# Effects of concentrate supplementation during summer on animal performance and heat stress of Angus steers grazing native grasslands in Uruguay

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**Keywords:** Native grasslands; cattle supplementation; summer; heat stress.

**Abstract.** Research in temperate grasslands has addressed livestock supplementation (SUPL) mainly during winter, but more studies are needed on the impact of SUPL during summer where heat stress (HS) conditions may occur. The objective of this study was to evaluate the effects of summer SUPL on average daily gain (ADG), respiratory rate (RR), and body temperature (BT) of steers grazing native grasslands (60% TDN, 7.3% CP) in Uruguay (33°14'S, 54°15'W). Eighteen 15-month-old Angus steers (285±11 kg) were randomly assigned to 6 groups (2 treatments x 3 replicates) with free access to shade and water on a continuous stocking system (1.5 steer/ha) for 84 days. Treatments were SUPL and un-supplemented (un-SUPL) cattle. Supplement (77% TDN, 16.8% CP) was delivered 3 days/week at 2.3% BW. Animal breaths per minute (bpm) were registered in 18 days at 09:00 am, 12:00 pm, and 03:00 pm by visual observation and BT was hourly recorded using a subcutaneously implanted logger. The temperature-humidity index (THI) was calculated hourly using air temperature and relative humidity recorded by automatic sensors. According to THI, cattle was in the 'normal' category (THI<74, absence of weather-based HS) during 72% of the time, the rest being exposed to ‘moderate’ (19%) and ‘severe’ (9%) HS. Supplemented steers had greater ($P < 0.05$) ADG than CONT cattle (mean ± s.e.m.: 0.729±0.053 and 0.393±0.169, respectively). Respiration rate was no affected by SUPL ($P > 0.05$), averaging 45±1 (09:00 am), 56±2 (12:00 pm), and 62±3 (03:00 pm) bpm across treatments. Supplementation did not increase daily BT ($P > 0.05$), averaging (±s.e.m.) 38.2±0.1°C across treatments. The greatest BT difference ($P > 0.05$) between groups was observed at 09:00-10:00 am, coincidently with the time of supplementation (SUPL: 39.3±0.1°C; un-SUPL: 38.3±0.1°C). Summer supplementation in native grasslands resulted in better animal performance without affecting animal-based heat stress indices compared to un-supplemented steers.

## Introduction

Supplementation (SUPL) of beef calves grazing native grasslands during their first winter has been previously studied in Uruguay (Rovira and Velazco, 2012). The results showed a positive productive and economic response to winter SUPL. However, there are lack of studies related to the impact of summer SUPL of yearling steers on native grasslands. Animal response to SUPL may vary between winter and summer as climatic conditions, pasture attributes, and animal physiology are different between those seasons. In addition, there is an increasing concern about heat stress (HS) in cattle in temperate regions due to climate change and increased heat susceptibility in high-producing animals (Thornton et al., 2022). Therefore, the objective of this study was to evaluate the effects of summer SUPL on average daily gain (ADG), respiratory rate (RR), and body temperature (BT) of steers grazing native grasslands in Uruguay. The hypothesis was that summer SUPL increases ADG of grazing steers without affecting animal-based HS indices compared to un-supplemented (un-SUPL) steers.

## Methods and Study Site

The experiment was established at the ‘Palo a Pique’ Research Station of the National Institute of Agricultural Research (INIA) in Uruguay (33°14'S, 54°15'W) in a 12-ha area dominated by warm-season grasses. The main species corresponded to *Cynodon dactylon* (bermudagrass), *Axonopus affinis*, *Paspalum notatum*, *Stipa setigera*, and the weed *Eryngium horridum*. The experiment procedure was approved by the Ethical Committee of INIA for the care and use of animals for research. Eighteen 15-

month-old Angus steers (285±11 kg) were randomly assigned to 6 groups (2 treatments x 3 replicates) in a complete randomized block design. Each group had 3 animals in 2 ha (1.5 steers/ha) with free access to artificial shade (4 $m^2$/animal) and water on a continuous stocking system between December 2020 and March 2021 (84 days). Treatments were SUPL and un-SUPL cattle. Supplement (commercial ration: 2.8 Mcal/kg ME;14% CP; 29% neutral detergent fiber) was delivered 3 days/week (Monday, Wednesday, and Friday) on the grazing paddock at a level of 2.3% BW each day corresponding to 1.0% BW on a daily basis. The main ingredients of the supplement were corn and sorghum grain, rice bran and hulls, soybean meal, and a vitamin-mineral premix. The reduction in pasture intake per kg of concentrate (substitution rate, SR) was estimated according to the equations used by CSIRO (2007). Pasture attributes and individual cattle body weight (BW) were recorded every 21 days. Animal breaths per minute (bpm) of 2 animals per group were registered in 9 random days of supplement delivery at 09:00 am, 12:00 pm, and 03:00 pm counting the flank movements for 60 seconds. At the beginning of the experiment, a thermo-logger device (iButton DS1921H-F5#, Maxim Integrated, San José, CA, USA) was inserted subcutaneously in one steer per group following the procedure reported by Lee et al. (2016) to monitor BT at one-hour intervals. Ambient temperature (T) and relative humidity (RH) were recorded by a HOBO data logger (MX23011A, Onset Computer Corporation, Bourne, MA, USA) at one-hour intervals. Then, the temperature-humidity index (THI) was calculated (Thom, 1959) and THI thresholds of potential weather-based HS were normal ≤ 74, moderate 75-78, severe 79-83, and emergency ≥ 84 (NOAA, 1976). The effect of treatments was tested using a generalized linear model analysis with significance set at $P \leq 0.05$. The group of animals and the paddock were considered as the experimental unit for animal and pasture-based variables, respectively.

## Results and Discussion

According to THI values, cattle were exposed to moderate and severe heat stress during 19% and 9% of the time, respectively. Mean ± SD pasture allowance (1.52±0.34 t DM/ha) and sward height (5.4±1.9 cm) were not affected ($P > 0.05$) by supplementation. Forage crude protein (CP) level and total nutrient digestibility (TDN) averaged 7.3±1.2% and 60.2±1.1%, respectively. As a result, the estimated TDN:CP ratio averaged (± SD) 8.5±1.7 (min. 7.4; max. 10.8), suggested that the forage contained a sufficient amount of energy for the available CP of the forage. According to Moore et al. (1999) an NDT:CP ratio >7 indicates nitrogen deficit. Supplementation increased ($P < 0.05$) final BW, average daily gain (ADG), and BW production per ha (Table 1). Providing supplementation to steers grazing grasslands resulted in +0.336 kg/a/day and +44 kg BW/ha more compared with grazing alone. The supplement increased the energy and protein supply to animals and improved the total diet TDN:CP ratio compared to CONT animals. In average, an extra kg of BW was produced for every 10.5 kg of supplement offered to SUPL steers (min. 7.3, max. 16.0). Estimated SR was 0.72 meaning a reduction of 720 grams in pasture intake for each 1 kg of concentrate fed. Research has shown that when high-starch supplements are fed to cattle grazing low quality pastures, forage intake often decreases reducing the energy derived from the pasture (Kunkle et al., 2000).

Table 1. Mean (±SD) body weight (BW), average daily gain (ADG), production per ha, and feed conversion for control (CONT) and supplemented (SUPL) grazing steers.

| | Treatment | |
|---|---|---|
| Variable | CONT | SUPL |
| Initial BW, kg/a | 279±1 | 278±6 |
| Final BW, kg/a | 314±8 | 356±4 |
| ADG, kg/a/day | 0.393±0.169 | 0.729±0.053 |
| BW production, kg/ha | 52±24 | 96±8 |
| Feed conversion[1] | - | 10.5±4.8 |

[1]Ratio of amount of supplement offered to SUPL steers to the additional BW gain above that of CONT steers

Respiration rate was not affected ($P > 0.05$) by SUPL in days with feed delivery (Figure 1A). Mean (±SD) RR was 44±1 (09:00 am), 57±4 (12:00 pm), and 62±6 (03:00 pm) bpm averaged across treatments. However, RR increased significantly at 12:00 pm and 03:00 pm compared to 09:00 am suggesting that time of the day was more important than SUPL to influence the RR of animals. Respiration rate elevation is the first reaction towards heat load shown by cattle (Schmeling et al., 2022), although mean RR values in our study were within the normal range for adult cattle (Silanikove, 2000). Subcutaneous BT was not affected by SUPL (Figure 1B), although the greatest numeric difference ($P > 0.05$) between groups was observed following supplement intake between 09:00 and 10:00 am (SUPL: 39.3±0.1°C; un-SUPL: 38.3±0.1°C). This BT peak could have contributed to the reduction in forage intake that resulted in a high SR.

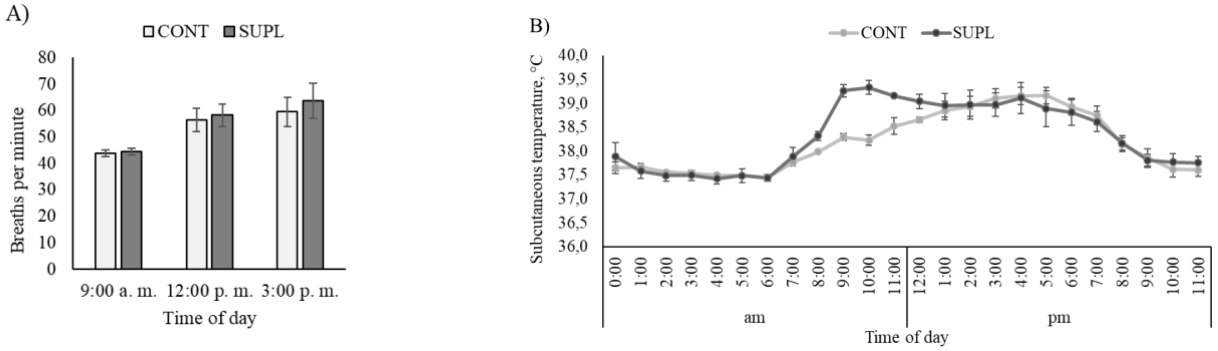


Figure 1. (A) Respiration rate of cattle in the control (CONT) and supplemented (SUPL) groups at 09:00 am, 12:00 pm, and 15:00 pm on days with supplement delivery. (B) Hourly evolution of subcutaneous body temperature on animals in the CONT and SUPL groups.

## Conclusions

Summer supplementation of steers grazing native grasslands with an energetic-protein ration increased animal body weight and average daily gain without increasing the risk of cattle heat stress measured by the respiration rate and body temperature. Supplementation programs can be implemented to accelerate the backgrounding of cattle fed grassland-based diets during summer. However, and according to the feed conversion and substitution rate, animal performance could be improved by adjusting the relationship between pasture, animal, and supplement variables. As a result, future studies should focus on animal stocking rate (as a tool to manage herbage allowance), type of supplement, and/or the daily amount of supplement provided for cattle grazing native pastures during summer.

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