The Effect of Some Environmental Factors on the Milk Yield of Frisian- Bunaji Cross Bred Raised In the Northern Guinea Savanah of Nigeria

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Abstract: This study seeks in understanding the effects and interaction of some environmental stressors (temperature, rainfall, and relative humidity) on milk yield. Six hundred and twenty five (625) lactation records for milk yield of Frisian- Bunaji crossbred cows were obtained from the dairy herd of National Animal Production Research Institute, Shika, Zaria. The records were kept from 2005- 2009. The data were analyzed to determine the effect of some environmental factors (month, season and year of calving) on milk yield of the cows. The result revealed that month, season and year of calving had significant effect ($P<0.05$) on milk yield of the cows. This suggests that the environment has significant role to play in the milk yield of these crossbred cows. The correlation between temperature, rainfall, relative humidity and milk yield were positive and significant ($P<0.05$; $P<0.01$). In conclusion, there is need for physical modification of environment through shading and cooling, genetic development of heat tolerant breeds and improved nutritional management practices for effective dairy cows production.

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1. Introduction

All animals have a specific range of ambient environmental temperature termed as the thermo neutral zone which is the range of temperature that is conducive to health and performance of the animals. The upper critical temperature is the point at which heat stress effects begin to affect the animal. There are numbers of environmental factors that contribute to heat stress. These include high temperature, high humidity and radiant energy (sunlight). Environments of high temperatures and humidity are detrimental to the productivity of commercial animal agriculture (Fuquay, 1981). Farm animals have known zones of thermal comfort (ZTC) that are primarily dependent on the species, the physiological status of the animals, the relative humidity, and velocity of ambient air, and the degree of solar radiation (NRC, 1981).

Today one of the greatest challenges to production facing dairy farmers is heat stress and the strain that it causes the lactating dairy cow. Lactating dairy cows expose to high ambient temperature, often coupled with high relative humidity or radiant energy (direct sunlight) usually responds with reduced milk yield. But the metabolism of an animal is always in a state of dynamic equilibrium in which the influx if nutrients is balanced by the production of energy in anabolic and catabolic processes, reproduction and lactation. Nutrient intake by high-producing cow is closely related to the amount of milk produced.

In a classical work at Missouri (Kibler and Brody, 1952) demonstrated that as ambient temperature increased in the presence of low or high relative humidity, cooling mechanism employed by the cow shifted from non-evaporative processes (convective, conductive, and radiation) to evaporative (sweating and panting) combine effect of environmental stressors may be more critical to cow comfort and performance than a single measures and such as ambient temperature.

Climatic condition in the northern part of Nigeria where cattle are mostly dominant are such that warm (hot) season is relatively longer than wet season, there is intense heat radiant energy for an extended period of time, and there generally the presence of high relative humidity. Thus heat stress is chronic in nature, there is often little relief from the heat during the evening hours, and intense burst of combined heat and humidity further depress milk yield. Lactating daily cows create large quantity of metabolic heat and accumulate additional heat from radiant energy. Heat production and accumulation, couple with compromised cooling capability because of

environmental conditions cause heat load in the cow to increase to the point that body temperature rises, feed intake declines and ultimately the cows' productivity decline, but the effect alleviates when cows get cooled (Her *et al.,* 1988).

An understanding of the interaction of various environmental factors with lactation performance is necessary so that management techniques and cooling practices can be developed to meet the needs of the high producing cow subjected to the effects of stressful conditions. This study was therefore carried out to determine the relationship between environmental stressors (temperature, rainfall and relative humidity) and milk yield.

2. Material and Methods

The study is originated from the Dairy Herd of the National Animal Production Research Institute (NAPRI), Shika, Ahmadu Bello University, Zaria, Nigeria. Shika is geographically located between latitude 11° 12'N and longitude 7° 33' at an altitude of 640m above sea level (Akpa *et al.,* 2002). It has three distinct climatic seasons. These are the cold dry season (November - February), the hot dry season (March - May) and the wet season (June - October). The total annual rainfall ranges from 617 to 1365mm with a 50-year average of 1041mm and with most of the rains fall between July and September (Oni *et at.,* 1991). And various macroclimatic parameters from the year 2005-2009 was used viz; Temperature, rainfall and relative humidity which were obtained from the Institute of Agricultural Research, Zaria (Metrologicai unit of IAR).

Data used were obtained from 625 lactation records for milk yield of Friesian X Bunaji cows from the year 2005-2009. The details of lactating Dams management is such that the animals were taken out for grazing by 9.00 am after milking and returned from grazing by 3.00pm after which the animal were milked again by 4.00pm. Water and mineral salt licks were provided free choices. But the animals were supplemented with concentrate during milking of which if not supply the animals will not let-down milk.

Milking was done manually. A bucket was used for the collection. Measuring cylinder was used for measuring the quantity of milk obtained from the lactated cow. Writing materials (Book and Pen) was used for recording the daily records. The animals were milked twice daily (Morning and Evening) from the beginning of their lactation till when they were dried. The records generated from year 2005 to 2009 were used for this research. The Friesian X Bunaji cows productive performance records used include; the number of cows lactated during the period and average milk yield per lactation length.

Data collected for the productive performance of the cross bred cows lactation records for milk yield and climatic parameter were analyzed using the least square procedure of SPSS version (SPSS, 2001). The mathematical model assumed was:

$Yijk = \quad + Fjjk + \quad_{ijk}$

Where:

Yijk= measurement of a particular trait

= population mean

F= effect of all fixed effects (months/year/season of calving, rainfall)

$_{ijk}$ = random error

3. Results and Discussion

The least square means for monthly aggregate for the five years study on milk yield are presented in Table 1. Least squares means for milk yield showed much fluctuation in different months. The cows calved during the month of August produced maximum milk (271.44 ± 99.73kg). The milk yield dropped to 158.16 ± 29.85kg, 166.90 ± 30.12 kg and 182.42 ± 79.22kg for the cows calved during December, November and April respectively. Increase in the milkyield was observed and milk yield averaged 262.86 ± 93.35kg, 266.70 ± 109.76kg and 271.44 ± 99.73kg, for the month of June, July and August respectively. The results of analysis for milk yield revealed that unevenness due to the monthly aggregate for the five years of calving was significant ($P<0.01$). These results are in agreement with the work of Rege (1991) and Javed *et al.,* (2002), who reported similar findings in Friesian (Kenya) and Jersey (Pakistan) breeds of cattle, respectively. The variation in milk yield observed in the different months reflected the level of management, as well as environmental effects. The level of management is bound to vary according to the ability of farm manager, his efficiency in the supervision of the labour and use of financial resources (Khan, 1986). For the months that high milk yield is observed may be due to the time of season when raining season is observed when the climate is cooler and there are enough grasses for the animals to graze on.

Table 2 shows that season of calving had significant ($P<0.05$) effect on the milk yield of the cows. The average milk yield during the early dry, early wet, late wet and late dry seasons were statistically the same and had higher milk yield than that early dry season. The observed significant effect of season on milk yield in this study agreed with the early reports of Akpa, *et al.,* (2006) and Gebeyehu *et al.,* (2007). The variations observed in the milk yield with season may be due to changes in quality and quantity of pasture available to the cows to feed on across the seasons Gebeyehu *et al.,* (2007) and the conducive environmental condition in terms of

coolness. The drop in yield at early dry season may be due to the set in of hot weather at that period in the study area which affect milk yield. The significant effect of the season on milk yield suggests that the environmental factors have a role to play in the milk yield of the cows.

Table1: Effect of monthly aggregate of lactation on milk yield of Frisian x BunajiCows (2005-2009).

Month	N	Mean +SE
January	625	261.64±126.08[a]
February	625	252.98+1 50. 57[a]
March	625	249.32+ 140.05[a]
April	625	1 82.42+79.22[b]
May	625	245.94±92.22[a]
J u n e	625	262. 86±93.35[a]
July	625	266.70±109.76[a]
August	625	271.44±99.73[a]
September	625	197.48+24.32[ab]
October	625	214.76±47.84[ab]
November	625	166.90±30.12[b]
December	625	158.16±29.85[b]

p<0.05, a, b=Means with different super script along the column differ significantly N-number of records.

The herd under study was a crossbred off Frisian-Bunaji. Frisian which was imported from temperate zone and was kept in the tropical environment, where ambient temperature often rises up to 45 C in somemonths. Javed *et al.* (2002) noted that Genotype x environment interaction ispotentially extremely important in cattle breeding in thetropics. The animals of temperate regions maintainedin tropical conditions cannot behave similarly in boththe environments.

Table2: Least square means for the effect of season on milk yield of Frisian x Bunaji Cows

Season	N	Mean +SE
Early wet	625	230.41+48.25[a]
Late wet	625	245.21+47.25 [a]
Early dry	625	179.94±20.82[b]
Late dry	625	254.65±74.45[a]

*p<0.05, a, b=Means with different super script along the column differ significantly
N--number of records

Table 3 shows the effect of year of calving on the milk yield of the cows. Least squares means for milk yield showed much fluctuation in different years. The cows calved during the year 2006 produced maximum milk (449.88 ± 83.42kg). The milk yield dropped to 86.73 ± 16.19kg for the cows calved during 2007. Thereafter, a gradual increase in milk yield was observed and milk yield averaged 163.43 ± 14.34kg during the year 2008. After a slight increase during 2009, a drop in milk yield was observed and it reached its minimum value (86.73 ± 16.19kg) during the year 2007. The variation in the milk yield with months is probably due to the variations in the climatic condition (rainfall, temperature and relative humidity) across the months. Year of calving had significant (p<0.05) effect on the milk yield of the cows and this is in line with the reports of (Akpa, *et al.,*2006: Gebeyehu*et al.,* 2007). The significant effect of year of calving on milk yield is a reflection of fluctuation in the environmental influences on the lactating cows across the years. In situation where both the amount and distribution of the rainfall fluctuates greatly, such significant differences are expected since it will affect the quantity and quality of the pasture available for the cows to feed on (Akpa, *et al.,* 2006).

Thermal stress may also explain seasonal variation in performance in the study area where the present herd was being managed; dry months are invariably the hottest months. Javed *et al.* (2004) explained that, a combination of nutritional inadequacy and thermal stress may well explain the seasonal variation in performance of the Friesian cows. This is even more likely given that ambient temperatures around 40^{o}C or even higher are not uncommon in this region and dry periods longer than three months often occur. These results indicate that calving in early dry months is undesirable. Seasonal variation in animal performance in tropics is expected to be primarily a manifestation of variation in feed quality and quantity (Javed *et al.,* 2000).

Table 3: Least square means for the effect of year on milk yield of Frisian x Bunaji Cows

Years	N	Mean +SE
2005	625	287. 89+45. 39[b]
2006	625	449.88+83.42[a]
2007	625	86.73±16.19[C]
2008	625	163.43±14.34[C]
2009	625	149.83±10.13[C]

*p<-0.05, a, b=Means with different super script along the column differ significantly N = number of records.

The relationship between temperature, rainfall relative humidity and milk yield was shown in Table 4. The correlations between the stressor factors (temperature, rainfall, relative humidity) were all positive and significant (P<0.05; P<0.01).

Table 4: Correlation among temperature, rainfall, relative humidity in relation to milk yield

Parameter	Temp (°C)	Rainfall (mm)	Relative Humidity (%)	Milk yiel (l)
Temp	____			
Rainfall	0.0504	____		
Relative Humidity	0.5105*	0.4509*	____	
Milk yield	0.3345	0.8549**	0.4692*	___

**p<0.01

The positive correlations between rainfall, relative humidity and milk yield indicates that increase in these factors would favour milk yield of the cows while temperature does not have positive correlation. This might be due to the direct influences of the temperature, rainfall, and relative humidity on the quantity and quality of the pasture available for the cows.

4. Conclusion

From the result obtained in this study it could be noted that environmental factors are one of major factors militating against cow's milk production and these climatic parameters should be taking into consideration when making selection. An understanding of the interaction of various environmental factors with lactation performance is necessary so that management techniques and cooling practices can be developed to meet the needs of the high producing cow subjected to the effects of stressful conditions. There is need for physical modification of environment through shading and cooling, genetic development of heat tolerant breeds and improved nutritional management practices for effective dairy cows production. Efforts should be diverted to the conservation of feed and feed supplements during the scarcity periods, in addition to provision of shade for reducing the thermal stress. Moreover, breeding should be in a way that most calving occur in autumn, winter or spring seasons. This may eliminate seasonal and nutritional stress on cows.

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