Impact of breed, body score and animal category on the pregnancy rate of bovine females under IATF management

Rosana Dias Campos[1], Otaviano de Souza Pires Neto[2], Carolina Magalhães Caires Carvalho[3], Fernanda Santos Silva Raidan[4], Janderson Tolentino Silveira[5], Igor Dias Soares[6], Abel Martins Lafetá Lírio Brant[7], Alice Ranielly Chaves Santos[8], Bruna Naiara Cardoso[9]

ABSTRACT:

This study evaluate the impact of the reuse of the intravaginal progesterone implant (DIP), the body condition score and the racial composition on the pregnancy rate of Nelore and Angus heifers (F1) and Nelore cows of different categories submitted to different protocols of TAI, from a database of 3,093 females submitted to the same hormonal induction protocol and from the mating season of a commercial farm in the north of Minas Gerais. The racial composition influenced the pregnancy rate of heifers, with rates of 55.11% for Nellore heifers and 64.36% for ½ Angus, showing that the ½ Angus breed has 1.55 times more chances of successful gestation compared to the breed Nellore. There is no effect of the progesterone implant until the third use on the pregnancy rate of the heifers evaluated. The increase of one unit in the body condition score on the scale of 1 to 5 implies 1.9109 or 91.09% times more success in pregnancy. The category of calving cows did not significantly affect the pregnancy rate in the evaluated herd, with pregnancy rates of 58.1%, 62.8%, 77.7% and 62.9% for primiparous, early primiparous, secondary and multiparous, respectively. The introduction of ½ Angus heifers to explore the effects of heterosis and complementarity between breeds is a viable alternative. Cows, when well managed in the postpartum period, obtain pregnancy rates higher than that observed in the national average.

Key Words: Angus. Body score. Gestation rate. Nelore. Progesterone intravaginal device.

[1]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias. Pós Graduação em Produção Animal. Montes Claros, MG. Brasil.
 https://orcid.org/0000-0001-7794-9212

[2]Faculdades Integradas do Norte de Minas. Curso de Medicina Veterinária. Montes Claros, MG. Brasil.
 https://orcid.org/0000-0002-1159-4559

[3]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias. . Montes Claros, MG. Brasil.
 https://orcid.org/0000-0002-3145-0253

[4]Commonwealth Scientific and Industrial Research Organisation (CSIRO) - Brisbane - Austrália.
 https://orcid.org/0000-0002-1919-295X

[5]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias. . Montes Claros, MG. Brasil.
 https://orcid.org/0000-0002-9497-8223

[6]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias, Zootecnista. Montes Claros, MG. Brasil.
 https://orcid.org/0000-0002-1696-4424

[7]Faculdades Integradas do Norte de Minas-Funorte, Médico veterinário. Montes Claros - MG. Brasil.
 https://orcid.org/0000-0002-5902-1370

[8]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias, Discente do curso de Zootecnia. Montes Claros, MG. Brasil.
 https://orcid.org/0000-0003-2870-2517

[9]Universidade Federal de Minas Gerais, Instituto de Ciências Agrárias, Discente do curso de Zootecnia. Montes Claros, MG. Brasil.
 https://orcid.org/0000-0002-9884-1566

*Autor para correspondência: rosanacampos8@yahoo.com.br

Impacto da raça, do escore corporal e da categoria animal na taxa de prenhez de fêmeas bovinas em manejo de IATF

Resumo

Este estudo teve como objetivo estudar o impacto da reutilização do implante intravaginal de progesterona (DIP), do escore de condição corporal e da composição racial na taxa de prenhez de novilhas Nelore e Angus (F1) e vacas Nelore de diferentes categorias submetidas a protocolos de IATF, a partir de um banco de dados de 3.093 fêmeas submetidas ao mesmo protocolo de indução hormonal e oriundos da estação de acasalamento de uma fazenda comercial do Norte de Minas Gerais. A composição racial influenciou a taxa de prenhez das novilhas, com índices de 55,11% para novilhas Nelore e 64,36% para ½ Angus, mostrando que a raça ½ Angus tem 1,55 vezes mais chances no sucesso da gestação comparado a raça Nelore. Não existe efeito do implante de progesterona até o terceiro uso sobre a taxa de prenhez das novilhas avaliadas. O incremento de uma unidade no escore de condição corporal na escala de 1 a 5 implica em 1,9109 ou 91,09% vezes mais de sucesso na gestação. A categoria de vacas paridas não afetou significativamente a taxa de prenhez no rebanho avaliado, com taxas de prenhez de 58,1%, 62,8%, 77,7% e 62,9% para primíparas, primíparas precoces, secundíparas e multíparas, respectivamente. A introdução das novilhas ½ Angus visando explorar os efeitos da heterose e complementaridade entre raças é uma alternativa viável. Vacas quando bem manejadas no pós-parto obtêm taxas de prenhez superiores ao observado na média nacional.

Palavras- Chaves: Angus. Dispositivo intravaginal de Progesterona. Escore corporal. Nelore. Taxa de gestação.

Introduction

It's notable the distinction between nulliparous, multiparous and primiparous with respect to reproductive efficiency in beef cattle production systems. The hormonal release responsible for raising stress levels in the pre and postpartum associated with the presence of the calf, along with the effect between growth and lactation, increases the nutritional requirement and decreases reproductive performance (Pilau; Lobato, 2009), especially for primiparous.

The Nelore breed, known for its adaptability and robustness, is the most numerous racial group raised in Brazilian herds. The crossbreeding between different breeds, such as Angus, allows to explore the effects of heterosis and complementarity of the breeds, which among other benefits can also increase the reproductive efficiency of national cattle herds (Reggiori *et al.*, 2016). Some indices with marked differences between *Bos indicus* and *Bos taurus* are age at puberty, environmental adaptation, response to physiological stress and results of estrus synchronization programs (Vasconcelos et al., 2014).

Thus, to intensify the gain on the herds, it is essential the efficient development, understanding, improvement and use of technologies that contribute to optimize the available labor and increase animal productivity (Baruselli *et al.,* 2018). For example, the Fixed-Time Artificial Insemination (TAI) can be a facilitating mechanism of reproductive management that, when properly performed paying attention to animal physiology, presents itself as a positive artifice, ensuring a greater and more efficient roof planning, births, weaning, and disposal of females (Fontana *et al.*, 2014).

Furthermore, fertility indices of females in the herd can be improved through the use of estrous synchronization protocol. For example, reduction in anestrous period via hormonal stimulation, increase in the number of calves and reduction in age at first covering and calving by inducing puberty of replacement heifers (Santos *et al.*, 2018).

However, it's important to note that, in any production system, the applicability of this methodology is available to help and optimize reproductive rates and not exclusively to correct inefficient management in the production process.

Given the above, the objective of this research was to evaluate the pregnancy rate of different categories of postpartum Nelore cows, Nelore and ½ Angus heifers, and to study the impact of intravaginal progesterone implant (IVP) reuse, body condition score and race composition on the heifers' pregnancy rate.

Material and Methods

The present study was conducted from the evaluation of a database corresponding to the mating season of the period 2018/2019, in a commercial beef cattle farm located in the municipality of Jequitaí, Minas Gerais (MG). The study implementation steps did not need to go through the Ethics Committee on Animal Research, given the character of the study in which there was no effective manipulation of animals, but only the analysis of data previously obtained by the property.

From the original database, the objective was to evaluate the pregnancy rate of 3,093 females of reproductive age, subjected to TAI protocols and maintained under

the same conditions of feed management with *Brachiaria brizantha (cv. Marandu)*, mineral supplementation and water *ad libitum*. As this is a retrospective analysis, only animals with complete information that could be manipulated were used.

It was considered as study material the animal category (nulliparous, primiparous, early primiparous, secundiparous and multiparous), racial composition (Nelore vs Angus (F1)) and body condition score through visual evaluation methodology (being classified on a scale of 1 to 5, where 1= very thin and 5= obese). As a criterion for stratification of the animals to be evaluated, the body condition score was used, including females with scores from 2.25 to 4.

The animals were grouped according to the categories studied: 2280 heifers (Nelore and Angus/Nelore (F1)) with average ages ranging between 36 and 24 months, respectively), and 813 calving and suckling Nelore cows, divided into early primiparous, primiparous, secundiparous and multiparous.

The estrous synchronization protocol started at a random period of the reproductive cycle and a minimum period of 45 days of uterine involution was respected for the group of calving cows. All animals were subjected to the same hormone induction protocol, with a management model of 11 days. On Day zero (D0), 2mg of Estradiol Benzoate was applied intramuscularly and a 1.9g Progesterone intravaginal device of first, second and third use was inserted. On Day 7 (D7), 500 mcg of the luteolytic agent Prostaglandin PGF2α was also applied intramuscularly. On Day 9 (D9), the intravaginal device was removed and 0.5 mg of Estradiol Cypionate and 500 mcg of Prostaglandin PGF2α was administered intramuscularly. On day 11 (D11) insemination of all animals was performed. As shown in Figure 1.

Figure 1 – Schematic representation of the hormone protocol.
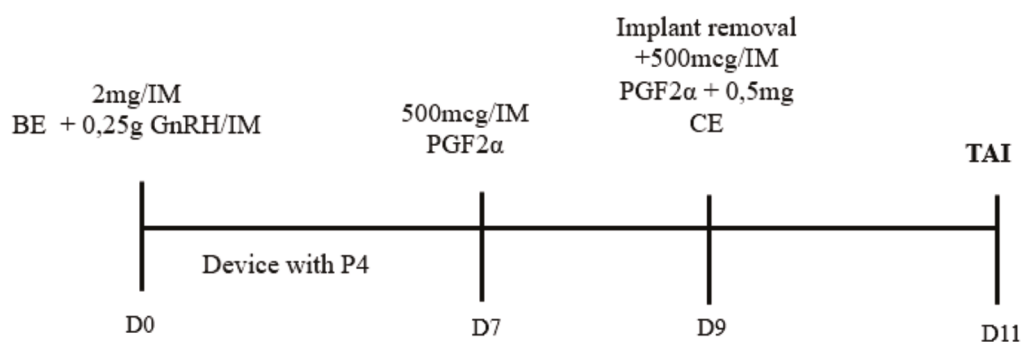
Key:BE: Estradiol Benzoate, Progesterone Implant, PGF2: Prostaglandin, CE: Estradiol Cypionate, IATF: Fixed Time Artificial Insemination.

Source: From the authors, 2020.

Inseminations were performed by trained and experienced inseminators, using random semen from Nelore and Angus bulls. After 35 days of artificial inseminations, gestational diagnosis was performed by transrectal ultrasonography.

The variables considered were: female categories, number of progesterone device uses, body condition score, and breed composition.

Pregnancy rates were grouped into tables and evaluated by the non-parametric method of Chisquare ((χ2) with 5% probability of error.

The response variable of pregnancy diagnosis was assumed for presenting a binomial distribution (P = pregnant; V = empty), being analyzed based on the logistic regression methodology. This analysis can verify the significance of each variable to explain the variation in pregnancy diagnosis, quantify the change in the chance of pregnancy for each unit increase in the regressor variables and use these variables to predict the probability of pregnancy. All analyses were performed using R Studio software, version 3.5.1 (2020).

Results and Discussion

Pregnancy rates according to racial composition are depicted in Figure 2, with rates of 55.11% for Nelore heifers and 64.36% for Angus (F1). The pregnancy rates obtained in this study are favorable at TAI and our results corroborate those observed by Nonato *et al.* (2019) who found pregnancy rates of 45% to 59% in pubertal and pre-pubertal Nelore heifers. Pregnancy rates between 40%

and 60% gestation rate are considered satisfactory when compared to the national average in TAI rograms (Sales *et al.*, 2014; Andrade *et al.*, 2018). Heifers are represented as the group of animals of primary importance in any production system, because they will be the possible replacements cows, so the earlier an animal contribute te the breeding herd, greater the economic impact on the productivity of the livestock sector, because heifers that conceive early will produce more calves and have their life cycle intensified.

Figure 2 – Pregnancy rate of artificially inseminated Angus/Nelore (F1) and Nelore heifers.
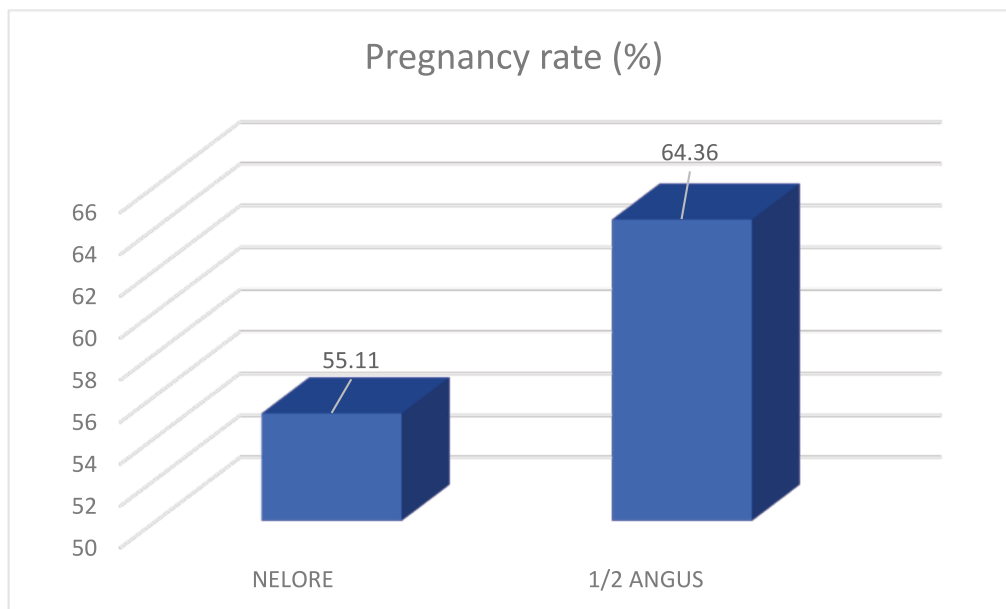
Prepared by the author himself (2020).

Table 1 shows an *odds ratio of* 1.56, indicating that Angus (F1) breeds have 1.56 times more chance of a positive pregnancy when compared to Nelore heifers, probably due to the greater precocity observed in *Bos taurus* cattle. And although zebu animals usually show greater adaptability and rusticity to pasture production systems in tropical regions, the effects of heterosis may have favored sexual precocity in Angus heifers (F1) par-tially explaining the superiority of the pregnancy rate for the F1 animals evaluated in our study (Sartori *et al.*, 2010; Reggiori *et al.*, 2016). In their experiment, Reggiori *et al.* (2016) observed that the reproductive performance of ½ Angus x Nelore crossbred heifers were superior to Nelore females due to the greater sexual precocity observed in *Bos taurus taurus*.

Table 1 – Relationship between pregnancy probability and breed composition (½ Angus breed vs the Nelore breed).

Variable	odds ration	p value
Breed (1/2Angus x Nelore)	1.5587 (55.877%)	p<0.01

Legend: * = *p* Value (< 0.05). ** = *p* Value (< 0.01). *** = *p Value* (< 0.001).

The successful pregnancy rate observed in this experiment, greater than 55%, can be explained by the fact that most heifers are already in puberty at the beginning of the TAI rotocol (Batista *et al.*, 2012) since the inclusion of unproductive females is one of the causes of low efficiency of the TAFI protocol (Gottschall, 2011). Thus, gynecological evaluation prior to synchronization is essential to ensure the success of the technique and avoid losses in the production system. Nutrition also contributes to the pregnancy rates obtained here, the animals were kept on quality feed and with favorable body condition scores when starting the mating season. On the other hand, animals with compromised body condition scores start their puberty later due to the demand of nutrients for their basic functions, placing reproduction as the last parameter to be attended.

Exposed to quality feed zebu heifers reach puberty between 18 and 24 months of age, while taurines under the same conditions begin their reproductive activity between 11 and 15 months. In addition, taurines have larger measures of follicular diameter, which demonstrates their sexual precocity (Lunardelli *et al.*, 2013; Nepomu-ceno, 2013), and the corpus luteum of zebu females has smaller dimensions due to the smaller follicular diameter (Figueiredo *et al.*, 1997).

There is no effect of intravaginal progesterone implant of up to third use on the pregnancy rate of heifers

evaluated (Table 2 and 3), demonstrating that intravaginal progesterone(P4) devices can be reused, allowing the start of the synchronization of the cycle from lower concentrations of this hormone, without reducing conception rates, being a viable and efficient way to perform the TAI Medalha *et al.*, 2015).

Table 2 – Correlation between pregnancy probability and reuse of intravaginal progesterone implantation in the Nelore breed.

Variable	odds ratio	p value
Implants up to 3 uses	1.1786	0.4828

Legend: * = *p* Value (< 0.05). ** = *p Value* (< 0.01). *** = *p Value* (< 0.001).

Table 3 – Relationship between probability of pregnancy and reuse of the intravaginal progesterone implant in the ½ Angus breed.

Variable	odds ratio	p value
Implants up to 3 uses	0.9687	0.853

Legend: * = *p* Value (< 0.05). ** = *p Value* (< 0.01). *** = *p Value* (< 0.001).

The results of this work corroborate those published in the literature on the reuse of heifer progesterone device implants up to 3 times (Carvalho et al., 2019; Santos et al., 2018; Medalha et al., 2015; Gottschall et al., 2012). The use of fourth-use intravaginal progesterone devices is an effective alternative for inducing puberty in heifers, thus, the authors reported a pregnancy rate of 35.14% in this category (Coelho et al. (2021), and in the same In this sense, Figueredo et al., (2019) found a pregnancy rate of 48.18% also in beef heifers and under conditions similar to those observed in this study.

The adequate concentration of P4 present in the CIDR of 1.9 g (Pereira *et al.,* 2018) does not compromise the synchronization of a new follicular growth wave when the device is reused. The reuse of P4 implants is feasible as long as it has a concentration above 1ng/ml (Savio *et al.* 1993). In new devices, on the other hand, P4 values should remain above 2ng/ml until the device is removed in 7 or 9 days (Rathbone, 2012).

According to studies by Muth-Spurlock et al. (2016), the concentration of progesterone in the devices reused for up to two times was 1.5ng/ml, which did not influence the final pregnancy rate of heifers and Angus cows.

Follicles become more responsive to Luteinizing Hormone in the presence of high concentrations of progesterone which consequently improves fertility and final conception rate (Giordano *et al.,* 2013). Thus, when thinking about cost x benefit in TAI the reuse of the 1.9g progesterone intravaginal device becomes a viable procedure, since pregnancy rates are maintained independent of the use of new or reused progestogens. The reduction in production costs, without interference in production performance, means improvement in the efficiency of the system.

Gottschall and Silva (2018) reported a pregnancy rate of 57.6% in beef heifers using third use progesterone devices, a result similar to that found in this study. Gottschall et al. (2009) observed pregnancy rates of 61.1% and 49.7% in Aberdeen Angus cows using intravaginal progesterone devices, of 1st and 2nd use , respectively, showing that the reuse of the progesterone device in the protocol TAI is also effective in lactating cows with calf at foot.

The pregnancy rates and odds ratio obtained by heifers according to body condition score are summarized in Tables 4 and 5. The effect of body condition score on pregnancy diagnosis was evaluated through logistic regression (Table 5). According to odds ratio and corroborating the results shown in Table 4, the increase of one unit in the body condition score of heifers implies in 1,9109 or 91,09% more success in pregnancy.

Other authors reported the importance of body condition on the conception rate in nulliparous, primiparous and multiparous females (Ferreira et al., 2013; Costa et al., 2019; Hartmann; Machado, 2022).

The results of this study are similar to the findings of Alves *et al.* (2022), where they observed pregnancy rates ranging from 50.78% and 39.68% in the first and second IATF in heifers with body score 3 (on a scale of 1 to 5). Costa *et al.* (2019) also achieved a higher pregnancy rate in beef cattle with a score above 3 points, extensively bred in the North of Minas Gerais region.

Therefore, according to Hartmann; Machado (2022) and Martini *et al.* (2022), body scores equal to or greater than 3.1 result in high conception rates in systems that adopt fixed-time artificial insemination as a reproductive method. Demonstrating that nutrition is closely linked to the onset or return of clinical luteal activity in bovines.

Table 4 – Relationship between the probability of pregnancy and the evaluated body scores of Nelore and ½ Angus heifers.

Score	Gestation Rate %.	N	Total inseminated
2.25 a 2.75	58	1009	1739
3.25 a 3.75	60	318	528
4	84	11	13

Table 5 – Correlation between ECC and pregnancy in artificially inseminated Nelore and ½ Angus heifers.

Variable	odds ratio	p value
ECC	1.9109 (91.09%)	0.00168

Legend: * = *p* Value (< 0.05). ** = *p Value* (< 0.01). *** = *p Value* (< 0.001).

Studies by Tarouco *et al.* (2020) indicate that the probability of pregnancy increases when the animal has a body condition score of at least 3 points on a scale of 1 to 5, and that increasing the body condition scale by 0.4 points increased the chances of pregnancy by 25% in cows and heifers. Abreu *et al.* (2018) correlated body condition score with pregnancy rate in Brangus and cross-bred heifers, with scores that ranged from 2.5, 3.0 and 3.5 points on the 1 to 5 scale, and lead to the conclusion that the pregnancy rate was considerably higher when

0.5 (half) unit was added to the body score of these animals, with a pregnancy percentage of 34.7%, 41.3% and 61.3%, respectively, Reinforcing the obtained results in this study. Torres *et al.* (2015) and Vaz and Lobato (2010) also observed a significant correlation between SCC and probability of pregnancy.

The pregnancy rates of Nelore cows submitted to the TAI protocol according to each category are simplified in Table. 6.

Table 6 – Gestation rate of Nelore cows calved and divided according to animal category and inseminated by means of IATF protocols.

Category	Inseminated Animals	Pregnant	Rate %
Primiparous	74	43	58.10
Early Primiparous	35	22	62.85
Secundiparous	18	14	77.77
Multiparous	686	432	62.97
Total	813	511	62.85
p=0.341 p=0.3417			

Legend: * = *p* Value (< 0.05). ** = *p Value* (< 0.01). *** = *p Value* (< 0.001).

The animal category did not significantly affect the pregnancy rate (p=0.3417) in the evaluated herd. In the group of primiparous females, 58.1% or (43/74) females became pregnant, while early primiparous females obtained a pregnancy rate of 62.8% (22/35), while second and multiparous females achieved a pregnancy rate of 77.7% (14/18) and 62.9% (432/686), respectively.

The results presented here corroborate those reported by Silva *et al.*, (2017) who found a pregnancy rate of 61.88% and 61.49% among multiparous and primiparous females, respectively. Usualty primiparous females are less efficient when compared to multiparous and secundiparous females, due to the higher nutritional requirements of this category (Patterson *et al.*, 1992; Medalha *et al.*, 2015). For this reason, the return to cyclic luteal activity of these animals becomes compromised,

which increases the calving interval and service period (Cunha *et al.*, 2013).

Medalha *et al.* (2015) when synchronizing primiparous and multiparous cows, concluded that primiparous cows had lower chances of conceiving compared to multiparous cows. However, Castilho *et al.*, (2018) reported a 55.2% gestation rate in primiparous Red Angus cows calved and submitted to TAI protocols.

Similar results to those observed in this study were reported by Resende *et al.* (2014), who found that early primiparous well-nourished cows can achieve pregnancy rates of 62.79% and that it is financially viable to exploit their genetics to the maximum in rural areas because the pregnancy rate is not lower than that of multiparous or secondary cows. It is believed that

nutritionally well-managed primiparous cows may have gestation results equivalent to those observed in older and experienced cows and that the energy required for their essential functions would be being supplied by the good nutrition offered, not influencing the response to estrous synchronization protocols (Silva *et al.*, 2017) which justifies the rates observed in our study.

The secundiparous achieved a high pregnancy rate among the categories, demonstrating the good potential of these animals, overcoming the conception rate observed by Carvalho (2017) with pregnancy rates close to 70%. The high pregnancy rate was due to the feeding strategy implemented on the property for pre and postpartum.

The postpartum period constitutes as the most critical phase in the reproductive efficiency of an animal and although there is follicular development during the postpartum anestrus, no follicle matures sufficiently to ensure an ovulation, and this occurs due to the intervention in the release of LH due to the impairment in the hypothalamic-pituitary-gonadal axis (Montiel; Ahuja, 2005). This intervention occurs mainly due to low food intake, loss of SCC, lack of proper nutritional management and the presence of the calf that together suppress the release of hormones essential for follicular growth and ovulation, compromising the results of the TAI (Bó *et al.*, 2016). However, these factors, do not seem to interfere with the final gestation rate of the females due to the nutritional management in a strategic way on the farm, causing most of these animals not to lose body condition during the transition period and to be able to perform their genetics to the maximum. Animals that did not conceive during the reproductive season were able to return to cyclicity, increasing the probability of a new conception.

Therefore, the satisfactory pregnancy rate observed in this study was due to the strategic nutritional management instituted in the property in the pre and postpartum period, which caused most cows not to remain in reproductive anestrous due to low weight loss

and SCC and return as soon as possible to cyclic luteal activity, with a total pregnancy rate of 62.8%. Similar result to that obtained by Viana *et al.*, (2015) in farms in Northern Minas Gerais of 62% pregnancy rate.

The pregnancy rate found is above the national average of 50% of pregnancies obtained in IATF programs (Siqueira *et al.* 2008; Gottschall *et al.*, 2009). According to Borges (2008) the acceptable pregnancy rates to the IATF can range from 25 to 70%, and according to Ereno *et al.* (2007) are considered satisfactory pregnancy rates above 50%, because the costs for implementation of the technique, as well as specialized labor and purchase of medicines would not justify the low percentages of pregnancy, however, the results obtained here can be seen as appropriate in programs of IATF.

Conclusion

½ Angus heifers showed greater precocity compared to Nelore heifers. Intravaginal progesterone devices can be reused up to 3 times in pure and crossbred heifers without affecting pregnancy rate at the end of the breeding season. The body condition directly affects the cyclicity and consequently the response to hormone treatment, being observed a higher percentage of pregnancies in nulliparous that were in better body condition. The inclusion of younger cows in the herd becomes feasible in the production system, since the indexes are similar in the different phases.

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Authors contribution

RDC, OSPN,CMCC, FSR - Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - Original Draft; RDC, JTS, IDS, AMLLB - Investigation; ARCS, BNC, Writing - Review & Editing.

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