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Reproductive Behavior of Zebu and 5/8 Zebu x 3/8 Simmental Genotypes in Central Cuba Locations

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ABSTRACT

The aim of this paper was to evaluate the reproductive behavior of female Zebu and 5/8 Zebu x 3/8 Simmental on a genetic farm in the central region of Cuba. The research was made between 2010 and 2014. The individual records of 255 cows; 200 Zebus (106 white and 94 bermeja) and 55 crossbreds (5/8 Zebu x 3/8 Simmental) were included. The calving-first insemination interval (CFII), calving-gestation interval (SP), inter-calving period (CCI), and service per gestation (S/G) were calculated. Besides, the effects of genotype, parity, quarter and calving year were evaluated using the above indicators. The descriptive statistics were estimated, and a general linear model was used to determine the effects of each variation source. The three genotypes showed low reproductive efficiency, though slightly more favorable for 5/8 Zebu x 3/8 Simmental. The CFII, SP, and CCI were influenced ($P < 0.05$) by the calving year, genotype, and parity, whereas SP was influenced by the calving quarter only ($P < 0.05$). The gestation service was not affected by any factor. It was concluded that the three genotypes studied underwent severe deterioration of reproductive indicators, influenced by the genotype, quarter, calving year, and parity.

Key words: *reproductive behavior, Zebu, reproduction, anestrus*

INTRODUCTION

The reproductive efficiency of bovine herds is attributed to inadequate reproduction management, environmental factors, genotypes, and reproductive diseases. The most significant, though, is nutritional factors (Rocha, Gallego, Vásquez, Pedraza, Echeverri, Cerón and Martínez, 2012; Álvarez, Hernández, and Blanco, 2015), with a negative effect on cost-effectiveness (Balarezo, García-Díaz, Hernández-Barreto, and García López, 2016).

Over the years, Zebu was the main cattle breed in Cuba. It was used in most crossing projects aiming to enhance the herds genetically for higher beef and dairy yields (Uffo, Martín-Burriel, Martínez, and Ronda, 2006).

Simmentel is a widespread breed, either the purebred and crossed animals can adapt well to a wide range of environmental conditions. It is used for genetic breeding of Zebu, in order to achieve higher tolerance to tropical climate conditions, meet the demands of the meat processing industry, improve reproductive efficiency, and preserve Zebu's productivity and adaptability to tropical conditions (Rosales-Alday, Elzo, Montaño and Vega, 2004).

The 5/8 Z x 3/8 S genotype produces more milk, which increases calf's weight at weaning. This genotype can start reproduction at 25 months of age, weighing 330 kg, with a first calving in 40 months, a calving-gestation interval of 230 days, inter-calving periods of 456 days, 80.1% natality, and 290 days of lactation. These indicators are more favorable than for Zebu (Ramos, 2010).

These results were reported several years ago, but proper statistics was not applied in terms of genetic and environmental factors that may affect them; therefore, these data are unreliable and have limited scientific value. It is important to update the data, in order to broaden knowledge of the genotype, and contribute to the national genetics project with a larger population.

The aim of this paper was to evaluate the reproductive behavior of Zebu and 5/8 Zebu x 3/8 Simmental cows on a genetics farm in the central region of Cuba.

MATERIALS AND METHODS

Location of the experimental area and animal characteristics

This research was made between 2010 and 2014 on a genetics farm in central Cuba, located on 22º 39' and 56" north latitude and 80º 55' 18" west longitude. The three herds studied were under time-limited rotational grazing (16 h daily), stocking rate of 244.8 LU ha^{-1} $day^{-1,}$ and a global stocking rate of 1.5 animals per ha^{-1}. The cows were not milked to enable natural calf rearing.

In the rainy season, the animals mainly fed grass and mineral supplementation with dicalcium phosphate, whereas in the dry season, supplementation was made with sugar cane and molasses. There was abundant native grass in the location (*Paspalum notatum*, *Dichantium annulatum*, and common *Cynodon dactilum* cv.).

Procedure

The records of 3-9 year-old 200 Zebu cows (106 white and 94 bermeja), and 55 5/8 Z x 3/8 S cows, with 1-5 calvings, and free from Brucellosis and tuberculosis, were processed, totaling 255 animals.

Intervals calving-first service (CFSI), calving-gestation (SP), calving-calving (CCI), anestrus-post-calving period (APC), natality rate, and service-gestation (S/G), were evaluated according to the methodology described by Brito, Blanco, Calderón, Preval, and Campo (2010). The efficiency to determine the estrus females (EDEF) was evaluated through various procedures, according to Heersche and Nebel (1994); González-Stagnaro (2001); O'Connor (2007) and Mazzucchelli, Parrilla, and Pérez-Salas (2010). Quarter, calving year, and genotype were taken from the animal's individual records, and their influence on each reproductive indicator was evaluated.

Throughout the estrus detection period, observations were made between 6 and 10 am, and 2 and 6 pm by a watcher with three teaser bulls (deviated penis), in a 1:25 bull/cow ratio. The voluntary waiting period (VWP) was 60 days, and insemination was performed using the deep intrauterine method (60-65% efficiency in the last 4 years), using frozen semen from high quality studs.

Statistical analysis

The mean, standard deviation, and frequency distribution were calculated for all the reproductive indicators in the study. Then the effects of genotype, parity, quarter, and calving year on these parameters were determined according to the minimal square method based on a general linear model, prior to corroboration of the assumptions for analysis, linearity, independence, and normality of the distribution of each indicator.

The model was adjusted with all the first order interactions previously excluded due to the absence of statistical significance. The model was adjusted again with the inclusion of the statistically significant factors only (Duarte and Perrotta, 2007). Accordingly, the model below was adopted:

$$Y_{ijk} = \mu + AP_i + G_j + P_k + TP_l + e_{ijkl}$$

Where:

Y_{ijkl} = the i^{th} CFII, SP or CCI in the ijkl subclasses.

μ μ Population mean.

AP_i = effect of i^{th} calving year (i= 1,2,…, 5)

G_j = effect of j^{th} genotype (j = 1, 2…, 3)

P_k = effect of k^{th} calving (k = 1, 2,…,4)

TP_l = effect of l^{th} calving quarter (l = 1, 2,…,4)

e_{ijkl} = random error normally distributed with mean and variance.

Statgraphics Centurion XV.II (Statistical Graphic Corp., USA), (2006) was used for statistical processing.

RESULTS AND DISCUSSION

CFII was very deteriorated in the genotypes studied, and indicated the existence of a very prolonged postcalving anestrus period; the average values for 5/8 Z x 3/8 S were slightly higher for 6 months, whereas they were high during 7 months for Zebu (Table 1). This indicator should not prolong the VWP over 18 days (González-Stagnaro, 2001; Soto-Belloso, 2001; and González-Stagnaro, 2002).

In the 5/8 Z x 3/8 S genotype, 10% of cows underwent less than 60 days of CFII; another 10%

was observed to have between 60 and 90 days. It was more dramatic in Zebus (white and bermejo) with 2-3% of cows showing a lower CFII than VWP, and 9% and 7% between 60 and 90 days, respectively. The cows´ CFII lasted more than 180 days: 56% in the 5/8 Z x 3/8 S genotype; 68% in white Zebu, and 59% in bermejo Zebu (Table 1).

Table 2 shows the average values of services per gestation (S/G): 69.4% and 70.0% gestation achieved in the first service to white and bermejo Zebus, respectively; and 58.8% to 5/8 Z x 3/8 S, which may be considered good and with a proper fertility level (González-Stagnaro, 2001).

The gestation of 70% white Zebu, 71% bermejo Zebu, and 45% 5/8 Z x 3/8 S cows was achieved in one insemination service. Two insemination services were necessary for 19, 18, and 41% of the cows, respectively, so 87-89% of cows were fertilized in one or two services, and only a small percent required three or more inseminations to achieve gestation (Table 2). It indicated the inexistence of cows repeating in the herds, and the high efficiency of artificial insemination.

SP was excessively long for the three genotypes, though slightly shorter in the 5/8 Z x 3/8 S genotype (Table 3), thus demonstrating the severity of this indicator (González-Stagnaro, 2002). Only 7, 6, and 16% of white Zebu, bermejo Zebu, and 5/8 Z x 3/8 S cows, respectively, showed a lower SP at 90 days, contrary to the 180 days observed in more than 70% of the animals.

A SP above 120 days may indicate anestrus, errors in estrus detection, or silent, little intense or little noticeable estrus (González-Stagnaro, 2002). When it occurs, it is important to determine the exact cause of SP prolongation; therefore, real or supposed anestrus due to foul estrus detection should be discarded at first. Estimation of estrus detection efficiency (EDEF) using the methodology suggested by Heersche and Nebel (1994), González-Stagnaro (2001), and Mazzucchelli *et al.* (2010), produced 14.10, 11.40, and 33.10%, respectively, which may lead to the mistaken conclusion that something is wrong

However, the above procedures have serious flaws; they are based on the assumption that all the females at the end of the voluntary waiting period are within the cycle, which is not always right, many are in anestrus. The method described by O'Connor (2007) produced higher EDEF (70%) in the three herds, which is the right one (González-Stagnaro, 2002). This method is more appropriate, since it considers inter estrus intervals, regardless of artificial insemination or its results (Roelofs, López-Gatius, Hunter, and Van Eerdenburg and Hanzen, 2010).

Moreover, the 1.41 S/G indicated that estrus detection and artificial insemination were adequate, and that all inseminations were performed in true estrus animals. Therefore, the cause of CFII, SP, and CCI prolongation may be the existence of post-calving anestrus, with 165.86, 172.50, days in the white and bermejo Zebu, respectively, and 131.43 days in the 5/8 Z x 3/8 S.

The average CCI was too long for the three genotypes (Table 4), though approximately 30 days shorter in the 5/8 Z x 3/8 S. Natality was 66.6, 66.9, and 70.9% in the white Zebu, bermejo Zebu, and 5/8 Z x 3/8 S, respectively. Likewise, 9, 10, and 20% of cows showed CCI below 400 days, respectively, which is adequate to achieve 90% natality. CCI was above 540 days (18 months), in 50, 54, and 43% of cows.

The CFII, SP, and CCI were influenced by the calving year, the genotype, and parity ($P < 0.05$); the SP and CCI were influenced ($P < 0.05$) by the calving quarter (Table 5).

The CFII, SP, and CCI values were higher ($P < 0.05$) in 2014, lower ($P < 0.05$) in the 5/8 Z x 3/8 S genotype, higher ($P < 0.05$) after the second calving, and lower ($P < 0.05$) after the fourth calving. CFII and SP were higher ($P < 0.05$) in the April-May-June quarter, with the best results in the July-August-September quarter. The calving quarter did not influence CCI (Table 6).

The prolongation of CFII, SP, and CCI in Zebu may be linked to post-calving anestrus when the calf is reared by the mother until seven months old (Santiesteban, Bertot, Vázquez, Loyola, Garay, de Armas, Avilés and Honrach, 2007), and weight loss after calving (Corea-Guillén, Alvarado, Leyton, 2008).

The differences found in the indicators in relation to calving year coincided with reports made of other breeds when the system underwent fluctuations of basic indicators, like feeding and management between years, the main cause of CFII and SP prolongation (De la Torre, Bertot, Collantes, and Vázquez, 2006; Viamonte, 2010).

The results for white and bermejo Zebu coincided with reports for the breed made in several genetics projects in Cuba (Ramos, 2010). The 5/8 Z x 3/8 S genotype had a better reproductive behavior, perhaps due to heterosis or hybrid vigor when the progenies from consanguineous mating or purebred populations exceed the average performance for certain trait (Hernández, 2003).

The CCI achieved for 5/8 Z x 3/8 S was above the 456 days reported for Simmental-Fleckvieh bovines, in the Amazon (Maicelo and Bardales, 2017); these authors estimated CCI from 80% natality of the herd. In this study, natality was 71% for 5/8 Z x 3/8 S.

The reproductive attitudes of Simmental (early sexual maturity, adequate fertility, maternal skills, and high dairy yields) are passed on with breeding. These features have a positive effect on the reproductive activity of crossbred animals from this breed (López-Ordaz, Vite-Cristóbal, García-Muñiz, and Martínez-Hernández, 2009). Therefore, the 5/8 Z x 3/8 S genotype showed a reproductive behavior in between the two breeds that originated it; which is ideal for Cuban conditions for cattle raising production.

The outcome in terms of calvings coincided with the reports made for the Cuban cow (Viamonte, 2010), and breeds Caracú, Romosinuano, and San Martinero. Araújo, Martins, de Assis Melo, Braga, (2000); Pereira, Laborde, Carriquiry and Meikle (2008) found better reproductive indicators between the third and fourth calvings in comparison to primiparous cows.

Perhaps, the difference in relation to parity is given by the reproductive maturity related to older age in the animals, and the middle aged cows have a better reproductive behavior than younger or too old ones (Pérez y Moreno, 2009).

The lower CFII, SP, and CCI values observed in the cows that calved in the July-August-September quarter may be influenced by the greater availability of pastures in the year, particularly, in June, with enhanced nutrition for the gestating cows and better body condition (BC) for calving. Furthermore, temperatures and the ensuing effects of heat on fertility, are lower in the following quarter, as opposed to calving in the April-May-June quarter.

At calving, the cows that have a BC below 3 points (5-point scale), lose more weight, have a negative more prolonged energy balance, and begin ovarian activity at a later time than cows with a BC above 3, thus increasing the number of empty females (Santiesteban *et al.*, 2007). The reproductive indicators of the Cuban cow, in the east of the country, were influenced by the quarter alone, or in combination with the calving period and parity (Viamonte, 2010).

CONCLUSIONS

The three genotypes studied showed a marked deterioration in the reproductive indicators evaluated, which were more favorable in the 5/8 Z x 3/8 S cows, also influenced by the quarter, calving year, and parity.

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Table 1 Descriptive statgraphs of the calving-fisrt service interval (CFII) in white and bermejo Zebu, and $^5/_8$ Z x $^3/_8$ S

Parameters	White Zebu		Bermejo Zebu		$^5/_8$ Z x $^3/_8$ S	
$\bar{X} \pm SD$	225.86 ± 92.90		232.54 ± 91.81		191.43 ± 89.40	
Intervals	RF	ARF	RF	ARF	RF	ARF
≤ 60	0.02	0.02	0.03	0.03	0.10	0.10
60-90	0.06	0.09	0.04	0.07	0.10	0.21
90-120	0.06	0.16	0.04	0.11	0.01	0.23
120-150	0.02	0.18	0.07	0.19	0.05	0.29
150-180	0.11	0.30	0.07	0.26	0.12	0.41

180-210	0.09	0.39	0.12	0.39	0.12	0.54
210-240	0.16	0.56	0.11	0.51	0.14	0.69
> 240.0	0.43	1.00	0.48	1.00	0.30	1.00

FR: relative frequency ARF: accumulated relative frequency

Table 2 Descriptive statgraphs of service per gestation (S/G) in white and bermejo Zebu, and $^5/_8$ Z x $^3/_8$ S

Parameters	White Zebu		Bermejo Zebu		$^5/_8$ Z x $^3/_8$ S	
$\overline{X}$ ± SD	1.44 ± 0.83		1.41 ± 0.77		1.70 ± 0.78	
Intervals	RF	ARF	RF	ARF	RF	ARF
1.0	0.70	0.70	0.71	0.71	0.45	0.45
2	0.19	0.89	0.18	0.89	0.41	0.87
3 3	0.07	0.97	0.08	0.97	0.09	0.96
> 3 3	0.02	1.00	0.02	1.00	0.03	1.00

RF: relative frequency ARF: accumulated relative frequency

Table 3 Descriptive statgraphs of the calving-gestation interval (SP) in white and bermejo Zebu, and $^5/_8$ Z x $^3/_8$ S

Parameters	White Zebu		Bermejo Zebu		$^5/_8$ Z x $^3/_8$ S	
$\overline{X}$ ± SD	255.51 ± 109.16		259.72 ± 103.47		225.50 ± 105.83	
Intervals	RF	ARF	RF	ARF	RF	ARF
≤90	0.07	0.07	0.06	0.06	0.16	0.16
90.0-120	0.04	0.12	0.04	0.10	0.03	0.20
120.0-150	0.04	0.16	0.05	0.15	0.03	0.23
150.0-180	0.09	0.26	0.04	0.20	0.05	0.29
180.0-210	0.08	0.34	0.11	0.31	0.10	0.40
210.0-240	0.11	0.45	0.08	0.40	0.12	0.52
240.0-270	0.14	0.59	0.16	0.56	0.10	0.63
> 270	0.40	1.00	0.43	1.00	0.36	1.00

RF: Relative frequency ARF: Accumulated relative frequency

Table 4 Descriptive statgraphs of the calving-calving interval (CCI) in white and bermejo Zebu, and $^5/_8$ Z x $^3/_8$ S

Parameters	White Zebu		Bermejo Zebu		$^5/_8$ Z x $^3/_8$ S	
$\overline{X}$ ± SD	547.91 ± 112.72		545.20 ± 105.57		514.40 ± 106.27	
Intervals	RF	ARF	RF	ARF	RF	ARF
≤365	0.04	0.04	0.04	0.04	0.12	0.12
365-400	0.04	0.09	0.06	0.10	0.07	0.20
400-435	0.04	0.13	0.06	0.16	0.03	0.23
435.0-470	0.12	0.26	0.05	0.21	0.05	0.29

470-505	0.09	0.36	0.11	0.33	0.16	0.45
505-540	0.13	0.50	0.12	0.45	0.10	0.56
> 540	0.50	1.00	0.54	1.00	0.43	1.00

RF: relative frequency ARF: accumulated relative frequency

Table 5 Main variation sources of reproductive indicators in white and bermejo Zebu, and $^{5}/_{8}$ Z x $^{3}/_{8}$ S

Variation sources	FD	Mean square					
		CFII		SP		CCI	
		MC	p	MC	p	MS	p
CY	4	43 110.3	0.0001	37202.6	0.0030	38 851.2	0.0035
G	2	35 156.5	0.0064	31 168.9	0.0334	35 347.0	0.0270
P	3	86 118.8	0.0000	12 3218.1	0.0000	129 208.3	0.0000
CQ	3	16 583.6	0.0654	25 792.5	0.0379	23 190.1	0.0480
Exponential	242	6 810.0	-	9 041.2	-	9 640.2	

CY: Calving year G: Genotype P: Parity CQ: Calving quarter FD: Freedom degree MS: Mean square CFII: Calving-first insemination interval SP: Service period CCI: Calving-calving interval

Table 6 Comparison of reproductive indicators within the variation sources

Variation sources		CFII		SP		CCI	
		$\overline{X}$	SE±	$\overline{X}$	SE±	$\overline{X}$	SE±
CY	2010	235.98^{a}	21.47	235.81^{ab}	24.98	522.44^{ab}	25.23
	2011	157.16^{b}	16.37	170.90^{b}	18.86	462.71^{b}	19.44
	2012	161.89^{b}	14.22	201.42^{ab}	16.18	485.01^{b}	16.53
	2013	191.99^{ab}	15.18	231.54^{ab}	17.51	517.60^{ab}	18.04
	2014	233.62^{a}	14.80	269.78^{a}	17.09	563.34^{a}	17.57
G	W. Zebu	210.68^{a}	8.59	237.51^{a}	9.87	529.75^{a}	10.16
	B. Zebu	208.55^{a}	10.06	231.17^{a}	11.56	515.51^{a}	11.91
	$^{5}/_{8}$ Z x $^{3}/_{8}$ S	169.15^{b}	11.97	196.98^{b}	13.79	485.40^{b}	14.22
P	1	219.39^{ab}	16.20	269.87^{ab}	18.95	561.77^{ab}	18.86
	2	257.69^{a}	11.82	293.41^{a}	13.58	583.0^{a}	13.91
	3	198.22^{b}	14.77	215.40^{b}	17.05	502.48^{b}	17.51
	4	109.21^{c}	21.58	108.87^{c}	24.93	393.60^{c}	25.62
CQ	J-F-M	180.80^{b}	16.30	219.97^{ab}	18.82	506.08^{a}	19.34
	A-M-J	219.37^{a}	10.04	249.51^{a}	11.44	536.42^{a}	11.79
	J-A-S	189.75^{b}	10.77	211.55^{b}	12.36	497.05^{a}	12.68
	O-N-D	194.59^{ab}	10.99	206.51^{b}	12.73	501.35^{a}	13.06

ab: unequal letters in the same column within the variation source, differ for (P <0.05), Bonferroni. CY: calving year G: Genotype P: Parity CQ: Calving quarter J-F-M: January, February, March A-M-J: April, May, June. J-A-S: July, August, September. O-N-D: October, November, December