Final Technical Reports Cattle Enhancement Board, Inc.

Final Technical Report

FCEB Project #1

FINAL REPORT – FLORIDA CATTLE ENHANCEMENT GRANT

Project Title: Evaluation of new warm-season perennial grass cultivars propagated by seed in Florida (P0233671 – FCEB #1)

Investigators: Joao Vendramini, Lynn Sollenberger, and Philipe Moriel

1. Project Overview

The general objective of this proposal is to evaluate forage production, nutritive value, and persistence of two new seed-propagated warm-season perennial grasses in Florida. Based on our previous research projects, it is our hypothesis that there are two new forage cultivars, propagated by seeds, that can be used as forage for grazing in South and Central Florida. This proposal addresses the FCA Priorities #1 Fertilization, Environmental interaction, refine recommendations for bermudagrass and limpograss varieties; and #3 Pasture and Forage Management, New annual and perennial options for North and South Florida, and Warm season varieties that thrive under low soil fertility.

Treatments were the factorial arrangement of three forage species/cultivars, Spain, Camello, and Jiggs bermudagrass (main plots) and two grazing frequencies (2 or 4-weeks regrowth interval) distributed in a randomized complete block design with four replicates. The 2 weeks regrowth interval had the objective to simulate a continuous grazing, which is expected to challenge the persistence of the plant. The 4 weeks regrowth interval would be the ideal to optimize forage production, nutritive value, and persistence.

Plots were 30 x 15 ft with 5 ft aisle between plots. Plots were mob grazed by beef cows at 7 inches stubble height at the specific regrowth interval. An area of 18 sq ft will be harvested at the center of the plot and used for forage production calculation before each grazing event. Forage samples were analyzed for CP, NDF, in vitro digestible dry matter., and NDF digestibility.

Root and rhizome samples were collected immediately after the last harvest in 2021 using a circular soil core (10.5-cm diam. by 20-cm depth). The root and rhizome mass are important indicators of persistence and the root mass per acre will be determined. In addition, the plots were evaluated for ground cover after the last harvest of 2021.

Data were analyzed by fitting mixed-effects models using the PROC MIXED procedure of SAS (SAS Institute Inc., 1996). Block and its interactions will be considered random effects and months were analyzed as repeated measures. The data were presented as the total forage production in 4 weeks or the sum of 2 harvests at 2 weeks regrowth interval. Treatments were considered different when $P < 0.05$.

Deliverables	Progress
1. Plot establishment and forage production measurements	Thirty-two plots were established, and forage production, light interception, and forage height data collected every 2 or 4 weeks
2. Forage nutritive value analysis	240 samples were analyzed for CP, NDF, ADF, and IVTD. In addition, 64 samples were analyzed for total gas and methane production.
3. Forage persistence and root-rhizome mass	Ground cover, plant frequency, and root-rhizome mass samples were collected at the end of the 2021 growing season
4. Plot preparation for 2022 growing season	Plots were fertilized and sprayed for weeds and maintained during the winter and spring 2022 and samples of forage production and nutritive value were collected from March to July 2022.

Percentage of completion: 100%

2. Project Results

Mombaca and Spain had the greatest herbage accumulation in May and June, followed by Camello, and Jiggs had the least herbage accumulation on those months. Camello had the least herbage accumulation in the remaining months of the grazing season, while Spain, Jiggs, and Mombaca had similar herbage accumulation. Overall, Spain and Mombaca had greater herbage accumulation than Camello and Jiggs. The herbage accumulation decreased in July and August due to frequent rainfall and water standing on the pastures. Plots grazed at 4-weeks interval had 40% greater herbage accumulation than 2-weeks, indicating that a rotational grazing with at least 4-week interval may be required to optimize herbage accumulation of the forage species/cultivars tested in this trial.

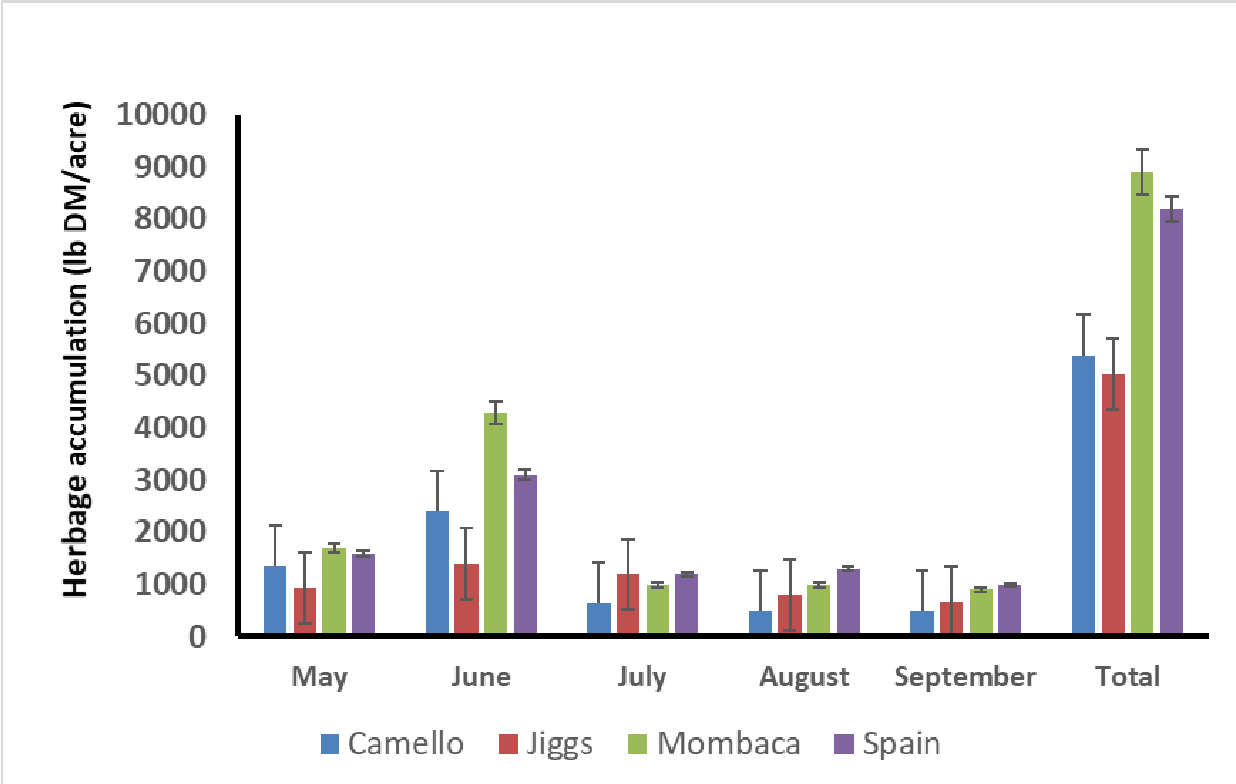


Figure 1. Herbage accumulation of Camello, Jiggs, Mombaca, and Spain grazed at 2- or 4-week regrowth interval in 2021.

Camello had the least CP concentration and there was no difference among Jiggs, Mombaca, and Spain when harvested at 2-wk interval. However, Jiggs had the greatest CP concentration and there was no difference among Camello, Mombaca, and Spain. Crude protein at 2-wk grazing interval was greater than 4-wk for all forage species.

Mombaca and Spain had greater in vitro digestible organic matter than Camello, while Jiggs had the least in vitro digestible organic matter concentration for 2- and 4-k grazing interval. Conversely from the CP concentrations, there were no differences between in vitro digestible. The in vitro digestibility of Mombaca and Spain was above the requirements for lactating mature cows and at the requirements for pregnant 2-year-old beef heifers. The superior digestibility of those species made them very attractive options for cow-calf production enterprises in Florida.

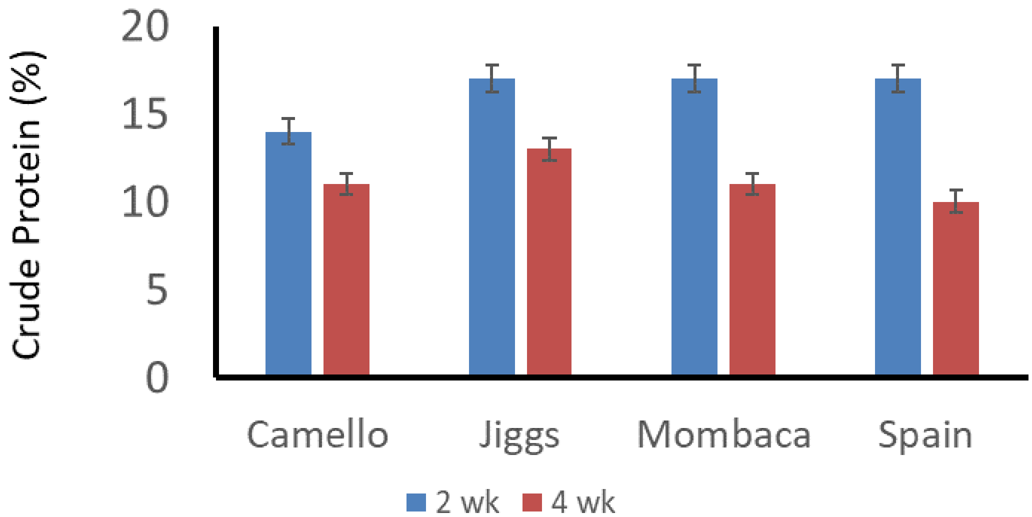


Figure 2. Crude protein concentration of Camello, Jiggs, Mombaca, and Spain grazed at 2- or 4-week regrowth interval in 2021.

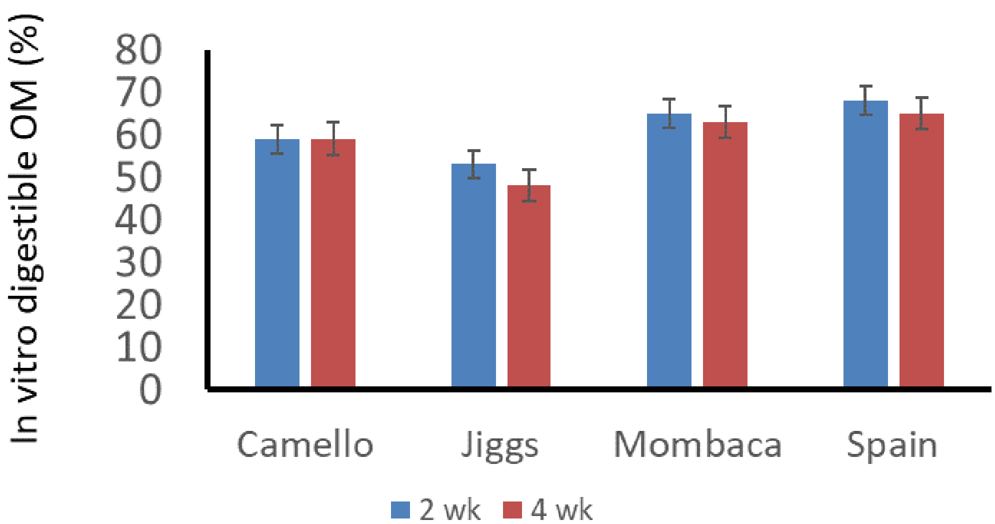


Figure 3. in vitro digestible organic matter concentration of Camello, Jiggs, Mombaca, and Spain grazed at 2- or 4-week regrowth interval in 2021.

There were differences in ground cover after the first year of grazing among species/cultivars. Jiggs and Spain had the greatest ground cover, followed by Mombaca, and Camello had the least ground cover. Considering that there was no effect of grazing frequency on ground cover, it is likely that the persistence of the plots is closely related to tolerance of the species/cultivars to poorly drained soils.

There was a poor correlation between root-rhizome mass and ground cover. Mombaca had the greatest root-rhizome mass, while Jiggs had the least. However, Jiggs had the greatest ground cover at the end of the growing season.

Table 1. Root-rhizome mass and ground cover of Camello, Jiggs, Mombaca, and Spain grazed at 2- or 4-week interval in 2021.

Cultivar	Root-Rhizome Mass (lb DM/acre)	Ground Cover (%)
Camello	9500b	12c
Spain	9280b	56a
Mombaca	12700a	42b
Jiggs	4800c	67a

3. Implications

Camello and Spain had similar or greater forage production and nutritive value to Jiggs bermudagrass; however, Camello should not be planted and grazed in poorly drained soils, frequently found in South Florida.

Spain has superior forage nutritive value and can be a desirable forage choice for growing animals with greater nutrient requirements.

The cultivars/species tested in this trial, except for Camello, were persistent under 2-wk grazing frequency, demonstrating that they are resilient to eventual overgrazing scenarios. However, all species/cultivars had greater herbage accumulation with a 4-wk grazing frequency.

The second year of study will be crucial to evaluate the longer-term production and persistence of these new warm-season grass species and cultivars.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Board Grant
Final Report
August 10, 2022

Utility of Liquid Nitrogen Fertilizer and Soil Surfactants for Smutgrass Control with Hexazinone

Investigators: Brent Sellers and Pratap Devkota

Project # P0233853 (FCEB #2)

Background. Giant smutgrass (*Sporobolus jacquemontii*) is native to tropical Asia but has become a problematic weed in improved and native perennial grass pastures throughout Florida. Control of giant smutgrass can be achieved with 1.0 lb/A (2 qt/A) hexazinone during July, August, and early September when rainfall is sufficient for uptake from the soil solution (Mislevy et al. 2002; Ferrell et al. 2006); however, previous research funded through the FCEB has found that hexazinone activity is typically diminished when <0.25 and >3 inches of rainfall occur within a week of hexazinone application. Therefore, research is needed to determine ways to increase hexazinone activity when rainfall is either limited or excessive.

The use of liquid nitrogen fertilizers as a carrier for herbicides is not new and provides an option for growers to control weeds and fertilize the crop in one-pass (Soltani et al. 2012). Most of the research in this area has been conducted solely with postemergence herbicides, and not with herbicides that are absorbed through the roots. However, preliminary evidence from our program has shown that the use of 32% urea ammonium nitrate (UAN) with hexazinone at 1 qt/A provides smutgrass control at similar levels to 2 qt/A of hexazinone applied in water. While this provides the basis for using UAN as a carrier for hexazinone, applying 50 lb/A of N during extreme rainfall events may not be environmentally friendly. Therefore, it is necessary to determine if lower rates of UAN could be utilized as carrier solution to increase the efficacy of hexazinone.

In recent years, the use of soil surfactants to increase water infiltration or to provide improved herbicide performance by increasing the adsorption of soil residual herbicides in the upper soil profile have become available in the market. Since hexazinone is highly water soluble, extreme rainfall events often result in hexazinone leaching below the smutgrass rootzone ultimately reducing smutgrass control. Therefore, the use of soil surfactants that reportedly reduce herbicide leaching should be investigated.

Approach. ***Using UAN as a carrier for hexazinone.*** Plots were established in smutgrass-infested pastures to validate the appropriate UAN and hexazinone rates near Ona and Marianna, FL. Hexazinone at 1 or 2 qt/A will be mixed in diluted UAN at various rates. Rates of UAN will include 0, 10, 20, 30, 40 and 50 lb N/A. The hexazinone mixture was applied at 30 gallons per acre. These same treatments were applied to smutgrass-free bahiagrass in Ona and Marianna to evaluate crop response.

Smutgrass control was evaluated visually and by recording smutgrass densities at 0, 30, 60, and 365 days after treatment. Smutgrass densities at 30 and 60 days after treatment (DAT) were converted to percent of pretreatment counts for analysis. Bahiagrass was harvested at 30 and 60 DAT, and dry weights recorded after 3 to 4 days in a hot oven to estimate bahiagrass yield. Data were subjected to analysis of variance and means separated using the appropriate non-parametric test.

Effect of soil surfactants on hexazinone activity. Five soil surfactants, including Nanopro, Grounded, Hydrovant, Sorbyx, and Break Thru are under investigation in smutgrass-infested pastures in Ona and Marianna. The surfactants were mixed with either 1 or 2 qt/A hexazinone and applied at 30 gallons per acre. Control plots were treated with hexazinone at 1 or 2 qt/A with no soil surfactant included. Smutgrass control will be evaluated visually and by recording smutgrass densities at 0, 30, 60, and 365 days after treatment. Smutgrass densities at 30, 60, and 365 DAT will be converted to percent of pretreatment counts for analysis. Data will be subjected to analysis of variance and means separated using the appropriate non-parametric test.

A controlled greenhouse experiment will also be conducted. Currently, smutgrass is growing in the greenhouse and will be treated later this fall when smutgrass plants have reached a clump size of approximately 8 inches in diameter, treatments will be applied as described above. Approximately 4 hours after herbicide application, rainfall will be simulated at 0, 0.25, 0.5, 1.0, 2.0, and 4.0 inches. Smutgrass control will be evaluated visually at 15 and 30 DAT, and by removing top growth at 30 and 60 (regrowth) DAT. Biomass will be dried in a hot-air oven for 72 hours and dry weights will be converted to percent of the untreated controls. Data will be subjected to analysis of variance as stated previously.

Results. Due to the timing of these experiments, very limited data are available at this time. However, we saw very little smutgrass response to hexazinone treatments with and without UAN, regardless of rate at either location (Table 1) as control was less than 50% (based on plant densities) at 60 days after treatment. This is likely due to the limited rainfall that has been received at each location following treatment application. Statistically, bahiagrass was not impacted by hexazinone with and without UAN as compared to the untreated check (Table 2). Different results are expected from the July treatment as well as the fall application.

Table 1. Smutgrass control 60 days following the May application of hexazinone with and without 32% UAN at Ona and Marianna, FL.

Hexazinone	UAN	Ona	Marianna
lb/a	lb/a	--------% of initial -------	
0.5	0	0	9
0.5	13	3	25
0.5	25	0	15
0.5	40	0	12
0.5	50	2	12
1.0	0	24	35
1.0	13	15	34
1.0	25	28	28
1.0	40	31	41
1.0	50	29	20
0	0	0	0
p-value	-	0.0656	0.0022

Table 2. Response of bahiagrass 60 days following hexazinone and 32% UAN application. Data represents the cumulative yield of 30 and 60 day after treatment harvests.

Hexazinone	UAN	Ona	Marianna
lb/A	lb/A	---------lb/A -------	
0.5	0	7785	7402
0.5	13	9781	7138
0.5	25	8882	7206
0.5	40	10,180	7074
0.5	50	10,729	6629
1.0	0	6088	4738
1.0	13	7635	6549
1.0	25	7386	5885
1.0	40	8484	5803
1.0	50	9472	6984
0	0	10,380	4970
p-value	-	0.0858	0.7388

Percent Completion: 100%

Literature Cited

Mislevy P, Martin FG, Hall DW. 2002. West Indian dropseed/giant smutgrass (*Sporobolus indicus* var. *pyramidalis*) control in bahiagrass (*Paspalum notatum*) pastures. Weed Technol. 16:707-711.

Ferrell JA, Dusky JA, Mullahey JJ, Roka FM. 2006. Competition of giant smutgrass (*Sporobolus indicus*) in a bahiagrass pasture. Weed Sci. 54:100-105.

Soltani N, Shropshire C, Sikkema PH. 2012. Urea ammonium nitrate as the carrier for herbicides in winter wheat. Am. J. Plant Sci. 3:417-424.

Final Technical Report
FCEB Project #1

Final report August 2022

Project Title: Genomics to Phenomics integration to predict feed efficiency in beef cattle.

Project number: P0233664 (FCEB #3)

Award number: AWD11208

Proponent:

Angela Gonella D; a.gonelladiaza@ufl.edu; (850) 526-1612 (Work) or (850) 693-6465 (cell)

Affiliation: University of Florida – North Florida Research and Education Center

Research team: Nicolas Di Lorenzo (Co-PD/PI), Albert DeVries (Co-PD/PI), Ricardo Chebel (Co-PD/PI), Jose Dubeux (Co-PD/PI), Raluca Mateescu (Co-PD/PI), Mario Binelli (Co-PD/PI), Mark Mauldin (Co-PI).

Collaborators: Florida Bull Test, Deseret Cattle and Citrus, Williamson Cattle company.

1. **Significance:**

High feed efficiency animals have a similar overall performance with lower feed intake, reduced input cost, and increased profitability than feed inefficient animals. Therefore, identifying and selecting animals with high feed efficiency is crucial and a priority for the beef industry. It has been calculated that around 80% of the beef industry's production costs are related to feeding the animals. This means that finding animals that can eat less but produce the same amount of meat as their counterparts can increase the producers' profits and the industry's efficiency. To achieve this goal, determining the feed efficiency of an animal requires collecting individual feed intake and weight gain data at least for 56 days. This expensive and time-consuming procedure requires special recording equipment (Police et al. 2018). Additionally, the hereditability of the feed efficiency is low (around 0.11-0.28; Police et al. 2018, Freely et al. 2020), which means that the individual genome explains only 11% to 28% of the feed efficiency variation. As a result, other pathways and technologies must be explored to identify high-feed efficiency animals.

Omics technologies are high-throughput technologies in which a comprehensive or global assessment of a set of molecules is analyzed. Omics have revolutionized medical and livestock research, as the data they produce is useful as markers of a disease or phenotype of interest (i.e., more fertile animals, animals resistant to high temperatures, etc.) and to give insight into which biological pathways or processes are different between the groups (Goldansaz et al. 2017). Figure 1 shows preliminary data collected by the PI of this proposal aimed to predict feed efficiency using omics technologies. In this case, plasma samples were obtained on animals the day before entering the feed efficiency trial and were used to analyze the plasmatic lipidome. Based on the feed efficiency data collected, animals were classified as High or Low feed efficiency at the end of the feed efficiency trial. The OPL-S analysis shows a clear separation of the High and Low feed efficiency animals according to their lipid profile before the beginning of the test, with components 1+2 explaining the 59% of data variability. These preliminary data are promising by showing that it could be possible to predict which animal will later be classified as efficient using only lipidomic data. Still, we believe that other data sources, such as Genomics and Phenomics, should be included in the model to increase its predictive value. Therefore, this proposal's primary goal is to explore the integration of genomics, metabolomics, and phenomics data to find markers for feed efficiency prediction in beef cattle.

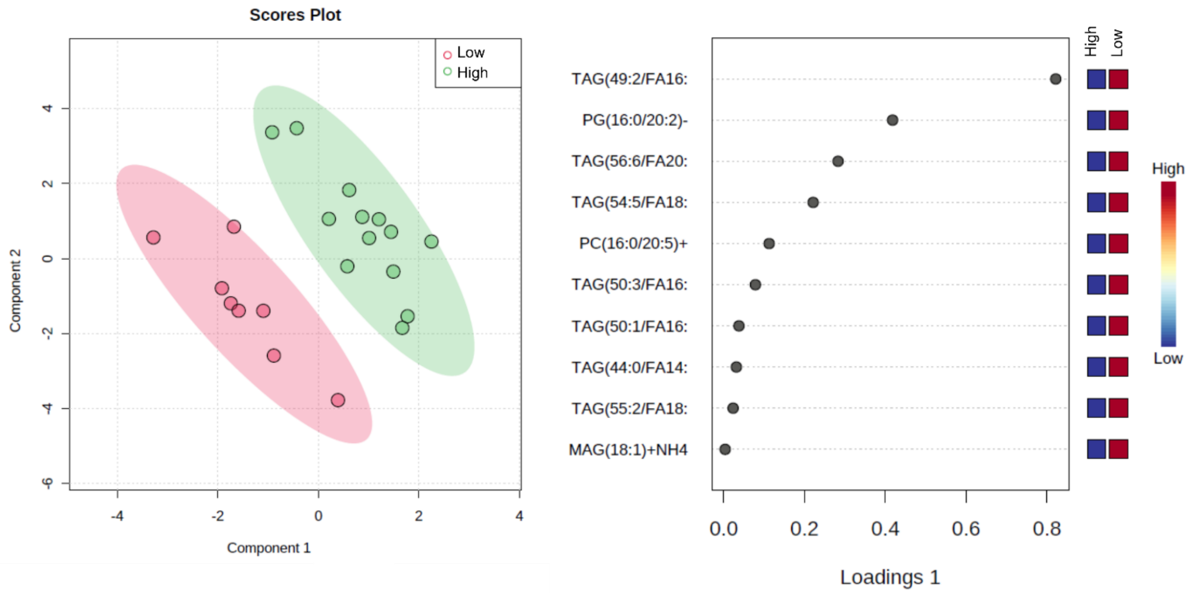


Figure 1: Preliminary data. Left: OPL-S Analysis of plasma lipidomic data in beef heifers. Red Circle: Low feed efficiency animals; Green Circle: High feed efficiency animals. Components 1 + 2 explain 59% of data variability. Right: VIP compounds. This figure shows ten of the lipids that explain the most the separation of Low and High feed efficiency.

2. Objectives:

This proposal explores the integration of genomics, metabolomics, and phenomics data to find markers for feed efficiency prediction in beef cattle. The specific goals are:

- Use available feed efficiency data (average daily gain, gain to feed ratio, and residual feed intake) from the 2021 Florida Bull Test to classify Bulls as high or low feed efficiency.
- Collect blood samples at day zero of the test and evaluate the genome, metabolome, hormonal concentration (Cortisol and Testosterone), and the presence of stable isotopes of Carbon and Nitrogen.
- Collect phenotypic data using automated monitoring devices (locomotion and rumination), ribeye area, semen quality, and feeding behavior.
- Use multivariate statistics to identify molecular and phenotypic markers of feed efficiency and to predict which animals are feed efficiently or inefficiently retrospectively.
- Create machine learning algorithms to predict feed efficiency status retrospectively.

This proposal addresses the FCA Research Priorities <u>#5 (Herd nutrition) and #7 (Bos indicus Genetics)</u> by focusing on the feed efficiency variation across different genotypes and how this variation could be predicted using multi-omics integration.

3. Progress made:

Performance test:

We proposed using animals consigned to the 2021 Florida Bull test program. In addition, Deseret Cattle & Citrus and Williamson Cattle Company allows to include animals of their property consigned at the feed efficiency facility in the experiment. Therefore, samples and data from 320 bulls tested for feed efficiency were collected in 2021-2022.

Upon arrival (Day -14), bulls were weighed and placed in the feed efficiency facility to collect individual intake data. A 14-day acclimation to the diet and facilities preceded a 56-day feeding trial. The daily feed intake was recorded for each bull to determine the average daily gain, gain-to-feed ratio, and residual feed intake or feed efficiency (Figure 2). Bodyweight was collected every two weeks before daily feeding. By the end of the feed efficiency test, animals were ranked according to their RFI and blocked by group and breed. We excluded animals that did not complete the test or were sick or lost weight during the test. Our final population consists of 276 animals.

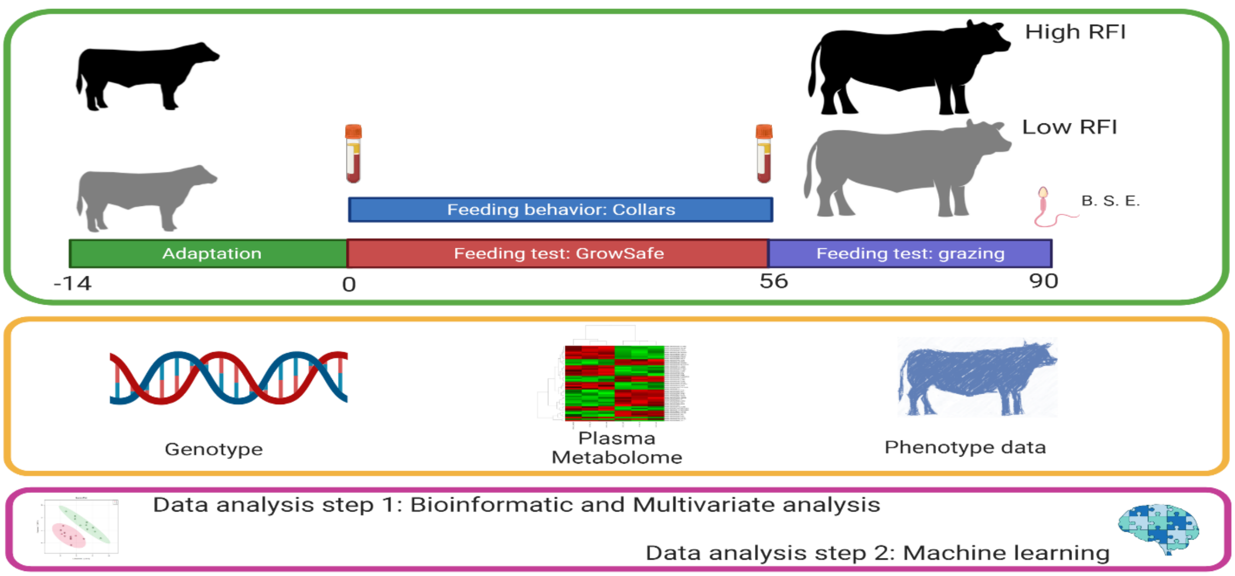


Figure 2: Experimental design of the present study.

Animal Selection:

Table 1 shows the summary of the performance test. Data are presented as average ± standard deviation. On day 0, the initial body weight was 1,223.55 ± 30.45 lbs. After 56 days of the test, the final body weight was 1,498.45 ± 35.56 lbs. The average daily gain (ADG) was 4.53 ± 0.13 lbs and the dry matter intake was 35.71 ± 0.69 lbs. After finishing the performance test, animals were ranked according to their RFI. We chose 60 animals according to their position at the RFI ranking: 30 animals at the bottom (low-RFI; most efficient animals) and 30 animals at the top of the ranking (high-RFI; most inefficient animals). We chose the top and bottom-ranked animals from each consigner (Florida Bull test, Deseret Ranches, and Williamson Cattle company). Performance during the test contrasted when comparing the low and high RFI bulls. High and low RFI bulls presented similar initial (High-RFI: 1,278.88 ± 104.08 lbs.; Low-RFI: 1,263.05 ± 93.66 lbs) and final body weights (High-RFI: 1,558.48 ± 119.17 lbs.; Low-RFI: 1,556.99 ± 108.39 lbs.). Also, there were no significant differences when comparing the average daily gain (High-RFI:

4.72 ± 0.34 lb/d; Low-RFI: 4.94 ± 0.35 lb/d). However, as we expected, high and low-efficient animals presented a contrasting dry matter intake. While high-RFI animals eat 43.24 ± 2.33 lb/d., low-RFI animals eat 30.83 ± 1.36. This means that efficient animals (low-RFI) required 28.70% less feed to achieve similar final body weight than inefficient animals (high-RFI).

Table 1: Summary of the performance test.

	High-RFI n = 30	Low-RFI n = 30	Total n = 276
Initial body weight (Day 0)	1,278.88 ± 104.08	1,263.05 ± 93.66	1,223.55 ± 30.45
Final body weight (Day 56)	1,558.48 ± 119.17	1,556.99 ± 108.39	1,498.45 ± 35.56
Dry Matter intake (lb./d)	43.24 ± 2.33	30.83 ± 1.36	35.71 ± 0.69
Average daily gain (lb./d)	4.72 ± 0.34	4.94 ± 0.35	4.53 ± 0.13

Figure 3 shows two scatter plots created to visualize the result of the performance test. Figures shows the variation of the Dry matter intake (left panel) and the average daily gain (right panel) in regard to the RFI. Top bottom animals (blue) and top high animals (orange) are highlighted in both figures.

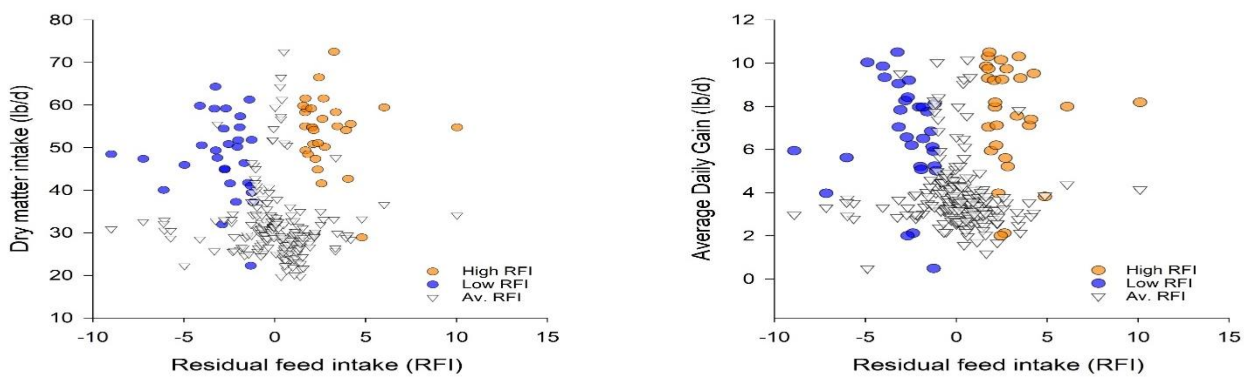


Figure 3: Scatter plot or Residual Feed Intake and dry matter intake (left panel) and average daily gain (right panel). Data was collected after 56 days of a performance test. Animals with high or low RFA were selected, and their samples were submitted for genomics, metabolomics, and transcriptomics analysis.

Genomics Data:

Blood samples were collected from the jugular vein on days 0 and 56 (Figure 2). Plasma aliquots were preserved from each bull for metabolome (commercial platform to quantify 550 compounds), testosterone and cortisol concentration, and stable C and N isotopes analysis. Whole blood samples were used for DNA extraction. Total DNA was extracted with the Qiagen DNA Blood Mini Kit (Cat. No. 51104). Next, samples were shipped to NeoGen corporation for complete genome analysis. Genomic analysis was conducted in all the final groups of animals (n= 276). We completed this genotyping in July of 2022, and we are currently in processing and analyzing the data.

<u>Metabolomics Data:</u>
Plasma samples collected on days 0 and 56 were snap freeze and stored at the – 80°C Ultra Freezer until further analysis. Samples from 60 animals (Days 0 and 56) were submitted for metabolomic analysis. These animals were selected according to their position at the RFI ranking. We chose the top and bottom-ranked animals from each consigner (Florida Bull test, Deseret Ranches, and Williamson Cattle company). Plasma Samples were submitted to the Beaumont Research Institute at the William Beaumont Hospital (Royal Oak, Michigan). All metabolomic analyses were completed in June 2022, and we are currently working on the data analysis.

<u>Carbon and Nitrogen stable isotopes analysis:</u>
Plasma and red blood samples from all the remaining animals in the study (n=276, days 0 and 56) were included. Briefly, samples were lyophilized and submitted to Mass Spectrometry at the Dr. Jose Dubeux Lab. Most of the samples were analyzed. We still need to run the analysis of 80 samples.

<u>Cortisol and testosterone analysis:</u>
Plasma samples (days 0 and 56) from the top and bottom ranked bulls were stored at the -80°C Ultra Freezer. Hormonal concertation was measured with the IMMULITE system. Intra and Inter-assay coefficient of variation was lower than 4.5%. All analyses were finished in June 2022.

<u>Phenomics Data Collection:</u>
Phenomics data was collected from different sources. Data generated by the feed efficiency facility (feeding behavior and individual feed intake on a second-by-second basis) was collected from day 0 to day 56. Also, automated monitoring devices (AMD) were placed in one group of bulls from day 0 to day 56 (Deseret Cattle and Citrus only). The AMD records individuals' rumination, activity, resting, and panting on a minute-by-minute basis.

<u>Data Analysis:</u>
We have already completed all the laboratory analyses of our samples. We are initiating the data analysis.

4. Conclusions

1. Performance test.

Our project was successful in collecting data and samples of animals submitted to feed efficiency test. Later, animals were ranked according to their RFI and animals of the bottom and top of the ranking presented contrasting performance.

2. Laboratory analysis.

Most of the laboratory analysis are finished at this point. On the next few months, we expect to start the data analysis and to construct the prediction model using multivariate statistics.

3. Practical implications.

Because feed prices account for the bigger portion of the production cost, finding animals that eat less but produce the same amount of meat than their counterpart is a goal of our industry. This project aims to use novel technologies (Genomics, metabolomics, phenomics) to identify those animals without the need of a conventional feed efficiency test.

5. Acknowledgments:

The authors are grateful to the North Florida Research and Education Center, especially to the Beef Unit team: Mr. David Thomas, Mr. Mark Foram, Mr. Daniel C. Wood (Cole), Mr. Chad Stephens, Mr. Troy Windham, and Mrs. Olivia H. Helms for their assistance in the performance test and animal handling.

We thank the Florida Bull test committee and cosigners, Deseret Cattle and Citrus, and Williamson cattle company for permitting us to use their bulls in our study.

We thank Dr. Martin Ruiz Moreno, Tessa Schulmeister, and Daniella Heredia for their support in the data collection and laboratory analysis.

We thank all graduate students (Mauro Venturini, Kamryn Joyce, Maria Camila Lopez) and inters (Camila Santos, Georgia Dubeux) of the NFREC-Repro Lab for their assistance with sample collection and laboratory analysis.

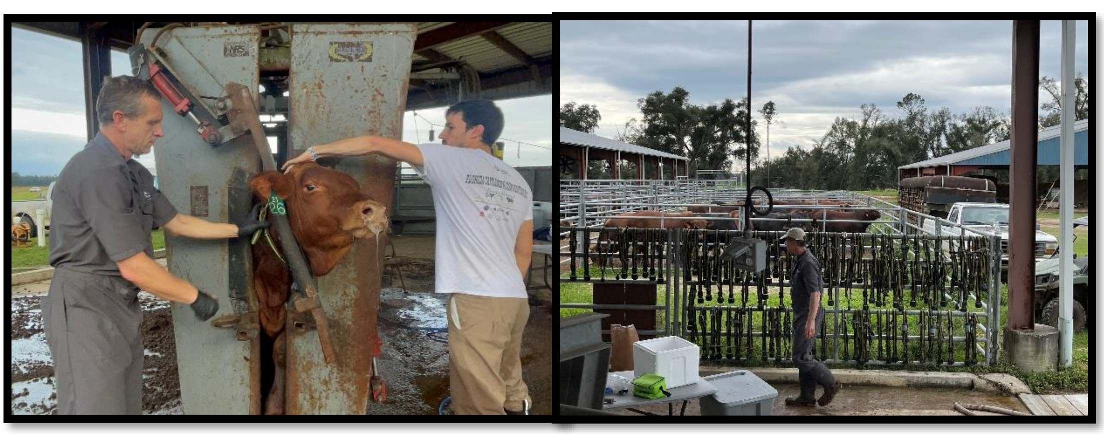
We also thank Federico Tarnonsky and Federico Podversich for their assistance with the AMD collars. Finally, we are indebted to the **Florida Cattleman's Association** and the **Florida Cattle Enhancement Fund** for funding this proposal.

Citations:

1. Goldansaz, SA. Guo, AC. Sajed, T. Steele, MA. Plastow, GS. Wishart, DS. 2017. Livestock metabolomics and the livestock metabolome: A systematic review. PLoS One. 12(5): e0177675.
2. Police, GHG. Grigoletto, L. Carvalho, ME. Rossi Junior, P. Ferraz, JBS. Santana, JHA. 2018. Genetic correlations and heritability estimates for dry matter intake, weight gain, and feed efficiency of Nellore cattle in feedlot. Livestock Sci., 214: 209-210.
3. Freely, HC. Kuehn, LA. Thallman, RM. Snelling, WM. 2020. Heritability and genetic correlations of feed intake, body weight gain, residual gain, and residual feed intake of beef cattle as heifers and cows. J. Anim. Sci., 98 (1): skz394.

Appendix

Appendix 1. Bulls from Deseret Cattle and Citrus during the performance test and wearing the automatic monitoring devices (AMD).



Appendix 2. Left panel: graduate students positioning the AMD in one bull. Right panel: AMD used during this study.

Appendix 3. Plasma sample collection (left) and processing (Right) in the lab.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Board Final Technical Report – August 1, 2022

Project #: P0143791 (FCEB #5)

Title: Selecting New Bahiagrass Varieties for the Florida Cattle Industry

Investigators: Lynn Sollenberger, Marcelo Wallau, Kevin Kenworthy, and Esteban Rios

PI Contact Information: lesollen@ufl.edu; (352) 273-3420

Project Overview:

The Florida beef cattle industry relies on bahiagrass as a major source of nutrients for livestock. Bahiagrass is grown on approximately 2.5 million acres in Florida and is valued for tolerance of grazing, low fertility soils, and a wide range of soil drainage characteristics. Ability to thrive with low-input management makes it a perfect fit for the Florida beef cattle industry. Recent bahiagrass variety releases (Tifton 9, TifQuik, UF Riata) are selections out of Pensacola bahiagrass and are more upright in growth habit. Although they yield more when cut, they are less tolerant of heavy grazing. There is need for variety development focused on use in grazed pasture and based on selections from Argentine bahiagrass. This project evaluated under grazing nine elite Argentine types developed by four UF breeding programs. Our goal was to identify lines that maintain the grazing tolerance of Argentine, improve production during critical spring and fall forage gaps, increase forage nutritive value, and are compatible for use as both forage and sod. This work addressed FCA Research Priority #4, Winter Forages/Legumes – Warm season varieties that thrive under low soil fertility and non-irrigated conditions, and #5, Forage Varieties Under Low Input Systems – Forage "Performance".

Overall Goal and Specific Objectives:

The overall goal of our research program is to develop, screen, and release new bahiagrass varieties for Florida cattlemen. We are specifically targeting bahiagrass types that have the desirable characteristics of current variety Argentine (persistence under grazing and tolerance of low soil fertility), but in addition have greater early- and late-season growth, improved nutritive value during summer, and superior turf characteristics that facilitate use as both forage and turf. Nine elite bahiagrass breeding lines were evaluated and compared with the standard variety Argentine. This screening approach has proven successful in earlier research, as it led to recent release of limpograss (*Hemarthria*) varieties Gibtuck and Kenhy.

The specific objectives of this project were to:

1. Evaluate the seasonal forage production of elite bahiagrass lines for ability to fill critical spring and fall forage gaps relative to the currently-used variety, Argentine bahiagrass.
2. Compare grazing tolerance, competitiveness with weeds, and nutritional value of elite lines of bahiagrass vs. Argentine bahiagrass under stressful and optimal grazing management.

3. Quantify presence of desirable turfgrass characteristics among elite lines of bahiagrass in order to determine their potential for dual purpose use as pasture and sod.

Summary of Activities, Important Findings, and Next Steps:

More than 12,000 bahiagrass plants of the 9 experimental lines and the Argentine control were multiplied in the greenhouse and planted in the field in July 2019. Grazing of the 10 bahiagrasses occurred from May through October 2020 and 2021. Grazing treatments were chosen to apply significant stress (every two weeks to a two-inch stubble) or approach optimal grazing management (every four weeks to a four-inch stubble). In both years, we measured forage yield and nutritive value, percentage soil cover by bahiagrass and weeds, and bahiagrass root biomass and reserve storage.

The main findings of our study are:
1. Two of the nine breeding lines (Hybrids 3 and 93) consistently outyielded Argentine.
2. Forage digestibility and protein favored Argentine over the hybrids, but differences were small.
3. The best of the new lines had fewer weeds after two years than Argentine.
4. Hybrid 93 was consistently more productive than Argentine in Spring and Fall.

Next steps:
Four of the nine lines tested in this project showed either superior early-season growth, greater total forage production, or better persistence under grazing than Argentine. Before recommending any of these lines for release, we need assurance that they produce sufficient seed to meet industry and producer demand and that their performance will be acceptable when soil nutrients are limiting. Thus, these four lines (M98Alt, FPN 1901, Hybrid 3, Hybrid 93) will be evaluated further in comparison with Argentine with the specific goal of determining the one or two lines that are best suited for release to the Florida cattle industry.

Products from the Project:

The link below is a video of the experiment and describes its importance and the methods we used. It can be viewed by cutting and pasting the link below into a browser.
https://www.facebook.com/UFForageTeam/videos/604794916833932/?__tn__=kCH-
R&eid=ARAZ03wr7dHXb7MuM-
W1QeEVVn5QCspLIMDFiS7pJvlMzbYz5ALvdxkWVibmGVfawqyLkPOgkghRqgXe&hc_ref=ARSF-
tr8U0hBh0jVY89RgQel4LHkyyoJ8oYhTuSQbrjaR0GjSIjFBK8v-
_nQ7jgV_nI&fref=nf&__xts__[0]=68.ARC3lMucgZ6IHP7s-
ejWNJTQFg0n9N6Z7lxuufF7eGO0rI39_7aRAonCOEoDGnQ7vJkRuIPrteBfZPRYnMkeJHWhUj3W_Fir0BN6j
X1tt2NiP9yu6UDkLBAenNln6vSJbCGTISMz8xA6113fAi8ujaw5R2CI0Nrkp8ApCmOe5j4WLpohFeQSVo0Lby
qs69lHA01Rex32ZAu4WJkgzf1hHEgxxr0vp5GXYFgCAlcnjZW5oaXBd0paRKDCBpoUKZVu0tRtZ0_CQHcAKm
ZGRcapYili9b_lNHwqY5liq0D32TkBV8OdwfS686R9GNLxmetqffkyJFKf0vXQFYJpSaIhr72rBF1e_g

On the following two pages, we show 1) the Abstract from the M.S. thesis written by student Haley Hayes, whose project was part of this funded research, and 2) the Poster summarizing project results that was presented at the 2022 Florida Cattlemen's Annual Meeting at Marco.

Abstract of Haley Hayes' Thesis

Title: AGRONOMIC PERFORMANCE AND PERSISTENCE OF TETRAPLOID BAHIAGRASS BREEDERS' LINES UNDER DIFFERENT GRAZING MANAGEMENT STRATEGIES

Florida cattle ranchers have relied on bahiagrass (*Paspalum notatum* Flügge), a hardy, warm-season perennial forage, since its introduction in the early 1900s. Several improved cultivars are utilized in the southeastern US for grazing, hay, and sod; with the majority being diploid "Pensacola types". Many producers favor 'Argentine' bahiagrass for its wider leaf blade width and fewer seedheads, but Argentine is slow to initiate production in spring and is less cold tolerant than 'Pensacola'. Due to challenges of breeding apomicts, there is dearth of viable tetraploid "Argentine types" to address limitations of Argentine. This study evaluated nine new tetraploid breeders' lines from multiple UF breeding programs under different grazing managements. Two experiments tested the lines' agronomic performance and persistence compared with Argentine. Lines possessing upright growth habits, Hybrids 3 and 93, outperformed Argentine in forage accumulation. Most entries had comparable nutritive value and visual persistence to Argentine. Entry morphology and physiology were comparable to Argentine with entries M6Alt, FPN 1901, and M98Alt having relatively high ground cover and tiller density, and FPN 1901 and Hybrid 93 having the greatest root-rhizome total nonstructural carbohydrate content. Intensive grazing (5-cm stubble height, two-week grazing interval) produced greater forage accumulation and nutritive value for most entries, while moderate grazing (10-cm stubble height, four-week grazing interval) fostered less weed encroachment and greater bahiagrass ground cover. Seasonality was an important aspect for all agronomic and persistence responses. Two promising entries across both experiments, Hybrid 93 and FPN 1901, are recommended for further evaluation for potential cultivar release.

Selecting New Bahiagrass Varieties for the Florida Cattle Industry

Haley Hayes, Marcelo Wallau, Lynn Sollenberger, Kevin Kenworthy, and Esteban Rios; UF-IFAS Agronomy Department

Background

Bahiagrass is the most important forage for the Florida beef cattle industry.

Bahiagrass breeding programs have focused on "Pensacola types" like UF Riata, TifQuik, and Tifton 9.

"Argentine types" have desirable characteristics but have received less attention.

Objectives

Identify a potential variety with grazing tolerance of Argentine, but with better spring and fall production and nutritive value.

What we did

Entries (10):
Compared Argentine and 9 "Argentine type" breeding lines of bahiagrass developed by Agronomy forage breeders.

Grazing methods (2):
Intensive – every 2 weeks to 2 in.
Moderate – every 4 weeks to 4 in.

Years (2): 2020 and 2021

Location: Beef Unit - Gainesville

What we learned

Two of the nine breeding lines (Hybrids 3 and 93) consistently outyielded Argentine.

Digestibility and protein favored Argentine, but differences were small.

The new lines had fewer weeds after two years than Argentine.

Hybrid 93 was consistently more productive than Argentine in Spring and Fall.

Bahiagrass entry	Yield (lb/acre/year)	Digestibility (%)	Crude protein (%)	Weed frequency (%)
Hybrid 3	7370	50.0	11.3	11
Hybrid 93	8170	50.2	11.8	9
Argentine	5400	51.4	12.5	19

Bahiagrass entry	2020		2021	
	Spring	Fall	Spring	Fall
	- - - - - - - - - - lb/acre	- - - - - - - - - -		
Hybrid 3	1130	580	910	680
Hybrid 93	1340	820	910	1160
Argentine	890	440	360	300

Next steps

Continue evaluating most promising entries under grazing to confirm performance.
Evaluation of seed production of most promising entries to prepare for release.

Final Technical Report

FCEB Project #1

Project Name: Diversifying Forage Options for Beef Cattle Systems in Florida
Project# P0233665 (FCEB #6)
Principal Investigator (PI):

Dr. Esteban Rios, Forage Breeding Program
Agronomy Department, University of Florida
2005 SW 23rd Street, Bldg. 350 Off 5, Gainesville, FL 32608
Email: estebanrios@ufl.edu, Phone: 352-301-2244

Co-PIs: Kenneth Quesenberry, Kevin Kenworthy and Marcelo Wallau

Specific Aims addressing the priority to develop new annual and perennial options for North and South Florida.
1. Seed increases for advanced legume breeding lines: alfalfa, white, red and crimson clover.
2. Application of remote sensing in the development of high-quality alfalfa adapted to Florida.
3. Developing novel annual ryegrass cultivars using genomic resources.
4. Breeding warm-season legumes adapted to Florida flatwood soils.
5. Dissemination of planting material for Newell bermudagrass.

Aim 1 - Seed increases for advanced legume breeding lines. Percent completion 90% (*crimson clover seed will be harvested the last week of August in Pullman, WA).

Anticipated Outputs:

Seed increase trials were established in Fall 2021 at the Agronomy Forage Research Unit, Hague, Florida for red clover and crimson clover. Plants started to flower in late February and seed was harvested in April 2022. These new populations will be used for variety trials for the 2022-2023 cool-season trials.

Seed increases for a white clover breeding line is being conducted in the Forage Breeding and Genetics greenhouse, Gainesville, Florida. This is the multi-leaf white clover population and seed was harvested in May. These new populations will be used for variety trials for the 2022-2023 cool-season trials.

Seed increases for the new crimson clover cultivar UF_CC17 is being produced in Pullman, Washington. Seed will be harvested during summer in Pullman, Washington, and the seed will be used for variety trials for the 2022-2023 cool-season trials.

Aim 2 – Application of remote sensing in the development of alfalfa adapted to Florida. Percent completion 100%

Anticipated Outputs:

1 – Prediction equations were developed to model alfalfa yield and quality using drones.

2 – Several new alfalfa breeding lines have been selected for improved yield and nutritive value.

3 – We established a protocols to implement high-throughput phenotyping using remote sensing in forage breeding, and the results have been published in a peer-reviewed journal: https://www.frontiersin.org/articles/10.3389/fpls.2021.756768/full

4 – Trained a graduate student on novel methods in plant breeding: Anju Biswas is expected to complete her PhD degree in December 2022. She is writing her dissertation on alfalfa breeding.

Aim 3 – Developing novel annual ryegrass cultivars using genomic resources. Percent completion 90%

Anticipated Outputs:

1 – Pablo Sipowicz is a new PhD student with Dr. Rios. Pablo presented a poster titled Genetic Diversity in Wild and Cultivated Annual Ryegrass during the 2021 Crop Science Society meeting and received 2nd place for best poster. Pablo showed that genetic diversity in cultivated ryegrass is narrow and there is a need to introgress novel genetic diversity from wild and landrace populations.

2 – Pablo is working on developing advanced annual ryegrass breeding lines with improved yield, nutritive value and disease resistance. New trials will be established in Fall 2022.

3 – Pablo is being mentored and trained on novel methods in forage breeding.

Aim 4 – Breeding warm-season legumes adapted to Florida flatwood soils. Percent completion 70%

Anticipated Outputs:

A field trial is being conducted at the Agronomy Forage Research Unit, Hague, Florida to screen warm-season legumes. Four species were included in the study: Aeschynomene (7 breeding lines), hairy indigo (4 breeding lines), carpon desmodium (2 breeding lines) and alyce clover (2 breeding lines). Yield data will collected in August 2022, and seed will be harvested in October 2022.

Aim 5 – Dissemination of planting material for Newell bermudagrass. Percent completion 90%

Expected Outputs:

We started the increase in acreage of planting material with cultivar Newell among beef cattle producers. Several acres of Newell were planted in FL farms, and we are also increasing planting material at the Agronomy Forage Research Unit, Hague, Florida, and the Beef Research Unit, Gainesville, Florida. We will continue with the dissemination of planting material in late summer 2022.

Final Technical Report

FCEB Project #1

FINAL REPORT – FLORIDA CATTLE ENHANCEMENT GRANT

Project Title: Project Title: Refining phosphorus fertilization recommendations for limpograss in South Florida (P0233670 – FCEB #9)

Investigators: Joao Vendramini and Maria Silveira

1. Project Overview

The general objective of this proposal is to evaluate forage production, nutritive value, and persistence of two limpograss cultivars to different levels of phosphorus fertilization. In addition, we aimed to evaluate the impacts of these P fertilization levels on water P concentration. Our hypothesis is that Gibtuck has greater forage production than Floralta and the P fertilization levels may have to be adjusted accordingly. In addition, it is our hypothesis that the P fertilization levels recommended by IFAS do not impact water quality. This proposal addresses the FCA Priorities #1 Fertilization, Environmental interaction, refine recommendations for bermudagrass and limpograss varieties; #3 Pasture and Forage Management, warm season varieties that thrive under low soil fertility.

Two experiments were conducted at the Range Cattle Research and Education Center, Ona, FL, in 2022 and 2023.

Plot study

Treatments were the split plot arrangement of two limpograss cultivars, Floralta and Gibtuck, and three P_2O_5 fertilization levels, 0, 20, and 40 lb/acre, distributed in a randomized complete block design with four replicates.

An established area with Floralta and Gibtuck with low soil P concentration levels were used. Plots were 0.2 acres with 5 ft aisle between plots. Plots were harvested every 8 weeks, 4 times during the grazing season. An area of 50 sq ft were harvested at the center of the plot and used for forage production, nutritive value, and tissue P concentration.

Root and rhizome samples will be collected immediately after the last harvest in 2022 using a circular soil core (10.5-cm diam. by 20-cm depth). The root and rhizome mass are important indicators of persistence and the root mass per acre were determined. In addition, the plots will be evaluated for ground cover after the last harvest of 2022.

Ten soil core samples were taken from the Ap (0- to 15-cm) and Bh (60- to 75-cm) horizons from each experimental unit before the initiation of the study and at the termination of the study in 2022. Soil samples will be analyzed for Mehlich-3, soil test P, and water extractable

P. Lysimeters were placed at 3 depths for periodical water sampling during the experimental period in two replicates of each treatment.

Greenhouse study

The objective of the greenhouse study were to determine the minimum P tissue concentration in limpograss plants.

The study was conducted at the University of Florida Range Cattle Research and Education Center, Ona, FL under greenhouse conditions from July to December 2021 and 2022. New plants were established each year. The "E" horizon of a Pomona sand soil was collected and used as a growing medium.

Treatments were the factorial arrangement of three N fertilization levels (0, 60, and 120 lb N/acre/harvest), three P_2O 5 fertilization levels (0, 20, and 40 lb P_2O5/acre/harvest), and two limpograss cultivars (Floralta and Gibtuck). distributed in a complete randomized design with four replicates.

Pots designed to grow tree seedlings (3.9-inch diameter x 16.1-inch height) were used and filled with approximately 22 lb of soil. All pots received the equivalent of 60 lb K_2Oacre/harvest and 1.8 lb/acre/harvest of micronutrients (F503G micromix).

Limpograss plants were grown in propagation trays and transplanted into pots 3 wk after shoot emergence. Forage was clipped with 8 weeks regrowth interval, 4 consecutive times, 7-inch stubble height for forage production and tissue P determination. Fertilizer treatments were re-applied after every harvest.

At termination of the study, pots were destructively sampled for root-rhizome mass determination. Roots and rhizomes from the entire pot were separated from the soil by washing with water over a standard window screen (~1-mm mesh) and root-rhizome mass and root-rhizome P concentration were reported.

The data were analyzed by fitting mixed-effects models using the PROC MIXED procedure of SAS (SAS Institute Inc., 1996). In the plot study, P fertilization and harvest were considered fixed effects and blocks random effect. Treatments were considered different when $P \leq 0.05$. Single degree of freedom orthogonal polynomial contrasts were used to test the P fertilization effects and were considered significant at $P \leq 0.05$. in the greenhouse study, N and P fertilization were fixed effects and replicates and year random effects. Treatments were considered different when $P \leq 0.05$. Single degree of freedom orthogonal polynomial contrasts were used to test the P fertilization effects and were considered significant at $P \leq 0.05$. The correlation between HA and tissue P concentration was analyzed using the PROC NLIN procedure of SAS (SAS Institute Inc., 1996).

Deliverables	Progress
1. Plot establishment and forage production measurements	The experimental area was established, fenced, and 3 harvests were conducted to measure forage production
2. Equipment installation in the experimental area	The water collection wells were installed in 12 plots and the pressure transducer installed to measure the fluctuation of the water table.
3. Water and tissue P concentration	96 plant tissue samples and 83 water samples were analyzed for P concentration
4. Greenhouse establishment and data collection	72 pots were established with limpograss in the greenhouse, the data collected for forage production, and 144 samples analyzed for tissue P concentration. The last harvest will be analyzed in August 2022.

Percentage of completion: 100%

2. Project Results

There was no effect of P fertilization on forage production. The average forage production across P fertilization treatments were 2,600 lb DM/acre. However, Gibtuck had greater forage production than Floralta (2,900 vs. 2,400 lb DM/acre). In addition, there were differences in forage production across different harvests (Figure 1). The variation occurred primarily due to rainfall during the experimental period.

There were P fertilization level effects on tissue P concentration. Tissue P concentration increased linearly with increasing levels of P fertilizer (Figure 2); however, there was no effect of cultivar on tissue P concentration. In addition, there was no effect of P fertilization level or cultivar on tissue N concentration (mean = 1.85%).

There was no effect of P fertilization levels or cultivar on leachate P concentration (mean = 0.13 mg/kg). The experimental area has poorly drained soils and the water table is usually close to the surface during the summer; however, the rainfall during the experimental period was below average and the water table on the experimental units stayed significantly below the soil surface (Figure 3).

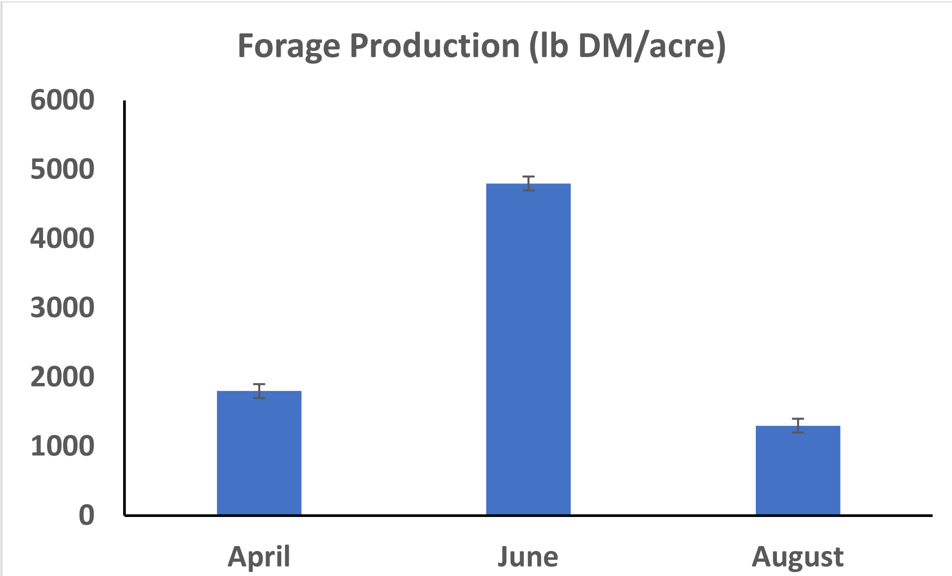


Figure 1. Forage production of Gibtuck and Floralta limpograss fertilized with different levels of P from April to August 2022.

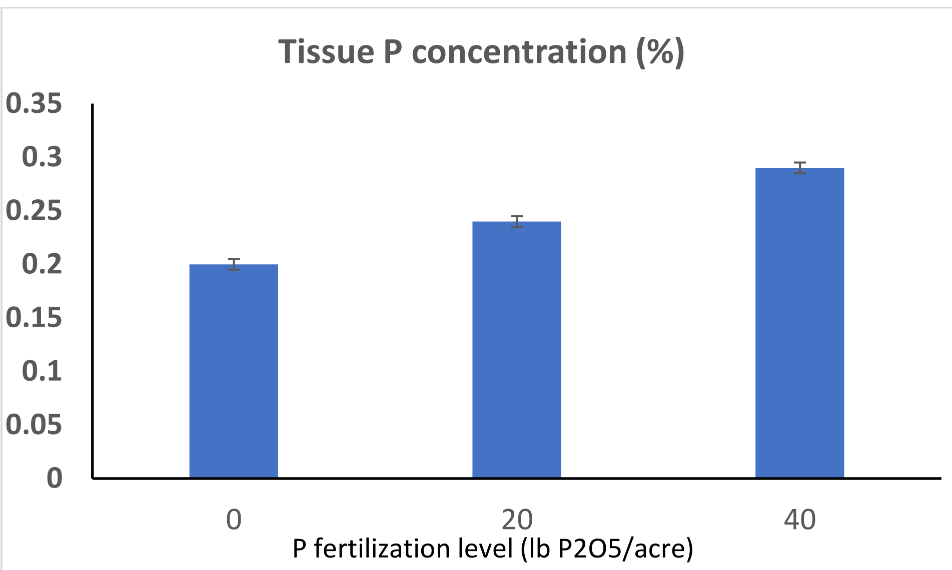


Figure 2. Forage production of Gibtuck and Floralta limpograss fertilized with different levels of P from April to August 2022.

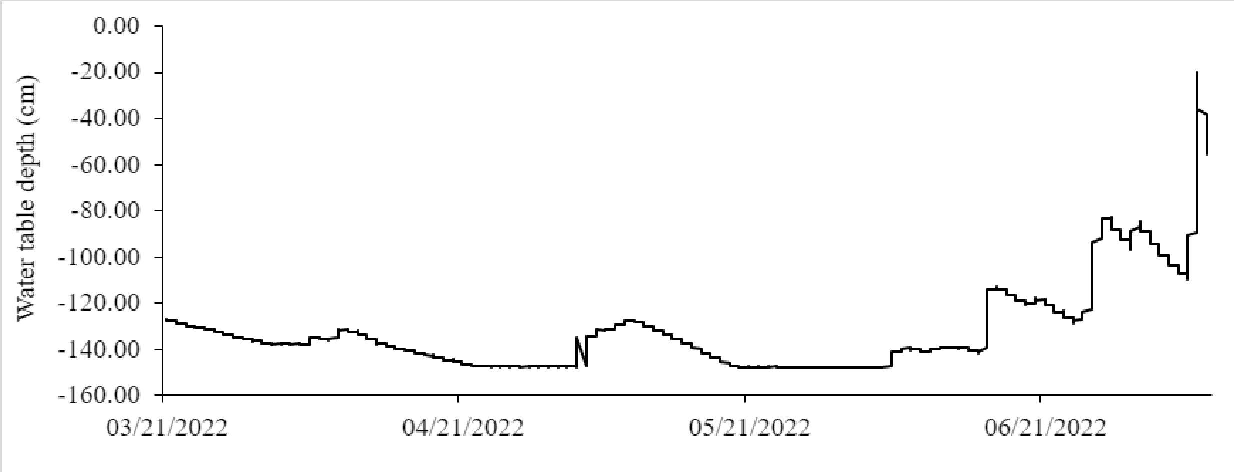


Figure 3. Water table fluctuation during the experimental period.

In the greenhouse, there were no differences in forage production, tissue P and N concentrations between cultivars. However, there was an increase in forage production with P fertilization levels from 0 to 20 lb P_2O_5/acre and no difference from 20 to 40 lb P_2O_5/acre (Table 1). In addition, N fertilization levels from 0 to 60 and 120 lb N/acre increased forage production (Table 1).

Tissue P concentration increased with greater P fertilization levels and decreased with greater N fertilization levels. In addition, tissue N concentration decreased with greater P fertilization and increased with greater N fertilization levels. The decrease in tissue P and N concentrations are primarily due to increase in forage production and dilution effect.

Table 1. Forage production, tissue P and N concentration levels in Gibtuck and Floralta limpograss in the greenhouse study.

	P fertilization level (lb P_2O_5/acre)			N fertilization level (lb N/acre)		
	0	20	40	0	60	120
Forage production (g DM/pot)	7.2b	11.1a	10.9a	7.7b	11.0a	11.9a
Tissue P concentration (%)	0.17b	0.29a	0.31a	0.29a	0.23b	0.22b
Tissue N concentration (%)	1.9a	1.5b	1.5b	1.2b	1.7a	1.9a

3. Implications

The P fertilization levels tested in the field study had no impact on forage production and water quality; however, forage receiving no P fertilization had reduced levels of tissue P concentration. Although the soil at the experimental area has low P concentration, there is P in subsurface from the soil parental material, and it may have been uptake by the plants and maintained the forage production. Conversely, limpograss receiving no P fertilization in the greenhouse study had lesser forage production than 20 and 40 lb P_2O_5/acre, likely because there are no other sources of P supplied to the plants. The tissue P concentration in the limpograss receiving no P fertilization was 0.17%, which is close to critical tissue P concentration observed for other warm-season grasses. The experiment will be repeated in 2023 and we expect to find the critical tissue P concentration that limits limpograss production.

Gibtuck had greater forage production than Floralta and greater P soil extraction (forage production x tissue P concentration); however, it is likely that the subsurface soil P concentration may be able to supply the additional P to the plants for a limited timeframe.

It is expected that by the end of the second year of this year, the combination of soil P concentration, tissue P concentration, and forage production will provide sufficient data to refine the current P fertilization recommendation for limpograss in Florida.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Board Grant
Final Report
August 10, 2022

Impact of Individual Macronutrients on Broomsedge Densities in Bahiagrass Pastures

Investigators: Brent Sellers and Maria Silveira

Project #: P0233678 (FCEB #10)

Background: Broomsedge (*Andropogon*) species are native, warm-season, short-lived perennial bunchgrasses with an average life span of 3 to 5 years. While some species are desirable in many natural areas and native rangeland, they are becoming problematic in improved bahiagrass pastures throughout central and south Florida as mature broomsedge is typically avoided by cattle. There is no easy answer to this increasing problem as there are no herbicides that will selectively remove broomsedge from desirable forage grasses. Therefore, some type of management program is needed to help reduce broomsedge infestations and invasion, especially in bahiagrass pastures.

Limited research has been conducted concerning pasture management to reduce broomsedge infestations. Many extension specialists in the southeastern US indicate that soil testing followed by the appropriate amendments to increase the competitive ability of desirable species is the only way to manage broomsedge. However, with over 18 species of broomsedge present in Florida, an across-the-board recommendation for all species is not likely attainable. For example, bushy bluestem appears to grow in alkaline soils (pH >7) more so than in acidic soils, while other species are observed growing in more acidic soils. Therefore, liming alone may or may not result in a decrease in broomsedge density over time. Furthermore, the pH target levels for desirable grasses may not inhibit the growth of broomsedge species. Applications of phosphorus have also been suggested to decrease broomsedge invasion, but this has not been documented in Florida where subsoils are typically rich in phosphorus.

Preliminary results from our research have indicated that bushy bluestem density decreases over time as a result of NPK fertilization at 50, 25, and 50 lb/A, respectively, when applied annually as early as 2 years after the first application, and density was approximately 50% of non-fertilized plots. Liming resulted in a 50% decrease in purple bluestem density within 3 years after application, and application of NPK fertilizer applied annually at 50, 25, and 50 lb/A, respectively, resulted in a 58% reduction in density compared to non-treated plots 4 years after the first application. However, the macronutrient responsible for the decrease in broomsedge density in our previous long-term experiments has not been verified.

Since our previous long-term experiments revealed that at least two broomsedge species responded to increased NPK fertilization, our objective is to determine which soil macronutrient, N, P, or K, is causing broomsedge density to decline. Our hypothesis is that increasing the fertility levels of the pasture will increase the competitive ability of the desirable forage and limit new broomsedge seedlings from becoming established. Since broomsedge has a life span of 3 to 5 years, it will likely take several years before significant results can be achieved.

Since selective herbicides are not available for managing broomsedge in bahiagrass pastures, soil fertilization may be our only approach. Additionally, the invasion of broomsedge species ultimately results in reduced stocking rates as these species are typically not consumed by cattle. Since our ongoing study is indicating that at least two broomsedge species can be managed through increasing soil fertility, providing this information to cattlemen will ultimately increasing stocking rates through long-term management programs.

Approach. *Effect of single macronutrients on broomsedge density.* Plots were established in pastures infested with broomsedge species at the Range Cattle REC and Buck Island Ranch in 2017. Prior to initiating the experiments, soil and tissue were sampled for baseline measurements of soil pH as well as soil and tissue nutrient concentrations. Individual plots measure 100 x 100 ft, and each treatment is replicated 4 times in a randomized complete block design. Lime has been applied according to soil testing results across the entire experimental area. Broomsedge density was recorded prior to beginning the experiment in geo-referenced locations within each plot and is recorded annually prior to fertilization. Treatments include: 1) N (50 lb N/A); 2) 25 lb P/A; 3) K (50 lb K_2O/A), 4) N + P (50 lb N/A + 25 lb P/A); 5) N + K (50 lb N/A + 50 lb K_2O/A; 6) P + K (25 lb P/A + 50 lb K_2O/A); and 7) N + P + K (50 lb N/A + 25 lb P/A + 50 lb K_2O/A). An untreated check is also included to be able to observe any natural changes in time due to other management imposed on the pasture. Fertilizer will be applied annually in the spring (March-April) of each year.

Results.

Broomsedge densities in studies initiated in 2017 were not affected by macronutrient applications within one year after the first application (data not shown). However, potassium (K) did impact broomsedge densities at both locations following two years of K application (Table 1). Broomsedge densities at Buck Island were reduced by 36, 44, and 55% in plots receiving K by 2019, 2020, and 2021, respectively. Hexazinone was applied at the Ona location in 2017 to control smutgrass, and we believe that the application of hexazinone resulted in reduced broomsedge densities across all treatments by 2018. However, broomsedge began re-infesting plots in 2019, but K application has resulted in a 73, 60, and 55% reduction in broomsedge in K-treated plots in 2019, 2020 and 2021, respectively. No other macronutrients had an impact on broomsedge densities at either location. We plan to continue these studies for an additional two years to determine if K continues to have a negative impact on broomsedge densities.

Acknowledgements. We wish to thank our cooperators, Gene Lollis (Buck Island Ranch) and David Ward for allowing us to conduct this research on their ranch properties as well as assisting us with scheduling application of soil amendments.

Percentage of Completion for 2022: 100%

Table 1. Impact of potassium applications on broomsedge density at Buck Island and Ona from 2018 through 2021.

Treatment[1]	Buck Island				Ona			
	2018	2019	2020	2021	2018	2019	2020	2021
	————————————no. of plant/m^2———————————————							
0 K	6.4 a[2]	7.8 a	8.4 a	9.6 a	0.4 a	2.6 a	4.8 a	13.3 a
50 K	5.4 a	5.3 b	3.0 b	4.3 b	0.3 a	0.7 b	1.9 b	5.9 b
p-value	0.2322	0.0184	0.0007	0.0006	0.3360	0.0126	0.0050	0.0085

[1] Potassium was applied annually beginning in 2017 at 50 lb K/acre.

[2] Values within each column followed by different letters are significantly different at P<0.05.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Grant Application

Title: ***Biomarkers to predict future cow performance and response to supplementation***
AWD11211
Investigators: Philipe Moriel, Mario Binelli.

Project Overview

Our proposal will address FCA Priorities **#2 (Calf Weaning Rate)** and **#5 (Herd nutrition)**. Identifying nutritional strategies that improve cow reproduction and subsequent calf growth and health is crucial to optimize cow-calf production. Precalving supplementation of protein and energy for Brangus cows (60 to 90 days before calving) improved growth and reproductive performance of cows and their calves. **The next frontier in cow-calf nutrition is to develop the ability to early predict which cows will or will not respond to precalving supplementation**. The objective of this proposal is to evaluate the plasma profile of metabolites and hormones (*collected 60 to 90 days before calving*) to identify potential biomarkers that could be used to predict which cows will respond to maternal precalving supplementation. Rather than supplementing the entire herd, producers would be able to focus their investments on supplementation only for cows that will positively respond to precalving supplementation (*cows that if supplemented will become pregnant*), improving the efficiency of their nutrition program and leading to massive savings and increased profitability of cow-calf systems.

Deliverables	Progress
Metabolomics	Completed
Plasma hormones	Completed in June 2022

% completion by August 1st, 2022 = 100%

A manuscript is currently being prepared for peer-review publication. In addition, slides and a webinar are being prepared to educate stakeholders on results obtained from this project.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Fund
Progress Report – Project P0234209 (FCEB#20)
August 10, 2022

Tenderness of *Bos indicus*-influenced beef

Tracy Scheffler (PI), Jason Scheffler (Co-PI), and Chad Carr (Co-PI)

Department of Animal Sciences, University of Florida; Gainesville, FL 32611-0910
Email: tscheffler@ufl.edu Phone: 352-392-7529

Specific Aims

Our ***long-term goal*** is to improve the quality and consistency of *Bos indicus* influenced beef. Beef tenderness is a key determinant of product value and consumer acceptability. Yet, *Bos indicus* influenced cattle tend to produce tougher steaks and exhibit greater variability in tenderness than *Bos taurus* breeds. While calpastatin content is typically greater in *Bos indicus* (Brahman) compared with *Bos taurus* (Angus), we have observed that variation in calpastatin content does not explain the tenderness differences observed **within** beef from Brahman steers. Importantly, tenderness is an end-point measurement resulting from a dynamic process whereby living muscle is converted to meat. We aim to identify muscle properties that modulate tenderness development in *Bos indicus*, in order to better target novel approaches that can be used to enhance beef tenderness and reduce product variation. Muscle proteins are important to the "conversion of muscle to meat" because proteins continue to function early postmortem, and they serve diverse roles in metabolism, stress response, contraction, protein degradation, structure, and cellular communication.

The *objectives* are to

- Classify Brahman loin muscle as "tender" or "tough" and analyze the entire complement of muscle proteins (proteome) and modified proteins (phosphoproteome). These analyses will be conducted with muscle samples collected at 1 and 24 hours after death to represent initial content of muscle proteins (1 hour) and establish changes related to the conversion of muscle to meat (24 hours).
- This will allow us to (1) identify proteins that differ in content between tough and tender steaks and (2) establish modifications that influence protein function and tenderization.

Anticipated outcomes and potential benefits

Variation in tenderness in *Bos indicus* represents an opportunity to identify muscle factors associated with tough and tender beef. Tenderization is a dynamic and complex process that is largely related to muscle attributes, adaptation to environmental stimuli, and conditions during the postmortem conversion of muscle to meat. In general, loin muscle from Brahman steers appears more resistant to changes that occur during the postmortem period. The resistance to postmortem changes is expected to result in slower or less tenderization; however, there is still considerable variation in tenderness within Brahman. Completion of our research objectives will **establish proteins that differ in content and degree of modification in tender and tough**

samples. This will provide further insight into factors in muscle that contribute to postmortem tenderization and may be used as the basis for additional studies targeting specific mechanisms involved in tenderness.

Progress (September 2021 – August 2022)

Tender and tough muscle samples were selected from samples that had been collected from previous experiments. When possible, we paired samples by sire, contemporary group, and harvest day in order to limit influence of confounding variables such as management. Five samples per group were chosen based on sensory analysis (trained panelists) of loin steaks aged 14 days. The tender and tough groups had average sensory scores of 5.64 vs. 3.75, respectively (3 = moderately tough, 4 = slightly tough, 5 = slightly tender, 6 = moderately tender). Marbling was also similar between tender and tough groups (average: slight^{64} vs. slight^{92}, respectively; high select quality grade). For each tenderness group, loin samples collected at 1 hour and 24 hours postmortem were processed for protein extraction (n = 5 per tenderness group and time point; 20 total). The samples containing extracted proteins were submitted to the Proteomics & Mass Spectrometry Core of the Interdisciplinary Center for Biotechnology Research (ICBR) at UF. Personnel at the ICBR conducted the tandem-mass tag labeling which permits determination of the identity and relative abundance of peptides. Samples were processed for LC-MS/MS. Peptides and proteins were identified and quantified using software that interprets LC-MS/MS data. Approximately 4600 total proteins were identified, and 1800 proteins were identified with high confidence. The data were normalized to control and will undergo further statistical analysis.

A research progress update (oral presentation) was given at the Florida Beef Cattle Short Course in early May. Progress was also reported (poster) at the Florida Cattlemen's Convention in June.

Next steps

The normalized data from LC-MS/MS will be used to establish proteins that differ in expression between tough and tender steaks, and to identify modifications (phosphorylated sites) on proteins that may be important for protein function and tenderization during aging. A moderated t-test will be used for pairwise comparisons between tenderness group and time points. The proteins and phosphorylation sites that are different between tenderness groups and time points will be used for functional analysis to identify pathways and potential mechanisms involved in tenderization.

Findings will be reported in an article for the Florida Cattlemen & Livestock Journal, FCA quarterly, and/or Beef Cattle Short Course.

Final Technical Report

FCEB Project #1

FINAL REPORT – Project # P0234211 (FCEB #22)

Percentage completion of project deliverables: 100%

<u>Title</u>: Using genomics to estimate heterosis effect on growth and carcass traits

<u>Principle Investigator</u>: Raluca G. Mateescu[1*] (PD/PI), Co-PI: Fernanda Rezende
[1]Department of Animal Sciences, University of Florida, Gainesville, FL 32611-0910.
[*]Email: raluca@ufl.edu; Tel: 352-392-2367

<u>Relevance to Florida Cattle Industry:</u> Crossbreeding is a common strategy used in tropical and subtropical regions to enhance beef production. Planned crossbreeding programs, such as two and three- breed rotations, have probably been used longer and more effectively in Florida than in any other part of the United States. The economic benefits obtained from a crossbreeding system can be great, but efficacy of the system depends upon the proper mating of cows to superior, unrelated bulls. Heterosis, which is one benefit of crossbreeding, arises from combining the genes from different breeds in such a way that inferior recessive genes are concealed. Heterosis may result in the crossbred being better than either parental breed or simply better than the average of the two. While the maximum heterosis is achieved in the first cross of purebred animals (F1), retained heterosis in subsequent matings is not accurately known.

This proposal will benefit the Florida Beef Cattle Industry by developing the resources needed to develop management tools for *Bos indicus* influenced cattle. Genomic technologies, such as marker assisted management, offer the opportunity to increase productivity (i.e. using genetic information for mating decisions where parents are selected to optimize the level of heterosis for specific traits). Developing a reliable method of predicting heterosis for crossbred beef cattle could improve the efficiency of crossbreeding and improve the accuracy of estimated breeding values (EBV) by accounting for non- additive genetic effects in the genomic evaluation model.

<u>Objectives:</u>

This proposal had three objectives:

1) Genotype and record carcass and meat quality traits for a new set of 335 crossbred steers (born in 2020). This will increase our database to 1,372 animals with carcass records and 1,135 animals with meat quality records. Growth records are already available on the entire population. Increasing the number of animals with carcass and in particular meat quality records is imperative for an accurate prediction of heterosis.
2) Use the statistical method developed by our group to assign a breed of origin for all chromosomal fragments in a crossbred animal based on 250K high-density genotypes.
3) Estimate genomic heterosis based on the percentage of chromosomal fragments which have different breed origin along the genome. Existing commercial tests on the market can estimate heterozygosity which is a proxy of heterosis. Our method will provide a more accurate estimate of the true heterosis.

Results

Objective 1.

Genomic DNA was extracted from steaks using the DNeasy Blood & Tissue kit DNA and genotyped using the GeneSeek Genome Profiler F-250 (GeneSeek, Inc., Lincoln, NE, USA) which contains 221,077 SNPs. This represents the latest Illumina functional variant assay, designed using sequence data on over 400 individuals from multiple taurine breeds. Sequence data from the 1000 Bull Genomes Project, dbSNP and indicine cattle were used to validate the loci included in the design. Any SNP with < 0.90 call rate and SNP with minor allele frequency < 0.01 were removed from the analysis.

Cattle were implanted with Revalor XS (Merck & Co., Inc., Kenilworth, NJ) and fed a standard feedlot diet consisting of corn, protein, vitamins, and minerals until they reached a common physiological endpoint, with the goal of 1.27 cm of subcutaneous fat over the back. Cattle were harvested under USDA-FSIS inspection. Hot carcass weight (HCW) was recorded immediately following harvest. Carcasses were ribbed between the 12^{th} and 13^{th} rib at 48 hours postmortem and carcass traits will be recorded. Marbling score, lean maturity, and skeletal maturity were recorded according to USDA standards and used to calculate overall maturity and USDA quality grade using an industry standard method (Hale et al., 2006). Fat over the ribeye (FOE; cm) and ribeye area (REA; cm^2) were measured. Yield grade (YG) was calculated using the industry standard formula: YG = 2.5 + 2.5(FOE) + 0.2(KPH) + 0.0038(HCW) – 0.32(REA).

One 2.54 cm thick steak from the *longissimus lumborum*, posterior to the 12^{th} rib was obtained from each carcass and kept on ice until returning to the University of Florida Meat Processing Center (Gainesville, FL, United States). Steaks were trimmed of external fat then placed in heat shrink vacuum pack bags (B2570; Cryovac, Duncan, SC), and vacuum sealed with a Multivac C500 (Multivac Inc., Kansas City, MO). Steaks were aged for 14 days at 4^oC then placed in a freezer at -20^oC for storage.

Objective 2.

Individual breed composition was estimated from genomic data using a maximum likelihood model implemented in the software ADMIXTUREv1. Since fractional subgroup membership is allowed, membership coefficients can also be conveniently interpreted as the proportion of an animals' genome with a particular breed ancestry. In addition to not requiring allele frequency estimates from external reference populations, this method allows inference on the correct number of ancestral populations, an important feature when the full range of parental breeds involved is not certain.

The approach that we developed to assign breed of origin to alleles of crossbred animals, consists of three steps: (1) phasing the genotypes of both purebred and crossbred animals, (2) assigning breed origin to the phased haplotypes, and (3) assigning breed origin to alleles of crossbred animals based on the library of assigned haplotypes, the breed composition of the cross- bred animals and the zygosity (i.e., homozygosity or heterozygosity).

Objective 3.

The traditional heterosis is estimated at the population level. The formula for heterosis is based on the average of the crossbred animals and the average of the purebred animals for a particular trait of interest. This requires generation of crossbred (F1) animals and measuring the trait of interest on large numbers of both purebred and crossbred animals. Although this method generates a fairly accurate heterosis value for a particular trait, it doesn't allow an estimation of heterosis on an individual basis.

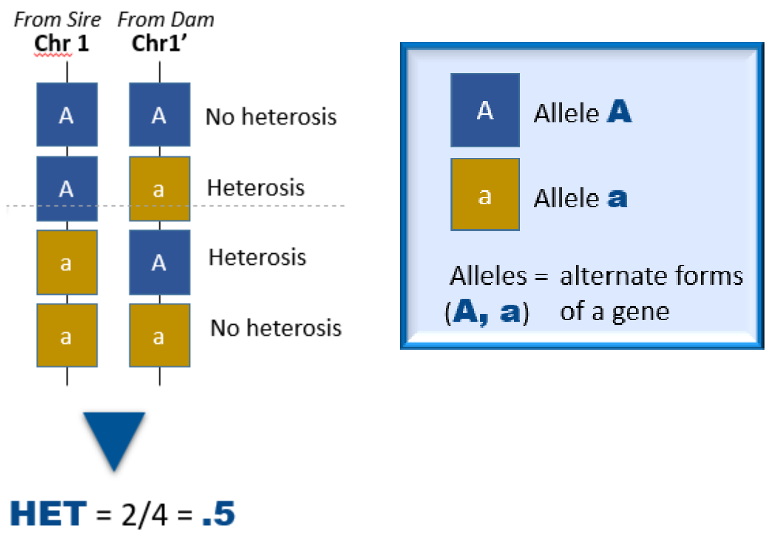


Figure 1. Using genomic information (250K genetic markers) we can calculate heterozygosity at the individual level as the percentage of markers in heterozygous state (Aa).

Estimate genomic heterosis based on the percentage of chromosomal fragments which have different breed origin along the genome. Existing commercial tests on the market can estimate heterozygosity which is a proxy of heterosis. Our method will provide a more accurate estimate of the true heterosis. More research is needed to be able to estimate the heterosis based on breed of origin information.

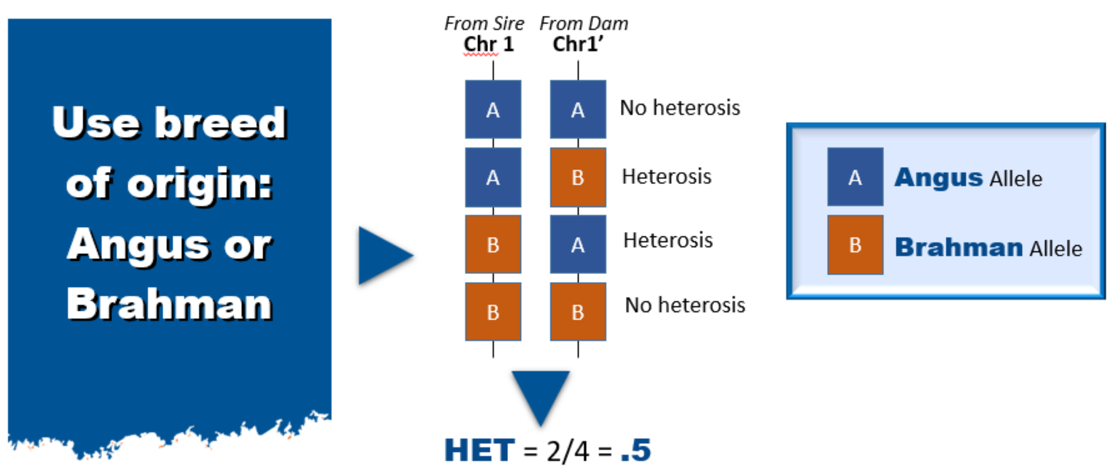


Figure 2. For a more accurate estimation of heterosis, the breed of origin (Angus or Brahman) for each allele at each of the 250K genetic markers has to be estimated. Using the breed of origin information, we can then calculate heterozygosity at the individual level as the percentage of markers in heterozygous state (one Angus allele and one Brahman allele).

Final Technical Report

FCEB Project #1

Project Name: Improving fertility, growth and carcass traits of the UF Brahman herd through genomic selection and targeted breeding (Project# P0233676 – FCEB #26)

Final Technical Report

Principal Investigator: Mario Binelli, PhD

1. Main Objective

The "Brahman Project" conducted at the University of Florida addresses many fundamental aspects that are relevant to the Bos indicus-influenced Florida cattle. The UF Brahman herd has recently achieved the goal of 250 breeding females. The next logical step is to focus on selection inside the breeding herd. Selection is based on the evaluation of both genomic and performance characteristics of the calf crop. The aim of the present proposal is to select and reproduce superior genotypes defined by our genomic database. We selected individuals in our herd with superior genotypes, based on genomic EPDs, to donate oocytes from which we generated embryos for transfer to recipients. Selection within the UF Brahman herd, along with collaboration with Brahman producers in Florida and elsewhere, continues to allow for meaningful studies related to genetic selection for improved carcass quality and reproductive performance. This proposal addressed FCA Research and Education Priorities 2 (Calf Weaning Rate: improve pregnancy attainment of cows and heifers) and 7 (Bos Indicus genetics).

2. Situation and Specific Objective

As of July, 2021, the Brahman female herd at UF was composed of 223 mature cows, 56 yearling heifers and 106 heifer calves, that totals 385 females.

The Specific Objective of the present proposal was to apply selection pressure in the breeding herd via the utilization of genomic tools and targeted breeding. Specifically, the goal was to select and propagate desirable genotypes, which were determined based on our genomic prediction models, and generate 40 pure bred Brahman calves.

3. Approach

Core methodology consisted of embryo transfer. We selected Brahman cows (n=10) as oocyte donors based on their genomic EPDs and produced 64 high-quality embryos that were placed fresh in our Angus/Brangus cows and heifers recipients as appropriate, in rounds 1 and 2. Another 30 high-quality embryos that were previously frozen were transferred to recipients in round 3.

Embryos were produced by in vitro fertilization at the University of Florida Bovine Embryo Laboratory directed by Dr. Peter Hansen. This laboratory has extensive experience with bovine in vitro fertilization. Oocyte collections were performed through a contract with Dr. Jeremy Block of Vintage Veterinary. Dr. Block is one of the leading embryo practitioners in the country and has trained many embryo technicians around the country. Embryo transfer was also performed by the crew at the University of Florida Bovine Embryo Laboratory.

4. Final Report

Results are summarized on Table 1. As proposed, we performed genomics and phenotypic analyses of our Brahman females and selected our top 10 oocyte donors. Donors underwent two rounds (rounds 1 and 2) of oocyte collection and 77 embryos were produced. There were three rounds of embryo transfer. Recipients in the first two rounds received embryos produced in rounds 1 and 2. Recipients on round 3 received Brahman embryos previously frozen. Pregnancy from rounds 1 and 2 was 31.25% (20 pregnancies / 64 recipients). Pregnancy on round 3 will be determined on September 1st, 2022.

Table 1. Results summary table.

Round	# oocyte donors	# embryos produced	# recipients	# embryos transferred (fresh/frozen)	Day of embryo transfer	% pregnancy	Day of pregnancy check
1	10	32	20	20/0	5/12/22	45% (9/20)	6/6/2022
2	10	45	44	44/0	6/23/22	25% (11/44)	7/18/2022
3	-	-	30	0/30	8/4/22	TBD	9/1/2022
Total	20		94	94		TBD	

5. Conclusion

Project was concluded. After the final pregnancy check is performed, we will know the final number of pregnancies, and in 2023, the final number of Brahman calves born.

Final Technical Report

FCEB Project #1

FINAL REPORT – Project # P0234214 (FCEB #27)

Percentage completion of project deliverables: 100%

Title: Improving the accuracy of genomic selection for carcass and meat quality

Principle Investigator: Raluca G. Mateescu[1*] (PD/PI), Co-PIs: Fernanda Rezende, Chad Carr, Tracy Scheffler.
[1]Department of Animal Sciences, University of Florida, Gainesville, FL 32611-0910.
[*]Email: raluca@ufl.edu; Tel: 352-392-2367

Relevance to Florida Cattle Industry: This proposal will benefit the Florida Beef Cattle Industry by developing the resources needed to effectively implement genomic selection and management tools for Brahman and Brahman influenced cattle. Brahman is a key component of the crossbred beef production system in Florida. Brahman brings great adaptability to Brahman-Bos taurus crossbred cattle permitting them to endure adverse hot and humid conditions. Brahman cattle are frequently criticized for a perceived lack of meat tenderness and marbling and their lower fertility relative to other breeds and crossbred cattle. However, recent research on the multibreed herd at University of Florida revealed that there is a high level of variation in tenderness across all quality grades. Furthermore, we showed that Brahman animals exhibit a range of EPD for fertility, growth, ultrasound, and carcass traits comparable to that of Angus, Brangus, and Brahman x Angus crossbreds.

Because the beef industry is currently using the USDA grading system to determine premium and discounts, Brahman and Brahman influenced cattle are routinely penalized for relatively low marbling score. About 30% to 40% of the variation in tenderness is due to genetics. Recent developments in genomics paves the way for making significant improvement in tenderness via genomic selection and offer opportunities for marketing of cattle on the basis of tenderness. Genetic markers discovered in other populations (Angus) are not informative in Brahman influenced populations. To adopt this technology, producers need population/breed specific information on the value of genetic testing and our project will provide this information for Brahman influenced cattle.

Results

Cattle were implanted with Revalor XS (Merck & Co., Inc., Kenilworth, NJ) and fed a standard feedlot diet consisting of corn, protein, vitamins, and minerals until they reached a common physiological endpoint, with the goal of 1.27 cm of subcutaneous fat over the back. Cattle were harvested under USDA-FSIS inspection. Hot carcass weight (HCW) was recorded immediately following harvest. Carcasses were ribbed between the 12^{th} and 13^{th} rib at 48 hours postmortem and carcass traits were recorded. Marbling score, lean maturity, and skeletal maturity were recorded according to USDA standards and used to calculate overall maturity and USDA quality grade using an industry standard method (Hale et al., 2006). Fat over the ribeye (FOE; cm) and ribeye area (REA; cm^2) were measured. Yield grade (YG) was calculated using the industry standard formula: YG = 2.5 + 2.5(FOE) + 0.2(KPH) + 0.0038(HCW) – 0.32(REA).

One 2.54 cm thick steak from the *longissimus lumborum*, posterior to the 12th rib was obtained from each carcass and kept on ice until returning to the University of Florida Meat Processing Center (Gainesville, FL, United States). Steaks were trimmed of external fat then placed in heat shrink vacuum pack bags (B2570; Cryovac, Duncan, SC), and vacuum sealed with a Multivac C500 (Multivac Inc., Kansas City, MO). Steaks were aged for 14 days at 4°C then placed in a freezer at -20°C for storage.

Tenderness was measured by WBSF on steaks from 155 Brahman influenced steers according to the American Meat Science Association Sensory Guidelines. Frozen steaks were allowed to thaw at 4°C for 24 hours, cooked to an internal temperature of 71°C in an open-hearth grill and cooled at 4°C for 18 to 24 hours. From each steak, six cores with a 1.27-cm diameter and parallel to the muscle fiber were sheared with a Warner-Bratzler head attached to an Instron Universal Testing Machine (model 3343; Instron Corporation, Canton, MA). The Warner-Bratzler head moved at a cross head speed of 200 mm/min. The average peak load (kg) of six cores from the same animal was calculated and analyzed.

The genomic evaluation program computes an annual genomic EPD using the unified approach developed by Ignacy Misztal and collaborators at the University of Georgia. This method yields the best possible accuracy for genomic EPD because it utilizes all available phenotypic, pedigree, and genotypic records. We will continue to compute genomic EPD and accuracy information for tenderness, marbling, reproductive tract score, and other reproductive, growth, ultrasound, and carcass traits from all animals in the UF herds.

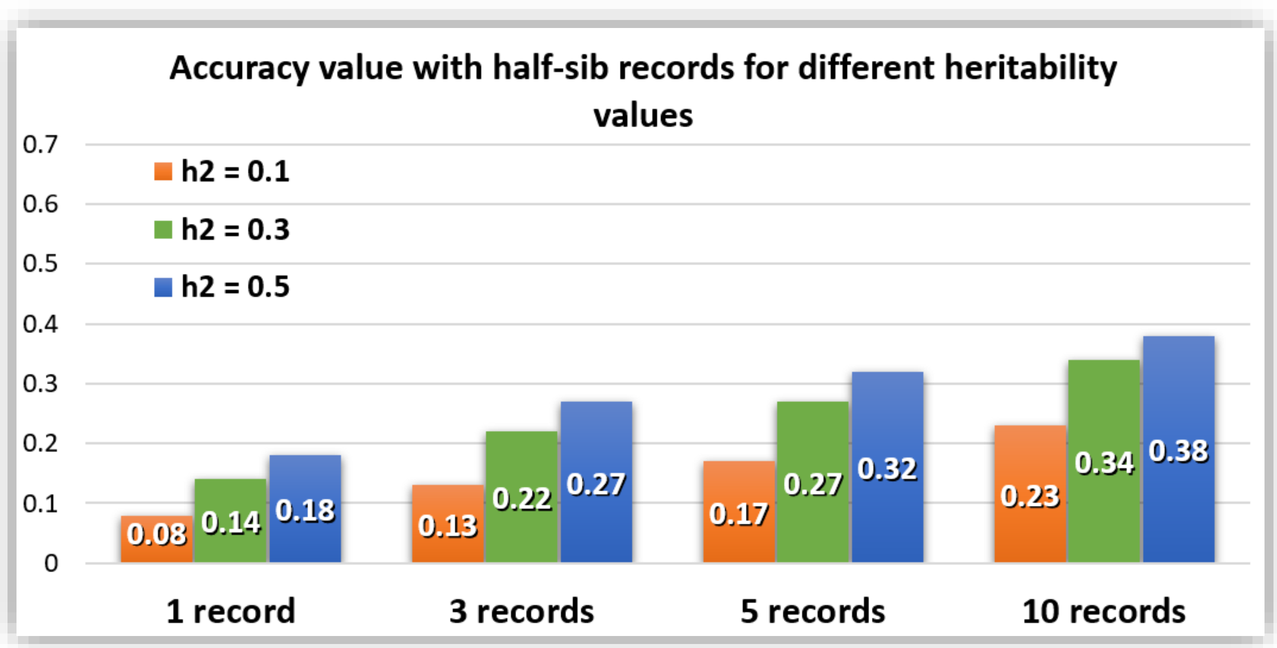


Figure 1. Accuracy values when 1, 3, 5 or 10 half-sib records (genetic relationship of 0.25) are available for traits with different heritabilities (from 0.1 = low heritability to 0.5 high heritability). Increasing the number of records leads to increased accuracies regardless of the heritability

value, however, lowly heritable traits like reproduction will have lower accuracies even when a large number of records are available compared to highly heritable traits like growth.

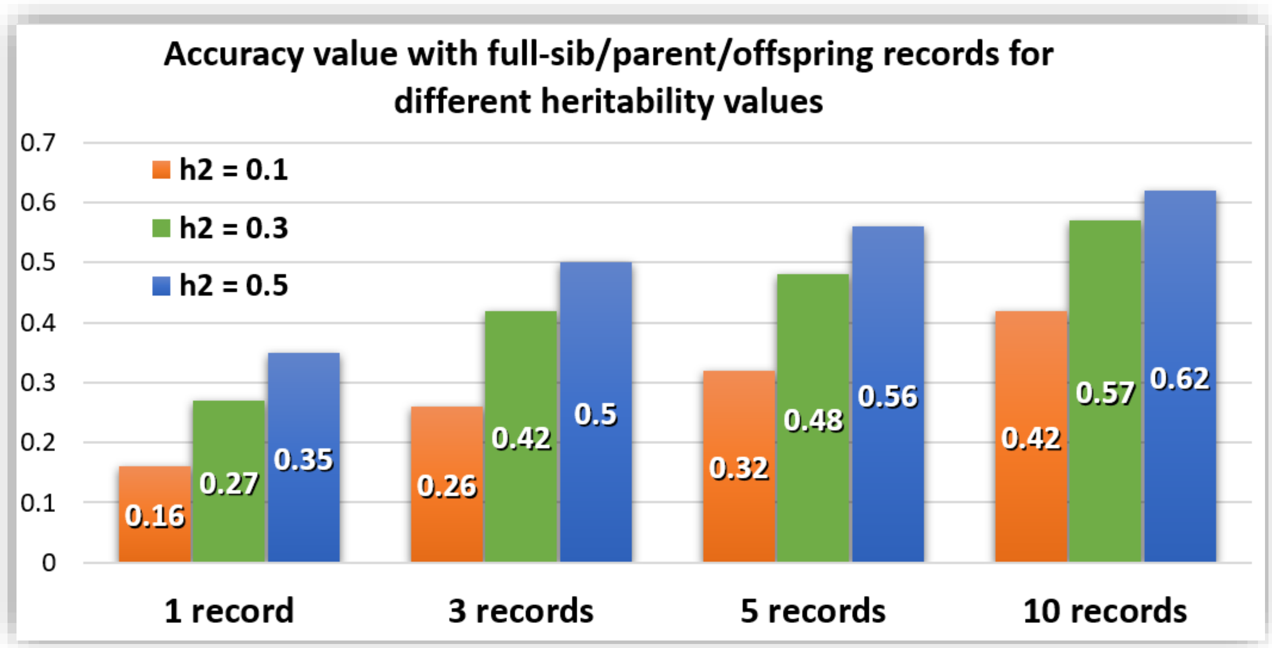


Figure 2. Accuracy values when 1, 3, 5 or 10 full-sib/parent/offspring records (genetic relationship of 0.5) are available for traits with different heritabilities (from 0.1 = low heritability to 0.5 high heritability). In general, the higher genetic relationship results in a higher accuracy across the board compared to same number of records in Figure 1. Increasing the number of records leads to increased accuracies regardless of the heritability value, however, lowly heritable traits like reproduction will have lower accuracies even when a large number of records are available compared to highly heritable traits like growth.

This is a long-term project whose impact on the UF Brahman and Multibreed populations will be assessed only after a number of years of consistent selection and assortative mating for these traits. Thus, this selection program would need to be continued for at least three generations of selection (9 to 10 years). Changes in the mean EPD values (i.e., genetic trends) for sires, dams, and calves over years will be used to assess the effectiveness of the selection and mating program. Yearly evaluation of genetic trends will also allow making timely modifications to within-herd and across-herd selection objectives and mating plans.

Final Technical Report

FCEB Project #1

Project Name: Predicting Puberty in Brahman Heifers and Bulls (Project # P0233669 – FCEB #28)

Final Technical Report

Principal Investigator: Mario Binelli, PhD

1. Main Objective

The Main Objective of this proposal was to identify molecular markers present in the blood of pre-pubertal heifers and bulls that are predictive of early attainment of puberty. The project directly addressed the Program Area Priorities 2 (Calf Weaning Rate: improve pregnancy attainment of cows and heifers) and 7 (*Bos Indicus* genetics).

.

2. Situation and Specific Objective

One main challenge associated with *Bos indicus* genetics is a delayed attainment of puberty, compared to *Bos taurus* animals. Indeed, data collected in the University of Florida Beef Research Unit indicate that while 31% (27/86) of the cross-bred yearling heifers that entered the 2019 breeding season having attained puberty, only 1.5% (1/62) of pure bred Brahman yearling heifers were pubertal. A similar low proportion was observed for yearling Brahman bulls. Notwithstanding, 13% (8/62) of the yearling Brahman heifers became pregnant to a single artificial insemination. Interestingly, Brahman heifers that did become pregnant varied in age (12 to 16 months) and weight (530 to 775 lb) at the beginning of the breeding season. This variability indicates that there is potential for the selection of early maturing genetics within the Brahman population. However, attainment of puberty and fertility was not associated tightly with the common phenotypic traits of weight and age. Thus, there is a critical need to discover alternative markers that are predictive of puberty attainment. This rationale is also applicable to Brahman bulls. The specific objective of this proposal was to discover non-genomic molecular markers that will be used to predict early puberty in Brahman heifers and bulls.

3. Approach

The study design was similar for heifers and bulls, except that animals were managed separately, according to sex, after weaning and data analyzes was also according to sex (Figure 1, heifers; Figure 2, bulls). Experiment started in the Fall of 2020 when Brahman calves were weaned. Sample and data collection were concluded in the Fall of 2021. Laboratory and data analyses were carried out from Spring to Summer 2022. Fifty six Brahman (*Bos indicus*) heifers and 28 Brahman bulls were used in this experiment. After weaning, animals were housed in paddocks cultivated with Bahiagrass at the UF beef units. Animals were monitored on a monthly basis until the beginning of the breeding season (14-months of age). During this period, the animals were body condition scored, weighted and measured. In addition, blood samples were collected 90 and 30 days prior to the beginning of the breeding season for metabolomic analysis.

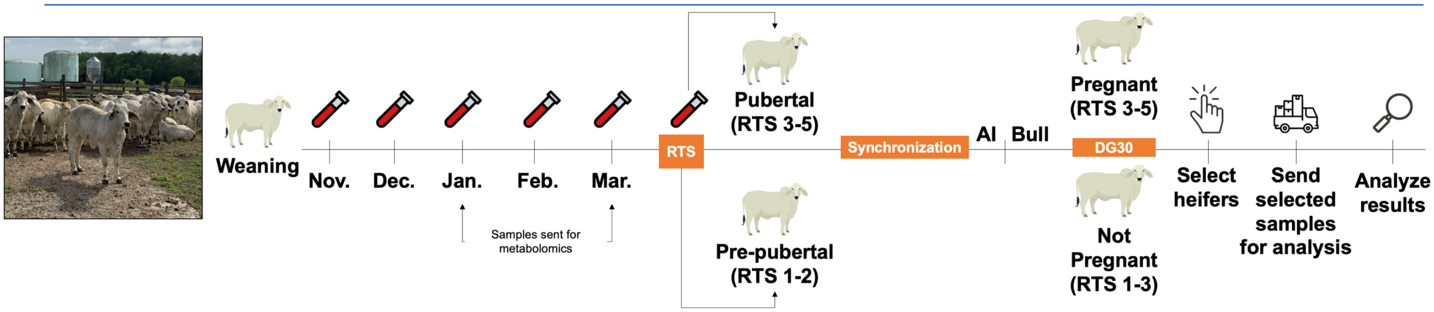


Figure 1. Samples were collected from 56 yearling Brahman heifers from 2020 – 2021. Plasma samples were collected once a month, starting at weaning. After application of the criteria described in Figure 3, samples from 12 pubertal and 12 pre-pubertal heifers were submitted for metabolomics analysis to identify non-genomic markers of puberty attainment.

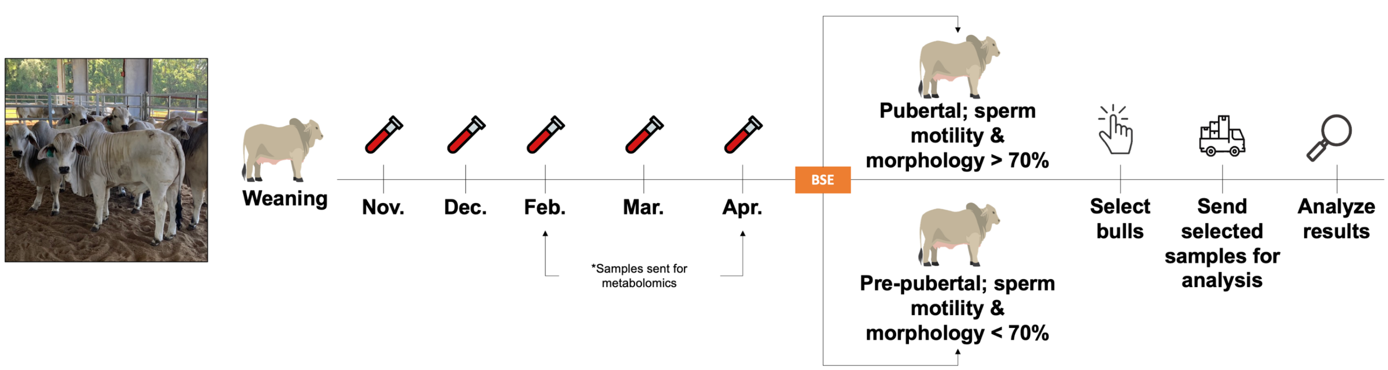


Figure 2. Samples were collected from 28 Brahman bulls from 2020 – 2021. Plasma samples were collected once a month, starting at weaning. After application of the criteria described in Figure 4, samples from 9 pubertal and 7 pre-pubertal bulls were submitted for metabolomics analysis to identify non-genomic markers of puberty attainment.

Heifers: during the breeding season, heifers were synchronized, artificially inseminated and exposed 14 days later to clean up bulls for 90 days. Pregnancies were checked by ultrasound 30 and 120 days post-AI to determine the proportion of heifers that became pregnant along the breeding season and ovaries were checked for the presence of a corpus luteum. At end of the breeding season, females were separated in two groups: heifers that had attained puberty (**Pubertal group**) and heifers that remained immature (**Pre-pubertal group**). Puberty status was defined considering a combination of the following criteria: (i) presence of a corpus luteum at 14 months; (ii) expression of estrus in response to the synchronization protocol; and (iii) pregnancy on day 30 of the breeding season. Pre-pubertal status was defined considering combination of the following criteria: (i) Reproductive Tract Score 1 to 2 at the end of the synchronization protocol; (ii) no expression of estrus in response to the synchronization protocol; (iii) not-bred at end of the breeding season; and (iv) absence of a corpus luteum along the breeding season (Figure 3).

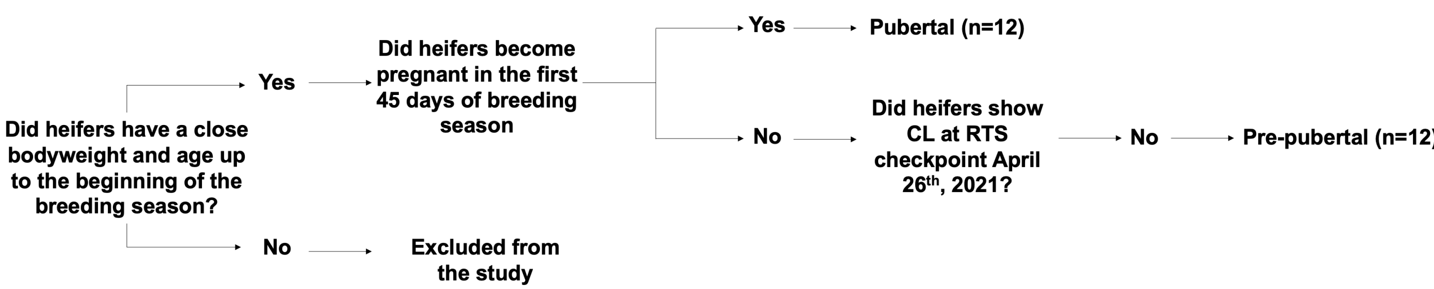


Figure 3. Criteria for selecting pubertal and pre-pubertal heifers. Heifers were considered PUBERTAL if: pregnant in the first 45 days of the breeding season and reproductive tract score (RTS) 3, 4, or 5 prior to synchronization. Heifers were considered PRE-PUBERTAL if: no corpus luteum at any point, RTS of 1 or 2 prior to synchronization and no estrus expression after synchronization.

Bulls: at the beginning of the breeding season (approximately 14 months of age), semen was collected from bulls via electroejaculation and analyzed using standard parameters of quality, including sperm concentration, motility and vigor. Bulls that achieve the desired parameters of fertility were considered to have attained puberty early, while bulls that did not achieve the desired parameters were considered as pre-pubertal (Figure 4).

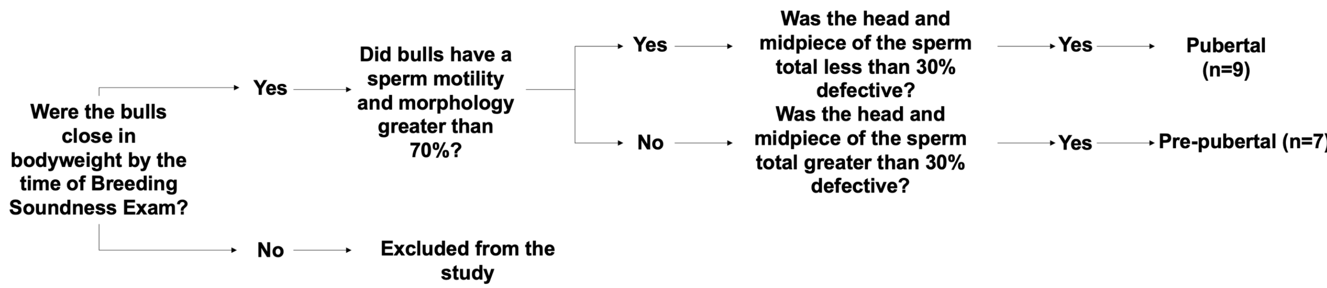


Figure 4. Criteria for selecting pubertal and pre-pubertal bulls. Bulls were considered PUBERTAL if: they had a sperm motility and morphology greater than 70%, head and midpiece total less than 30% defective. Bulls were considered PRE-PUBERTAL if: they had a sperm motility and morphology less than 70%, head and midpiece total greater than 30% defective.

Based on these criteria, 24 heifers and 16 bulls from both the Pubertal and Pre-pubertal groups were selected and their blood samples were screened for molecular markers, using metabolomics approaches.

Sample and data collection: blood samples were collected both from heifers and bulls, 90 and 30 days prior to the beginning of the breeding season and plasma was extracted. Metabolomic analysis was performed on samples from heifers and bulls classified as pubertal or pre-pubertal. On heifers, reproductive tract score (RTS) evaluations were performed by transrectal palpation and ultrasound scanning of the ovaries. On bulls, semen analysis was conducted by light microscopy.

4. Final Report

Body growth:

Body weight and hip height of heifers was measured from weaning to just before the breeding season (Figure 5). Heifers were retrospectively assigned to pubertal or pre-pubertal,

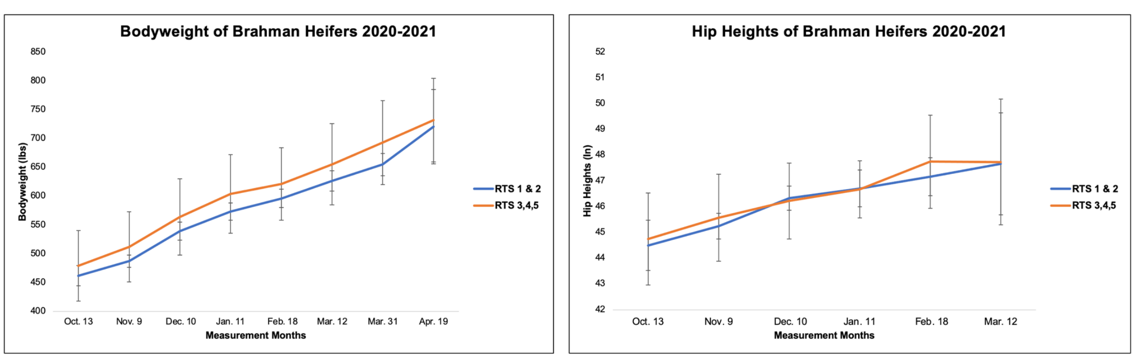


Figure 5. Bodyweight and hip height monthly averages for Brahman heifers prior to the breeding season. Measurements were taken once a month, on the same day of plasma collection. Heifers were grouped by their RTS, measured in April 2021.

based on the criteria discussed earlier. Body growth of heifers was similar between the pubertal and the pre-pubertal.

Body weight, hip height and scrotum circumference measurements of bulls are on Figure 6. Bulls were retrospectively assigned to pubertal or pre-pubertal, based on the criteria discussed earlier. Body growth of bulls was similar between the pubertal and the pre-pubertal.

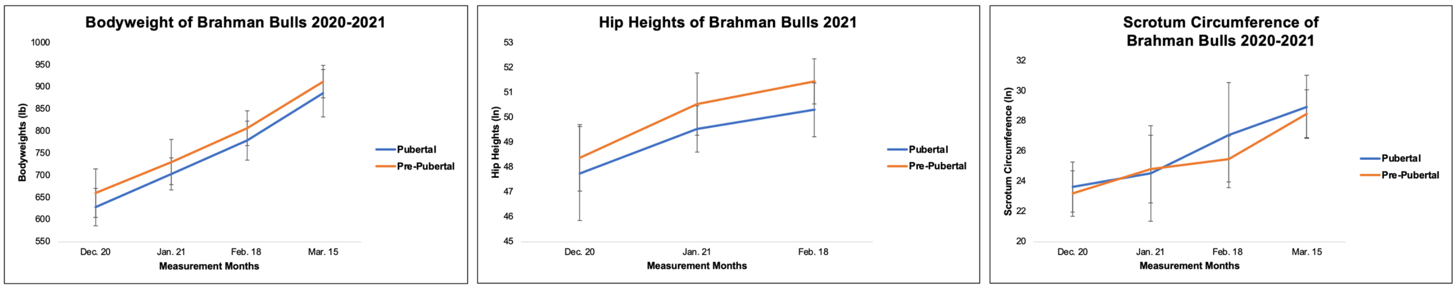


Figure 6. Bodyweight, hip height, and scrotum circumference averages for Brahman bulls prior to the breeding season. Measurements were taken once a month. Bulls were classified as pubertal or pre-pubertal based on sperm motility, morphology, head and midpiece defectiveness, measured in May 2021.

Metabolomics:

Blood samples from pubertal and pre-pubertal bulls and heifers collected 90 and 30 days prior to the breeding season were evaluated by targeted metabolomics (Figure 7). Among males and females, there was a clear separation between pubertal and pre-pubertal animals, suggesting that pubertal status affects the blood metabolome.

5. Conclusion

Project is concluded. We found evidence that both for bulls and heifers, prior to the breeding season, it is possible to distinguish animals that will, from those that will not attain puberty early. Early puberty is critical for lifetime reproductive success. Delayed puberty is a major challenge for the Brahman breed, and the identification of individuals that will attain puberty earlier may be used as a tool for early selection of replacement heifers and herd bulls. Importantly, as by experimental design, pubertal and pre-pubertal animals had similar body growth characteristics. This suggests that blood markers associated with puberty attainment do not depend on body growth. Future work should focus on validating these findings on a greater number of animals, prior to application in beef operations.

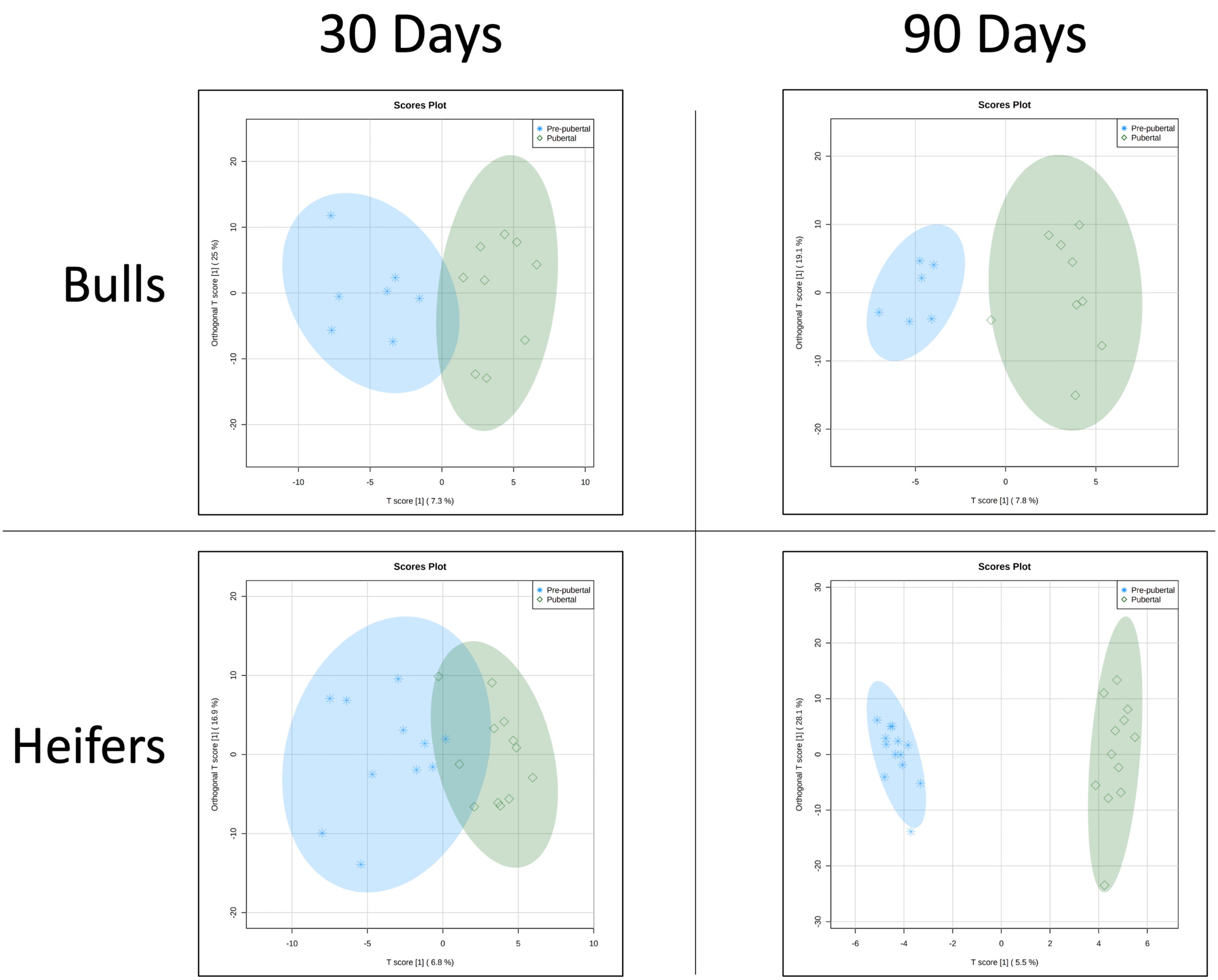


Figure 7. Metabolomic profile of pubertal (green) and pre-pubertal (blue) bulls (top panels) and heifers (bottom panels) collected 30 (left panels) or 90 days (right panels) prior to the breeding season. Each point represents the composite blood metabolome of each individual animal.

Final Technical Report

FCEB Project #1

Final Technical Report - UF Brahman Project
(Project # P0233673 - FCEB #30)

Principal Investigators: Fernanda Rezende and John Arthington

1. Main objective

The mission of the UF Brahman Project is to optimize the performance traits of Brahman cattle to improve their contribution to the commercial beef industry in warm environments. The **main objective** of this proposal was to provide consistency in annual data collection of the UF Brahman Project while serves a tripartite role in Research, Teaching, and Extension.

2. Situation and specific objective

The Brahman breed is well-adapted to Florida's subtropical climate. The remarkable hybrid vigor of Brahman x Bos taurus cattle, combined with their favorable adaptability to Florida, make these cattle well-suited to Florida and much of the Southeast. The UF Brahman Project seeks to improve meat quality and fertility traits of Brahman cattle, which would directly impact the commercial beef industry. The **specific objective** of the present proposal was to support the genotype, feedlot, and carcass data collection from UF Brahman herd. Basic annual data collection serves as a resource for current and future Cattle Enhancement Board projects seeking to investigate the Brahman breed and Florida producers interested in the topic.

3. Approach

Basic annual collection of reproduction, feedlot, and carcass data from the UF Brahman Project. Briefly, cows are bred to deliver first calves in mid-February and calves are the result of ET, AI, and natural service. At weaning, Brahman calves are pre-selected for development. Few young bulls are enrolled in a feed efficiency trial for individual assessment of feed intake. The feed efficiency trail consists of 21-days adaptation period and 56-days of testing period conducted at the UF Feed Efficiency Facilities in Marianna. Carcass ultrasound is performed twice on bulls at the beginning and end of feed efficiency trail, in the latter heifers are also evaluated. Following the development period, a selected group of heifers remains for replacement and only the best bulls are kept for breeding, all others are castrated, finished, and harvested for carcass and meat quality evaluation.

4. Final report

A total of 160 heifers and steers were genotyped using the GeneSeek Genome Profiler F-250 (GeneSeek, Inc., Lincoln, NE, USA). Forty-eight Brahman steers were transported after weaning to UF Feed Efficiency Facilities in Marianna for measurements of individual feed intake and growth rates. On day 0 of feed efficiency trail, ultrasound examination was performed on the steers to determine LM area, fat thickness at the 12th rib, and intramuscular fat percent. A second carcass ultrasound evaluation on the 48 Brahman steers was performed at the end of feed efficiency trail. Carcass ultrasound was performed on 82 Brahman heifers and remaining records will be available soon. Carcass data collection and evaluation of carcass loss in 28 steers was also performed. The data collected under this proposal are summarized in Table 1.

Table 1. Summary table of collected data.

Trait	Category	N	Min	Max	Mean
Ribeye area_ultrasound	Heifers	16	8.60	10.90	9.76
Rib fat_ultrasound	Heifers	16	0.11	0.45	0.24
Intramuscular fat_ultrasound	Heifers	16	1.60	3.54	2.85
Rump fat_ultrasound	Heifers	16	0.30	0.62	0.42
Ribeye area_ultrasound	Bulls	48	9.42	13.43	11.47
Rib fat_ultrasound	Bulls	48	0.20	0.42	0.28
Intramuscular fat_ultrasound	Bulls	48	2.49	4.19	3.26
Rump fat_ultrasound	Bulls	48	0.21	0.46	0.31
Average daily gain (lb/d)	Bulls	48	1.48	4.70	3.33
Dry matter intake (lb/d)	Bulls	48	11.73	29.51	22.09
Residual feed intake	Bulls	48	-14.21	16.35	0.00
Hot carcass weight (kg)	Steers	28	517	833	716
Marbling	Steers	28	270	520	342
Fat over rib	Steers	28	0.15	0.90	0.40
Ribeye area	Steers	28	9.70	14.60	11.90

5. Conclusion:

The project was concluded, and data is available for research and public use by anyone interested in the topic.

Final Technical Report

FCEB Project #1

FINAL REPORT - FLORIDA CATTLE ENHANCEMENT GRANT

Project Title: Evaluating the agronomic and environmental impacts of new FL-DEP biosolids rule (P0233677 - FCEB #31)

Investigators: Maria L. Silveira

Project Overview – This study evaluated the impacts of new FL DEP biosolids rule on bahiagrass responses, soil health, and water quality. Based on the new Rule 62-640, Florida Administrative Code, biosolids have to be applied at reduced rates (to meet crop P requirements). This approach significantly limits the rates of biosolids that can be recycled in pastures. In addition, reduced biosolids application (P-based rates) do not supply adequate amounts of N and other essential nutrients. New biosolids regulations also require water quality monitoring when annual P application rates exceeds 40 lb P2O5/A. Our hypothesis is that biosolids application will result in no significant impact on water quality but reduced (P-based) rates will reduce bahiagrass production and nutritive value. This project addresses the **FCA Priorities # 9 "Land Application of Biosolids on Pastures" and # 1 "Fertilization (Alternative Fertilizer Sources).**

Final Report- All deliverables associated with this project were accomplished successfully. No major limitations have occurred during the 2021 and 2022 growing season. One PhD and one undergraduate student are currently working on this project. Treatments (biosolids and commercial fertilizer) was land applied in 2021 and 2022. Forage, water, and soil responses have been monitored during the 2021 and 2022 growing season. Results obtained in 2020-2022 growing season will be disseminated through peer-reviewed publications, extension articles, and presentations.

***Objective 1*.** To maintain an established, long-term, instrumented research and demonstration field trial designed to evaluate the agronomic benefits and environmental risks associated with land application of biosolids

A field experimental area was established at the UF/IFAS Range Cattle REC in 2016 on a bahiagrass pasture. **The site represents the only established field trial in Florida addressing**

issues related to biosolids application. The experimental area consisted of ~ 20 acres that was fenced and heavily instrumented. A total of 40 experimental plots were marked and instrumented in February, 2016. Previous results (2016-2020) have been disseminated through peer-reviewed publications, extension materials, presentations, and field days.

The current trial will be carried out for 3 years (2021-2023) using the same experimental area. The site consisted of an established bahiagrass pasture and the predominant soil is a Smyrna sand (sandy, siliceous, hyperthermic Aeric Alaquods). Each experimental unit is 6 by 9 m with 1.8-m alleys between plots. The experiment was arranged in complete randomized block design in a 3x3 factorial (3 fertilizer sources X 3 P application levels + control), with three replicates for a total of 30 plots. Treatments included three fertilizer sources (Class B aerobically digested biosolids, composted biosolids, and inorganic fertilizer) and three P-based application levels (low: 40 lb P_2O_5 A^{-1}; intermediate: 80 lb P_2O_5 A^{-1}; and high: 120 lb P_2O_5 A^{-1}). Treatment selection was based on soil SPSC of the experimental site (average of 64 mg kg^{-1}; 0-15 cm depth) and proposed new DEP biosolids regulations, up to 113 lb P/A/year could potentially be land applied.

Objective 2: To evaluate the impacts of new FL DEP biosolids rule on bahiagrass responses and water quality.

Bahiagrass was harvested at 45-day intervals from June to November, 2021 to determine herbage accumulation and nutritive value. At each harvest event, a 0.9 x 3 meters forage strip was harvested with a forage harvester and the remaining biomass will be mowed to the same stubble height. Forage samples will be analyzed for crude protein and total P concentrations, and in vitro digestible organic matter (IVDOM).

Leachate was monitored in 21 plots (2x3 factorial experiment design + control) using drain gauge lysimeters (Drain Gauge G3). Groundwater level, soil moisture content, and weather data were also continuously monitored during the 2021 growing season. Leachate samples were analyzed for total and inorganic P, total N, NO_3-N and NH_4-N concentrations. Pore water (~ 20 mL) was collected from the A horizon using suction ceramic cups. The frequency of pore water collection was two weeks or after extreme rainfall events (> 10 mm). In-situ soil P availability was estimated using anion exchange membranes.

<u>Objective 3.</u> To evaluate the impacts of repeated (6 yr) biosolids application on soil health

Soil core samples were randomly collected from eat plot at the 0-10, 10-20, 20-40, 40-60 and 60-90 cm depths in June 2021 At each sampling event, soil samples were air-dried, and sieved through a 2-mm stainless steel screen. Samples will be analyzed for pH, electrical conductivity, water extractable phosphorus, total C, N, and P, active C, extractable ammonium (NH4-N) and nitrate (NO3-N), and oxalate and Mehlich-3 extractable P, iron (Fe), and aluminum (Al).

Soil bulk density, water-stable aggregates, and particle size distribution was also determined in 2021and 2022. Soil volumetric moisture content was recorded using soil moisture sensors (EC-5) equipped with data logger (Em-50). Soil sensors were installed at the depth of 10 and 30 cm (effective root zone) in 21 plots. Soil water retention curve will also be determined in the lab. Soil microbial biomass and microbial community composition using the phospholipid fatty acids (PLFA) technique was determined. Additional soil characterization (water retention curve, respiration, hydrolysable carbon) is currently underway.

Results

Biosolids or inorganic fertilizer showed no effect on leachate nitrate-, ammonium-nitrogen, or P concentrations. No differences in leachate P between biosolids and control treatments were observed. Regardless of P source or rate, negligible amounts of P leached (~0.15% of applied P). This response was mainly due to the relative high soil P sorption capacity and crop P use efficiency. However, P mass leached was affected by year. In 2021, P mass leached was 18% greater than that in 2020 (Figure 1). Differences in P leaching across year may be due to extreme precipitation events recorded in 2021 that increased water table levels and subsequently favored P transport.

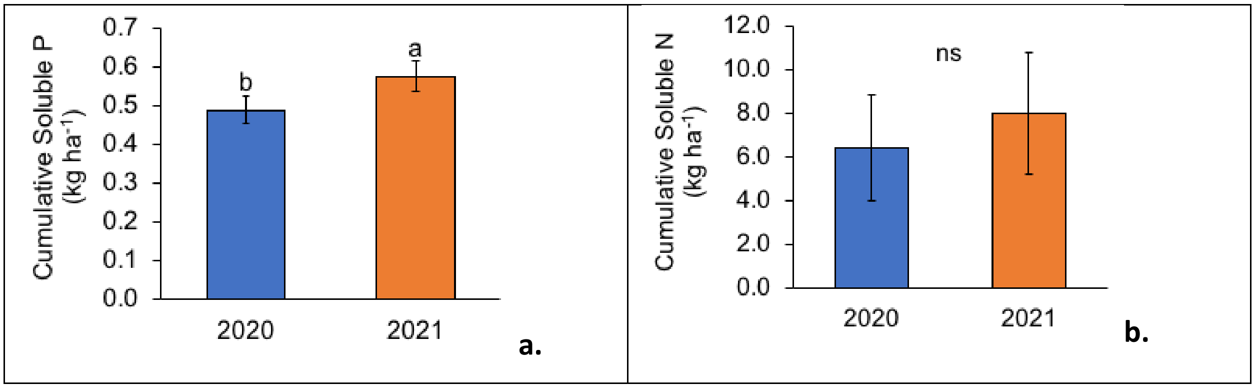


Figure 1. Cumulative mass of P (A) and inorganic N (B) leached (kg ha-1) in 2021 and 2022. Different letters show significant differences (Tukey test, $p < 0.05$). Error bars represent ± standard error of the means.

Water quality data collected in 2020-2021 and 2021-2022 growing seasons were also consistent with our previously published work. One of the main conclusions from our previous studies was that environmental conditions play a much stronger role on P losses than nutrient additions. Data obtained in the current study support this hypothesis.

We also used anionic exchange membranes and ceramic porous cups to monitor in-situ soil P availability during the growing season. Data suggested that biosolids acted as a slow-release fertilizer and provided a steady source of P that sustained bahiagrass production while also reducing the risk of P losses. Conversely, inorganic fertilizer increased in-situ P availability during the beginning of the growing season but P concentrations decreased as the growing season progressed.

Our results that although biosolids application increased bahiagrass production by ~105% relative to control (no N or P added) (Figure 2), bahiagrass herbage accumulation recorded in 2021 and 2022 was ~ 50% less than previously observed/published data for the same experimental area (Figure 3). This reduction in bahiagrass production was due to reduce biosolids application required by new FL-DEP regulation. In addition, biosolids-P is less bioavailable than inorganic P fertilizer, therefore, biosolids application at the same rates as inorganic fertilizer will also detrimentally affect forage production. To address this concern, a new greenhouse experiment was initiated in 2022 to evaluate the relative bioavailability of P in various biosolids compared to triple superphosphate in soils with contrasting P levels and P storage capacity. Treatments consisted of 2 soils (Low or High soil P storage capacity) x 3 P sources (triple superphosphate, 2 biosolids materials: composted Class AA, and biological P removal, applied at 0, 45, 90, and 135 lb P_2O_5 A^{-1}. This trial is currently underway and data will be distributed as soon as it becomes available.

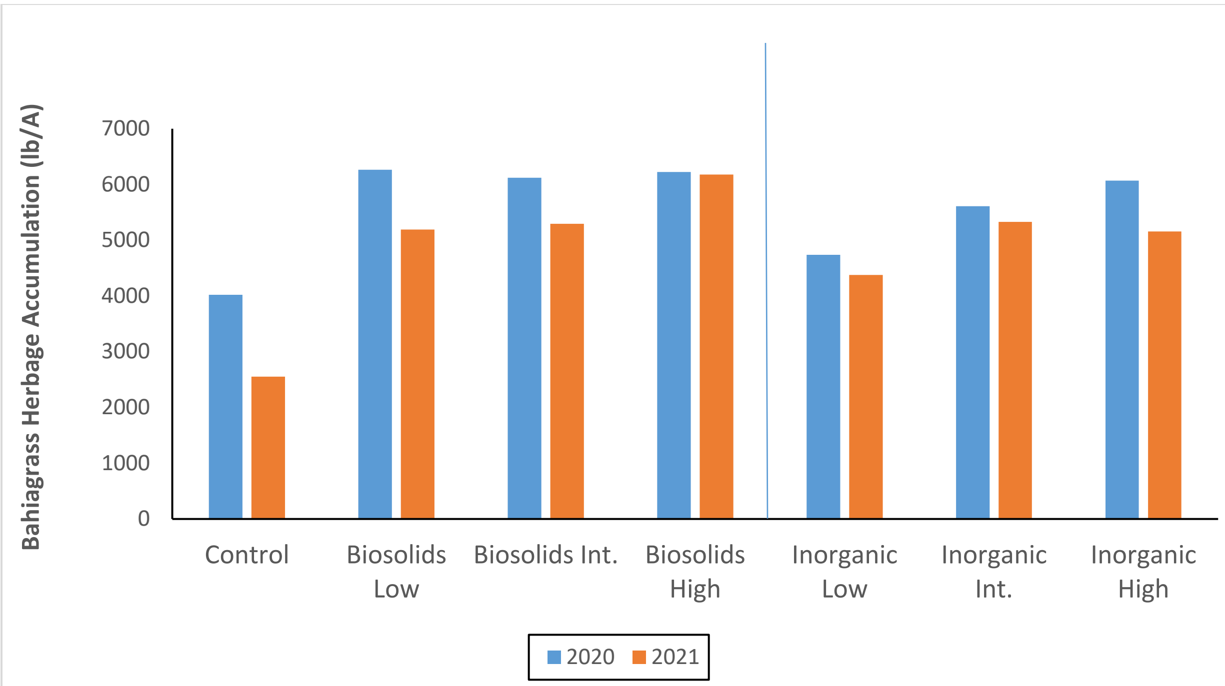


Figure 2. Bahiagrass herbage accumulation in 2020 and 2021 as affected by P source and rate

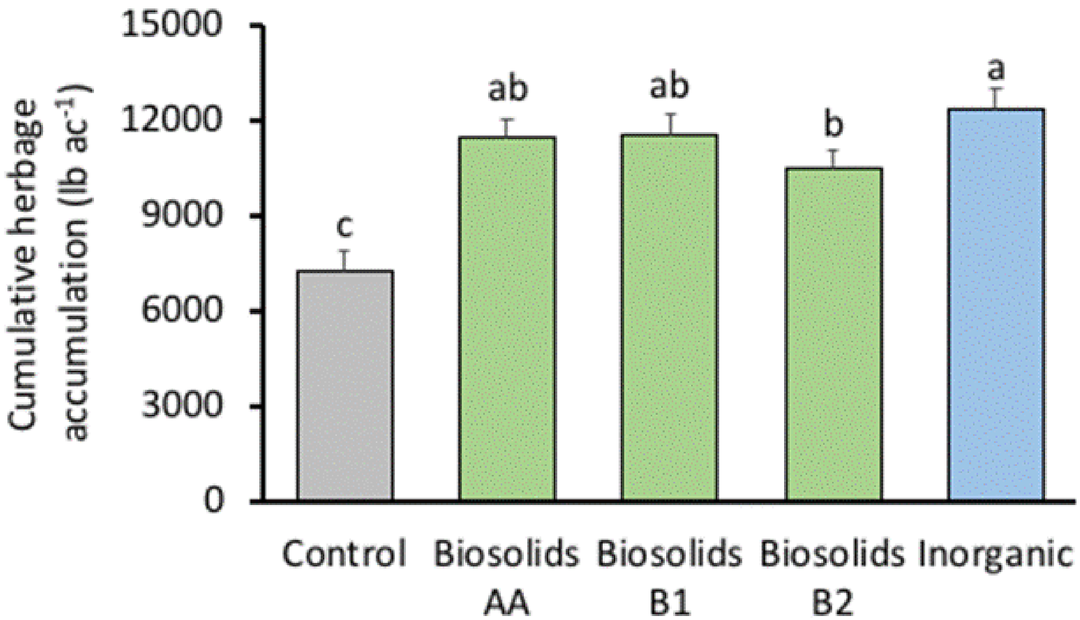


Figure 3. Bahiagrass herbage accumulation previously reported in the experimental area (adapted from Lu et al., 2019).

Soil health indicators (i.e., soil carbon concentration, water holding capacity, respiration, microbial biomass) were not affected by nutrient management strategies (data not presented). Although we expected that repeated biosolids application would lead to an increase in soil carbon levels, data showed no treatment effect on any measured soil properties. Additional analyzes are underway to verify whether there was any impact of biosolids or inorganic fertilizer additions on specific soil microbial responses.

Summary and conclusions

Several biotic and abiotic factors (e.g., rainfall, temperature, and timing of fertilizer application) may affect bahiagrass responses to biosolids application. Thus, multi-year research is necessary to confirm and validate the data. Pastures represent the major cropping system for biosolids recycling in FL, but multi-year **field** data to support the sustainability and safety of the practice are scarce. Most previous studies were conducted in greenhouses or laboratories. The agronomic and environmental impacts must be demonstrated in the field to credibly promote environmentally-sound biosolids land applications in livestock production systems.

Data obtained during the 2021-2022 growing season suggested application of biosolids or inorganic fertilizer had no significant impact on water quality. Similarly, no effect of nutrient additions on soil properties was observed. However, new FL-DEP biosolids rule will cause reduction in bahiagrass herbage accumulation when using biosolids as the only nutrient source.

ACKNOLEDGEMENTS - We thank the Florida Cattle Beef Board for providing the funds to support this project.

Final Technical Report

FCEB Project #1

Florida Cattle Enhancement Board
Final Report

Date submitted: 8/9/2022

Project title: Florida-raised beef strip steak quality audit

Project#: P0233735 (FCEB #33)

Principle investigators: Todd Thrift (PI)

Todd Thrift
University of Florida
Department of Animal Sciences
Building 459 Rm 210 C
PO box 110910
Gainesville FL 32611
tathrift@ufl.edu
352-538-3146 cell

Specific Aims

This project utilized the cattle being finished in the Fed Beef Challenge to validate that beef from Florida is equivalent in quality, yield, and tenderness to beef produced in other parts of the United States. This research addresses FCA research priority 8 Beef and Beef Products as well as priority 7 *Bos indicus* genetics.

Significance

The National Beef Tenderness Survey, first conducted in 1991, is a tool utilized by the U.S. beef industry to verify improvements in beef tenderness and quality. The primary area of focus for this audit has been to provide benchmark values regarding the quality of beef products from fed steers and heifers, enabling continual improvement of the industry and greater market share of U.S. beef as a competitive, center-plate protein option.

Consumer demand for local, Florida-raised beef has been steadily increasing in recent years. However, for Florida beef producers to continue improving product quality, benchmarking data are needed. Beef cattle genetics used in most operations in the Southeastern region have enabled producers to mitigate heat-stress, parasite, and insect challenges associated with beef production at subtropical climates. However, carcasses from these cattle have historically been associated with decreased marbling and palatability. With consumers reporting willingness to pay a premium for guaranteed tender beef, tenderness has repeatedly been identified as the most important palatability attribute (Shackelford et al., 1999). For a Florida-raised beef product to be successful it must provide a positive eating experience consistent with typical low Choice beef available in the U.S. retail case.

Improvements in genetics, nutrition, and management practices have positively affected the palatability of beef from Florida-raised cattle. However, industry perceptions of meat quality attributes of Florida cattle have changed relatively little over time, negatively impacting valuation of cattle from the Southeastern region. <u>The present study aims to conduct an audit of strip steak quality attributes from Florida-raised beef cattle. Data derived should validate that Florida raised beef is equal in quality and tenderness to beef produced elsewhere in the United States.</u>

Approach

Fed Beef Challenge Cattle were finished at Quincey Cattle Company in the fall of 2020 and spring of 2021. Cattle were known genetics, management, and represent a snapshot of the types of cattle raised in Florida. The Florida-raised steers (130 head from 9 ranches) on feed as a part of the Florida Fed Cattle Challenge program were harvested at a commercial processor in two groups (April 30 and June 18, 2021) upon reaching a uniform compositional endpoint. At 48 hours postmortem, a 1" slice of longissimus lumborum muscle was be taken from between the 12th and 13th rib section, stored on ice, and brought back to UF Animal Science where they were aged for 14 days. Steaks were analyzed for slice shear force (tenderness). All steaks were tempered for approximately 24 h at 4°C to allow them to completely thaw prior to analysis and cooked on an open-top grill until steaks reach 71°C. Three slices were removed from each steak and sheared. Peak shear force for each slice was recorded and averaged.

Control steaks were obtained from a major retailor that procures beef from all over the United States. The Control steaks originated from 7 different packers/suppliers providing a representative sample. They were all listed as in the Low Choice quality grade. Samples had been aged 14 days and were handled exactly the same as the Fed Beef Challenge steaks listed previously.

Ear punch samples were collected on the Fed Beef Challenge cattle and sent to Neogen for analysis of Brahman percentage using their Igenity Indicus genotyping system. The test technically identifies the % *Bos indicus*. *Bos indicus* does not always equate to Brahman. However, in this country, Brahman is the most predominant *Bos indicus* breed and was used in the formation of the American breeds like Brangus. The term % Brahman will be used to describe the % *Bos indicus* in this study. The % Brahman for each steer was correlated to marbling and tenderness shear force measures.

Results and Discussion

Averages for the 2021 Feed Beef Challenge cattle are presented in Table 1. Starting and finishing weight are similar but slightly lower to current industry averages. These cattle were fed as calves that had been weaned 45 days. The starting weight was lower and final weight was lower by approximately 100 lbs as compared to cattle that would enter the feedyard as yearlings. This is reflected in a slightly lower Hot Carcass Weight of 807 lbs which is still a very acceptable size carcass and likely provides more desirable sized retail cuts. Steers on the Feed Beef Challenge gained 3.14 lbs/d which is on target with industry standards. Marbling score averaged 400 which is right on the line to qualify for low choice. The % Choice was 64% with the remaining cattle (36%) falling into the Select grade. The national average for cattle presented for grading is closer to 80% Choice. This represents an area where Florida producers could make some improvement in Quality Grade as it is related to juiciness and overall eating satisfaction and is a major factor in pricing carcasses. It should be noted that steers in the Fed Beef Challenge graded in a very narrow window with most of them falling between a marbling score of 350 (middle Select) and 450 (middle Low Choice). Only 3 steers fell into the Average Choice Quality grade so very few Florida calves would have fallen into a Premium Quality category like CAB. Fed Beef steers were harvested at .47 inches of backfat which is below the national average. This was by design to determine which cattle have the ability to grade Choice at less than ½ inch of backfat. Certainly, if the cattle were taken to a higher degree of finish, they would likely have higher Quality Grade but would suffer in Yield Grade. Ribeye Area averaged 14 square inches and was very acceptable for the consumer market. Yield Grade averaged 2.79 which is also very acceptable. Tenderness measured as Slice Shear Force was 19.4 kg. Steaks under 20 kg are considered very acceptable to the consumer.

Table 1. Averages for the 2021 Fed Beef Challenge Cattle/Steaks

Start weight, lb	667
Average Daily Gain, lb/d	3.14
Days on Feed, d	211
Hot Carcass Weight, lb	807
Marbling Score	400
Yield Grade	2.79
Fat Thickness, inches	0.47
Ribeye Area, sq inches	14.0
Tenderness, kg	19.4

Cattle in the Fed Beef Challenge were sorted into 5 breed of sire classifications. Angus and Red Angus cattle had numerically higher Marbling Score and were both above the threshold (400) for the low choice quality grade (Figure 1). Charolais, Shorthorn, and Brangus/Brahman were slightly lower and all similar in marbling score. Differences in marbling score by breed of sire were minimal and numbers for some subgroups were small so no definitive conclusions should be drawn on level of marbling and breed of sire. No one sire breed was far superior in marbling.

Slice Shear force by sire breed is shown in figure 2. Tenderness was similar for all cattle regardless of sire breed. Differences observed were small and did not mirror differences observed in marbling. This suggest that although some breeds (of sire) had slight advantage in marbling it did not translate to improvements in tenderness.

Brahman % was estimated via DNA using Igenity indicus test from Neogen. Fed Beef Cattle ranged from 0% to 100% Brahman and averaged 30% for the entire group. Cattle were grouped by their indicus profile into 0-10%, 11-20%, 21-30%, 31-40%, 41-50%, and the remaining cattle were combined into 51-100%. Marbling Score declined slightly as Brahman percentage increased (Figure 3). The largest decline occurred for cattle above 31% and was similar for the top three Brahman % groups. It has been well documented that as Brahman % increases marbling score declines. As with the Breed of Sire evaluation, it should be noted the decline was small and was not a linear decline but rather a stair step down when cattle were around 1/3 Brahman. All marbling scores regardless of Brahman % were in a very narrow window suggesting there was little variation in actual fat content of the muscle.

Slice Shear force was highest for the 51-100% Brahman influenced cattle (figure 4). It should be noted that this represents two pens of cattle. One was Brahman sired and one was purebred Brahman. Tenderness in these cattle ranged from extremely tender to extremely tough. Previous research with Brahman cattle has shown that tenderness generally increases linearly as Brahman % increases and more importantly the variation in tenderness increases with higher Brahman %. Slice shear force values were numerically second highest in the 0-10% Brahman group, and very similar to tenderness values of all other groups. All groups under 50% Brahman were acceptable in average tenderness and below the 20 kg threshold for tender beef. Therefore, current discounts on cattle/calves that are less than ½ Brahman breeding are not warranted based on perceptions about tenderness.

The original intent of this study was to compare beef from Florida Raised, Fed, and Harvested cattle to cattle from across the United States. Steaks from a major retailer served as Controls. These steaks were aged, handled, and cooked identical to the Fed Beef Challenge steaks. By design these steaks had higher degree of marbling and many were in the Average Choice range. Slice Shear Force of the Florida raised Fed Beef Challenge Cattle (19.43 kg) was identical to the Control Choice steaks (19.72 kg) from the major retailer (Table 2). The range in shear force values was smaller in the Fed Beef Challenge cattle. Only 6 % of Fed Beef Challenge Cattle would have been classified as tough with a shear force of more than 25 kg. The Control cattle had 12% of steaks fall into the over 25 kg tough classification. Tenderness is the attribute most consumers desire when eating beef and is the trait most associated with eating satisfaction. Florida Raised beef has been shown to be comparable to Choice beef in tenderness even though the level of marbling is slightly lower. This research documents that cattle from Florida are capable of producing the tender product that the beef consumer is demanding in today's marketplace.

Summary
Cattle were more tender in the 2021 Fed Beef Challenge than in previous years. No one breed of sire was superior for tenderness. Brahman percentage was not a major factor affecting tenderness in cattle that were under 50% Brahman. Steaks from steers with minimal Brahman % (0-10%) were not more tender. Improvements in marbling score are justified in the Florida cattle. Marbling score tended to decline as % Brahman increased. Marbling score in the Fed Beef Cattle was in a very narrow window from mid select to mid low choice.

For Florida beef to gain market share as a competitive, center-plate protein option with regional consumers, it must provide a positive eating experience consistent with typical low Choice beef available in the U.S. retail case. Steaks from Florida Fed Beef Challenge cattle were as tender as steaks from a major retailer suggesting that beef raised in FL is comparable in tenderness to steaks from the rest of the United States. Locally raised Fresh from Florida beef appears to be a viable market for Florida Cattle.

Figure 1. Quality Grade by Breed of Sire for the 2021 Fed Beef Challenge cattle.

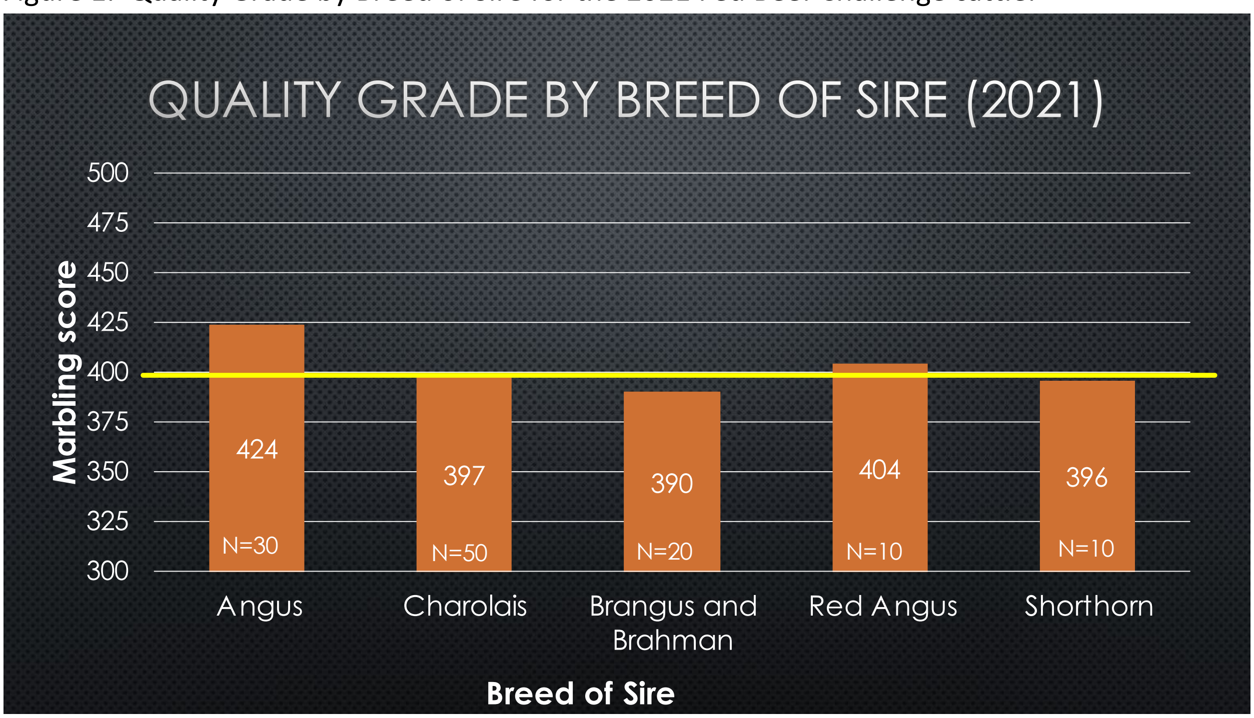


Figure 2. Slice Shear Force by Breed of Sire for the 2021 Fed Beef Challenge cattle.

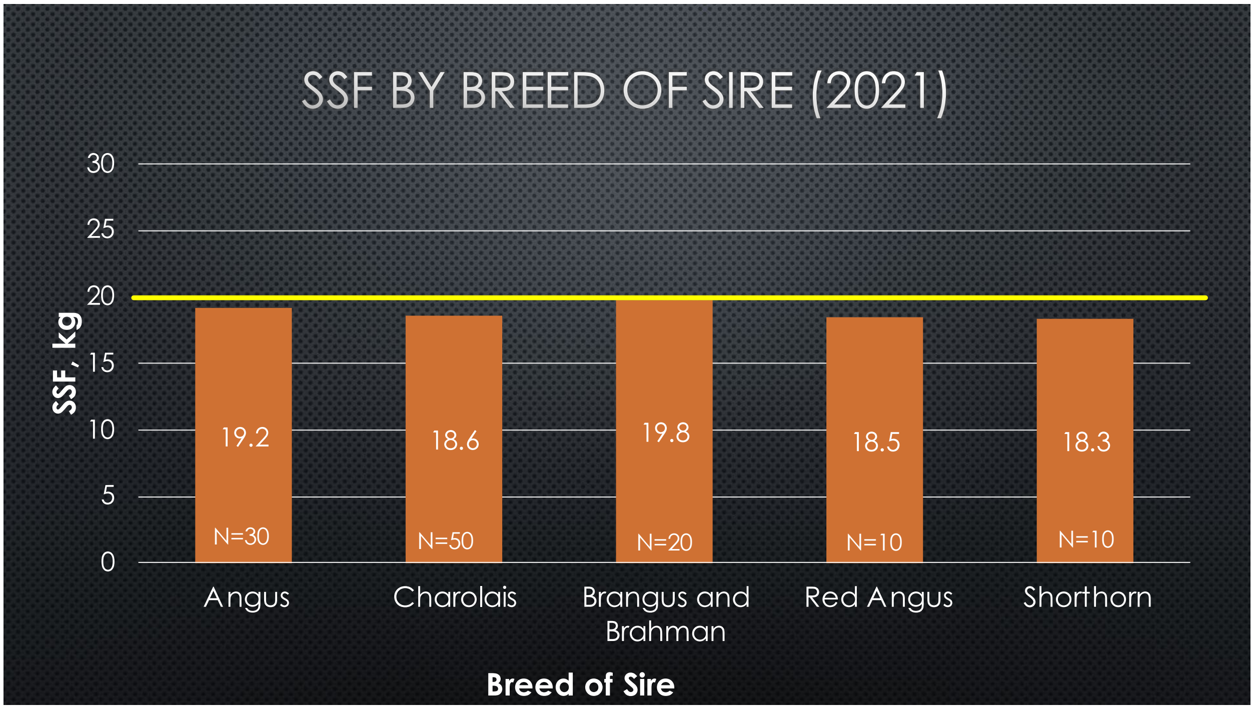


Figure 3. Marbling Score by Brahman % for the 2021 Fed Beef Challenge cattle.

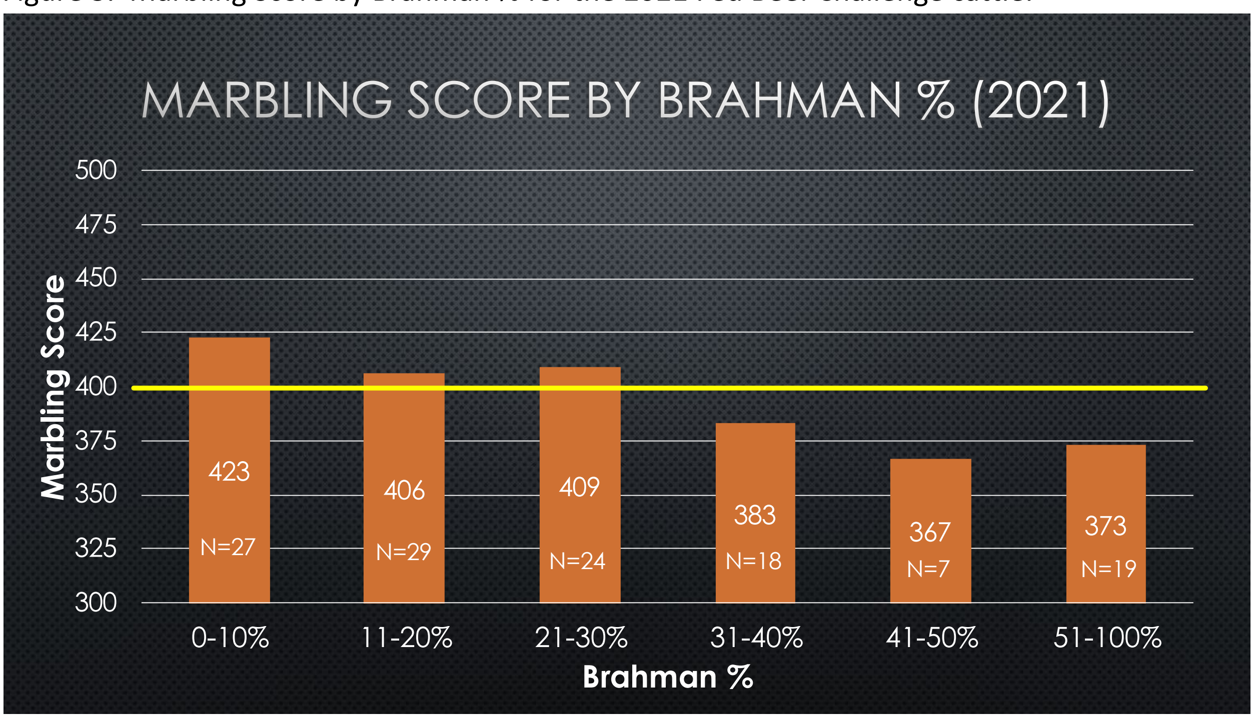


Figure 4. Slice Shear Force by Brahman % for the 2021 Fed Beef Challenge cattle.

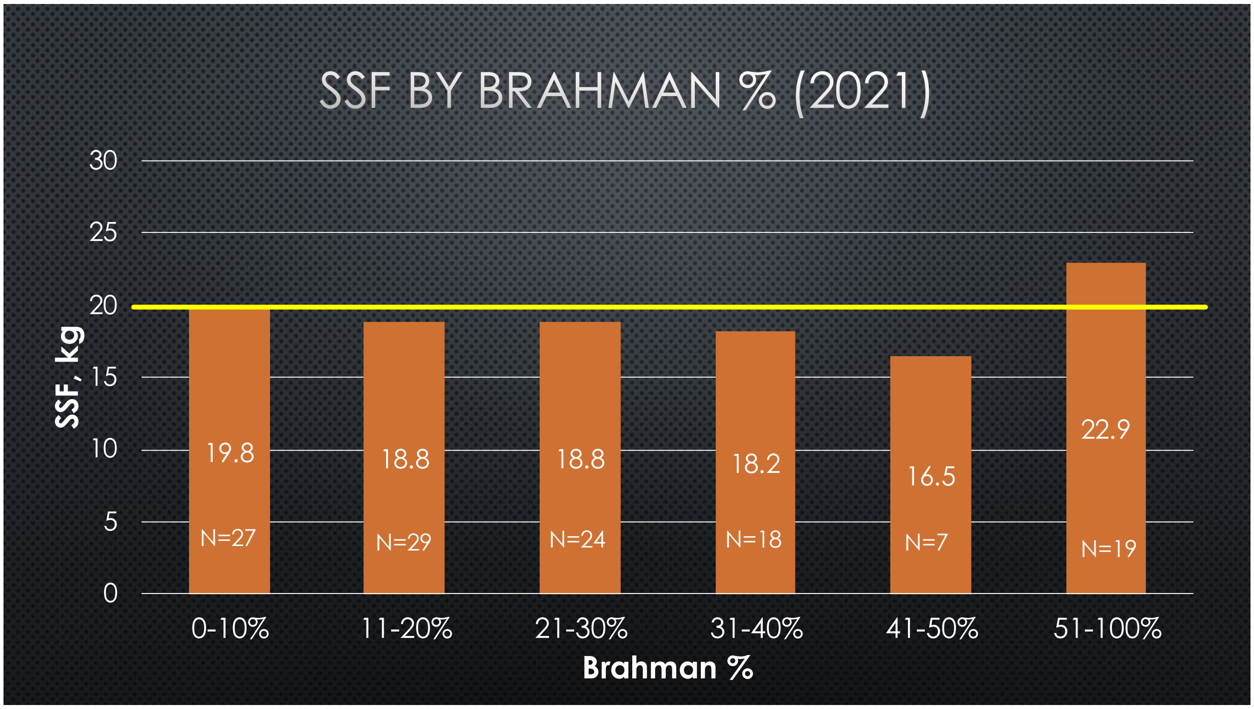


Table 2. Comparison of the 2021 Fed Beef Challenge steaks to Control Choice steaks

HOW DO THEY COMPARE?

	Fed Beef Challenge 2021	Major Retail Outlet 2021
Number head	130	210
Marbling Score	400	400-500+
% CH	64%	100%
Brahman %	30 %	???
SSF	19.43 kg	19.72 kg
SSF range	12.0 – 32.1 kg	11.3 - 37.4 kg
% over 25 kg	6 %	12%

Final Technical Report

FCEB Project #1

Final Technical Report - Cattle Enhancement Board

Project P0233674 (FCEB#35)

Project title and principal investigator contact information

Identifying genetic markers for neonatal weak calf syndrome in Brahman cattle. Principal investigator: Peter J Hansen, Dept of Animal Sciences, University of Florida, pjhansen@ufl.edu; 352-359-5753.

Co-principal investigators: D. Owen Rae and Myriam B. Jimenez, Dept of Large Animal Clinical Sciences, University of Florida; Raluca Mateescu, Dept. of Animal Sciences, University of Florida; and Francisco Peñagaricano, Dept. of Animal and Dairy Sciences, University of Wisconsin

Specific aims

There are two specific aims:

1. Identify genomic regions associated with neonatal weak calf syndrome (NWCS) in Brahman cattle.
2. Identify genetic markers (mutations) within these genomic regions with biological relevance for predicting NWCS.

Approach

We proposeed to obtain semen from 100 of the Brahman sires used in the study of Jimenez et al. (unpublished), isolate DNA from the semen and subject it to genotyping analysis using the GeneSeek GGP F250K Bovine SNP chip (Lincoln, NE). The plan was to examine genes located in the genomic regions found to be associated with NWCS and examine their relationship to each other and their known function in biology to learn about the physiological mechanisms making a calf susceptible to NWCS.

Progress to Date

This project was not taken to successful completion because we were not been able to find semen from all of the original 100 bulls that we proposed to genotype. In fact, we only genotyped about 10-15 bulls. We will not spend more than $2,100 of the $12,902 budgeted. Accordingly, we have notified Dusty Holley of the Cattle Enhancement Board of the fact that we would not spend more than $2100 of the $12,902 on Feb 27 2021 and requested that $10,802 be reallocated to other projects.

Final Technical Report

FCEB Project #1

Evaluating the carbon balance and global warming potential of typical Florida cow-calf production systems.

Rosvel Bracho[1*] and María L. Silveira[2]

[1]School of Forest, Fisheries & Geomatics Sciences, 136 Newins Ziegler Hall/ University of Florida, Gainesville, FL 32611. *Email: rbracho@ufl.edu. [2]UF-IFAS/Range Cattle REC. 3401 Experiment Station, Ona, FL 33865. [2]UF/IFAS Soil and Water Science Department, 2181 McCarty Hall A, Gainesville, FL 32611.

1. PROJECT OVERVIEW

Grazing lands are the dominant land use in the US. In Florida, more than half of the agricultural lands (> 4.4 million acres) are used for cattle production, providing food to millions and many other benefits including support and regulation of ecosystems services. The typical cow-calf production systems in the state use native rangeland areas and planted pastures as major source of food for cattle. Research is focused on increasing food provision to cattle through proper management in both cow-calf production systems and on quantifying environmental impacts associated with the management strategies. However, the impact of cow-calf production practice on ecosystem carbon balance, and warming potential in the region is still unknown. Our **main objectives** were (1) *To evaluate ecosystem carbon balance (difference between the amount of carbon fixed during photosynthesis and carbon losses by respiration) associated with typical pasture-based cow calf production system in Florida. (2) To evaluate the greenhouse gas emissions and warming potential of typical pasture-based cow-calf production systems in Florida*. **Our main hypothesis** is that the cow-calf production systems are a carbon sink under the current management practices, making a significant contribution in the fight against global warming. This project fills a significant gap in warming potential in cow-calf production systems, a native rangeland and a planted bahiagrass pasture***. It addresses the FCA Priority # 4, Ranching activities: Interactions with the environment (Potential Global Warming).***

2. PROJECT ACTIVITIES

Experimental Setup

This research used an established USDA, LTAR site located in Ona FL (ABS-UF LTAR site 27°23′76″N, 82°56′11″ W). It was conducted on two experimental areas, a 54 acres native rangeland and a 46 acres bahiagrass pasture. The native rangeland site is grazed at a rate of 13 acres/animal from November to February using cull cows. The bahiagrass pasture is grazed with 1.5 acres/animal year-round using adult cows. Eddy covariance towers equipped to measure carbon dioxide fluxes has been running over the last four years at the native rangeland site and at the improved pasture site since February 2021. Eddy covariance methane measurements started during the springtime of 2021 at the native rangeland, and in July 2021 at the improved pasture site. Data presented in this report cover a complete year of carbon dioxide and methane exchange at both sites. Ancillary meteorological data including precipitation, air temperature, relative humidity, radiation (global incoming, net, and photosynthetically active radiation), soil temperature, soil moisture and soil heat flux were also collected at each site. Soil greenhouse gasses emissions (carbon dioxide, methane, and nitrous oxide) are being measured using static chambers at each site since September 2021 at the pasture site and November 2021 at the native rangeland.

Key variables

Net ecosystem productivity (NEP), the net carbon exchange as carbon dioxide, and **methane fluxes** at ecosystem level were calculated from the eddy covariance measurements of both gases, fluxes were integrated over monthly and yearly time frames. **Cows' emission factor (EF)** was calculated according to IPCC Tier 2 guidelines (IPCC, 2006) for two subcategories 1) lactating cows and 2) pregnant cows. Cows' methane emission was converted into emissions per area by using the stocking rate. **Methane emissions** were converted into carbon dioxide equivalent (CO_2eqv) in 100 years scenario by multiplying methane emissions by 28 (IPCC 2014), the global warming potential as compared to carbon dioxide. **Nitrogen emissions**, a factor of 3.88 Kg CO_2eqv (IPCC 2014) for fabrication of nitrogen fertilizer was used, and since we do not have a complete year of N_2O emissions we used an emission factor of 2.73 Kg CO_2eqv per kg on nitrogen applied (Ledgard et al, 2011). **Global warming potential** for each ecosystem was calculated by integrating NEP, and carbon dioxide equivalent for methane (ecosystem + cows) and nitrogen emissions. Each variable is reported in pounds of carbon as carbon dioxide equivalent per acre per year (lbs. Ceqv $acre^{-1}$ $year^{-1}$). Negative NEP indicates net gain of carbon by the ecosystem.

3. RESULTS

Monthly carbon equivalent fluxes

Both ecosystems showed a strong seasonality in net ecosystem productivity (NEP) (Figure 1), with higher carbon uptake during the spring and summer time, the improved pasture reached NEP close to -900 lbs acre^{-1} month^{-1} of carbon as CO_2 during the growing season, while the native rangeland reached maximum NEP close to -320 lbs acre^{-1} month^{-1} of carbon as CO_2. Native rangeland acted as a carbon source at the end of the dry season (June), while the improved pasture was a carbon source during the dormant season (December – February). Methane emissions from the native rangeland are very small compared to the improved pasture, even during the grazing time, due to the low stocking rate, and it can be a small methane sink during the dry season. The improved pasture was a methane source year-round and ecosystem methane emissions more than doubled potential emissions by cows.

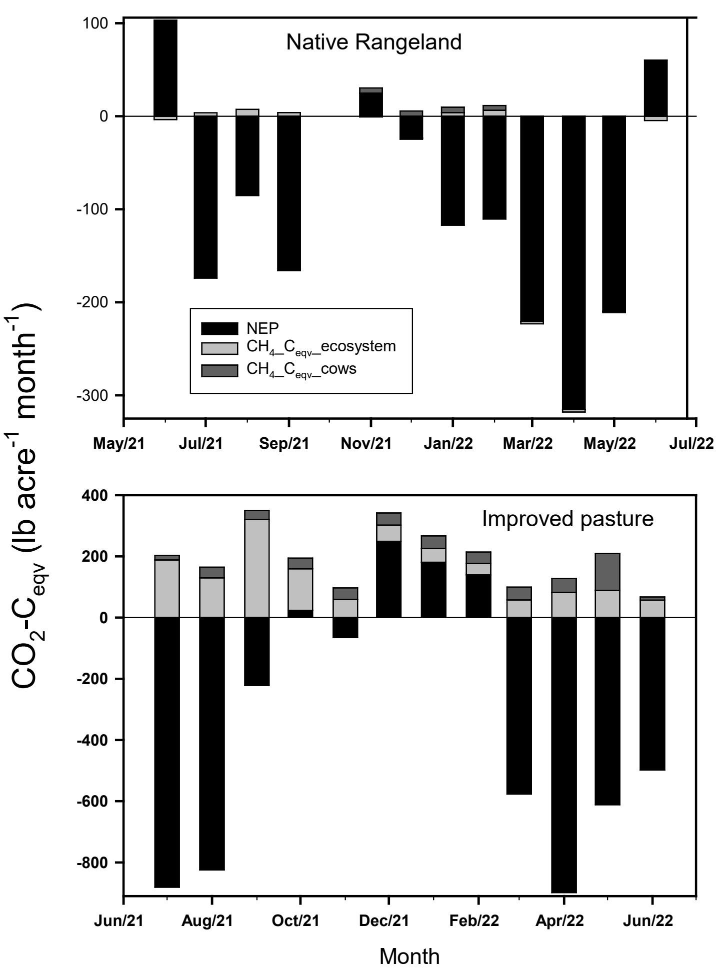


Figure 1. Monthly CO_2-Ceqv for a native Florida rangeland and an improved Bahia grass pasture. NEP = net ecosystem productivity; CH_4_Ceqv_ecosystem = methane emissions by the ecosystem as CO_2_Ceqv; CH_4_Ceqv_cows = methane emissions by cows as CO_2_Ceqv.

Annual balance and warming potential

On the yearly basis, both ecosystems were carbon sinks as indicated by negative NEP (Table 1). The improved Bahia grass pasture was three times more productive than the native rangeland during the study period; however, net carbon uptake capacity by the improved pasture is reduced by 47% when ecosystem methane emissions and potential emissions by enteric fermentation, plus fertilization, are counted for. Nevertheless, the improved pasture site remained as a strong carbon sink with a warming potential of **-2161 lbs. acre^{-1} year^{-1}** of carbon as carbon dioxide equivalent, and almost doubled the native's rangeland carbon sink strength.

Table 1. Annual net ecosystem production (NEP), carbon equivalent methane emissions (CH_4_Ceqv) by ecosystem and cows and by fertilizer, and final warming potential for two typical Florida cow-calf production systems.

Ecosystem	NEP	CH_4_Ceqv (Ecosystem)	CH_4_Ceqv (cows)	Fertilizer (Ceqv)	Warming Potential
Native Rangeland	-1233	9	22.2	0	-1201
Improved Pasture	-3984	1252	491	80	-2161

All values are in pounds per acre per year (lbs. acre^{-1} year^{-1})
NEP = Net ecosystem productivity
CH_4_Ceqv = Methane emissions as carbon equivalent by the ecosystem or cows' emissions.
Fertilizer (Ceqv) = carbon emitted to produce nitrogen fertilizer
Warming potential = Warming Potential in 100 years scenario (IPCC).
Negative values indicate uptake/sink capacity by the ecosystem.

4. SUMMARY AND CONCLUSIONS

The two cow-calf production systems were fully instrumented through 2021, and a great effort devoted to maintaining a continuous data collection and complete record of grazing stocking rates. Complete simultaneous measurements of carbon dioxide and methane using eddy covariance started the second part of year 2021. Soil greenhouse collection started late during 2021, this task requires a great effort to complete it. **Data collected on carbon dioxide and methane fluxes indicated that the two cow-calf production systems established in Ona FL (ABS-UF LTAR site Ona FL) were a significant carbon sink under the current**

management and the climatic conditions prevailing during the year of study, indicating that both cow-calf production systems can be a viable option to help on the fight for carbon mitigation while providing many other services like food, biodiversity and water protection among many others. However, climatic variability is very broad in the region, with the presence of multiyear droughts or very wet periods, as it was during the second part of 2021. Consequently, multi-year research aimed to cover the climatic variability and its interaction with management practices is required.

ACKNOLEDGEMENTS

We thank the Florida Cattle Beef Board for providing funds to support this project. We also thank the support from the Long-Term Agroecosystem Research (LTAR) network for providing the instrumentation of both sites.

5. PERCENTAGE COMPLETION OF PROJECT DELIVERABLES: 100%

6. SUMMARY OF ACADEMIC PRODUCTS DERIVED FROM THIS PROJECT

PRESENATIONS

Rosvel Bracho, María L. Silveira, Marta M. Kohmann, Abmael S. Cardoso & Gerardo Celis. 2022. Carbon balance and global warming potential of typical Florida cow-calf production systems. 8th International Greenhouse Gas & Animal Agriculture Conference. June 5 – 9, 2022. Orlando, Florida USA.

REFERENCES

Intergovernmental Panel on Climate Change (IPCC). 2006. Emissions from livestock and manure management. Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K, editors. 2006 IPCC guidelines for national greenhouse gas inventories. Vol. 4. Agricultural, forestry and other land uses. IGES, Japan. p. 10.1-10.87.

IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

Ledgard, S.F., Boyes, M., Brentrup, F., 2011. Life cycle assessment of local and imported fertilisers used on New Zealand farms. In: Currie, L.D., Cristensen, C.L. (Eds.), Adding to the Knowledge Base for the Nutrient ManagerOccasional Report No. 24. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand (Available at http://flrc.massey.ac.nz/publications.html, accessed 12th January 2015). (13 pp.).