

Seasonal climatic changes affect fertility of Holstein Friesian cows on large-scale dairy farms in Malawi

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Abstract

Challenges limiting reproductive efficiency of the potentially high producing Holstein Friesian cows performing in tropical conditions include the environmental effects, which play their role either directly through the extreme effects of temperature and humidity or indirectly through feed and management. Affected may be the onset of normal oestrus cycles, detection of oestrus, and embryonic survival. Under harsh environmental conditions, generally, most mammals develop important strategies to modulate the timing of conception to take advantage of resource abundance hence depress fertility or produce fewer offspring. The current analysis investigated factors affecting fertility of Holstein Friesian cows performing on large-scale farms in Malawi. Period of intense reproductive activity calculated retrospectively from date of calving for 2362 cows between 1986 and 1997 was used as proxy for fertility. Results indicated seasonality in fertility with the highest ($p<0.001$) estimates (41.61%) occurring in the cold-dry season compared to 31.29% for hot-wet season and 27.10% for hot-dry season. Further, fertility was affected ($p<0.001$) by cow, parity, and year-effects indicating individual cow's coping mechanisms. The hot-wet season, characterised by high humidity, high temperatures and low wind speed, seem to exert some stress on the Holstein Friesian cows. Sound management strategies should be developed to optimize the seasonal fertility rhythms for reproductive efficiency.

Introduction

Reproductive traits in dairy cattle are not only a measure of fertility but also of productivity and lifetime production potential of an animal. Fertility may be defined as the ability to conceive and produce a viable calf following an appropriately timed insemination (Royal et al., 2000). Challenges limiting reproductive efficiency of the potentially high producing Holstein Friesian cows performing in tropical conditions include the environmental effects, which play their role either directly through the extreme effects of temperature and humidity or indirectly through feed and management. Affected may be the onset of normal oestrus cycles, detection of oestrus, and embryonic survival. Under harsh environmental conditions, generally, most mammals develop important strategies to modulate the timing of conception to take advantage of resource abundance hence depress fertility or produce fewer offspring. The current analysis investigated factors affecting fertility of Holstein Friesian cows performing on large-scale farms in Malawi.

Materials and Methods

Climate

Malawi lies between latitude 9°S and 17°S and longitude 32° 42'E and 36° 36'E and has altitude that ranges from 52 to about 1632 m above sea level (in the arable region). During the period for which data was corrected (1986 to 1996) the mean annual temperature in the study locations was 21°C. The warmest month was November, with an average maximum temperature of 29.5°C with the standard deviation (SD) of 1.9 and the coolest was July with the average maximum temperature of 22.8°C SD, 1.1. The highest average minimum temperature of 18.4°C SD, 0.9 was in December while the lowest average minimum temperature of 10.1°C SD, 1.8 was in July. The rainfall pattern is unimodal, confined to the period from early November to April and peaks in January. The meteorological data are depicted in Figure 1. Three distinct seasons occur: Hot-Wet (December to April), Cold-Dry (May to August) and Hot-Dry season (September to November).

Data

Performance records on production and reproduction from the three large-scale farms in Malawi was utilized. Breeding at these farms was done through artificial insemination using Holstein Friesian frozen semen imported mainly from Canada. The bull semen was selected based on breeding values for milk yield estimated in their countries of origin as presented in the sire catalogues. Initially the data set had 2362 records of lactation one to three from cows calving between 1986 and 1996. Cows with missing birth dates, breeding dates, calving dates, and cows with both parents missing were dropped from the analysis. After editing, 1968 records were available for analysis. Periods of intense reproductive activity were calculated retrospectively from date of calving. Together with inseminations per conception and calving interval, intense of reproductive activity were used as indicators of fertility.

Data analysis

Data were subjected to analysis of variance applying the following mixed model:

$$Y_{ijklm} = \mu + b_1(D)_{ijklm} + b_2(C)_{ijklm} + SG_i + P_j + H_k + (YR*SS)_l + e_{ijklm}$$

Where; Y_{ijklm} = the response reproductive traits; μ = overall population mean; $b_1(D)_{ijklm}$ = random effect of dam as a covariate with a linear coefficient b_1 ; $b_2(C)_{ijklm}$ = random effect of cow as a covariate with a linear coefficient b_2 ; SG_i = fixed effect of sire group ($i = 1, 2, 3$); P_j = fixed effect of parity ($j = 1, 2, 3$); H_k = fixed effect of herd ($k = 1, 2, 3$); $(YR*SS)_l$ = fixed effect of season within year; e_{ijklm} = random residual effects, $e_{ijklm} \sim N(0, \sigma_e^2)$. The seasons were defined as Hot-Wet, Cold-Dry and Hot-Dry season.

In the analysis the year and season was defined as year or season of birth, insemination, and calving depending on the reproductive trait being analysed for.

Results and Discussion

The average number of inseminations per conception (NSC) was 1.5 (sd = 0.82). Although the mean NSC was low with a range of 3, the within trait variation was quite high with a coefficient of variation of 54.54%. On average, the cows in the current study took 277.61 (sd = 23.81) days from conception to parturition. Gestation interval (GI) had the lowest variation of all the traits studied. The coefficient of variation for GI was 8.54%. Holstein Friesian cows performing on large-scale dairy

farms calved for the first time at an average age of 31.96 (sd = 4.61) months. Age at first calving (AFC) was found to have moderate variation with the coefficient of variation of 14.43% (Table 1). Results from the study indicated that calving interval (CI) from first to second calving was 415.98 (sd = 96.91) days and that from second to third lactation was 408.12 (sd = 80.84) days. Calving interval had moderate variation with coefficient of variation of 23.30% for CI1 and 19.81% for CI2. There was more variation in CI1 than in CI2. Means, standard deviations, and coefficients of variation are presented in Table 1.

Table 1. Descriptive statistics for some reproductive traits of Holstein Friesian cows at large scale dairy farms in Malawi (raw data)

Trait	n	Mean	Standard deviation	CV %
NSC	1968	1.50	0.82	54.54
GI (days)	1968	277.61	23.81	8.54
AFC (months)	817	31.96	4.61	14.43
CI1 (days)	1059	415.98	96.91	23.30
CI2 (days)	738	408.12	80.84	19.81

NSC = number of services per conception, GI = gestation interval, AFC = age at first calving, CI1 = calving interval between first and second calving, CI2 = calving interval between second and third calving

Results indicated seasonality in fertility (Table 2). Reproductive activity intense was highest ($p < 0.001$) in the cold-dry season (41.61%) compared to 31.29% for hot-wet season and 27.10% for hot-dry season. Cool-dry season had the lowest number of inseminations per conception. Cows calving in the hot-wet season had shortest calving interval while those calving in the hot-dry season had the longest meaning that those cows breed in the hot-wet season had the longest calving interval. When the fertility indicators are looked at in totality, hot-wet season was the most problematic of the three with respect to fertility of Holstein Friesian cows on large-scale dairy farms in Malawi. Further, fertility was affected ($p < 0.001$) by cow, parity, and year-effects indicating individual cow's coping mechanisms. The results indicate that the physical, management and nutrition environment influence reproductive traits of a Holstein Friesian herd performing in a tropical climate of Malawi a lot more than it is usually assumed (Chagunda et al., 2004). Since these factors reflect the effect of management practices and other environmental conditions that are likely to vary from one herd to another (Van Bebber et al., 1997), ancillary studies should investigate and quantify other factors such as heat stress, physiological balance and health.

Table2. The description of season in terms of Temperature Humidity Index (THI) and its effect on fertility of Holstein Friesian cows at large scale dairy farms in Malawi

Season	THI (mean)	Reproductive Activity Intense	Inseminations per conception	Calving Interval (days)
Hot-Wet	76.44	31.29%	1.54 ^a	401 ^a
Cool-Dry	71.84	41.61%	1.38 ^b	407 ^a
Hot-Dry	75.77	27.10%	1.44 ^{ab}	433 ^b

Hot-Wet = December to April, Cool-Dry = May to August, and Hot-Dry = September to November

Conclusion

The hot-wet season, characterised by high humidity, high temperatures and low wind speed, seem to exert some stress on the Holstein Friesian cows. Sound management strategies should be developed to optimize the seasonal fertility rhythms for reproductive efficiency.

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