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Number of Calving and Its Relationship with Productive Indicators in Nelore Cows

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Abstract: The objective of this study was to evaluate the relationship of the calving number with productive indicators in Nelore cows in a grazing system in the Bolivian tropics. Retrospective data, corresponding to the period between 1991 and 2019 referred to 1,566 primiparous and multiparous Nelore breed cows were used. A decrease in the total number of animals was observed from the first to the fifth calving, it was also observed that the age of the first calving was similar in all cows without significant differences, showing that longevity is not associated with the age at the first calving. Live weight presented significant differences ($p \leq 0.05$), according to the number of calvings; the fourth and fifth calving cows are the heaviest. Weight of calf at birth did not show a relationship with the number of calvings either. However, it does so in the weight of calf at weaning, which increases from the first to the fifth calving with significant differences ($p \leq 0.05$). There were significant differences ($p \leq 0.05$) for the interval between calvings, decreasing as the calvings progressed. It is concluded that there is a relationship between the number of calving with productive indicators in Nelore cows in a grazing system in the Bolivian tropics, fundamentally those efficiency variables where longevity is important.

Key words: Zootechnic efficiency, interval between calvings, calf weight at weaning, accumulative production, grazing system.

1. Introduction

The adaptation of the cow to the environment in which it will be developed is a crucial element for the sustainability of the system [1]. The age at the first calving (AFC), life expectancy and longevity of cows are of great importance in livestock, especially beef cows, because the cost of raising calves and being able to wean them largely depend on how early the cows calve and how long they remain in production during their life [2]. It is clear that an objective of any production system is the generation of productive and efficient results that would lead to maximizing economic returns [3]. Brumatti *et al.* [4] suggest that greater efficiency in raising cattle for meat in cows can be achieved by improving the genetic quality of cattle through selection. Functional traits, such as health, fertility, efficiency of feed utilization and milking capacity, are variables that are used to summarize the characteristics of the animals, making it possible to increase production efficiency and collaborate in the reduction of input costs [5]. Longevity is the most important functional trait in cattle selection worldwide [6]. There are previous works where they show negative correlations between the weight of the cow and the stability or the useful life of the same; this made that the main associations of meat breeds in the USA report on the permanence or fertility of cows [7]. Some of the fertility measures used in beef cow evaluations, such as length of productive life, interval between the first and second calving, and calves born at a specific age, should be incorporated into analyses of the entire life of the cow [8]. Once the genetic constitution is defined, the productive behavior in general will be subject to environmental changes, management and other non-genetic factors [9, 10] therefore the objective of this study was to evaluate the relationship of the calving number with productive indicators in Nelore cows in a grazing system in the Bolivian tropics.

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2. Materials and Methods

Retrospective data corresponding to the period between 1992 and 2019 were used for the research work which belongs to the Technology Center on Agriculture and Livestock in Bolivia (Fundacion Cetabol) in Okinawa Japanese Community (17°13′12″ south latitude, 62°53′39″ west longitude), Santa Cruz, Bolivia. The community is located at 286 m above sea level and they present a tropical climate, with significant rains in most months of the year and a short dry season with little effect on the general climate. The annual average temperature is 24.3 °C with average rainfall of 986 mm in Japanese Community Okinawa, Santa Cruz.

2.1 Animals

The data corresponding to 1,566 primiparous and multiparous Nelore cows were used. Weaning occurs between seven and eight months in two or three stages depending on body and general condition. Gynecological control is performed routinely at weaning, by a technical advisor, as well as health.

2.2 Feeding and Management

The herd was fed grazing managed in intensive conditions, with cultivated pastures *Brachiaria decumbens* (8-12 t/ha/year of dry matter (DM)), *B. humidicola* (8-10 t/ha/year of DM), *B. dictyoneura* (8-10 t/ha/year of DM), *Cynodon dactylon* (10-20 t/ha/year of DM) and *Panicum maximum* cv. Mombaza (20-28 t/ha/year of DM) [11].

2.3 Statistic Analysis

Cows were ordered by lactation number (1-5 calvings). Variables to analyse and method of obtaining were described in Table 1. The means and standard deviations were estimated and the analysis of variance and Tukey's comparison of means tests were applied ($p < 0.05$) [12]. Five dispersion graphs were made taking as an independent variable the weights of the calves at weaning and as a dependent variable the accumulative production according to calving number. Statistical analyses were performed with the JMP software package in its version 5.0 for Windows (JMP®, SAS Institute, 2003).

3. Results and Discussion

The results according to the number of calving of the cows was described, where a decrease in the total number of animals from the first to the fifth calving is observed, it is also evident that the age of the first calving was similar in all cows without significant differences, showing that longevity is not associated with AFC (Table 2).

Live weight presents significant differences ($p \leq 0.05$), according to the number of calvings; the fourth and fifth calving cows are the heaviest. Weight of calf at birth did not show a relationship with the number of calvings either. Although, it does so in the weight of calf at weaning, which increases from the first to the fifth calving with significant differences ($p \leq 0.05$), the heaviest being the cows with the highest number of calving. For the interval between calvings, there were significant differences ($p \leq 0.05$), decreasing as the calvings progressed.

The AFC did not show significant differences between the numbers of calvings. The values found are lower than those 1,206 ± 149 d reported by Lobo *et al.* [13] and the 1,180 d found by Garcia *et al.* [14] and similar to 1,086 ± 268 d presented by Flores and Ortiz [15]. The weights found in the analyzed cows differed ($p \leq 0.05$) according to the number of calvings showing that the fifth calving cows are the heaviest, with weights similar to the 425.8 ± 3 kg reported by Segura-Correa *et al.* [16] and below the 577 ± 5 kg obtained by Foianini *et al.* [17]. The calves weights at birth did not show a relationship with the number of calvings, they were above the 29 kg and 32 kg reported by Santana *et al.* [18], Boligon *et al.* [19] and Chud *et al.* [20].

The calf index, accumulative production and the stock efficiency of the calf presented significant differences ($p \leq 0.05$) (Table 3). The cows with the highest

Table 1 Variables to analyze.

Variable name	Method of obtaining
Age at the first calving (AFC) (days)	The age of the first calving (date of birth-date of the first calving)
Cow live weight (LW) (kg)	Average cow weight of all the weights of her first lactation
Calf weight at birth (CWB) (kg)	Average calf weight at birth for all calvings
Calf weight at weaning (CWW) (kg)	Average calf weight at weaning of all calvings
Interval between calvings (IBC) (days)	Average calving interval of calvings
Calf index (CI) (kg)	Total production of weaned calf/longevity in days (date of discard or death–date of birth in days)
Accumulative production (PAC) (kg) [12] $PAC = \frac{P_d * n_p * C_a}{EVP_n - C_i}$	PAC: P_d = average weight of weaned calves (kg); n_p = total number of calves produced by the cow (calves born); C_a = constant equal to 365 d that allows expressing fertility on an annual basis; EVP_n = age of the cow at the last calving (days). The characteristics were analyzed using C_i = constant equal to 550 d approximately 18 months, representing the age at the first conception
Stock efficiency (SE) (kg)	Kilogram produced from calf/kg kept from cow

Table 2 Averages and standard errors of productive and reproductive variables according to calving number.

Number of calvings	Number of cows	AFC (days)	LW (kg)	CWB (kg)	CWW (kg)	IBC (days)
1	540	1,018 ± 5	494 ± 2[c]	36.7 ± 0.2	206 ± 2[b]	-
2	369	1,018 ± 6	512 ± 3[b]	36.7 ± 0.3	219 ± 2[a]	446 ± 5[a]
3	283	1,021 ± 7	522 ± 3[ab]	36.6 ± 0.3	219 ± 3[a]	430 ± 6[ab]
4	211	1,017 ± 8	531 ± 4[a]	36.4 ± 0.4	222 ± 3[a]	410 ± 7[b]
5	163	1,016 ± 9	533 ± 4[a]	36.7 ± 0.4	222 ± 3[a]	406 ± 8[b]

Different letters in the column indicate significant differences $p \leq 0.05$.
All values correspond to the arithmetic mean ± standard error.

Table 3 Averages and standard errors of efficiency variables according to calving number.

Number of calvings	Number of cows	CI (kg)	PAC (kg)	SE (kg)
1	540	0.164 ± 0.001[e]	110 ± 1[d]	0.423 ± 0.007[e]
2	369	0.252 ± 0.002[d]	141 ± 1[c]	0.844 ± 0.008[d]
3	283	0.306 ± 0.002[c]	156 ± 2[b]	1.257 ± 0.009[c]
4	211	0.348 ± 0.002[b]	167 ± 2[a]	1.679 ± 0.011[b]
5	163	0.378 ± 0.003[a]	173 ± 2[a]	2.102 ± 0.012[a]

Different letters in the column indicate significant differences $p \leq 0.05$.
All values correspond to the arithmetic mean ± standard error.

number of calvings showed the highest values in the three efficiency indicators used. Calves weights at weaning were related to the number of calvings showing significant differences ($p \leq 0.05$), noting that cows from the third to the fifth are those that wean heavier calves, this can be explained because they do not have the requirement to continue growing and they can allocate it to greater milk production. The same occurs with the interval between calving values, with a significant relationship ($p \leq 0.05$) with the calving number where the cows with the highest calving number have the lowest interval between calving values, being those that they best suited the system. The calf index, accumulative production and stock efficiency values showed significant differences according to the number of calvings, being a logical result that the longest-lived cows accumulate better values, it is precisely with efficiency indicators that the advantages of having longer-lived cows are demonstrated at rodeos.

The relationship between accumulative production and weaning weight, in this case for the first calving cows was described in Fig. 1. There is an initial growth of accumulative production, and then its growth decreases until it reaches an asymptote. The best fit was achieved with a second degree polynomial equation $y = 80.195\ln(x) - 317.32$, $R^2 = 0.3609$, $p \leq 0.001$. The maximum value of accumulative production does not coincide with the highest weight at weaning.

The relationship between accumulative production and calf weight at weaning was detailed, in this case for the second calving cows (Fig. 2). There is an initial growth of accumulative production and then its growth decreases until obtaining an asymptote. The best fit was achieved with a second degree polynomial equation $y = 111.03\ln(x) - 456.58$, $R^2 = 0.4249$, $p \leq 0.0001$. The maximum value of accumulative production does not occur with the highest calf weight at weaning.

The relationship between accumulative production and calf weight at weaning was explained, in this case for the third calving cows (Fig. 3). It was fitted with a linear equation $y = 0.651x + 10.938$, $R^2 = 0.6049$, $p \leq 0.0001$.

The relationship between accumulative production and calf weight at weaning was presented, in this case for the fourth calving cows (Fig. 4). In this case, it was also the linear equation $y = 0.7369x$, $R^2 = 0.6501$, $p \leq 0.0001$.

The relationship between accumulative production and calf weight at weaning was plotted, in this case for the fifth calving cows (Fig. 5). The linear equation $y = 0.764x$, $R^2 = 0.7068$, $p \leq 0.0001$ reported the best fit. The maximum value of accumulative production does not agree with the greater weight at weaning, as in the previous Figs. 3-5.

There is a need to use aggregated or integrated indicators in the cow-breeding systems for meat, because it would allow the evaluation of the behavior of both the genotypes and racial groups involved as well as the impact of the management strategies (non-genetic) on the both biological and economic

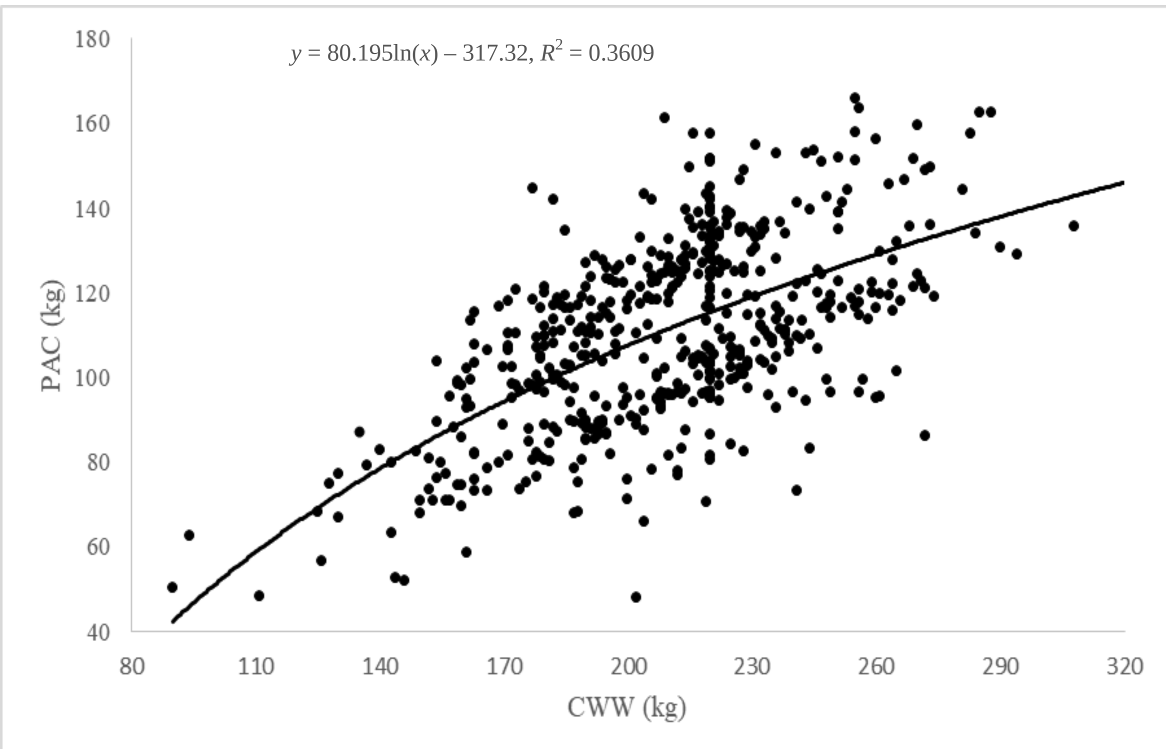

Fig. 1 Relation of accumulative production (PAC) and calf weight at weaning (CWW) in Nelore cows of the first calving.

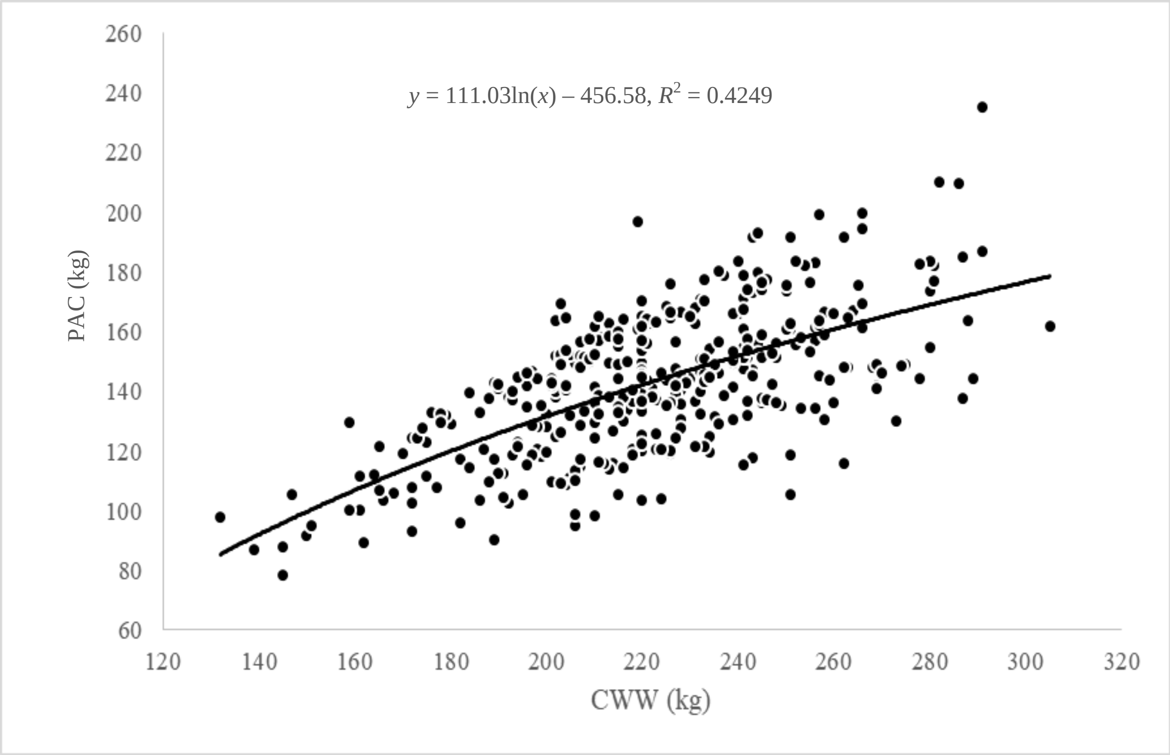

Fig. 2 Relation of PAC and CWW in the second calving Nelore cows.

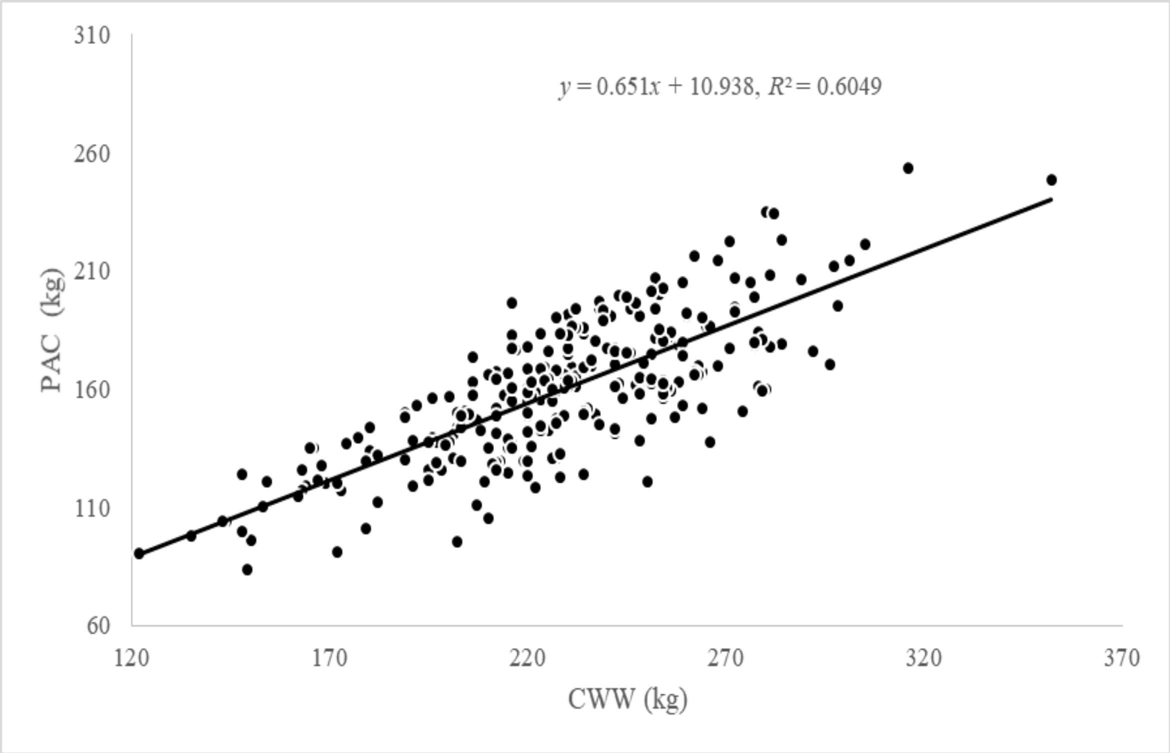

Fig. 3 Relation of PAC and CWW in the third calving Nelore cows.

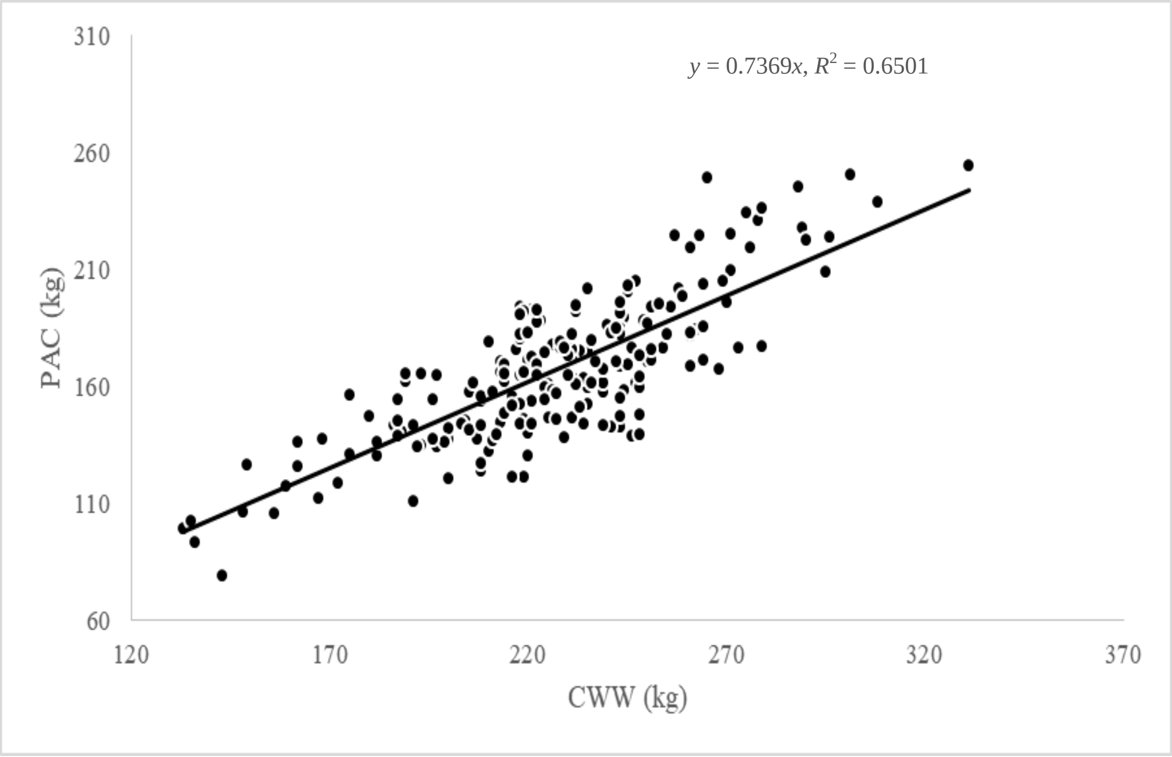

Fig. 4 Relation of PAC and CWW in the fourth calving Nelore cows.

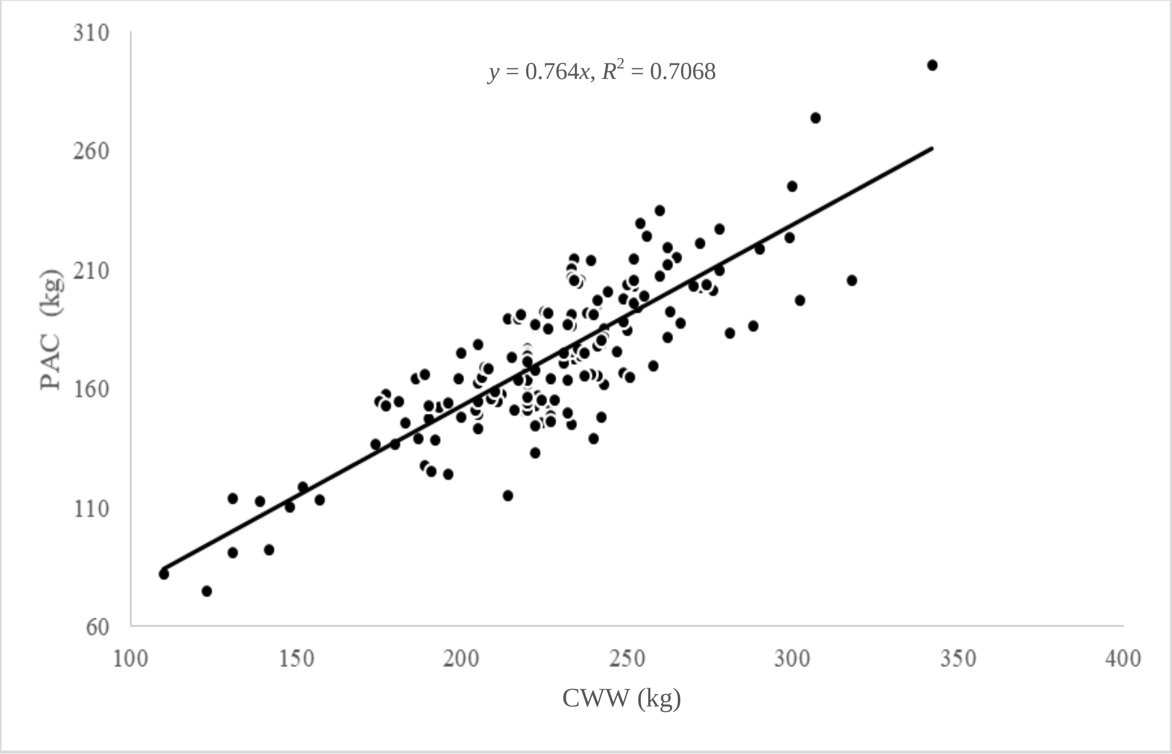

Fig. 5 Relation of PAC and CWW in the fifth calving Nelore cows.

efficiency of the evaluated systems. This would coincide with what was reported by Ikeda *et al.* [21] here using indicators of this nature would help to avoid the overvaluation of one of the characters involved in the characterization of a suitable cow for meat and would allow identifying the biotypes most adapted to the different environments existing in the place of evaluation. This is demonstrated with Figs. 3-5 where from the third parturition it would make sense to search for a greater calf weight at weaning, since the relationship between the calf weight at weaning and accumulative production is linear, that is, as the cow progresses in its calvings it would allow the use of efficiency indicators. The results found allow to advance in this sense, where the look of the search for a cow adapted to its environment is reflected by its longevity and reproduction, two of the traits associated with biological efficiency or fitness [22].

4. Conclusions

It is concluded that the Nelore cows in a grazing system in the Bolivian tropics that had a greater number of calvings, showed a better performance for the productive and reproductive variables studied. In addition, it was shown that from the third lactation it makes sense to seek to obtain a greater weight at weaning, since the relationship between weight at weaning and accumulative production is linear.

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References

[1] VinhasÍtavo, L. C., Filho, K. E., de Almeida Torres Júnior, R. A., Brandão Ferreira Ítavo, C. C., Nogueira, E., and Menezes Dias, A. 2014. "Efficiency of Calf Production of Cows from Two Genetic Groups." *R. Bras. Zootec*. 43 (7): 390-4.

[2] Dákary, I., Márton, D., Keller, K., Fördös, A., Török, M., and Szabo, F. 2006. "Study on the Age at First Calving and the Longevity of Beef Cows." *Journal Central European Agriculture* 7 (3): 377-88.

[3] Damasceno Carvalho, C. V., and Calmon de Bittencour, T. C. 2015. "Breeding Objectives for a Nellore Cattle Rearing System." *Pesq. Agropec. Bras. Brasília* 50 (9): 814-20. doi: 10.1590/S0100-204X2015000900010. (in Portuguese)

[4] Brumatti, R. C., Ferraz, J. B. S., Eler, J. P., and Formigonni, I. B. 2011. "Development of a Selection Index Based on a Bioeconomic Model Approach." *Archivos de Zootecnia* 60: 205-13. doi: 10.4321/S0004-05922011000200005. (in Portuguese)

[5] Groen, A. F., Torstein, T., Colleau, J., Pedersen, J., Pribyl, J., and Reinsch, N. 1997. "Economic Values in Dairy Cattle Breeding, with Special Reference to Functional Traits." *Livest. Prod. Sci*. 49: 1-21.

[6] Jovanovac, S., Raguž, N., Sölkner, J., and Mészáros, G. 2013. "Genetic Evaluation for Longevity of Croatian Simmental Bulls Using a Piecewise Weibull Model." *Arch. Tierzucht* 56: 89-101.

[7] Snelling, W. M., Kuehn, L. A., Thallman, R. M., Bennett, G. L., and Golden, B. L. 2019. "Genetic Correlations among Weight and Cumulative Productivity of Crossbred Beef Cows." *J. Anim. Sci*. 97: 63-77. doi: 10.1093/jas/sky420.

[8] Moore, K., Moran, A., Mrode, R., and Coffey, M. 2018. "Using Commercial Data and Genomics to Improve Female Fertility and Calf Survival of Limousin Beef Cattle in the UK." In *Proceedings of the World Congress on Genetics Applied to Livestock Production Species—Bovine (Beef)*, Vol. 2, Auckland, New Zealand, 65.

[9] Chirinos, Z., González-Stagnaro, C., Madridbury, N., and Rivera, J. 1999. "Lifespan, Longevity, and Causes of Elimination in Dual-Purpose Crossbred Cows." *Rev. Científ. FCV-LUZ.* 9 (6): 477-84. (in Spanish)

[10] Khaushik, S. N., Agarwai, S. C., and Garg, R. C. 1994. "Lifetime Traits in Hariana Cattle." *Indian J. Anim. Sci*. 64: 1104-7.

[11] ESCASAN. 2020. *Grass Seed Matsuda.* Accessed Sept, 2020. https://www.escasan.com.ni/etiqueta-producto/matsuda/. (in Spanish)

[12] Sokal, R. R., and Rohlf, F. J. 1979. "Biometrícs–Statistical Principles and Methods in Biological Research." Madrid, H. Blume Ediciones. (in Spanish)

[13] Lôbo, R. N., Madalena, F. E., and Vieira, A. R. 2000. "Average Estimates of Genetics Parameters for Beef and Dairy Cattle in Tropical Regions." *Animal Breeding Abstract* 68: 433-61.

[14] García, G. A., Maldonado-Estrada, J. G., and López, J. G.

2003. “Productive and Reproductive Characterization of Livestock Farms in the Lower Cauca and the Atlantic Coast of Antioquia. II. Behavior of Four Racial Group *Bos indicus* in a Tropical Dry Forest System (bs-T).” *Rev. Col. Cienc. Pec.* 16: 117-25. (in Spanish)

[15] Flores, V. H. D., and Ortiz, T. T. J. 2010. “Determination of the Reproductive Parameters of the Nelore Bellies in the Parabano Ranch (Cordillera Province, Santa Cruz Department).” Thesis MVZ-UAGRM Santa Cruz, Bolivia, 57. (in Spanish)

[16] Segura-Correa, J. C., Magañ Monforte, J. G., and Centurión-Castro, F. 2013. “Effect of Racial Group and Age at First Calving on the Number of Calving during the Lifespan of Zebu Cows.” Autonomy University of Yucatán, Merida, Yucatán, México, 41-4. (in Spanish)

[17] Foianini, J. C. S., Pereira, J. A., Landivar, J. H., and Ortiz, J. 2010. “Determination of the Gestation Period of Nelore Calves Born to I.A. and T.E.” Thesis FMVZ-UAGRM Santa Cruz, Bolivia, 70. (in Spanish)

[18] Santana, M. L., Eler, J. P., Cardoso, F. F., Albuquerque, L. G., Bignardi, A. B., and Ferraz, J. B. S. 2012. “Genotype by Environment Interaction for Birth and Weaning Weights of Composite Beef Cattle in Different Regions of Brazil.” *Livest Sci.* 149: 242-9. doi: 10.1016/j.livsci.2012.07.017.

[19] Boligon, A. A., Bignardi, A. B., Mercadante, M. E. Z., Lôbo, R. B., and Albuquerque, L. G. 2013. “Principal Components and Factor Analytic Models for Birth to Mature Weights in Nellore Cattle.” *Livest Sci* 152: 135-42. doi: 10.1016/j.livsci.2013.01.005.

[20] Chud, T. C. S., Caetano, S. L., Buzanskas, M. E., Grossi, D. A., Guidolin, D. G. F., and Nascimento, G. B. 2014. “Genetic Analysis for Gestation Length, Birth Weight, Weaning Weight, and Accumulated Productivity in Nellore Beef Cattle.” *Livest Sci* 170: 16-21. doi: 10.1016/j.livsci.-2014.09.024.

[21] Ikeda, A., Barbona, I., Hayashi, Y., Pereira, J. A., and Marini, P. R. 2019. “Longevity of Nelore Cows of the Bolivian Tropics. Is It Possible to Explain It through Productive Variables?” *Sustainable Agriculture Research* 8 (4): 28. doi: 10.5539/sar.v8n4 :28.

[22] Rauw, W. M., Kanis, E., Noordhuizen-Stassen, E. N., and Grommers, F. J. 1998. “Undesirable Side Effects of Election for High Production Efficiency in Farm Animals: A Review.” *Livest Prod Sci*. 56: 15-33.