https://doi.org/10.22319/rmcp.v16s4.6725

Article

Effect of cow weight on production efficiency at weaning in Brahman cows

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Abstract:

In order to evaluate the productive efficiency of Brahman cows based on their body size at weaning, the records of 765 Brahman cows were used. All animals were kept in extensive grazing with the same management during the preweaning period. The response variables analyzed were the adjusted 205-d weaning weight of the calf (AW205), the cow weaning weight (CWW), and the weaning efficiency measure used was (AW205/CWW) * 100 (WWR). The analyses of CWW, AW205, and WWR were performed with PROC GLM of SAS. Analyses included the effect of cow weight group (light, moderate, and heavy), the effects of the year (1998–2019) and month (November, December, January, and February) of cow birth, and cow age at calving (2–8). For CWW, there were differences (P<0.01) between the three weight levels of the cows. Cows in the heavy group were 19 and 10 % heavier (P<0.01) than cows in the light and moderate groups. All estimated correlations were significant (P<0.05), except for the correlation between AW205 and CWW in the heavy cow group. The most efficient cows at weaning were those with lighter weaning weights. WWR, as an efficiency measure, should be used cautiously as it does not consider possible increases in feed intake or milk production.

Keywords: Brahman, Cow weight, Weaning efficiency.

Received: 10/06/2024

Accepted: 10/09/2024

Introduction

The differences between cow weight and weaning efficiency are an important factor in the productivity of cow-calf production systems. Weaning efficiency is affected by several factors, such as the genetic makeup of the cattle, the environment, and management. Estimated values of cow growth curve parameters, such as mature weight and maturation rate, can significantly affect their efficiency, defined as the number and weight of their weaned calves(1,2). In Retinta cows, it was found that cows with higher mature weight tended to wean fewer calves. However, calves from these cows did not have significantly higher birth or weaning weights than those from lighter cows(1). This may indicate that, although heavier cows may have the potential to produce heavier calves, this does not translate into greater weaning efficiency. Some authors have suggested that cow size is an important consideration, especially in the context of environmental stressors such as drought. It has been observed that smaller cows consistently show higher efficiency compared to large cows, especially under drought conditions(2). This may indicate that smaller cows can better adapt to harsh environments and maintain their productivity despite resource scarcity. The assessment of the relationship between the weaning weight of the calves and the cow's weight as an indicator of the efficiency of the females suggests that this may not be an adequate selection criterion since the responses to selection are limited to maternal effects(3). This points out the complexity of the influence of genetic factors on cow efficiency at weaning and the need for a better understanding of direct and maternal genetic effects.

The age at weaning and supplementation of cows influences changes in cow weight and weaning weight of their calves, thus affecting overall efficiency(4). The relationship between the characteristics of cows and their calves with efficiency measures suggests that crossbreeding systems that favor lighter cows and larger bulls could improve efficiency(5).

Success in animal selection depends on the right combination of production potential, animal needs, nutrient availability, and the type of environment in which it will be produced. With large animals, more productive and economical responses can be obtained in stress-free environments where food is abundant. In stress-free environments with abundant feed, better productive and economical responses can be obtained with larger animals[1]. In adverse conditions, where resources are scarce, animals with a moderate body structure are preferred. Given the above, this study aimed to evaluate the productive efficiency of Brahman cows based on their body size at the time of weaning.

Material and methods

Study site. The study was conducted on a farm in the municipality of Playa Vicente Veracruz, located in a transition area that goes from the Sierra Oriental to the alluvial plain. The region has a humid tropical climate, an average temperature of 26.8 °C, and rainfall of 2,200 mm annually[6].

Animals. The records used corresponded to body weight records of 765 Brahman cows and their calves born between 2006 and 2019. The cows were mated with 41 pure bulls by natural mating in breeding seasons between March and June. All animals were kept in extensive grazing with the same management during the preweaning period.

Response variables. The response variables analyzed were the adjusted 205-d weaning weight of the calf (AW205), the cow weaning weight (CWW), and the weaning efficiency measure used was (AW205/CWW) * 100 (WWR)[2,4,5].

The cows were grouped according to the weight of the cows at weaning, considering one standard deviation of the mean (58.46 kg). The groups created were: “Light” (cows weighing less than or equal to half a standard deviation below the mean; ≤ 540.36 kg), “Moderate” (cows weighing more than half a standard deviation below the mean and less than half a standard deviation above the mean; > 540.36 and < 598.79 kg) and “Heavy” (cows weighing more than half a standard deviation above the mean; ≥ 598.79 kg). The number of cows and the general statistics of the information are shown in Table 1.

Table 1: Descriptive statistics of adjusted 205-d weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-d weight to the weaning weight of her calf (WWR), by cow weight group

Weight group	n	Variable	Mean	Standard deviation	Minimum	Maximum
Light	233	AW205	209.42	26.86	112.00	279.00
		CWW	503.76	31.16	360.00	540.00
		WWR	41.68	5.57	22.22	66.05
Moderate	295	AW205	214.09	27.91	121.00	276.00
		CWW	568.36	16.08	541.00	598.00
		WWR	37.68	4.90	21.01	50.92
Heavy	237	AW205	216.40	30.41	106.00	281.00
		CWW	635.80	33.04	599.00	793.00
		WWR	34.13	5.11	14.30	43.85

Statistical analysis. The analyses of CWW, AW205, and WWR were performed using the general linear model procedure (PROC GLM) of the SAS package (SAS, 2013)[7]. The analyses included the effect of the cow weight group (light, moderate, and heavy), the effects of the year (1998 – 2019) and month (November, December, January, and February) of cow birth and cow age at calving (2-8). In addition, the interactions of two factors that were significant in preliminary analyses were included ($P<0.05$). Mean comparisons were made based on Fisher's protected least significant difference. Regression analyses of the variables under study on the year of birth and age of the mother and of AW205 on CWW were performed with PROC REG (SAS, 2013)[7]. Pearson's correlations between the variables under study in all cows and within the cow weight group were obtained with PROC CORR (SAS, 2013)[7].

Results

The formation of groups based on the standard deviation of the mean cow weight determined groups with mean weights of 503.76, 568.36, and 635.80 kg for light, moderate, and heavy cows, respectively (Table 1).

Table 2 shows the probability values of the effects considered in the analysis for AW205, CWW, and WWR. The clustering of cow weight and birth month were significant sources of variation (*P*<0.05) for CWW and WWR. The year of birth and the age of the cow at weaning were significant (*P*<0.01) for all the variables under study.

The least square means and standard errors for AW205, CWW, and WWR by cow weight grouping are presented in Table 3. No differences (*P*>0.05) were detected for AW205 of calves among cow weight groups (average of 215.19 kg). For CWW, there were differences (*P*<0.01) between the three weight levels of the cows. Cows in the heavy group were 19 and 10 % heavier (*P*<0.01) than cows in the light and moderate groups. Cows in the moderate group had 10 % higher weights (*P*<0.01) than lightweight cows.

Table 2: Probability values of the effects included in the final statistical model for adjusted 205-d weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-d weight to the weaning weight of her calf (WWR)

Effect	**AW205**	**CWW**	**WWR**
Cow weight	0.15	<.0001	<.0001
Birth year	<.0001	<.0001	<.0001
Birth month	0.41	<.0001	0.03
Cow age at weaning	<.0001	<.0001	<.0001

For WWR, the ratio was 41.57 ± 0.41, 38.21 ± 0.35, and 34.83 ± 0.42 % for cows in the light, moderate, and heavy weight groups, respectively. Lightweight cows were 8.8 and 19.3 % more efficient than moderate-weight and heavy cows, respectively. Moderate-weight cows were 9.7 % more efficient than heavy-weight cows.

Table 3: Least square means and standard errors for adjusted 205-d weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-d weight to the weaning weight of her calf (WWR), by cow weight group

Cow weight group	**AW205 (kg)**	**CWW (kg)**	**WWR (%)**
Light	211.95 ± 2.23 ^{a}	511.85 ± 2.11 ^{a}	41.57 ± 0.41 ^{a}
Moderate	215.87 ± 1.90 ^{a}	566.46 ± 1.79 ^{b}	38.21 ± 0.35 ^{b}
Heavy	217.76 ± 2.29 ^{a}	630.38 ± 2.17 ^{c}	34.83 ± 0.42 ^{c}

^{abc} Means with a different letter within the column are different (*P*<0.05).

Regression of AW205 on birth year resulted in a decrease (*P*<0.05) of AW205 of 1.1 kg per year [*y*= 2246.67 -1.01(year), R^2= 0.03, *P*<0.01]. The regression of AW205 on CWW resulted in a decrease (*P*<0.05) of 2.73 kilograms in cow weight per year [*y*= 6055.58 – 2.73 (year), R^2= 0.05, *P*<0.01]. For WWR, the regression slope was not significant [*y*= 4.45 + 0.02 (year), R^2= 0.02, *P*=0.70].

Table 4 presents the least square means and standard errors by cow birth month for AW205, CWW, and WW. Cows born in November and December had significantly lower weaning weights than those born in November. The weaning efficiency of cows born in November and December was higher than those born in January. The behavior of those born in February was intermediate. Although some of these differences were significant (*P*<0.01), the magnitude of these differences is small.

Table 4: Least square means and standard errors for adjusted 205-day weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-day weight to the weaning weight of her calf (WWR), by cow birth month

Birth month	AW205 (kg)	CWW (kg)	WWR (%)
November	214.12 ± 2.16 [a]	559.00 ± 2.04 [a]	38.64 ± 0.40 [a]
December	217.67 ± 1.93 [a]	563.85 ± 1.82 [a]	39.00 ± 0.35 [a]
January	213.49 ± 2.25 [a]	575.35 ± 2.12 [b]	37.48 ± 0.41 [b]
February	215.53 ± 3.75 [a]	580.04 ± 3.55 [b]	37.70 ± 0.69 [ab]

[abc] Means with different letters within the column are different (*P*<0.05).

Table 5 shows the least square mean and standard errors by cow age for AW205, CWW, and WWR. Cows eight years old or older weaned calves of lower weight (*P*<0.05) than those of other ages. Two-year-old cows had lower weaning weights (*P*<0.05) than all other cow age groups. For WWR, two- and three-year-old cows were more efficient (*P*<0.05) than fourth and fifth-calving cows. Cows with eight calvings or more had the lowest (*P*<0.05) WWR values.

Table 5: Least square means and standard errors for adjusted 205-d weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-d weight to the weaning weight of her calf (WWR), by cow age

Cow age	AW205 (kg)	CWW (kg)	WWR (%)
2	219.13 ± 3.59 [ab]	550.51 ± 3.39 [a]	40.44 ± 0.66 [a]
3	219.10 ± 2.89 [ab]	567.24 ± 2.73 [b]	39.13 ± 0.53 [a]
4	213.2 0± 2.88 [a]	569.37 ± 2.72 [b]	37.77 ± 0.53 [b]
5	214.35 ± 2.96 [a]	573.15 ± 2.80 [cd]	37.75 ± 0.54 [b]
6	222.46 ± 3.21 [b]	576.19 ± 3.03 [cd]	38.93 ± 0.59 [ab]
7	217.56 ± 3.54 [ab]	579.82 ± 3.34 [bc]	37.95 ± 0.65 [ab]
8 +	200.62 ± 2.24 [c]	571.56 ± 2.11 [d]	35.47 ± 0.41 [c]

[abc] Means with different letters within the column are different (*P*<0.05).

The linear and quadratic effect of the age of the mother was significant (*P*<0.05) for AW205 [y= 195.14 + 9.56(age) – 0.98(age^2), R^2= 0.03, *P*<0.01], CWW [y= 409.31 + 54.22(age) – 3.97(age^2), R^2= 0.24, *P*<0.01], and WWR [y= 46.23 + 2.30(age) – 0.12(age^2), R^2= 0.13, *P*<0.01].

Pearson's correlations between AW205, CWW, and WWR of all cows and by weight group are shown in Table 6. All correlations were significant (*P*<0.05), except for the correlation between AW205 and CWW in the heavy cow group. In all cows, the correlation between AW205 and CWW was positive and weak, the correlation between AW205 and WWR was positive and high, and the correlation between CWW and WWR was negative and moderate.

Within the weight groups of light and moderate cows, the correlations of AW205 and CWW were positive and weak, indicating slight increases in AW205 as the CWW increased. In all cases, the correlations between AW205 and WWR were positive and high, from 0.85 to 0.98, indicating that when AW205 increased, WWR increased. Similarly, the correlations between CWW and WWR were negative with values between -0.38 and -0.31, indicating that as CWW increased, WWR decreased.

Table 6: Pearson’s correlations and standard errors between adjusted 205-d weight (AW205), cow weaning weight (CWW), and the ratio of adjusted 205-d weight to the weaning weight of her calf (WWR), of all cows and by weight group

	Variable	CWW	WWR
Overall	**AW205**	0.12 ± 0.03*	0.75 ± 0.01*
	CWW		-0.55 ± 0.01*
Light	**AW205**	0.20 ± 0.06*	0.85 ± 0.01*
	CWW		-0.31 ± 0.06*
Moderate	**AW205**	0.13 ± 0.06*	0.98 ± 0.01*
	CWW		-0.31 ± 0.06*
Heavy	**AW205**	-0.06 ± 0.06NS	0.95 ± 0.01*
	CWW		-0.38 ± 0.06*

*= *P*<0.05, NS= *P*>0.05.

Discussion

The weaning efficiency of females in the cow-calf system is affected by various environmental factors. Heat stress and humidity are critical factors in the weaning behavior of cows and calves[5,8]. The differences detected by year, month of birth, and age of the cow at weaning, in the present work, reflect differences in environmental variability, management practices, health, or genetic changes over time. In this study, lightweight cows had higher WWR than cows in the moderate and heavy weight groups. Likewise, other authors have found that the classification of cow weight groups has a significant effect on WWR; lightweight cows had higher WWR than heavier cows (51.6 ± 12.7 *vs* 49.3 ± 12.7 %)[9]. These results suggest that cows with higher WWR may be able to transfer nutrients from feed more efficiently to their calves from birth to weaning.

The present study did not detect any interaction between the year and the weight group; however, other authors[5], with Angus x Gelbvieh cows, observed that cow size did have an effect on the weaning weight of the calves depending on the year (*P*<0.05) and the effect was variable according to precipitation conditions. In drier years, as cow size increased, weaning weight increased, and larger cows weaned heavier calves (*P*<0.05). The opposite trend was evident in rainier years, as cow size increased, calf weaning weight decreased, and smaller cows weaned heavier calves (*P*<0.05). In years of moderate rainfall, intermediate-sized cows weaned the heaviest calves. In slightly wetter than average years, cows at the extremes (smaller or larger) weaned heavier calves than intermediate-sized cows (*P*<0.05).

In Charolais cows with three groups of body weights similar to those of this study, it was observed that the productive efficiency at 210 d, measured as calf weight at 210 d compared to the weight of the cow at calving, also showed better behavior ($P<0.05$) of lightweight cows compared to cows of the other weight groups, with increases of 13.07 and 13.38 % and 29.9 and 24.91 % of moderate and heavy cows, respectively[3]. These authors mention that the choice of the size of the animal should be made according to the conditions of production of the calves. The production system, the likely production of kilograms of calves per cow in the herd, can be improved by using technologies to increase the birth and weaning rate or the development of calves with better herd feeding levels[10]. Factors other than cow weight at weaning may also influence WWR and efficiency in beef production[9], such as the milk production potential of different breeds used in beef production[11,12].

Results of regression analyses between efficiency characteristics and weaning weight confirm the importance of weaning weight as a predictor of weaning efficiency in cow-calf systems[2]. In this study, the regression slope of AW205 on WWR was not significant and the predictive value of the equation was very low (R^2= 0.02). Pearson's correlation between AW205 and CWW was weak and positive, similar to that estimated by other authors, of 0.06 with pure Angus and Charolais cows and their reciprocal crosses[2]. These same authors observed that the correlation between CWW and WWR was negative and moderate (-.49), similar to that of this study of -0.55 ± 0.01. Similarly, the correlation between AW205 and WWR was positive and high (0.84), similar to that found in this study of 0.75 ± 0.01.

Conclusions and implications

The results of this work provide information on how cow weight affects production efficiency at weaning in cow-calf systems. In general, these results indicate that the most efficient cows at weaning were those with lighter weaning weights. WWR, as an efficiency measure, should be used cautiously as it does not consider possible increases in feed intake or milk production.

Acknowledgements and conflict of interest

We are grateful to the Huaxpala farm for facilitating animal information collection.
The authors have no conflict of interest in the publication of this paper.

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