

# LIVE WEIGHT PREDICTION MODEL OF DRAUGHT OXEN FROM LINEAR BODY CHARACTERISTICS MEASUREMENTS IN YOLA REGION, ADAMAWA STATE

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## Abstract

*Live weight prediction model of draught oxen was developed and validated for smallholder farming systems in Yola region of Adamawa state, Nigeria. The aim is to evaluate the impact of the intensity of work on the draught animal body and health throughout the cropping season (June- October) using body length and girth measurements in a random sample of forty smallholder draught animal farmers. Prediction model was generated using 78 % of the data and validated using the remaining 22 % of the data measured. Body weight was regressed on heart girth around the hump using mix model analysis. The regression analysis was highly significant ( $P < 0.001$ ), and gave a coefficient of determination of  $r^2 = 0.9685$  which is an acceptable level of significance and the correlation coefficient  $r = 0.93$  indicated a close linear relationship between the two variables. The general prediction equation model developed for live weight humped Ox was  $LW = 2.8471(\text{circumf}) - 227.02$ . This implies that the use of the heart girth measurements in prediction of live weight of cattle is credible. The results also show that both individual ox and pair of oxen across the traction groups lost weight during the period of intense work in June-July. The weight recovery period started at the end of August due to the decrease in field work demand. The model equation can be used to monitor mean body weight of the oxen population across working and nonworking periods of the year. It provides a simplified processes necessary for the farmers and researchers in selecting draught animals for field operations and better management through improved feeding and husbandry.*

**Key words:** body measurements, heart girth, live weight, oxen, weight-prediction

## 1 INTRODUCTION

**D**etermination of live weight of draught animal is necessary to calculate draught capability, feed requirements, animal growth, marketing weight and estimation of animal's cash value as well as conducting breeding studies, field experiments and estimation of animal weight losses [1]. Draught animal pulling capacity and power are the most important considerations in selecting animals for work. In general, the selection of animal(s) for any farm work depends on many factors. The weight of an animal is of paramount importance in draught work. It is important to be able to estimate the weight of the animal in the field without having to depend on conventional tools of measurement. The optimum weight is rather arbitrary and depends on the breed of the animal [2]. Under these conditions there are no weighing devices to determine liveweight changes. Animal

owners and cattle traders depend on eye judgment to liveweight. The accuracy of such method depends on individual experience [3]. In another development, cattle weighing instruments are beyond the means of many livestock breeders, especially in remote and rural areas. They are costly to obtain and maintain [1, 2, 3]. According to [4] live animal body weight can be determined empirically as:

$$LW = G^2 \times L \times 92.46 \times 10^{-6} \quad (1)$$

Where, LW = Animal live weight, kg, G = the heart girth, m (the circumference of the torso at the point of the head), L = body length from front shoulder to the base of the tail, m.

According to [1, 3], numerous studies have been conducted to develop methods of estimating live weight of cattle using formulae derived from body measurement. A well-documented research conducted between body weight and pulling capacity of draught animal showed that the pulling capacity was directly proportion to the animal body weight [6, 7, 8, 9, 10] which in turn was affected by the body condition of the animal and the harnessing system. Horses, donkeys and camels are reported to pull about 10% and 15 – 34% of their body weights respectively [11, 12, 13]. [10, 11, 13] put the general figure at 10 – 14% for oxen, buffaloes and camels and 10 – 16% for donkeys. A general rule accepted is that, an animal can exert a constant pull on a load over an extended period rather than concentrated which equals approximately 10 – 12 % of its body weight [9, 10, 11]. [9, 11, 14] stated that a convenient rule-of-thumb for estimating the working ability of oxen when drawing tillage tools is that a well-conditioned team can handle draught chain equal to 10-12% of their body weight throughout the day. As a general rule, provided all other factors are favourable, bovines (mainly cattle and buffaloes) should be able to provide a sustainable draught force of 10 to 12 percent of their body weight, while equines (mainly horses, donkeys and mules) and camel are able to sustain draughts of 12 to 14 percent of their body weight [12, 13]. [13, 14] stated that cattle less than 200 kg are too light to cope with the strain of work and the optimum weight for draught is 500 kg. According to [15, 16] periodically measuring and recording the weight of each ox in a team help in adjusting the amount of feed for the faster-growing ox to keep both animals close to the same size. However, there is little information available on estimating live weight of working oxen using body measurement [17]. Thus, the work reported here, although based on data collected in 2014 as part of research to develop a method for predicting zebu cattle live weight using body measurement, remain unique because it monitored changes in body weight and heart girth of oxen on smallholder farms across working periods for five months (June – October). The findings presented remain valid and are applicable for future calculations of draught oxen energy balance and feeding system evaluation found in many parts of Adamawa State today.

## 2 MATERIALS AND METHODS

The study was conducted in two districts of Yola area namely Girei designated as agro-ecosystem zone I and Yola-south designated as Zone II. In each zone, two villages were identified. These areas were purposely selected for the study because of the popularity of animal traction utilization. The village elders played an important role in creating a strong working relationship between the researchers and the animal draught farmers. Twenty four pairs of oxen, each pair belonging to a different farmer for traction were used for the measurement. External body measurements of the lengths and girths were measured using measuring steel tape graduated in centimeter using the procedures reported by [1, 2, 3, 5, 16]. The length was measured in (cm) from the

neck to the tail tip (point where the tail joint the body) and the girth (cm) was measured at the point of heart around the hump (Fig.1 and 2).



Figure1. Length Measurement (cm)



Figure 2. Heart Girth Measurement (cm)

The live weight was obtained using equation 1. The measurement were taken between 06:00 and 07:00 before animal were fed, watered or allowed to graze, resulting in all oxen being on the same daily feeding-grazing schedule and receiving similar feedstuffs to avoid introducing an extra source of variation. The more feed they take before the measurements, the more the variation is introduced in the model [2, 16]. The data were then grouped in three (I, II, and II) according to weight distribution frequency. Group I contained the bulls weighing 500 kg and above, termed heavy weight, group II contained bulls between 400 to 499 kg, termed medium weight and group III those weighing 399 kg and below, termed light weight animals. Draught animals do not appreciate being touched by outsiders. The measurement was done with the collaboration of the farmers. The best solution was to put them under a yoke before making measurement. A follow up of the draught animals to monitor all the activities performed by the draught animals during the rainy season (June-October) was carried out. These include live weight losses or gain at the end of every month, feeding systems, the type of activities carried out during the given period and handling and care.

The live weight of draught animals is generally unknown to the majority of the farmers. During this field study none of them was able to give the live weight of their draught animals. Also, weighing scales are not generally available to farmers to help them determine the weight of their animals. The simplicity and the speed of the measurement technique consisted of measuring the circumference at the point of heart (cm) of individual animal and the length from the neck to the tail tip (cm) as stated by [1, 2, 3]. In order to develop the model at this stage of research, more draught animals were included in the sample to have enough point to generate a better fit [16]. The recorded data was compiled; tabulated and analyzed using descriptive statistics and regression analyses using a general linear models (GLM) procedure [17]. The regression technique was used to obtain the relationship between live weight and heart girth measurements for each month. Monthly mean body weight and heart girth measurements were compared using the Tukey HSD-procedure [2].

### 3 RESULT AND DISCUSSION

The live weight (LW) in kg of draught ox is the required input in all models developed to determine the draught capability and energy requirement of draught animals [11, 17]. The regression analysis performed with the draught oxen gave a coefficient of determination of  $r^2 = 0.9685$  which is an acceptable level of significance [1, 2]. The regression equation is:

$$LW = 2.8471(\text{circumf}) - 227.02 \tag{2}$$

The analysis gave a correlation  $r = 0.93$  and explained more of the variation observed. The coefficient of determination  $r^2 = 0.9685$  shows a better fit. Most of the variations are due to the errors committed when performing the measurements of the thorax circumference. The correlation coefficient between live weight (LW) in kg and circumference (CIRCUMF) in cm was  $r = 0.93$  to demonstrate a close relationship between the two variables (Figure 1).

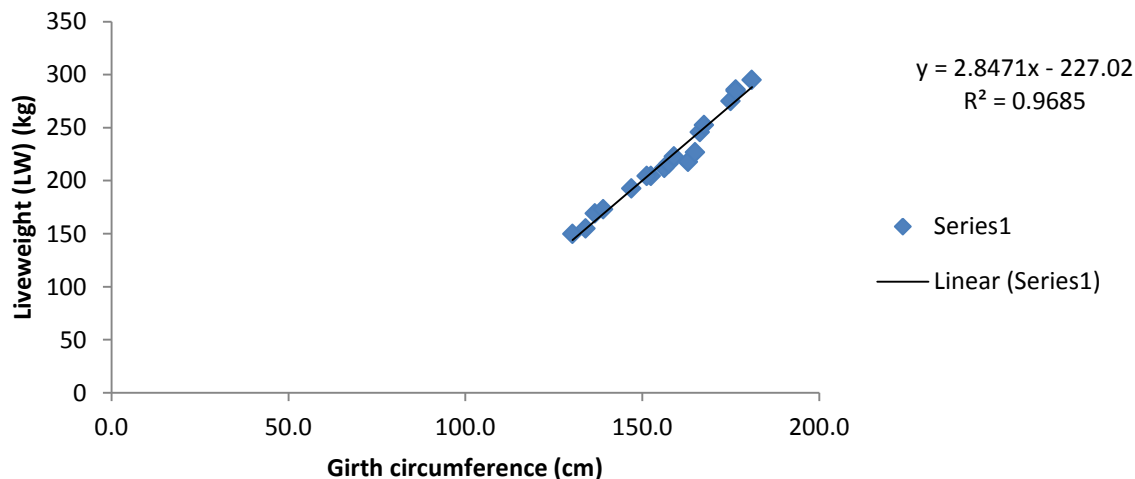


Figure 1: Linear regression of live weight – girth relationship

Analysis of variance of the regression coefficients shows there is a significant difference at 0.05 probability level (Table 1). The fitted regression line works well in predicting live weight of humped zebu breeds.

Table 1. Analysis of variance of Live weight vs Circumference

Sources	Df	SS	MSS	F	$t_{cal} = \text{sqrt}(F)$	$t_t$
Regression	1	33142	33142	492.1	22.183	12.706
Error (ESS)	16	1078	67.35			
Total	17	34219				

### 3.1 Model Validation

The proposed model Equation 2 was validated by comparing the results of the model generated and measured field experimental oxen live weight under farmers’ field conditions. The result showed a very well agreement between the predicted and field experimental data with  $R^2 = 0.9684$  as shown in Figure 2 with the value of the slope and intercept (regression coefficient) as 0.9694 and 7.0613 respectively. The regression equation obtained from the least square analysis for the predicted and measured results were:

$$y = 0.9694x + 7.0613 \tag{3}$$

A paired t-test conducted for the means value of the predicted and measured data at 0.05 significant levels showed that the calculated t-value (-0.16366) is less than the t-critical value (2.109816). The results show that the model has a high correlation with the measured data from the animal live weight measurement (Table 2). The live weight (LW) model developed in this study will

be very useful in future calculations of draught animal energy balance and feeding system evaluation [16].

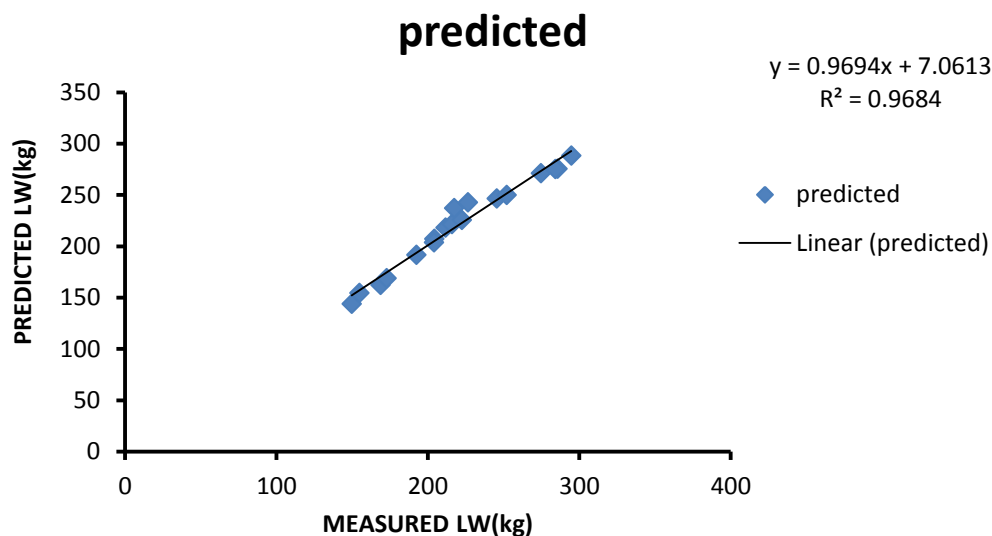


Figure 3. Predicted Oxen Live Weight against the Measured Oxen Live Weight

Table 2. t-Test: Paired Two Sample for Means of Measured and Predicted Oxen Live weight

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	220.9959	221.3033
Variance	2006.977	1947.819
Observations	18	18
Pearson Correlation	0.984051	
Hypothesized Mean Difference	0	
Df	17	
t Stat	-0.16366	
P(T<=t) one-tail	0.435963	
t Critical one-tail	1.739607	
P(T<=t) two-tail	0.871926	
t Critical two-tail	2.109816	

### 3.2 Live weight Changes and Body Condition

In order to evaluate the impact of the intensity of work on the draught animal body and health, the live weight of each draught animal of the base sample was monitored by means of weighing by simple measurement. The measurements performed on the pairs of draught oxen are shown in Tables 3 and 4.

Table 3. Live weight (kg) variation of pair of oxen

Month	Group I			Group II			Group III		
	B1	OS	D2	B2	S1	S2	K1	K2	D1
June	521	538	581	417	439	445	342	343	359
July	456	459	564	399	426	389	334	321	328
Aug.	478	470	636	423	470	415	348	363	313
Sept.	508	474	623	436	482	386	363	389	362
Oct.	541	475	634	438	500	390	373	407	376

Table 4. Average Liveweight (kg) variation of traction group

Month	G I			G II			G III		
	Aver. (kg)	Std (kg)	CV (%)	Aver. (kg)	Std (kg)	CV (%)	Aver. (kg)	Std (kg)	CV (%)
June	547.33	25.04	4.57	433.67	12.04	2.78	348.00	7.79	2.24
July	492.00	50.91	10.35	404.67	15.63	3.86	327.67	5.31	1.62
Aug.	531.33	76.44	14.39	436.00	24.26	5.56	341.33	20.95	6.14
Sept.	538.33	63.75	11.84	434.67	39.20	9.02	371.33	12.50	3.37
Oct.	553.33	65.22	11.79	442.67	45.03	10.17	385.33	15.37	3.99

### 3.3 Body Weight Losses (LWL in kg/day)

The analysis of the variation of the liveweight shows that both individual ox and pair of oxen across the traction groups lost weight during the period of intense work in June-July. The recovery period started at the end of August and corresponded to the decrease in field work demand. The coefficient of variation (CV) ranged from 4.57% to 11.79% for group I, 2.78% to 10.17% for group II and 2.24% to 6.14% for group III. The average liveweight variation (LWV) in kg and in percent per traction group was calculated and summarized in Table 5. From June to July, each pair of oxen went through high level of utilization. The amount of body weight lost during the process was converted into energy (15 MJ/kg of LWL) [15, 19] towards the accomplishment of the job. This means that the execution of most field operations required more energy than available from the feeding system. The effect of work on body weight has been reported in many publications [9, 13, 15, 19] but need to be evaluated for different species.

Table 5. Liveweight losses and gained (June to October)

Month	GI		GII		GIII	
	LWV (kg)	%	LWV (kg)	%	LWV (kg)	%
June-July	-55.33	10.11	-29.00	6.69	-20.33	5.84
July-August	39.33	7.99	31.33	7.74	13.66	4.17
Aug.- Sept	7.00	1.32	-1.33	0.30	30.00	8.79
Sept. – Oct	15.00	2.79	8.00	1.84	14.00	3.77

NB: The negative sign (-ve) in the Table 5 shows the loss in weight during intense work.

The average number of days worked during this period was 29 with a CV = 5.05%. Based on this number of worked days, the liveweight losses in kg/day (i.e LWV/29) per traction group were as follows:

Group I: LWL = 1.91kg/day

Group II: LWL = 1.00kg/day

Group III: LWL = 0.70kg/day

In accordance with the number of cases observed throughout the world, animal traction researchers agree on the fact that even a good feeding system would not prevent draught animals from losing weight during this peak working time of the season [9, 15, 17, 20]. The body weight losses converted into energy must be taken into account when calculating the daily energy balance of draught animals.

#### 4 CONCLUSION

Oxen continue to provide the main source of power for tillage for smallholder farmers in the Yola region. A study on live weight prediction model of draught oxen in Yola region of Adamawa state, Nigeria was developed for smallholder farming systems with the aim of evaluating the impact of the intensity of work on the draught oxen body and health throughout the cropping season (June-October). The work was carried out using body length and girth measurements in a random sample of forty smallholder draught animal farmers. The data were then grouped in three groups (I, II, and III) according to weight distribution frequency. Prediction model were generated using 78 % of the data and validated using the remaining 22 % of the data measured. Body weight regression on heart girth around the hump using mix model analysis was carried out. The regression analysis was highly significant ( $P < 0.001$ ), and gave a coefficient of determination of  $r^2 = 0.9685$  which is an acceptable level of significance and the correlation coefficient  $r = 0.93$  indicate a close linear relationship between the two variables. The general prediction equation model developed for live weight humped Ox is  $LW = 2.8471(\text{circumf}) - 227.02$ . The results shows that both individual ox and pair of oxen across the traction groups lost weight during the period of intense work in June-July. The weight recovery period started at the end of August due to the decrease in field work demand. It is recommended that the prediction equation for the complete year be used to estimate oxen weights on farms around Yola and in surrounding areas. The equation will be most accurate when used to estimate mean body weight of a particular population of oxen at village level or market survey, rather than the weight of an individual ox. The model provides a simplified representation of the processes necessary to meet the farmers and researchers requirement in selecting draught animals for field operations and better management through improved feeding and husbandry. However, as with heart girth, changes in body weight may not be accurately correlated with indicies represented by body condition score [2].

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