Strategic feeding supplementation: An alternative for sustainability of beef production in native pastures

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Abstract

The present study aimed to evaluate the effects of a strategic feeding supplementation protocol on reproductive and economic results of exclusively fixed timed artificial inseminated (FTAI) beef cows from a southern Brazilian herd. The experiment was carried out over 2 consecutive breeding seasons (2016 and 2017, from October to January). Two-hundred, 3 and 4 years old, non-suckled, Angus cows (n=100/year), were divided into two homogeneous groups (by weight and body condition score) 25 days before the first FTAI of the breeding season (First FTAI=Day 0). As a representation of traditional management of herds grazing on natural pastures from Rio Grande do Sul Province, Brazil, cows from control group (CG; n=100; 50 cows in each year) received basic mineral supplementation (without protein an energy) ad libitum during the entire experimental period. As an alternative feeding protocol, supplemented group (SG; n=100; 50 in each year) received a mineral supplementation enriched with protein (23%), energy (44% NDT) and sodium monensin (0.25%) ad libitum from days: –25 to 80 of breeding season. Cows were maintained in 2 separated paddocks of native pasture with similar forage composition and availability. All cows were submitted to a progesterone/estradiol-based estrus synchronization protocol on day -10, and cows not pregnant at diagnosis were resynchronized on days 28 and 76 using the same hormonal treatment. There was no year effect (P>0.1) on weight gain and reproductive results, data from both breeding seasons were polled together for further analyzes. Cows from SG presented higher average daily weight gain and gained more weight than cows from CG (p<0.001). Conception rate was higher for SG than CG at the first FTAI cycle (p<0.05). No differences between groups were detected on final pregnancy rates (CG=80% and SG=88%; p>0.1). Cows from SG became pregnant earlier (p<0.01) during the breeding seasons. Also, the feeding supplementation provided an opportunity to increase gross margin. In conclusion, strategic feeding supplementation of beef cows grazing in natural pasture and submitted exclusively to fixed timed artificial insemination increases cows' weight gain, anticipates pregnancies during the breeding season and can increase profit margin when compared to traditional management adopted in southern Brazil.

Introduction

Traditional beef cattle production in southern Brazil, especially in Rio Grande do Sul state, utilizes native pastures as the main feeding resource (Lobato et al., 2014). In this pastoral system, animals can continuously graze year-round on the natural pasture with little or no feed supplementation. Pampa is one of the six officially recognized biomes in Brazil and the largest natural grassland biogeographic unit in South America (Carvalho et al., 2008; 2009). Beef production on natural grasslands is an alternative for sustainable environment preservation. However, historically, cattle farmers have managed the natural grasslands using practices that result in overgrazing, low productivity and low farm income. This scenario stimulates the region's conversion of natural pampas to more profitable activities, such as high technology agriculture, which puts regional cattle production and Pampa biome sustainability at risk (Carvalho, 2011).

Ruviaro et al. (2016), using scenario simulations, concluded that system profitability, based on animal grazing on native grasslands and protein-energetic supplementation, would achieve the best results. The supplementation would allow a higher calf weaning weight and fertility rates at reasonable investment costs. In tropical countries like Brazil, breeding season occurs during the spring and summer (September to March) when there is a greater supply of natural pastures (Ruviaro et al., 2014). Forage production is strongly affected by climatic variations, affecting overall performance, especially reproductive indexes. The minimum use of technology and human interference leads to very low productivity indexes. In 2013, Rio Grande do Sul state registered only 21% average cattle offtake, presenting a calf/cow ratio of 0.56 (SEAPA, 2013). Nevertheless, in Brazil as a whole, little research has been conducted on natural pasture systems to improve the current reproductive indexes.

High reproductive performance is an essential requirement to ensure maximum livestock production and satisfactory economic return (Baruselli et al., 2012). In this context, the incorporation of reproductive programs can optimize reproductive outcomes and profitability. Artificial insemination (AI) promotes genetic and economic gains through the use of superior genetic bulls. Currently, FTAI programs are applied routinely in Brazilian beef herds, providing a systematic approach to the use of AI (Baruselli et al., 2017). For pasture-based systems, high pregnancy rates in the beginning of the breeding season are critical for herd profitability. Cows that become pregnant earlier in the breeding season will calf earlier in the next calving season, and, consequently, will have additional time to recover before the next breeding season.

Reproductive management using exclusively FTAI have been developed using resynchronization programs (Colazo et al., 2007; Pessoa et al., 2018). Recent studies have shown that is possible to obtain better results than natural breeding and estrus detection-based AI (Bo & Baruselli, 2014; Campos et al., 2013). However, studies using only FTAI under natural pasture are limited.

Taking this information into account, the present study aimed to evaluate the effects of a strategic feeding supplementation protocol on reproductive and economic results of exclusively fixed timed artificial inseminated (FTAI) beef cows from a southern Brazilian herd. The primary objective was to determine if the strategic supplementation would allow cows to gain more weight and became pregnant earlier during the breeding season than cows submitted to the traditional feeding system. The secondary objective was to verify if the difference in weight gain would be enough to cover supplementation costs.

Material and Methods

The study was conducted in a commercial beef farm, localized at northwest region (28°35'21.6"S; 55°08'09.1"W) of Rio Grande do Sul state, Brazil. The prevailing climate of the region is humid subtropical according to Köppen's classification. The mean annual temperature varies from 14.3 to 25.2 ºC, with a minimum of 9.7 ºC in August and maximum of 39.9 ºC in January. The mean annual relative air humidity is 73%, and precipitation is 1950.9 mm. All animal handling procedures in these experiments followed general guidelines for animal welfare.

The experiment was carried out over two consecutive breeding seasons (2016 and 2017, from October to January). Two hundred, 3 and 4 years old, non-suckled, Angus cows (n=100/year), were divided into two homogeneous groups (by weight and body condition score) 25 days before the first FTAI of the breeding season (First FTAI=Day 0). Only clinically heathy cows (general and gynecological exam) with body condition score (BCS) of at least 2.5 (1- emaciated; 5- obese) were enrolled in the study. Cows were weighed on days -25, 0, 28 and 76. All cows received the same sanitary protocol for vaccinations and control of endo- and ectoparasites.

Groups of cows were maintained in two separated paddocks (57 hectares each) of native pasture with similar forage composition and availability and submitted to continuous grazing (Table 1). The forage mass was determined by the direct visual estimation method with double sampling (Gardner, 1986). During spring and summer season, samples of grazing simulation were collected, and analyzed for dry matter (DM), mineral matter (MM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) (Van Soest et al., 2018) and extract ether (EE) (Silva & Queiroz, 2002). Analysis of the digestibility of organic matter (OM) was conducted according to Tilley and Terry (1963).

Table 1 – Mean forage mass during spring and summer of the second Year of the study.

Samples	DM (%)	% DM					
		MM	CP	NDF	ADF	EE	OM
Spring (Day = -25)	85,83	10,48	15,81	63,87	30,31	4,86	56,72
Summer (Day = 80)	86,17	7,42	12,17	66,04	33,88	4,29	52,16

Experimental design

As a representation of traditional management of herds grazing on natural pastures from Rio Grande do Sul state, Brazil, cows from control group (CG; n=100; 50 cows in each year) received basic mineral supplement (Table 2) ad libitum during the entire experimental period. As an alternative feeding protocol, supplemented group (SG; n=100; 50 in each year) received a mineral supplementation enriched with protein (23%), energy (44% NDT) and sodium monensin (0.25%) ad libitum from days: –25 to 80 of breeding season. Treatments were available in covered mineral feeders at all times during the experimental feeding period.

Table 2 – Mineral supplements composition used for control (CG) and supplemented groups (SG).

Element	CG	SG
Calcium (min-max)	55-68 g	54-65g
Cobalt (min)	38.9mg	10mg
Copper (min)	---	121mg
Crude Protein (min)	---	230g
Fluor (max)	---	100mg
Iodine (min)	50mg	50mg

Magnesium (min)	2.3mg	4.2g
Manganese (min)	---	180mg
Sodium Monensin (min)	---	250mg
NDT (min)	---	440g
NNP equivalent (min)	---	150g
Phosphorus (min)	45g	10g
Selenium (min)	9mg	5mg
Sodium (min)	152g	55g
Sulfur (min)	---	6g
Zinc (min)	2,520mg	500mg

Total individual consumption was estimated by dividing the total amount (kg) of supplement offered for each group by the number of cows per group. Daily individual consumption was estimated by dividing total individual consumption by the period of supplementation.

Reproductive Management

On day -10, all cows received an intravaginal device containing 1.0 g of progesterone, plus 2.0 mg of estradiol benzoate IM. Eight days later, the device was removed, and cows were given 0.25 mg of cloprostenol sodium IM and 300 IU of equine chorionic gonadotropin IM. At intravaginal device removal, cows received 1 mg of estradiol cypionate IM. Cows were inseminated 48 to 52 h after the progesterone device was removed. Inseminations were performed by one technician, using frozen-thawed semen from one bull each season, previously approved for use in accordance with the Brazilian College of Animal Reproduction (2016).

Twenty-eight days (day=28) after every FTAI, pregnancy diagnosis was performed using transrectal ultrasonography (8 MHZ probe). Detection of an embryonic vesicle with viable embryo (presence of heartbeat) was used as indicator of pregnancy. The conception rate for each FTAI was calculated as the proportion of cows pregnant 28 d after FTAI, divided by the total number of cows inseminated per group. Pregnancy rate was calculated as the proportion of cows pregnant 38 d after the last FTAI of the breeding season, divided by the total number of cows per group.

Data analysis

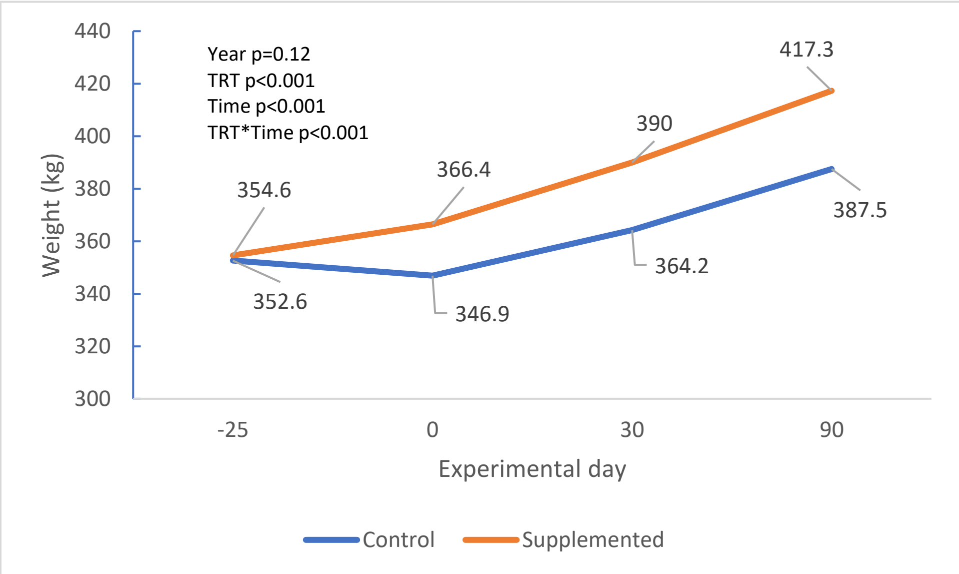
Total weight gain was compared by standard least square including (year nested within treatment). Data are reported as least squares means ± standard error of the mean. Survival analysis using the Kaplan-Meier estimator was performed to calculate cumulative conception rates during the breeding season. Final pregnancy rates were compared by chi-square test. Repeated measures multivariate analysis of variance (MANOVA) was used to examine effects and interactions of treatment and year on changes in weight during experimental period. All analyses were performed using the software JMP Pro14 (SAS Institute Inc., Cary, NC, USA).

For estimation of herd-level economic analysis, all financial values are presented in US dollars (U$), and the following parameters were considered: treatment cost (U$/per kg); total consumption (kg); total weight gain (kg), and regional marked value of replacement heifers (U$/per kg). Marked value gain was estimated as a result of total weight gain multiplied by marked value per kg. Treatment gross margin was estimated as the result of the subtraction of treatment cost from marked value gain according to each group (U$/cow). Treatment costs and replacement heifers value (https://www.scotconsultoria.com.br/cotacoes) were updated on June 10, 2019.

Results

Beef production based on regional native pasture biomes requires cost-effective strategies for its sustainability. The present work compared the effects of a strategic feeding supplementation protocol on reproductive and economic results of exclusively FTAI beef cows from a southern Brazilian herd. Since there was no year effect (P>0.1) on weight gain and reproductive results, data from both breeding seasons were polled together for further analyses. Confirming the experimental hypothesis, there was a significant effect of treatments on individual weight over time (p<0.01), independent of year (p>0.1). During experimental period, cows from SG presented greater total weight gain compared to CG (p>0.01; 62.7±1.1 and 34.9±1.1, respectively; Figure 2).

Figure 2 - Effect of treatments on weight gain during two breeding seasons of fixed timed artificial inseminated (FTAI) beef cows from a southern Brazilian herd.



Conception rate was higher for SG than CG at the first FTAI cycle (p<0.05; Table 3). No differences between groups were detected on final pregnancy rates (CG=80% and SG=88%; p>0.1). Cows from SG became pregnant earlier (p<0.01) during the breeding seasons than CG (Figure 3). Cows from SG consumed approximately 7.4 x more supplement and the total investment required for the strategic feeding supplementation was 12.6x higher than CG (Table 4). Considering only the weight gain variable as an economical return indicator, the strategic feeding protocol resulted in 41.0% increase on gross margin per animal, since cows from SG gained 79.6% more weight than CG cows (Table 4).

Table 3 – Effects of treatments on conception rates per IATF cycle and final pregnancy rates of the two breeding seasons of fixed timed artificial inseminated (FTAI) beef cows from a southern Brazilian herd.

Group	IATF			Pregnancy rate
	1st	2nd	3rd	
Control - % (Preg/IA)	29.0[a] (29/100)	42.3 (30/71)	51.2 (21/41)	80.0 (80/100)
Supplemented - % (Preg/IA)	44.0[b] (44/100)	53.6 (30/56)	53.8 (14/26)	88.0 (88/100)

[a,b]different letters in the same column indicate statically difference (p<0.05).

Figure 3: Effects of treatments on survival curves (p=0.01) for proportion of non-pregnant cows submitted exclusively to FTAI, performed at days 0, 38 and 76 of two breeding seasons.

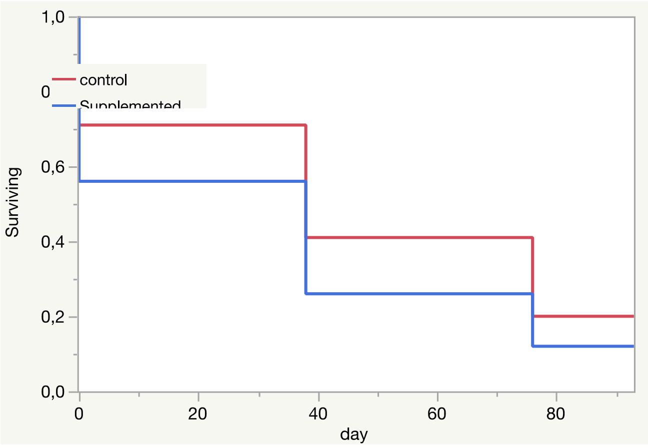


Table 4 – Economic analysis of strategic feeding supplementation of fixed timed artificial inseminated (FTAI) beef cows from a southern Brazilian herd.

	Control	Supplemented
Treatment cost (U$/kg)	0.22	0.38
Total consumption (kg/cow)	7.07	52.02
Average weight gain (kg/cow)	34.9	62.7
investment (U$/cow)	1.55	19.77
Marked value per kg (U$/cow)	1.3	1.3
Marked value gain (U$/cow)	45.37	81.51
Gross Margin (U$/cow)	43.82	61.74

Discussion

In view of the cattle ranching tradition of the state of Rio Grande do Sul, one expects greater productive, reproductive and economic efficiency of this activity. However, present median weaning rate is 62.4% (Lobato et al., 2014; SEAPA, 2019), and 160 cows are needed to produce 100 calves per year. Undernutrition plays a main role in decreasing beef productivity, especially under natural pasture. Energy and protein supplementation can be an auxiliary tool to improve individual animal performance, increase pasture stocking rate, increase total meat production per unit area and improve reproductive efficiency (Mulligan et al., 2001; Lobato et al., 2014). Lack of information about the feasibility and nutritional basis involved in the response to supplementation at different stages of life of animals has hindered adoption of the practice of supplementation on production systems (Hawkins et al., 2000). The present work shows, after two breeding seasons, that cows from SG had enhanced productive, reproductive and economic performance than CG cows.

In general, the genetic potential of animals is not maximized under tropical pasture regime, mainly due to the restriction in energy and protein intake (Fieser et al., 2007; Forero et al., 2019). Here, the SG cows had higher weight gain than the CG ($P < 0.1$). Mulligan et al. (2001) mention that during the hot seasons (spring-summer), it may be convenient to supplement with protein sources of lower ruminal degradability, even for animals grazing fodder with high protein levels. An important discussion related to the energetic-protein-mineral supplementation, emphasizes that it could improve the utilization of the pasture protein. This fact may justify results observed during the present study.

Besides protein and energy, the supplement used in SG during the present study contained sodium monensin. These ionophores have been associated with positive results on beef production for a long time (Rouquette et al., 1980). Monensin fed through a mineral supplement can improve weight gain on pasture-based systems. Also, there is evidence that mineral deficiency correction may interact with monensin in increasing weight gain (Fieser et al., 2007; Forero et al., 2019). The effect of an energy supplement with monensin on CH_4 emissions and performance of stocker calves grazing has recently been suggested (Thompson et al., 2019). The inclusion of ionophores in cattle diets, such as sodium monensin, causes changes in the microbial population and alters the final proportions of volatile fatty acids. In a meta-analysis study, a linear effect of ionophore was observed to improve feed efficiency, reduce dry matter intake and increase daily average gain (Duffield et al., 2012).

The higher conception rates observed here at first FTAI had a positive effect that lasted throughout the entire breeding seasons (Figure 5). The precocious pregnancy will result in early parturitions in the following calving season (Baruselli et al., 2018; 2019). This could lead to remarkable outcomes, since cows and heifers that calve earlier have greater chance to conceive in the following breeding season. It also seems important to highlight that calves born in the beginning of the season are heavier at weaning. These events can positively affect the entire beef production chain (Rodgers et al., 2012; Funston et al., 2012).

Reproductive managements using FTAI and resynchronization programs have the potential to accelerate genetic gain and improve overall productive efficiency (Rodgers et al., 2012). The estimated cost to obtain a pregnancy in managements using FTAI followed by resynchronizations is lower when compared to FTAI followed by natural service (Baruselli et al., 2017). Here, as a management proposal, we used exclusively FTAI for two consecutive breeding seasons and obtained pregnancy rate over 80%. This is a cutting-edge biotechnology tool for beef farms that could, if adequately implemented, help reverse the low reproductive indexes currently observed in the field (Oosthuizen, 2018).

The causes threatening natural grasslands in southern Brazil are very similar for all countries facing the classical global production versus conservation dilemma (Carvalho et al. (2008). Expansion of the agricultural border and overgrazing are frequently cited as the basis of the phenomena. Regarding agricultural expansion, soybean and forestry are the main recent agricultural initiatives threatening natural grasslands. Discussions on the sustainability of different human activities have been highlighted (Robèrt, 2000;), especially with regard to beef cattle production and the impact of this activity on plant-animal dynamics (Dick et al., 2015).

The Pampa biome consists of very old grasslands, covering an area of 178,243 km2 and encompassing the entire country of Uruguay, part of Argentina and about two-thirds of Rio Grande do Sul state in southern Brazil (Overbeck et al., 2007). Cattle grazing native pasture has been suggested as the main conservation tool, as it maintains Pampa biome flora and fauna diversity (Bustamante et al., 2012; Modernel et al., 2013). Historically and presently, from the socioeconomic point of view, low livestock productivity results in minimal returns for local economy, lower population density and regional development (Santos & Trevisan, 2009). A proposed alternative would be considering those farmers as environmental protectors and reward their efforts through monetary compensation (Overbeck et al., 2009). Veysset et al. (2010) point out that French cattle culture calf stage focuses on low fertility mountainous pasture areas, thus being a fundamental activity for regional development, maintaining the landscape and biodiversity level of some of the systems.

Meanwhile, the strategies for increasing production must be economically justified to be adopted by producers. Based on the present data, strategic feeding supplementation provides an opportunity to increase gross margin. First, the difference in weight gain between groups was enough to cover supplementation costs. Although to obtain these results would require an investment almost 13x more (U$1.55 vs U$19.77; Table 4) than for the traditional feeding system, the 41% increase on gross margin per animal (U$43.82 vs U$61.74; Table 4) can justify the adoption of this management during breeding season. Also, the already discussed benefits for anticipation of pregnancy during breeding season further support this notion.

In conclusion, strategic feeding supplementation of beef cows grazing in natural pasture and submitted exclusively to fixed timed artificial insemination increases cows' weight gain, anticipates pregnancies during the breeding season and can increase profit margin when compared to traditional management adopted in southern Brazil. The adoption of this nutritional management option must be conditioned by farmer's productive purposes and linked to the cost-benefit of his practice. It seems important to highlight that more studies aiming to evaluate technologies to optimize the use of available natural resources, increase profit and key production indicators are required to assure production and environmental sustainability.

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