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Development and validation of an objective method for the assessment of body condition scores and selection of beef cows for timed artificial insemination

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ABSTRACT

The objectives of this study were to: 1) evaluate the relationship of the angle formed between the left and right sides of the rump with body condition score (BCS) in cattle; and 2) develop an objective tool to select cows for timed artificial insemination (TAI) based on their BCS. In Experiment 1, 801 lactating Nelore cows, 3–12 years old and weighing 400–625 kg were enrolled. All females were evaluated according to BCS (scale 1–5). In addition, the angle formed between both sides of the rump was measured in all cows with a goniometer. The relationship between BCS and the rump angle was analyzed by linear regression. There was a positive relationship between BCS and rump angle ($P < 0.0001$). The linear regression equation was angle =77.76+9.94 x BCS; R^2=0.67. The aim of Experiment 2 was to evaluate BCS in a simple, direct and objective way using rump angle and related BCS to TAI performance. A device was developed called Vetscore® to determine BCS according to rump angle. Using the Vetscore, cows were classified into three different categories of BCS using a color-based method: red, BCS < 2.75; green, BCS between 2.75 and 4.5; and yellow, BCS > 4.5. A total of 429 Nelore suckling cows, 4–8 years old, were subjected to a TAI protocol based on estradiol benzoate, exogenous progesterone, prostaglandin F2α, equine chorionic gonadotropin and estradiol cypionate. At Day 0, all cows were evaluated with the Vetscore® and classified according to the device's BCS color scale. Pregnancy diagnosis was performed by ultrasonography 30 d after TAI. Pregnancy per AI (P/AI) was analyzed using the chi-square test. A good level of agreement was observed between Vetscore's scale and visual BCS (82.9%). Cows classified as “green” had higher P/AI than cows classified as “red” and “yellow“ (60.4%, 168 of 278; 42.4%, 61 of 144; and 28.6%, 2 of 7; respectively; $P < 0.001$). These results demonstrate that Vetscore® is an efficient and low-cost methodology for the assessment of BCS and, indirectly, nutritional status of beef cows. Finally, cows classified as adequate according to Vetscore® color scale had higher P/AI at 30 d compared with those considered inadequate.

1. Introduction

Nutrition is one of the most important factors affecting fertility in cattle (Robinson et al., 2006), particularly in extensively managed Zebu (*Bos indicus*) cows raised under tropical conditions that rely on pastures (Jolly et al., 1995; Samadi et al., 2013). Visual evaluation of body condition score (BCS) is widely accepted as an important tool for subjective quantification of endogenous energy reserves in B. indicus cattle (Ayres et al., 2009; Silveira et al., 2015). Despite its subjective nature, BCS is an easy and inexpensive method to evaluate body tissue reserves in lactating cows independent of frame size and body weight (Edmonson et al., 1989). Nonetheless, only a small proportion of farmers and technicians use this tool routinely as part of cow nutritional management in beef herds in South America and elsewhere. One issue is that evaluation of BCS is subjective and distinct evaluators can score the same cow differently. The time spent to perform evaluation of BCS may also hamper its adoption, especially in large beef herds.

The profitability of beef farms is highly associated with the capacity of cows to resume ovarian activity early after parturition and to

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respond properly to timed artificial insemination (TAI) protocols to conceive within the first trimester postpartum. Additionally, BCS at calving and the puerperium period were associated with the likelihood of pregnancy early in the breeding season (Richards et al., 1986; Moraes et al., 2007). Evaluation of BCS may be an important tool to select cows eligible for activities related to the reproductive management of livestock, such as TAI. Previous studies involving BCS and reproduction in B. indicus cattle (Nelore cows) have used a BCS scoring system with a scale of 1–5 points (Ayres et al., 2009; Souza et al., 2009; Torres et al., 2014), and have demonstrated that BCS close to breeding is highly associated with reproductive performance. Others reported a positive influence of an adequate BCS on pregnancy outcomes after TAI in suckled beef cows (Sales et al., 2011; Sa Filho et al., 2013). For instance, Nelore cows with low BCS (< 2.75) had lower pregnancy per AI (P/AI) than cows with BCS > 2.75 at breeding (Sa Filho et al., 2010; Sales et al., 2011). Similarly, Nelore cows with BCS of 2.5 had lower P/AI than cows with a BCS of 3.5 (Meneghetti et al., 2009).

At the higher end of BCS, obese females can experience suboptimal reproductive performance (McCann and Reimers, 1986; Kawashima et al., 2008). Thus, it is generally accepted that cows with moderate to good BCS (2.75≤BCS≤4.5) are more likely to be fertile than thin or fat cows. Consequently, optimal pregnancy outcome could be achieved by evaluation of BCS by a well trained technician to determine which females are suitable for entering a TAI program. The inherent subjectivity of visual evaluations and the extra time spent to evaluate BCS, however, impairs widespread use of BCS determinations prior to TAI in large beef cattle operations.

One approach to evaluate body reserves is measurement of rump fat thickness (RFT; Schroder and Staufenbiel, 2006; Ayres et al., 2014). This trait is an accurate indication of subcutaneous fat (Silva et al., 2003) and body energy reserve (Ayres et al., 2009). The RFT is a measure of the accumulation of adipose tissue on both sides of the rump and is highly correlated with BCS (Ayres et al., 2014). Thus, it seems logical to investigate whether angle formed between both sides of the rump is associated with BCS in cows.

The primary objectives of this study were to determine the relationship between the internal angle formed between the left and right sides of the rump (IAR) and visual BCS; and to develop an objective tool for BCS evaluation in beef cows. Accordingly, we sought to determine the rate of agreement between IAR and the visual subjective evaluation of BCS; and whether a device to measure IAR would be useful to select cows for inclusion in TAI programs.

2. Material and methods

The Committee for Ethics in Animal Experimentation at Embrapa approved all experimental procedures described in this manuscript (Protocol F02.2014).

2.1. Experiment 1

Lactating beef cows (*B. indicus*, Nelore; n=801), 3–12 yr of age, maintained under a grazing system (pastures of *Brachiaria brizantha* grass) with *ad libitum* access to mineral salt and water were enrolled in this study. The experiment was conducted in State of Rondônia, Brazil, from June 2012 to March 2014. The descriptions of number of farms enrolled in the experiment and average BCS of cows at time of enrollment are depicted in Table 1.

All animals underwent a BCS evaluation at random stages of lactation. The BCS of each cow was determined, by a single observer (LFMP), using the visual technique developed for Nelore cows (Ayres et al., 2009), which in turn was adapted from a scoring system for dairy cattle (Edmonson et al., 1989). Cows were classified using a 1 (very thin) to 5 (very fat) scale with 0.25-unit increments, as described elsewhere (Ayres et al., 2009). Also, each cow was restrained in a chute to measure IAR. A goniometer was used to measure the angle between the two sides of the rump, as shown in Fig. 1A. The goniometer device was placed on the rump, one rod to each side of the rump, between the sacral bone and the first coccygeal vertebrae. The data for IAR were recorded directly from the goniometer device (Fig. 1A).

Table 1
Descriptive statistics of experiments 1 and 2.

Item	
Experiment 1	
Farms	4
N.of cows in study	801
Mean BCS (1–5 scale)	3.11
Experiment 2	
Farms	2
N. of primiparous cows	147
N. of multiparous cows	282
Mean BCS (1–5 scale)	
Primiparous	2.3
Multiparous	3.0
Number of sires used in TAI	8

2.2. Experiment 2

A device for IAR measurements in cattle was developed and named Vetscore® (Fig. 1B; patent n. BRA1020140049916). The device aims to evaluate BCS in a simple, direct and objective way. Experiment 2 was then designed to validate the use of Vetscore in beef cows. Lactating Nelore cows (n=429) from two commercial beef farms in the State of Rondônia, were used in this experiment, performed from October 2014 to April 2015. Cows were kept in pastures of *Brachiaria brizantha* grass and had *ad libitum* access to minerals and water. The experimental design is described in Fig. 2 and the number of farms, parity, average BCS at Day 0 of the TAI protocol, and number of sires used are shown in Table 1. The TAI protocol was initiated between 30 and 80 days postpartum. At Day 0, cows were given 2 mg of estradiol benzoate (Bioestrogen®, Biogénesis-Bagó, Curitiba, Brazil) i.m. and received an intravaginal progesterone insert (1.9 g progesterone, CIDR®, Pfizer Animal Health, São Paulo, Brazil) to synchronize follicular wave emergence. The CIDR was removed at Day 8 when all cows were treated with 150 µg i.m. of D-Cloprostenol (PGF2α-analogue; Croniben®, Biogénesis-Bagó, Curitiba, Brazil), 1 mg i.m. of estradiol cypionate (E.C.P.®, Pfizer, Cravinhos, Brazil), and 300 IU, i.m., of equine chorionic gonadotrophin (eCG; Novormon®, Syntex, Buenos Aires, Argentina). Timed artificial inseminations were performed 48 ± 2 h after CIDR removal by a single technician within each farm.

Ultrasound examinations were performed at Day 10 to determine the diameter of the pre-ovulatory follicle (POF) and 30 d after TAI for pregnancy diagnosis. Visualization of the embryonic vesicle and detection of the embryonic heartbeat were the positive criteria for pregnancy.

2.3. Definitions

At Day 0, cows were evaluated using the Vetscore® and categorized according to the BCS observed on the device. Vetscore® was used to classify the BCS according to the IAR into three statuses: 1) red (n=144), cows with BCS < 2.75 and IAR < 102°; 2) green (n=278), cows with 2.75≤ BCS ≤4.5 and 102° ≤ IAR ≤124°; and 3) yellow (n=7), cows with BCS > 4.5 and IAR > 124°. The three classes of BCS (< 2.75, 2.75–4.5, and > 4.5) were adopted to classify cows according to the potential benefits on fertility that were reported by previous studies: Nelore cows with BCS < 2.75 had lower P/AI than cows with BCS > 2.75 (Sa Filho et al., 2010; Sales et al., 2011). Thus, such values were considered as representing adequate and inadequate BCS, respectively. Conversely, cows considered obese were of low fertility (Siddiqui et al., 2002; Kawashima et al., 2008). Therefore, cows in the study with BCS