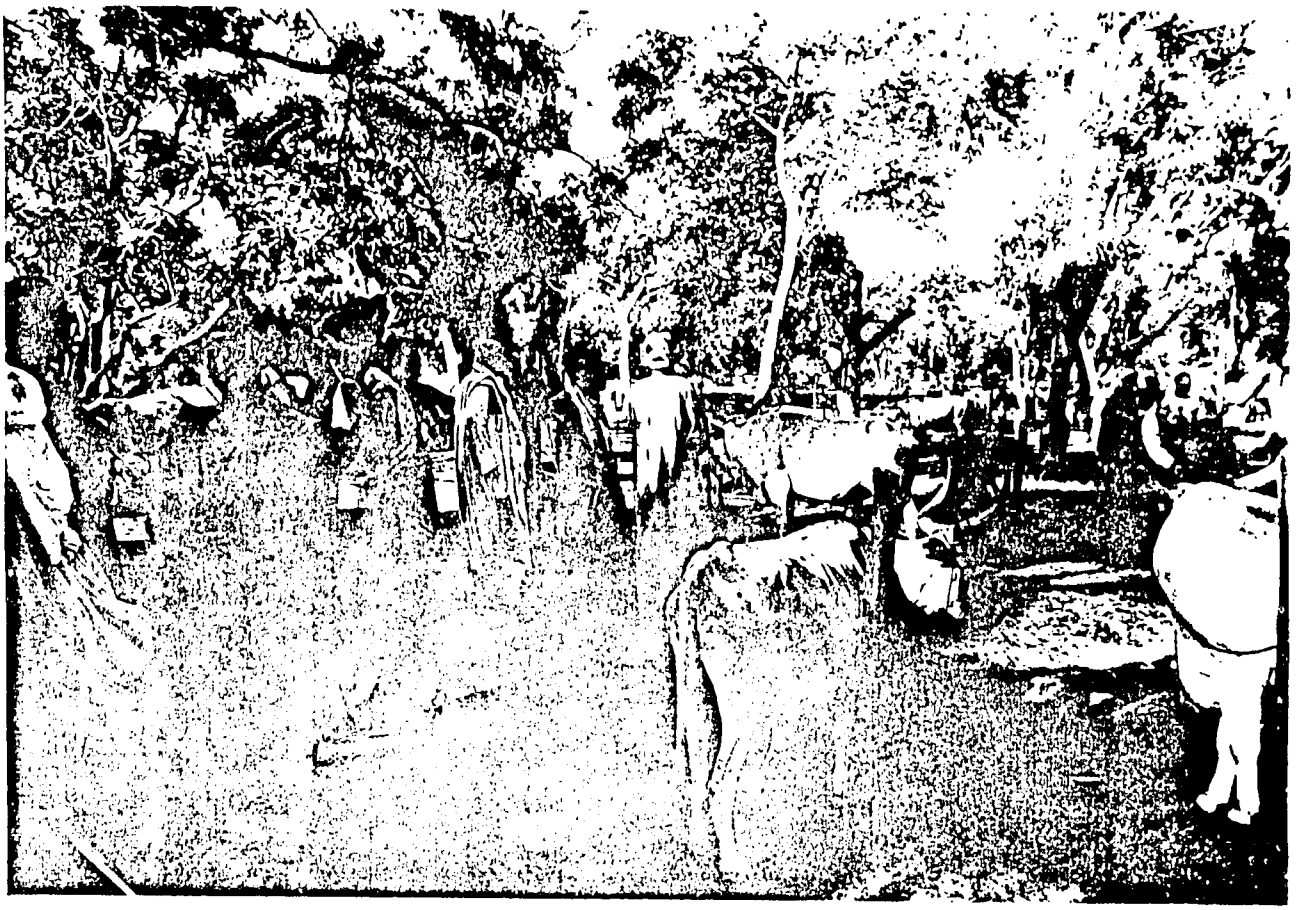
3. Kidman, Don and Solomon Owens, 1985. The Commercialization of Maize in The Gambia.

4. Marlett, Melanie and Marie Sambou, 1985. Food Production/ Consumption Linkage.

5. Eastman, Clyde and Momodou O.S. Jammeh, 1985. Gambian Livestock Owners Associations: A Brief Evaluation.

6. Spencer, William P., 1985. A Handbook of Graphs and Tables of Market Prices of Selected Agricultural Products in The Gambia, 1984-85.

7. Russo, S., 1986. Leucaena: A Potential Forage Crop for The Gambia.



N'Dama Cattle Being Sold for Slaughter
at the Abuko Abbatoir, near Banjul.

Estimating Live-Weight and Carcass Weight in Gambian N'Dama Cattle

by

W.P. Spencer, J.B. Eckert and P. Jakus

Introduction

Estimating live-weight of cattle without the use of scales is of obvious importance as a practical field technique, particularly in less developed countries. As agriculture begins to commercialize, especially in settings where the livestock sector has important potentials, accurate live-weight and carcass weight estimations become essential to orderly marketing. Further, live-weight figures are needed for calculating medicine doses as well as economic gain from management or husbandry alternatives being tested.

Standard procedures for live-weight estimation of cattle utilize correlations between selected body measurements and liveweight. Several body dimensions have been explored with heart girth generally accepted as the most satisfactory of the single variable correlations (Wanderstock and Salisbury, 1946). Most of the research calibrating this relationship has dealt with European breeds (Ragsdale, 1954; Johnson, 1940; Branton and Salisbury, 1946). Bonsma and Neser (1951) calibrated heart girth:weight relationships for the South African Afrikander cattle while Ross (1958) and Hutchinson (1959) studied Zebu cattle in East Africa. Only one study is known that examined heart girth relationships in the smaller bodied N'Dama breed of West Africa and this work, due to its emphasis on early growth, measured animals only up to 30 months of age (Fall, et al., 1982). Carcass weights were not investigated.

The N'Dama breed (Bos taurus) comprises the large majority of cattle in The Gambia and is an important contributor to the welfare of nearly half of the rural compounds (Haydu, et. al., 1986). Cattle are sold to other farmers, to specialized cattle traders, and to the Livestock Marketing Board, both up-country and directly at the government abbatoir. Due to their tolerance to trypanosomaisis, N'Dama cattle are occasionally exported live to other West African countries for breeding purposes. As these various marketing channels expand, the capability of accurately estimating live and carcass weights in the field becomes more important.

This paper's objective is to calibrate heart girth:weight relationship for marketed N'Dama cattle reared under village conditions in The Gambia. We further examine selected factors influencing this relationship.

Methods

Data were collected on 3000 animals sold to the government abbatoir at Abuko, near the capital of Banjul. Measurements were collected from April 1-30 and again from October 15 to November 30, 1985 in an attempt to obtain samples representing the ends of the dry and wet seasons respectively. Animals were expected to be near their worst and best conditions at these two times. It must be emphasized that this was not a random sample of the Gambian cattle herd, but rather a complete sample of those animals marketed through the abbatoir during the enumeration periods. Thus the actual animals measured were the result of a farmer selection process based on whatever criteria determine his choice of which animal to sell, where to sell and when.

Live-weight was obtained using an Avery beam balance scale adjusted daily to an accurate reading of 200 kg. Carcass weights were obtained on an Avery spring balance scale with a capacity of

500 kg. Weights were taken between 17:00 - 18:00 before slaughter, seven days a week. Sex was recorded by class: males, castrated males and females. Finally, age was estimated by dentition and recorded in broad, three year age classes to minimize the chance of classification error.

Of the 3000 animals measured on the hoof, 56 carcasses were condemned for health reasons and, thus, were unavailable for the final carcass measurement. The remaining sample was distributed as follows :

	Wet Season	Dry Season
Males	411	491
Castrates	462	542
Females	631	407
Total	1504	1440

Results

The data indicated that no statistically significant difference existed between males and castrates with respect to mean marketed weight, carcass weight, girth or the weight:girth relationship. Both castrated and uncastrated males were, thus, pooled for analysis and are denoted "males" in data presented below. Females, by contrast, differed significantly from males in all four characteristics and were analyzed separately.

Linear Relationships

The most satisfactory single, body measurement proxy for live-weight has been shown to be heart girth, and a linear relationship is normally used (Wanderstock and Salisbury, 1946; Ross, 1958). While we shall show subsequently that small improvements in accuracy are possible with more complex functions (eg. Johnson, 1940), the linear, single term estimator has definite uses under field conditions in Africa.

Pooling wet and dry season observations from the Gambian data and regressing live-weight (LW) on heart girth (HG) resulted in the following equations :

[1] Males : $LW = -363.79 + 4.27\ (HG)$ $R^2 = 0.82$

[2] Females : $LW = -212.48 + 3.10\ (HG)$ $R^2 = 0.56$

Equations of the form used in [1] and [2] were estimated for each sex separately for the wet and dry season subsamples. Examination of the results indicated that within each sex, slopes were nearly identical while intercept values differed with a statistical significance of 99 percent. Consequently, a binary (0,1) variable (S) was added to capture this seasonal effect. Results are given in [3] and [4] below where the regression coefficient for S gives the additional kilograms of weight found at the end of the wet season in comparison to weights recorded at the end of the dry season. Modest improvement in statistical fit is obtained by including the season variable.

[3] Males : $LW = -423.12 + 4.60\ (HG) + 27.82\ (S)$
(.04) (1.00)
$R^2 = 0.87$

[4] Females: $LW = -336.67 + 3.89\ (HG) + 24.19\ (S)$
(.09) (1.39)
$R^2 = 0.66$

Analysts using these formulae must remember that observations were timed to capture marketed animals in their best and worst conditions. Weight:girth relationships will vary over the year, increasing from the dry season value to a high at the end of the wet season, then declining back to a minimum again. Thus for an approximate year long average relationship, half the value of the seasonal coefficient should be used.

It is apparent from the four equations presented thus far that heart girth is a more accurate estimator of live-weight in male animals than in females sent to market. It seems likely that females, subject to the added stress of calving and lactation under poor nutrition, health and management conditions, might evidence greater variability in body measurement relationships. Furthermore, female cattle are considerably older when marketed in The Gambia than are males. Thus, additional variability from body wasting will be a more common phenomenon in the female sample.

Non-Linear Relationships

Heart girth and age are not independent variables in cattle. Thus the single variable equations given above, while useful in the field, utilize a biased estimate of the true relationships between live-weight and girth due to autocorrelation. After an early period of rapid skeletal growth, cattle then add mass in the form of flesh and organs, rather than bone. The relationship between total weight and girth can be expected to vary over the animal's life. To confirm this phenomenon, regressions of the form used for equations [3] and [4] were estimated separately for each three year age group within each sex. Table 1 presents the results. Figure 1 graphs the family of linear equations given in Table 1 for male animals.

Variations in body composition with age should affect the LW/HG relationship. Visual examination of the data suggested a curvilinear relationship between the kg/cm ratio and age. Quadratic equations [5] and [6] were estimated with three year age classes (A) as specified in Table 1 as the independent variable. All coefficients are highly significant and properly signed, indicating that a statistically significant relationship exists. In the case of females, however, this relationship explains only a small fraction of total live-weight variance.

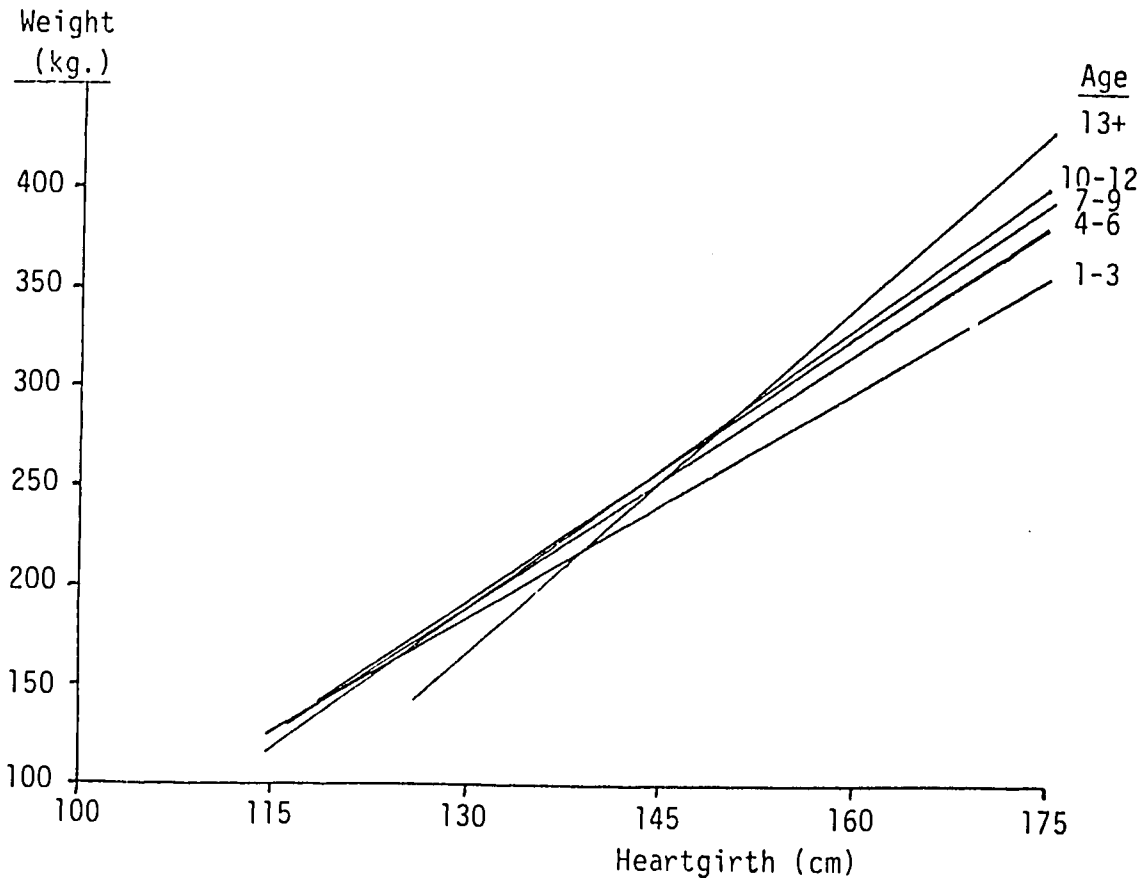
[5] Males: $$KG/CM = 0.96 + \underset{(0.02)}{0.48}(A) - \underset{(0.004)}{0.06}(A^2) \qquad R^2 = 0.46$$

[6] Females: $$KG/CM = 1.17 + \underset{(0.03)}{0.25}(A) - \underset{(0.004)}{0.037}(A^2) \qquad R^2 = 0.07$$

Table 1. Age-Specific Linear Equations for Estimating Live-Weight of Gambian N'Dama Cattle from Heart Girth, By Sex.

	Constant	Girth Coeff.	Season Coeff.	S.E.$\hat{Y}$	R^2	n
Males						
1-3	-320.80	3.80	24.47	15.09	0.80	360
4-6	-377.20	4.26	25.64	20.56	0.76	710
7-9	-396.73	4.43	29.10	21.74	0.74	709
10-12	-430.17	4.70	16.15	22.92	0.68	97
13+	-604.40	5.83	27.36	21.71	0.85	30
Females						
1-3	-233.09	3.11	1.78	12.42	0.86	19
4-6	-308.66	3.66	27.58	20.22	0.62	124
7-9	-348.20	3.97	25.69	18.16	0.68	381
10-12	-352.31	4.02	22.30	19.41	0.64	298
13+	-274.00	3.44	16.83	18.00	0.57	219

Figure 1. Male Equations from Table 1.



To approximate an unbiased estimate of the girth:weight relationship, it is necessary to incorporate all significant variables endogenously to the equation. Thus two somewhat more complex equations were estimated. Heart girth and age were common to both as continuous variables, as were binary variables for season and sex where applicable.

The two equations differed in the way in which each sought to capture the effect of age. In one, age entered as both linear and quadratic terms in an attempt to model a decline in body mass at older ages. That equation took the form :

[7] $LW = f(HG, A, A^2, Season, Sex)$

The alternative was to include an interaction term between age and heart girth, as below :

[8] $LW = f(HG, A, HG*A, Season, Sex)$

Both formulations were estimated for males (including castrates), females and the entire sample combined.

Both served equally well in modeling all cattle combined. However, due largely to the age composition of marketed animals in each sex class, the two equations differed in their ability to model the male and female samples individually. Female cattle averaged 9.5 years old when sold. Thus an ample number of older cows were observed to depict the body wasting found in aged animals with the quadratic term in [7]. The interaction term (HG*A) in [8] was very insignificant for females.

Few males were marketed above the age of 9 years. We were, thus, unable to depict the declining phase of life in males, however, the interaction term was positive and highly significant.

In conclusion, the best predictive equations for males and females estimated separately are [8] and [7] respectively while either equation will serve for all animals combined. Table 2 presents estimated coefficients for such prediction. All are significant at the 99 percent level of confidence or higher.

The negative terms for age in equation [8] is inconsistent with expectations, but the pattern depicted is one in which LW/HG increases with age as captured in the interaction term. The extent of the increase diminishes with each successive age class as shown in the negative adjustment associated with age class.

Equations [7] for females and [8] for males successfully model the modest curvatures found in scatter diagrams for the respective subsamples. However, coefficients of determination for these two equations do not offer a significant improvement over those found for equations [3] and [4].

Table 2. Non-Linear Equations for Estimating Live-Weight in Gambian N'Dama Marketed Cattle

	Equation [8]		Equation [7]	
Variable	Male	All	All	Female
Constant	-332.42	-369.69	-410.04	-339.82
Girth (in cm)	3.86	4.04	4.25	3.82
Age (see Text)	-23.92	-15.13	12.11	9.02
Age * Age	----	----	-1.48	-1.38
Girth * Age	0.21	0.13	----	----
Season (0=Dry)	27.48	28.14	26.24	22.50
Sex (0=Female)	NA	17.51	19.12	NA
R^2	0.88	0.86	0.86	0.66

Practical Considerations

Carcass Weight

One of the early concerns that led to this study was a desire to develop a few selected relationships that would be useful in the livestock marketing subsector of The Gambia. Not only was live-weight of interest but so was carcass weight. Carcass weight was determined for each animal immediately after slaughter. Hides, viscera, feet below the knee joint, head and tail were removed before the weighing. Preliminary analysis indicated that carcass weight varied stochastically as a percent of live-weight and not in any apparent association with age, girth or sex. Simple linear equations such as [9] and [10] can estimate carcass weight adequately from actual live-weight, or, with appropriate allowance for the additional standard error of estimation, from live-weights estimated by several of the above equations. There is no significant difference between the slopes for males and females and a dressing percentage of 50 is an adequate rule of thumb within the range of animal weights offered for sale in 1985.

[9] Males $$CW = -1.526 + 0.502\ (LW)$$
$$R^2 = 0.949$$

[10] Females $$CW = -2.198 + 0.489\ (LW)$$
$$R^2 = 0.859.$$

The Dalton Weighband

The Dalton Weighband is a common tool used in field estimation of live-weight for cattle and live or carcass weight for hogs. The weighband consists of non-stretch, vinyl on fabric tape, calibrated in centimeters with associated weights in pounds. No distinction is made for sex but cattle weights are included for "normal fed" and "very fat" cattle. Graphing the

normal fed data defines a rising, non-linear curve, convex to the x, or centimeter axis. This would appear to be consistent in concept to the analysis above, that being that live-weight is more than a linear function of girth. The Dalton Weighband was developed in England and presumably calibrated with european cattle.

In order to determine whether this tool can be applied to Gambian N'Dama cattle, weighband calibrations were compared with N'Dama live-weight values estimated using equations [7] and [8]. Age-specific mean girth measurements were entered for each sex along with the corresponding age class. Live-weight estimates derived from the weighband and the two equations are compared to the actual mean weight recorded in Table 3.

It is apparent that [8] more accurately estimates mean live-weight for marketed male animals than does the Dalton Weighband. Only in the case of very old males, of which there are few sold, does the weighband provide closer figures. However, the differences are small and statistically insignificant. Observed girths in The Gambia lie within a range of 105 - 170 cm, while the Dalton tape covers a range of 50 - 232 cm. Gambian cattle under village conditions do not get bigger than 430 kg regardless of age. Consequently the deviation of the weighband at the upper end of the Gambian scale is not surprising.

Similarly [7] outperforms the weighband as an estimator for females by a small margin at all age groups but the 7 - 9 year olds. It is particularly better at the older age groups.

Perhaps the most useful conclusion from Table 3 is that for any age group except the extremes at which few animals are marketed (old males and young cows) all three estimation methods are provide approximately the same answer. Statistically no significant differences exist. Thus, in the absence of calculation eqipment, the Dalton Weighband is usable in The Gambia. If one has the time for the arithmetic, the linear [3]

and [4] are sufficient as there is no gain in accuracy from a more complex formula. Only if one needs to capture the modest curve in the male and female data sets for some reason, is it neccessary to use equations such as [7] and [8].

Table 3. Comparison of Alternative Live-Weight Estimates with Actual Values

	Age Class (years)				
	1-3	4-6	7-9	10-12	13
Males					
Actual Mean Weight	181	239	290	306	309
% of Sample	29.2	37.9	27.7	4.1	1.1
Eq [3] est.	185	240	290	309	310
Eq [8] est.	189	237	292	318	328
Weighband	186	234	280	302	305
Females					
Actual Mean Weight	179	209	220	216	207
% of Sample	1.8	11.9	36.7	28.7	20.8
Eq [4] est.	190	206	212	213	213
Eq [7] est.	185	205	213	214	211
Weighband	200	215	222	223	223

References

Bonsma, J.C. and F.W.C. Neser, 1951. Practical application of growth studies in cattle. Farming in South Africa 26:365-374

Branton, C. and G. W. Salisbury, 1946. "The Estimation of the Weight of Bulls from Heart Girth Measurements", Jl. Dairy Sci. 29:141-143

Fall, A., M. Diop, J. Sandford, Y.J. Wissocq, J. Durkin and J.C.M. Trial, 1982. Evaluation of the productivities of Djallonke sheep and N'Dama cattle at the Centre de Recherches Zootechniques, Kolda, Senegal, ILCA Research Report No.3, Addis Ababa.

Haydu, J., M. Alers-Montalvo and J.B. Eckert, 1986. "Mixed Farming in the Gambia", Technical Report No.10, Gambian Mixed Farming and Resource Management Project, Banjul.

Hutchinson, H.G., 1959. "Variations in Live-weight of cattle on farm and ranch in Tanganyika", East Africa Agric. Jl.

Johnson, P.W. 1940. "Livestock Weights from Measurements" Minn. Agr. Exp. Sta. Folder 70

Ragsdale, A.C. 1954. "Growth Standards for Dairy Cattle" Mo. Agr. Exp. Sta. Bul. 336. Columbia.

Ross, J.G., 1958. "A method of estimating live-weights in small shorthorn Zebu cattle from linear body measurements", East Africa Agric. Jl..

Wanderstock, J.J. and G.W. Salisbury. 1946. "The Relation of Certain Objective Measurements to Weights of Beef Cattle." Jl. An. Sci., 5:264-271