BREED AND ENVIRONMENTAL EFFECTS ON BIRTH WEIGHT, WEANING WEIGHT AND CALVING INTERVAL OF ZEBU CATTLE IN SOUTHEASTERN MEXICO[1]

[EFECTOS RACIALES Y AMBIENTALES SOBRE EL PESO AL NACER, PESO AL DESTETE E INTERVALO ENTRE PARTOS EN GANADO CEBÚ EN EL SURESTE DE MÉXICO]

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SUMMARY

Records of beef cows from a ranch in southern Mexico gave 1967 birth weights (BW), 1587 weaning weights adjusted to 210 days of age (AWW) and 2001 calving intervals (CI) for the comparison of the breed groups: Brahman (BR), Guzerat (GU), Nellore (NE) and crosses born to zebu dams by Brown Swiss sires. Animals were fed mainly pasture. Data were analysed using general linear procedures. The statistical model that described the data for BW and AWW included the fixed effects of breed group (BR, GU, NE, BS x BR, BS x GU and BS x NE); year of birth or calving (2005 to 2014), season of parity of the cow (dry, rainy, windy), sex of the calf (female or male), parity (1 to =>8) and the simple interaction of year x season of birth or calving. The model for CI was similar to the previous one, except that only the Zebu purebreds were included. The overall means and standard deviations for BW, AWW and CI were 33.5±0.75 kg, 178.9±19.7 kg and 456.4±79.2 days. All effects included in the model had significant effect on BW and AWW, but season and sex on CI. The smallest least squares means for BW corresponded to the cross of BR x NE and the largest to the cross of BS x BR (33.3 and 33.7 kg, respectively); whereas the lowest and largest least squares means for AWW corresponded to the NE (173.8 kg) and BS x BR (191.8 kg). NE cows had shorter CI than BR and GU cows (413.9, 446.2 and 481.3, respectively). Male calves weighed more at birth and weaning than females. Year x season interaction indicate that season effects on performance of calves or cows were not similar throughout the years studied.
Key words: Crossbred cattle; preweaning traits; purebred cows; tropics.

RESUMEN

Registros de vacas de carne de un rancho del sureste de México de 1967 pesos al nacer (PN), 1587 pesos al destete ajustados a 210 días de edad (PDA) y 2001 intervalos entre partos (IEP) fueron analizados para comparar los grupos raciales Brahman (BR), Guzerat (GU), Nelore (NE) y cruzas de vacas cebú con toros suizos. Los animales estuvieron en pastoreo principalmente. Los datos fueron analizados usando procedimientos de modelos generales. El modelo estadístico que describió los PN y PDA incluyó los efectos fijos de grupo de raza (BR, GU, NE, BS x BR, BS x GU and BS x NE), año de nacimiento o parto (2005 to 2014), época de parto de la vaca (seca, lluviosa y nortes), sexo de la cría (hembra o macho), parto (1 a 8) y las interacciones simples de año por época de nacimiento o parto. El modelo para IEP fue similar al modelo previo, excepto que sólo las razas cebuínas puras fueron incluidas. Las medias generales y desviaciones estándares para PN, PDA e IEP fueron 33.5±0.75 kg, 178.9±19.7 kg y 456.4±79.2 días, respectivamente. Todos los efectos incluidos en el modelo tuvieron efecto significativo sobre PN, PDA, excepto época y sexo sobre IEP. La menor media de mínimos cuadrados para PN correspondió a la cruza BR x NE y la mayor a la cruza BS x BR (33.3 and 33.7 kg, respectivamente); mientras que la menor y mayor media de cuadrados mínimos para PDA correspondió a la raza NE (173.8 kg) y la cruz BS x BR (191.8 kg). Las vacas NE tuvieron IEP más cortos que

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las vacas BR y GU (413.9, 446.2 y 481.3, respectivamente). Las crías macho pesaron más al nacimiento y al destete que las hembras. La interacción de año por época indica que el comportamiento de los becerros o vacas en las distintas épocas no fue similar en los diferentes años.
Palabras clave: Ganado cruzado; rasgos predestete; vacas puras; trópico.

INTRODUCTION

Zebu cattle (*Bos indicus*) plays an important role as a genetic resource for beef production in the tropics of Mexico, due to its adaptation to high temperatures and humidity, as well as resistance to parasites. Zebu has superior capacity to regulate body temperature during heat caloric stress in comparison with European livestock as the result of lower metabolic rates and a greater capacity to lose heat (Hansen, 2004, 351). In Mexico Brahman, Guzerat and Nellore cattle breeds are quite important, especially for beef production. Weaning calves is the main livestock activity in Mexico; therefore, reproductive traits of cows and growth of the calves are of economic interest (Delgado *et al*., 2004, 23; Magaña and Segura-Correa, 2006, 38). In the Mexican tropics, the production of beef cattle is limited mainly by poor reproductive and productive performance. They have low fertility, calving intervals greater than 14 months and calves weighing <160 kg at 8 months of weaning (Magaña and Segura-Correa, 2001; Delgado *et al*., 2004). A longer calving interval means less replacement cows and more time and feed to produce a weaned calf. However, in spite of the importance of reproductive traits and growth of the calves, the information under tropical conditions is limited.

Besides breeds, another factors need to be taken into consideration to improve livestock production, are nutrition, disease and management level, which are known to vary with year, season of the year, sex of the calf, age or parity of the cow. It is also known that the effect of those factors changes according to the agroecological region, production unit and genetic structure of the population under study; therefore, it is necessary to assess the degree to which these factors affect economic traits, under specific circumstances.

The aim of this study was estimate the birth weight, weaning weight and calving interval of Brahman, Guzerat, Nellore and their crosses with Brown Swiss, and to determine the effects of some environmental factors on those traits in the Southeastern tropics of Mexico.

MATERIAL AND METHODS

Localization, animals and management

Information was obtained from the productive records of a ranch, located in Yucatan, Mexico, at latitude 21°09′, 21° 28′ N and longitude 88°04′, 88°24′ W. The climate of the region is tropical sub-humid (AW0) with rain in summer, annual average temperatures ranging from 25°C to 28°C, average relative humidity between 75% and 80%, and 984 mm rainfall (INEGI, 2007).

The data included retrospective records of 1967 birth weights (BW) and 1587 weaning weights, adjusted to 210 days of age (AWW) of Brahman (BR), Guzerat (GU), Nellore (NE), and crosses of those zebu breeds with Brown Swiss (BS) sires. Data also included 2001 calving intervals of Brahman, Guzerat and Nellore cows. Weaning weight was adjusted to the mean weaning age (210 days). Cattle grazed at night (6:00 P.M. to 6:00 A.M.) under extensive conditions of production in Guinea (*Panicum maximum*), and Brizantha (*Brachiaria brizantha*) grass paddocks. During the day, animals were kept in the corral where they had access to water and minerals ad libitum, and the calves stayed with their dam. Animals were vaccinated every year against rabies, clostridiasis, pasteurellosis, and leptospirosis. Deworming against intestinal parasites it is also a common practice. Controlled mating and artificial insemination were used in the herds during the whole year. Calves were identified and weighed during the first 24 h of birth and again at weaning. Gestation diagnosis was done routinely by rectal palpation for all the cows after 4 months of calving and at weaning for non-pregnant cows during the previous diagnosis. The information registered to estimate BW, AWW for calves and calving interval (CI) for cow was cow identification, breed group of the dam and sire, date of birth, date at calf weaning, and birth and weaning weight. Because of the small number of data in 2015, information was grouped into year 2014, also parities greater than 8 were grouped into parity 8. Three seasons of birth or calving were defined based on monthly temperature and rainfall distribution during the year: dry (February to May) when quantity and quality of forage is poor; rainy (June to September) when heavy rain occurs and an excess of pasture exists; windy and rainy (October to January) when rain is sporadic, pastures start to dry and pasture quality declines.

Data and Statistical analyses

Data were analysed using general linear models. The statistical model that described the data for BW and AWW included the fixed effects of breed group (BR, GU, NE, BS x BR, BS x GU and BS x NE); year of birth or calving (2005 to 2014), season of parity of the

cow (dry, rainy, windy), sex of the calf (female or male), parity (1 to =>8) and the interaction of year x season of birth or calving. The model for CI was similar to the previous one, except that only data for Zebu purebreds were included. Al statistical analysis were carried out using the SAS package (SAS, 2008).

RESULTS

The overall means and standard deviations for BW, AWW and CI were 33.5±0.75 kg, 178.9±19.7 kg and 456.4±79.2 days. All factors included in the model had significant effect on BW and AWW, but season and sex for CI. The least squares means by breed group, season, sex of the calf and parity are shown in Table 1. The lowest least squares means for BW corresponded to the cross of BS x NE and the largest to the cross of BS x BR (33.3 and 33.7 kg, respectively), whereas the lowest and largest least squares means for AWW corresponded to the NE (173.8 kg) and BS x BR (191.8 kg). NE cows has shorter CI than BR and GU (413.9, 446.2 and 481.3 days, respectively). Male calves weighed more at birth and weaning than females, but sex of the calf had no effect on CI. First and second party cows as well as cows with 8 or more parities had the lowest weights. CI means tended to decreased with parity. Year x season interaction was significant on all traits, indicating that season effects on performance of calves or cows were not similar throughout the years studied (Figures 1, 2 and 3).

Table 1. Breed and environmental least squares means and standard errors by factor for birth weight (BW), adjusted weaning weight at 210 days (AWW) and calving interval (CI) in Zebu cattle and crosses.

Breed group	N	BW	N	AWW	N	CI
Brahman (B)	345	33.4±0.044b	317	183.7±1.23c	475	446.2±4.21b
Guzerat (G)	218	33.4±0.054b	191	117.2±1.55ab	577	481.3±3.80c
Nellore (N)	803	33.4±0.033b	563	173.8±0.99a	949	413.9±3.21a
Brown Swiss x B	130	33.7±0.073c	114	191.8±208d		
Brown Swiss x G	320	33.3±0.047ab	292	178.2±1.32b		
Brown Swiss x N	151	33.2±0.067a	130	180.6±1.92bc		
Season						
Dry	907	33.6±0.036c	732	188.5±0.93c	905	447.4±3.42a
Rainy	460	33.4±0.041b	374	174.7±1.21a	483	451.4±4.85a
Rainy and windy	600	33.2±0.040a	501	179.4±1.09b	613	442.6±3.88a
Sex of calf						
Female	1017	33.0±0.031a	872	178.8±0.90a	1048	444.3±3.18a
Male	950	33.8±0.032b	735	182.9±0.93b	953	450.0±3.23a
Parity						
1	387	33.1±0.042a	326	169.6±1.24a	427	507.0±4.18e
2	331	33.3±0.044b	294	179.8±1.27bc	369	465.4±4.32d
3	296	33.4±0.047b	257	184.4±1.35d	319	446.3±4.73c
4	266	33.4±0.051bc	218	185.8±1.48d	277	440.9±5.11bc
5	231	33.6±0.055c	187	185.3±1.60d	227	428.9±5.69ab
6	185	33.6±0.061c	142	183.7±1.84cd	170	436.4±6.55abc
7	123	33.5±0.074c	91	182.3±2.27cd	108	433.1±8.11abc
8	148	33.4±0.071bc	92	176.0±2.31b	104	419.0±8.50a

a,b,c,d Means by factor level with different letter are significantly different (P<0.05).

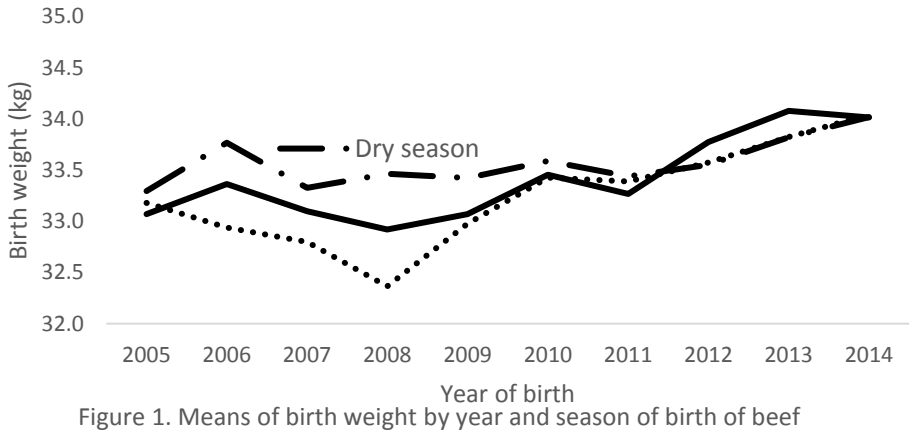

Figure 1. Means of birth weight by year and season of birth of beef calves in southeastern Mexico

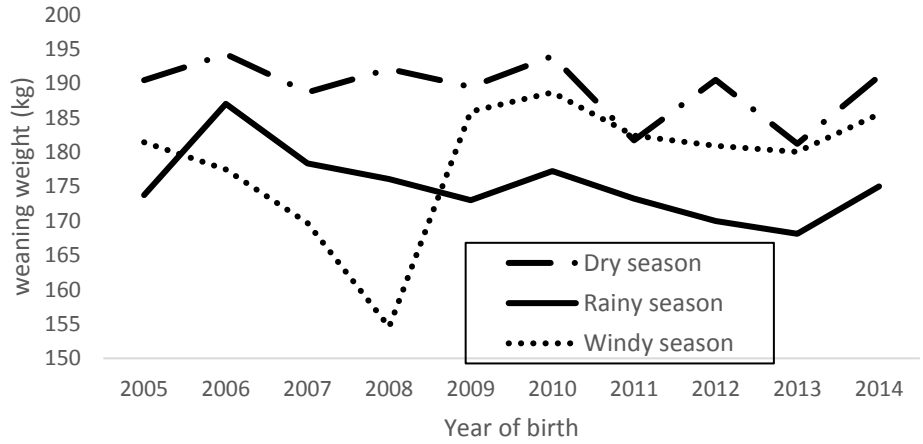

Figure 2. Adjusted weaning weight means, at 210 days, by year and season of birth of beef calves in southeastern Mexico

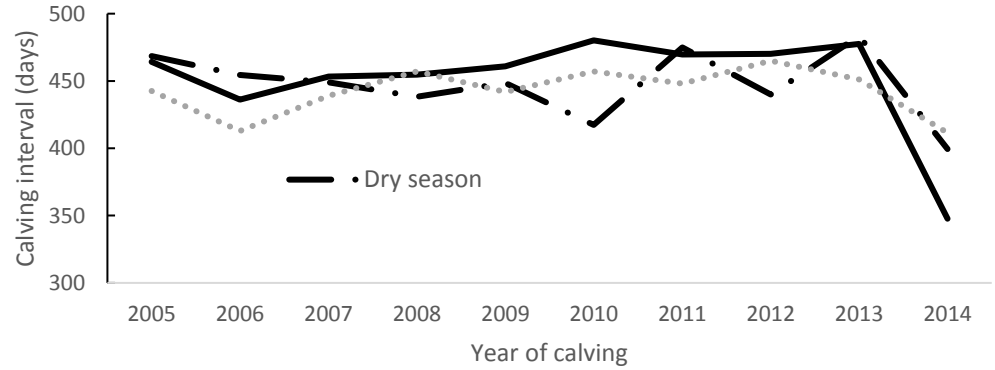

Figure 3. Calving interval means by year and season of calving of Cebú cows in southeastern Mexico

DISCUSSION

BW is a trait of economic importance because is positively correlated with pre and post weaning growth (Boligon *et al*. 2009). The major problem associated with heavy birth weight is dystocia; however, Galina and Arthur (1989) reported a low frequency (2%) of calving difficulty for Gyr cattle, and stated that, in tropical environments, the only reports of dystocia greater than 10% occur in European cattle. According to Koch *et al*. (1993), Zebu cows have low incidence of dystocia because of a result of large pelvic area, small body weight and low ca1f BW. This statement is supported by the low (< 40 kg) BW found in this study, where the means of the Zebu breeds, here studied, varied from 33.3 to 33.7 kg. The overall mean BW, in this study (33.5 kg), is greater than the means reported in Mexico for Zebu and their crosses with european cattle (Torner *et al*., 1984; Trung *et al*., 1986; Rojas *et al*., 1987; Segura-Correa *et al*., 1988; Magaña, and Segura 1997; Magaña *et al*., 2002; Medina-Zaldivar *et al*., 2005; Rodríguez *et al*., 2009a; Martínez-González *et al*., 2009; Estrada-Leon *et al*., 2014) where it is mentioned that the BW was around 32.0 kg. It is also greater than the overall mean of 50 papers carried out in America (Plasse, 1978) where means varied from 20.9 to 31.8 kg. However, it is lower than the means BW of 34.8 kg reported by Segura-Correa (1990) for a commercial zebu herd in the same region. Commercial zebu in Mexico is known to have some genes of European cattle. European cattle has a mean of about 40 kg at birth and the crosses of Zebu and European cattle ranges between 30 to 35 kg, depending of the breeds involved. Chin-Colli *et al*. (2012) reported an average BW of 36.3 kg for BS cattle in the tropical region of Mexico.

The mean for weight at weaning corrected at 210 days was 178.9 kg, which is 9.1 kg less than the mean of 188 kg, at 205 days, reported by Hernandez-Hernandez et al (2015). These results agree with those reported in the literature (Martínez-González *et al*., 2009; Rodriguez *et al*., 2009b; Estrada-Leon *et al*., 2014). However, Plasse *et al*. (2000) in Brahman and Medina-Zaldivar *et al*. (2005) in Nellore found a lower WW (147.1 kg and 168.8 kg, respectively). This may be associated with differences in management practices and geographical differences as well as maternal ability of the breeds used in each study. In cattle and other mammals the calf and the dam contribute to the weaning weight. Growth during the suckling period is affected both by the calf which growth is measured and by the dam which provides the developmental environment (Willham, 1972).

The overall CI mean (456 days) is shorter than that reported by Hinojosa and Segura (1979; 548 days), Osorio-Arce and Segura-Correa (2010; 558 days) and by Duarte-Ortuño *et al*. (1988; 478 days) in southeastern Mexico; although slightly greater than that reported by Hinojosa and Segura (1986; 445 days) and Magaña and Segura (2001; 448 days), at same tropical region. In general, a high mean value of CI is an indicator of poor pregnancy rate. Tropical conditions that limit the reproductive functions of cows, such as heat stress and poor quality pastures may be responsible for that poor performance. Therefore is advisable to improve the feeding of cows during the critical months to improve reproductive traits, to establish culling programs of infertile cows and to improve cow health especially against brucellosis to reduce the possibility of abortions.

Breed group

Breed differences for BW and AWW have also been reported by Magaña *et al*. (2002) but in NE, Indubrazil, Gyr and Commercial Zebu in the same region. In this study, BW of crosses of Brown Swiss sires with Zebu cows was expected to be heavier due to additive and heterosis effects; however, the BS x NE and BS x GU crosses had lower BW means than BR, GU and NE calves (Table 1). Lack of significant differences for BW between Zebu breeds and commercial Zebu have been reported by Magaña and Segura (1997).

Mejia-Bautista *et al*. (2010) reported that BR and BS had higher AWW than NE cows. In our study, the crossbred cows perform better than the purebreds. Magaña and Segura-Correa (2006) found a better performance, at weaning and 18 months of year, of BS and their crosses in comparison with Zebu cattle. Results from Latin America show advantages of 7 to 11% for weaning weight for F1 calves compared with BR. Also the superiority of backcrosses over pure BR cattle ranges from 17 to 25% (Plasse, 1989). The superiority of crossbred cows at weaning, is probably associated to better maternal ability and heterosis effects of crossbred cows.

Breed differences in CI were found here, where the NE group had shorter CI than BR and GU cows (Table 1). Similarly, Magaña *et al*. (2002, 307) reported differences in CI between NE, Indobrazil, Gyr and Commercial Zebu in the same region. Mejia-Bautista *et al.* (2010, 289) also found that Ne cows had better reproductive performance (CI) than BR cows, whereas the BS and commercial Zebu cows were in between. BR and BS had higher WW than NE cows. However, this result is different from what was observed by Osorio-Arce and Segura-Correa (2010) in Tabasco Mexico who reported no differences between BR cows and their crosses with BS and Charolais sires.

Sex

Males weighed 0.80 kg more at birth than females, which is less than the 1.6 kg difference reported by Segura-Correa (1990) in a commercial herd in the same region. This finding agree with reports in the literature, which indicates a greater BW for males (Segura-Correa *et al*., 1988; Magaña *et al*., 2002). The difference in BW between sexes may be attributed to longer gestation period of male calves or higher androgen concentration in fetuses.

It was observed that the male calves had larger AWW with a mean of 182.9 kg compared to females (178.8 kg). Similar results (172.2 vs 161.6 kg) were found by Medina-Zaldivar *et al*. (2005) in Nellore cattle; Hernandez-Hernandez *et al*. (2015) in Brahman (193.3 vs 173.9 kg) and Rodríguez *et al*. (2009b) also in Brahman (203.8 vs 189.6 kg). The sex difference in weight is attributed mainly to androgenic hormones, particularly testosterone.

The sex of the calf seems not to be an important source of variation for CI. Similar results have been reported in other studies (Hinojosa and Segura, 1986; Magaña *et al*., 2002).

Parity

First and second parity cows as well as cows with 8 or more parities had the lowest BW. It is known that young and too old cows have lighter calf than middle age cows. This agree with the results of Magaña *et al*. (2002) who observed that first parity cows and cows with 7 or more calvings had lower BW than 3 to 6 parity cows. Segura-Correa (1990) notified that cows between 5.5 to 6.5 years of age had heavier BW than cows with less than 4 and more than 8.5 years old. Plasse (1978) explain this phenomenon to the fact that the prenatal growth depends on the placental size and body weight of the cow. Young cows are still growing and old cows have suffered a physiological waste, and in consequence they calf light calves. Plasse (1978) also indicates that 5 to 9 years cows calf heavier calves than first parity cows and too old cows.

In this study, first parity zebu or European x zebu cows had calves with lower weight at weaning than mature cows, which agrees with other reports in the literature (Magaña and Segura, 1998; Magaña and Segura-Correa, 2006). However, some authors did not report effect of age of the dam or parity (Torner *et al*. 1984; Segura-Correa, 1988). Nevertheless, it is recognized that first parity cows produce lightest calves because young cows have not complete its body development and they produce less milk than mature cows. Clutter and Nielsen (1987, 1313) reported that milk intake of the calf was highly correlated with 205 days weight.

First parity cows last longer to get pregnant than multiparous cows, but too old cows also show poor reproductive performance (Magaña *et al*., 2002). The poor performance of first parity cows is commonly associated to the stress caused by the fact that they are growing and to the demand of milk by the calf, which affect ovarian activity (Linares and Plasse, 1966). Hinojosa and Segura (1986), Segura and Segura (1991) and Osorio-Arce and Segura-Correa (2010) also reported longer CI for first parity cows than for mature cows.

Interaction of year x season

As mention before, the effects of year of birth x season of birth was significant on BW, AWW and CI ($p<0.05$). It was observed that calves born in 2006 and in the dry season were heaviest with 33.8 kg, while those born in 2013 in the rainy season were the heaviest 34.1 kg (Figure 1). The effect of season reported in Table 1, showed that calves born during the rainy season weighed an average of 200 g more than calves born during the dry season. These results are similar to those obtained by Pereda-Solís *et al*. (2005), who obtained 31.0 kg in the dry season and 32.0 kg for the rainy season. As expected, environmental conditions during the rainy season provide more quantity and better quality of pasture for cows that translated into a higher BW of calves. However, Segura-Correa (1990) and Hernandez-Hernandez *et al*. (2015) reported no significant effect of season on BW.

The significant interaction effect of year x season obtained for AWW (Figure 2), suggest variation in quantity and quality of pasture by season within years. Calves born at the beginning of the rainy season benefit from a higher milk production provided by dams, which have access to good pasture. On the contrary, cows calving late in the rainy season graze on mature and less digestible pastures, which negatively influence milk yield of the cow. In this study feed supplement were given in some years, which must contributed to year x season interaction significant effect. Biffani *et al*. (2000) reported that animals, which received supplementary feeding, achieved higher weight at weaning. Weaning weight is an important trait because it provides the owner of the farm with information about both calves and dams. In fact, growth of calf is based on its own genome (half supplied by the dam) but also depends on milk yield and mothering ability of the dam (Willham, 1972). Both, calf growth and maternal ability should receive appropriate emphasis when selection choices are made. Year x season interaction effects on weaning weight have also been reported by Rodríguez *et al*. (2009b) and Plasse *et al*. (2000).

The interaction effect of year x season ($P < 0.001$) on CI (Figure 3), as for the case of AWW, it is probably due to variation in quantity and quality of pasture by season within years. Cows calving at the beginning of the rainy season may benefit from a better body condition and a sooner return to estrous and pregnancy. On the contrary, cows calving late in the rainy season graze on mature and less digestible pastures, which negatively influence reproductive traits. Significant effects ($P<0.05$) of year and season on CI were reported by Duarte-Ortuño *et al*. (1988) and Luna de la Peña *et al*. (2008).

CONCLUSION

This is one of the few studies comparing bred differences under the same tropical field conditions. The BS crossbred cows produced heavier calves at weaning than the zebu purebreeds (BR, GU and NE). Among Zebu breeds, the NE cows had the shortest calving interval mean. Male were heavier at birth and weaning than females for all breed groups. Parity of cow significant1y affected all traits. Year x season interaction was also an important source of variation.

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