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# Seasonal Morpho - Physiological Pattern of Pastoral Cattle, Grazing the Guinea Savannah Zone of Nigeria

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**ABSTRACT**

**The objective of the study was to determine the seasonal morpho-physiological characterization of pastoral indigenous cattle, grazing the guinea savannah zone of Nigeria. The data were generated through the use of short questionnaires, oral interviews and field observations. Rectal temperature were taken using digital thermometer via the rectum while the respiratory and pulse rates were measured using stopwatch, visual and stethoscope. There were insignificant ($p > 0.05$) differences among the mean body condition scores of cattle in the three study locations and were linked to the similarity in climatic conditions of the zone which influenced forage productivity and biomass availability. However, it was observed that female animals had higher mean BCS than males. BCS of Adamawa Gudali was significantly ($p < 0.05$) higher than White Fulani, Red Bororo and Sokoto Gudali. Cattle raised under semi-sedentary system had higher body condition scores compared to those on pastoral system and late rainy season (LRS) recorded the highest mean body condition score. This was not surprising because late rainy season coincided with the period of feed availability especially luxuriant forages and browses. Water resources are also available with streams, ponds, dams, hand dug wells and surface run offs still flowing. The rectal temperatures of cattle from Mubi North and Gombi were significantly ($p < 0.05$) higher compared to cattle from Jada Local Government Area. This variations in rectal temperatures of cattle within the same climatic zone could be as a result of individual animal's physical activity, physiological status, solar radiation, environmental conditions, feeding and atmospheric humidity of the locations. Pastoral cattle recorded significantly higher mean rectal temperatures than those under semi - sedentary management system. the mean rectal temperature of cattle in early rainy season (April to June) was significantly ($p < 0.05$) higher than others. The results showed significant ($p < 0.05$) distinctions in the respiratory rates of cattle from Mubi North, Gombi and that of Jada LGAs respectively. The results indicated that, cattle from Mubi North had significantly ($p < 0.05$) higher pulse rates than cattle from Gombi and Jada LGAs. The results showed that, there were significantly ($p < 0.05$) higher pulse rates of White Fulani, Red Bororo and Sokoto Gudali cattle than that of Adamawa Gudali. cattle under the pastoral system had higher rates compared to those under semi - sedentary system. This implies that, cattle in the pastoral system might have been exposed to greater stress and activities that increased their breathing rates. BCS, rectal temperature, respiratory and pulse rates are good indicators and pointers that a farmer could use to diagnose animal's nutritional and environmental stress, disease and physiological problems which affect production.**

**Key words: Season, Morpho - Physiology, Indicators, Pastoral, Cattle, Nigeria.**

## INTRODUCTION

Body condition score reflects the plane of nutrition on which an animal has been exposed over a reasonable length of time (Stuth *et al*., 1998). Several authors have documented association between body condition scoring and fertility (Buckley *et al*., 2003), health and market values of animals (Roche and Berry, 2006). While, an animal's abnormal temperature may play a part in the veterinarian's ultimate diagnosis of a disease, and the visual symptoms of abnormal temperature are often the first noticeable clue the owner may detect (Shelton 2000; Daramola and Adeloye 2009). When an animal's temperature is above normal limits, it's considered to have a fever; if it's below normal, it's called hypothermia (Nienaber *et al*., 1990; Oladimeji *et al*., 1996 ; Ayo *et al*., 1998). Although the measurement of temperature is one of the most characteristic and reliable methods to judge the degree of fever in animals, it does not always have a direct relationship in animals, especially in cattle. One must, also, consider other symptoms, such as chill, uneven distribution of the external temperatures, pulse and respiration rates, appetite, digestion, morbidity, etc. The objective of the study was to determine the seasonal morpho-physiological characterization of pastoral indigenous cattle, grazing the guinea savannah zone of Nigeria.

## MATERIALS AND METHODS

### The Study Area

Adamawa State is located at the area where the River Benue enters Nigeria from Cameroon Republic and is one of the six states in the North-East geopolitical zone of Nigeria. It lies between latitudes $7^0$ and $11^0$ North of the Equator and between longitudes $11^0$ and $14^0$ East of the Greenwich Meridian (Mohammed,1999). It shares an international boundary with the Republic of Cameroon to the East and interstate boundaries with Borno to the North, Gombe to the North-West and Taraba to the West and South (Adebayo, 1999; ASMLS, 2010a; ASMLS, 2010b), as can be seen in Figure I.

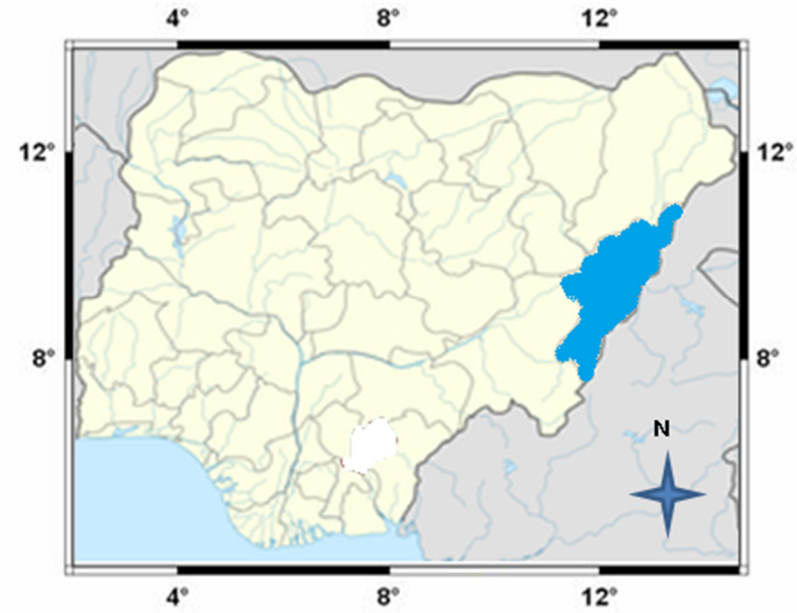


**Figure I: Map of Nigeria Showing Adamawa state as the Study Area**

According to Adebayo and Tukur (1997), Adamawa State covers a land mass of about 38,741km². The state is divided into 21 State Local Government Areas with three Senatorial Zones (Northern, Central and Southern) which translated to agricultural zones as defined by INEC (1996).

The State has minimum and maximum rainfall of 750 and 1050mm and an average minimum and maximum temperature of $15^0$C and $32^0$C, respectively. The relative humidity ranges between 20 and 30% with four distinct seasons that include: early dry season (EDS, October – December); late dry season (LDS, January – March); early rainy season, (ERS, April – June) and late rainy season (LRS, July – September) (Adebayo, 1999).

The vegetation type is best referred to as guinea savannah (Areola, 1983;Adebayo and Tukur, 1997). The vegetation is made up of grasses, aquatic weeds along river valleys and dry land weeds inter-spaced by shrubs and woody plants. Plant heights ranges from few centimeters (Short grasses) to about one meter tall (tall grasses), which form the bulk of animal feeds.

Cash crops grown in the state include cotton and groundnuts, sugar cane, cowpea, benni seed, bambara groundnut, tiger nut, while food crops include maize, yam, cassava, sweet potatoes, guinea corn, millet and rice. The village communities living on the banks of rivers engage in fishing, while the Fulani and other tribes who are not resident close to rivers are pastoralists who rear livestock such as cattle, sheep, goats, donkeys, camels, horses and poultry for subsistence (Adebayo and Tukur, 1997; Adebayo, 1999).

### Study Sites

Three Local Government Areas, one from each of the three senatorial districts in the state were chosen for the study. The Local Government Areas were purposively selected to cut across the state which represents the pastoral zones with higher number of cattle producers in the state (Adebayo, 1999). The study areas include Mubi North (Northern Senatorial Zone), Gombi (Central Senatorial Zone) and Jada (Southern Senatorial Zone) as shown in Figure II . Ten

communities/pastoral camps were randomly selected in each of the study area and one hundred (100) livestock farms were visited in each study area for interviews, direct observation and data collection across early rainy season (ERS), late rainy season (LRS), early dry season (EDS) and late dry season (LDS), respectively.

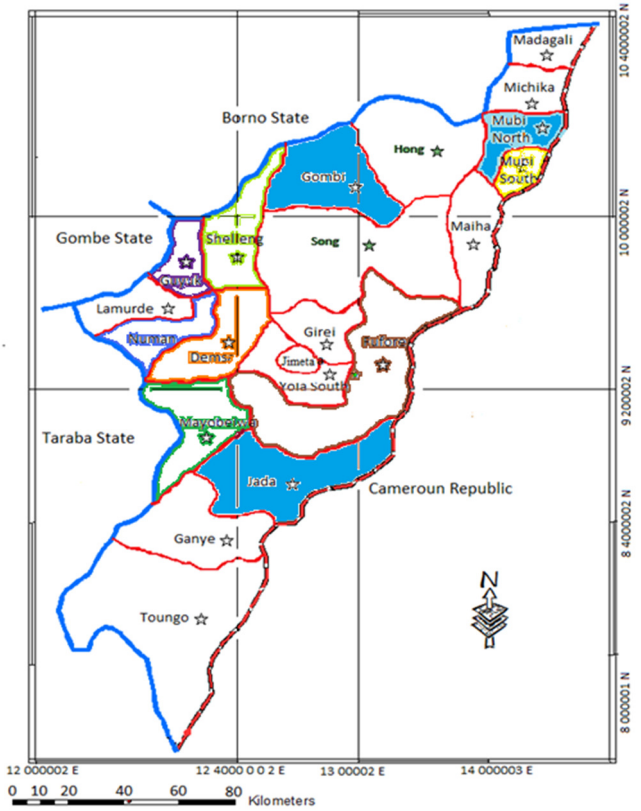


**Figure II: Map of Adamawa State Showing the Three Study Local Government Areas**

Mubi North Local Government Area is located in the Northern part of old Sardauna Province which now forms Adamawa North Senatorial district as defined by INEC (1996). The region lies between latitudes $9^0$ 30´´ and $11^0$ North of the Equator and longitudes $13^0$ and $13^0$ 45´´ East of Greenwich Meridian. Mubi region is bound in the North by Borno State, in the West by Hong and Song LGAs and in the South and East by the Republic of Cameroon. It has a land area of about 4,728.77 km² and human population of about 759,045 going by (1991) census projected figure (Adebayo and Tukur, 1991).

Gombi Local Government Area is one of the oldest Local Government Areas in Adamawa State strategically positioned North of the River Benue in the State. The region lies between Latitudes $10^009'$ and $10^040'$ North and Longitudes $12^044'$ and $13^023'$ East. It is bordered in the East by Hong Local Government Area, West by Shelleng Local Government Area, South by Song Local Government Area and South-East by Biu Local Government Area of Borno State. It has high number of cattle producers and a good cattle market every Friday (Adebayo and Tukur, 1991).

Jada Local Government Area is one of the Local Government Areas in the Southern Senatorial Zone of Adamawa State. It is located at an elevation of 360 meters above sea level and has population of 250,459 people. Its coordinates are 8°46' North and 12°9' East. It is bordered in the North - East by Yola south Local Government Area, South-East by Ganye Local Government Area, West by Mayo Belwa Local Government Area and South by Zing Local Government Area in Taraba State (Adebayo and Tukur, 1991).

**Experimental Farms**

The study was conducted in three semi-sedentary livestock farms, one from each of the study locations across the state. In Mubi North Local Government Area, Northern Senatorial Zone , the Federal Polytechnic Mubi , Livestock

Farm was used. The Polytechnic was established in 1982 to serve the North- East geopolitical zone with middle class technical skilled man power.

The livestock farm consists of five units, which include large ruminants (cattle), small ruminants (sheep and goats), piggery, rabbitary and poultry units. The common cattle breeds in the farm are White Fulani (Bunaji), Red Bororo (Rahaji), Sokoto Gudali (Bokoloji) and Adamawa Gudali. Cattle population ranges between 120 and 150 animals including service bulls, castrated bulls, bullocks, heifers, dry cows, nursing cows and pregnant cows. The small ruminants unit has over 100 animals. There are, also, piggery and rabbitary units with more than 50 animals in each. The farm, also, has a poultry unit that accommodates 2,000 to 4,000 both layers and broilers.

The livestock management system involves taking out sheep and goats, pigs and cattle every morning and bringing them back in the evening by herdsmen to graze forages in the wet seasons and scavenge the crop residues and by - products in the dry seasons. Crop by- products are also gathered and preservered to supplement feeding during critical periods of the year. The animals drink water in the nearby Rivers Yadzaram and Vimtim but occasionally water is supplied to them using farm water tanker. Natural or pasture mating is the common breeding system in the farm. Make shift Kraals constructed with sticks and barbed wires are used for cattle owned by individuals and members of staff, while a permanent concrete kraal is used for cattle owned by the institution. The animals have access to veterinary services with occasional use of ethno- veterinary medicine.

The stocks are sourced from Mubi international livestock market. Such cattle are brought from other countries such as Cameroon, Chad, Senegal, Central Africa, Zambia and Burundi. The Polytechnic is bordered with Adamawa State University, Mubi, College of Health Technology, Mubi and Government Technical College, Mubi.

In Gombi Local Government Area, Ali Matakala Kwargashe livestock farm was used. The farm is non-institutional, a private farm established in 1994 and located in Lala District of Western part of Gombi Local Government Area. The common cattle breeds found on the farm are the Zebu cattle including White Fulani (Bunaji), Red Bororo (Yakanaji), Sokoto Gudali (Bokoloji) and Adamawa Gudali. Cattle population ranges between 100 and 180 animals including service bulls, castrated bulls, bullocks, heifers, dry cows, nursing cows and pregnant cows. The farm has over 100 sheep and goats.

The livestock management adopted by the farm is similar to that of the Federal Polytechnic, Mubi, where herds men are involved in taking animals out to grazing areas with luxuriant growth of forages, riverside areas and bringing them back in the evenings. During the dry seasons, animals are moved to crop farms within the vicinity after harvest to scavenge the crop residues and by - products. Crop by- products are gathered and preservered to supplement feeding during critical periods of the year. Some tree legumes and fodder herbs are logged down for the animals, while limited concentrates are given to the animals even during the critical periods of the year. The animals drink water in the nearby rivers and streams (Kwargashe and Nyora). Natural or pasture mating is the common breeding system in the farm. Make shift Kraals constructed with sticks and barbed wires are used for both cattle and sheep. The animals have limited access to veterinary services but ethno- veterinary medicine for livestock health management are commonly exploited. The stocks are sourced from Fotta, Gombi, Song and Kwaya livestock markets in Adamawa and Borno States, respectively.

In Jada Local Government Area, Southern Senatorial Zone, Alhaji Adamu Hamman Joda privately owned cattle ranch was used. The livestock farm was established in 1999 for breeding, dairy and beef production. The ranch consists of two units, namely: large ruminants (cattle) and small ruminants (sheep and goats). The common cattle breeds in the ranch are White Fulani (Bunaji), Red Bororo (Rahaji), Sokoto Gudali (Bokoloji) and Adamawa Gudali. Cattle population ranges between 200 and 300 animals including service bulls, castrated bulls, bullocks, heifers, dry cows, nursing cows and pregnant cows. The small ruminants unit has over 150 animals.

The animal management system include moving the animals to graze on pasture like forages fenced with barbed wires to prevent other stray livestock trespassing. During wet seasons, abundant forages are persevered in form of hay and silage which are used with crop residues and by - products as an intervention feed resources during lean feed periods in the dry seasons. The animals drink water from streams in the ranch and occasionally, water is supplied to them from the farm bore hole. Natural or pasture mating is the common breeding system in the farm. Permanent concrete kraals are used in the farm. The animals have access to veterinary services but occasionally the use of ethno-veterinary medicine to augment western medicine is also common. The stocks are sourced from Numan, Ngrore, Jada, Ganye, Mayo Belwa and Zing livestock markets in Adamawa and Taraba States.

**Data Collection**

The data collection instruments include, short questionnaires, oral interviews and field observations. Well structured questionnaires were developed in English language and distributed and where a farmer does not understand English, Hausa and Fulfulde languages were used.

**Selection of Respondents**

Random selection of respondents were carried out after preliminary survey and herds with minimum of 20 animals (15 females and 5 males) were legible for inclusion in this study. Ten communities or pastoral camps were randomly selected at each of the study sites. On the whole 100 livestock farms were visited in each study area for interviews, direct observations and data collection. This was done across four seasons namely early rainy season (ERS), late rainy season (LRS), early dry season (EDS) and late dry season (LDS).

**External Physiological Characterization of Cattle**

**(a). Body condition scores (BCS):** Body condition scores of 10 male and 10 female animals in each breed randomly selected in each study area were determined using visual indicators or a combination of visual and palpation of key bone structures for fat cover. The key areas that were evaluated are the backbone, ribs, loin area and tail head by the use of scale 0 – 5 grades as described by Jefferies (1961), Lawman *et al*. (1976), Pullan (1978), Gatenby (2002), Todd (2008) and Addass (2011).
**(b). Body temperature (T°) :** Rectal temperature of the animals were taken once in the morning across every season using digital thermometer via the rectum as described by Piccione *et al*. (2007) and Burfeind *et al*. (2010).
**(c). Respiratory rate (beats/ minute):** Respiratory rate of animals were measured once in the morning across every season by counting the number of flank movement, sound of the nostrils and the chest area per minute using stopwatch, visual and stethoscope as shown in Figure III (Mitlöhner *et al*., 2001; Eigen- berg *et al*., 2005).
**(d). Pulse rate (beats/ minute):** Pulse or heart rate of animals were determined in the morning once across every season by feeling the pulse, listening to heart beat using stethoscope and stopwatch as can be seen in Figure III. The pulse rates of cattle were taken from the external maxillary artery crossing the lower edge of the jaw as described by Hopster and Blokhuis (1994); Marjan *et al.* (2006).

**Figure III: Showing the student taking respiratory and pulse rates of cattle**

**Data analysis**

All survey data generated were subjected to descriptive statistics such as frequencies and percentages. The morpho-physiological data were analyzed using the GLM procedure as contained in statistix 9.1 package USA (2009). Analysis of variance, means and standard error as well as interaction effects were calculated; correlations between parameters were determined**.** Significant means were separated using LSD procedure as contained in statistix 9.1 package USA (2009).

## RESULTS AND DISCUSSION

### Body condition scores (BCS) of cattle of in Adamawa State, Nigeria

Body weights and condition scoring are the traditional methods used to assess nutritional status of animals (Ndlovu *et al*., 2007; Addass, 2011). This is because nutritional status of cattle is useful in quantifying the extent to which cattle are affected by diseases or other environmental factors, especially where seasonal fluctuations in the quantity and quality of forages occur, as is common during different seasons in tropical and sub-tropical areas (Flier and Maratos - Flier, 2000). The purpose of condition scoring, therefore, is to achieve a balance between economic feeding, good production and good welfare (Todd, 2008). Another objective of body condition scoring is to ensure that cows calve down safely whether on pastoral or semi-sedentary production system. According to the report of Akpa *et al*. (2011), calving ease increased with age, parity and body condition score of a dam. Poor body condition is, also, associated with reduced income per cow, increased post-partum interval, weak calves at birth, low quality and quantity of colostrum, reduced milk production, increased dystocia, and lower weaning weights (Akpa *et al*., 2011). This indicates that, BCS is one of the most important factors in determining subsequent reproductive performance of cattle (Gatenby, 2002).

### (a) Effect of location on body condition scores (BCS) of cattle in Adamawa State, Nigeria

Table 1a shows the results of mean body condition scores of cattle grazing the guinea savannah zone of Adamawa State. There were insignificant ($p > 0.05$) differences among the mean body condition scores of cattle in the three study locations, although, higher BCS was recorded in Mubi North followed by Jada and Gombi Local Government Areas. This similarity in BCS could be linked to the similarity in climatic conditions of the zone which influenced forage productivity and biomass availability. The results revealed that, all the animals examined had body condition scores ranging from 2.0 to 4.0 as shown in Figures IV, V, VI and VII. Animals with body condition 0 (base line), 1 (very poor) and 5 (upper limit or obese) were not common during the study period. The values recorded in this study were not out of context for Zebu cattle under pastoral and semi - sedentary systems of management in tropical environments like ours and are in agreement with the earlier reports of Stuth *et al*. (1998) that, body condition score reflects the plane of nutrition on which an animal has been exposed over a reasonable length of time. Kubkomawa *et al*. (2010), also, reported mean body condition score of repeat breeder cows to be 3 in cattle from four Local Government Areas of Adamawa State, Nigeria. The present results, also, agree with the reports of 3.15 BCS by Alphonsus *et al*. (2012) for Bunaji and Friesian cows grazed at National Animal Production Research Institute, (NAPRI) Shika, Nigeria.

**Figure IV: Showing a White Fulani cow with a BCS of 3 in pastoral herd during early rainy season**

**Figure V: Showing a Red Bororo cow with BCS of 2 in pastoral herd during late dry season**

**Figure VI: Showing Sokoto Gudali (Bokoloji) bull with a BCS of 4 in semi-sedentary herd during early dry season**

**Figure VII: Showing Adamawa Gudali cow with a BCS of 3 in semi-sedentary herd during late rainy season**

**Table 1: Body Condition Scores (BCS) of Cattle in Adamawa State, Nigeria**

| Distribution of mean BCS | Minimum | Maximum | Mean | SEM |
|---|---|---|---|---|
| **(a) Effect of location on mean BCS** | | | | |
| Mubi North | 2.000 | 4.000 | 3.0320 | 0.0169 |
| Gombi | 2.000 | 4.000 | 2.9980 | |
| Jada | 2.000 | 4.000 | 3.0245 | |
| **(b) Sex effects on mean BCS** | | | | |
| Male | 2.000 | 4.000 | 3.0145 | 0.0138 |
| Female | 2.000 | 3.500 | 3.0218 | |
| **(c) Breed effects on mean BCS** | | | | |
| White Fulani | 2.000 | 4.000 | 2.9326 [a] | 0.0195 |
| Red Bororo | 2.000 | 4.000 | 3.0234 [b] | |
| Sokoto Gudali | 2.000 | 3.500 | 3.0161 [b] | |
| Adamawa Gudali | 2.000 | 4.000 | 3.1004 [c] | |
| **(d) Mgt effects on mean BCS** | | | | |
| Pastoral | 2.000 | 3.500 | 2.8564 [a] | 0.0138 |
| Semi - sedentary | 2.000 | 4.000 | 3.1799 [b] | |
| **(e) Seasonal effects on mean BCS** | | | | |
| Late Rainy Season (LRS) | 2.000 | 4.000 | 3.1016 [a] | 0.0195 |
| Early Dry Season (EDS) | 2.000 | 4.000 | 3.0342 [b] | |
| Late Dry Season (LDS) | 2.000 | 3.500 | 2.9271 [c] | |
| Early Rainy Season (ERS) | 2.000 | 4.000 | 3.0098 [b] | |

abc means with different superscript(s) are significantly different ($p < 0.05$)

**(b) Sex effects on BCS of cattle**

The results in table 1b again, showed no significant ($p > 0.05$) differences in the mean body condition scores of male and female cattle in the study areas (Table 1b). However, it was observed that female animals had higher mean BCS than males. Even though on individual basis, the best BCS of 4 was found among the male cattle as shown in Figure VI. This was likely because some of the bulls were more physically strong compared to cows and can compete better in terms of feeding. The physically strong bulls, also, have the tendency to bully weak ones, thereby giving them higher opportunity for more bites per square meter of pasture land compared to other animals. The size difference between male and female animals is usually not due to genes but hormones. Androgen in the mature male has anabolic effect and is, therefore, responsible for the bigger frame of the male animal.

Several authors have associated body condition score with sex and fertility (Buckley *et al*., 2003) and health (Roche and Berry, 2006) indicating that, the higher the body condition the better in terms of productivity. Addass (2011) also reported that, bulls with body condition scores of 4 appeared in good conformation and had higher sperm reserves compared to those with lower body condition scores in Zebu cattle in the guinea savannah zone of Mubi, Adamawa State. In breeding, cows, heifers and bulls', body condition is closely related to their fertility and forage convertibility. In beef cattle, steers and heifers raised for beef production, BCS determines health, ability to gain, and when the animals are ready for slaughter (Gatenby, 2002).

**(c) Breed effects on BCS of cattle**

Table 1c shows that, the mean body condition scores of Adamawa Gudali was significantly ($p < 0.05$) higher than White Fulani, Red Bororo and Sokoto Gudali. Again, the mean body condition scores of Red Bororo and Sokoto Gudali were significantly ($p < 0.05$) higher than that of White Fulani cattle. Furthermore, the results also showed insignificant ($p > 0.05$) differences between the mean body condition scores of the Red Bororo and that of Sokoto Gudali. This implies that Adamawa Gudali breed is the best cattle found as measured by the body condition scores in the study area and could be attributed to genetic makeup of the cattle since they phenotypically look like Muturu and Ndama breeds in body size and frame. Adamawa Gudali are smaller in stature, withstands more hardship and would probably require less nutrients for maintenance and productivity compared to the larger framed breeds which may need a lot of reserve energy to maintain the body conformation and then for production. The results corroborate earlier study conducted by Wright and Russell (1984) who stated that, although the condition score gives a good indication of fatness, breeds differ in the way they deposit fat reserves. Dairy cattle generally deposit more fat internally than do beef cattle.

**(d) Management effects on BCS of cattle**

The results of the mean body condition scores of cattle differed significantly ($p < 0.05$) between the two management systems investigated (Table 1d). Cattle raised under semi-sedentary system had higher body condition scores compared to those on pastoral system. This is probably because under semi-sedentary system, cattle had better access to crop residues and by- products, occasional feed supplementation, veterinary services and water supply. Pastoral cattle have been reported to face divers issues such as stress, shortages of forages, limited access to crop residues and by- products, limited veterinary facilities and water resources especially during the dry periods (Oulun, 2005; Agenas *et al*., 2006). The results corroborated the earlier study conducted by Akpa *et al*. (2012), who reported that, body condition scores allow producers to group cattle according to their nutritional requirements, thereby improving the efficiency of nutrition programs. The results also agree with Oulun (2005) and Agenas *et al*. (2006) who reported that, body condition score is an objective indicator of nutritional status, which could be reliably and routinely used to aid management of cattle in rural areas.

**(e) Seasonal effects on BCS of cattle**

The results of mean body condition scores of cattle differed significantly ($p < 0.05$) across four seasons as shown in Table 1e. Late rainy season (LRS) recorded the highest mean body condition score followed by early dry season (EDS), early rainy season (ERS) and late dry season (LDS), respectively. This was not surprising because late rainy season coincided with the period of feed availability especially luxuriant forages and browses. Water resources are also available with streams, ponds, dams, hand dug wells and surface run offs still flowing. At this period migration of pastoralists are minimal because of the high intensity of crop farm lands in guinea savannah zones, while higher cases of crop farms destruction are common.

Early dry season (October - December) was another period where the animals had fair body condition scores because of the abundance of crop residues and by - products. At this period, pastures and range land forages have grown to maturity producing high lignin and fibre contents but low in protein and nitrogen. Even though the pastures may still be seen standing, they provide limited nutrients to the animals since the farmers do not usually harvest and process the matured forages to improve their palatability and digestibility. Early rainy season (March to May) was another period where the animals had the lowest body condition scores. This was because, the season is a critical period characterized by low feed availability and water resources. The pastures and crop residues obtained during the early dry season could not be sustained because of poor management and lack of proper handling procedures. Some crop residues and by - products are allowed to waste in the fields or consumed by straying animals and bush fire. Since this period marks the beginning of rains and rainstorms, the period is full of dust and heat that tends to contaminate and spoil the reminants of the crop residues and by- roducts.

The findings corroborated Odenyo *et al.* (1997), Shelton (2004) and Babayemi *et al.* (2004) who reported that, during the dry periods in guinea savannah zones of Nigeria, diets for ruminant animals, especially forages, crop residues or by-products are limited by shortages in amount and quality which result in reduced livestock productivity in those arid and semi- arid zones of tropical countries. The results, also, agree with Devendra (1989) who reported that, in the Northern parts of the country, ruminants suffer greatly due to malnutrition because the nutrients available in the grass during the dry season do not meet their maintenance levels, which therefore, make most animals depend on other sources or non-conventional supplementary diet.

**Rectal Temperatures of Cattle in Adamawa State, Nigeria**

An animal's body temperature is the result of the balance between heat produced by the basal metabolism and muscular activity of the body and the heat lost from the body (Jeffrey and Michael, 2010). Rectal temperatures have been used as reliable indicators of short time physical stress in animals (Oladimeji *et al.*, 1996 ; Ayo *et al.*, 1998). Cattle rectal temperatures have, also, been used in detection and management of diseases and changes in the state of cows' estrus, heat stress and the onset of calving for decades (Jeffrey and Michael, 2010). Attempts to measure body temperature of cattle have been made at various anatomical locations including rectum, ear (tympanic), vagina, reticulum-rumen and udder (milk) (Prendiville *et al.*, 2002).

**(a) Effect of location on mean rectal temperatures of cattle in Adamawa State, Nigeria**

The results showed that, the rectal temperatures of cattle from Mubi North and Gombi were significantly ($p < 0.05$) higher compared to cattle from Jada Local Government Area, while there were no significant ($p > 0.05$) differences between means of those from Mubi North and that of Gombi LGAs (Table 2a). This variations in rectal temperatures of cattle within the same climatic zone could be as a result of individual animal's physical activity, physiological status, solar radiation, environmental conditons, feeding and atmospheric humidity of the locations. However, despite the variations in the rectal temperatures of the cattle in this study, the results were within the normal range of 36.0 - 39.3$^0$C (Hahn *et al.*, 1990; Babayemi *et al.*, 2014).

The results of the present studies also concur with that of Udeh *et al.* (2011), who reported similar rectal temperatures of Zebu and Muturu cattle to range from 38.96 and 39.96$^0$C in Delta State, Nigeria. When an animal's body temperature increases by at least 1°C above the normal upper limit, the animal is considered to have a fever and if it's below normal, it's called hypothermia (Prendiville *et al.*, 2002). Although the measurement of temperature is one of the most characteristic and reliable methods to judge the degree of fever, it does not always have a direct relationship in animals, especially in cattle (Hahn *et al.*, 1990). Other parameters such as chill, uneven distribution of the external temperature, pulse and respiration rates, appetite, digestion and morbidity (Babayemi *et al.*, 2014), should also be considered.

**Table 2: Rectal Temperature (RT°) of Cattle in Adamawa State, Nigeria**

| Distribution of mean RT° | Minimum | Maximum | Mean | SEM |
|---|---|---|---|---|
| **(a) Effect of location on mean RT°** | | | | |
| Mubi North | 24.000 | 38.000 | 37.698$^a$ | 0.0378 |
| Gombi | 24.000 | 38.000 | 37.746$^a$ | |
| Jada | 24.000 | 38.000 | 37.411$^b$ | |
| **(b) Sex effects on mean RT°** | | | | |
| Male | 24.000 | 38.000 | 37.622 | 0.0309 |
| Female | 24.000 | 38.000 | 37.615 | |
| **(c) Breed effects on mean RT°** | | | | |
| White Fulani | 24.000 | 38.000 | 37.686$^a$ | 0.0436 |
| Red Bororo | 24.000 | 38.000 | 37.792$^a$ | |
| Sokoto Gudali | 24.000 | 38.000 | 37.760$^a$ | |
| Adamawa Gudali | 24.000 | 38.000 | 37.236$^b$ | |
| **(d) Mgt effects on mean RT°** | | | | |
| Pastoral | 24.000 | 38.000 | 37.180$^a$ | 0.0309 |
| Semi - sedentary | 24.000 | 38.000 | 36.057$^b$ | |
| **(e) Seasonal effects on mean RT°** | | | | |
| Late Rainy Season (LRS) | 24.000 | 38.000 | 37.719$^a$ | 0.0436 |
| Early Dry Season (EDS) | 24.000 | 38.000 | 37.728$^a$ | |
| Late Dry Season (LDS) | 24.000 | 38.000 | 37.768$^a$ | |
| Early Rainy Season (ERS) | 24.000 | 38.000 | 37.958$^b$ | |

abc means with different superscript(s) are significantly different ($p< 0.05$)

To use body temperature properly as a measure of illness, it is necessary to know what is normal (Babayemi *et al*., 2014). Unfortunately, normal temperatures for cattle rise during the day. In fact, body temperature in cattle follows a daily pattern where there is a period of increasing heat load and rising body temperature then period of heat dissipation and falling body temperature. Cattle minimum body temperature usually occurs early in the morning, then steadily increases during the day (Amakiri and Funsho, 1979). They reported the mean morning (38·62°C) and late afternoon (39·19°C) rectal temperatures in cattle in Ibadan, Nigeria. In general, animal temperatures will vary, depending on breed, feeding, solar radiation, humidity, physical activity, stage of pregnancy, time of the day, and environmental surroundings (Babayemi *et al*., 2014).

**(b) Sex effects on rectal temperatures of cattle**

The results showed no significant ($p > 0.05$) differences between the mean rectal temperatures of male and that of female cattle in the study locations (Table 2b). However, male had higher values compared to that of female cattle. The similarity recorded could be attributed to the similarity in the environmental conditions that the animals were exposed to. Those conditions may include nature of the climate, ambient temperatures, feed and water resources, handling and restraining methods, housing, grazing systems, diseases and parasite infestations. It could also be that, majority of the female animals were open and not on estrus during the survey which resulted to their temperatures not being elevated beyond that of the males.

**(c) Breed effects on rectal temperatures of cattle**

The results of the study indicated that, there were no significant ($p > 0.05$) differences in the mean rectal temperatures of White Fulani, Red Bororo and Sokoto Gudali breeds but that of Adamawa Gudali differed significantly ($p < 0.05$) from the other three breeds as shown in Table 2c. Red Bororo had the highest value followed by Sokoto Gudali, White Fulani and Adamawa Gudali breeds in that order. The similarity recorded in the mean rectal temperatures of White Fulani, Red Bororo and Sokoto Gudali breeds could be as a result of their similarity in body size, since all of them have larger body frames compared to Adamwa Guadali breed which has smaller body frame.

Additionally, the differences recorded amongst the breeds could be associated with differences in coat type and colour. Fadare *et al*. (2012) reported that, coat colour contributes to physiological adaptation in mammals and mediates response to thermal stress. Animals with light coloured, silk coats absorb less heat from the environment than dark coloured woolly-coated animals. Coat colour is a qualitative trait and an indicator of genetic superiority or productive adaptability of animals to heat tolerance (Helal *et al*., 2010; McManus *et al*., 2011).

**(d) Management effects on rectal temperatures of cattle**

The results of the study showed significant ($p < 0.05$) variations between the mean rectal temperatures of cattle raised under the two management systems (Table 2d). Pastoral cattle recorded significantly higher mean rectal temperatures than those under semi - sedentary management system. This significant variations may be due to the management and handling or restraining methods used during the survey. The herdsmen under the pastoral system had to chase some of the animals around to catch them because of the nature of their kraals while cattle in semi - sedentary were restrained without much struggle because of their well constructed kraals with fitted strong crutches. The findings supported that of Clarke *et al*. (1994) who reported that, cattle gain heat from metabolic activity and the environment and acute elevations in body temperature occur directly after feeding or exercise.

**(e) Seasonal effects on rectal temperatures of cattle**

The results of the study showed no significant ($p > 0.05$) disparities in the mean rectal temperatures of cattle during the late rainy season ( July to September), earlly dry season (October to December) and late dry season (January to March), respectively. However, the mean rectal temperature of cattle in early rainy season (April to June) was significantly ($p < 0.05$) higher than others (table 2e). This is probably a reflection of the effects of higher temperature and increasing humidity characteriatic of this period of the year because of the return of the rains. Air temperature, solar radiation, relative humidity and wind speed are the important climatic variables that distinguishes one season from the other (Clarke *et al*., 1994). These results agree with Musa-Azara *et al*. (2010), who reported mean morning rectal temperature of $38.2^0$C during cold and $38.87^0$C in the hot dry season and the mean afternoon temperature of $38.8^0$C during the cold season, while $39.05^0$ C during the hot-dry season of Holstein Friesian in the Nigerian Guinea Savanah zone of Nigeria.

The values obtained in this study are lower than that of Concepta *et al*. (2014), who reported higher rectal temperatures (38.5 to 39.5 ºC) in crossbred cattle in Central Brazil as compared with those of European animals in cold weather.

**Respiratory Rates of Cattle in Adamawa State, Nigeria**

Respiration is the act of breathing or taking in oxygen, using it in the body tissues, and giving off carbon dioxide (Lu, 1989; Becker *et al*., 1989). Respiration consists of inspiration, or the expansion of the chest or thorax and expiration, or the expulsion of air from the lungs. The normal respiratory rate in mature cattle at rest ranges from 10 to 30 breaths per minute (Gaughan *et al*., 2000). Any deviation from the normal respiratory rates is frequently attributed to primary and secondary disease in cattle. Respiratory rates have been used as reliable indicators of physical stress in animals (Plyaschenko and Sidorov, 1987; Verstergen, 1987). Many diseases that affect all classes of farm animals spread and settle in areas of the respiratory system (Oladimeji *et al*., 1996; Ayo *et al*., 1998).

**(a) Effect of location on mean respiratory rates of cattle in Adamawa State**

Table 3a shows the mean respiratory rates of cattle grazing the guinea savannah zone of Adamawa state. The results showed that, there were significant ($p < 0.05$) distinctions in the respiratory rates of cattle from Mubi North, Gombi and that of Jada LGAs respectively. However, Jada had the highest value followed by Mubi North and Gombi which recorded the least rate. In any case, the respiratory rates of cattle obtained in this study fall within the normal range of 10 to 30 breathings per minute (Gaughan *et al*., 2000). The values were higher than that of Babayemi *et al*. (2014) who reported in their text book that, normal respiratory rate of cattle breeds in Nigeia ranges from 8 to 12 breathings per minute. This variations could be linked to factors such as body size, age, breed, exercise, excitement, ambient temperature, atmospheric conditions, pregnancy, and fullness of the digestive tract. It was also observed that, small framed animals tend to exhibit slower, quieter and fewer rates compared to larger sized animals which respire faster with a great deal of sound. This could also be attributed to the size of their lungs, other organs and rumen contents which influence the act.

**Table 3: Respiratory Rate (RR) Beats/ Minute of Cattle in Adamawa State, Nigeria**

| Distribution of mean RR | Minimum | Maximum | Mean | SEM |
|---|---|---|---|---|
| **(a) Effect of location on mean RR** | | | | |
| Mubi North | 24.000 | 28.000 | 26.066[a] | 0.0332 |
| Gombi | 24.000 | 28.000 | 25.972[b] | |
| Jada | 24.000 | 28.000 | 26.159[c] | |
| **(b) Sex effects on mean RR** | | | | |
| Male | 24.000 | 28.000 | 26.108[a] | 0.0271 |
| Female | 24.000 | 28.000 | 26.023[b] | |
| **(c) Breed effects on mean RR** | | | | |
| White Fulani | 24.000 | 28.000 | 25.996[a] | 0.0384 |
| Red Bororo | 24.000 | 28.000 | 26.214[b] | |
| Sokoto Gudali | 24.000 | 28.000 | 26.041 | |
| Adamawa Gudali | 24.000 | 28.000 | 26.013 | |
| **(d) Mgt effects on mean RR** | | | | |
| Pastoral | 24.000 | 28.000 | 26.062 | 0.0271 |
| Semi - sedentary | 24.000 | 28.000 | 26.069 | |
| **(e) Seasonal effects on mean RR** | | | | |
| Late Rainy Season (LRS) | 24.000 | 28.000 | 26.073 | 0.0384 |
| Early Dry Season (EDS) | 24.000 | 28.000 | 26.032 | |
| Late Dry Season (LDS) | 24.000 | 28.000 | 26.038 | |
| Early Rainy Season (ERS) | 24.000 | 28.000 | 26.120 | |

abc means with different superscript(s) are significantly different ($p< 0.05$)

**(b) Sex effects on respiratory rate of cattle**

Table 3b shows the mean respiratory rates of cattle on sex basis. The results showed that, there were insignificant ($p > 0.05$) differences between the respiratory rates of male and female cattle. The male had higher values as compared to the female cattle implying that, majority of the female animals are probably not pregnant or in early

stage pregnancies. Another reason could be that, all the cattle were Zebu (*Bos indicus*) which agrees with the findings of Concepta *et al*. (2014) that, the genetic make-up had significant influence on respiratory rates of cattle.

**(c) Breed effects on respiratory rate of cattle**

Table 3c shows the mean respiratory rates of cattle on breed basis. The results showed that, there were significant ($p < 0.05$) differences between the respiratory rates of White Fulani and that of Red Bororo, Sokoto Gudali and Adamawa Gudali. However, there were no significant ($p > 0.05$) differences in the respiratory rates of the Red Bororo, Sokoto Gudali and Adamawa Gudali breeds of cattle. But Red Bororo had the highest values followed by Sokoto Gudali, Adamawa Gudali and White Fulani breeds of cattle. The values obtained in the present study are lower than that of Concepta *et al*. (2014), who reported higher respiratory rates (24-50 per minute) in crossbred cattle in Central Brazil as compared to those of European animals in cold weather. Swenson and Reece (1996) and Blood *et al*. (1983), also, reported similar rates in Zebu cattle in the same region. The higher rates reported by Concepta *et al*. (2014) could be because of the environmental conditions of the study location which was cooler compared to the present location. However, the results of the present studies corroborate that of Udeh *et al*. (2011), who reported respiratory rates of Zebu (20.36) and Muturu (22.86) cattle in Delta State, Nigeria.

**(d) Management effects on respiratory rate of cattle**

Table 3d shows the mean respiratory rates of cattle on management system basis. The results showed that, there were no significant ($p > 0.05$) differences in the respiratory rates of cattle under the two systems of management. However, cattle under semi-sedentary system had higher values compared to pastoral cattle which were within the normal range. Respiratory rate is the first physiological measure that increases when the animal undergoes heat stress or exercise, showing greater variation than other physiological measures such as rectal temperature and this agrees with McManus *et al*. (2009), who studied heat tolerance in local cattle breeds in the same region of Central Brazil.

**(e) Seasonal effects on respiratory rate of cattle**

Table 3e shows the seasonal mean respiratory rates of cattle. The results showed that, there were no significant ($p > 0.05$) differences in the respiratory rates of cattle during the four seasons. Cattle had highest values during early rainy season (April to June) followed by late rainy season (July to September), late dry season (January to March) and then early dry season ( October to December). During periods of stress, an animal when exposed to the sun would have higher radiating heat load than its metabolic heat production. Studies have shown that, respiratory rate of animals exposed to the sun are significantly higher than those in the shade (Faria *et al*., 1988; McManus *et al*., 2009). The studies of Gaughan *et al*. ( 2000) demonstrated that, the effect of ambient temperature on respiratory rate is not constant and is subject to a number of influencing factors. Under hot conditions, the increase in respiratory rate varied from 2.8 breaths/min (BPM) to 3.3 BPM for every $1^{0C}$ temperature increase and the animal's response changes over time.

**Pulse Rates of Cattle in Adamawa State, Nigeria**

Pulse rate is the regular beat rate of the arteries, as the blood is pumped through them from the heart and is an important indicator of stress and disease in cattle (Heath and Olusanya, 1985). It is an easy way to count the heart rate. Pulse rate which is expressed in beats per minute can be altered rapidly due to external factors such as temperature or biological activities by the animal itself.

**(a) Effect of location on mean pulse rate of cattle in Adamawa State, Nigeria**

Table 4a shows the mean pulse rates of cattle in Adamawas State. The results indicated that, cattle from Mubi North had significantly ($p < 0.05$) higher pulse rates than cattle from Gombi and Jada LGAs. But there were insignificant ($p > 0.05$) differences between the pulse rates of cattle from Gombi and Jada LGAs. However, Jada had higher values compared to Gombi LGA. Most importantly, the results fall within the reference values of normal pulse rate of 40 to 70 as reported by Heath and Olusanya (1985). Atmospheric conditions, time of the day, exercise, eating and excitement are likely factors that influence variations in pulse rate. The normal pulse frequency varies in different species and individual animals. Increased secretion of adrenalin and noradrenalin from the core of the adrenal gland into blood results in an accelerated heart rate. The results agree with Babayemi *et al*. (2014) , who reported normal

pulse rate of cattle to be 55 beats per minute and Fasoro (1999), who reported a normal range of 40 - 70 beats per minute.

**Table 4: Pulse Rate (PR) Beats/ Minute of Cattle in Adamawa State, Nigeria**

| Distribution of mean PR | Minimum | Maximum | Mean | SEM |
|---|---|---|---|---|
| **(a) Effect of location on mean PR** | | | | |
| Mubi North | 52.000 | 60.000 | 56.023[a] | 0.0583 |
| Gombi | 52.000 | 60.000 | 55.520[b] | |
| Jada | 52.000 | 60.000 | 55.568 [b] | |
| **(b) Sex effects on mean PR** | | | | |
| Male | 52.000 | 60.000 | 55.756 | 0.0476 |
| Female | 52.000 | 60.000 | 55.651 | |
| **(c) Breed effects on mean PR** | | | | |
| White Fulani | 52.000 | 60.000 | 55.902[a] | 0.0673 |
| Red Bororo | 52.000 | 60.000 | 55.742 [a] | |
| Sokoto Gudali | 52.000 | 60.000 | 55.738 [a] | |
| Adamawa Gudali | 52.000 | 60.000 | 55.432[b] | |
| **(d) Mgt effects on mean PR** | | | | |
| Pastoral | 52.000 | 60.000 | 55.705 | 0.0476 |
| Semi - sedentary | 52.000 | 60.000 | 55.702 | |
| **(e) Seasonal effects on mean PR** | | | | |
| Late Rainy Season (LRS) | 52.000 | 60.000 | 55.765[a] | 0.0673 |
| Early Dry Season (EDS) | 52.000 | 60.000 | 55.804 [a] | |
| Late Dry Season (LDS) | 52.000 | 60.000 | 55.704 [a] | |
| Early Rainy Season (ERS) | 52.000 | 60.000 | 55.541[b] | |

abc means with different superscript(s) are significantly different ($p < 0.05$)

**(b) Sex effects on pulse rate of cattle**

The findings in respect to sex, also, showed insignificant ($p > 0.05$) differences between the pulse rates of male and female cattle in the study areas (Table 4b). In spite of this, the male had higher mean values compared to female animals and again, the values were within the recommended normal range. Under normal condition, heart rate is inversely proportional to the weight of the animal and this is observed directly by counting the heart beat through listening or by feeling with the index finger at particular point of the body (Ameen *et al*., 2010).

**(c) Breed effects on pulse rate of cattle**

Table 4c highlighted the effects of breed on pulse rates of cattle. The results showed that, there were significantly ($p < 0.05$) higher pulse rates of White Fulani, Red Bororo and Sokoto Gudali cattle than that of Adamawa Gudali, while the pulse rates of White Fulani, Red Bororo and Sokoto Gudali did not differ significantly ($p > 0.05$). However, the White Fulani recorded the highest values followed by Red Bororo, Sokoto Gudali and Adamawa Gudali cattle, respectively. The findings also fall within the world acceptable normal range. The findings of this study however, were lower than that of Concepta *et al*. (2014), who reported higher pulse rates of 60 - 80 beats per minute in crossbred cattle in Central Brazil as compared with those of European animals in cold weather. The results of the present study also corroborates the earlier reports of Udeh *et al*. (2011) on pulse rates of Zebu (51.52) and Muturu (55.68) cattle in Delta State, Nigeria.

**(d) Management effects on pulse rate of cattle**

Table 4d shows the respiratory rates of cattle based on management system. The results showed that, there were no significant ($p > 0.05$) differences in the pulse rates of cattle under the two production systems. However, cattle under the pastoral system had higher rates compared to those under semi - sedentary system. This implies that, cattle in the pastoral system might have been exposed to greater stress and activities that increased their breathing rates. The results agree with that of Hutchinson *et al*. (1976) and John *et al*. (2013) who reported that, some of the factors that influences the elevation of pulse rates is heat stress and coat colour. Heat flow from the environment into the body of a black animal on a hot sunny day is 30% greater than that of a white coloured animal.

**(e) Seasonal effects on pulse rate of cattle**

Table 4e shows the seasonal pulse rates of cattle in Adamawa State. The results depicted insignificant ($p > 0.05$) variations in the pulse rates of cattle across three seasons (LRS, EDS and LDS). However, there were significantly ($p < 0.05$) lower pulse rates in cattle during early rainy season (April to June). This period is characterized by serious shortage of feed, water resources and nutrient-deficiency-related disease conditions. Most of the cattle spend the hot periods of the day lying down quietly under tree shades ruminating occasionally, looking physically weak and emaciated. However, the values were within the normal range recommended in literature (Fasoro, 1999).

## CONCLUSION AND RECOMMENDATIONS

It was concluded that, the BCS, rectal temperatures, respiratory and pulse rates of cattle in the three study locations in four seasons fall within the referenced values. Therefore, any deviation from the normal recommended values indicate a sign of abnormality that should not be taken for granted. The parameters therefore, serve as good indicators and pointers that a farmer could use to diagnose animal's nutritional and environmental stress, disease and physiological problems that affect production.

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