# Reproductive performance of Cuban Dairy Zebu and Dairy Crossbred Zebu heifers in the Genetic Cattle Enterprise "Los Naranjos"

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The historical performance of productive indicators of Cuban Dairy Zebu (CDZ) and Dairy Crossbred Zebu (DCZ) heifers from the Genetic Cattle Enterprise "Los Naranjos" is described. From 558 records of the incorporation years 2000- 2007, the traits incorporation-first service (IFS), interval first insemination-positive insemination (IPI), interval incorporation-gestation (IIG), age at first calving (AFC) and number of services per gestation (S/G) were analyzed. A generalized linear model of mixed effects was applied, considering the random effect of the nested animal included in the fixed effect of the genotype (CDZ or DCZ), the incorporation age as linear co-variable and the fixed effects of incorporation year, unit and season, respectively (rainy or dry), as well as the interactions year-season, genotype-year and genotype-season-year. In respect to the significant effects, the Tukey-Kramer test was applied for the multiple comparison of the minimum square means. The mean transformed values were: 70 ± 58 d, 215 ±179 d, 285 ±181 d, 3.2 ± 1.7 and 50 ± 8 months, for IFS, IPI, IIG, S/G and AFC, respectively. Only signification of the incorporation year and unit was obtained for all traits. The interaction year- incorporation season was only for IFS. No significant differences were obtained between genotypes for the analyzed reproductive traits. In general, it was proved that the intervals between incorporation and first calving were extremely high in these genotypes. Measures on the reproductive management and feeding should be taken to counteract this unfavorable situation.

Key words: *Cuban dairy zebu, productive traits, heifers*.

The reproductive efficiency of the cattle herds is a complicated aspect and of great importance, closely related with milk production. It is known that short inter-calving periods increase the total milk production per productive life and a proper genetic gain rate. Ramírez *et al*. (2008) stated that the prolonged anoestrus is among the characteristics of dairy cattle rearing of the tropics, being one of the main causes of its low reproductive efficiency. Among the factors affecting these physiological events are feeding, season, body condition, breed, alterations of the reproduction apparatus, type of managing, errors detecting heat and others (Galina and Arthur 1990, Ramírez and Segura 1992 and Silva *et al*. 1992). The reproductive traits are characterized by their low heritability (González-Recio and Alenda 2005), so a respond to the selection of these characteristics may not be expected. The improvement depends, in great extent, on the influence of other factors related with management and feeding.

One of the genotypes obtained in Cuba from the *Bos taurus* x *Bos indicus* crossing is Cuban Dairy Zebu. This crossing allowed the Cuban cattle rearing to have a genotype adapted to harder conditions than those required by the Siboney (5/8H: 3/8C) or Mambi de Cuba (3/4H: 1/4C). Differently from the lasts, it is used as double purpose.

Considering that this proportion Holstein-Zebu is the less studied in Cuba, in spite of being one of the most used genotypes in the artificial insemination plan in commercial cattle rearing at national level, historical information is intended to be provided in this study about reproduction after incorporating the Cuban Dairy Zebu and Dairy Zebu crossbred females (sire Dairy Zebu) widely spread at present in commercial cattle rearing.

## Materials and Methods

The reproductive records from the incorporation to the first calving were analyzed in living females and were low. These animals corresponded with the genotypes Cuban Dairy Zebu (CDZ, ¾ Zebu ¼ Holstein) and Dairy Crossbred Zebu (DCZ, or females with CDZ sire and dam for diverse origin), from the herd of the Genetic Cattle Enterprise "Los Naranjos", in Mayabeque province. They were placed in centers for heifers until gestation, where the *Dichantium caricosum*, *Dichantium annulatum* and *Sporobolus indicus* grasslands were the main feeding basis. The supplementation with concentrates was only a priority for milking cows. This last was practiced with the calf's help.

The traits analyzed were incorporation to the first service (IFS), incorporation-gestation (IIG), interval first insemination-positive insemination (IPI), age at first calving (AFC) and number of services per gestation (S/G).

First, a test was conducted to know whether the data had the normal distribution with the SAS/INSIGHT. The non-achievement of the normal distribution of the data was proved by the results of the goodness of fit test for the normal distribution (Kolmogorov-Smirnov, Cramer-Von Mises and Anderson-Darling) and the mean descriptive statistics, moda and mean, as well as the curtosis and asymmetry.

Through the macro Glimmix of the SAS (2007) version 9.1.3, a generalized linear model of mixed effects was conducted. It used the logarithm as link function and the errors with a Poisson disribution. The eqaution's model was the following:

$Y_{ijklmn} = \mu + a_i(\alpha_j) + \beta_k + \varepsilon_l + \gamma_m + \tau_n + (\varepsilon\gamma)_{lm} + (\alpha\gamma)_{jm} + (\alpha\varepsilon\gamma)_{jlm} + e_{ijklmn}$

where:

$Y_{ijklmn}$: o-th observation, corresponding to the i-th individual of the j-th genotype in the k-th herd *l*= 1, 2, 3…..558 (maximum)

$\mu$: general constant or mean, common to all the observations for each trait

$\alpha_j$: fixed effect of the j-th genetic group j=1, 2 (CDZ or crossbred females)

$a_i(\alpha_j)$: random effect, corresponding to the i-th individual nested within the j-th genetic group

$\beta_k$: k- th herd (incorporation unit,) k=1, 2….10.

$\varepsilon_l$ : l-th season l=1, 2 (dry season: November-April and rainy season: May-October)

$\gamma_m$: m-th incorporation year m=2000, 2001…..2007.

$\tau_n$: Covariable incorporation age, associated to the n-th individual

$(\varepsilon\gamma)_{lm}$: Interaction of the l-th season and the m-th incorporation year

$(\alpha\gamma)_{jm}$: Interaction of the i-th genotype and the l-th year

$(\alpha\varepsilon\gamma)_{jlm}$: Interaction of the i-th genotype, the l-th season and the m-th incorporation year

$e_{ijklmn}$: random error, normally assumed and independently distributed $(0,\delta_e^2)$.

Table 1 shows a summary of the number of observations per each effect considered in the model. A multiple comparison test was applied for the minimum square means when the effects were significant, according to the test of Tukey- Kramer (Kramer 1956).

Table 1. Nmber of observations per each effect analyzed in the model.

| Genotype | Observations | Season | Observations | Year | Observations | Unit | Observations |
|---|---|---|---|---|---|---|---|
| CDZ | 178 | Dry | 361 | 2000 | 36 | 142 | 35 |
| DCZ | 380 | Rainy | 197 | 2001 | 48 | 163 | 36 |
| Total | 558 | | | 2002 | 98 | 170 | 25 |
| | | | | 2003 | 115 | 174 | 16 |
| | | | | 2004 | 78 | 613 | 11 |
| | | | | 2005 | 44 | 615 | 18 |
| | | | | 2006 | 98 | 656 | 248 |
| | | | | 2007 | 41 | 915 | 13 |
| | | | | | | 999 | 148 |
| | | | | | | 9898 | 14 |

## Results and Discussion

The analysis of variance for the studied traits is shown in table 2. Out of the effects included in the model, the incorporation year was significant in all the traits. The herd effect was significant for all the traits, except for that of the number of services per gestation. The incorporation age only influenced on the age at first calving. No significant differences were obtained between genotypes or season for any of the analyzed reproductive traits.

The season effect was not significant, agreeing with that obtained by Rodríguez (2009), who analyzed the effect of the different seasonal variants (trimester or four-month period of incorporation) on these same genotypes. This author found, for the same traits analyzed in this study, that this effect was not significant on the variability of most of the traits. In this study, the objective of working during the rainy and dry seasons was to increase the number of observations for his effect. However, only the season per incorporation interaction was significant for the IFS. The reproductive intervals were pretty long, due to incorporation with an improper body condition. Rodríguez (2009) proved that the Cuban Dairy Zebu heifers were incorporated to reproduction with average age of 27.5 months, at about 301 kg of weight and daily weight gain of 375 g $d^{-1}$ in this period.

Table 3 shows the performance of the intervals during the years of study, when this effect was significant. The IIG for the genotypes under study varied between 95 and 425 d, showing that, as average, these heifers were gestated almost nine months after their incorporation to reproduction. These values were higher than those obtained by Ponce de León and Toledo (1988) in Holstein cows. These authors informed values of 42 and 56 d for these same traits, respectively, with more favorable average of 1.4 services per gestation (less than half of the value for this study).

This is closely related with the genotype and management and feeding conditions, which are different in each case. In the genotypes under study, the average age at first calving (at about 50 months) showed superior

Table 2. Analysis of variance according to GLIMMIX (F value) procedure for the reproductive traits of Dairy Zebu heifers and their crossbred animals

| Variation sources of the model | fd | IFS, d | IIG, d | IPI, d | S/G | AFC, months |
|---|---|---|---|---|---|---|
| Incorporation age | 1 | 0.64 | 0.96 | 0.39 | 0.14 | 377.56*** |
| Genotype | 1 | 0.72 | 0.04 | 0.09 | 0.07 | 0.28 |
| Incorporation year (IY) | 7 | 9.55*** | 7.92*** | 3.55** | 4.39*** | 9.79*** |
| Incorporation unit | 9 | 6.50*** | 4.71*** | 2.33* | 1.36 | 6.33*** |
| Season | 1 | 0.17 | 0.35 | 0.14 | 0.06 | 0.01 |
| Genotype x IY | 7 | 1.39 | 0.40 | 0.76 | 0.87 | 0.30 |
| IY x season | 7 | 2.55* | 0.39 | 0.62 | 0.66 | 0.31 |
| Genotype x season | 1 | 2.34 | 0.51 | 0.07 | 1.20 | 1.03 |
| Genotype x IY x season | 7 | 0.67 | 1.37 | 1.75 | 0.87 | 1.13 |
| Error | 492 | | | | | |
| Criteria of goodness of fit | Verosimilarity | 1443.8 | 1105.2 | 1370.4 | 923.5 | -572.5 |
| | Akaike | 1447.8 | 1109.2 | 1374.4 | 925.5 | -570.5 |
| | Bayesian | 1445.2 | 1106.6 | 1371.8 | 924.2 | -571.8 |

*P < 0.05 ** P < 0.01 *** P < 0.0001. IFS Incorporation to the first service, IIG: Incorporation- gestation, IPI: Internal first insemination- positive insemination, S/G: Number of service per gestation, AFC: Age of first calving

Table 3. Performance of the reproductive traits of the heifers during th years of study

| IY | IIG, d | SE± | IPI, d | SE± | S/G | SE± | AFC, months | SE± |
|---|---|---|---|---|---|---|---|---|
| 2000 | 6.0[c] (425.3) | 0.1 | 5.5[ab] (256.5) | 0.2 | 1.2[abc] (3.3 ) | 0.1 | 4.00[d] (54.75) | 0.01 |
| 2001 | 5.9[c] (391.6) | 0.1 | 5.7[b] (306.7) | 0.1 | 1.3[bc] (3.8) | 0.1 | 3.98[d] (53.99) | 0.01 |
| 2002 | 5.6[bc] (277.5) | 0.1 | 5.3[ab] (203.2) | 0.1 | 1.0[ab] (2.7) | 0.1 | 3.90[bc] (49.50) | 0.02 |
| 2003 | 5.8[bc] (344.3) | 0.1 | 5.7[b] (310.9) | 0.2 | 1.4[c] (3.9) | 0.1 | 3.95[cd] (52.06) | 0.01 |
| 2004 | 5.6[bc] (275.5) | 0.1 | 5.3[ab] (202.6) | 0.2 | 0.9[abc] (2.5) | 0.1 | 3.89[bcd] (49.38) | 0.02 |
| 2005 | 5.2[ab] (190.0) | 0.2 | 4.9[ab] (143.6) | 0.3 | 0.9[abc] (2.6) | 0.1 | 3.85[abc] (47.08) | 0.03 |
| 2006 | 5.3[ab] (201.9) | 0.1 | 5.4[ab] (217.7) | 0.2 | 1.2[abc] (3.2) | 0.1 | 3.85[ab] (47.19) | 0.02 |
| 2007 | 4.5[a] (94.90) | 0.3 | 4.4[a] (81.5) | 0.4 | 0.7[a] (2.1) | 0.1 | 3.78[a] (43.88) | 0.02 |

[abcd]Means with different letters per row differ at P < 0.05. ( ) Retransformed means (Kramer 1956). IIG: Incorporation- gestation, IPI: Internal first insemination- positive insemination, S/G: Number of service per gestation, AFC: Age of first calving

value to that of the Sahiwal of Kenya cattle, with 44 months (Ilatsia *et al*. 2007). It was also superior to 37 months in studies of Tapia *et al*. (1995) for the Retinta breed in Spain, surpassing also to the mean of 37.7± 10.1 months, reported by Espinoza *et al*. (2007) in Cuban Zebu.

In spite of the heifer category, the interval first insemination-positive insemination describes the efficiency on managing reproduction (analogous to the service period in the cows' category). According to Aloísio *et al*. (2001), the service period is a trait with great values variations, maybe due to the irregularities in the presentation of the heat cycles, due to the deficiencies on nutritional and sanitary management. Problems on detecting heat could influence on the studied genotypes, as those that did not get gestated should be repeated at 21 d and during a service period of 215 d. They should have repeated heat at least 10 times. This is in agreement with the proportion of Zebu genes of these genotypes, in which heat is presented later than in taurins. It should be added that in the *Bos indicus* cattle the heat detection is difficult, as referred by Baca *et al*. (1998), it is characterized by its short duration and a less intense presentation than that of the *Bos taurus*. Likewise, Segura and Rodríguez (2000) affirmed that the Zebu cattle have low reproductive indexes characterized by wide intervals and advanced ages at first calving.

The effect of the calving year was presented with a slight improvement in all the traits, corroborated with a significant difference between the minimum square means of all the traits between 2000 and 2007. However, it should be considered that in 2007 this effect was evidenced when finishing the information, so lower improve values of the indicators having certain orientation could be manifested.

Significance of the interaction season x incorporation year was obtained for the IFS trait, mainly due to the differences between years, because, when comparing specifically the means between the dry and rainy season in the same years, no significant differences were found. The extreme values propitiating these differences are mainly reflected in the dry season. During this stage, the means between years had higher variation than in the rainy season (figure 1).

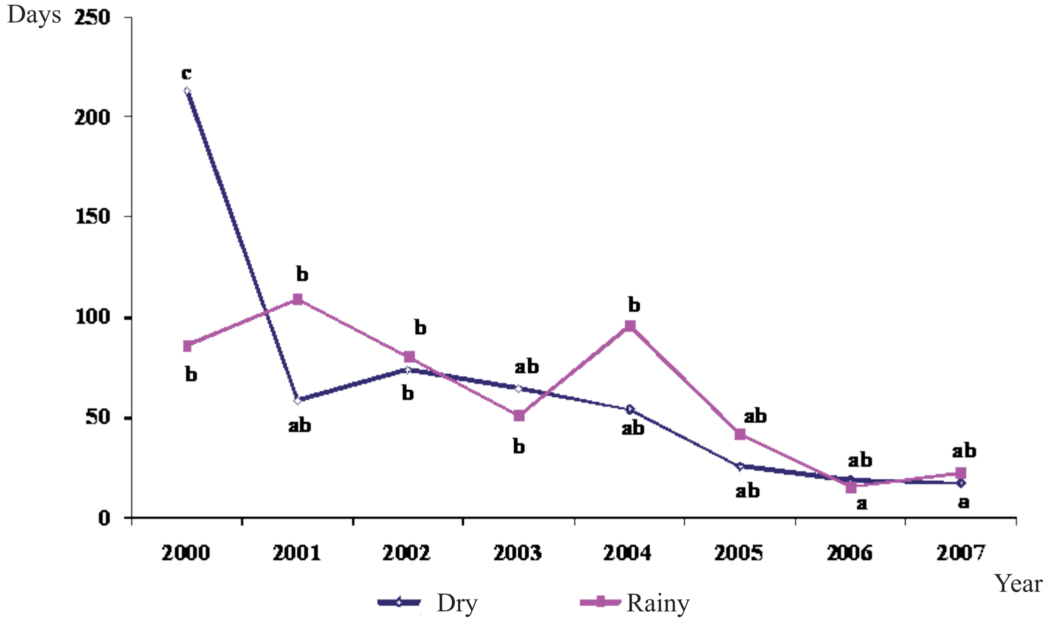


Figure 1. Performance of the interaction season-incorporation year on the interval incorporation-first service (different letters per year differ at $P < 0.05$), according to Kramer (1956)

The mean values of the reproductive intervals of the CDZ and DCZ heifers, as well as the number of services per gestation were high. This implies that the reproductive cycles of these animals lengthen, so the selection process is much slower.

Rosete and Zamora (1990) stated that the heifers' management is the starting point when beginning a productive improvement program of a double-purpose herd. Nevertheless, this process is generally postponed because it is not of immediate utility and it is considered as with scarce profitability. In spite the today's heifers are tomorrow's cows, these animals are not paid attention frequently, in respect to their management and nutrition.

In Cuba, this animal category has occupied traditionally a secondary place, after dairy cows and calves. It is fed the worst quality pastures and is placed on low productive areas, originating a poor development, avoiding a proper weight and age at calving.

It is concluded that the intervals between incorporation and first calving are extremely high in the analyzed genotypes. Taking measures on the reproductive management as well as on the feeding from the initial development stage of these animals is recommended to counteract this unfavorable situation.

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