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Weight at First Calving and Its Relationship With Productive Indicators in Nelore Cows in a Grazing System of the Bolivian Tropics

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Abstract

Considering only selection for increased weight gain until after one year could cause adult cow weight gain that would not be desirable depending on the production system. To evaluate the relationship of weight at first calving and its relationship with productive indicators in Nelore cows in a grazing system of the Bolivian tropics. Retrospective data from the years 1992 to 2019 were used, which were part of two cooperatives: Agropecuaria Integral San Juan de Yapacan í and the Centro Tecnol ógico Agropecuario located in Santa Cruz de la Sierra, Bolivia. The data corresponding to 1052 Nelore primiparous cows were used for the research work. The lightest cows had the same calf weight at birth as the rest of the heaviest cows, weaned a lighter calf, arrived the first calving rapidly, showed no differences with the Accumulated Production and the Calf Index with the heaviest cows, but had the highest stock efficiency. Identifying the group of lightest cows as the most efficient was considered a positive tool to recommend producers to take into account at the time of selection. The study shows that the age at first calving is related to indicators of productive efficiency in Nelore cows in a grazing system of the Bolivian tropics and that their use would have a greater impact in identifying the most efficient cow for each production system.

Keywords: Nelore cows, Efficiency, Accumulated production, Calf index, Grazing system

1. Introduction

The use of Nelore cattle to the Bolivian production systems constitutes an advance to obtain heavier animals with high daily weight gain at a lower cost, that is, more efficient (Flores and Ortiz, 2010). Although, the selection only for greater weight of calves at weaning can increase adult weight due to the medium to high genetic correlation between final weight and weight at different ages (Boligon *et al*., 2009). In the same way, the elimination of cows due to their low weight gain can reduce their age at first calving. However, considering only selection for increased weight gain until after one year could cause adult cow weight gain that would not be desirable depending on the production system (Boligon *et al.*, 2010). The efficiency of animal production systems is an objective to be achieved, not only from an economic-productive point of view but also from a socio-environmental point of view (Hegarty *et al.*, 2007). Many of the efforts to improve efficiency in livestock have focused on different measures of feed efficiency (variations in amount of feed consumed and rate of weight gain) determined during the growth phase. While this approach provides pertinent information on efficiency during the growth phase, the relationship to cow efficiency has yet to be determined (Ikeda *et al*., 2019). An increase in body growth and a decrease in food consumption would be the main measures to consider in an improvement program whose objective is to improve dietary efficiency using traits described for this purpose as selection criteria (Grion *et al.*, 2014). Mature weight (MW) can be used as an indicator of animal size, mainly due to its easy measurement and inclusion in management practices (Silveira *et al.*, 2015). Consequently, the objective of this study was to evaluate the relationship of weight at first calving and its relationship with productive indicators in Nelore cows in a grazing system of the Bolivian tropics.

2. Method

In this work, retrospective data from the years 1992 to 2019 were used, which were part of two cooperatives: Agropecuaria Integral San Juan de Yapacan í(16 ° 59 ′ 0 ″ south latitude, 63 ° 58 ′ 0 ″ west longitude) and the Centro Tecnol ógico Agropecuario (17 ° 13 ′ 12 ″ south latitude, 62 ° 53 ′ 39 ″ west longitude) located in the Japanese communities of San Juan and Okinawa in Santa Cruz de la Sierra, Bolivia. The area has a tropical climate and rains for

much of the year (986-1805 mm) and a short dry season, at a height of 286 meters above sea level. The average annual temperature is 24.3 ℃.

2.1 Animals

The data corresponding to 1052 primiparous Nelore cows were used. The calving months of the cows were May and July of each year. Weaning occurs between seven and eight months depending on body condition and general condition. The gynecological and sanitary control is carried out by a technical advisor on a routine basis.

2.2 Feeding and Management

The herd was fed grazing managed in intensive conditions, with cultivated pastures *Brachiaria decumbens* (8 to 12 t / ha / year of DM), *Brachiaria humidicola* (8 to 10 t / ha / year of DM), *Brachiaria dictyoneura* (8 to 10 t / ha / year of DM), *Cynodon dactylon* (10 to 20 t / ha / year of DM) and *Panicum maximum cv mombaza* (20 to 28 t / ha / year of DM), (ESCASAN, 2020).

$$PAC = \frac{P_d * n_p * C_a}{EVP_n - C_i}$$

2.3 Body Weight Record

The cows had at least two individual weight checks. The weighing of the animals was always carried out at the same time (8:00 am). The calves were weighed with a brand manual scale (POCKET BALANCE; Made in Germany) the same day of birth. From two months of age, calves and mothers were weighed with a brand electronic scale (ICONIX New Zealand Ltd.).

2.4 Variables to Analyze

Cow live weight (LW) in kg: average live weight of each cow of the weights made in its first lactation.

Calf weight at birth (CWB) in kg: average calf weight at birth for all calvings.

Calf weight at weaning (CWW) in kg: Average calf weight at weaning of all calvings.

Age at first calving (AFC) in months: The age of first calving (date of birth - date of first calving).

Longevity (L) in days: Date of discard or death - date of birth in days.

Calf Index (CI) in kg: Total production of weaned calf / longevity in days (Date of discard or death - date of birth in days).

Accumulative Productivity (PAC) in kg (L ðbo *et al.*, 2000).

PAC: Pd = average live weight of all weaned calves (kg); np = total number of calves given birth by the cow; Ca = constant equal to 365 days, making it possible to express fertility on an annual basis; EVPn= age in days of the cow at the last calving; Characteristics were analyzed using Ci = constant equal to 550 days approximately 18 months, which represents age at first conception.

2.5 Statistical Analysis

The criteria used in previous work (Marini and Oyarzabal, 2002a; Marini and Oyarzabal 2002b) were applied to divide the cows in categories. The cows were ordered from lowest to highest weight, and they were divided into three groups of equal numbers, forming three categories: low (l), medium (m) and high (h) weight at weight calving. To check whether this criterion differentiated three age levels at the first delivery, the means and standard deviations were estimated and the Tukey Analysis of Variance and comparison of means ($p < 0.05$) tests were applied (Sokal and Rohlf, 1979). Averages were obtained by category and for all variables based on weight at first calving. It was analyzed by ANOVA and the comparison of means was made through Tukey's tests ($P < 0.05$). Statistical analyzes were performed with the JMP software package in version 5.0 for Windows (JMP®, SAS Institute, 2003).

3. Results and Discussions

The growth of animals is related to the ability to gain body mass, being affected by diet, weather conditions, health and genetics. Knowledge of this process is very important for meat production systems, because it is possible to identify phases of the animal's life that describe different growth rates (Lopes *et al.*, 2011; Malhado *et al.*, 2009). The live weight (average ± standard error) of the first lactation cows was 465 ± 62 kg for the total of the cows analyzed. Significant differences were found between the calving years analyzed and the weight ($p \leq 0.001$), with 1994 being the year with the lowest weight of the cows 447 ± 61 kg and 1998 with the heaviest weight of the cows 524 ± 13 kg. The weights found in the cows analyzed are higher than those cited by Rosa *et al.*, (2001) where the general average adult weight was 447 kg, with a coefficient of variation of 11%, and from those reported by Lopes *et al.*, (2016) of 555 ± 71 kg in adult cows and the

425.8 ±3 kg reported by Segura-Correa *et al.,* (2013). And they were found below the 577 ±5 kg obtained by Foianini *et al.,* (2010).

The cows were grouped by calving decades and the average weights were obtained: Decade I (1992-2000), Decade II (2001-2010) and Decade III (2011-2019), showing significant differences ($p \leq 0.001$), in the average weights of the cows belonging to the same: Decade I (157) 508 ±4.9 kg, Decade II (462) 497 ±2.8 kg and Decade III (433) 487 ±2.9 kg. It should be noted that in the last Decade III group there are many of the cows analyzed that have not yet reached adult weight, and possibly this could have modified the average weight of the decade. Obviously, there is a variation in the weight of Nelore cows that can be the effect of several factors (management, feeding, genetics, environment) that cause this difference in weight. When seeing the results of the weights of the cows between decades, these have been decreasing, although the weights continue to be above the cited authors. Since the late 1980s, cooperatives have been working with cattle herds with the aim of providing pure Nelore breeders to their associates. The selection criteria in these cooperatives was to achieve animals that have increased average daily weights that would allow having a calf as heavy as possible at weaning (Ikeda y Marini, 2021).

Table 1. Productive variables y weight categories at first calving

	LW (kg)	CWB(kg)	CWW (kg)	AFC (days)
1 (353)	426 ± 1.6^{c}	34.5 ± 0.2^{a}	200 ± 1.9^{b}	1045 ± 11^{a}
2 (353)	495 ± 0.9^{b}	34.5 ± 0.2^{a}	209 ± 1.9^{a}	1096 ± 11^{b}
3 (346)	564 ± 1.6^{a}	35.3 ± 0.2^{a}	210 ± 1.9^{a}	1114 ± 11^{b}

Different letters in the column indicate significant differences $p \leq 0.05$

All values correspond to the arithmetic mean ± standard error

Live weight (LW): Average cow weight of all the weights of its life

Calf weight at birth (CWB) in kg

Calf weight at weaning (CWW) in kg

Age at first calving (AFC) in days

Table 1 shows that three categories of cows were found with significant differences ($p \leq 0.05$) between them, according to weight at first calving. The three categories do not differ in calf birth weight, although they do differ in weaning weight ($p \leq 0.05$) where the medium and high weight categories have the highest calf weaning weight values. The same behavior is observed with age at first delivery, where the medium and high weight categories reach their first delivery at an older age than those of the low weight category ($p \leq 0.05$).

In general, zebu cattle have an average birth weight (BW) of 30 kg (Reynolds *et at*., 1980; Paschal *et al.,* 1991). More recent works showed that the birth weight in Nelore cattle was between 29 and 32 kg on average (Silva *et al.,* 2008; Santana *et al*., 2012; Boligon *et al.,* 2013; Chud *et al.,* 2014). A study by Chirinos *et al.,* (2017) using first calving cows showed that the average weight of the calves was 27.0 ±4.9 kg less than those found by Silva *et al.,* (2008) in rodeos of Paran á, Santa Catarina and R ó Grande do Su with average of 30.4 ±2.4; 29.1 ±2.9 and 29.8 ±2.9 kg. The weights found in the different categories in this work are grater than those previously mentioned. It is important to note that the average weight determined in this study was well above parameters that the Asocebu-Colombia (2016) refers to for Nelore cattle, which is between 26 to 28 kg. One of the explanations could be that the weight at birth is commonly considered as a selection criterion in cattle for beef, the growth traits (expressed as body weight) are easily measurable, highly correlated from birth to adulthood, and respond well selection due to heritability estimates that are moderate to high (Yokoo *et al.,* 2007; Boligon *et al.,* 2009; Zuin *et al.,* 2012) and therefore the search for calves heavier at calving. Weaning weight is often used as a correlated trait in genetic evaluation programs and is used for decision-making on replacement selection (Guidolin *et al.,* 2012). Alfonso *et al.,* (2001) showed that the live weight of calves was 145 kg average for Nelore calves weaned at seven months of age for four consecutive years (1994-1999), in the same sub region. However, Santos *et al.* (2004) found lower values in extremely dry years for Nelore calves at 12 months of age, with an estimated mean weight of 146 kg. Itavo *et al.,* (2008) found that Nelore calves weaned at eight, nine and ten months of age with an average of 181.5 kg LW for animals raised in cultivated pastures. These higher weights, the authors attributed it to the diversity of the grass and the possibility of diet selection. The values found in this work respond to calf weights in cultivated pastures, where the heaviest and intermediate cows in the group have the calves with the highest weaning weight. This result would coincide with the previous explanation where a greater possibility of selection of the diet with quantity and quality of pasture would cause a greater weight of the calves. Table 1 shows that the age at first delivery found significant differences ($p \leq 0.05$)

between them according to weight at first delivery.

Cows in the high and medium weight categories take longer to have their first calving than cows in the low weight category. This could be because high and medium weight cows need more time to reach their optimum weight and more time for the development of the reproductive system. The results of age at first calving are below that reported by Duitama *et al.*, (2013) where it showed that the average in Brahman cows was 1226 days. Although being similar to the values found in Nelore cattle (Lôbo *et al.*, 2000), at 1180 days reported by Garcí a *et al.*, (2003) and at 1086 ± 268 days presented by Flores and Ortiz (2010) in the ranch Parabano (Cordillera Province, Santa Cruz Department).

Table 2 shows that the three categories do not differ in the Accumulated Production nor in the Calf Index. However, they show a significant difference ($p \leq 0.05$) in Stock efficiency where the underweight categories are the ones with the highest values.

Table 2. Variables of productive efficiency by age categories at first calving

	PAC (kg)	CI	SE
1 (353)	103 ± 1.3[a]	0.158 ± 0.001[a]	0.471 ± 0.004[a]
2 (353)	102 ± 1.3[a]	0.159 ± 0.001[a]	0.422 ± 0.004[b]
3 (346)	100 ± 1.3[a]	0.158 ± 0.001[a]	0.373 ± 0.004[c]

Different letters in the column indicate significant differences $p \leq 0.05$

All values correspond to the arithmetic mean ± standard error

Accumulated Production (PAC): Accumulated Productivity in kg of weaned calf per year

Calf Index (CI) in kg

Stock Efficiency (SE) in kg

Table 2 shows that the Accumulative Production results show that the cows in the three categories do not show significant differences. The results obtained in this work are similar to the 96.7 kg ± 46.7 kg of Accumulated Production weight reported by Azevedo *et al.*, (2005) and lower than those of Rosa (1999), working with data from herds of the Genetic Improvement Program of the Nelore Breed in Brazil, with an average of 144 kg for PAC and Schwengber (2001), also working on the information generated in the herds of the Nelore Breed Genetic Improvement Program in Brazil showed an average of the Accumulated Production of 130 kg of calves. The Calf index (Table 2) assesses the kg of calf produced from birth to discard, it is an indicator that involves various stages of the cow's life, not only production, longevity and reproduction, but also the rearing stage of the cows. The results showed that there were no significant differences between the groups of cows, that is, the three groups from birth generated the same amount of kg of calf per day.

In Table 2 the results of the stock efficiency by category are observed, where there were significant differences between the categories ($p \leq 0.05$), with the cows of less weight obtaining the highest efficiency in kg of calf. In other words, the lightest cows were the ones that produced the highest kg of calf per kilo of cows kept. Normally, one of the criteria used is to achieve a greater weight of the cow at the first calving, because it would achieve a better productive behavior, among them a greater weight of the calf at weaning, which according to the results obtained in this work would be achieved. However, it does not mean that these cows are the most productive efficient, since the lightest cows show equal weight at birth, younger age at first calving, the same efficiency in the indicators of Accumulated Production (PAC) and Calf Index (IT) and have the highest stock efficiency. This means that the 10 kg of weaning calf achieved by the heaviest cows is not enough to achieve a stock efficiency similar to that of the lightest cows, the difference in kg between both categories should be not less than 70 kg with respect to the lightest to achieve the same stock efficiency. These results could be explained by the search for greater weights of the calf at weaning that both cooperatives have had, this has not allowed an integral selection but directed to the search for a single element with greater weight. It is necessary to use various indicators for measurements and subsequent decision-making to search for the most efficient cows in the evaluated systems.

4. Conclusion

It is concluded that the age at the first calving is related to indicators of productive efficiency in Nelore cows in a grazing system of the Bolivian tropics and that their use would have a greater impact in identifying the most efficient cow for each productive system.

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