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Heat stress in Beef Cattle

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Presentation Overview

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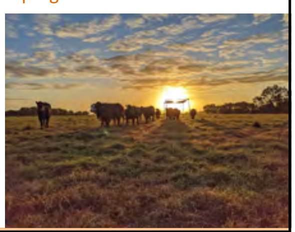
Introduction and current challenges

On-going studies:

- Nutritional strategy for replacement heifers
- Nutrition and management of pregnant heifers
- Pre- and postnatal heat stress mitigation
- Creep-feeding fortification for heat stressed calves



Heat stress – Livestock production

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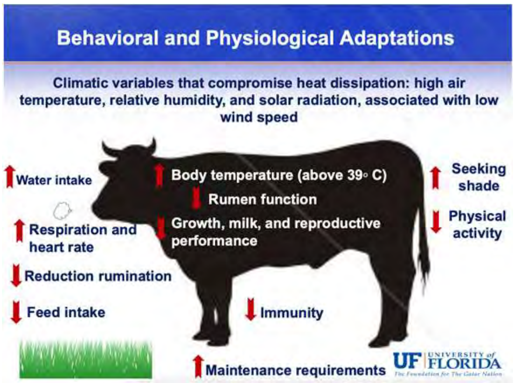
- **Annual losses of $900 million for dairy and $300 million for beef and swine in the U.S.** *(St. Pierre et al., 2003; Pollman, 2010)*
  - **Large constraint to maximizing animal productivity**
  - **Compromises almost every metric of animal agriculture profitability**

Develop strategies (genetic, management, nutritional, and pharmaceutical) to alleviate heat stress and optimize animal well-being, improving the sustainable production of high-quality protein for human consumption.



Slide from Drs. Silva & DiLorenzo – Marianna/NFREC

Gestational heat stress – Dairy Cattle

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- **Reduced fetal growth and birth weight by 9 lb** (Tao et al., 2019)
- **Reduced weaning weights by 18 lb** (Tao et al., 2019)
  - Remained after 1 year of age (Monteiro et al., 2016ab)
- **Reduced calf postnatal body weight, passive immunity**
  - Reduced apparent efficiency of IgG absorption (Tao et al., 2012b)
  - Reduced cellular immunity and proliferation rate of peripheral blood mononuclear (Tao et al., 2012a)
  - Suggestive of underdeveloped immune organs due to maternal in utero heat stress
- **Reduced milk production of dairy heifers by 8 lb/day during first and second lactations** (Laporta et al., 2018)
  - Transgenerational effects reducing milk yield of the dam's granddaughters (Laporta et al., 2020)

Gestational heat stress – Dairy Cattle

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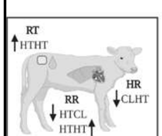
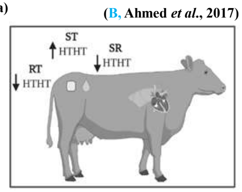
(A, Dado-Senn *et al.*, 2020a)



(B, Ahmed *et al.*, 2017)



Heat stress during late gestation decreased heat tolerance immediately after birth, but increased heat tolerance at maturity by increasing capacity to dissipate heat and maintain core body temperature.

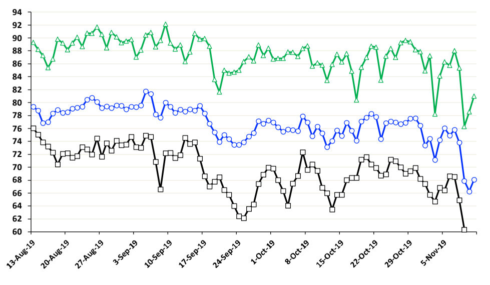
(A) Calves exposed to in-utero heat stress then postnatal heat stress (HTHT) had a higher rectal temperature (RT) and respiration rate (RR). Calves exposed to in-utero cooling then heat stressed postnatally had the lowest heart rate (HR).

(B) Heifers exposed to in-utero heat stress and then heat-stressed during lactation had a lower RT and sweating rate (SR) but a higher skin temperature (ST).

Challenges – Heat Stress in grazing systems

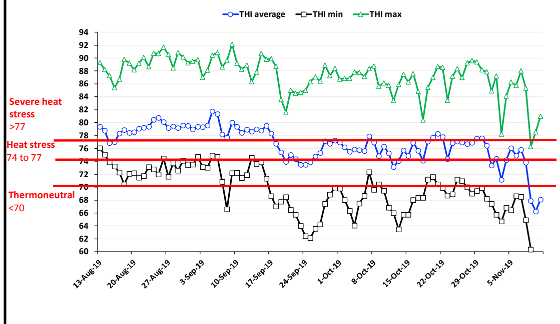
- Limited options to alleviate heat stress compared to feedlot system
- Heat stress effects vary among breeds (Ahmed *et al.*, 2017; Liao *et al.*, 2019)
  - *B. indicus*-influenced cattle display different physiology, metabolism and growth compared to *B. taurus* cattle under similar management (Cooke *et al.*, 2020; Ranches *et al.*, 2021)
- No evidence of impacts of heat stress during gestation on beef progeny performance

Thermal humidity-index (THI) - Ona 2019



NRC (1971): $THI = (1.8 \times T_{environ.} + 32) - [(0.55\text{-}0.0055 \times \text{Relative Humidity}) \times (1.8 \times T_{environ.} - 26)]$.

Thermal humidity-index (THI) - Ona 2019



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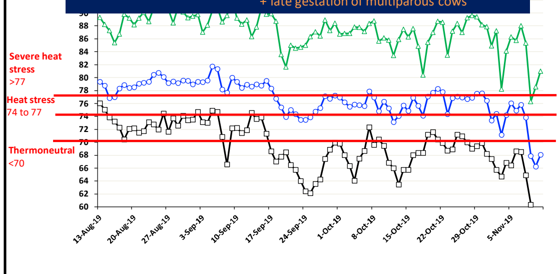
Summary vs. Critical periods in beef cattle production

June to September = Late gestation of first calf cows
July/August = Weaning and shipping of feeder calves
August to November = Developing replacement heifers
+ late gestation of multiparous cows



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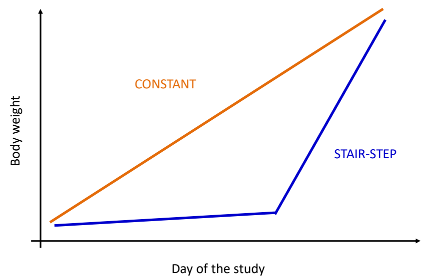
STRATEGIES TO BOOST PUBERTY ATTAINMENT

Stair-step strategy



Boosting reproduction without increasing feed costs of beef heifers in Florida

Funded by Florida Cattlemen Enhancement Board - 2019/2020

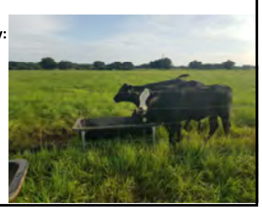
Sep. 2019 to June 2020 (Yr 1) and Sep. 2020 to June 2021 (Yr 2)

- 64 Brangus heifers per year assigned to 16 bahiagrass pastures
- Treatments assigned to pastures (6 pastures/treatment/year):

CONTROL = concentrate supplementation at **1.50% of body weight** from September until the start of the estrous synchronization (November; d 0 to 100)

STAIRSTEP = concentrate supplementation at **1.05% of body weight** from Aug. to Sep. (d 0 to 49) + **1.95% of body weight** until the start of the estrous synchr. (d 50 to 100).

After d 100, all heifers were managed similarly:
AI from d 113 to 115; Timed-AI on d 115
Bulls from d 121-211
Concentrate supp. at 1.50% of BW until d 211

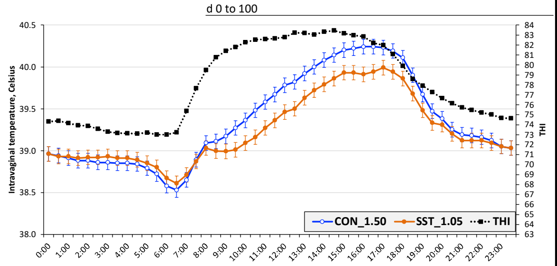


Intravaginal Temperature and Thermal Humidity Index – Yr 1

d 25-31 (Sep 7th to 13th, 2019)

CON = Suppl. 1.50% of BW d 0-100
SST = Suppl. 1.05% of BW d 0-49
Suppl. 1.95% of BW d 50-100

Item	Supplementation strategy CON	SST	SEM	*P-value*
ADG, lb/day				
d 0 to 49	1.39	1.37	0.088	0.87
d 49 to 100				
d 0 to 100				

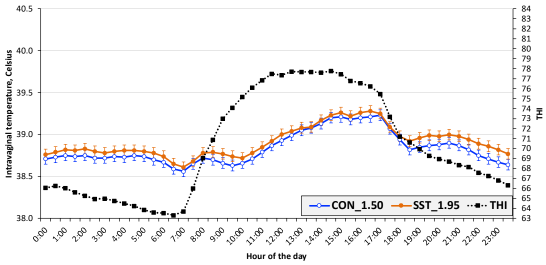


Intravaginal Temperature and Thermal Humidity Index – Yr 1

d 85-91 (Nov 6th to 12th, 2019)

CON = Suppl. 1.50% of BW d 0-100
SST = Suppl. 1.05% of BW d 0-49
Suppl. 1.95% of BW d 50-100

	Supplementation strategy			
Item	**CON**	**SST**	**SEM**	***P-value***
ADG, lb/day				
d 0 to 49	1.39	1.37	0.088	0.87
d 49 to 100	1.23	1.61	0.097	0.01
d 0 to 100	1.30	1.50	0.068	0.07



Growth performance and Supplement DM offered – Yr 1

d 0-100 (Aug 13th to Nov 21th, 2019)

CON = Suppl. 1.50% of BW d 0-100
SST = Suppl. 1.05% of BW d 0-49
Suppl. 1.95% of BW d 50-100

	Supplementation strategy			
Item	**CON**	**SST**	**SEM**	***P-value***
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d 0 to 49	1.39	1.37	0.088	0.87
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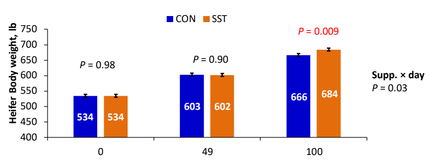
Total supplement DM offered, lb/heifer				
d 0 to 100	892	903	7.7	0.26



Reproductive performance – Yr 1

d 100-211 (Nov 21th, 2019 to Mar 11th, 2020)

CON = Suppl. 1.50% of BW d 0-100
SST = Suppl. 1.05% of BW d 0-49
Suppl. 1.95% of BW d 50-100

	Supplementation strategy			
Item	**CON**	**SST**	**SEM**	***P-value***
Pubertal heifers, % of total				
d 91	**65.6**	**62.4**	8.23	0.79
d 101	**71.9**	**79.3**	8.23	0.54
Reproductive tract score, d 101	**4.37**	**4.52**	0.173	0.58
Heifers in estrus, % of total				
d 101 to 105	**25.0**	**27.6**	7.99	0.82
d 113 to 115	**59.4**	**49.1**	8.35	0.40
Pregnant heifers, % of total				
AI (d 154)	34.4	36.7	8.15	0.85
Final (d 275)	71.9	89.5	6.76	0.07

Reproductive performance – Yr 1

d 100-211 (Nov 21th, 2019 to Mar 11th, 2020)

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Suppl. 1.95% of BW d 50-100

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Stair-step strategy reduced vaginal temperature during heat stress and improved growth and reproductive performance of heifers, without increasing feed costs

Upcoming research studies

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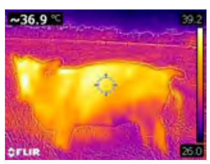
Feed additives and management to alleviate heat stress and promote growth and reproductive performance of beef females in tropical/subtropical environments

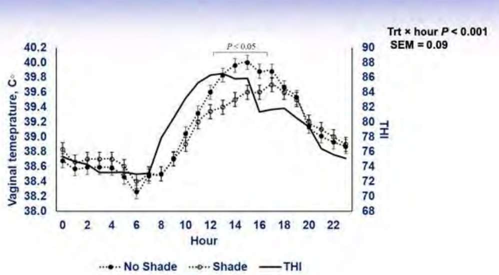


Artificial shade

- **Protect cattle from direct solar radiation exposure using natural or artificial shade** (Rovira and Velazco, 2010)
- **Reduce total heat load by 30-50%, rectal temperatures (38.9 vs. 39.4°C) and respiratory rate (54 vs. 82 breaths/min) compared to a non-shaded environment** (Collier et *al.*, 2006)

Slide from Drs. Silva & DiLorenzo – Marianna/NFREC

Pregnant Brangus heifers provided Shade or no shade for 49 days

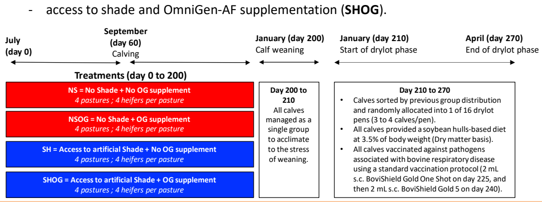


	Shade	No Shade	SEM	P-value
ADG, lb/day	0.44	-0.04	0.154	0.08

Silva et al. (2021) Trans. Anim. Sci.
https://doi.org/10.1093/tas/txab053

Study 1 - Effects pre- and post-partum access to shade and OmniGen-AF supplementation on thermoregulation of Brangus heifers and growth and physiological responses of their offspring

- 64 Brangus, pregnant beef heifers on bahiagrass pastures
- Treatments (July until start of the breeding season):
  - No access to shade and no OmniGen-AF supplementation (**NS**);
  - access to shade but no OmniGen-AF supplementation (**SH**);
  - no access to shade but offered OmniGen-AF supplementation (**NSOG**);
  - access to shade and OmniGen-AF supplementation (**SHOG**).



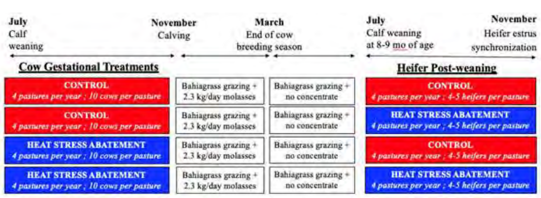
Study 2 – Combining heat stress mitigation strategies during pre- and postnatal phases: Impacts on cow and heifer offspring performance

160 Brangus, pregnant mature beef cows on bahiagrass pastures

Treatments (2 x 2 factorial design): Applied during gestation and then heifer development

(1) No heat abatement (CONTROL) = No access to artificial shade

(2) Heat abatement strategy (HAST) = Unlimited access to artificial shade (40 sq ft per animal)



Study 3 – Improving preweaning nutrition of heat stressed beef calves in Florida

- **May 2022 to July 2022**
- **160 Brangus cow-calf pairs (50% steers ; 50% heifers) will be assigned to 1 of 16 bahiagrass pastures (20 acres and 10 cow-calf pairs per pasture).**
  - 90 days before weaning (day 0)
  - Creep-feeding supplementation of 0.5 lb/day of a protein/energy concentrate (75% TDN and 20% CP) until weaning.
- **Treatments will consist of adding or not a mixture of minerals and feed additives (OmniGen-AF) into creep-feeding supplements for 90 days before weaning.**
- **Calves will be weaned and then assigned to a 45-day period in the feedlot**
  - Vaccinated against pathogens associated with bovine respiratory disease to evaluate the calf immune response to vaccination.

Register at
https://rcrec-nbf.eventbrite.com/

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