Trop Anim Health Prod (2009) 41:1357–1362
DOI 10.1007/s11250-009-9322-y

SHORT COMMUNICATION

Breed differences in calving interval in the humid Mexican tropic

Aída Lorena Murillo Medina · Alejandro Córdova-Izquierdo · Ramón Soriano Robles · Germán David Mendoza Martínez · Héctor Castillo-Juárez

Accepted: 6 February 2009 / Published online: 20 February 2009

Abstract The objective of this study was to evaluate the influence of breed, breed and sex of the calf, farm, calving number (CN), type of calving, and their interactions on CI using records from four different beef breeds performing in the humid tropical environment of Mexico. The influence of these factors on CN was also evaluated. CI and CN varied with farm, breed of the dam, and with breed of the dam by calf breed interaction (P<0.001), while CI also varied with CN. Significant differences between *Bos indicus* and *Bos taurus* breeds for CI (432 *vs*. 488 days) and for CN (2.13 *vs*. 1.92) were observed (P<0.001). The interaction effects observed between breed of the dam by breed of the calf on CI and on CN were due to a favorable F_1 calf effect on CI observed only in Angus cows, although with an apparent unexpected negative impact on CN.

Keywords Calving interval · *Bos taurus* · *Bos indicus* · Beef cattle · Mexican tropics

A. L. M. Medina · A. Córdova-Izquierdo ·
G. D. M. Martínez · H. Castillo-Juárez (✉)
Departamento de Producción Agrícola y Animal,
Universidad Autónoma Metropolitana,
Unidad Xochimilco, Distrito Federal, México
e-mail: hcjuarez@correo.xoc.uam.mx

R. S. Robles
Departamento de Biología de la Reproducción,
Universidad Autónoma Metropolitana,
Unidad Iztapalapa, Distrito Federal, México

Introduction

Reproductive efficiency affects beef cattle production costs with a usually bigger impact in the tropics. Calving interval (CI) is an important fertility trait and its ideal duration is considered by some authors to be approximately 12 months (Kanuya and Greve, 2000; Montiel and Ahuja, 2005). To achieve optimal CI in the beef grazing production systems in the tropics, it is necessary to consider, among other factors, breed differences regarding their ability to adapt to the adverse weather conditions of these environments (Holloway et al., 2002; Arthington and Kalmbacher, 2003; Bó et al., 2003; Pinos et al., 2003). This is so because in tropical farms, hot temperatures and high humidity levels negatively affect beef production (Bó et al., 2003), and the cattle's ability to resist heat stress is then crucial.

Other factors affecting CI are body condition (Pryce et al., 2002; Arthington and Kalmbacher, 2003; Ciccioli et al., 2003), season of the year, age or calving number, as well as the farmers' ability to detect estrous where AI is practiced (Hernández-Reyes et al., 2001; Bó et al., 2003). Cows whose body condition deteriorates during lactation regularly show a large CI by increasing the interval length from first calving to first estrous (Roche et al., 2000; Ciccioli et al., 2003). They also show low fertility (Pryce et al., 2002) and low weight calves at calving (Ciccioli et al., 2003). Younger cows tend to have longer postpartum periods and prolonged anestrous (Abeygunawardena and Dematawewa, 2004; Ahuja et al., 2005), while still requiring nutrients for growth, maintenance and lactation when compared to multi-calving cows, which usually can more easily achieve shorter days open and CI durations (Lobago et al., 2007).

One reproductive goal in beef farms, especially in the tropics, is to maintain a short CI that results in a maximum production of calves (Holloway et al., 2002; Montiel and Ahuja, 2005), increasing the length of productive life and yielding the largest possible number of calvings per cow in the herd.

The aim of this study was to evaluate the influence of breed, breed and sex of the calf, farm, calving number, type of calving, and their interactions on CI using records from four different beef breeds performing in the humid tropical environment of Mexico. Since calving number can be considered as a surrogate of length of productive life, the influence of breed, breed and sex of the calf, farm, type of calving and their interactions on calving number were also evaluated in the same population.

Materials and methods

The study was conducted in the north of Veracruz, Mexico, in four different beef farms having similar management practices. In this tropical region, with an altitude of 40 m above sea level, weather conditions are hot, with an average temperature of 24.3°C, relative humidity of 85% and an annual rain precipitation of 1,391 mm.

The breeds used were Brahman (B) (*Bos indicus*), Brangus (BA) (*Bos indicus* x *Bos taurus*), Aberdeen Angus (A) (*Bos taurus*) and Brown Swiss (BS) (*Bos taurus*). Feeding is based on grazing with African Star (*Cynodon plectostachyus*) and Bermuda Coast (*Cynodon dactylon*). In the four farms animals are supplemented with sorghum silage (*Sogrum vulgare*), minerals and molasses.

Data records from 1993 to 2005 were used. Records included 2,048 calvings with 1,341 CI, farm origin, dam's breed (B, BA, A, BS), calving number (CN) (1, 2, 3, and ≥4), date of calving, sex of the calf, breed of the calf grouped like same as its dam (S), and different than its dam (F_1). For BA, A, and BS dams, sires of F_1 calves were always B, whilst for the case of B dams only A sires were used. Only CI equal or longer than 305 days were considered for analysis. CI longer than 730 days were set to 730 days. Possible sources of CI and CN variation were analyzed using fixed effects linear models for unbalanced data (with SAS software, Version 9.1., 2004. SAS Institute Inc., Cary, NC, USA). These sources included dam's breed, breed and sex of the calf, farm, CN (for CI model), type of calving, as well as their interactions. Due to the unbalanced data structure, all means reported and their comparisons are based on least square means.

Not all the breeds were represented in all the farms (Table 1) but at least two of the studied breeds were represented in every farm. Moreover, connectedness criteria for breed of the dam across farms was fully met (i.e., these effects were not confounded), allowing to calculate best linear unbiased estimators (BLUE) for these effects (Searle, 1987). In any case, a model including breed of the dam nested within farm and breed of the calf within farm analysis was also used. It is worth to say that every calving number was represented in every farm and in every breed and thus, these effects were not confounded either.

Results and discussion

The CI general mean (S.D.) was of 467 (100) days. This value is within the range (418 to 516 days) reported in literature for the tropical environments of Colombia, Costa Rica, and Mexico in the American Continent (Casas and Tewolde, 2001; Hernández-Reyes et al., 2001; Ruíz-Flores et al., 2006; Vergara et al., 2007) of Ethiopia and Kenya in the African Continent (Lobago et al., 2007; Ilatsia et al., 2007) as

Table 1 Number of records by farm and breed of the dam

Breed of the Dam	Angus		Brangus		Brahman		Brown Swiss	
Farm	CI	CN	CI	CN	CI	CN	CI	CN
A	0	0	0	0	461	626	143	220
B	0	0	0	0	147	216	76	117
C	105	171	54	90	125	226	0	0
D	156	263	34	49	40	60	0	0

CI = Calving interval

CN = Calving number

well as of Thailand in the Asian Continent (Boonprong et al., 2008).

Regardless of the model used, CI varied with farm, calving number, breed of the dam, and with breed of the dam by calf breed interaction (P<0.001) (Table 2) but not with the sex of the calf (P>0.05). Results showed significant differences between *Bos indicus* (B, BA) and *Bos taurus* (A, BS) breeds for CI (432 *vs.* 488 days) but also for CN (2.13 *vs.* 1.92) (P<0.001). The longest CI (S.E.M.) was observed for Angus breed with 489 (16.5) days, this value is longer than that observed in zebu cattle (455 days) by Ruíz-Flores et al. (2006). The shorter CI was observed for Brahman with a mean (S.E.M.) of 427 (13.8) days, which is only a few days longer than that observed by Casas and Tewolde (2001) of 418 days in beef cattle in the tropics of Costa Rica.

The breed of the calf (S *vs.* F_1) did not seem to influence CI (460.4 *vs.* 459.7 days) but an interaction between breed of the dam by breed of the calf was found (Fig. 1). This interaction showed that it was only Angus cows which were affected with longer CI when calving Angus calves (520 days), when compared to calving F_1 calves (473 days). F_1 calvings accounted for 27.7% of the total calvings.

Table 2 Least square means of calving interval for identified effects

	N	LSM	SEM
Breed of dam			
Angus	261	489.0 [a]	16.5
Brahman	773	426.6 [b]	13.8
Brangus	88	438,0 [b]	17.9
Brown Swiss	219	486.8 [a]	15.5
Calving number			
2	691	484.8 [a]	13.6
3	373	453.8 [b]	14.4
≥4	277	441.6 [b]	15.1
Farm			
A	604	470.6 [b]	14.8
B	223	491.5 [a]	16.0
C	284	431.8 [b]	15.2
D	230	446.5 [a]	15.2
Breed of the calf			
Same as dam	952	460.5 [a]	14.1
F1	389	459.7 [a]	14.3

Means with different letter within factor are statistically different (P<0.05)

LSM = Least square means

SEM = Standard error of the mean

N = number of records

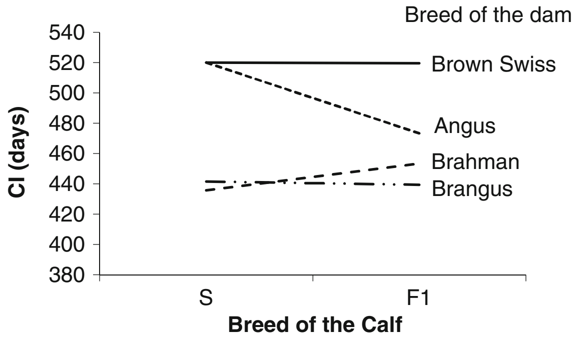

Fig. 1 Calving interval (CI) by breed of the dam by breed of the calf

In the present study the general mean (S.D.) of the CN was 2.12 (0.97). There was an effect of calving number on CI. The longer CI was observed in the second calving cows with a mean (S.E.M.) of 485 (13.6) days, while the shorter CI was observed in cows with four or more calvings with 442 (15.1) days (Table 2). The fact that the young cows are still growing and developing their mammary glands has been found to negatively affect their CI (Ciccioli et al., 2003), as in our case where younger cows had a longer first CI than older ones; this is also similar to Hernández-Reyes et al. (2001) findings in the tropics of Yucatan, Mexico, who observed 455 days CI in the first calving interval versus 402 to 413 days in fourth to sixth calving cows.

The effect of CN is positively reflected in some productive traits since as CN increases, the productive indicators of economic importance increase as well. The effect of farm on CI influenced the productive life of cows measured as CN. Results showed there were farm differences for CN (P<0.01) (Table 3), which is in agreement with recent findings of beef cattle reproductive performance in Thailand (Boonprong et al., 2008) and with the review by Montiel and Ahuja (2005) who mention that low fertility in the tropics could originate from management deficiencies associated to different farm practices. It is important to emphasize that, in general, management practices across the four studied farms are very alike. Similarly, Villagómez et al. (2000) observed that differences in farms exert significant effects on beef cattle reproductive performance, both in tropical and subtropical

Table 3 Least square means of calving number for identified effects

	N	LSM	SEM
Breed of dam			
Angus	434	1.99 [a]	0.128
Brahman	1128	2.20 [b]	0.111
Brangus	149	2.06 [ab]	0.137
Brown Swiss	337	1.86 [a]	0.122
Farm			
A	846	2.38 [a]	0.118
B	333	2.21 [b]	0.127
C	487	1.69 [c]	0.115
D	382	1.83 [c]	0.119
Breed of the calf			
Same as dam	1481	1.94 [a]	0.111
F1	567	2.11 [b]	0.113

Means with different letter within factor are statistically different ($P<0.05$)

LSM = Least square means

SEM = Standard error of the mean

N = number of records

environments. Hernández-Reyes et al. (2001) and Villagómez et al. (2000) also found differences across years, both in relation to the weather and in how the farm workers carry out their activities (management practices), as well as in the availability of food.

Calving number did not vary with sex of the calf ($P>0.05$) but was affected by the breed of the dam ($P<0.01$) (Table 3), with *Bos indicus* breeds performing better than *Bos taurus* breeds. An interaction effect between breed of the dam and calf breed was observed on CN too. In this sense, while calving F_1 calves had, in general, a favorable effect on CN, Angus cows calving F_1 calves had lower CN values (1.81) than those calving Angus calves (2.17) (Fig. 2). It is recognized that *Bos taurus* cows may improve their fertility when bred with *Bos indicus* sires. This could help to explain the shorter CI observed in these Angus cows, but we do not have an obvious explanation for the fact that these Angus cows ended up having lower number of calves, since the opposite would be the expected outcome.

Interval from calving to first ovulation, which is a component of CI, is affected by calf weaning age that may differ depending on the production system. This has been reviewed by Montiel and Ahuja (2005) and Rhodes et al. (2003). The inhibiting effects of calf suckling over the ovarian activity influences the duration of the postpartum ovulation period (Pérez et al., 2001, Wettermann et al., 2003). That is why the permanence of the calf with the cow during the entire lactation lengthens the duration of the anestrous postpartum (Villagómez et al., 2000). Differences in CI across farms found in our study could have been due to non identified small differences in management practices or to sampling, since herd sizes are rather small, which is very common in tropical environments (see for example Ilatsia et al., 2007; Lobago et al., 2007; Vergara et al., 2007; Boonprong et al., 2008). In any case, there were no differences regarding calves weaning age among the studied farms, averaging between 7 and 8 months.

The deficiency in detecting estrous signs in cattle living in tropical conditions, especially in *Bos indicus*, can be explained by the fact that the estrous in these animals is significantly shorter in duration by approximately 10 hrs (Landaeta et al., 2002; Bó et al., 2003; Ahuja et al., 2005; Parra et al., 2005) and its signs are less evident and intense if compared with *Bos taurus* and occurs more frequently during the night (Bó et al., 2003; Abeygunawardena and Dematawewa, 2004).

It is important to consider, based on what has been previously mentioned by Hernández-Reyes et al. (2001) and by Montiel and Ahuja (2005), that to be able to increase the reproductive efficiency in any bovine productive system, management practices oriented to reduce days open, increase number of calvings per cow and to extend productive life within adequate productive levels, need to be addressed.

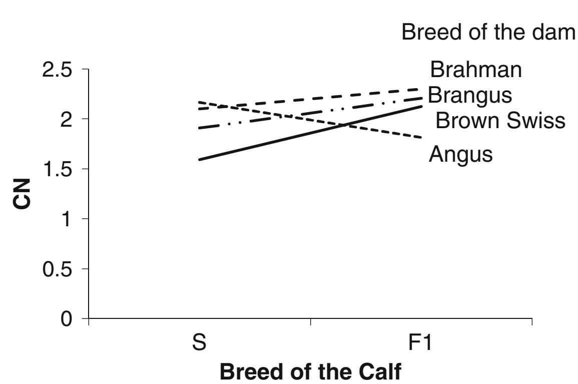

Fig. 2 Calving number (CN) by breed of the dam by breed of the calf

In tropical regions of Mexico, beef production is primarily based on breeds originating from *Bos indicus* (Ahuja et al., 2005) or crosses between *Bos taurus* and *Bos indicus* (Montiel and Ahuja, 2005) whose adaptations to these environments have been observed to be better. However, in warm climates there is an abundance of different crosses with *Bos taurus* origins in beef and dual purpose production farms (see for example Holloway et al., 2002; Ahuja et al., 2005; Ruiz-Flores et al., 2006; Vergara et al., 2007). The presence of these type of animals in tropical environments has increased although it is commonly characterized by low reproductive efficiency with CI of even more than 450 days, as was observed in our study.

The productive performance of the cattle in the tropics is affected negatively by factors that hinder the potential genetic expression of the animals in different production systems (see Casas and Tewolde, 2001). In general, most of the published studies show a better reproductive performance of the *Bos indicus* cattle compared to that of the *Bos taurus*, when they are both in tropical or subtropical climates (Holloway et al., 2002; Bó et al., 2003; Ahuja et al., 2005).

In our analysis of the CI and CN under Mexican humid, tropical weather conditions, *Bos indicus* and its cross with *Bos taurus* showed in general a shorter CI and a higher CN mean, and therefore, a better reproductive performance than *Bos taurus*. Calving number (age of the cow) had an effect on CI, while CI and CN were both affected by farm (i.e., management), and by the interaction between breed of the dam and breed of the calf. This interaction was due to a favorable F_1 calf effect on CI observed only in Angus cows performing in the tropical conditions of the study, although with an apparent negative impact on CN.

Acknowledgements This study was financed in part by CONACYT-México, by way of a scholarship for the first author, with a registration No 193726, and by Universidad Autónoma Metropolitana, Xochimilco Campus, in México. Authors are thankful to Marcia Castillo-Mendoza for her comments on the manuscript.

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