

Seasonal Influences on the Productive Performance of Horro Cows at Bako, Ethiopia

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ABSTRACT

Ten years' data of milk production and reproduction from 473 Horro cows at Bako Agricultural Research Center was investigated if there was seasonal variation in milk production and reproductive parameters (days open and services per conception) of Horro cows. Cows grazed on natural pasture for about 7 hours by day and kept in barns at night. Supplementary feeds (hay, silage, concentrate) were provided to cows from 7 months of pregnancy until parturition and only concentrate meal during milking.

Multiple regression analysis from SAS was used to investigate the relationship of milk production, days open and services per conception with mean temperature, relative humidity, sunshine hours and wind speed. Stepwise selection procedure was used to examine the different regression equations.

Mean temperatures and Temperature Humidity Index remained higher in February to April, after which they declined. Milk yield was affected by daily mean temperature ($P<0.001$), sunshine hour ($P<0.001$) and wind speed ($P<0.05$). The over all mean (\pm SE) milk yield (kg) of the cows was 402.86 ± 19.31 over a mean lactation length of 185 ± 4.77 days. Production did not vary significantly ($P>0.05$) among seasons, but was higher for cows calved in the spring and summer. Milk production was found to be significantly ($P<0.01$) influenced by parity; yields increasing from parity one to parity four where it peaked. Services per conception were significantly ($P<0.01$) affected by only relative humidity. Significant ($P<0.05$) differences were observed in days open with the highest days open being in February (224 days). Days open was significantly affected ($P<0.001$) by daily mean temperature.

Key words: Horro-cow, season, reproduction, production

INTRODUCTION

Major climatic variables directly affecting cattle are temperature, humidity, air movement, and radiative conditions (Kifle, 1985; Payne and Trevor, 1999). Tropical environments, though diverse, are generally characterized by high environmental temperature, often-high relative humidity and increased solar radiation. These thermal elements of the environment coupled with

the genetics of the animal, incidences of disease and parasite, poor/ traditional management practices and seasonality of feed supply have contributed to lowered productivity of indigenous cattle. Climate also has an indirect effect on an animal performance through its influence on pasture growth and availability. Pasture growth varies with geographical location and rainfall pattern and hence pasture growth is seasonal.

Dry matter feed intake can be influenced by

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climate. The impact of thermal neutral zone upon intake is minimal, but high ambient temperatures reduce intake. Ronchi *et al.* (2001) indicated that exposure to high ambient temperature caused a 23% reduction in dry matter intake of cattle. Feed intake in lactating cows begins to decline at ambient temperatures of 25–26°C and drops more rapidly above 30°C (National Research Council, 1989).

Seasonal high temperatures in sub tropical, tropical and arid areas are known to reduce fertility in bovine (Abeygunawardena and Dematawewa, 2004).

Different cattle breeds have acquired different inherent capacities of regulating body temperature in response to heat stress. Compared to *Bos taurus*, *Bos indicus* has superior ability of regulating body temperature during heat stress and this indicated to be the result of lower metabolic rates as well as an increased capacity for heat loss (Hansen, 2004).

Survey work in the Western parts of Ethiopia showed that average milk yield per cow per day was 0.4 liters and 0.8 liters in the dry and wet seasons, respectively and lactation length of seven months (Legesse *et al.*, 1987). Similarly, Tesfaye (1991) reported an average yield of 1.7 liters (range 0.5 to 6 liters) per cow per day and eight months (range 4 to 12 months) of lactation length. Mulugeta *et al.* (1993) reported an average lactation milk yield of 508±341kg (range 100 to 1155kg) per lactation with a daily average of 2.41kg/cow and lactation length of 229.8±74 days. However, it will take long selection within the breed because of the variation in production among individual cows and generation of appropriate husbandry practices adaptable to the farming community can improve the productivity of the breed. To generate improved husbandry practices, one of the areas to be considered is to obtain base line information on how the breed performs under various environmental conditions (season-temperature).

MATERIALS AND METHODS

Location

The study was carried out at Bako Agricultural Research Center, Ethiopia with longitude, latitude and altitude of 37° 09' E, 09° 06' N and 1650 m above sea level, respectively. The center is located 257 km west of the capital city, Addis Ababa.

Climate

Mean minimum, mean maximum and average temperatures are 14°C, 28°C and 21°C, respectively. The rainfall pattern is bimodal with short rains in March/April. The rainy season covers May to September. The mean annual rainfall is about 1243.7 mm with peak rains in August.

Ten years' data of mean daily temperature (tem), relative humidity (rh), sunshine hours (sh), wind speed (ws) and rainfall (rf) of Bako Agricultural Research Center were obtained from the meteorology section of the center. There are four distinct seasons in the year: June to August is the summer (kiremt) season which is the rainy season with peak rains in August. September to November is the spring (Tseday) season sometime known as the harvest season. December to February is the dry winter season with frost in most parts of the country in the morning specially in January. March to May is the autumn (Belg) season with occasional showers.

Animals

Production and reproduction records of 473 Horro cows and heifers from the breeding herd of Bako Agricultural Research Center were used in this study. The data covered a period of 10 years (1993-2002). Lactations initiated by abortion are excluded from the records.

Management

All animals were herded at natural pastures for about seven hours by day and enclosed at barns

at night. All milking cows were run/grazing together. Cows were artificially inseminated or naturally mated upon observation of heat symptoms. From conception up to 7 months of pregnancy cows remain grazed on natural pasture after which they were kept in doors where they were offered roughages (silage, hay) and concentrate feed (noug cake 49%, ground maize 49%, bone meal 1%, salt 1%). The dams remained in the barn for the first five days being fed on hay, silage and concentrate feeds after which they joined the milking herd. A monthly weight of each cow was taken regularly. Cows were milked manually twice a day, early in the morning (5:00 – 7:00 am) and late in the after noon (5:00-7:00 pm). Natural pastures in the grazing areas were predominantly hyperhenia (*Hyperhenia anamesa*) Sporobolus (*Sporobolus praminmidales*) Cynadon (*Cynadon dactylon*) and legumes such as Neonotonia (*Neonotonia wights*), stylosanthes and desmodium species. Concentrated supplement of about 1 kg/head/day was given to the milking cows during milking, but the more a cow gave milk, the more she stood to be milked and the more concentrated it would offer. All animals were given routine veterinary services and vaccinated against major diseases such as Black leg, Anthrax, Pasteurellosis.

Statistical analysis

Multiple regression analysis from SAS (1999) was used to investigate the relationship of milk yield to temperature (°C) relative humidity (%), sunshine hour (h) and wind speed (km/h). Stepwise procedure of selection of variables was used. The criterion for selecting the best regression equation was statistical significance in the explained variance. General linear models procedure from SAS (1999) was used to assess the effects calving months (season) on milk yield, days open and services per conception. Temperature humidity index was calculated using the formula $THI = (C_{db} + C_{wb}) + 40.6$ (McDowell, 1972); where THI = Temperature Humidity Index,

C_{db} = Dry bulb temperature and C_{wb} = Wet bulb temperature.

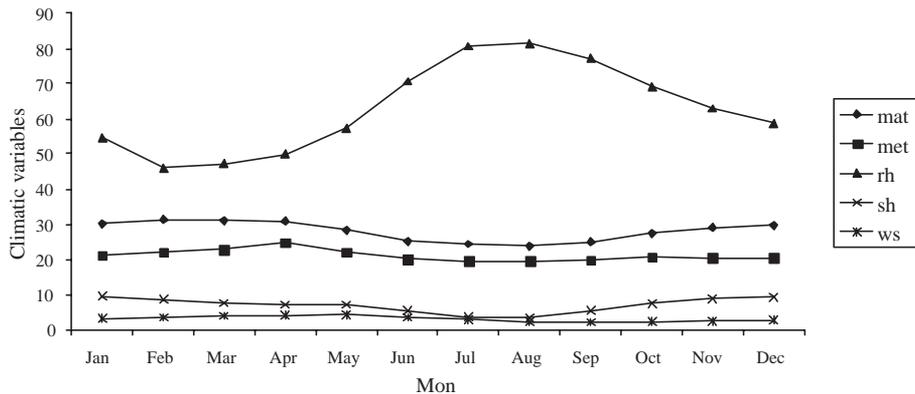
RESULT

Mean maximum, mean and minimum temperatures of the period considered (1993 to 2003) were 28 ± 0.04 , 21 ± 0.01 and 14 ± 0.03 °C, respectively. Furthermore, the relative humidity, sunshine hours and wind speed at 2 meters above ground level were 62 ± 0.08 %, 6.74 ± 0.01 h and 3.6 ± 0.01 (km/h), respectively. Normally, the rainy season lasted from the end of May to the beginning of September preceded by intermittent showers in March/April; the remaining parts of the year were generally dry. The patterns of all these climatic variables in the years considered at Bako, Ethiopia are given in Figure 1.

The Temperature Humidity Index (THI) followed a similar trend to that of temperature in the year. Mean (\pm se) THI was highest in February and April (73.7 ± 0.76) and lowest in August (69.5 ± 0.78). The THI of Bako is indicated in Figure 2.

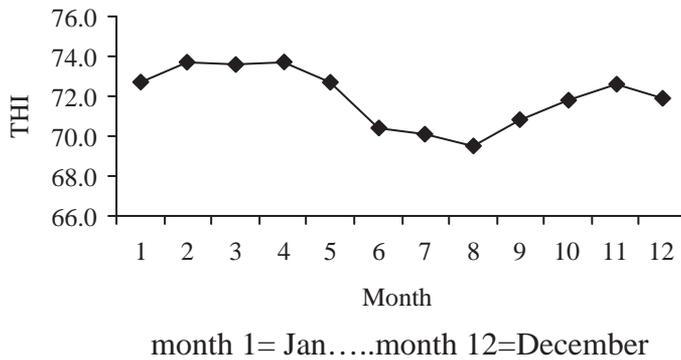
Milk yield was significantly affected by daily mean temperatures ($P < 0.001$), sunshine hour ($P < 0.001$) and wind speed ($P < 0.05$); these were the variables significant in the model. The best regression model selected was $MY = 2.01 + 0.02 MET - 0.01 SH + 0.02 WS$, $R^2 = 0.0012$ where MY = milk yield, MET = mean temperature, SH = sunshine hour. Mean lactation yield (\pm se) of Horro cows was 402.86 ± 19.31 kg over mean lactation length of 185 ± 4.77 . Milk yield did not significantly differ among seasons in which cows calved, but milk production was lower for those which calved during the dry and warmer seasons of the year. Mean lactation yield of Horro cows is depicted in Table 1.

Milk yield was different ($P < 0.05$) among parities. There was an increasing trend in milk production from the first to the fourth parity at which peak was reached. Thereafter production



mat=maximum temperature, met=mean temperature,
rh=relative humidity, sh=sunshine hour, ws=wind speed

Figure 1 Mean values of climatic variable at Bako Agricultural Research center.



month 1= Jan.....month 12=December

Figure 2 Mean temperature-humidity indices of Bako Agricultural Research center.

tended to decline. Milk yield of Horro cows by parity is given in Table 2.

Days open was significantly affected ($P < 0.001$) by daily mean temperature. No other variables met the 0.15 significance level for entry into the model. For stepwise selection the default entry and staying p-values are both 0.15 (Cody and Smith, 1997). The equation expressing the relation of days open to climatic variables was reduced to $\text{Days open} = 537.3 - 17.31\text{MET}$, $R^2 = 0.05$ and MET = daily mean temperature. Days open in cow calving in different months of the year is given in Table 3. The over all mean days open and gestation length were 171.9 and 283.0 days respectively.

Services per conception was significantly

($P < 0.01$) affected by only relative humidity. The best equation explaining its relationship with relative humidity was services per conception = $1.3 + 0.005\text{RH}$, RH = relative humidity, $R^2 = 0.024$. A range of values for number of services per conception for Horro cows at Bako Agricultural Research Center is presented in Table 4.

DISCUSSION

It was obvious that the calving interval obtained in this study was much more than what was thought optimum. Under many cattle production systems in tropical countries, a one-year calving interval is often difficult or impossible

to achieve and, in some situations, even undesirable. In Ethiopian highland Zebu cattle, raised under traditional management, the calving intervals average 25 months (Mukasa-Mugerwa, 1989). This means that cows conceive a longer period after the end of lactation, which appears to be the period required to regain body weight and condition, to continue the cycle and conceive again. In this work in most of the values observed, there was a trend of high values of days open for calving during the dry and warmer months of the year; the highest value for days open was in February where both temperature and THI were high. In agreement with this, Mulugeta (2003)

Table 1 Mean milk yields of Horro cow in different seasons of the year.

Season	Milk yield±S.E.
Summer	401.7±50.7 ^a
Spring	422.6±57.9 ^a
Winter	393.9±49.1 ^a
Autumn	386.9±48.9 ^a

N=65129

Means with the the same superscripts are not different ($p>0.05$).

Table 3 Lsmeans days open of Horro cows.

Month	Days open±S.E.
January	188.8±24.7 ^{ab}
February	224.3±22.9 ^a
March	175.2±18.3 ^{ab}
April	147.9±21.5 ^{ab}
May	189.6±19.2 ^{ab}
June	174.4±24.7 ^{ab}
July	148.0±19.7 ^{ab}
August	163.7±29.1 ^{ab}
September	138.6±26.4 ^b
October	170.4±26.4 ^{ab}
November	162.2±23.1 ^{ab}
December	164.1±23.6 ^{ab}

N = 454

Overall mean = 171.9

Means with different superscripts are significantly different ($P<0.05$).

reported that Horro cows calved during the dry season recorded a longer post partum anoestrous interval, compared with cows calving during the wet season (81.7 ± 2.9 days for dry season vs. 72.5 ± 3.4 for wet season); Similarly Oyedipe *et al.* (1982), working with white Fulani heifers (zebu), found calving intervals of 15.3 and 18 months for the dry and wet seasons, respectively. It is also well-documented (Thompson *et al.*, 1999; Barash *et al.*, 2001; Rensis and Scaramuzzi, 2003;) that high environmental temperature has a negative effect on the productivity of cows but the severity

Table 2 Mean lactation milk yield of Horro cows of different parities.

Parity	Milk yield±S.E.
1	345.9±60.6 ^b
2	403.8±50.8 ^b
3	433.5±42.9 ^b
4	470.5±51.0 ^a
5	398.5±77.9 ^b
6	445.7±90.2 ^b

Means with different superscripts are significantly different ($p<0.05$).

Table 4 Lsmeans services per conception of Horro cows.

Month	Services per conception±S.E.
January	1.57±0.16
February	1.72±0.16
March	1.60±0.13
April	1.83±0.15
May	1.69±0.13
June	1.42±0.17
July	1.36±0.14
August	1.42±0.19
September	1.50±0.18
October	1.72±0.2
November	1.48±0.2
December	1.44±0.2

N= 655

Overall mean = 1.57

All Means are not different from each other ($P>0.05$).

of the effect depends on the breed and temperature range. The numbers of service per conception were influenced by factors related to the cow, the bull or artificial insemination (AI) and the farming system. Values greater than 2 were considered as poor (Mukasa-Mugerwa, 1989). However, in this work the numbers of service per conception were considered fair, though improvements seemed possible by improved feeding and management practices. As was the case with days open high values of service per conception were observed in the warm and dry months.

Ray *et al.* (1992) indicated that first lactation cows had the lowest milk production, and the highest production occurred in either lactation four or five. Similarly Meikle *et al.* (2004) also reported that primiparous cows produced less milk than multiparous cows. These works supported the findings of this study. Horro cows seemed to be adapted to the environment inhabited but their productivity was influenced by probably inadequate nutrition, since the major feed resource was natural pasture that seasonally varied in quality and quantity.

CONCLUSION

Temperatures around Bako were high from February to May, but the proportion of variability explained in the productive and reproductive parameters by climate was small. This was indicative of the presence of other factor(s) related to seasonal variation that contributed a larger share than climate in affecting the productivity of cows during the warm seasons. Feed resource is among the major factors to be considered in cattle production and the major feed resource in the country is natural pasture, the availability and quality of which seasonally vary.

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