Florida Cattle Enhancement Board Final Report 9/15/2017

Comparison of long-term progestin-based protocols to synchronize estrus prior to fixed-time artificial insemination or natural service in *Bos indicus*-influenced beef heifers

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Abstract

An experiment was designed to evaluate breeding strategies for *Bos indicus*-influenced beef heifers. Treatments were designed to compare natural service (NS) and fixed-time artificial insemination (FTAI) as well as evaluate the effect of estrus synchronization with melengestrol acetate (MGA; 0.5 mg·animal^{-1}·d^{-1}) or a controlled internal drug release (CIDR; 1.38 g progesterone). Weights and reproductive tract scores (RTS; Scale 1-5) were obtained for heifers (n = 1,456) within a single location prior to assignment of one of five treatments: NS with no estrus synchronization (NS); NS beginning 10 days after a 14 d feeding of MGA (MGA + NS); natural-service beginning 10 days after treatment with a CIDR for 14 d (CIDR + NS); FTAI following the 14-d MGA-PG protocol (MGA + FTAI); or FTAI following 14-d CIDR-PG protocol (CIDR + FTAI). Heifers in FTAI treatments were administered $PGF_{2\alpha}$ (PG; 25 mg, IM) 19 or 16 d following MGA or CIDR removal, respectively. For MGA-PG and CIDR-PG treatments, FTAI was performed 72 and 66 h after PG, respectively. Gonadotropin-releasing hormone (GnRH; 100μg, IM) was administered concurrent with FTAI. Estrus detection aids were applied at PG to heifers in FTAI treatments and evaluated at AI to determine estrous response. Blood samples were collected and ovarian ultrasounds were performed at PG and FTAI to compare serum concentrations of estradiol, progesterone, and follicular dynamics between the two FTAI treatments. Heifers in FTAI treatments were exposed to fertile bulls 12 d following FTAI. Heifers in the three NS treatments were exposed to fertile bulls for 60 d, beginning 10 d after progestin removal for MGA + NS and CIDR + NS groups. Pubertal status was based on reproductive tract score and outcomes were evaluated within three groups: prepubertal RTS = 1-2; peripubertal RTS = 3; pubertal RTS = 4-5. Pregnancy status was determined at the end of a 60 d breeding period. Data were analyzed using PROC FREQ, GLM, and GLIMMIX procedures of SAS. Heifers that exhibited estrus by FTAI had higher serum concentrations of progesterone ($P = 0.006$; 8.6 versus 4.5 ng/ml) and larger dominant follicle diameter (LFD; $P = 0.01$; 9.2 versus 7.5 mm) at PG administration. At FTAI, LFD was influenced by pretreatment pubertal status ($P = 0.02$). Females assigned to the MGA + FTAI treatment had higher serum concentrations of progesterone at PG ($P = 0.04$; 8.1 versus 5.0 ng/ml) than CIDR + FTAI treated heifers. Serum concentrations of estradiol at FTAI were higher among CIDR- versus MGA-treated heifers ($P = 0.04$; 8.2 versus 6.4 pg/ml); however, estrous response after PG (53%) and pregnancy rates after FTAI (40%) did not differ between MGA- and CIDR-PG treatments. Across all treatments, pregnancy rates were compared on 21, 30 and 60 d of the breeding period based on pretreatment weight, pubertal status, and treatment. Pregnancy rate was influenced by pretreatment pubertal status ($P \leq 0.03$) and weight ($P \leq 0.057$) at all three time points, with higher pregnancy rates observed among heifers that weighed more and were pubertal prior to treatment initiation. By day 30, the CIDR + NS treatment resulted in higher pregnancy rates as compared to both FTAI treatments ($P \leq 0.02$), while there were no differences among the three natural service treatments. There was no difference, however, among treatments with regard to pregnancy rate at day 21 or day 60 of the breeding season. These data can be used as a basis for considering various breeding management strategies for *Bos indicus*-influenced beef heifers, and highlight the importance of prebreeding evaluations to ensure adequate heifer growth and pubertal status prior to the start of the breeding period.

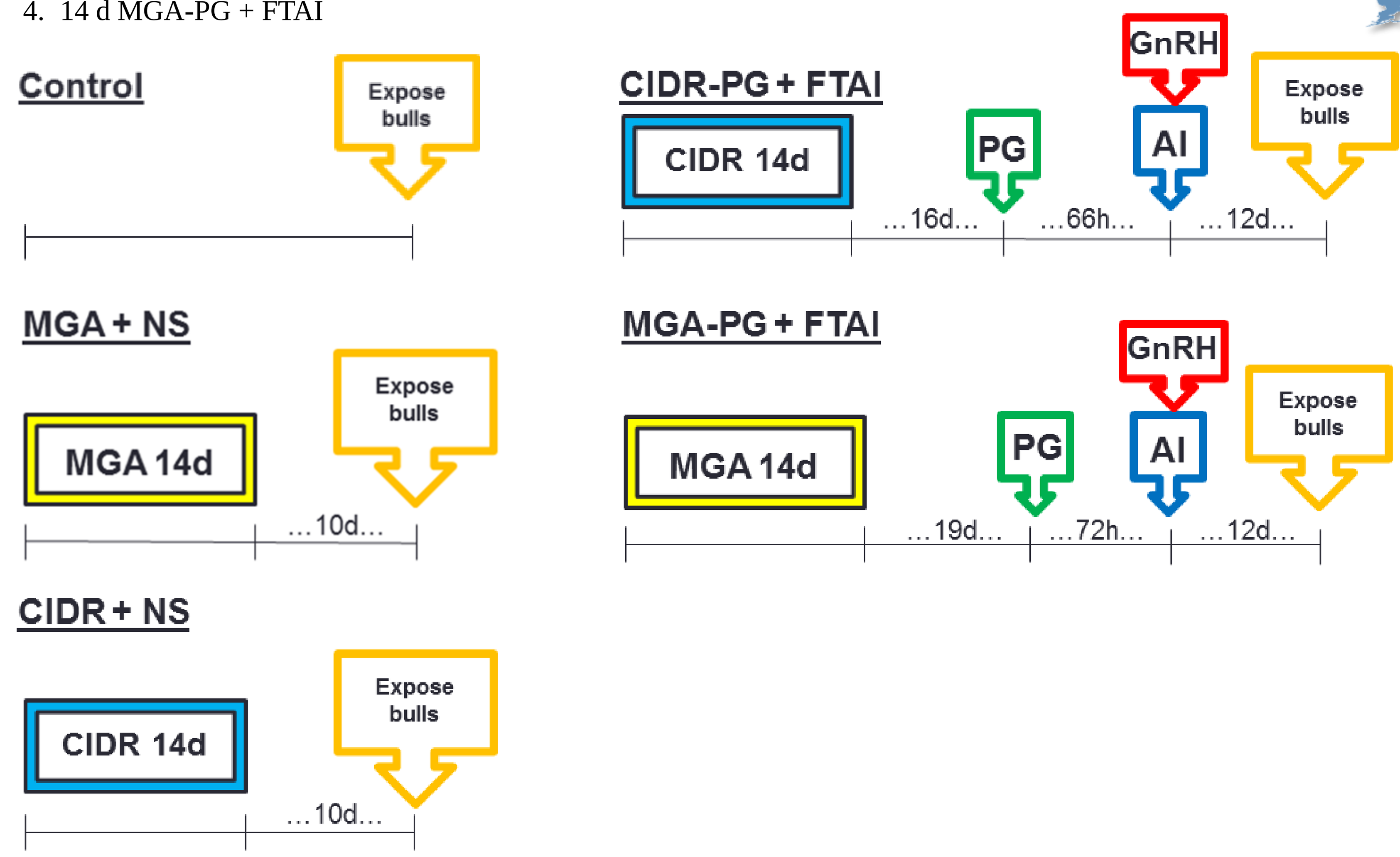
Introduction

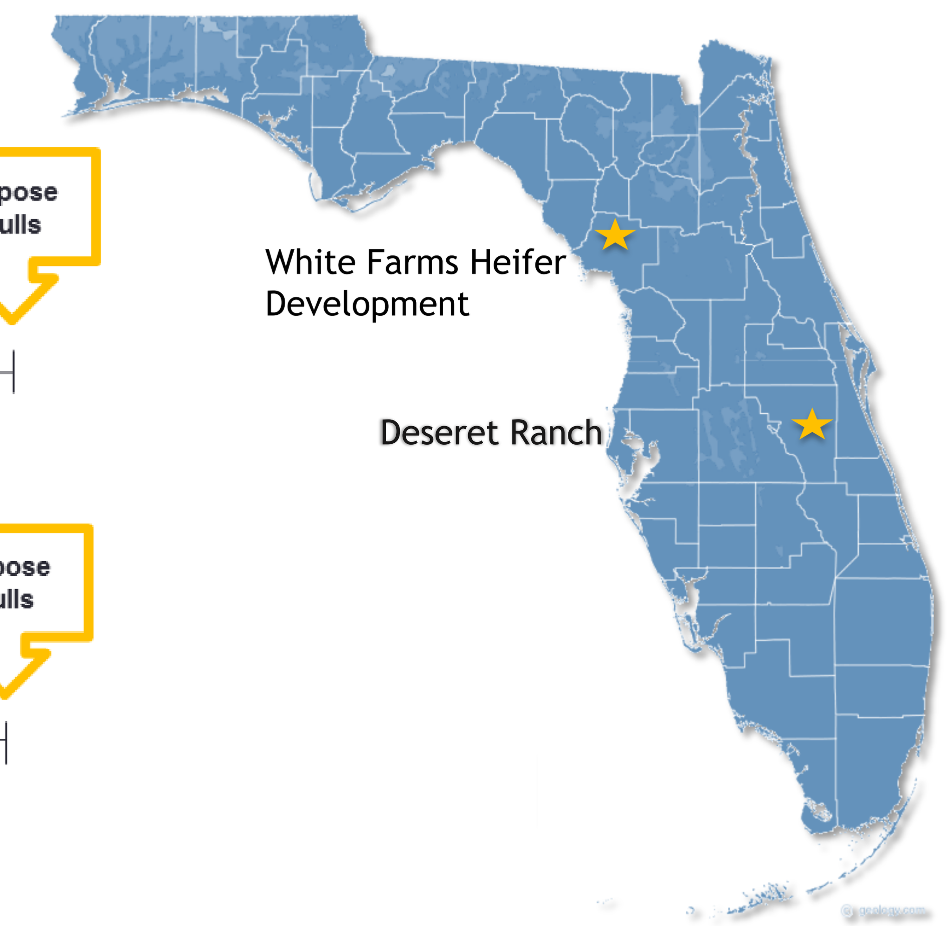
- *Bos indicus*-influenced beef heifers (Sartori, et al, 2010; Yelich and Bridges, 2012)
  - Thrive in Subtropical environments
  - Delayed Puberty
  - Differing response to synchronization drugs
  - Limited research using FDA-approved pharmaceuticals
- Long-term estrus synchronization protocols
  - Well-understood in *Bos taurus* heifers
  - Efficacy in *Bos indicus*-influenced heifers is not characterized

Materials and Methods

Pretreatment reproductive tract scores (RTS) and weights were recorded for 1456 heifers prior to assignment to one of five treatments:

1. Natural Service (NS) with no estrus synchronization
2. 14 d MGA + NS
3. 14 d CIDR + NS
4. 14 d MGA-PG + FTAI





Results

- Differences between FTAI treatments exist relative to follicular dynamics and mean progesterone and estradiol concentrations (Table 1).
- Pregnancy rate was significantly influenced by pretreatment pubertal status ($P \leq 0.03$) and weight ($P \leq 0.057$) at 21, 30, and 60 days of the breeding season (Table 2).
- No difference among treatments by Day 60 of the breeding season
- FTAI treatments resulted in a significantly lower mean day of conception compared to all three natural service groups (Table 3).

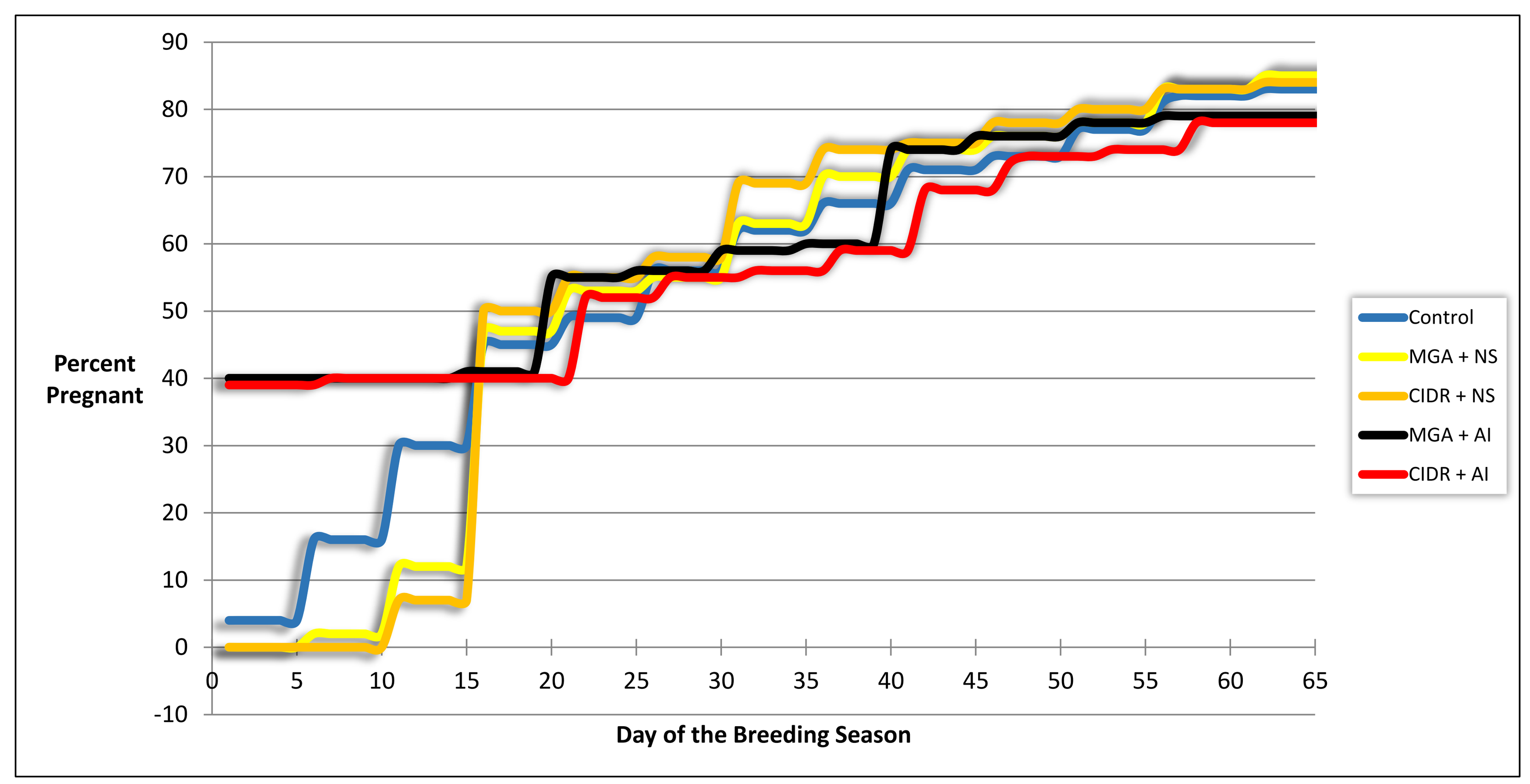


Table 1. Mean Progesterone (ng/ml), Estradiol (pg/ml) concentration, and Largest Follicle (mm) at PG administration and AI

Pubertal status	FTAI Treatment	P4 at PG	P4 at AI	E2 at PG	E2 at AI	LFD at PG	LFD at AI
Prepubertal	MGA	6.4	0.4	5.9	9.1	8.3	8.3^a
	CIDR	4.4	0.8	7.4	6.2	8.4^a	9.3
Peripubertal	MGA	7.8	0.8	6.5	6.6	7.7	8.5^a
	CIDR	4.7	0.7	6.3	7.0	7.3^a	10.4
Pubertal	MGA	8.3	1.0	6.4	8.5	8.1	11.4^b
	CIDR	6.9	0.7	6.2	7.2	10.1^b	10.4
Total	MGA	7.9^a	0.7	6.3	8.2^a	8.0	9.4
	CIDR	5.3^b	0.7	6.8	6.4^b	8.6	10.0

^{ab}Values within column with different superscripts differ ($P \leq 0.05$).

Table 2. Percent pregnant by days 21, 30, and 60 of the breeding season

Pubertal status	Breeding period	Control + NS No.	Control + NS %	MGA + NS No.	MGA + NS %	CIDR + NS No.	CIDR + NS %	MGA-PG + FTAI No.	MGA-PG + FTAI %	CIDR-PG + FTAI No.	CIDR-PG + FTAI %	Total No.	Total %
	Day 21	45/117	38^a	42/81	52	60/121	50	48/102	47^a	29/81	36^a	224/502	45^a
Prepubertal	Day 30	64/117	55^c	50/81	62	78/121	64	52/102	51^c	30/81	37^c	274/502	55^d
	Day 60	92/117	79	69/81	85	89/121	74	73/102	72	54/81	67^f	377/502	75^g
	Day 21	44/91	48^{ab}	51/97	53	51/89	57	53/98	54^{ab}	45/92	49^{ab}	244/467	52^b
Peripubertal	Day 30	55/91	60^{cd}	61/97	63	63/89	71	58/98	59^{cd}	50/92	54^d	287/467	61^e
	Day 60	73/91	80	83/97	86	79/89	89	81/98	83	72/92	78^{fg}	388/467	83^{gh}
	Day 21	57/91	63^b	64/117	55	47/79	59	61/95	64^b	71/105	68^b	300/487	62^c
Pubertal	Day 30	67/91	74^d	74/117	63	58/79	73	64/95	67^d	73/105	70^e	336/487	69^f
	Day 60	81/91	89	94/117	80	71/79	90	79/95	83	91/105	87^g	416/487	85^h
Total		246/299	82	246/295	83	239/289	83	233/295	79	217/278	78	1181/1456	81

^{abcdefg}Pregnancy rates at each time point within column with different superscripts differ ($P \leq 0.05$).

Table 3. Mean day of conception within the 60d breeding season

Pubertal status	Control	MGA + NS	CIDR + NS	MGA-PG + FTAI	CIDR-PG + FTAI	Total
	(Days)	(Days)	(Days)	(Days)	(Days)	(Days)
Prepubertal	25^{1a}	24^{13}	23^{13}	18^{2a}	18^{23a}	22^a
Peripubertal	23^{13ab}	25^1	24^1	17^{2a}	18^{23a}	21^a
Pubertal	18^{14b}	24^1	22^{13}	12^{2b}	13$^{24'b}$	18^b
Total	22^1	24^1	23^1	16^2	17^2	21

Day 0 corresponds to introduction of bulls in natural service treatments or performance of FTAI. ^{ab}Pubertal status within column with different superscripts differ ($P \leq 0.05$). ^{1234}Treatment comparison within row with different superscripts differ ($P \leq 0.05$). 4' denotes tendency ($P = 0.07$).

Discussion

Pubertal status prior to the start of the breeding season was the largest factor in predicting breeding success. Heifers that were prepubertal prior to the onset of the breeding season achieved lower pregnancy rates by the end of the breeding season than those heifers that were ≤ 30d from puberty ($P = 0.05$).

Pregnancy rates to FTAI could be improved by utilizing a bull that is known to work well in a FTAI approach. Appropriate bull:heifer ratio following tightly synchronized FTAI protocols is necessary in order to cover a large number of repeat cycling heifers that failed to conceive to AI.

Delayed LH peak has been observed in *Bos indicus* heifers with low concentrations of circulating progesterone (Batista et. al, 2017). This might help explain suboptimal FTAI pregnancy rates observed in this study where GnRH is utilized.

Split-time AI (STAI) could be used to increase the number of females that conceive to AI (Thomas et. al, 2014b, Bishop et. Al, 2017), by optimizing insemination time and decreasing GnRH administration, thereby eliminating concern of delayed LH surge.

Conclusion

- Established long-term estrus synchronization protocols are effective in *Bos indicus*-influenced beef heifers
- Estrus synchronization results in a greater number of heifers that become pregnant early in the breeding season
- Endocrine differences are apparent between MGA and CIDR treatments
  - No difference in estrous response or pregnancy rate to FTAI
- Prebreeding evaluations provide an opportunity to assess growth and pubertal status prior to breeding

References

Batista EOS, Del Valle TA, Ortolan MDDV, Rennó FP, Nogueira GP, Souza AH, Baruselli PS. The effect of circulating progesterone on magnitude of the GnRH-induced LH surge: Are there any differences between Bos indicus and Bost taurus heifers. Theriogenology 2017; In press.

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Acknowledgements

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- White Farms, Chiefland, FL (Darren Plank)
- Deseret Cattle and Citrus, St. Cloud, FL (Eric Jacobson, Travis Lybbert)

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Developing precise methods of estrous cycle control for Bos indicus influenced heifers and cows.					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Animals	N/A	100%	$ 25,724.37	Animals and supplies	9/1/2017
Consultant Services	N/A	100%	$ 26,301.23	Material for soil and forage analysis	9/1/2017
Final research project report	N/A			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Indirect Cost	N/A		$ 6,243.08		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 58,268.68**		

Florida Cattle Enhancement Grant Application
Title: Identification of superior limpograss cultivars under low-input systems

Investigators: Joao (Joe) Vendramini, Maria Silveira, Lynn Sollenberger, Jose Dubeux Jr., and Brent Sellers.

Award ID: 024122

Project Overview

Fertilization is one of the most costly inputs in cow-calf production systems in Florida. In 2014, IFAS released two new cultivars, Gibtuck and Kenhy, and there has been a rapid increase in acreage of these new cultivars in South and Central Florida. However, there is no information regarding specific fertilization requirements of the new limpograss cultivars and whether there is any difference in fertilizer use efficiency among cultivars. The objective of these studies will be to identify limpograss cultivars with greater production, nutritive value, and persistence under low-input systems. A plot study has been conducted in three locations, Ona, Gainesville, and Marianna and the treatments are the factorial combination of two fertilization levels, 80 lb N, 20 lb P2O5, 80 lb K2O/acre, or 40 lb N, 10 lb P2O5, and 40 lb K2O/acre, four limpograss cultivars, Floralta, Kenhy, Gibtuck, and 1, and two harvest frequencies, 6 and 12 weeks.

Deliverables	Progress
1. Plant tissue samples from the last 12 week cycle of the 2016 growing season analysis - N and IVDOM	256 samples from Ona and Gainesville 2016 growing season (last 12 week cycle) were analyzed and the results presented in this report
2. Forage yield and N use efficiency 2016 data	Forage yield and N use efficiency data from the last 2016 12-week cycle from Gainesville and Ona were finalized and included in this report.
3. Plot establishment, cleaning, staging, and fertilization	The plots in Marianna were established and subjected to herbicide application, mowing, irrigation, and initial fertilization for successful establishment. Plots in Ona, Gainesville, and Marianna were maintained and fertilized.
4. Initial tissue samples for RNA extraction and gene expression from plots in Marianna	Samples were collected from Ona and Marianna and analyzed. The samples were subjected to real time PCR for Dof1, GS, and rbcs gene expression analyses. The results for Dof1 and RBCS are included in this report. The GS gene from corn and rice were tested but the expression was not detected in limpograss tissue, therefore, the results were discarded.

5. Plot harvest, sample processing and analysis for the 2017 growing season.	The first 12-week cycle harvest in 2017 were conducted in Ona, Gainesville and Marianna. Results from Gainesville and Ona are included in this report. Results from Marianna are being processed and will be available in the near future. Samples from the first 12-week cycle from Ona, Marianna, and Gainesville, and from the second 12-wk cycle from Gainesville and Ona were submitted to the laboratory for analysis.

Project completion: 100%

Project Results

Herbage yield and nitrogen use efficiency results from 2016 and the first 12-week cycle of 2017 for Ona are presented in Table 1. Gibtuck had greater herbage yield than Floralta, Kenhy, and Entry 1 had the least yield among all cultivars. Forage yield harvested from two 6-week regrowth interval or one 12-week was similar; however, forage fertilized with greater fertilization levels had greater yield than lower levels. Similarly, nitrogen use efficiency was greater for Gibtuck than the other cultivars. Regrowth interval did not affect nitrogen use efficiency; however, plots fertilized with lower levels of nitrogen had greater nitrogen use efficiency (Table 1).

Plots harvested at 6-weeks regrowth interval had greater crude protein and digestibility than 12-weeks. In addition, forage receiving greater levels of fertilizer had greater crude protein concentrations but similar digestibility. There were similar crude protein and digestibility among cultivars.

In Gainesville, there was no differences in forage yield among Kenhy, Gibtuck, and Floralta, which were greater than Entry 1. Plots harvested at 12-weeks regowth interval had greater forage yields than 6-weeks and forage fertilized with greater levels of fertilizer had greater forage yield than lower levels. In addition, plots had greater yields in the summer 2017 than fall 2016 (Table 2).

Nitrogen use efficiency was greater for Kenhy, Gibtuck, and Floralta than Entry 1. Similarly to the results at Ona, plots fertilized with lower levels had greater nitrogen use efficiency than higher levels of fertilizer and the nitrogen use efficiency was greater in the summer 2017 than fall 2016 (Table 2).

Table 1. Forage yield and nitrogen use efficiency of limpograss plots harvest in Ona in the fall 2016 and summer 2017.

Reponse variables	Forage Yield (lb DM/acre)	Nitrogen use efficiency (lb DM/lb N fertilized)	Crude Protein (%)	Digestibility (%)
Cultivar				
Gibtuck	3,300a[1]	57a	7.6a	54a
Kenhy	2,700b	41b	8.0a	53a
Floralta	2,500b	47b	7.4a	54a
Entry 1	2,000c	36c	8.1a	54a
Regrowth Interval				
6 weeks	2,600a	45a	9.2a	57a
12 weeks	2,700a	46a	6.2b	51b
Fertilization				
80-20-80	2,700a	34b	8.5a	54a
40-10-40	2,100b	54a	7.1b	53a
Harvest				
Fall 2016	1,500b	26b	7.6	52
Summer 2017	3,500a	54a	--	--

[1]Means followed by the same lower case letters within column and response variable are not different ($P > 0.10$)

There was no differences in crude protein and digestibility concentrations among cultivars. Forage harvested at 6 weeks had slightly greater crude protein and digestibility concentrations than 12 weeks.

In Ona, there were differences in Dof 1 and Rubisco gene expression among cultivars. Floralta and Entry 1 had greater Dof 1 gene expression than Gibtuck and Kenhy. Entry 1 had the greatest expression of the Rubisco gene, followed by Floralta and Kenhy. Gibtuck had the least expression of the Rubisco gene (Table 3).

Table 2. Forage yield and nitrogen use efficiency of limpograss plots harvest in Gainesville in the fall 2016 and summer 2017.

	Forage Yield (lb DM/acre)	Nitrogen use efficiency (lb DM/lb N fertilized)	Crude Protein (%)	Digestibility (%)
Cultivar				
Gibtuck	10,000a[1]	184a	4.3a	40a
Kenhy	10,800a	197a	4.0a	41a
Floralta	9,800a	183a	4.4a	38a
Entry 1	8,800b	162b	4.7a	38a
Regrowth Interval				
6 weeks	7,800b	141b	5.6a	40a
12 weeks	12,000a	222a	3.1b	38a
Fertilization				
80-20-80	10,400a	130b	4.5a	38a
40-10-40	9,400b	233a	4.2a	39a
Harvest				
Fall 2016	8,400b	154b	4.3	40
Summer 2017	11,400a	208a	--	--

[1]Means followed by the same lower case letters within column and response variable are not different ($P > 0.10$)

In Marianna, Kenhy had the least Dof 1 expression, followed by Floralta and Gibtuck, while Entry 1 had the greatest Dof 1 expression. The expression of the Rubisco gene was similar in Kenhy, Floralta, and Entry 1, which were greater than Gibtuck (Table 3).

Location/Cultivar	Dof 1	Rubisco
	Fold increase	
Ona		
Gibtuck	1.9b	1.7c
Kenhy	1.5b	2.0b
Floralta	2.2a	2.1b
Entry 1	2.5a	2.5a
Marianna		
Gibtuck	2.0b	1.9b
Kenhy	1.6c	2.7a
Floralta	2.3b	2.7a
Entry 1	2.8a	3.0a

[1]Means followed by the same lower case letters within column and response variable are not different ($P > 0.10$)

There was a significant correlation between nitrogen use efficiency and Dof1 and Rubisco gene expression. As nitrogen use efficiency increased, the fold increase in Dof1 and Rubisco gene expression decreased (Figure 1 and 2).

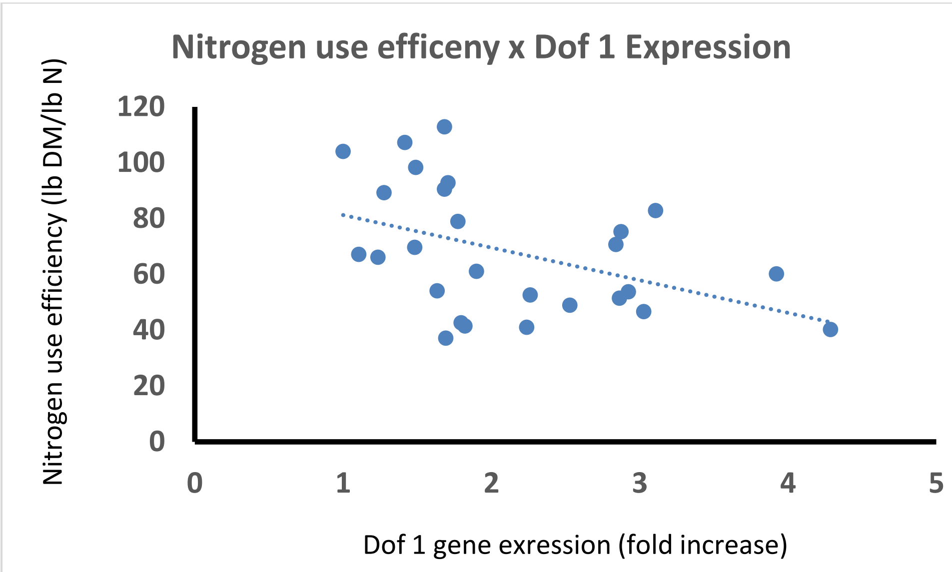

Figure 1. Correlation between nitrogen use efficiency and Dof 1 gene expression

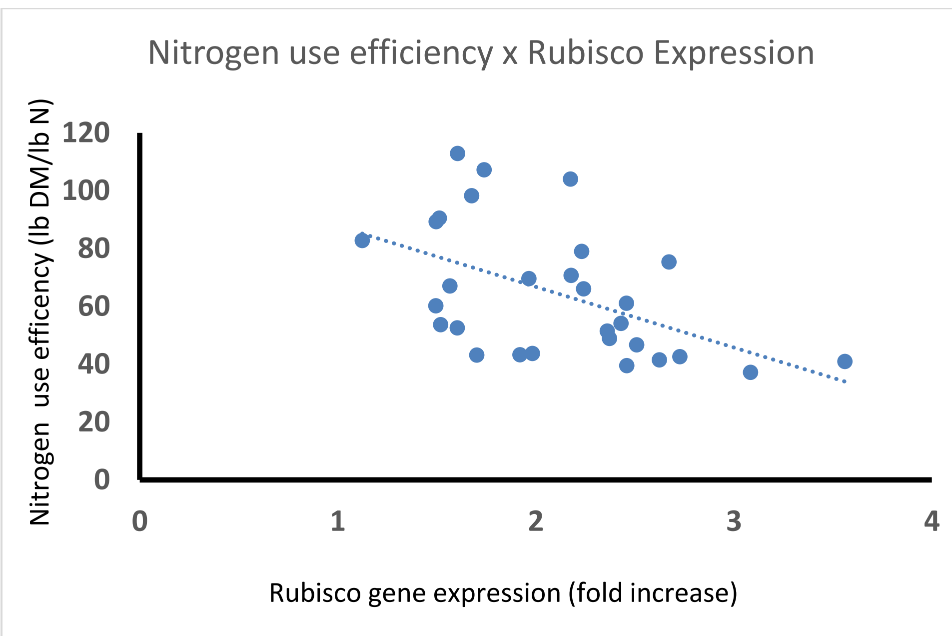

Figure 2. Correlation between nitrogen use efficiency and rubisco gene expression

Implications

Forage and livestock producers should consider planting Gibtuck or Kenhy in poorly drained soils in South Florida due to greater forage yield and nitrogen use efficiency. Gibtuck had 20% greater nitrogen use efficiency than Floralta, which could lead to significant increase in forage production efficiency.

Based on the current data, there are no attractive traits identified in Entry 1 that would justify the release of Entry 1 as a new cultivar of limpograss.

When managing limpograss for harvest as hay or silage, longer regrowth intervals should be considered if the objective is to producer greater yields. There is a detrimental effect on nutritive value; however, it can be compensated with the appropriate supplementation program. The persistence data will be collected at the end of 2017; however, there is an initial perception that plots harvested at 12-week have greater limpograss ground cover and decreased amount of undesirable species.

There was a significant but relatively small increase in forage yield when fertilizer levels were increased from 40-10-40 to 80-20-80. In addition, the nitrogen use efficiency was decreased with greater levels of fertilizer. Therefore, greater levels of nitrogen fertilization may not be economically viable. The efficiency of N fertilization in the spring/summer was greater than in the fall; however, forage produced in the fall has certainly greater value due to limited forage available.

The genes tested in this trial were promising and may be used as indicators of nitrogen use efficiency in limpograss. The goal for the continuation of the project will be to identify more genes that could also be used to select plants with greater nitrogen use efficiency. Ultimately, we could test several plants within the population of a specific cultivar and based on the expression of those genes, we will be able to select plants that will have greater production with less nitrogen fertilizer.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Identification of superior limpograss cultivars under low-input systems					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Plot establishment, maintenance, harv	N/A	100%	$ 8,843.70	Maintenance and harvest of plots in three locations, sample processing, preparation, and storage for analyses. Field supplies, fertilizer, herbicide, bags, zip ties, flags, fuel for forage harvester, parts for forage harvester	9/1/2017
Soil and forage analysis	N/A	100%	$ 1,722.92	Material for soil and forage analysis	9/1/2017
Laboratory Analyzes	N/A	100%	$23,761.38	Forage nutritive value and real time PCR analysis	9/1/2017
Final research project report	N/A			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Indirect Cost	N/A		$ 4,119.38		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 38,447.38**		

AGRONOMIC AND ENVIRONMENTAL IMPACTS OF LAND APPLICATION OF BIOSOLIDS TO BAHIAGRASS PASTURES IN FLORIDA

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1. PROJECT OVERVIEW

Biosolids have clear agronomic benefits, but concerns over nutrient accumulation in soils and subsequent impacts on water quality can limit land application in Florida. The ***objectives*** of this proposal are *(1) to establish a long-term, instrumented, research and demonstration field trial designed to evaluate the agronomic benefits of biosolids and biochar application on bahiagrass production and nutritive value, (2) to monitor the potential effect of biosolids application on water quality, and (3) to evaluate greenhouse gas (carbon dioxide, nitrous oxide, and methane) emissions and the potential impacts of biosolids and biochar application on soil chemical, physical and biological properties.* Our ***principal hypothesis*** is that most biosolids applied to pastures convey significant agronomic benefits and that they behave as "slow release" nutrient sources with minimal negative environmental impact. *This proposal addresses the **FCA Priorities # 9 "Land Application of Biosolids on Pastures"** and **# 1 "Fertilization (Alternative Fertilizer Sources)**.*

2. PROJECT ACTIVITIES (JANUARY – AUGUST 2017)

Experimental Setup

A field trial was established in 2016 to evaluate the agronomic and environmental impacts of various biosolids sources applied to bahiagrass (*Paspalum notatum* Flugge) pastures at the Range Cattle REC in Ona (Fig. 1). In 2017, one Class A biosolids, two Class B biosolids materials, and one wood biochar were selected and thoroughly characterized in the laboratory using routine analysis (Table 1). Biosolids materials were surface applied to the experimental area and compared to nutrition provided with mineral fertilizers. Land application of the residuals occurred during Spring 2017 (April 25-26). Biosolids sources were applied either alone or in combination with biochar to supply an estimated rate of 160 lb plant available N/A/yr, which correspond to UF/IFAS high N option for established bahiagrass and the most common application rate used by commercial cow-calf operations in Florida. The availability of the N in the biosolids was estimated using Florida -DEP factor of 1.5. Nitrogen mineralization from the various biosolids treatments (biosolids alone and co-applied with biochar) were evaluated in the field following the litter bag procedure described by Castillo et al. (2010). Field-incubated bags containing biosolids or biosolids+biochar-treated samples were collected at various intervals and analyzed for total N and inorganic N. Biochar was also applied in April, 2017 at 20 Mg ha^{-1} rate, which corresponds to an application rate of ~ 1% (wt. basis). Control treatments included plots receiving inorganic commercial fertilizer (ammonium nitrate + triple superphosphate alone and in combinations with biochar) and pastures receiving no biosolids, fertilizer, or biochar. Forage, soil, water quality, soil moisture, ground water levels, and gas emissions will be monitored during the 2017 growing season.

Forage Responses

Forage were harvested at 6-week interval from June to November. During each harvest, two 1- x 6-m forage strips were harvested from each plot to a 7.5-cm stubble height using a forage harvester. The remaining herbage was mowed with a flail harvester at the same stubble height. Samples were weighed fresh and sub-samples weighed and oven dried at 60^{o}C for 48 hr for DMY determination. Dried samples were ground to pass a 1-mm mesh and analyzed for total N, P, and trace elements concentrations.

Soil and Environmental Responses

Soil samples (0-12”) were taken in February 2017. Analyses included soil pH, Mehlich-3 extractable P, K, Ca, Mg, Fe, and Al and total C, N, P, and trace element concentrations. Extractable NO_3-N and NH_4-N will also be determined. For each soil depth, the P saturation ratio [PSR = Mehlich-3-P / (Mehlich-3-Al + Mehlich-3-Fe)] was calculated. The PSR relate to soil P retention capacity.

Leachate N and P were monitored in the treatments receiving the class B Bradenton biosolids and commercial fertilizer (total of 24 plots: 1 biosolids material + 1 commercial fertilizer, with or without biochar + 2 control * 4 replicates = 24). Groundwater level, soil moisture content, and weather data were continuously monitored in the experimental site. Leachate samples were collected at 2- or 4-wk intervals and analyzed for total and inorganic P, total N, NO_3-N and NH_4-N concentrations.

Greenhouse gas fluxes were measured (same treatment as the water quality monitoring) using the static chamber technique. Gas samples were collected at 14-d intervals and analyzed for carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) concentrations.

In addition to the field study, a number of laboratory studies (including a leaching and a static incubation experiments) were conducted from January to August, 2017. Data collection relative to these efforts are still underway.

3. RESULTS SUMMARY

Bahiagrass Responses

Addition of fertilizer (either as commercial N and P or biosolids) increased bahiagrass herbage accumulation by an average of 100% (Table 2). Greater bahiagrass herbage accumulation was generally associated with the treatments receiving commercial N and P fertilizer (Table 2). Class A and Class B St Pete biosolids plus biochar resulted in cumulative bahiagrass yields similar to commercial fertilizer.

Addition of biochar with commercial fertilizer increased bahiagrass yield by an average of 17%. Similarly, biochar also had generally positive impacts on bahiagrass yields for the treatments receiving biosolids. Currently, data are still being collected for the 2017 growing season. One more harvest event is expected to occur in October 2017 to confirm whether treatment differences will remain similar as the growing season progressed.

Water Quality and Greenhouse Gas Responses

Leachate P and N concentrations generally remained relatively constant throughout the growing season (data not shown). The only exception were the treatments receiving commercial inorganic fertilizer that resulted in greater N and P leaching compared with biosolids treatments (Table 3). Similarly, greater nitrous oxide and carbon dioxide emissions were also generally associated with the treatments receiving commercial fertilizer (Fig. 2). These results indicated that N and P losses associated with treatments receiving biosolids can be lower than commercial fertilizer. In addition, based on the water quality data collected from May to Aug., 2017, no potential benefit of biochar in reducing N and P losses has been observed.

4. SUMMARY AND CONCLUSIONS

Results suggested significant differences in bahiagrass responses to different biosolids sources. Because nutrients (mainly N) present in biosolids are slowly released, we expect that cumulative annual bahiagrass production for the treatments receiving biosolids will be comparable to commercial inorganic fertilizer. Based on the data from the 2 harvest events, it appears that co-application of biosolids with biochar promotes bahiagrass production. Application of biosolids (either alone or in combination with biochar) had no significant impact on water quality and greenhouse gas emissions. However, when bahiagrass received commercial inorganic fertilizer, large pulses of N and P were observed immediately after fertilizer application. Because temperature and soil moisture affect microbial processes controlling N and P dynamics, it is crucial to continue monitoring N and P losses throughout the entire growing season. We hope that funds will continue to be available through the Florida Cattlemen's Beef Enhancement program to support our current efforts that address research priorities # 9 "Land Application of Biosolids on Pastures" and # 1 "Fertilization (Alternative Fertilizer Sources).

ACKNOLEDGEMENTS

We thank H&H liquid disposal for their assistance obtaining and hauling the biosolids materials to the study site. We also want to extend our appreciation to the FCA for providing the funds to support this project.

5. PERCENTAGE COMPLETION OF PROJECT DELIVERABLES: 100%

Table 1. Characteristics of biosolids and biochar land applied in 2017.

Property[1]	Class AA Pellets biosolids	Class B - Bradenton biosolids	Class B St-Pete biosolids	Biochar
Moisture	8.4	85	84	14.1
T-N (%)	6.6	4.8	7.5	0.34
T-P_2O_5 (%)	4.3	7.5	5.9	0.21
T-K_2O (%)	0.17	0.42	0.63	0.76
NH_4^+-N	0.6	1.1	2.7	0.2
NO_3^--N	0.2	0.7	0.9	0.2
S (%)	2.1	1.0	1.1	0.03
B (%)	0.01	0.007	0.006	0.002
Zn (%)	0.09	0.1	0.06	0.002
Mn (%)	0.01	0.007	0.006	0.05
Fe (%)	1.1	4.4	0.3	0.1
Cu (%)	0.03	0.01	0.06	0.001
Ca (%)	2.5	2.7	2.7	1.0
Mg (%)	0.5	0.6	0.9	0.3
Na (%)	0.3	0.3	0.1	0.07
Al (%)	0.5	0.3	0.3	0.05
Cd(ppm)	1.6	0.6	0.8	0.001
Cr(ppm)	62.1	63.3	23.4	2.5
Pb(ppm)	29.7	14.5	11.8	0.8
Co(ppm)	1.2	3. 8	2.5	0.4
Ni(ppm)	45.3	23.8	13.5	0.2

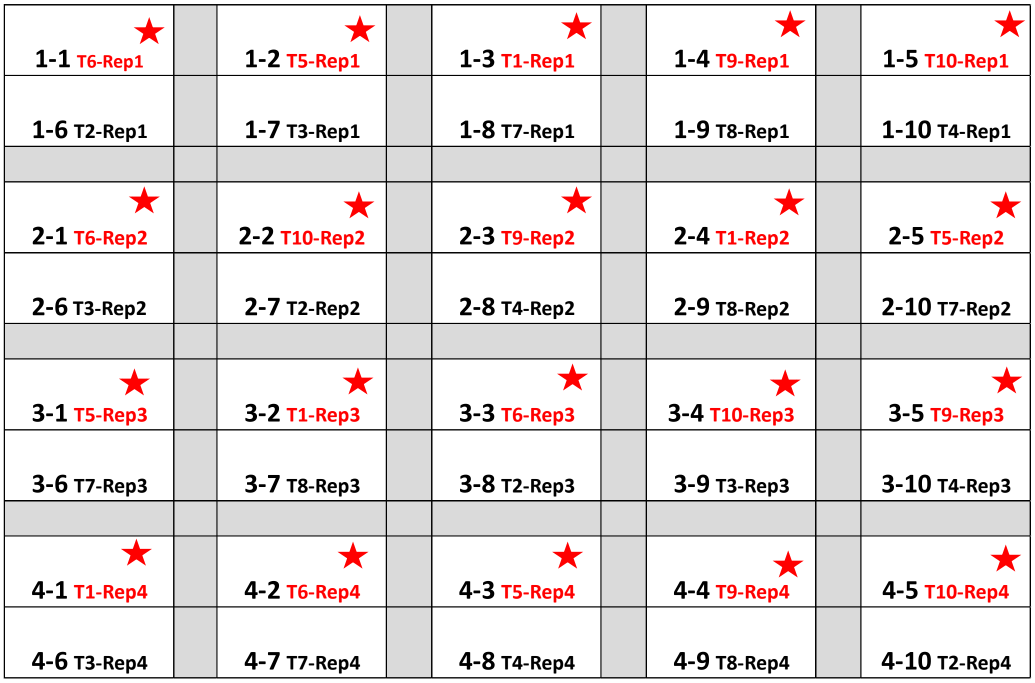
[1]Valuess are expressed in dry basis

Table 2. Bahiagrass herbage accumulation as affected by fertilizer and biochar application

Treatment	Harvest 1 (06/22/2017)	Harvest 2 (08/17/2017)	Sum
	Bahiagrass Herbage Accumulation (lb/acre)		
Control	864 f	2080 d	2944 d
Control + biochar	1073 ef	2114 d	3187 d
Class A pellets	2189 bcd	3154 c	5343 bc
Class A pellets + biochar	1967 cd	3937 ab	5904 abc
Class B Bradenton biosolids	1714 cd	3605 abc	5319 bc
Class B Bradenton biosolids + biochar	1797 cd	3627 abc	5424 bc
Class B St Pete biosolids	1616 de	3250 bc	4865 c
Class B St Pete biosolids + biochar	2305 abc	3884 ab	6189 ab
Commercial fertilizer	2763 ab	3128 c	5891 abc
Commercial fertilizer + biochar	2883 a	4025 a	6908 a
P value	<0.0001	<0.0001	<0.0001

Table. 3 Phosphorus and nitrogen leaching before and after fertilizer/biosolids application.

Treatment			3/14/2017 (Before fertilization)						5/5/2017 (After fertilization)					
Plot ID	**N sources**	**Biochar**	**Ortho-P**	**TKN**	**NH4-N**	**NOx-N**	**Organic N**	**Total P**	**Ortho-P**	**TKN**	**NH4-N**	**NOx-N**	**Organic N**	**Total P**
			µg/L	________________ **mg/L** ________________					**µg/L**	________________ **mg/L** ________________				
1-3	Control	no	1.55	0.37	0.16	0.04	0.21	0.37	3.06	0.54	0.27	0.06	0.27	0.54
2-4	Control	no	1.65	0.29	0.12	0.06	0.16	0.29	3.39	0.94	0.21	0.06	0.72	0.94
3-2	Control	no	1.11	0.92	0.09	0.01	0.83	0.92	**NO**	**NO**	NO	NO	NO	**NO**
4-1	Control	no	1.57	0.37	0.16	0.08	0.21	0.37	2.28	0.58	0.22	0.10	0.36	0.58
1-2	Class B_Bradenton	no	2.68	0.38	0.16	0.04	0.22	0.38	4.42	0.79	0.24	0.05	0.56	0.79
2-5	Class B_Bradenton	no	2.04	0.46	0.14	0.04	0.31	0.46	4.02	0.99	0.24	0.02	0.75	0.99
3-1	Class B_Bradenton	no	1.25	0.84	0.12	0.02	0.72	0.84	1.65	0.94	0.23	0.01	0.72	0.94
4-3	Class B_Bradenton	no	1.43	1.33	0.30	0.12	1.02	1.33	1.41	0.82	0.20	0.16	0.62	0.82
1-4	N+P inorg. Fertilizer	no	1.66	0.31	0.14	2.06	0.17	0.31	210.45	0.48	0.26	1.36	0.22	0.48
2-3	N+P inorg. Fertilizer	no	1.78	0.16	0.12	5.53	0.04	0.16	66.88	0.65	0.29	2.30	0.36	0.65
3-5	N+P inorg. Fertilizer	no	2.71	1.05	0.17	0.13	0.87	1.05	10.45	1.07	0.20	0.08	0.87	1.07
4-4	N+P inorg. Fertilizer	no	1.94	2.27	0.21	6.23	2.06	2.27	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
1-1	Class B_Bradenton	yes	1.94	0.49	0.16	0.11	0.32	0.49	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2-1	Class B_Bradenton	yes	2.33	0.66	0.12	0.03	0.54	0.66	5.31	0.61	0.26	0.03	0.34	0.61
3-3	Class B_Bradenton	yes	1.32	1.42	0.18	0.04	1.24	1.42	1.13	1.07	0.29	0.08	0.79	1.07
4-2	Class B_Bradenton	yes	1.72	0.70	0.19	0.12	0.51	0.70	2.06	0.74	0.20	0.11	0.54	0.74
1-5	N+P inorg. Fertilizer	yes	2.07	0.52	0.13	2.53	0.39	0.52	96.49	0.75	0.41	1.02	0.34	0.75
2-2	N+P inorg. Fertilizer	yes	2.13	0.45	0.11	7.76	0.34	0.45	8.18	0.20	0.32	5.11	**NO**	0.20
3-4	N+P inorg. Fertilizer	yes	1.06	0.62	0.24	0.16	0.38	0.62	6.11	0.85	0.17	0.22	0.67	0.85
4-5	N+P inorg. Fertilizer	yes	2.10	0.39	0.17	0.09	0.23	0.39	2.75	0.61	0.58	10.94	0.03	0.61



Treatment ID	Biosolids/Fertilizer	Biochar
1	Control	no
2	Control	yes
3	Class A pellets	no
4	Class A pellets	yes
5	Class B_Bradenton	no
6	Class B_Bradenton	yes
7	Class B_St Pete	no
8	Class B_St Pete	yes
9	N+P inorg. Fertilizer	no
10	N+P inorg. Fertilizer	yes

Fig. 1. Schematic representation of experimental layout

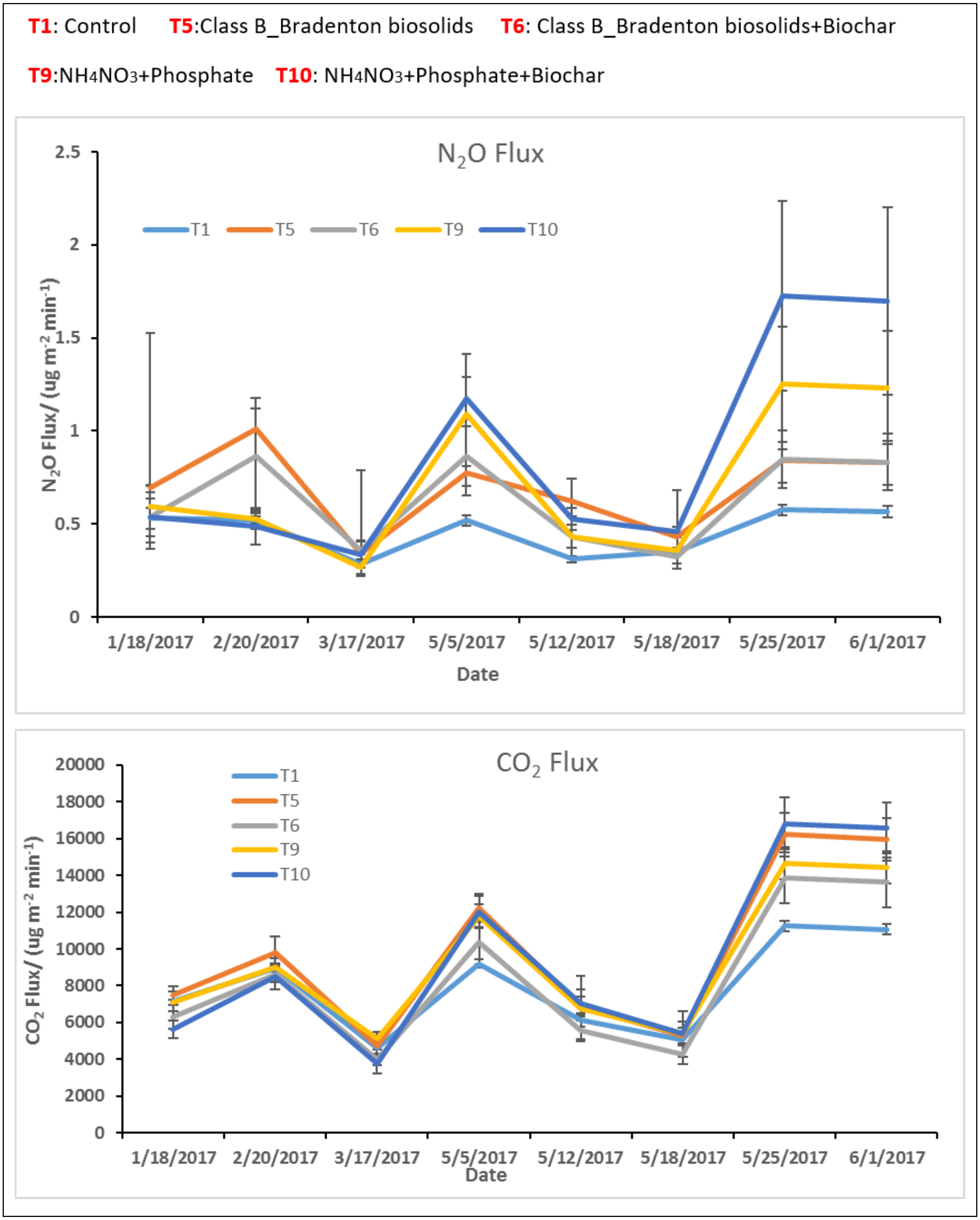


Fig. 2. Nitrous oxide (N_2O) and carbon dioxide (CO_2) fluxes from bahiagrass pastures under different fertilization strategies.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Agronomic and environmental impacts of land application of biosolids to bahiagrass pastures in Florida (# P0037802)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Water and gas sampling and analysis	N/A	100%	$ 16,931.33	lab consumables (reagents, filter paper, plastic containers, instrument parts), syringes, soil moisture sensors, tubes, vacuum pump	9/1/2017
Forage harvest and soil sampling	N/A	100%	$ 6,921.93	field supplies. Items include (but not limited to): paper bags, soil core liners, batteries	9/1/2017
Fertilizer materials	N/A	100%	$ 4,103.75	purchase of commercial fertilizer and biochar for the field study	9/1/2017
Laboratory analyses	Various	100%	$ 18,226.83	soil, plant tissue, biosolids, and biochar characterization, shipment of samples for analysis	9/1/2017
Equipment	1	100%	$ 5,932.14	soil water release curve characterization	9/1/2017
Final Research Project Report	1			project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Indirect Cost	N/A		$ 6,160.35		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 58,276.33**		

Florida Cattle Enhancement Grant Application

Title: *Does year-round supplementation of cows pay off?*

FCEB No: 6 UF Project No: AGR7486

Investigators: Philipe Moriel, Joao (Joe) Vendramini, Chris Prevatt, Nicolas DiLorenzo, Francisco Peñagaricano, and Luiz Ferraretto.

Project Overview

Our proposal will address the FCA Priorities **#3 (Calf loss)**, **#7 (Animal herd nutrition – mineral** and **winter supplementation)**, and **#8 (Animal health).** We will evaluate if year-round supplementation of cows will enhance their reproductive success and impact the long-term growth and health of their calves compared to the traditional Fall/Winter supplementation program. Our objectives include using year-round supplementation of beef cows to: **(1)** better manage the body condition score and increase pregnancy rates of cows; **(2)** improve calf development during gestation and impact their subsequent health and growth, and consequently, cowherd profitability; **(3)** improve our understanding of the differences on the metabolism of mature cows (and their calves) under different supplementation strategies, which will assist on designing future studies and harvest greater performance levels; and **(4)** generate novel information for local educational programs to further assist producers and county agents on cowherd supplementation strategies.

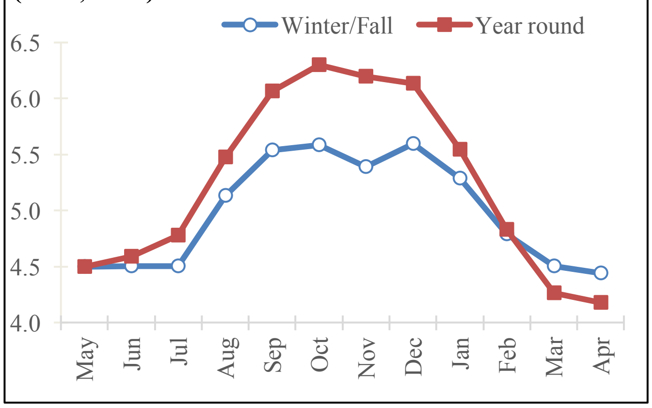
Significance

Fall/Winter seasons in Florida correspond with critical events that determine the economic success of a cow-calf operation, and those are the **late gestation**, **breeding season,** and **first trimester of the subsequent gestation** of beef females. These events occur during periods of low forage quality and availability, but highest nutrient demand for the growing fetus and cow milk production. Unfortunately, reproduction has the lowest nutrient priority, and consequently, it is often impaired by the mismatch between nutrient demand and availability. Increased reproductive success can be achieved by increasing body condition score at calving (5 or 6, according to a 1 to 9 scale) and trace mineral status of mineral-deficient beef cows. In fact, body condition score at calving is the most important factor that influences the interval from parturition to first ovulation, overall pregnancy rate, and calving distribution of beef cows. Most of FL cow-calf operations provide year-round supplementation of trace minerals, but provide protein and energy supplementation to alleviate cow weight loss only during early-lactation. However, inadequate dietary energy/protein during late pregnancy lowers reproduction even if the amount of energy and protein consumed during early-lactation are sufficient.

Until recently, the decisions about cow-herd supplementation considered only the cost of supplements and its impact on pregnancy rates. However, recent studies have shown that nutritional insults during gestation can also modify placental development, fetal organ formation, and offspring growth and health (a process called ***fetal-programming***). For instance, calves born to cows that experienced energy deficiency during the last 40 days of gestation (which often occurs in cows grazing warm-season grasses) experienced poor vaccine response and antibody production, which might compromise calf health and increase calf loss. Additional studies also indicated that providing beef cows sufficient nutrition during late-gestation can compensate for many of the negative consequences of nutrient restriction that occur in early- to mid-gestation, and improve calf survivability, weaning performance, and economic returns. Thus, the decisions about cowherd supplementation should also include the impact on future offspring performance. Identifying nutritional strategies that can improve reproductive performance of cows, decrease calf loss, and optimize future calf growth and health is crucial and the primary goal of this proposal.

One strategy that can improve cow reproductive success and offspring performance following birth is the use of year-round supplementation. Figure 1 simulates a scenario of body condition score change of two Brangus cows calving in November. Both cows received **similar total annual amount of sugarcane molasses** (600 lb of dry matter/cow) that was provided during the Fall/Winter season only or distributed throughout the entire year (see Table 1 also). Cows supplemented year-round might achieve a greater body condition score at calving without increasing the annual supplement amount. Another advantage is that the trace mineral salt can be mixed into the supplement, reducing annual fluctuations in voluntary intake and wastage of free choice trace mineral formulations, and improving cow trace mineral status. Our hypothesis is that year-round supplementation of molasses or range cubes will increase body condition score at calving and trace mineral status of cows throughout the year, which will enable cows to experience greater body condition loss during early-lactation without reducing their reproductive performance compared to cows supplemented with molasses during Winter/Fall season only. In addition, year-round supplementation of molasses and range cubes will improve calf development during pregnancy, and then, improve calf health, survivability, and growth following birth.

Figure 1. Body condition score simulation (NRC, 2016)



Approach

The 3-year experiment will be conducted at the IFAS-Range Cattle Research and Education Center (RCREC; Ona, FL). The study at RCREC will be repeated twice (**Cow group 1** = March 2017 to March 2019; **Cow group 2** = March 2018 to March 2020) in order to have stronger data and powerful statistical analyses.

Pastures and feed facilities were prepared in March 2017. In June (day 0 of the study), mature Brangus cows were allocated into 1 of 6 bahiagrass pastures (14 cow-calf pairs/pasture; 84 pairs/year). Treatments consist of control cows supplemented with molasses from calving until end of breeding season (November to April; **CON**), or cows receiving year-round supplementation of molasses (**YMOL**) or range cubes-based (**YRAN**) formulations (2 pastures/treatment). Total annual amount of supplement will be similar among all treatments (approximately 600 lb of supplement dry matter/cow annually; Table 1). Supplements are being offered twice weekly (Mondays and Thursdays) at 8 am. Trace mineral/vitamin supplementation is being provided during the entire year in a loose meal form for control cows, or mixed into the molasses or range cubes for cows assigned to year-round supplementation.

Table 1. Supplement dry matter intake (lb/cow daily) of cows offered molasses during Fall/Winter only (Control) or year-round supplementation of molasses or range cubes.

Treatments [a]	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
	lb of dry matter/cow daily											
Year-round Molasses	0.5	0.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	0.5
Year-round Range cubes	0.5	0.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	0.5
Fall/Winter Molasses						3.3	3.3	3.3	3.3	3.3	3.3	

[a] *Total annual supplement dry matter offered will be approximately 600 lb/cow.*

Cow body weight and condition score have been collected every 60 days. Also on these days, blood samples from jugular vein have been collected from 6 cows/pasture to determine the plasma concentrations of hormones and metabolites correlated with reproductive performance and energy metabolism (glucose, insulin growth factor-1, and non-esterified fatty acids). Also, 6 cows/pasture were assigned to liver tissue collections on days 0, 120, and 240 to determine the liver trace mineral status. Pregnancy rates will be determined in April 2018 and 2019.

Offspring evaluation: Calving season will occur from October to December of 2017 (cow group 1) and 2018 (cow group 2). Body weight of calves will be collected every 60 days from birth to weaning at 7-8 months of age. All calves will be vaccinated against bovine respiratory disease pathogens in March and July. After weaning, 45 steers will be randomly assigned to a post-weaning evaluation of growth and immune response, whereas 48 heifers will be selected for a 150-day development program (July to November) and a 60-day breeding season (December to February). Steers will be fed ground hay and concentrate for 45 days in drylot. Blood samples of steers will be collected from jugular vein on days 0, 1, 3, 7, 14, and 45, relative to weaning, to determine the plasma concentrations of haptoglobin and cortisol (indicators of innate immunity), and serum antibody titers against bovine viral diarrhea virus 1a and infectious bovine rhinotracheitis virus (indicators of vaccine response). Heifers will graze on bahiagrass pastures and receive concentrate supplementation to achieve 1.25 lb/day of weight gain until the end of breeding season. Blood samples of heifers will be collected every 7 days from September to February to assess the plasma progesterone concentrations (indicator of puberty assessment).

General comments to sponsors

By design, cow supplementation began during the second trimester of gestation, and thus, animal feeding phase began on June 5th, 2017 and will end on April 2018. However, all reagents for laboratory analyses of samples to be collected in 2017 were successfully purchased between July to August (the late purchase date of these reagents was intentionally used due to the short shelf life of commercial laboratory kits). Collection of blood and liver samples (Year 1) began on June 5th, and will be completed on October 5th. Laboratory analyses of these blood and liver samples will be performed before November 15th. An article summarizing the available data will be prepared and submitted to The Florida Cattlemen and Livestock journal in December 2017. Due to conflict of dates, the educational program for producers was postponed to October 2017. This program will be delivered in a 3-day format training in collaboration with livestock agents. The program will cover multiple topics related to body condition score and nutritional management of beef females. At the end of the program, producers will be exposed to an interactive body condition score training to improve the accuracy of body condition scoring. Due to the educational program being postponed, the **project completion percentage by September 1st, 2017 was 83%, but will reach 100% by November 2017.**

Data Summary (data collected from May to September 2017).

In this 3-year study, treatments consist of control cows supplemented with molasses from calving until end of breeding season (November to April; **CON**), or cows receiving year-round supplementation of molasses (**YMOL**) or range cubes-based (**YCUB**) formulations (2 pastures/treatment). From June to August 2017, cows assigned to YMOL and YCUB treatments were supplemented with 0.62 lb/day of molasses (and 0.13 lb/day of trace mineral salt mixed into the molasses) or 0.72 lb/day of range cubes (trace mineral salt included in the cubes), respectively. Supplement amount differed in order to equalize the daily intake of energy (total digestible nutrients; TDN) and protein (crude protein; CP). Supplements were offered twice weekly (Mondays and Thursdays) at 8 am. Calves were weaned on August 9th.

Table 1. Growth performance of cows receiving no molasses supplementation until calving (CON), or year-round supplementation of molasses (YMOL) or range cubes-based (YCUB).

	Treatments				*P*-value
Item	**CON**	**YCUB**	**YMOL**	**SEM**	**Treatment**
Cow Body Condition Score [1,2]					
Start of study (day 0; June)	4.70	4.40	4.60	0.097	-
Weaning (day 56; August)	5.04	5.14	5.10	0.053	0.42
Cow Body Condition Score change [1,2]					
June to August	0.52	0.60	0.57	0.054	0.65
Cow Body Weight [1]**, lb**					
Start of study (day 0; June)	957	907	954	10.5	-
Weaning (day 56; August)	941	966	936	13.9	0.39
Cow Average Daily Gain, lb/day					
June to August	0.09	0.57	0.00	0.249	0.34
Suckling calf Body Weight [1,2]**, lb**					
Weaning (day 56; August)	490	498	496	5.5	0.61
Calf Average Daily Gain, lb/day					
June to August [2], lb/d	1.87	2.02	1.99	0.100	0.52

[1] Covariate-adjusted to cow or calf body weight on day 0 ($P \leq 0.05$).
[2] Covariate-adjusted to calf age on day 0 ($P \leq 0.05$).

Data shown in Table 1 demonstrated that molasses or range cubes supplementation was not sufficient to impact body weight and body condition score change of cows during the first 56 days of the study compared to cows receiving no supplementation (CON cows). Starting in August 15th, supplement dry matter amount offered to YCUB and YMOL cows increased to 1.5 lb/day (approximately 2 lb of molasses and 1.74 lb of cubes) and will be provided until calving (November 2017). Consequently, it is expected that such increase in supplement amount will make YCUB and YMOL cows achieve greater body condition score at calving compared to CON cows.

However, data shown in Tables 2 demonstrated that despite the lack of differences on cow growth performance, range cubes supplementation tended to increase plasma concentrations of IGF-1 and glucose compared to cows receiving no supplementation (CON cows). Insulin-like growth factor 1 (IGF-1) and glucose are highly correlated with nutrient intake, and crucial metabolites and hormones for proper growth performance and calf development. For instance, glucose is the primary energy fuel for the growing fetus. Hence, the greater plasma concentrations of IGF-1 and glucose indicate that the energy status of YCUB cows were improved compared to CON cows, which could benefit calf growth during pregnancy and growth performance after birth. Calves will be born in November. Blood samples will be collected from calves immediately after birth to evaluate their immune status at birth. Calf body weight will be collected every 60 days from birth to weaning (August 2018) to evaluate their growth performance.

Table 2. Plasma indicators of energy metabolism of cows receiving no molasses supplementation until calving (CON), or year-round supplementation of molasses (YMOL) or range cubes (YCUB).

	Treatments				*P*-value
	CON	**YCUB**	**YMOL**	**SEM**	**Treatment**
Cow plasma concentrations in August (day 56)					
IGF-1 [1], ng/mL	40.6^a	48.2^b	38.7^a	2.46	0.11
NEFA, mEq/L	0.259^a	0.307^b	0.166^a	0.029	0.008
Glucose, mmol/L	3.80^a	4.79^b	4.71^b	0.307	0.06

[a-b] Within a row, means without a common superscript differed ($P \leq 0.05$).
[1] Covariate-adjusted the concentrations of respective plasma measurement obtained on day 0 ($P \leq 0.05$).

Liver samples were collected from cows at the start of the study (baseline trace mineral levels shown in Table 3). The next liver sample collection is scheduled for Oct 5^{th,} 2017, and will be used to determine the trace mineral status of all cows after 120 days of receiving no supplementation, or supplementation with molasses or range cubes from June to October.

Table 3. Average liver concentrations of trace minerals of samples collected on day 0 (start of the study).

Trace mineral	**Average concentration of liver trace minerals on day 0, ug/g of dry tissue**
Copper	142.5
Iron	308.3
Cobalt	0.34
Selenium	1.12
Zinc	135.3
Molybdenum	3.33
Manganese	11.3

In summary, a relatively small amount of molasses and range cubes supplementation (approximately 0.5 lb of dry matter daily) from June to August was not sufficient to increase cow growth performance compared to cows receiving no supplementation. However, physiological parameters crucial for fetal growth were increased by providing range cubes, which might positively affect calf development during gestation. We expect that due to an increase in supplement amount offered to cows from August to November, cow BCS at calving will be increased. We also expect that the physiological parameters related to energy metabolism and calf fetal growth will be further increased by providing molasses or range cubes during late-gestation.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Does year-round supplementation of cows pay off? (FCEB# 6)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and supplies	Various	100%	$ 3,483.47	Laboratory consumables used for collection of first set of liver biopsy samples (needles, RNA preservative, storage vials) and fencing supplies.	6/1/2017
Laboratory analyses - Liver trace minerals	Various	100%	$ 1,147.50	Collection and analyses of DNA samples from hair follicles for Year of the project	6/19/2017
Laboratory analyses - Plasma hormones and metabolites, and gene expression	Various	100%	$ 6,613.35	Estrus synchronization and artificial insemination supplies for Year 1 of the project	8/1/2017
Research Animals (per diem)	Various		$ 3,868.04	Research animals housed at the Feed Efficiency Facility to measure feed intake individually	6/9/2017
Data and sample collection, and feed sample analyses	N/A		$ 2,583.64	Data analyses for Year 1 to assess the relationship between feed efficiency and fertility and preparation of final report	6/19/2017
IDC	N/A		$ 2,123.54		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 19,819.54**		

MID-TERM REPORT – Project # P0038396 (FCEB# 8)

Title: Understanding the relationship between feed efficiency and fertility in replacement beef heifers

Principle Investigator: Dr Cliff Lamb and Nicolas DiLorenzo, North Florida Research and Education Center

Relevance to Florida Cattle Industry: Reducing feed costs in beef cattle can significantly improve profits to the production enterprise. Studies have shown differences in residual feed intake (RFI) values that range between -4.3 lb/day to 4.0 lbs/day. This represents a difference of over 8.3 lb/day feed savings in efficient versus inefficient animals. The savings in feed costs between low and high RFI animals could be as high as $92 (assuming 170 days on feed and $130/ton of feed). The relationship of fertility and feed efficiency has barely been researched. To beef producers, fertility often is overlooked as one of the most important traits to ensuring the economic viability of their operations. The University of Florida-IFAS Feed Efficiency Facility (FEF) is unique as it is the only facility in the Southeastern United States that has the capability to measure feed intake in real-time, and the GrowSafe™ system is a robust data collection system that significantly increases data acquisition over conventional individual feed measuring systems, thereby increasing the number of variables that can be analyzed and estimated. Therefore, the proposed study would investigate feed efficiency in animals that are known to be adapted to subtropical/tropical climates (such as Brangus and Braford) and the efforts at improving the efficiency of feed/forage use will have a large impact on reducing input costs of beef production.

Objective: The objectives of the proposed study is to investigate feed efficiency in animals that are known to be adapted to subtropical/tropical climates (such as Brangus and Braford), and the relationship between feed efficiency and fertility in replacement heifer.

Methods: Eighty-nine replacement beef heifers, Angus, Brangus, and Braford genetics produced at the NFREC, were enrolled in the experiment. Heifers were weaned and back-grounded on pasture for three months. From 10 to 12 months of age heifers entered the FEF and received a diet high in forage to reflect a similar diet to that received on pasture, and heifers had ad libitum access to feed. While in the FEF, heifers were exposed to a 14 d adaptation period, followed by a 70 d data collection period that included the collection of data for residual feed intake, feed to gain ratio, various measurements of temperament, and stress responsiveness. Body condition score and body weight were collected weekly. Puberty in heifers was evaluated by weekly collection of blood samples from January to May for analysis of progesterone. An antral follicle count was assessed on all heifers at the first day of the breeding season using transrectal ultrasonography. Subsequent fertility (conception and pregnancy rates) were evaluated after breeding by the use of transrectal ultrasonography.

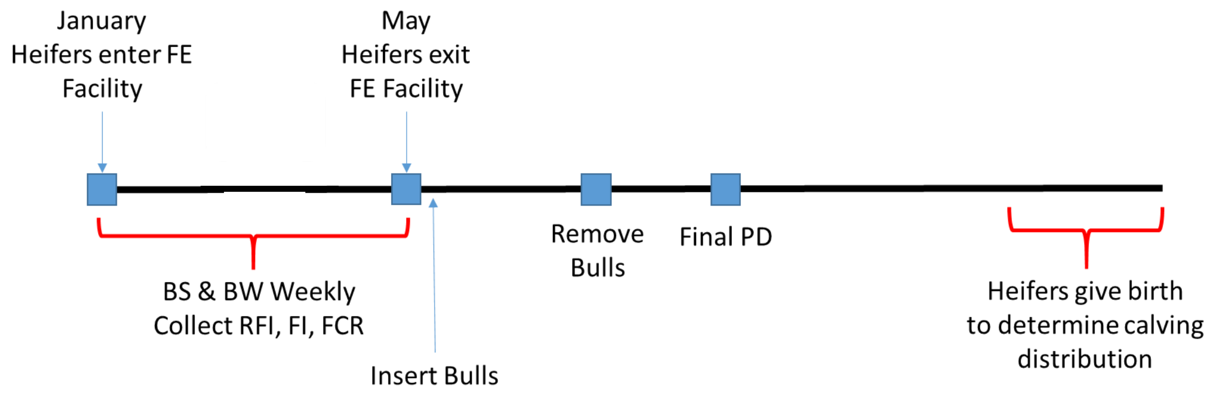


Figure 1. Yearly timeline of data collection events.

Results: Our preliminary data, after one year of data collection on 89 heifers of Angus, Brangus, and Braford breeds currently reveals no difference exists in the mean age at puberty among breeds (Table 1). However, a second year of data is necessary to increase the number of observations per breed to reduce the possibility of reporting a Type II statistical error. Using survival analyses it appears that Angus and Brangus heifers attained puberty earlier during the breeding season than Braford heifers. However, average daily gain (ADG) during the heifer development and feed efficiency determination portion of the project demonstrated that Angus and Brangus heifers was greater than in Braford heifers, but there was no difference among treatments for RFI (Table 1). Preliminary Pearson correlation coefficients currently indicate that there is a correlation between the age at the onset of puberty and dry matter intake of heifers and a correlation between the onset of puberty and residual feed intake (Table 2).

Table 1. Mean age at attainment of puberty for Angus, Brangus, and Braford heifers.

	Heifer breed		
	Angus	Brangus	Braford
No. of heifers	51	27	11
Mean age at puberty attainment, d	399 ± 6	410 ± 8	404 ± 12
Average daily gain, lb	3.5 ± 0.1^a	3.4 ± 0.1^a	3.0 ± 0.2^b
Residual feed intake, lb	-0.29 ± 0.40	0.59 ± 0.55	-0.10 ± 0.85

Table 2. Pearson correlation coefficients among feed efficiency and fertility traits for replacement beef heifers.

Item[1]	Initial BW	Final BW	DMI	ADG	RFI
Age at onset of puberty	0.154	0.174	**0.278**	0.139	**0.222**
	0.149	0.104	**0.008**	0.195	**0.037**
Initial BW		**0.948**	**0.380**	**0.381**	0.002
		<0.001	**<0.001**	**<0.001**	0.987
Final BW			**0.466**	**0.655**	0.001
			<0.001	**<0.001**	0.989
DMI				**0.453**	**0.863**
				<0.001	**<0.001**

[1] BW = Body weight; DMI = dry matter intake; RFI = residual feed intake

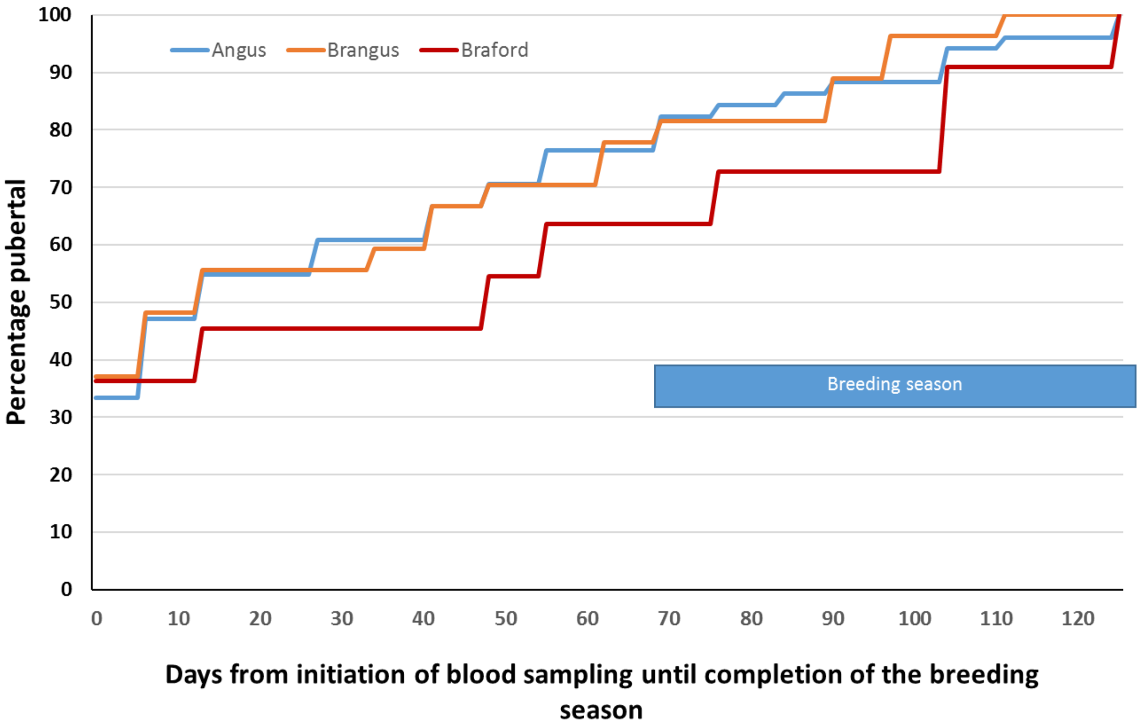


Figure 1. Survival analysis of onset of puberty prior to and during the breeding season for Angus, Brangus, and Braford heifers

Conclusion: Since this is a mid-term report and only reports data from heifers during the initial year of the experiment, it is unwise to report any definitive conclusions; however, during year 1 it is evident that Angus and Brangus heifers had greater average daily gain during the development phase and appear to attain puberty earlier during the breeding season than Braford heifers.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Understanding the relationship between feed efficiency and fertility in replacement beef heifers - (FCEB# 8)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Blood sample analysis	Various	100%	$ 8,000.00	Immulite analysis of P4 samples to complete the progesterone anlyses for Year 1	9/1/2017
Hair sample analysis for DNA for	Various	100%	$ 27,364.00	Collection and analyses of DNA samples from hair follicles for Year of the project	9/1/2017
Materials and supplies, for year 1	Various	100%	$ 5,104.00	Estrus synchronization and artificial insemination supplies for Year 1 of the project	9/1/2017
Research Animals (per diem)	Various		$ 14,400.00	Research animals housed at the Feed Efficiency Facility to measure feed intake individually	9/1/2017
Analysis of data and final report	Various		$ 6,465.00	Data analyses for Year 1 to assess the relationship between feed efficiency and fertility and preparation of final report	9/1/2017
IDC	N/A		$ 7,359.78		
GRAND TOTAL: (equal to percentage of completion)			**$ 68,692.78**		

FINAL REPORT – Project # P0038431 (FCEB # 9)

Title: Impact of Insulin-Like Growth factor 1 (IGF-1) on fetal development during the first trimester of pregnancy

Principle Investigator: Dr. Cliff Lamb and Dr. Nicolas DiLorenzo, North Florida Research and Education Center, Marianna, Florida

Relevance to Florida Cattle Industry: Developing strategies to alter fetal development and reduce potential pregnancy loss during pregnancy are essential to increasing calf survival in the Florida cattle industry. Therefore, focusing on fetal programming utilizing recombinant bovine somatotropin (bST) to beef females during the first trimester may improve embryo and fetal health with an overall increase in efficiency and profitability of beef production systems in Florida.

Objective: To determine the effects of biweekly administration of 500 mg of slow-release bST to increase IGF-1 on fetal development during the first trimester of pregnancy.

Methods: A total of ninety-seven *Bos taurus* beef heifers were exposed to the 7-day CO-Synch + CIDR ovulation control protocol and then artificially inseminated. At fixed-time artificial insemination (TAI; day 0 of the experiment) heifers were randomly assigned to receive one of two treatments: single subcutaneous injection with 500 mg of bST in the neck at TAI and then biweekly to day 57 of the experiment (BST; Figure 1); or an untreated control (CONT). Blood samples were collected on days -0, 22, 50, and 64 relative to TAI for analysis of concentrations of plasma IGF-1. Body weight of heifers was assessed on d -9, -3, 0, 15, 22, 29, 43, 50, 57, 64, and 77. Pregnancy was determined via transrectal ultrasonography on d 29 and d 64 after TAI. On day 85 after TAI heifers were euthanized and a subset of pregnant heifers (n = 7 for BST, n = 5 for CONT) were retained for assessment of fetal and placental characteristics. Heifers were harvested and complete gravid reproductive tracts and liver tissue were collected for analysis. Specific fetal measurements assessed were brain weight, crown to nose length, crown to rump length, heart girth, fetal body weight, eviscerated body weight, liver weight, and umbilical cord diameter, whereas extraembryonic measurements were fetal fluid volume, fetal membrane weight, placentome weights, and placentome number. In addition, maternal tract parameters of gravid uterine weight, empty uterine weight, ovarian weight, and corpus luteum weight were recorded.

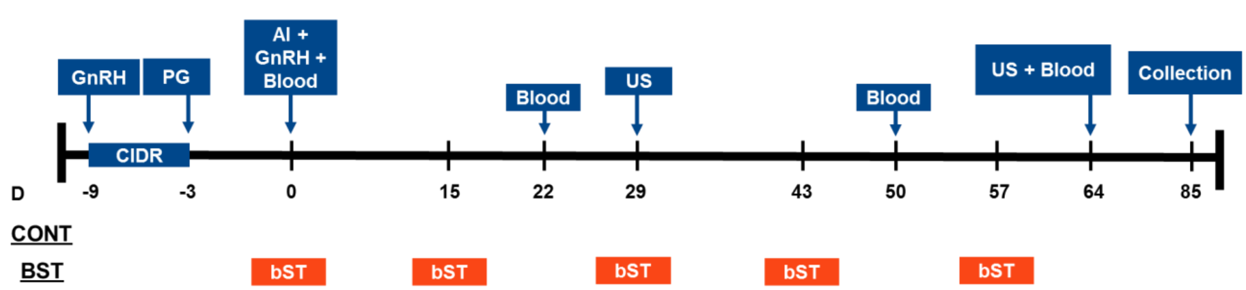


Figure 1. Schematic of treatments.

Results: Overall, mean change in body weight and ADG (0.95 kg ±0.27) of the heifers from TAI to d 77 did not differ between treatments (*P* > 0.05) (Table 1). Likewise, no differences were detected between treatments with regards to heifer carcass quality grade, carcass yield, or carcass weight. Mean concentrations of IGF-1 were greater (*P* < 0.001) in BST (346.50 ± 27.7 ng/mL) treated than CONT (134.70 ± 32.8 ng/mL) heifers. Mean placental weight (66.46 g), fetal membrane weight (0.256 kg), uterine weight (1.42 g), as well as ovarian and corpus luteum weights (15.1 g and 4.8 g, respectively) did not differ (*P* > 0.05) between treatments. Similarly, fetal crown to rump length, fetal weight, heart girth, and liver weight did not differ between treatments (*P* > 0.05). However, extraembryonic samples collected from heifers receiving bST (521.6 ± 22.9 g) resulted in greater (*P* = 0.027) quantities of fetal fluid compared to CONT heifers (429.6 ± 27.14 g). There was also a tendency for BST heifer reproductive tracts to have fewer placentomes (*P* = 0.084) and greater umbilical diameter (*P* = 0.091) than CONT heifers. Therefore, although concentrations of IGF-1 were increased in heifers that received biweekly administration of bST from TAI to day 57 of gestation, overall fetal development parameters did not differ between treatment. However, there was increased fetal fluid and a tendency for increased umbilical diameter and decreased placentome number in the BST heifers resulting in a physiological response in extraembryonic development due to stimulation by the GH and IGF system.

Conclusion: The administration of 500 mg of slow-release recombinant bovine somatotropin from TAI to day 57 of gestation has no current implications on overall fetal growth; however, based on these data there could be a potential benefit to placental function.

Table 1. Extraembryonic, maternal, and fetal measurements			
	CONT (*n* = 5)	BST (*n* = 7)	SEM
Fetal membrane weight, kg	0.27	0.24	0.134
No. of placentomes	73	54	6.8
Placental weight, g	73.61	61.30	6.754
Fetal fluid, mL	430	522	25
Gravid uterine weight, g	1.31	1.49	0.078
Empty uterine weight, kg	0.64	0.53	0.057
Ovarian weight, g	15.86	14.34	1.691
Corpus luteum weight, g	4.94	4.62	0.372
Brain weight, g	2.72	2.34	0.269
Crown-nose length, cm	3.84	4.08	0.243
Crown-rump length, cm	13.18	13.28	0.237
Fetal BW, g	60.08	59.40	2.464
Heart girth, cm	9.20	9.22	0.147
Liver weight, g	3.27	3.01	0.243
Umbilical cord diameter, mm	6.66	8.90	0.831

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Impact of Insulin-Like Growth factor 1 (IGF-1) on fetal development during the first trimester of pregnancy - Project # P0038431 (FCEB# 9)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Blood sample analysis in heifers	Various	100%	$ 4,800.00	Immulite analysis of P4 samples, Immulite analysis of IGF-1 samples, and ELISA anlysis of PEG	9/1/2017
Sample analyses in fetal tissues	Various	100%	$ 5,720.00	Collection and analyses of fetal blood samples to be analyzed for IFG-1, and fetal tissue collection and mRNA extraction	9/1/2017
Materials and supplies for blood and ti	Various	100%	$ 3,201.34	Blood and tissue collection tubes, syringes, reagents for ELISA and Immulite,purchase of bST	9/1/2017
Research animal per diem	Various		$ 18,772.00	Research animals housed at the NFREC Beef Unit	9/1/2017
IDC	N/A		$ 3,805.66		
GRAND TOTAL: (equal to percentage of completion)			**$ 36,299.00**		

FCEF Report 2_September 01, 2017

Florida Brahman: Genomic selection for tenderness, marbling, and reproductive tract score

Mauricio A. Elzo (PD/PI), Raluca G. Mateescu (Co-PD/PI), Chad Carr (Co-PD/PI), Owen Rae (Co-PD/PI), T. Scheffler (Co-PD/PI), J. Scheffler (Co-PD/PI), K. C. Jeong (Co-PD/PI), Danny Driver (Co-Investigator), and Michelle Driver (Co-Investigator)

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Specific Aims

Brahman is a key component of the Brahman-*Bos taurus* 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 the tenderness and marbling of their meat and for their lower fertility relative to other breeds and crossbred cattle. However, research at the University of Florida (UF) has shown 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. This project aims at developing a statewide selection and mating program for Florida Brahman cattle focused on genomic selection and assortative mating to improve three target traits: tenderness, marbling, and reproductive tract score. To maximize genetic progress in the complete population, we will utilize as many cattle from UF and participating herds as possible. We will increase UF Brahman herd size to 260 cows. We will construct a statewide tissue sample repository and a database with phenotypes, pedigree, and genotypes to conduct annual genomic evaluations of all Brahman cattle in the population. Animal genomic EPD for the three target traits will be published annually.

Anticipated Outcomes and Potential Benefits

This project seeks to increase the number of Florida Brahman cattle with improved EPD for tenderness, marbling, and reproductive tract score. To achieve this goal, we will:

1) Develop a statewide database with genotypes, pedigree, and phenotypes for all recorded traits (reproduction, growth, ultrasound, carcass, meat palatability) in the Florida Brahman population.

2) Increase the size of the UF Brahman herd to 260 cows.

3) Establish a statewide Brahman tissue sample (blood, hair, ear notches) and DNA repository.

4) Conduct annual genomic evaluations for tenderness, marbling, and reproductive tract score using information from phenotypes, pedigree, and genotypes.

5) Publish an annual summary with animal genomic EPD to aid selection and mating decisions to increase tenderness, marbling, and reproductive tract score within and across Florida Brahman herds.

6) Make semen and embryos from animals with favorable EPD for the three target traits as well as sires and heifers not used as replacements available to Florida cattlemen.

Educational Products and Outreach Activities

This genomics project depends on phenotypic and pedigree data, and genotypes from herds from the University of Florida and from Florida Brahman cattlemen. In fact, Florida Brahman cattlemen are an integral component of this project, thus their participation is crucial to achieve the statewide goals specified for this project (trait database, tissue sample and DNA repository, animal EPD summary). Thus, we will involve and keep Florida Brahman cattlemen informed of the work carried out in this project from the beginning and throughout its execution. Specifically, we will carry out the following educational and outreach activities:

1) We will contact Brahman cattlemen (email, telephone) to request their participation in the project (our goal is to have at least 500 cows from private herds in the project) in one of the two following options:
    1.1) Phenotypic and pedigree information only (option 1).
    1.2) Phenotypic and pedigree information, and tissue samples (option 2).
2) We will conduct meetings to address and provide information on the following aspects:
    2.1) Phenotypic, pedigree, and tissue samples needed from each participating Brahman cattleman.
    2.2) Structure of the Florida Brahman population involved in this project including connections through the utilization of sires to connect herds.
    2.3) Genomics aspects of the project, i.e., the inclusion of genomic information in the unified genomic evaluation procedure, the utilization of genomic EPD computed in this project for selection within and across herds, and the relationship of these Florida Brahman EPD with national Brahman EPD.
    2.4) The Florida Brahman genomic animal summary (i.e., explanatory information, traits, genetic parameters, trends).
    2.5) Utilization of genomic EPD information to construct indices to be used for mating and selection decisions.
3) We will provide reports on:
    3.1) Statewide trait database containing phenotypic, pedigree, and genotypic information.
    3.2) Statewide tissue sample and DNA repository and genotyping with Gene-Seek high and low-density genotyping chips.
4) We will write two articles for The Florida Cattleman & Livestock Journal to provide information on the design and outcomes of this project.
5) We will construct an internet page containing an online version of the Florida Brahman genomic animal summary and related information.

Areas of Work (January to August 2017)

1) Collaborative work and exchange of information with Florida Brahman breeders (emails, telephone calls, meetings).

1.1) Obtained the complete list of Florida Brahman breeders from the American Brahman Breeders Association (ABBA; n = 97; January 10, 2017).

1.2) First email (January 13, 2017) to Florida Brahman breeders with ABBA member identification number (n = 93) inviting them to participate in the genomics project, requesting an answer by January 23, 2017, and indicating that a first meeting would be scheduled for late January or early February. Three attachments: a) Approach_FL Brahman Genomic Selection Project_January-11-2017.pdf: detailed approach of the genomics project; b) EducProd&OutreachActiv_January-11-2017.pdf: educational products and outreach activities; and c) Summary_FL Brahman Genomic Selection Project_January-11-2017_aaaa.pdf: summary of the genomics project.

Second email (January 23, 2017) to all Florida Brahman breeders inviting them to participate in the genomics project. Email followed by telephone calls (January 23 to 30).

Response to invitation to participate in the project (email; telephone): Yes = 12; Would think about it = 5; No or no answer = 3. Final number of participants = 9 (3 breeders decided not to participate at a later date). One Brahman breeder decided to participate in August 2017. Current number of participants = 8 (Larry Barthle; Drew Tucker; Kempfer Cattle; Doc Parting_Ricky Booth; Larry Ford; John Traxler; Sean Sexton; Markus Shakelford; August 23, 2017).

1.3) Work on setting up the first meeting with Brahman breeders (emails, telephone calls; Ricky Booth, George Kempfer, Henry Kempfer, Raluca Mateescu, Owen Rae, Danny Driver; January 13 to February 22, 2017). Preparation of PowerPoint presentation for the first meeting with Florida Brahman breeders (16 slides; February 07-09, 2017).

Meeting occurred at the Florida Cattlemen’s Association headquarters (800 Shakerag Road, Kissimmee, FL 34744) on February 22, 2017 from 3:30 PM to 5:45 PM. Present at this meeting were George Kempfer, Henry Kempfer, Drew Tucker, Ricky Booth, Raluca Mateescu, and Mauricio Elzo. Meeting included a presentation on objectives, population structure, target and supporting traits, multiple-trait genomic evaluation for reproductive tract score, tenderness, and marbling, and selection indices. Discussion involved data contributions by breeders, incentives, and benefits of participation in the project. The long-term nature of the project was emphasized.

1.4) Conference call (February 28, 2017) to discuss reproductive tract score measurements. Present in the call were George Kempfer, Drew Tucker, Larry Barthle, Chad Carr, Owen Rae, and Mauricio Elzo. Items discussed were: a) Reproductive tract score description and visit schedule (March 1: Larry Barthle; March 15-16: Kempfer Cattle, Drew Tucker, Doc Partin Ranch_Ricky Booth); and b) Feedlot and carcass information data collection, contemporary groups, and schedule for groups to be sent to Quincey’s Farm (Mr. Larry Barthle sent 14 bulls to Quincey’s in March).

1.5) Exchanged numerous emails and telephone calls between March and August 2017 with participating Florida Brahman breeders concerning pedigree and phenotypic information as well as tissue sampling (ear notches, blood, semen) needed for the Brahman genomics project. Explained the importance of pedigree and phenotypic information from all animals in the herd (i.e., registered and non-registered) to increase the accuracy of genomic predictions.

1.6) Attended the Florida Brahman Field Day at Kempfer Cattle Company in Saint Cloud, Florida, on April 29, 2017 (Danny Driver, M. A. Elzo). Discussed the Brahman genomics project with John Traxler, Jay Sizemore, George Kempfer, and Larry Barthle's son.

1.7) Visited Kempfer Cattle farm with attendants to the 2017 S-1064 Southern Regional Meeting organized by UF (May 26, 2017). Various aspects of the Florida Brahman genomics project were presented and discussed during the S-1064 sessions in Gainesville and at the Kempfer Cattle farm. George Kempfer explained structure, management, and selection goals of Kempfer Cattle Co.

1.8) Prepared and emailed incentive invoices for approval from all participating Florida Brahman breeders (July 20, 2017).

2) Development of the Florida Brahman database and tissue sample repository

2.1) Requested Florida Brahman breeders (email, telephone calls, and meetings) to contribute with pedigree and phenotype information on target traits (i.e., tenderness, marbling, and reproductive tract score), dates and weights (e.g., insemination, birth, weaning, yearling, other weights), ultrasound records, carcass data (e.g., hot carcass weight, ribeye area, marbling), and reproductive tract score data (collected by Dr. Owen Rae) starting in January 2017.

2.2) Emailed prototypes of Excel sheets for calves, sires, and dams (February 27, 2017) to help Florida Brahman breeders with data collection and submission to this project. Received phenotypic information (calving, preweaning, ultrasound, and reproductive tract score on March 15, 2017, and 2016 heifer ultrasound data on March 22, 2107) on ABBA pdf file reports from Mr. Larry Barthle. Converted pdf files to Excel files using a combination of Word and Adobe Acrobat Pro DC 2015.

Utilized Mr. Barthles's information to construct prototypes for pedigree and calf work files for all participating Florida Brahman breeders (emailed prototype files on March 22, 2017).

To facilitate data retrieval and additional processing by breeders and researchers, ABBA could make information on reports available both in pdf and text formats (e.g., ABBA "pipe-delimited" text files, i.e., fields separated by "|", and csv: comma separated txt files). Files formatted as text could be easily read in Excel for further processing and research.

2.3) Collection of reproductive tract scores and blood samples (Dr. Owen Rae) from four farms: a) Mr. Larry Barthle: 13 yearling heifers and scrotal circumferences on 17 yearling bulls (March 01, 2017); b) Drew Tucker: 13 heifers (March 16, 2017); c) Kempfer Cattle: 23 heifers (March 16, 2017); d) Doc Partin: 22 heifers; Ricky Booth, Manager (March 16, 2017).

2.4) Contacted Mr. Chris Shivers, Executive Vice-President of ABBA to explore the possibility of obtaining phenotypic and pedigree records from Florida Brahman breeders submitted to ABBA (emails; telephone call; January 17 to February 3, 2017). Attached a list of Florida Brahman breeders and their ABBA numbers, summary of the Brahman genomics project, and detailed explanation of phenotypic records we could use in the project.

Received the initial set of phenotypic and pedigree files from ABBA (Chris Shivers, Peter Paine) on March 27, 2017. Requested information on traits and units of measurement in the ABBA phenotype file (uncorrected weights in lb, scrotal circumference in cm*10, rump fat in cm*100, rib fat in cm*10, ribeye are in squared inches*10, intramuscular fat in %*10) and sex of animal on March 27, 2017. Received sex information for animals in the ABBA pedigree file on March 30, 2017. These files provided information on ABBA registration numbers and birth dates on sires and dams reported by Florida Brahman breeders, and provided the largest fraction of information on growth traits for cattle from participating Florida Brahman breeders.

2.5) Contacted Ms. Armelinda Ibarra requesting phenotypes and pedigree data for approximately 500 Brahman animals without information in the ABBA pedigree and data files sent on March 30, 2017 (August 10, 2017).

2.6) Received pedigree and phenotypic information from participating Brahman breeders at various times between March and August 2017. Constructed individual herd Excel files with the information received and sent these files back to Brahman breeder. The goal was to create individual herd Excel files that could be used to exchange information expeditiously over the coming years.

2.7) Sent 1,600 ear notch sample kits and 9 applicators to the eight participant Florida Brahman breeders by FedEx (May 08, May 15, and August 14, 2017).

2.8) Received 630 blood and ear notch samples from 5 participating Florida Brahman Breeders between March 01 and August 21, 2017.

2.9) Processing of ear notch, blood, and semen samples as well as extraction of DNA from Florida Brahman and UF Brahman and Brahman-Angus multibreed herds is taking place at Dr. Raluca Mateescu's laboratory prior to submission to GeneSeek for genotyping with GeneSeek 250k or 50k. Brahman animals from all herds will be genotyped with the GeneSeek 250k chip. Because there is insufficient funds to genotype all animals with GeneSeek 250k, Brahman-Angus sires and dams will be genotyped with GeneSeek 250k whereas younger animals (weanlings and some yearlings) will be genotyped with GeneSeek 50k. It should be emphasized that information from the UF Brahman-Angus Multibreed herd is providing all the information for carcass traits (including marbling, Warner-Bratzler shear force, and tenderness score), most of the information for ultrasound traits, and a large fraction of growth traits. Thus, strengthening of the connections between animals in the Brahman-Angus multibreed herd and animals from the UF and Florida Brahman breeder herds through genotype information will increase the accuracy of EBV relative to connections through pedigree alone.

2.10) Processed an invoice from GeneSeek to genotype 1,080 animals with the Bovine GGP F250K chip and 1,097 animals with the Bovine GGP 50K chip.

2.11) Received an additional $60,000 for the Florida Genomics project on August 22, 2017. These funds (minus 12% for indirect costs = $7,200, i.e., $52,800) will be used for genotyping additional animals in the population.

3) Development of a statewide genomic evaluation for tenderness, marbling, and reproductive tract score

3.1) Developed a FORTRAN program (**ABBAData**) to construct joint pedigree and phenotypic files that included information from participating Florida Brahman breeders, ABBA, UF Brahman, and UF Brahman-Angus multibreed sources. Common link among datasets: registration numbers for animals. If unavailable, constructed a unique number using: a) the sequential herd number, year, and herd tag number for animals without ear notch samples; and b) the sequential herd number and the numeric part of the Allflex number for animals with ear notch samples. This program

3.2) Constructed edited pedigree, phenotype, and genotype files for genomic evaluation with the BLUPF90 Family of Programs from the University of Georgia using program ABBAData. The phenotype file contained all available reproduction, growth, ultrasound, carcass, and meat palatability traits of potential interest for genomic evaluation in the Florida Brahman population. The pedigree file included animals from the ABBA database, Florida Brahman breeders, and UF Brahman and Brahman-Angus multibreed herds. Genotypic data were from UF Brahman and Brahman-Angus multibreed herds genotyped with GeneSeek Bovine GGP F250K chip.

3.3) Conducted two rounds of estimation of variance components, heritabilities, correlations (genetic, environmental, phenotypic), and genomic-polygenic EBV for three sets of traits as data became available (the first one in June 2017, and the second one in August 2017; Only results from the second round are reported here). The three sets of traits were: a) Reproduction set (yearling weight adjusted to 305 days of age (YW), reproductive tract score (RTS), age at first calving (AFC), and calving interval (FCI); b) Ultrasound-carcass set (ultrasound weight (UW), ultrasound ribeye area (UREA), ultrasound fat (UBF), ultrasound percent intramuscular fat (UPIMF), slaughter age (SLA), hot carcass weight (HCW), ribeye area (REA), backfat thickness (FAT), and marbling score (MAR)); and c) Tenderness set (Warner-Bratzler shear force (WBSF) and tenderness score (TEND)). We also obtained predictions of single nucleotide polymorphism (SNP) marker effects and genomic variance accounted for by each SNP marker for each trait. Lastly, we constructed graphs of individual animal EBV for each trait as well as graphs of predicted SNP values and genomic variances accounted by each individual SNP.

The number of animals with one or more phenotypic records was 15,637 (9,327 Brahman and 6,310 Angus and Brahman-Angus crossbreds), and the number of animals in the pedigree files was 23,750 (16,818 Brahman and 6,932 Angus and Brahman-Angus crossbreds). Genotypic data were from 782 Brahman, Brahman-Angus, and Angus cattle from the UF Brahman and Brahman-Angus multibreed herds genotyped with GeneSeek Bovine GGP F250K chip.

Table 1 shows numbers of records, means, standard deviations, and heritabilities for traits in the three evaluation sets.

Table 1. Numbers of records, means, standard deviations, and heritabilities

Reproduction Set	**N**	**Mean**	**SD**	**Heritability**
YW, kg	2709	342.3	56.1	0.48 ± 0.05
RTS, units	664	3.0	1.2	0.28 ± 0.08
AFC, d	3205	1065.1	84.9	0.48 ± 0.05
FCI, d	1565	438.8	118.7	0.26 ± 0.06

Ultrasound-Carcass Set	N	Mean	SD	Heritability
UW, kg	2709	353.0	70.7	0.44 ± 0.03
UREA, cm^2	2709	56.1	12.2	0.35 ± 0.02
UBF, cm	2715	1.1	1.7	0.16 ± 0.01
UPIMF, %	2698	2.9	1.2	0.34 ± 0.02
SLA, d	2040	557.8	53.1	0.70 ± 0.02
HCW, kg	2027	334.4	45.8	0.70 ± 0.02
REA, cm^2	1989	8.0	1.1	0.56 ± 0.02
FAT, cm	2019	1.3	0.5	0.36 ± 0.02
MAR, units	2024	401.5	93.1	0.54 ± 0.03
Tenderness Set	**N**	**Mean**	**SD**	**Heritability**
WBSF, kg	1291	4.0	1.1	0.17 ± 0.03
TEND, units	824	5.4	0.9	0.47 ± 0.06

Table 2 presents numbers of animals, means, standard deviations, minimum, and maximum values of genomic EBV (GEBV) for traits in the three evaluation sets.

Table 1. Numbers of animals, means, standard deviations, minimum, and maximum values of genomic EBV

Reproduction Set	N	Mean	SD	Min	Max
YW, kg	23750	-0.2	9.9	-66.5	77.0
RTS, units	23750	-0.1	0.3	-1.3	1.3
AFC, d	23750	1.6	25.7	-218.9	169.8
FCI, d	23750	1.5	20.0	-102.6	161.8
Ultrasound-Carcass Set	**N**	**Mean**	**SD**	**Min**	**Max**
UW, kg	23750	-2.3	9.3	-59.2	66.5
UREA, cm2	23750	0.0	1.4	-9.0	12.1
UBF, cm	23750	0.0	0.1	-0.5	1.0
UPIMF, %	23750	-0.1	0.2	-1.3	1.6
SLA, d	23750	0.5	11.0	-83.3	81.0
HCW, kg	23750	-1.6	10.1	-62.5	58.8
REA, cm2	23750	-0.1	2.5	-16.2	20.3
FAT, cm	23750	0.0	0.1	-0.9	2.1
MAR, units	23750	-13.4	29.7	-127.1	234.1
Tenderness Set	**N**	**Mean**	**SD**	**Min**	**Max**
WBSF, kg	23750	0.1	0.1	-0.7	1.2
TEND, units	23750	-0.1	0.2	-1.9	1.1

Genomic EBV for the 16,818 evaluated Florida Brahman animals are shown as **red diamonds** in **Figure 1** for the four traits in the reproduction set, **Figure 2** for the nine traits in the ultrasound-carcass set, and **Figure 3** for the two traits in the tenderness set.

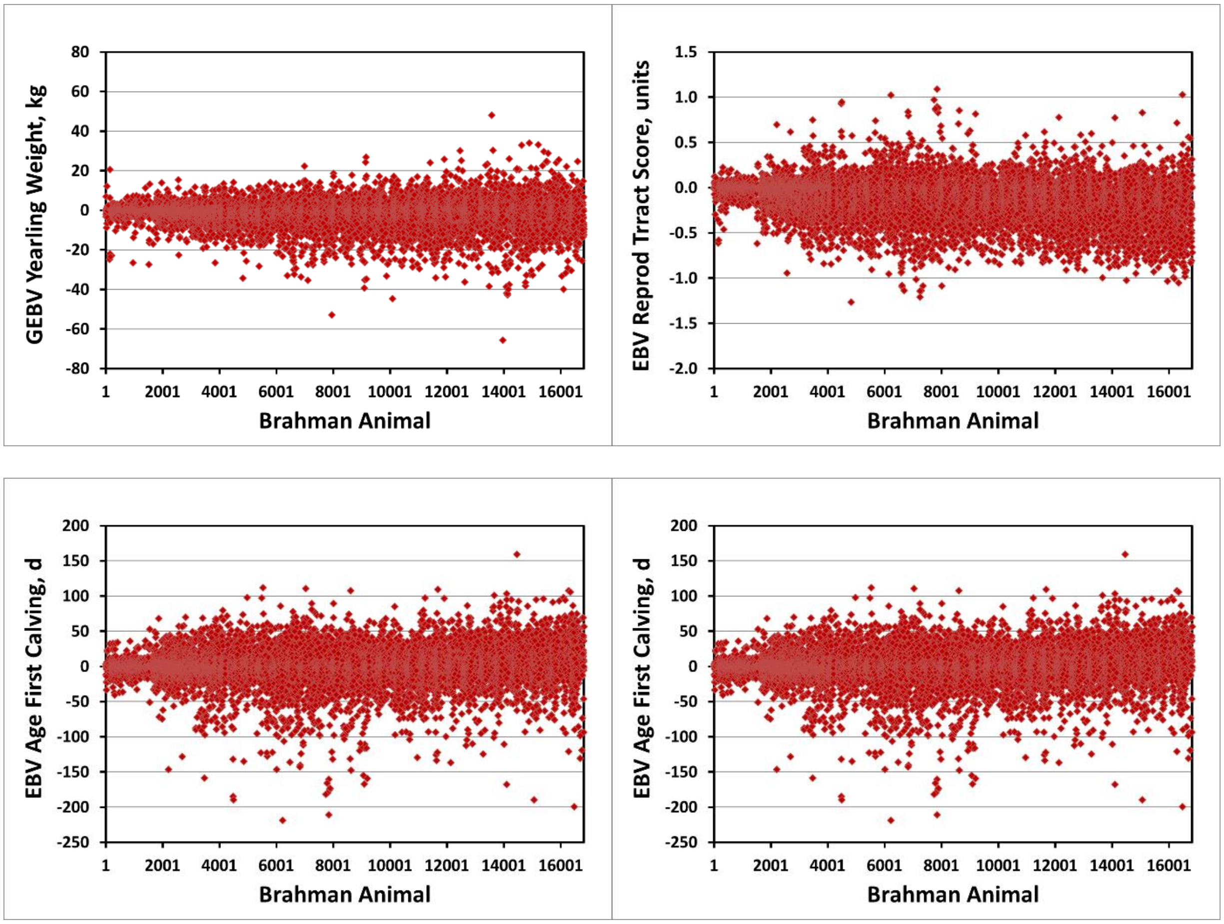
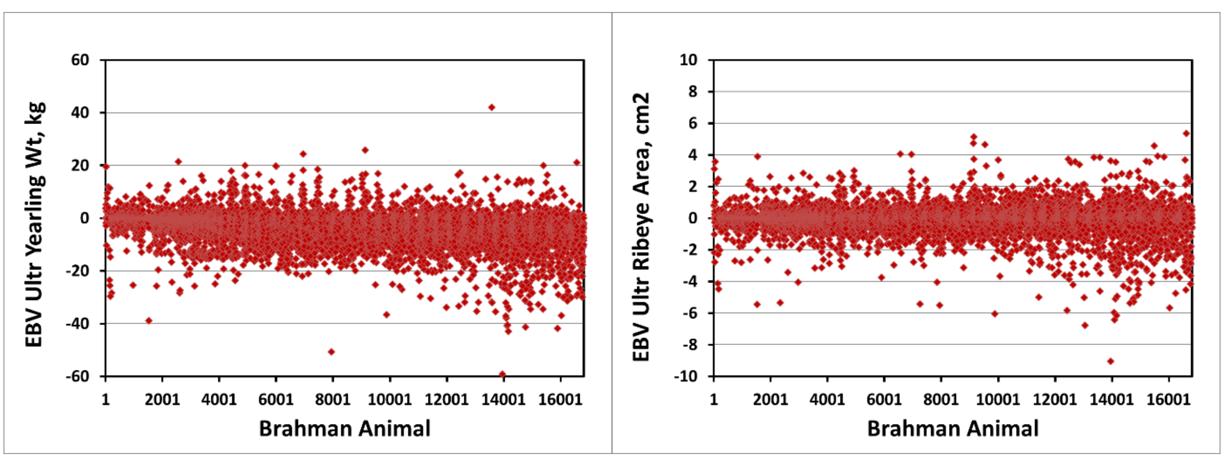
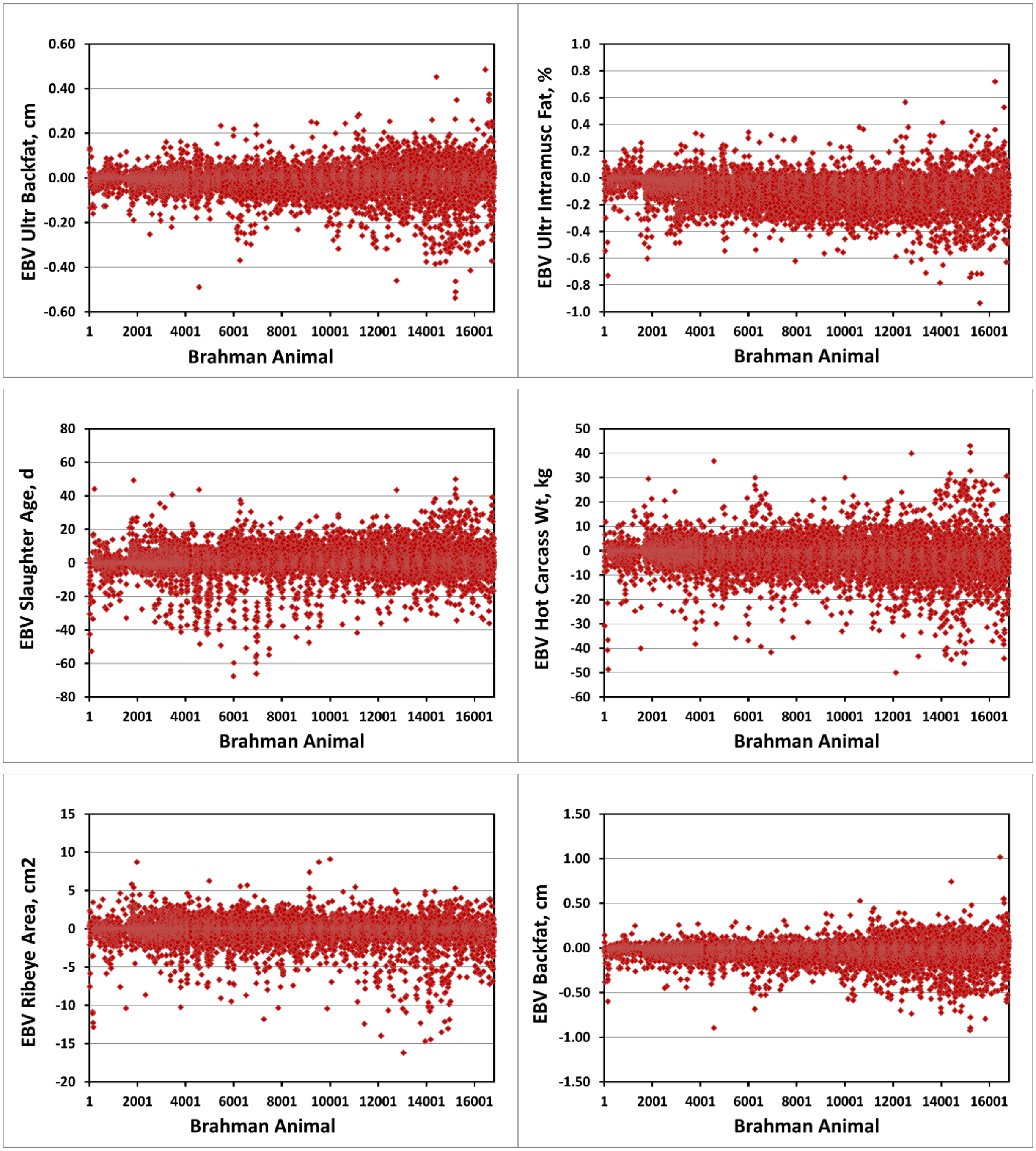


Figure 1. Florida Brahman animal genomic EBV for yearling weight adjusted to 305 days of age (YW), reproductive tract score (RTS), age at first calving (AFC), and calving interval (FCI)




EBV Ultr Backfat, cm
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
1
2001
4001
6001
8001
10001
12001
14001
16001
Brahman Animal
EBV Ultr Intramusc Fat, %
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Brahman Animal
EBV Slaughter Age, d
80
60
40
20
0
-20
-40
-60
-80
Brahman Animal
EBV Hot Carcass Wt, kg
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Brahman Animal
EBV Ribeye Area, cm2
15
10
5
0
-5
-10
-15
-20
Brahman Animal
EBV Backfat, cm
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
Brahman Animal

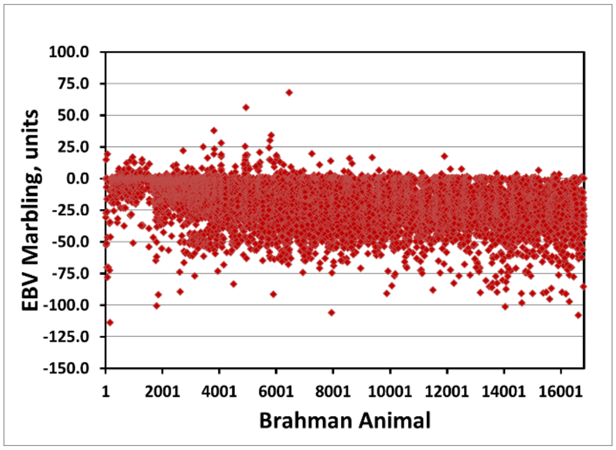


Figure 2. Florida Brahman animal genomic EBV for ultrasound weight (UW), ultrasound ribeye area (UREA), ultrasound fat (UBF), ultrasound percent intramuscular fat (UPIMF), slaughter age (SLA), hot carcass weight (HCW), ribeye area (REA), backfat thickness (FAT), and marbling score (MAR)

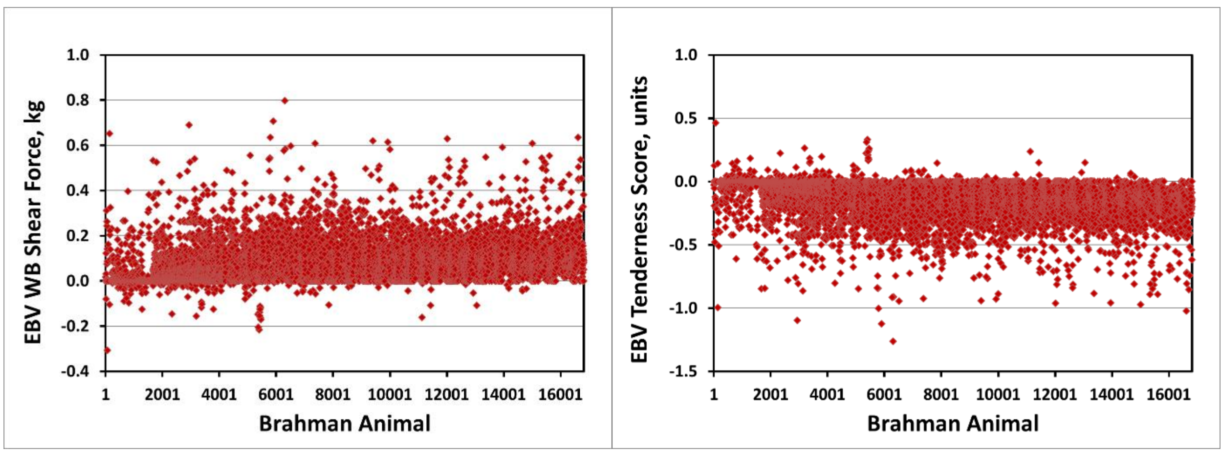


Figure 3. Florida Brahman animal genomic EBV for Warner-Bratzler shear force (WBSF) and tenderness score (TEND)

Figures 1, 2, and 3 clearly show that there is substantial genetic variation available in all traits in the Florida Brahman population for genomic selection to be effective, including the three target traits (tenderness, marbling, and reproductive tract score). **Thus, implementation of a genomic selection program for the target traits and other traits in the reproduction, ultrasound-carcass, and tenderness set should yield changes in the Brahman population in the desired direction. This means a larger number of Brahman cattle with more tender meat, more marbling, and reaching puberty and having their first calf at younger ages.**

Graphs of predictions of and variances accounted for single nucleotide polymorphism (SNP) marker effects are shown in **Appendix 1** for the four traits in the reproduction set, **Appendix 2** for the nine traits in the ultrasound-carcass set, and **Appendix 3** for the two traits in the tenderness set. Predictions of SNP are shown in the first four graphs of Appendix 1, the first nine graphs of Appendix 2, and the first two graphs of Appendix 3. Markers within each chromosome are in different colors. The remaining graphs in each appendix show the percent of the genetic variance accounted for by each SNP marker. Traits in Appendix 1 are yearling weight adjusted to 305 days of age (Trait 1), reproductive tract score (Trait 2), age at first calving (Trait 3), and calving interval (Trait 4). Traits in Appendix 2 are ultrasound weight (Trait 1), ultrasound ribeye area (Trait 2), ultrasound fat (Trait 3), ultrasound percent intramuscular fat (Trait 4), slaughter age (Trait 5), hot carcass weight (Trait 6), ribeye area (Trait 7), backfat thickness (Trait 8), and marbling score (Trait 9). Traits in Appendix 3 are Warner-Bratzler shear force (Trait 1) and tenderness score (Trait 2). **As expected for quantitative traits determined by large numbers of genes, most SNP markers had small effects for all traits. This was also reflected in the genetic variance accounted for each SNP marker. However, SNP markers with bigger effects were found in chromosomes 22, 23, 27, 28, 29, and X for most traits in the reproductive, ultrasound-carcass, and tenderness sets, except for reproductive tract score and marbling that had influential SNP markers across most chromosomes**.

4) Increase the size of the UF Brahman herd

This part of the project is being developed by the concomitant FCEF project on development and expansion of the UF Brahman herd led by Dr. Geoffrey Dahl. Two rounds of in vitro fertilization and embryo transfer (IVFET) were carried out and 45 sexed female embryos were located and purchased from Southern Cattle Co. These resulted in 47 IVF pregnancies. In addition, there are 88 pregnancies in the Brahman herd by AI and natural service (62 cows, 15 2-yr old heifers, and 11 yearling heifers), for a combined total of 135 pregnancies. For details, please refer to the second report of Dr. Dahl's project.

5) Equipment purchases

3.1) Tissue sampling and DNA repository: a) Ultralow Temperature Upright Freezer, 25.6 cu ft., -86^{o}C, to store tissue and DNA samples; b) Ear-Notch Kits for tissue sampling (n = 1,000). Requested numbers of animals to be genotyped (calves, sires, dams) from all participating Florida Brahman breeders (n = 560 for 3 herds; Need animal numbers for the other 9 participating herds); b) Allflex ear notch kits (n = 2,600) and applicators (n = 40) from Zoetis (April 24 and May 8, 2017).

3.2) Database construction and genomic evaluation: a) Dell Workstation; b) FORTRAN Compiler.

6) Next steps for Fall 2017 and 2018

5.1) Continue to collaborate and exchange information by phone, email, and in-person meetings with participating Florida Brahman breeders. Emphasize the importance of their role in pedigree, phenotype, and tissue sample collection for the continuity of the Florida statewide genomic evaluation system. In particular, highlight the importance of collecting phenotypic records on all animals in each herd at least for some traits (e.g., weaning weight) to avoid genomic selection biases due to missing records.

5.2) Add new information from ABBA, Florida Brahman breeders, and UF Brahman and Brahman-Angus multibreed herds to the accumulated Florida Brahman pedigree, phenotype, and genotype data files for the next series of genomic evaluations.

5.3) Collect tissue samples from all newborn animals and from new animals brought into the herd.

5.3) Conduct a third genomic evaluation of the Florida Brahman population for the three sets of traits (reproductive, ultrasound-carcass, and tenderness) utilizing all available historical information from ABBA, Florida Brahman breeders, and UF Brahman and Brahman-Angus multibreed herds and all available genotypic data.

5.4) Conduct periodic genomic evaluation updates for tenderness, marbling, and reproductive tract score of Florida Brahman in 2018 as new data pedigree, phenotype, and genotype data becomes available.

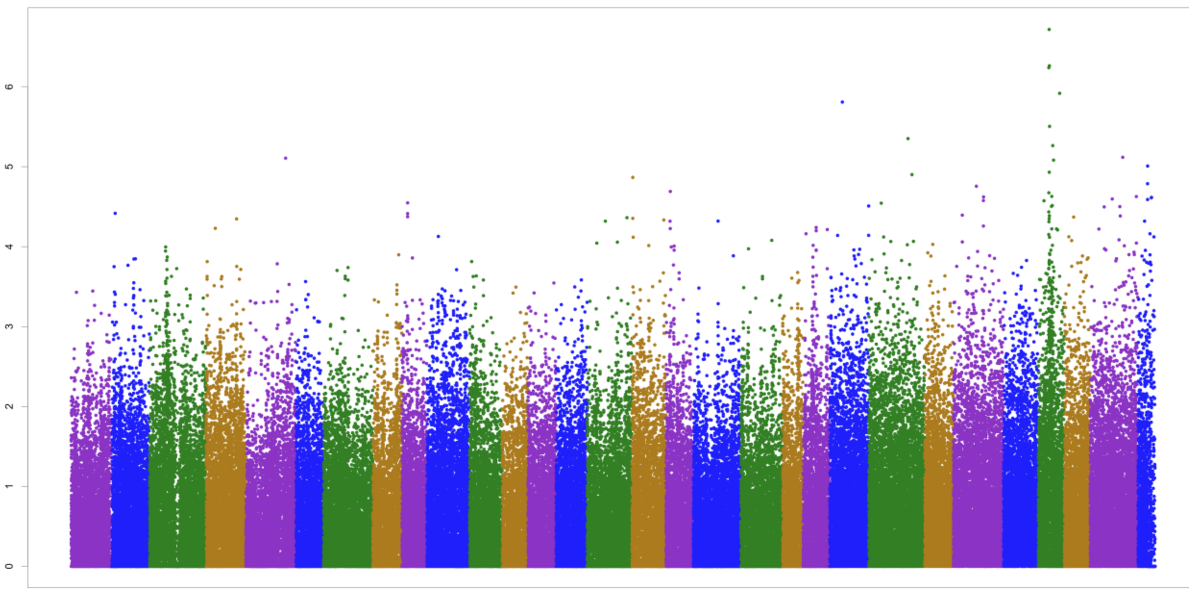
5.5) Publish one article on the Florida Cattleman & Livestock Journal providing information on current activities and outcomes of this project.

7) Publications

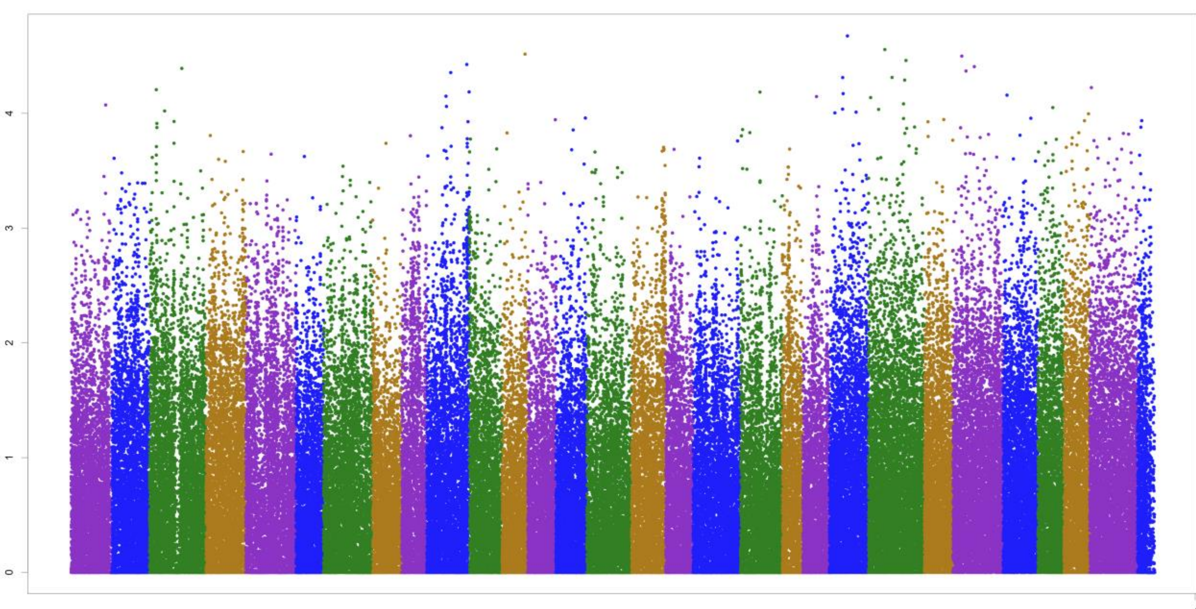
Elzo, M. A., R. Mateescu, C. Carr, D. O. Rae, T. Scheffler, J. Scheffler, J. D. Driver, and M. D. Driver. 2017. The Florida Brahman Genomic Selection Project: Initial Steps. The Florida Cattleman & Livestock Journal, 81(9):46-52. [**Appendix 4**]

Elzo, M. A., R. G. Mateescu, D. O. Rae, C. C. Carr, T. L. Scheffler, J. M. Scheffler, M. D. Driver, and J. D. Driver. 2017. Genomic-polygenic EBV for reproduction, ultrasound-carcass, and tenderness traits in the Florida multibreed Brahman-Angus population. Proc. 11th World Conf. Gen. Appl. Livest. Prod., Auckland, New Zealand, February 11-16, 2018 (Submitted). [**Appendix 5**]

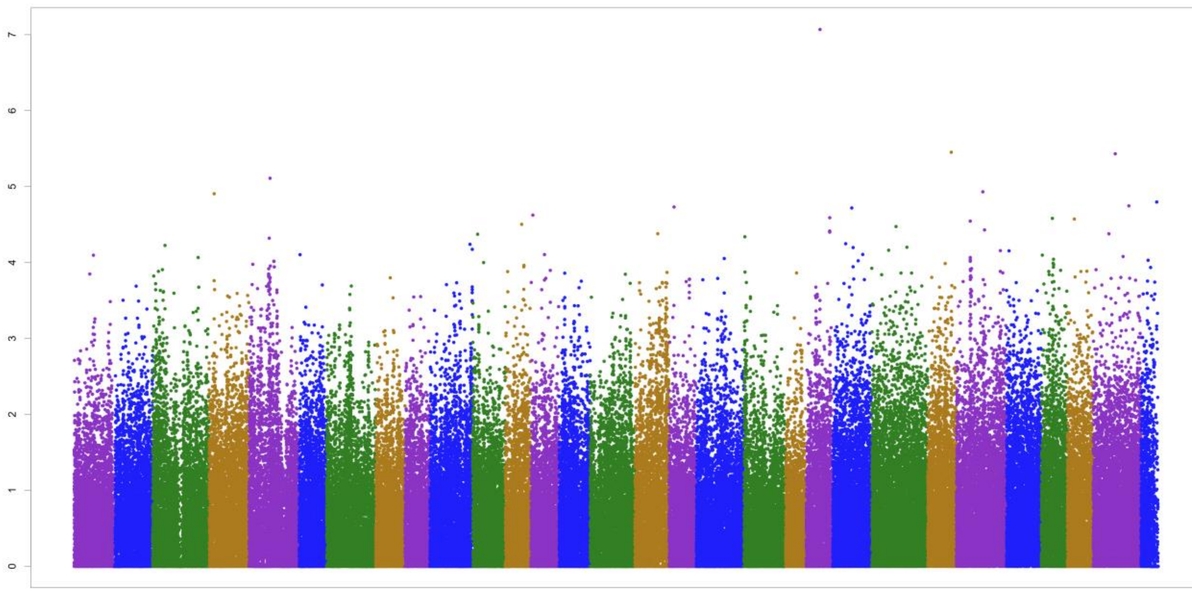
Manhattan Plot SNP Solution − Trait: 1 Effect: 6



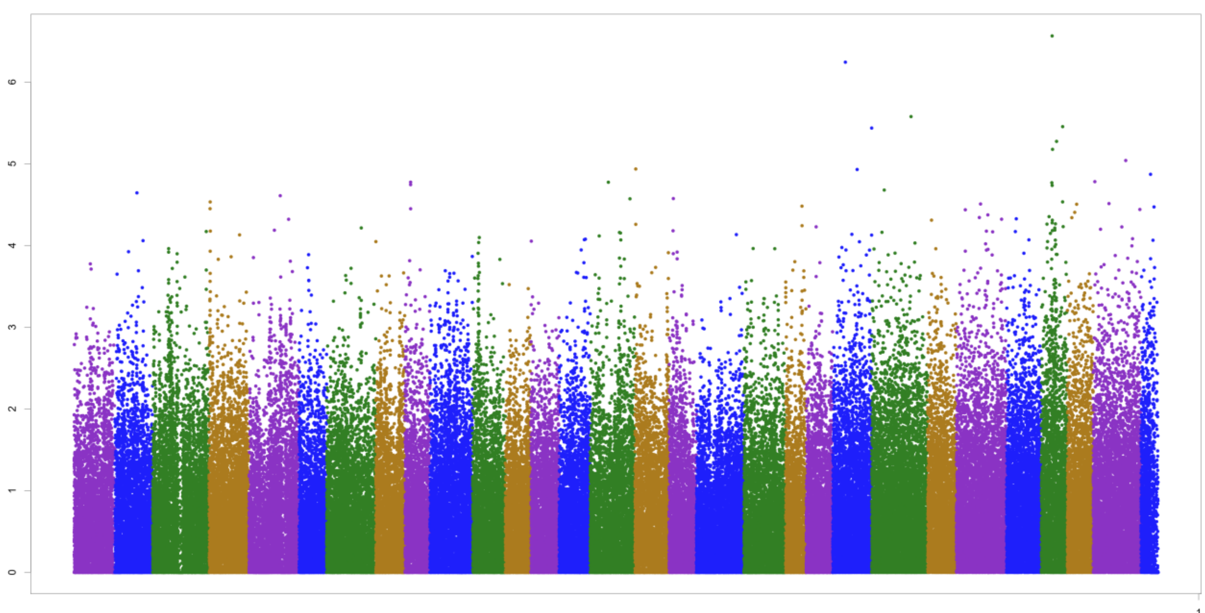
Manhattan Plot SNP Solution − Trait: 2 Effect: 6

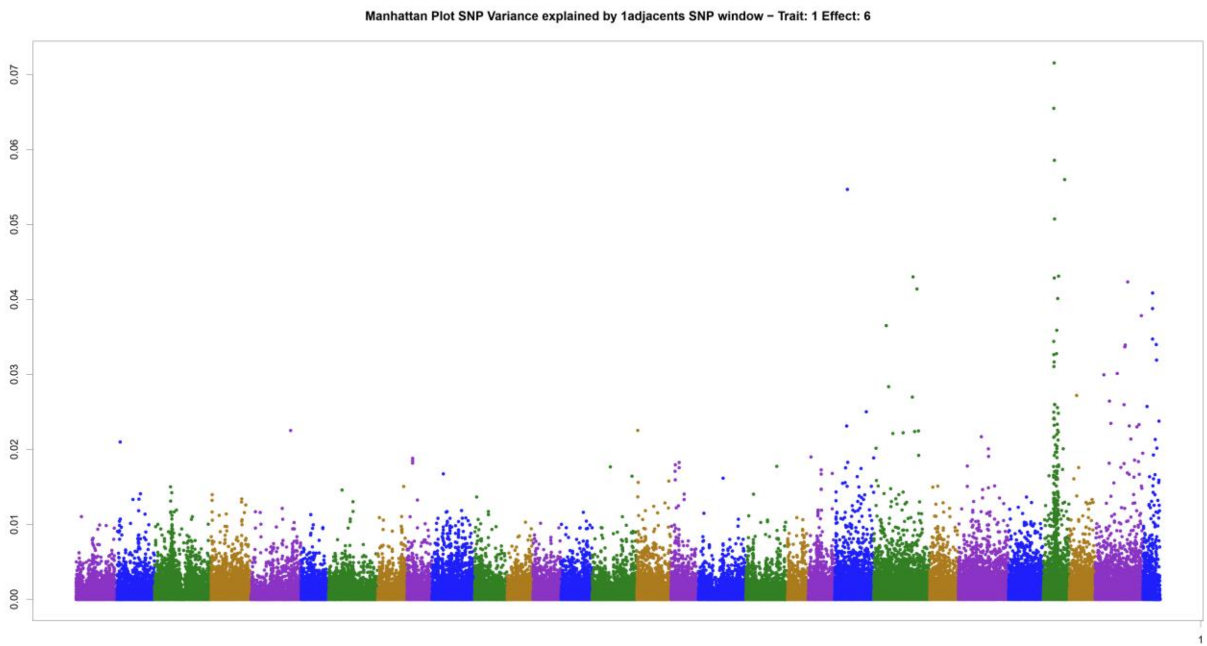


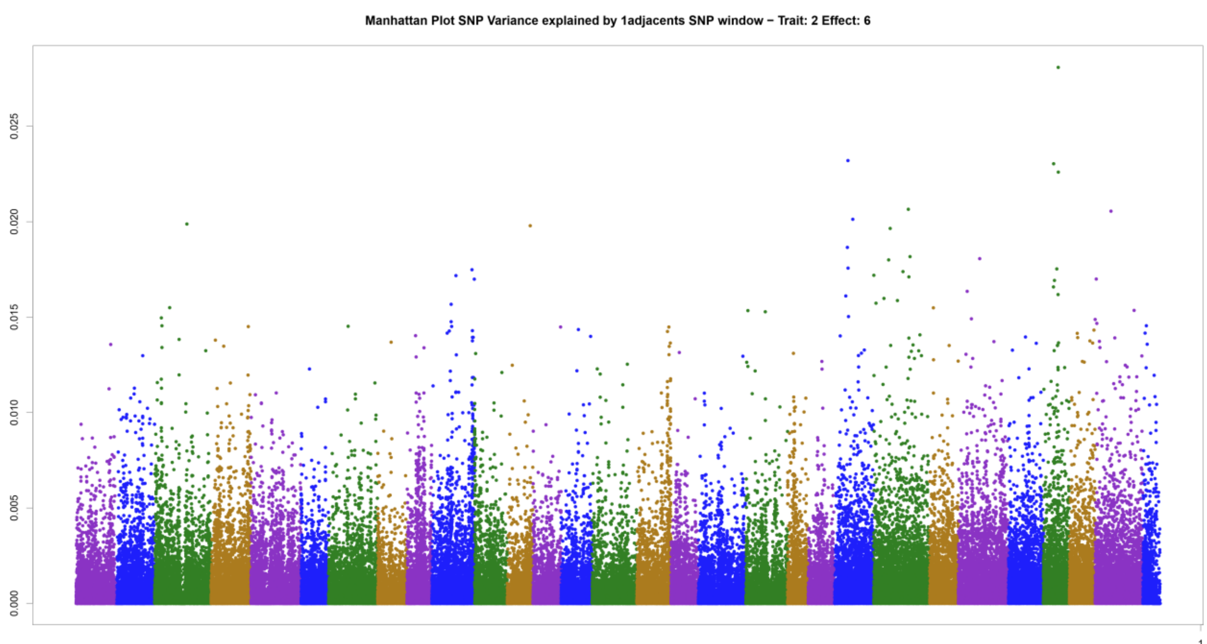
Manhattan Plot SNP Solution − Trait: 3 Effect: 6



Manhattan Plot SNP Solution − Trait: 4 Effect: 6




Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 1 Effect: 6
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1


Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 2 Effect: 6
0.000
0.005
0.010
0.015
0.020
0.025
1

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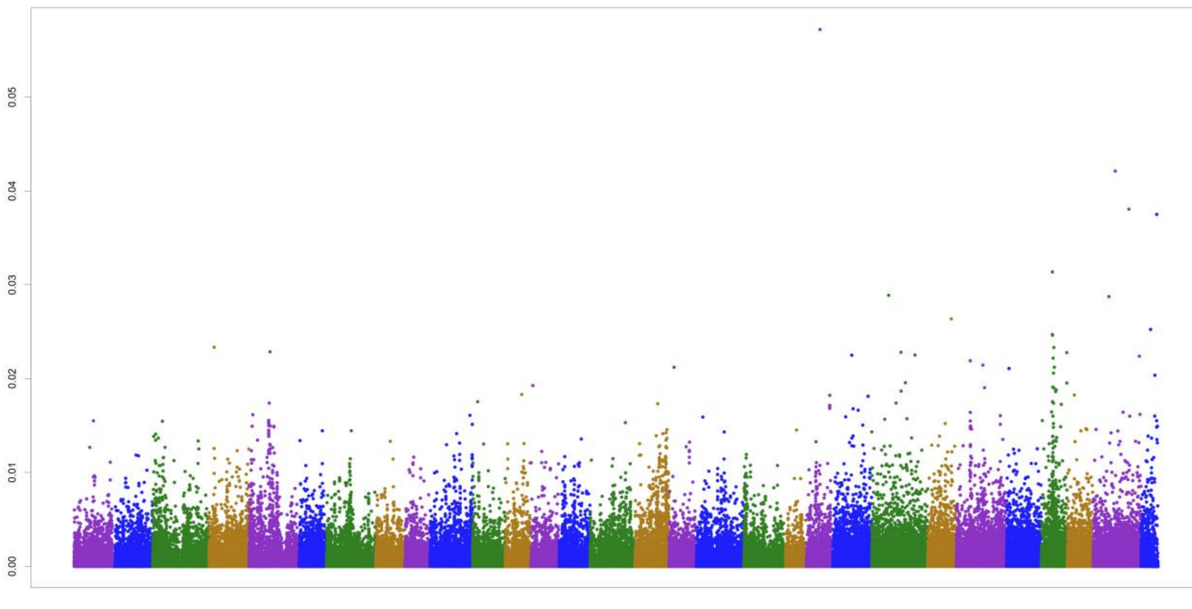

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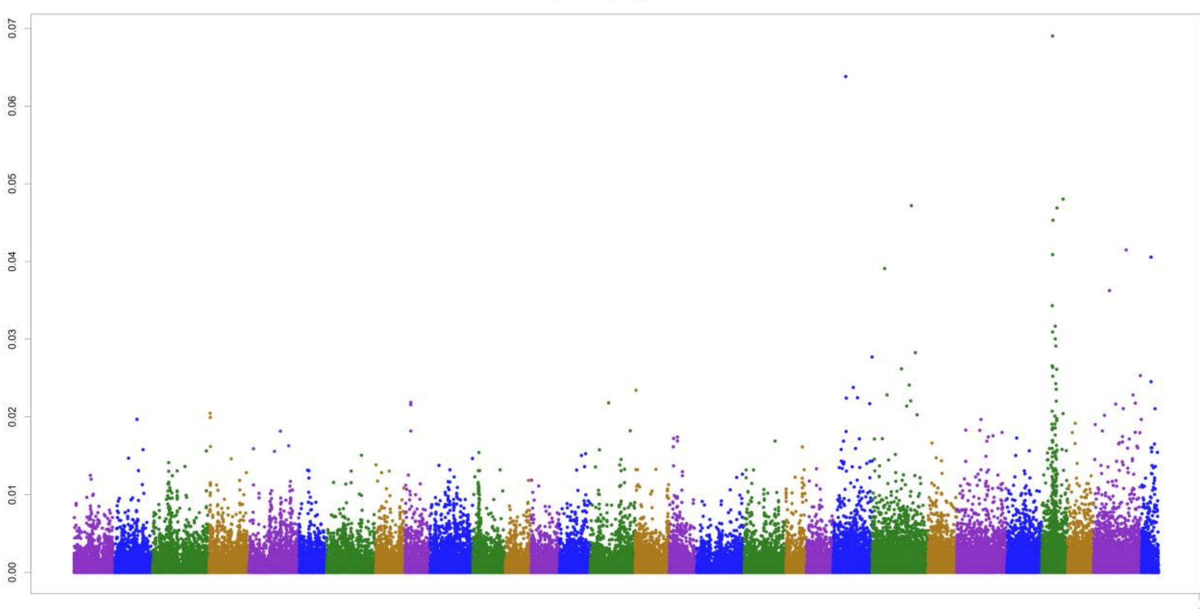
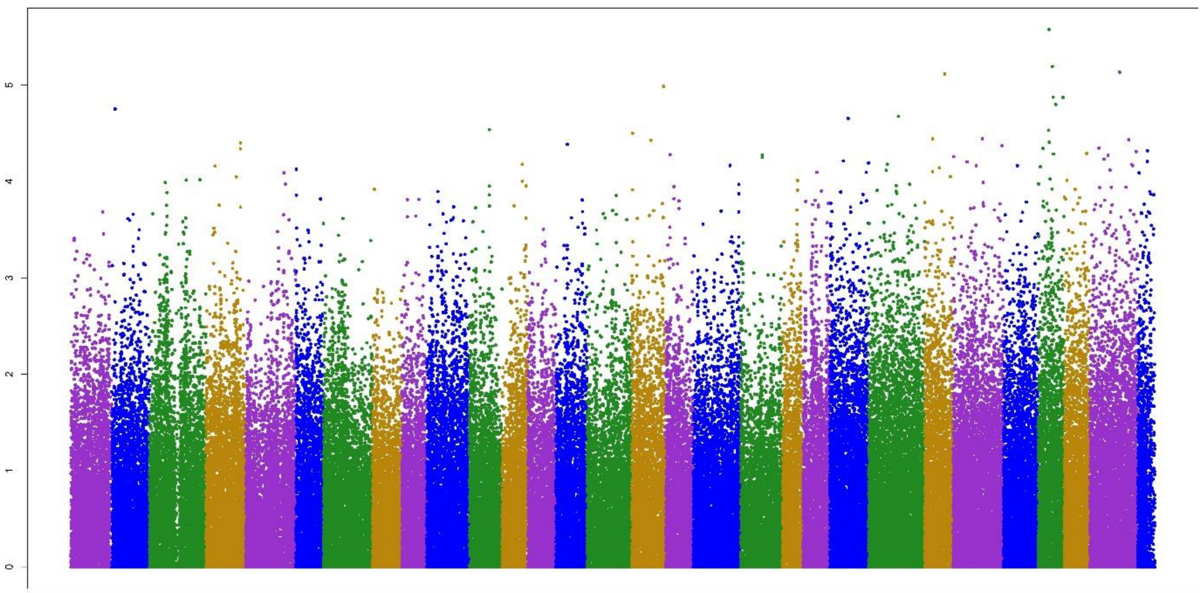


Manhattan Plot SNP Solution − Trait: 1 Effect: 5



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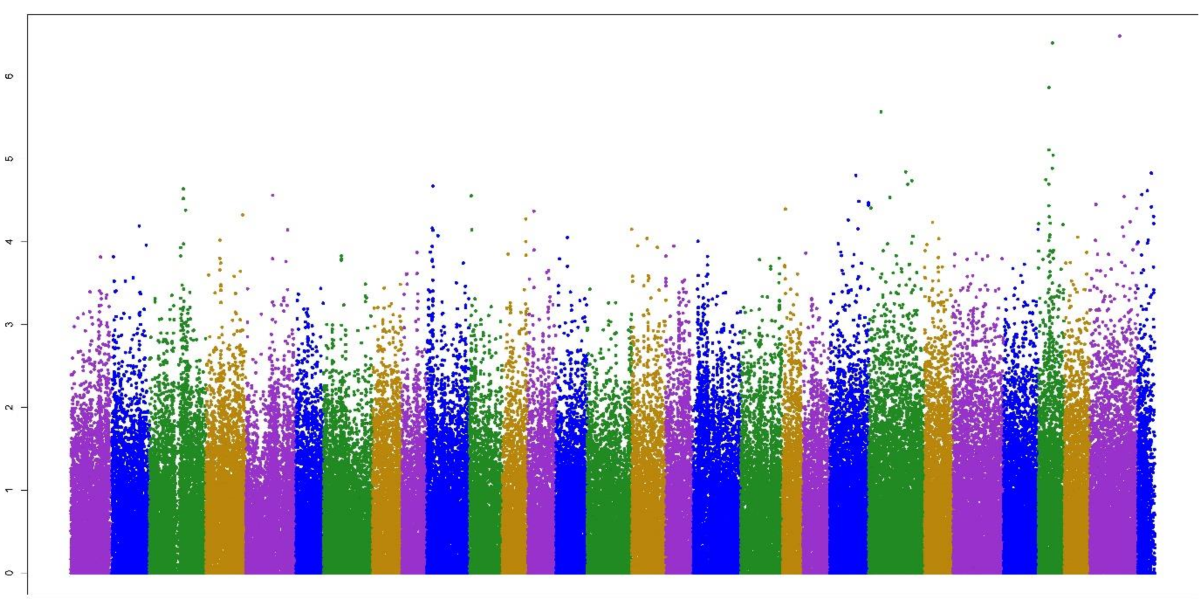

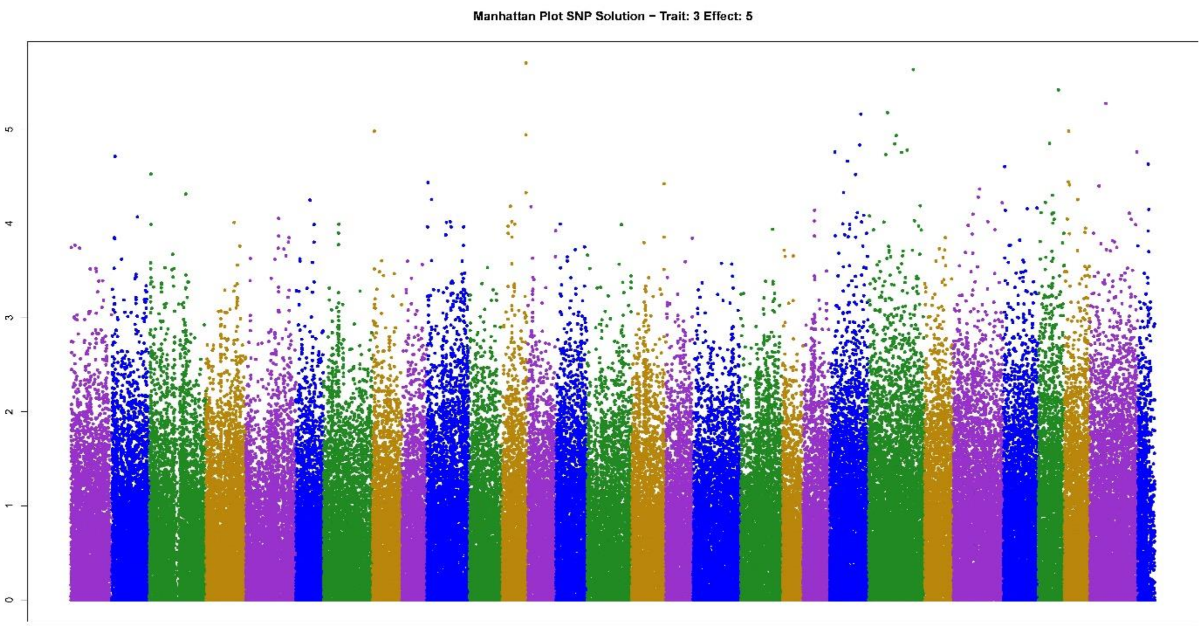
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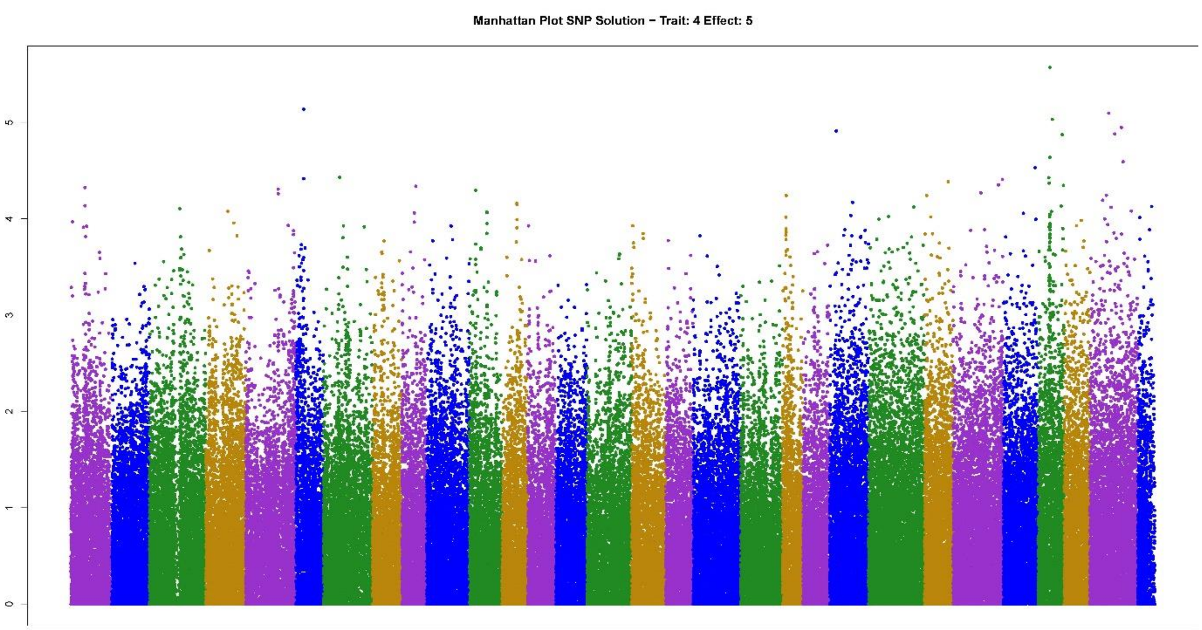
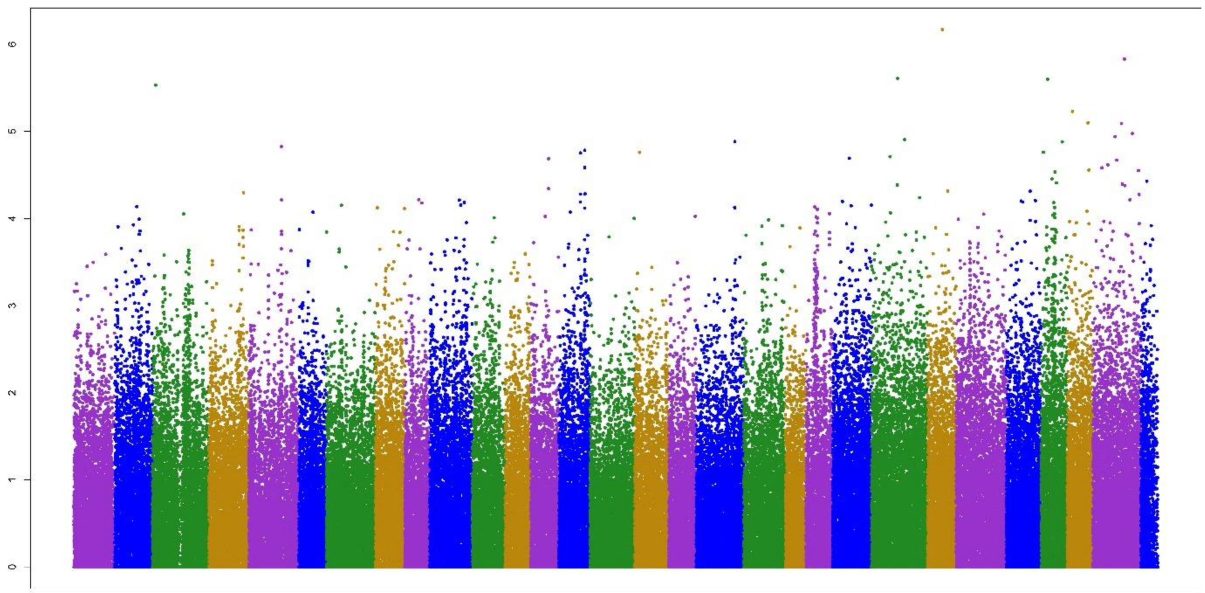
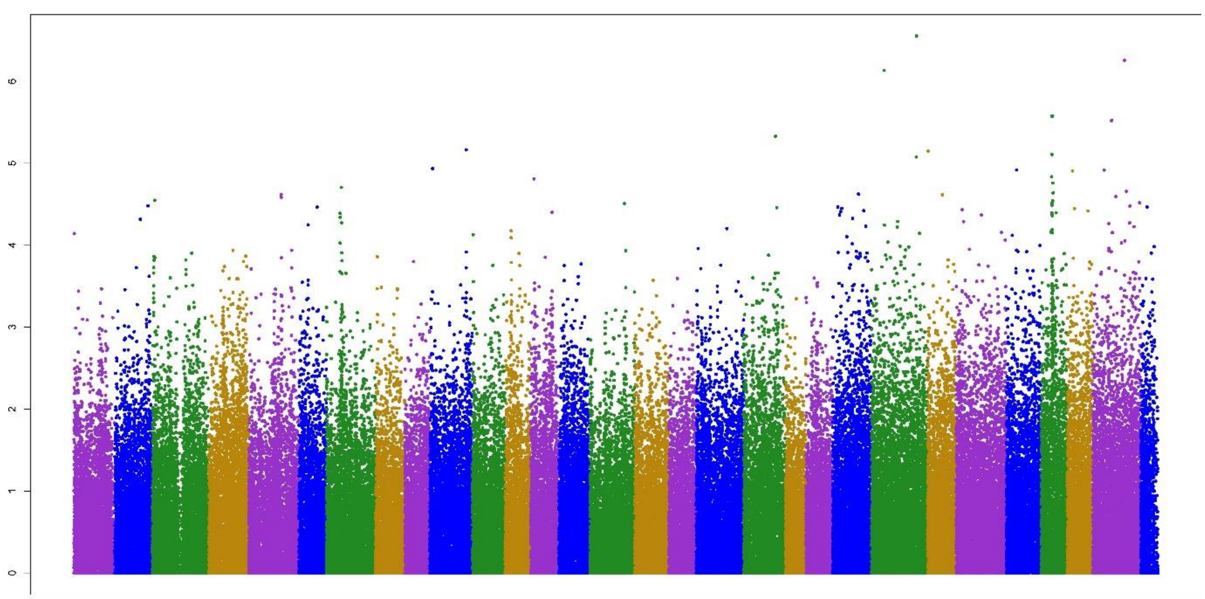
0
1
2
3
4
5

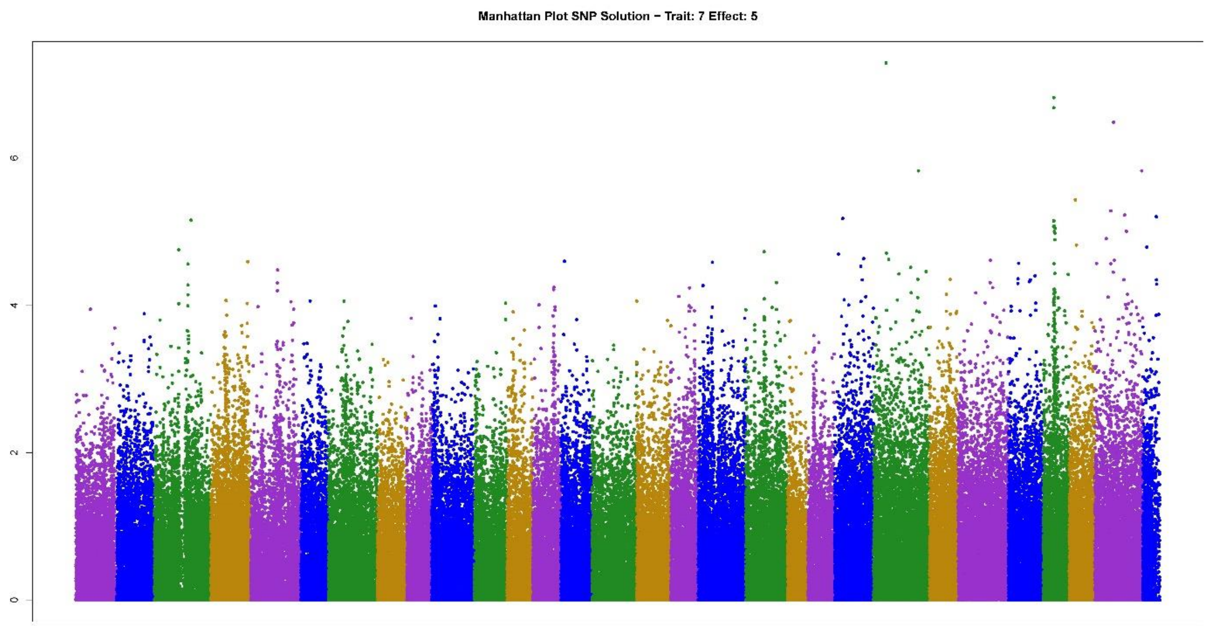

Manhattan Plot SNP Solution − Trait: 4 Effect: 5
0
1
2
3
4
5

Manhattan Plot SNP Solution − Trait: 5 Effect: 5



Manhattan Plot SNP Solution − Trait: 6 Effect: 5

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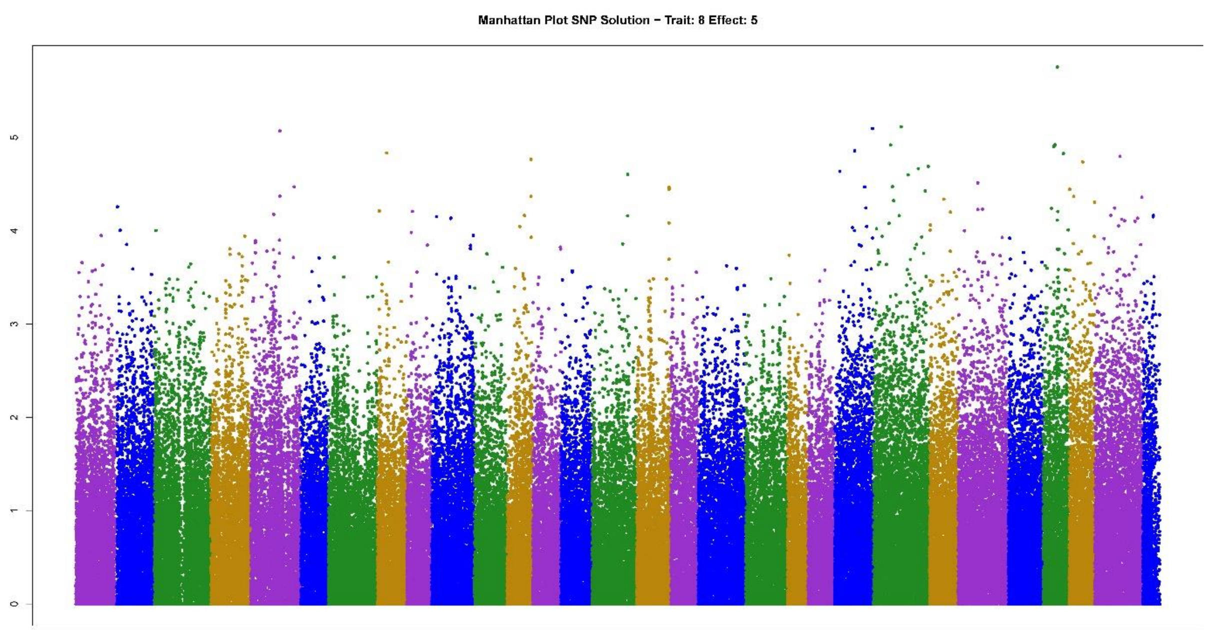
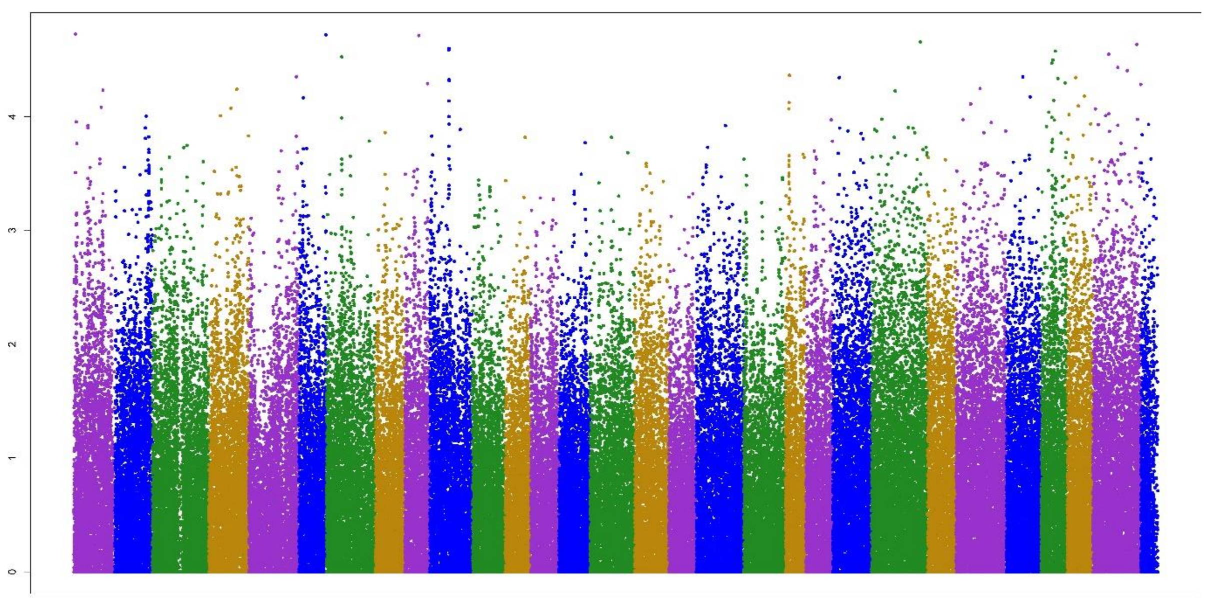
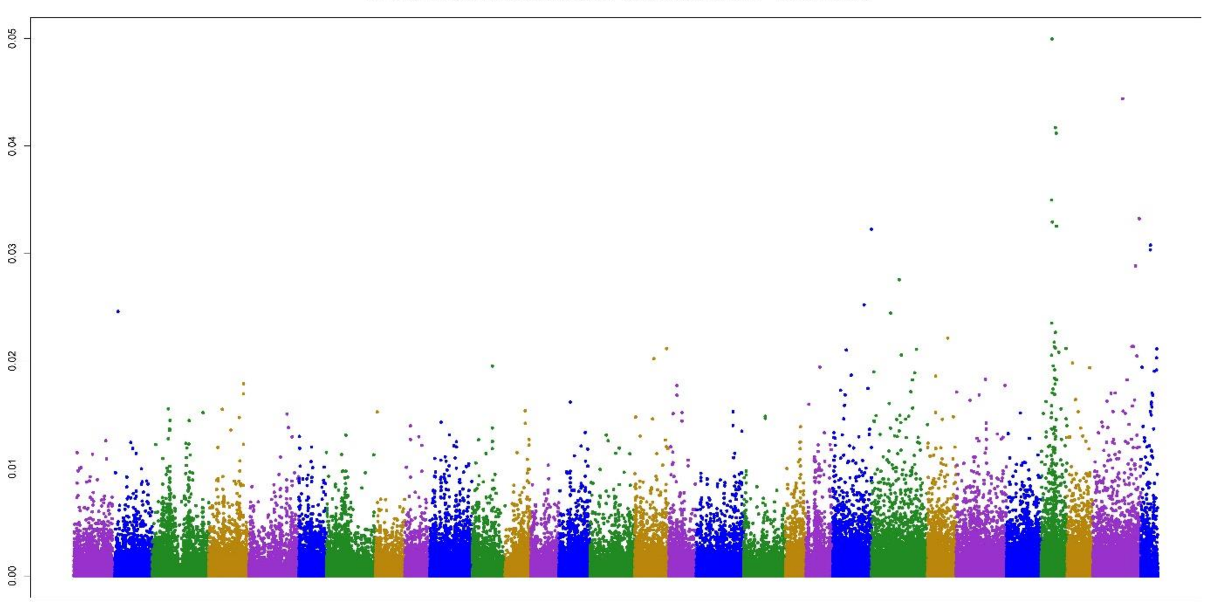
0
2
4
6


Manhattan Plot SNP Solution – Trait: 8 Effect: 5
0
1
2
3
4
5

Manhattan Plot SNP Solution − Trait: 9 Effect: 5



Manhattan Plot SNP Variance explained by 1adjacents SNP window − Trait: 1 Effect: 5



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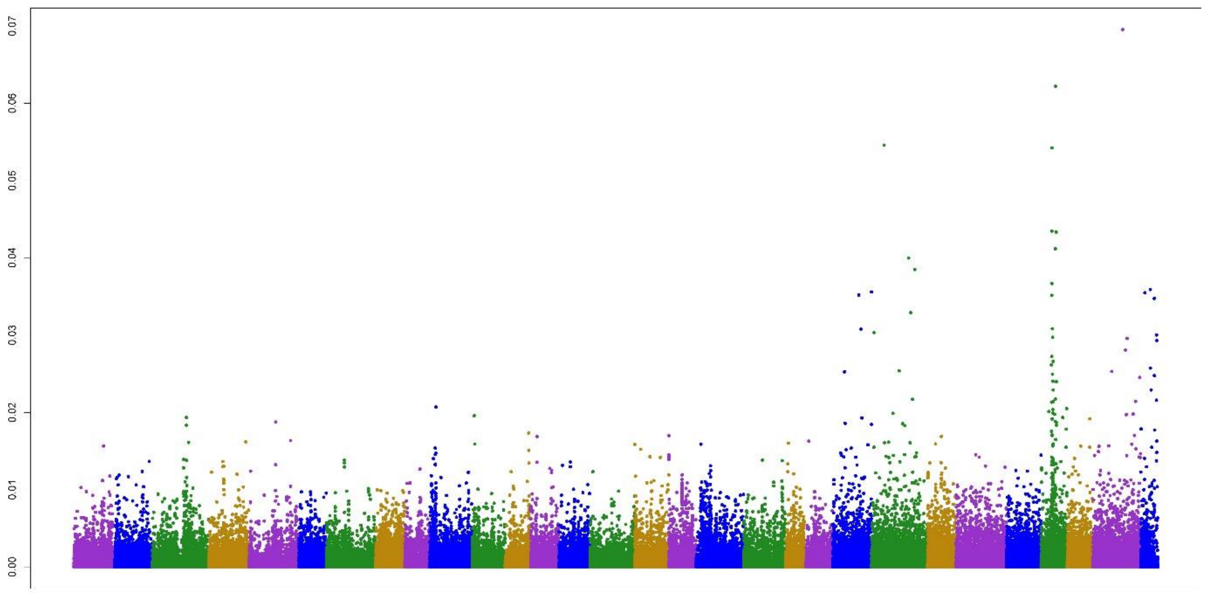

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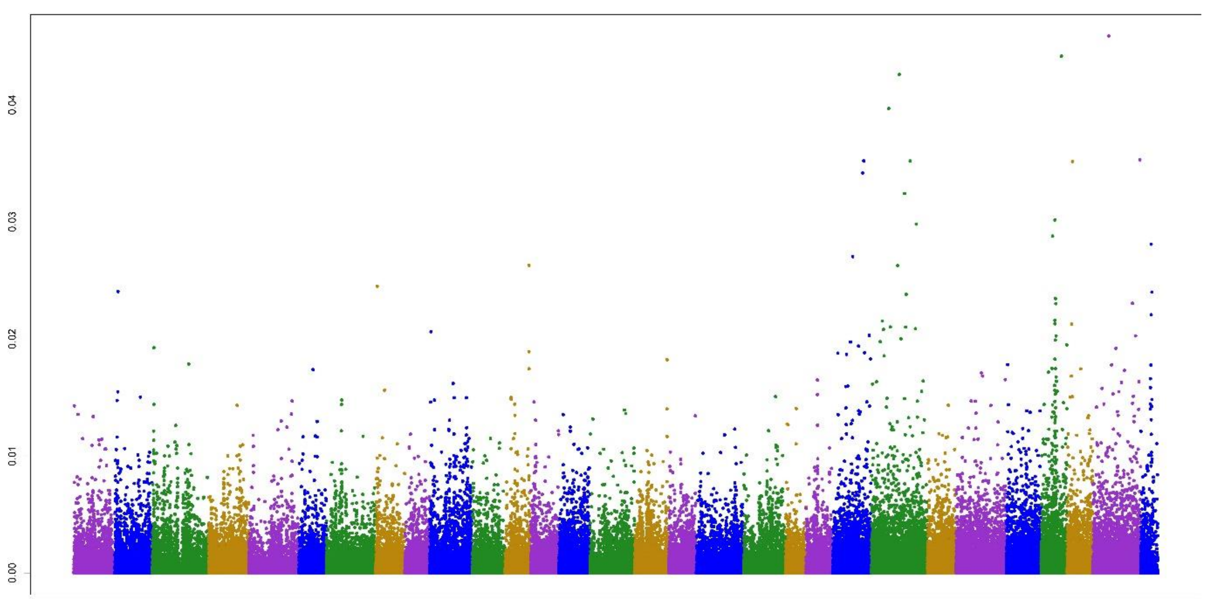

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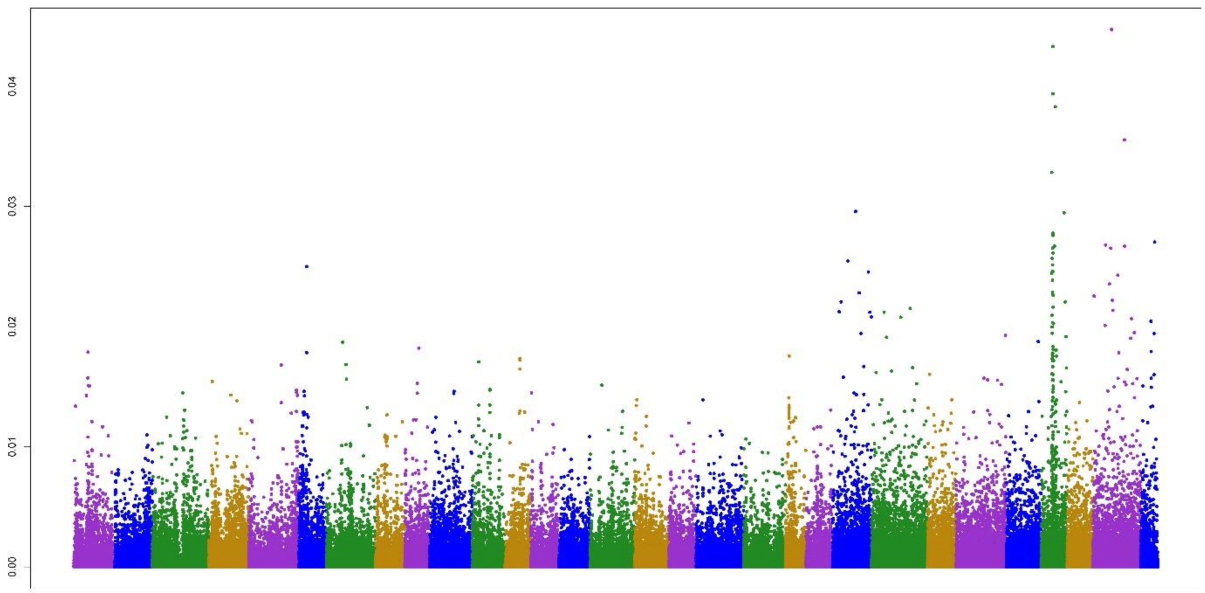
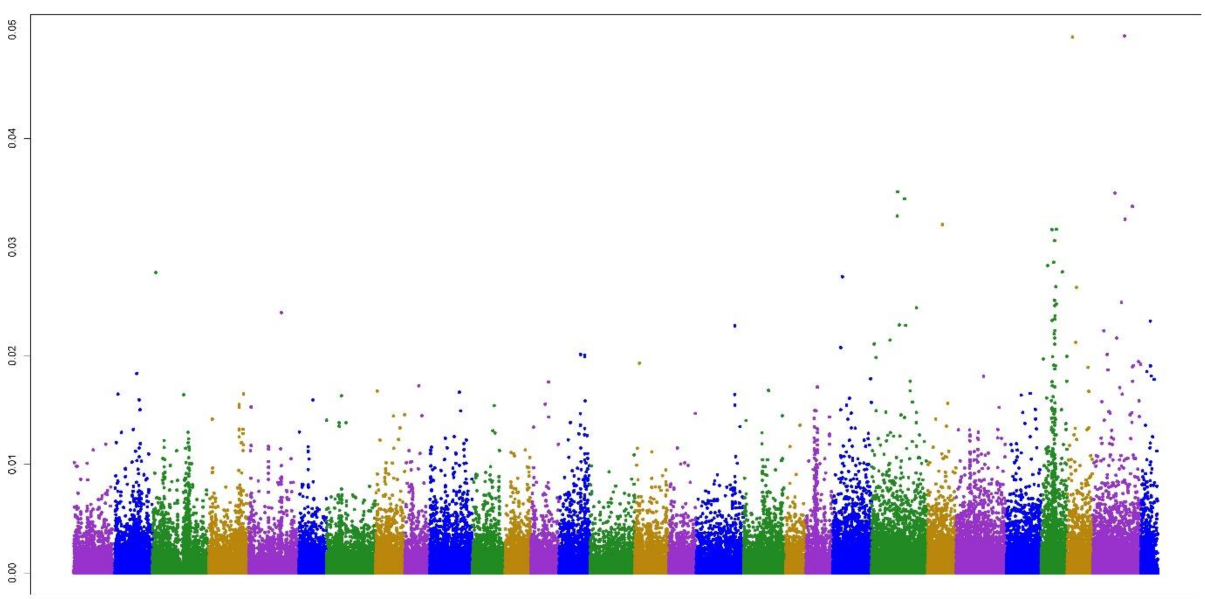
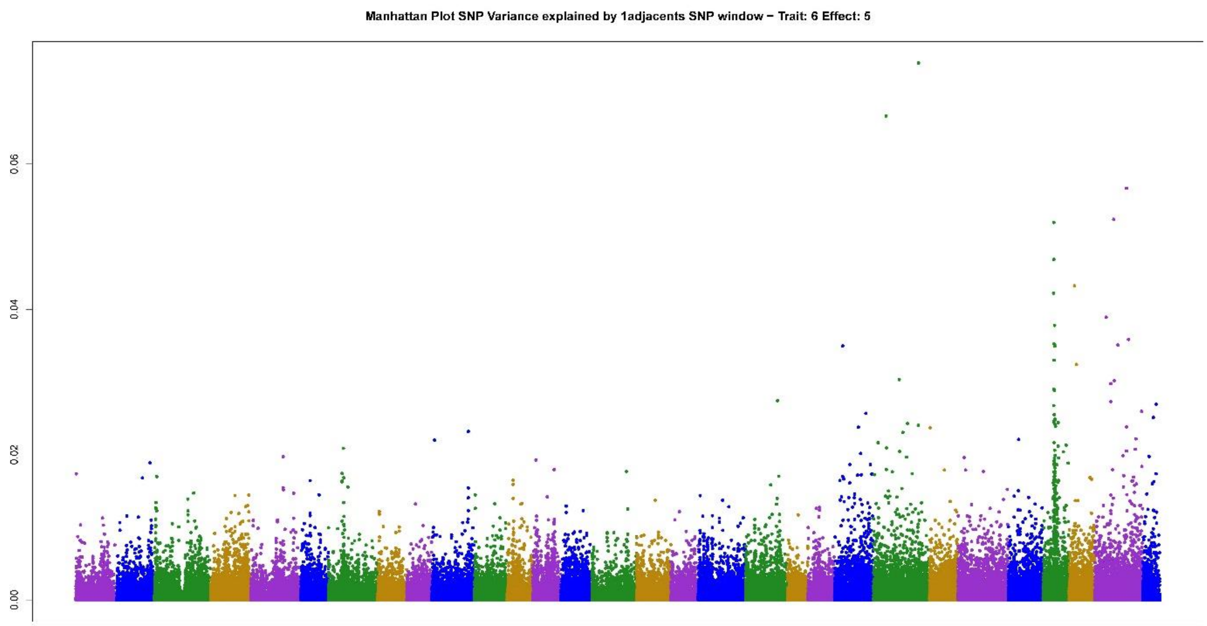
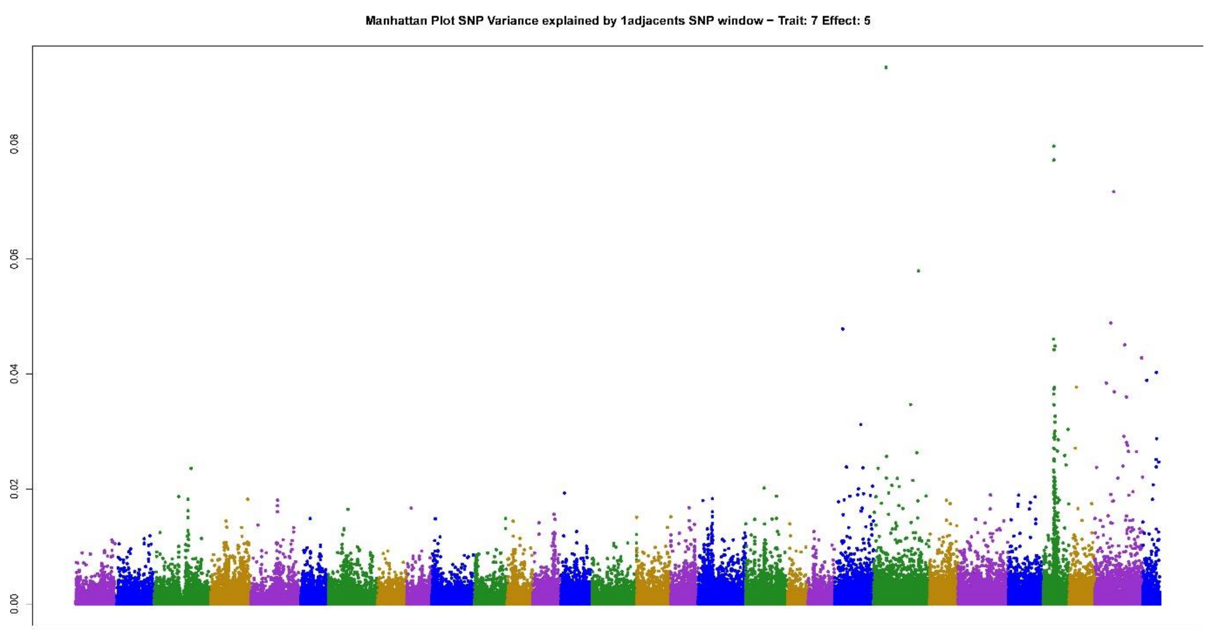


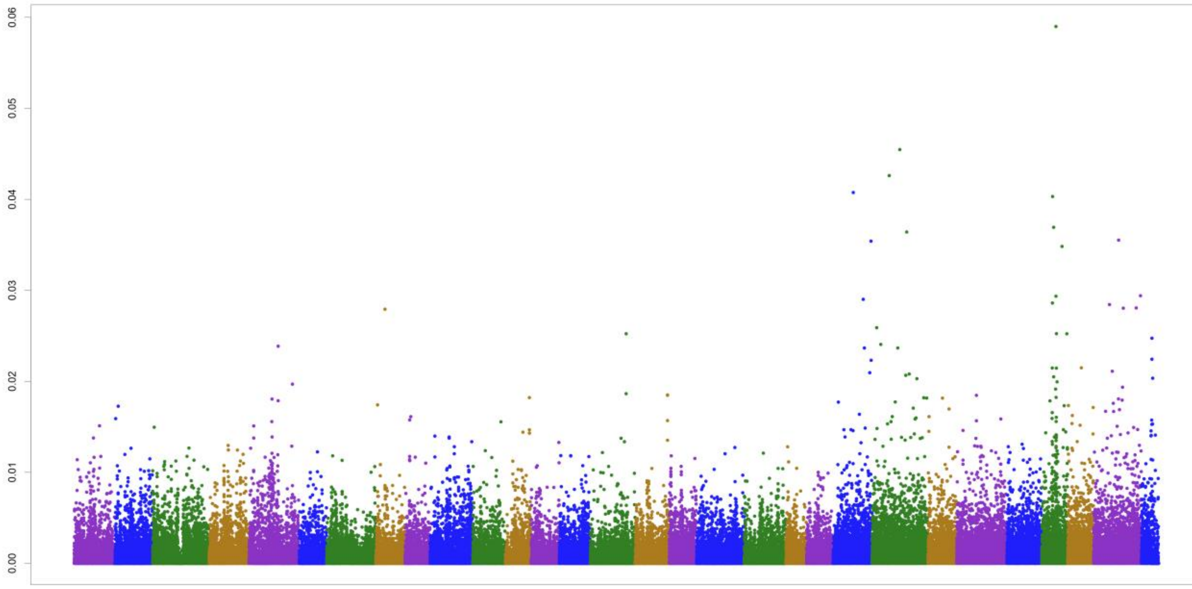
Manhattan Plot SNP Variance explained by 1adjacents SNP window − Trait: 5 Effect: 5



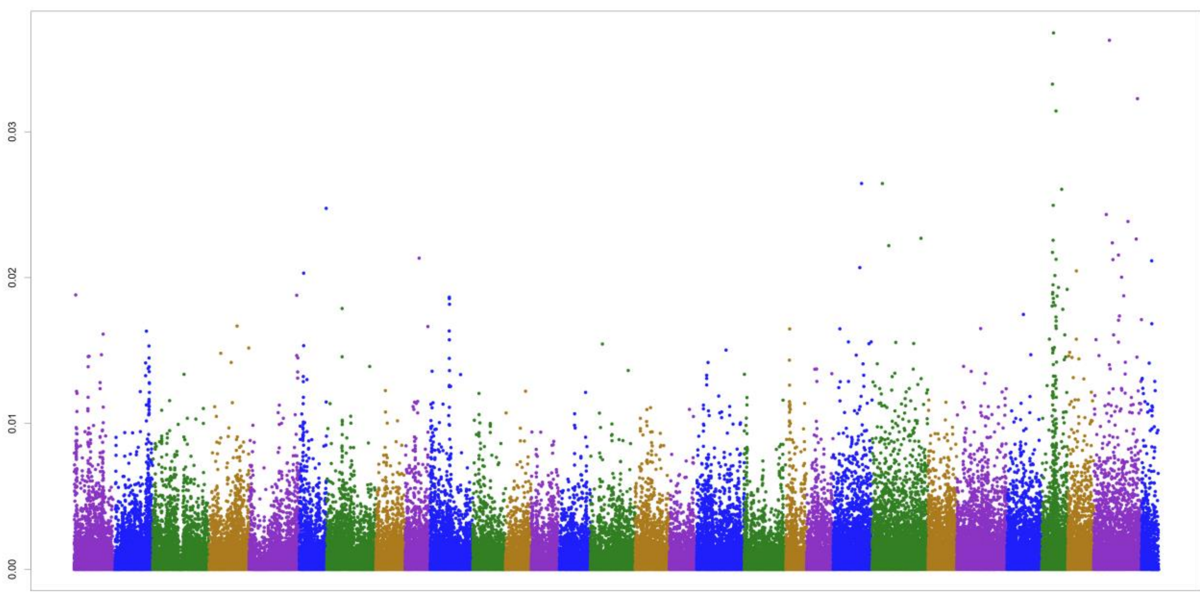

Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 6 Effect: 5
0.00
0.02
0.04
0.06

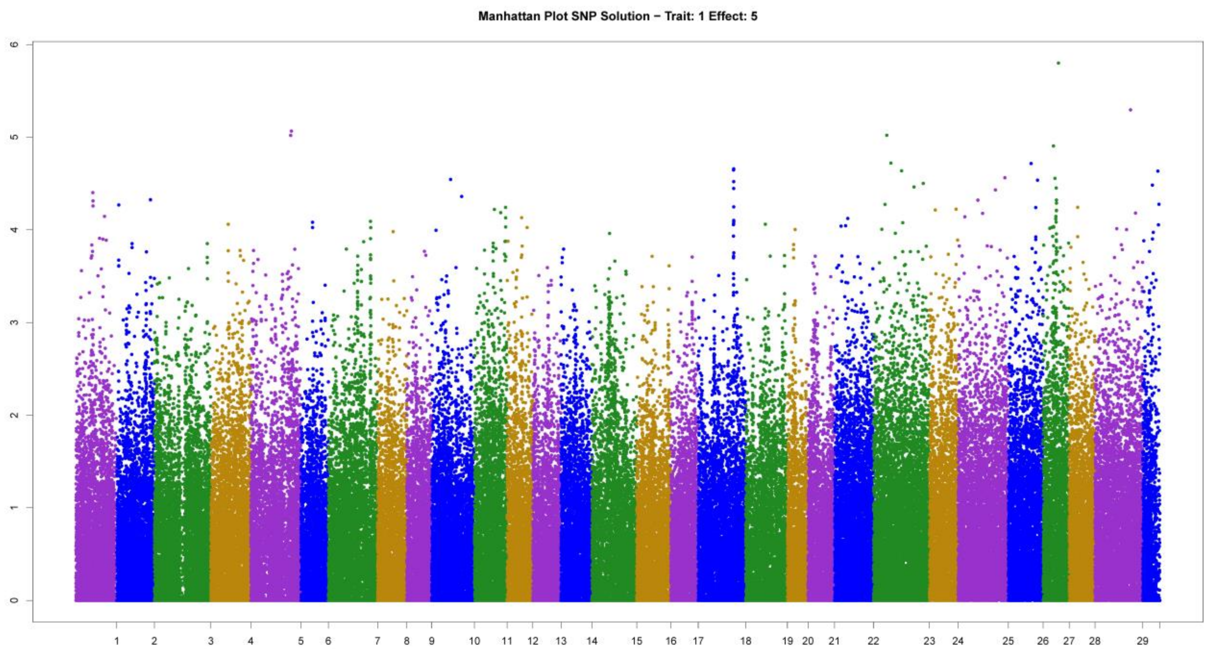

Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 7 Effect: 5
0.00
0.02
0.04
0.06
0.08

Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 8 Effect: 5

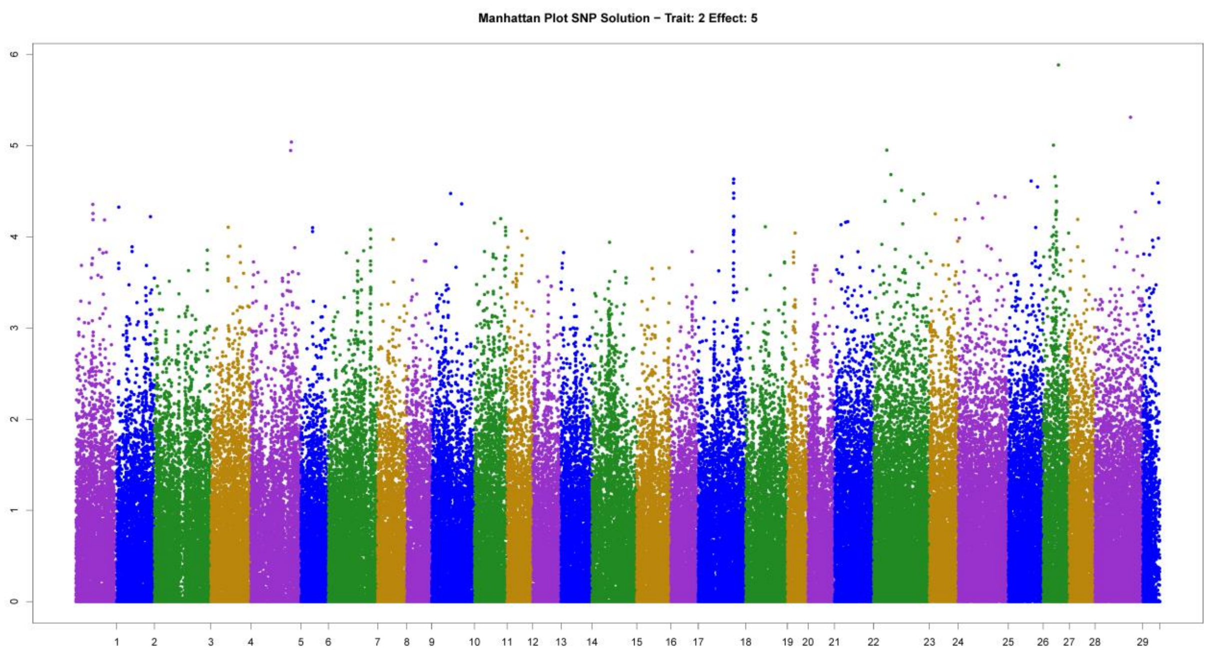


Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 9 Effect: 5



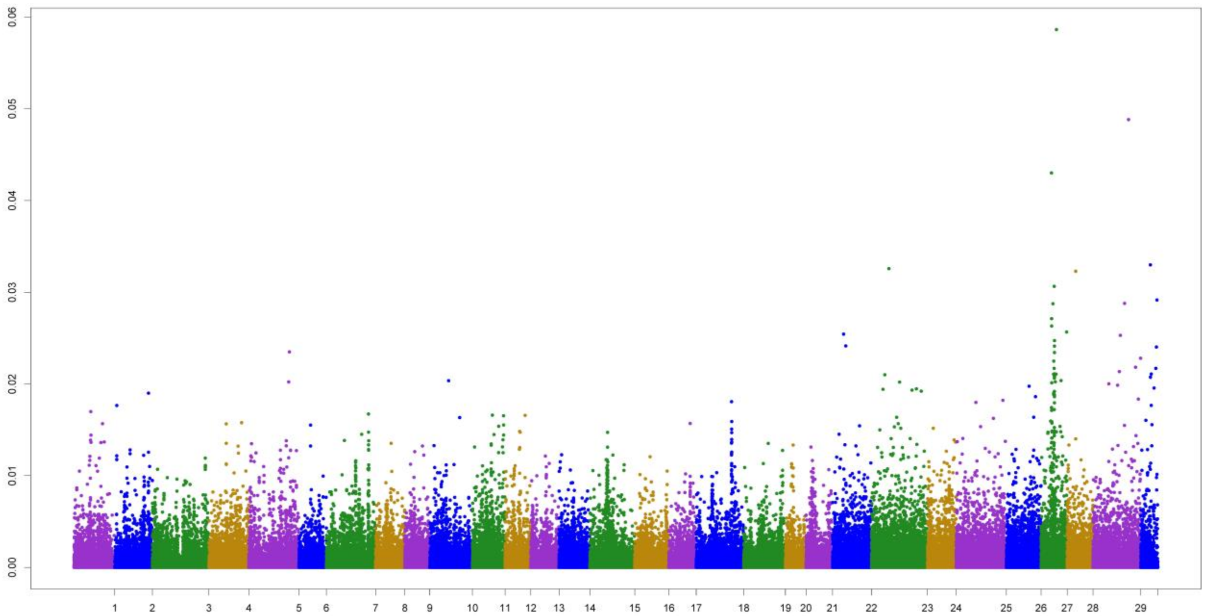


Manhattan Plot SNP Solution − Trait: 1 Effect: 5
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

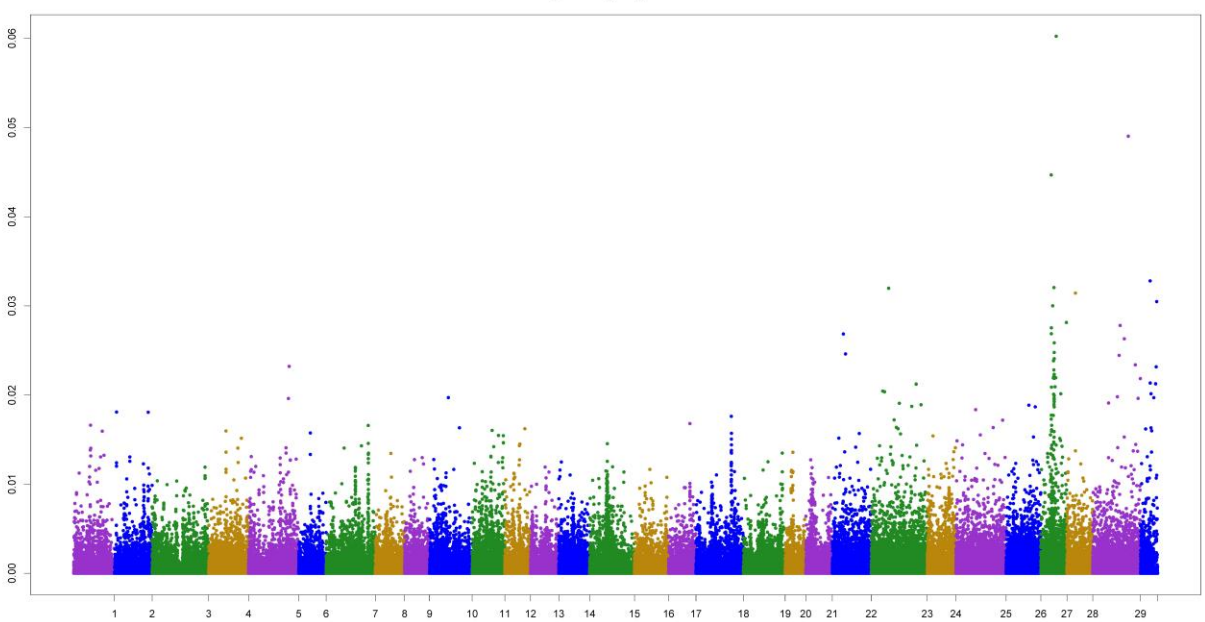


Manhattan Plot SNP Solution − Trait: 2 Effect: 5
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 1 Effect: 5



Manhattan Plot SNP Variance explained by 1adjacents SNP window – Trait: 2 Effect: 5



UF-Gainesville Beef Cattle News Corner

The Florida Brahman Genomic Selection Project: Initial Steps

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Introduction

Brahman is an essential component of crossbred beef production systems in Florida because of its great adaptability and endurance under the hot and humid conditions of this subtropical region. However, Brahman cattle are frequently criticized for the level of tenderness and marbling of their meat as well as their lower fertility relative to *Bos taurus* breeds and Brahman-*Bos taurus* crossbred cattle. ***Nevertheless, our research at the University of Florida (UF) has shown that Brahman animals display a range of EPD (expected progeny differences) for fertility, growth, ultrasound, and carcass traits comparable to that of Angus, Brangus, and Brahman × Angus crossbreds.*** The substantial genetic diversity among Brahman cattle observed in the UF cattle herds indicated that genetic improvement for these traits in Florida could be achieved through a concerted long-term selection effort. To maximize genetic progress throughout Florida, all available private Florida Brahman herds and the UF herds should participate in this endeavor. This was the original idea behind the Florida Brahman Genomic Selection Project. ***The aim of this project is to develop a statewide selection and mating program for Florida Brahman cattle focused on genomic selection and assortative mating to improve three target traits of high economic importance: meat tenderness, marbling, and reproductive tract score, a trait closely associated with fertility and age at first calving.*** The Florida Brahman project will generate genomic EPD for the three target traits as well as for various supporting traits (e.g., weaning and yearling weights, ultrasound traits, other carcass traits) utilizing pedigree, phenotypes, and genotypes. Genomic EPD for several traits would later be combined using relative economic weights to construct selection indexes for use within and across herds. Although this project was funded by the Florida Cattle Enhancement Board for 2 years (January 2017 to December 2018), it is actually a long-term project that should continue uninterrupted over the coming years to accomplish the intended goals and to appropriately assess its impact on the Florida Brahman population.

Research and Outreach Activities

The Florida Brahman Genomic Selection Project depends on pedigree, phenotypes, and genotypes from Florida Brahman private herds and UF herds. ***In fact, Florida Brahman breeders***

are an integral part of this project; their participation is crucial to achieve the statewide goals specified for this project (pedigree and phenotype database, tissue sample and DNA repository, genomic EPD summary). Consequently, our first task was to contact all Brahman breeders in Florida through email and telephone calls informing them of the project, goals, anticipated outcomes, and expected benefits. A meeting at the Florida Cattlemen's Association in February of 2017 was a turning point. Currently, eight Brahman breeders have confirmed their participation in the project. Their contribution consists of pedigree records (animals, sires, dams), phenotypic records (reproductive tract scores, growth, ultrasound, and carcass), and tissue samples for genotyping with a high-density chip (GeneSeek GGP250k). In addition, Mr. Chris Shivers, Executive Vice-President of the American Brahman Breeders Association (ABBA) provided us with the historical pedigree and phenotype files from all Florida Brahman breeders that submitted information from 1976 to 2016. We are currently constructing the accumulated pedigree and phenotype files needed for the Florida Brahman genomic evaluation using information supplied by contributing Florida Brahman breeders, ABBA, and UF Brahman and Brahman-Angus multibreed herds. Table 1 shows the current number of animals in the pedigree and phenotype files.

Table 1. Numbers of pedigree and phenotype records as of April 2017		
Dataset	**Pedigree file**	**Phenotype file**
Florida Brahman breeders (April 2017)	**198**	**115**
ABBA (All years; Unedited files)	**15,844**	**7,358**
UF Brahman herd	**673**	**446**
UF Brahman-Angus Multibreed herd	**8,302**	**6,755**

It should be emphasized that these numbers of animals and records correspond to unedited files; numbers of animals and records in the 2017 genomic evaluation will be smaller. However, the information from these four sources of data gives this project an excellent starting point. We are currently in the process of collecting tissue samples from a large number of animals from participating Brahman breeders and UF herds (calves, yearlings, 2-year olds, cows, and sires) that will be genotyped with high (GeneSeek GGP250k) and medium density chips (GeneSeek GGP 50k) in 2017. Genotypes from these animals will be added to the existing Illumina 3k from 1,300 animals, GGP150k from 120 animals, and GGP250k from 800 animals to be used in the first statewide Brahman genomic evaluation in 2017. The resulting edited pedigree, phenotype, and genotype files will be used to compute genomic EPD for the three target traits (meat tenderness, marbling, and reproductive tract score) as well as supporting traits (growth, ultrasound, and carcass) in the second semester of 2017. Substantial amount of information from Brahman breeders exist for growth and ultrasound traits; however, most of the information for meat tenderness, marbling, reproductive tract scores, and carcass traits will come from the UF

Brahman-Angus and Brahman herds. Thus, we will likely see a large variation among genomic EPD from Brahman animals in the complete Florida Brahman population similar to that observed in our research with UF Brahman and Brahman-Angus multibreed animals. Examples of this variation in genomic EPD from UF cattle herds are shown for ribeye area and marbling in Figure 1 below. Red diamonds represent EBV for individual animals. Brahman animals are those with Brahman fraction = 32, Angus are those with Brahman fraction = 0, and Brahman-Angus crossbreds have Brahman fractions ranging from 1/32nds to 31/32nds.

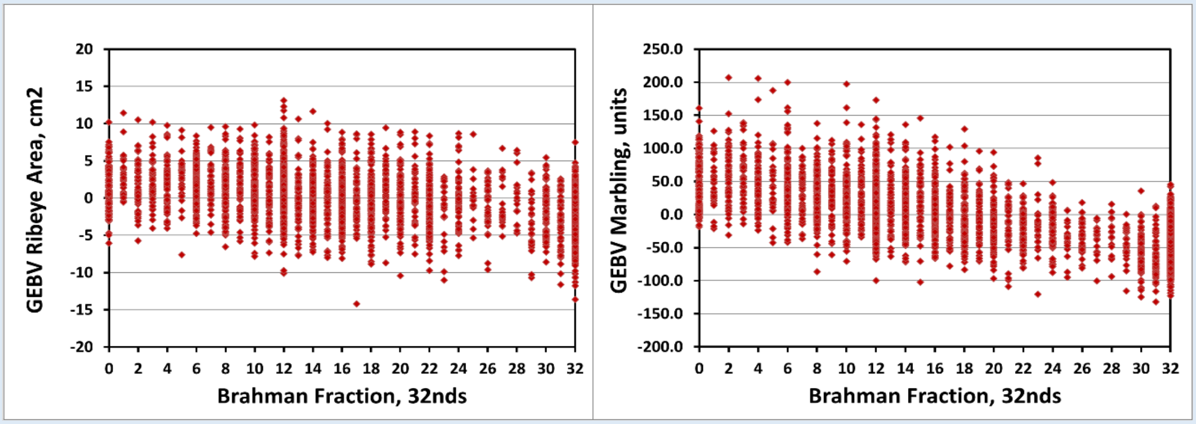

Figure 1. Variation in genomic EBV for ribeye area and marbling in UF Brahman and Brahman-Angus multibreed herds.

This variability among Brahman genomic EPD will greatly facilitate the identification of superior animals for meat tenderness, marbling, and reproductive tract scores to be used as parents of the next generation within and across Brahman herds. Continued genomic evaluation and selection of animals in the Florida Brahman population over the coming years should yield measurable progress for the three target as well as supporting traits. ***The larger the participation of private Brahman breeders in this program, the larger the chances of identifying individual animals with uniquely favorable meat tenderness, marbling, and reproductive tract scores.*** Hence the importance of the continued participation of the largest possible number of private Brahman breeders in the Florida Brahman genomic selection program.

For more information on this project or interest in joining the project, please contact Dr. Mauricio Elzo (maelzo@ufl.edu or 352-392-7564).

Genomic-polygenic EBV for reproduction, ultrasound-carcass, and tenderness traits in the Florida multibreed Brahman-Angus population

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Summary

The objectives of this research were to estimate genomic-polygenic parameters and EBV for sets of reproduction, ultrasound-carcass, and tenderness traits as well as to assess EBV trends as Brahman percentage increased from 0% to 100% percent in the state-wide Florida multibreed Brahman-Angus population. Reproduction set heritabilities were high for yearling weight adjusted to 365 d (0.53 ± 0.05), moderate for reproductive tract score (0.26 ± 0.04), and low for age at first calving (0.17 ± 0.04) and first calving interval (0.09 ± 0.02). Ultrasound-carcass set heritabilities were high for ultrasound weight (0.57 ± 0.05), slaughter age (0.57 ± 0.04), hot carcass weight (0.57 ± 0.04), ribeye area (0.55 ± 0.03), and marbling (0.50 ± 0.05), moderate for ultrasound ribeye area (0.35 ± 0.03), ultrasound intramuscular fat (0.33 ± 0.03), and backfat thickness (0.32 ± 0.03), and low for ultrasound backfat (0.07 ± 0.01). Tenderness set heritabilities were low for Warner-Bratzler shear force (0.17 ± 0.03) and moderate for tenderness score (0.47 ± 0.06). Heritability estimates indicated that genomic-polygenic selection for the target traits of the Florida Enhancement Fund project currently underway (reproductive tract score, marbling, and tenderness) should be feasible. The wide range of EBV among animals of all breed compositions indicated that the best animals regardless of their breed composition should be chosen as replacements if genetic progress is to be optimized in this multibreed population.

Key words: beef, cattle, genomic, evaluation, multibreed

Introduction

Brahman is a key component of the Brahman-*Bos taurus* 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 the tenderness and marbling of their meat and for their lower fertility relative to other breeds and crossbred cattle (Johnson *et al.*, 1990; Wheeler *et al.*, 2010; Elzo *et al.*, 2012). However, research at the University of Florida (UF) has shown that Brahman animals exhibit a range of EPD for fertility, growth, ultrasound, and carcass traits comparable to that of Angus, Brangus, and Brahman × Angus crossbreds (Elzo *et al.*, 2015a, b, 2016). These studies led to a Florida state-wide project initiated in 2017 with the aim of developing a selection and mating program for Brahman and Brahman crossbred cattle focused on genomic selection and assortative mating to improve tenderness, marbling, and reproductive tract score. This project required estimation of genomic-polygenic variance and covariance components for reproduction, ultrasound, and carcass traits to obtain genomic-polygenic EBV for all Florida Brahman, Angus, and Brahman-Angus animals using all available information from Brahman breeders as well as the UF Brahman and multibreed Brahman-Angus herds. Thus, the objectives of this research were: 1) to estimate genomic-polygenic parameters for sets of reproduction, ultrasound-carcass, and tenderness traits; 2) to obtain genomic-polygenic EBV for all these traits; and 3) to assess genomic-polygenic EBV trends as Brahman percentage increased from 0% to 100% percent in the state-wide Florida multibreed Brahman-Angus population.

Materials and Methods

Animals, feeding, and management

The research protocol was approved by the University of Florida Institutional Animal Care and Use Committee (IACUC protocol number 201003744). Animals were from four private Florida Brahman herds plus animals from the multibreed Angus-Brahman (MAB) and Brahman herds of the University of Florida (UF), Gainesville. The dataset contained 2,739 calves born from 2005 to 2016 with phenotypic data for various traits (637 bulls, 1,083 heifers, and 1,019 steers). Calves were the progeny of 218 sires and 1,170 dams. Matings in private herds were Brahman-Brahman only. Mating in the MAB herd followed a diallel design where sires from six breed groups were mated to dams of these same six breed groups (Elzo & Wakeman, 1998). These six breed groups were: BG1 = (1.0 to 0.80) A (0.0 to 0.20) B, BG2 = (0.79 to 0.60) A (0.21 to 0.40) B, BG3 = (0.625) A (0.375) B, BG4 = (0.59 to 0.40) A (0.41 to 0.60) B, BG5 = (0.39 to 0.20) A (0.61 to 0.80) B, and BG6 = (0.19 to 0.0) A (0.81 to 1.00) B, where A = Angus and B = Brahman. Number of calves were 790 in BG1, 363 in BG2, 304 in BG3, 482 in BG4, 245 in BG5, and 550 in BG6. Calves were raised with their dams on bahiagrass pastures (*Paspalum notatum*) at the four private herds and at the UF Beef Research Unit (UFBRU) from birth to weaning. Calves remained in their herds on bahiagrass pastures from weaning to yearling. During this period, calves at UFBRU were supplemented with bahiagrass hay, concentrate (1.6 kg to 3.6 kg of soy hull pellets per day; 14.0 % CP; 488 Pellet Medicated Weaning Ration, Lakeland Animal Nutrition, Lakeland, Florida), and a mineral supplement. Then, yearling steers were taken to a contract feeder where they were fed a standard feedlot diet comprised of corn, protein, vitamins, and minerals until their subcutaneous fat thickness over the ribeye reached 1.27 cm approximately.

Traits

The traits in the reproduction set included yearling weight adjusted to 365 d of age (YW), reproductive tract score (RTS, units; n = 516; Andersen *et al.*, 1991), age at first calving (AFC, d; n = 909), and first calving intervals (FCI, d; n = 447). The ultrasound and carcass set of traits comprised ultrasound weight (UW, kg; n = 2,734); ultrasound ribeye area (UREA, cm^2; n = 2,694), ultrasound backfat (UBF, cm; n = 2,698), ultrasound percent intramuscular fat (UPIMF, %; n = 2,680), slaughter age (SLA, d; n = 815), hot carcass weight (HCW, kg; n = 803), ribeye area (REA, cm^2; n = 803), backfat thickness (FAT, cm; n = 803), and marbling score (MAR, units; n = 802; 100 to 199 = practically devoid, 200 to 299 = traces, 300 to 399 = slight, 400 to 499 = small, 500 to 599 = modest, 600 to 699 = moderate, 700 to 799 = slightly abundant, 800 to 899 = moderately abundant, and 900 to 999 = abundant). The tenderness set of traits contained Warner-Bratzler shear force (WBSF, kg; n = 754), and tenderness score (TEND, units; n = 576; 1 = extremely tough, 2 = very tough, 3 = moderately tough; 4 = slightly tough; 5 = slightly tender; 6 = moderately tender; 7 = very tender; 8 = extremely tender).

Tissue sampling and genotyping

Tissue samples (blood, semen) from 782 animals (70 sires, 696 steers, and 16 heifers) were collected and stored at -80 °C between 2006 and 2015. The distribution of samples per breed group were: BG1 = 126, BG2 = 120, BG3 = 123, BG4 = 159, BG5 = 83, and BG6 = 171. DNA from blood and semen samples was extracted with a commercial kit (QIAamp DNA mini kit, Qiagen, Valencia, CA). Genotyping was done at Neogen with GeneSeek Genomic Profiler F250 (number of SNP in autosomes and X chromosome = 221,049; Neogen, 2016). Each animal in the genotype file had 127,016 SNP autosomal and X chromosome markers after discarding SNP with minor allele frequencies below 0.05 (n = 94,033).

Genomic-Polygenic Variance Components, Parameters, and Predictions

Three separate single-step genomic-polygenic multiple-trait mixed model analyses (Aguilar *et al.*, 2010) were conducted to estimate variance components and genetic parameters. The 4-trait model for the reproduction set (YW, RTS, AFC, and FCI) contained yearling contemporary group (herd-year-season-management group), age of dam (YW only), sex of calf (YW only), direct heterosis as a function of calf heterozygosity (probability of one Angus and one Brahman allele in 1 locus), and maternal heterosis (YW only) as fixed effects. Fixed effects for the 9-trait model for the ultrasound-carcass set (UW, UREA, UFAT, UPIMF, SLA, HCW, REA, FAT, and MAR) were yearling contemporary group (herd-year-season-management group), sex of calf, ultrasound age (ultrasound traits only), and heterosis. Fixed effects for the 2-trait model for the tenderness set (WBSF, TEND) contained the fixed effects of yearling contemporary group (herd-year-season-management group), sex of calf, heterosis, and slaughter age. Random effects were animal direct genetic and residual for all models. The mean for random additive direct genetic effects was equal to zero, and the variance was equal to $H \otimes V_a$, where H was the combined pedigree-genotype relationship matrix among animals with and without genotypes (Legarra *et al.*, 2009), and V_a was the direct additive genetic variance-covariance matrix of the 4 traits in the reproduction set, 9 traits in the ultrasound-carcass set, and 2 traits in the tenderness set. Similarly, the mean of the residual effects was zero and its variance was equal to $I \otimes V_e$, where I was an identity matrix, and V_e was the environmental variance-covariance matrix for each of the three trait sets.

REML estimates of variance components and genetic parameters (Corbeil & Searle, 1971; Patterson & Thompson, 1971) were obtained using an average information algorithm (Gilmour *et al.*, 1995) with the BLUPF90 family of programs (Misztal *et al.*, 2002; Tsuruta, 2017). Standard errors of variance components were obtained as square roots of the diagonals of the inverse of the information matrix, whereas SE of heritabilities and correlations (genetic, environmental, phenotypic) were computed using a repeated sampling procedure (Meyer & Houle, 2013).

Genomic-polygenic predictions were computed for each set of traits using estimates of variance components at convergence. Genomic-polygenic EBV for each trait were plotted against Brahman fraction to visualize EBV variation among animals and EBV trends as animal Brahman fraction increased from 0% to 100%.

Results and Discussion

Heritabilities and genetic correlations

Estimates of heritability for the reproduction trait set were high for YW (0.53 ± 0.05), moderate for RTS (0.26 ± 0.04), and low for AFC (0.17 ± 0.04) and FCI (0.09 ± 0.02). Additive genetic correlations among these traits were low and with high SE. Heritability estimates for the ultrasound-carcass trait set were high for UW (0.57 ± 0.05), SLA (0.57 ± 0.04), HCW (0.57 ± 0.04), REA (0.55 ± 0.03), and MAR (0.50 ± 0.05), moderate for UREA (0.35 ± 0.03), UPIMF (0.33 ± 0.03), and FAT (0.32 ± 0.03), and low for UFAT (0.07 ± 0.01). Additive genetic correlations between ultrasound-carcass traits ranged between -0.47 to 0.81. The highest positive additive genetic correlations were between UW and HCW (0.81 ± 0.08), HCW and REA (0.80 ± 0.07), UW and UREA (0.64 ± 0.06), UREA and REA (0.63 ± 0.07), and UREA and HCW (0.3 ± 0.09). The largest negative additive genetic correlations were between UFAT and SLA (-0.47 ± 0.08), UFAT and HCW (-0.34 ± 0.09), and UREA and UPIMF (-0.25 ± 0.07). Heritability estimates for the tenderness trait set were low for WBSF (0.17 ± 0.03) and moderate for TEND (0.47 ± 0.06). The additive genetic correlation between WBSF and TEND was negative and high (-0.97 ± 0.01). The heritabilities obtained for RTS, MAR, UPIMF, WBSF, and TEND indicated that genomic selection for the target traits (reproductive tract score, marbling, and tenderness) of the Florida Enhancement Fund project currently underway would be feasible in the statewide Florida Brahman-Angus multibreed population. Noticeably, carcass information in this population originates primarily from Brahman crossbred steers. Thus, the multibreed structure of the Florida beef population will play a major role in the Brahman genetic improvement for marbling and tenderness because the number of Brahman steers with carcass information is likely to remain low in the near future. Further, the number of animals genotyped (GeneSeek Genomic Profiler F250) in the Florida Brahman-Angus multibreed population will increase dramatically in the next couple of years as a result of the Florida Enhancement Fund project. These newly genotyped animals will provide additional ties among Brahman and Brahman crossbred animals, increasing the accuracy of animal genomic-polygenic evaluation and selection for both target and associated traits.

Genomic-polygenic EBV and trends from Angus to Brahman

High degree of variation among genomic-polygenic EBV existed for the sets of reproduction, ultrasound-carcass, and tenderness sets of traits across the spectrum of Brahman breed percentages in the statewide Florida Brahman-Angus multibreed population. Figure 1 presents graphs of genomic-polygenic EBV for two traits in the reproduction set (RTS and AFC), Figure 2 for four traits in the ultrasound-carcass set (UREA, REA, UPIMF and MAR), and Figure 3 for the two traits in the tenderness set (WBSF and TEND). These graphs show a wide range of genomic-polygenic EBV among animals of all Brahman percentages. No Brahman 32nds group was overwhelmingly better than any other one, including Angus (group with 0% Brahman). The most visible trend from Angus to Brahman occurred for RTS, where genomic-polygenic EBV tended to decrease as Brahman fraction increased. This indicated that heifers with higher Brahman fractions tended to be less mature as yearlings than heifers with higher Angus fractions.

Conclusion

Estimates of genetic parameters in the statewide Brahman-Angus multibreed population were large enough for genomic-polygenic selection for traits to be feasible. In particular, selection for the three target traits (reproductive tract score, marbling, and tenderness) in the Florida Enhancement Fund project is expected to be successful. The wide range of EBV among animals of all breed compositions indicated that the best animals regardless of their breed composition should be chosen as replacements if genetic progress is to be optimized in this multibreed population.

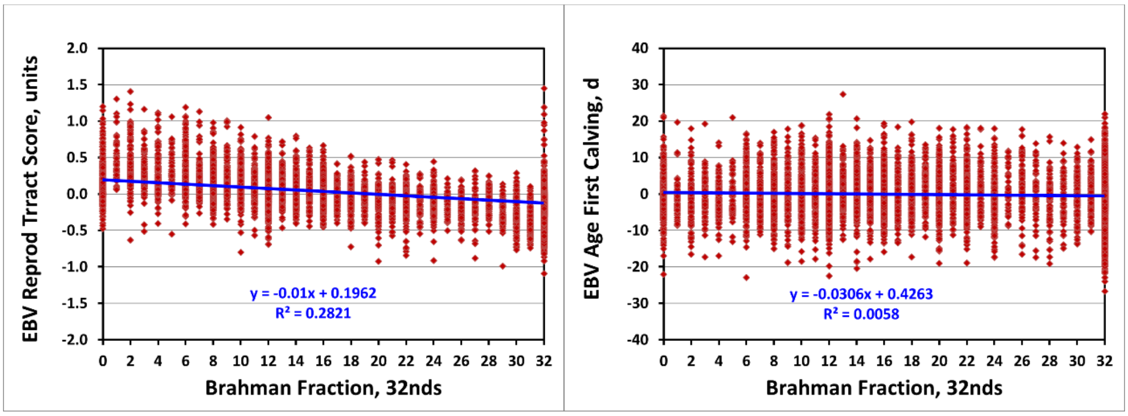

Figure 1. Genomic-polygenic EBV for two traits in the reproduction set.

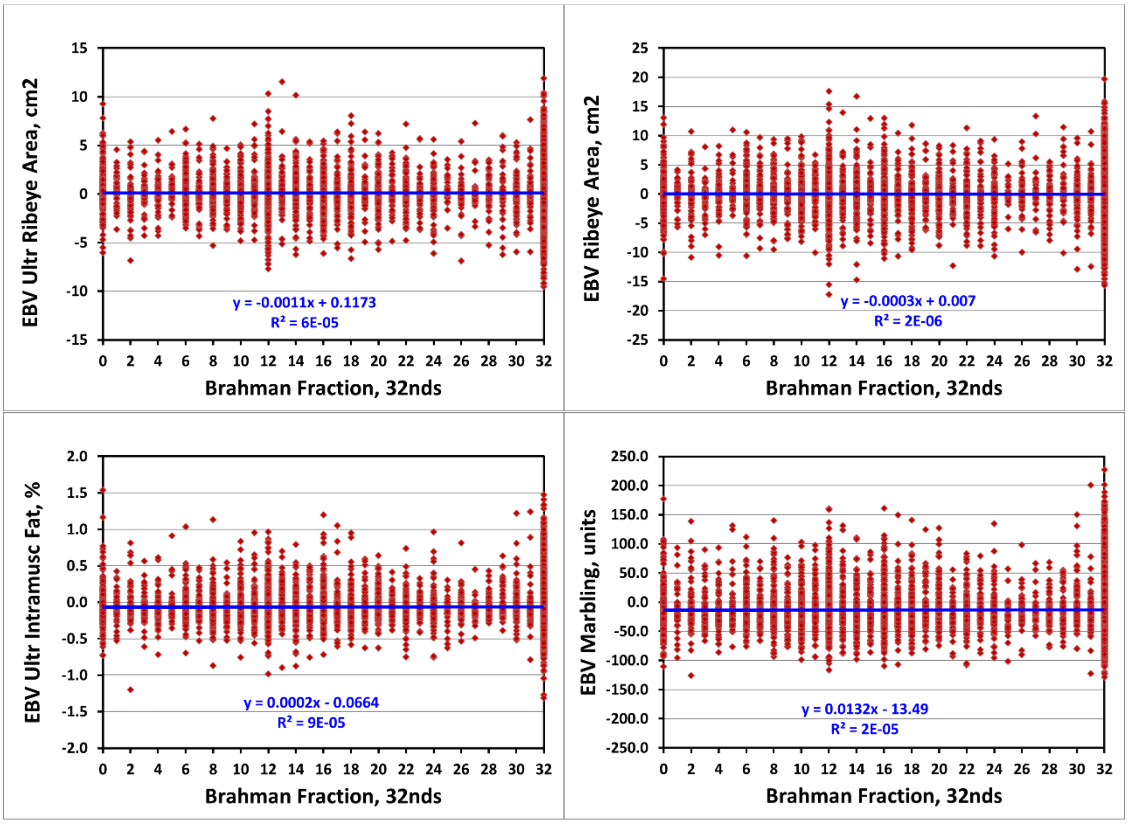

Figure 2. Genomic-polygenic EBV for four traits in the ultrasound-carcass set.

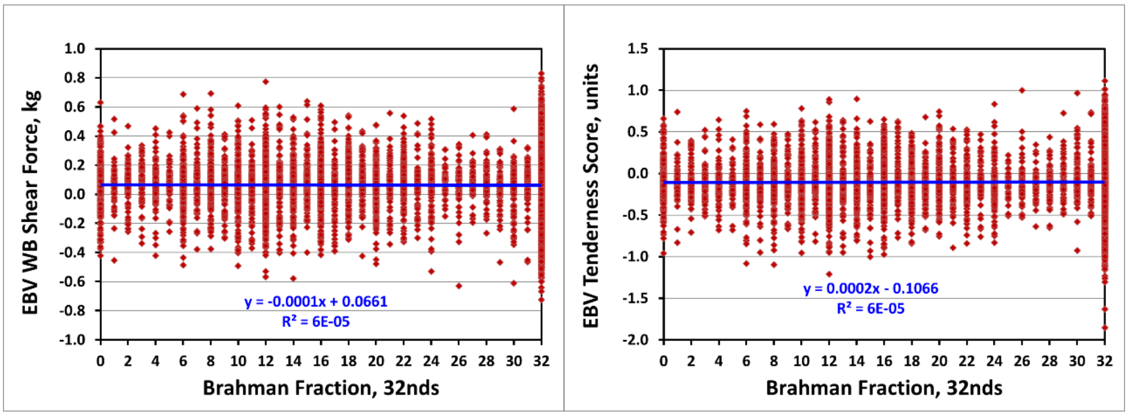

Figure 3. Genomic-polygenic EBV for the two traits in the tenderness set.

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BUDGET FOR FLORIDA CATTLE ENHANCEMEN			
PROJECT TITLE: Florida Brahman: Genomic selection for tenderness, marbling, and reproductive tr			
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL
Materials and supplies for collection of tissue samples	2600	100%	$ 7,750.00
DNA Extraction and Processing	2177	100%	$ 17,214.00
DNA Genotyping	2177	100%	$ 167,545.00
Equipment	2	100%	$ 26,170.00
Research animal incentives and collection of reproductive,ultrasound and carcass data	2177	100%	$ 20,200.00
UF Indirect Costs	1	100%	$ 29,505.00
Final Research Project Report			
GRAND TOTAL: (equal to percentage of completion)			**$268,384.00**

T FUND APPLICATION

act score; FCEB #: P0038402

EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and supplies for collection of tissue samples (ear notch kits, applicators, FedEx delivery to farms)	9/01/2017
Costs associated with tissue sample DNA extraction and processing including materials and supplies (personnel, tissue collectors, DNA extraction kits)	9/01/2017
Genotyping at Geneseek with the Bovine GGP F250k & 50k chips	9/01/2017
Dell workstation, peripherals, Fortran compiler, and ultralow temperature freezer	9/01/2017
Costs associated with incentives for animal use and collection of reproductive, ultrasound and carcass data	9/01/2017
UF indirect costs (12%)	9/01/2017
Project report detailing accomplishments, ongoing research, and next steps of the project.	9/01/2017
Total Grant = $208,384 + $60,000 = $268384	

Florida Cattle Enhancement Grant Application

Title: ***Evaluating cost-effective supplementation programs for cows during late-gestation***
FCEB No: 15 **UF Project No: AGR7485**
Investigators: Philipe Moriel, Joao (Joe) Vendramini.

Project Overview

Recent studies have shown that the supplementation of energy and protein during the entire-late gestation can also modify offspring growth and health after birth. For instance, cow supplementation of 1 lb of a high-protein supplement during the entire late-gestation increased weaning weights and carcass quality of steers, and accelerated puberty achievement of heifers. It is important to highlight that all studies mentioned above were conducted with *bos taurus* cows grazing cool-season forages, and not with cows having *bos indicus* genetic influence and consuming low-quality, warm-season forages that represent the majority of pastures in FL. It is unknown if cows and calves will experience similar positive results under our environment conditions.

Our proposal will address FCA Priorities **#3 (Calf loss)**, **#7 (Animal herd nutrition winter supplementation)**, and **#8 (Animal health).** We will evaluate if pregnant cows supplemented with energy and protein during the entire late-gestation will have greater reproductive success and long-term growth and health of their calves compared to non-supplemented cows. We also want to investigate if providing the same total amount of supplement, but for a shorter period (6 weeks versus 12 weeks), will achieve similar results, reduce labor, and be more cost-effective than a longer period of supplementation. More specifically, our objectives include using pre-calving supplementation of beef cows to: **(1)** increase their body condition score at calving and pregnancy rates; **(2)** improve calf development during late-gestation and impact their subsequent health and growth, and consequently, further increase cowherd profitability; **(3)** improve our understanding of the differences on the metabolism of mature cows (and their calves) under different pre-calving supplementation strategies, which will assist on designing future studies and harvest greater performance levels; and **(4)** generate novel information to further assist producers and county.

Significance

Figure 1. Total daily energy requirements (NEm), Mcal/day

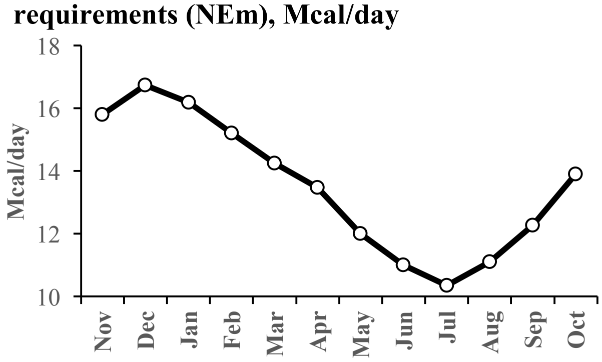

Figure 1 represents the daily energy requirement of a mature Brangus cows calving in November and weaning its calf in July. Within a production cycle, nutrient demand of cows achieves the lowest levels during the first 30 days after calf weaning, then exponentially grows during late-gestation. This occurs because approximately 2 thirds of calf fetus growth occur during the last 12 weeks of gestation. However, late-gestation also corresponds with the beginning of Fall/Winter seasons when forage nutritional value and availability are low. Unfortunately, reproduction has the lowest nutrient priority, and consequently, it will be impaired by this mismatch between nutrient demand and availability. Increased reproductive success can be achieved by increasing body condition score at calving (5 or 6, according to a 1 to 9 scale). In fact, body condition score at calving is the most important factor that influences the interval from parturition to first ovulation, overall pregnancy rate, and calving distribution of beef cows. Several cow-calf operations do not provide any kind of supplementation before calving, and inadequate dietary energy/protein during late pregnancy lowers reproduction even if the amount of energy and protein consumed after calving are sufficient. So, we are missing an opportunity to increase cow reproductive success.

In addition, recent studies have shown that the supplementation of energy and protein during the entire-late gestation can also modify placental development, fetal organ formation, and improve offspring growth and health (a process called ***fetal-programming***). For instance, calves born to cows that experienced energy deficiency during the last 40 days of gestation experienced poor vaccine response and antibody production, which might compromise calf health and increase calf loss. Also, cow supplementation of 1 lb of a high-protein supplement during the entire late-gestation increased weaning weights and carcass quality of steers, and accelerated puberty achievement of heifers. Thus, the decisions about cowherd supplementation should also include the impact on future offspring performance. Identifying nutritional strategies that can improve cow reproductive performance, decrease calf loss, and optimize future calf growth and health is crucial and the primary goal of this proposal.

It is important to highlight that all of those studies mentioned above were conducted with *bos taurus* cows grazing cool-season forages, and not with cows having *bos indicus* genetic influence and consuming low-quality, warm-season forages that represent the majority of pastures in FL. It is unknown if cows and calves will experience similar positive results under our environment conditions. Hence, our proposal will: **(1)** evaluate if supplementation of Brangus cows during the entire late-gestation **(2.25 lb/day for 12 weeks = 189 lb per cow)** will increase reproductive success of cows, calf development during gestation and performance after birth to levels higher than the cost of this supplementation strategy, and **(2)** investigate if concentrating cow supplementation during their period of lowest nutrient demand (first 6 weeks after weaning) will be more cost-effective than cows supplemented during the entire late-gestation. First, we believe that cows supplemented during late-gestation, regardless of length of supplementation, will have greater profitability than non-supplemented cows due to improvements on cow reproduction and calf performance. Second, we believe that supplementing **4.50 lb/day for 6 weeks after weaning** will reduce feeding costs, have the greatest improvement on cow weight gain and reproduction success, but not cause fetal-programming effects (due to the shorter supplementation period), whereas the supplementation of **2.25 lb/day for 12 weeks** will have greater feeding costs, have a lower improvement on reproduction, but enhance calf development during gestation and performance after birth.

Approach

The 3-year experiment is being conducted at the Range Cattle Research and Education Center (RCREC; Ona). The study began at weaning (August 2017) and will be repeated twice (**Cow group 1** = March 2017 to March 2019; **Cow group 2** = March 2018 to March 2020) in order to have stronger data and powerful statistical analyses. Pastures were prepared in March 2017. In mid-August (day 0 of the study), mature Brangus cows were allocated into 1 of 6 bahiagrass pastures (14 cows/pasture; 84 cows/year). Treatments consist of cows receiving:

(1) no concentrate supplementation until calving (**CON**);
(2) 2.25 lb/day of dry distiller grains (DDG) from mid-August to mid-November (**SUP12**; all 12 weeks of late-gestation; total of 189 lb of supplement/cow);
(3) 4.50 lb/day of DDG from mid-August to early-October (**SUP6**; first 6 weeks after weaning; total of 189 lb of supplement/cow).

Supplement will be offered twice weekly (Mondays and Thursdays). Trace mineral/vitamin mix will be provided separately in a loose meal form during entire late-gestation. After calving, cows and calves will be managed similarly until the end of the study.

Cow evaluation: Cow body weight and body condition score will be collected every 60 days from August until weaning of first calf crop. Blood samples from jugular vein will be collected from 6 cows/pasture before and after calving (days 0, 45, 90, 150, 180, and 210) to determine the plasma concentrations of hormones and metabolites correlated with reproductive performance and energy metabolism (glucose, insulin growth factor-1, and non-esterified fatty acids). Pregnancy rates will be determined in May 2018 and 2019 and confirmed at calving.

Offspring evaluation: Calving season will occur from October to December of 2017 (Cow group 1) and 2018 (Cow group 2). Calf blood samples will be collected within 24 hours of birth to determine the concentrations of IgG (indicator of immunity). Calf body weight will be collected at birth and every 60 days until weaning at 8-9 months of age. Calves will be vaccinated against bovine respiratory disease pathogens in March and July. After weaning, 30 steers will be assigned to a post-weaning evaluation of growth and immune response, whereas 48 heifers will be selected for a 150-day development program (July to November) and a 60-day breeding season (December to February). Steers will be fed ground hay and concentrate for 45 days in drylot. Blood samples of steers will be collected from jugular vein on days 0, 1, 3, 7, 14, and 45, relative to weaning, to determine the plasma concentrations of haptoglobin and cortisol (indicators of immunity and stress), and serum antibody titers against bovine viral diarrhea virus 1a and infectious bovine rhinotracheitis virus (indicators of vaccine response). Heifers will graze on bahiagrass pastures and receive concentrate supplementation to achieve 1.25 lb/day of weight gain until the end of breeding season. Blood samples of heifers will be collected from jugular vein every 7 days from September to February to determine the plasma progesterone concentrations (indicator of puberty assessment).

Anticipated outcomes and timeline for the project

***Breakeven scenario*:** The total amount of supplement will be the same (189 lb of DDG/cow), so the only difference among treatments is the additional hours of labor needed to provide supplements for 6 or 12 weeks. Assuming a herd of 100 cows, we expect that 2 hours of additional labor will be needed for every feeding event (2 hours × \$12.05/hour cost with minimum wage and fuel ÷ 100 cows = \$0.241/cow/feeding event). Thus, labor cost for cows supplemented for 6 weeks will be $2.89/cow (6 weeks × 2 feeding events/week × $0.241/cow/feeding event), whereas labor cost for cows supplemented for 12 weeks will be $5.78 (12 weeks × 2 feeding events/week × $0.241/cow/feeding event). Therefore, a herd of 100 cows will require 1,820 and 2,040 lb of additional pounds of weaned calves to cover the extra labor costs with pre-calving supplementation for 6 weeks or 12 weeks, respectively (See Table 1). In other words, pregnancy rate needs to increase by 3 to 4 percentage units or calf loss needs to decrease by 3 to 4 percentage units to cover the additional costs.

Table 1. Production level required to breakeven	**Supplementation for 6 weeks**	**Supplementation for 12 weeks**
Supplement cost (189 lb of DDG/cow @ $220/ton)	$20.79	$20.79
Feeding cost (labor + fuel)	$2.89	$5.78
Total cost, $/cow	**$23.68**	**$26.57**
Additional weaning weight (@$1.30/lb of calf weight)	18.2	20.4
Additional weaning weight for 100 cows	1,820	2,040
Additional 550-lb calves for 100 cows to breakeven	**3.31**	**3.70**

General comments to sponsors

By design, cow supplementation began at the start of the last trimester of gestation, and thus, animal feeding phase had to begin in min-August and will end in November 2017 (Cow group 1). However, all reagents for laboratory analyses of year 1 were successfully purchased from before August (the late purchase date of these reagents was intentionally used due to the short life of commercial laboratory kits). Blood samples collection began in mid-August and will be completed by mid-November. All laboratory analyses described in the proposal will be performed before early-December once all blood samples are available. An article summarizing the available data will be prepared and submitted to The Florida Cattlemen and Livestock journal in January 2018. Due to conflict of dates, the educational program for producers was postponed to October 2017. This program will be delivered in a 3-day format training in collaboration with livestock agents. The program will cover multiple topics related to body condition score and nutritional management of beef females. At the end of the program, producers will be exposed to an interactive body condition score training to improve the accuracy of body condition scoring. Due to the educational program being postponed, the **project completion percentage by September 1st, 2017 was 83%, but will reach 100% by November 2017.**

Data Summary (data collected from mid-August to September 2017).

The study began in mid-August. So currently, we only have the baseline performance data at the start of the study (Table 2). No complications have been observed, and cows are consuming the DDG supplement within a few minutes after morning supplementation. Cow blood samples, body weight and BCS will be collected in October and November, whereas calf birth body weight and blood samples will be collected immediately after calving (November). All reagents were purchased, so we are ready to run all laboratory analyses as soon as blood samples are available.

Table 2. Growth performance of cows receiving no supplementation from mid-August until calving (CON), or dry distillers grains supplementation from mid-August to October (4.50 lb of DDG daily for 6 weeks; SUP6) or from mid-August until calving (2.25 lb of DDG daily for 12 weeks; SUP12).

	Treatments				*P*-value
Item	**CON**	**SUP6**	**SUP12**	**SEM**	**Treatment**
Cow Body Condition Score					
August (Start of study; day 0)	5.04	4.96	5.22	0.097	-
October (day 45)					
November (calving day 90)					
Cow Body Condition Score change					
August to October					
October to November					
Cow Body Weight, lb					
August (Start of study; day 0)	908	939	935	10.2	-
October (day 45)					
November (calving day 90)					
Cow Average Daily Gain, lb/day					
August to October					
October to November					

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Evaluating cost-effective supplementation programs for cows during late-gestation					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and Supplies	Various	100%	$ 3,603.05	Laboratory consumables for upcoming collections of blood and feed samples, fencing supplies, and pasture shade structures.	8/15/2017
Laboratory analyses - Blood hormones and metabolites, and gene expression	Various	100%	$ 5,549.91	Cost to purchase commercial kits to analyze the plasma concentrations of IGF-1 and glucose (480 samples) and gene expression of liver tissue samples (100 samples)	8/1/2017
Data and sample collection	N/A	100%	$ 7,930.78	Cost for sample and data collection	7/31/2017
IDC	N/A		$ 2,646.26		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 19,730.00**		

Immune Response Test for Cattle Breeding and Health Management

Annual Report

Qun Huo (Ph.D.) and John E. Crews (DVM, MS)

August 30, 2017

This is a project summary of activities of the HIR Project (Immune Response Test for Cattle Breeding and Health Management) which began on January 7, 2017 through August 30, 2017. On January 7, 2017, 285 Crossbred cows (adult females of varying ages of Bos taurus-Bos indicus type cattle) from the G7 Ranch were individually identified and a whole blood sample (red top tube) was collected prior to administration of any immunizations. After the initial baseline Day 0 (D0) blood sample were drawn, the cattle were subcutaneously immunized with TRICHGUARD V5L™ vaccine manufactured by Boehringer Ingleheim Vetmedica Inc. (BI). The individual blood samples were analyzed by Dr. Qun Treen Huo, Ph.D. using the D2Dx™ Assay to determine a baseline response.

On January 14, 2017 (Day 7 post immunization-D7) the above cattle were processed and 277 of the above cattle received whole blood sample (red top tubes) draws which were subsequently analyzed by Dr. Huo using the D2Dx™ Assay. These results of the two blood draws were compared and used to identify HIR status. Dr. Huo classified 121 cows as High Immune Responders (HIR) which were identified as having test score above 4.0. The remaining 156 cows were identified as being Low Immune Responders (LIR) for study purposes. [Note: 7 cows of the original 285 cattle were not tested on 1/14/17 as these cows were not available for testing as they refused to be gathered due to very recently borne calves.]

The bulls to be used in the project to breed the test cattle were evaluated as described for the above cows. The bulls were individually identified and a health history was recorded. The statuses of the bulls had to be determined before the project was approved because the normal evaluations of these bulls had to occur prior to the project award date. The initial baseline whole blood sample draw (D0) was collected on December 12, 2016. The TRICHGUARD V5L™ vaccine manufactured by Boehringer Ingleheim Vetmedica Inc. was administered after the blood draw. The post immunization D7 blood draw on the bulls was collected on December 19, 2016. Dr. Huo stratified the results from the two blood draws to provide reference data of High and Low Immune responders. The initial plan was to maintain two separate herds of cattle – High and Low Immune Responding Cattle. However, due to the extreme drought in the project area, the herd owner was unable to maintain the two groups as totally separate herds. To prevent stratification bias issues because of this climatic variable that was beyond the control of the herd owner, only HIR bulls were selected to breed to the project cattle as a single herd.

As the participating veterinarian with the HIR Project, I have continued to monitor the cows and their offspring on at least a biweekly schedule. As of this date, 227 calves have been born to the 277 project cattle. All of the calves have been processed and are individually identified with a unique ear tag. The bull calves have been castrated, marked and branded, blood samples pulled pre and post vaccination as per the study protocol, weighed at the first blood test, and we have matched each calf with their dams (adult females) of the 277 project cattle.

As mentioned in the above paragraph, the calves have all had blood samples pulled pre and post immunization to determine an individual value of their High or Low Immune response status. This determination is made by processing the calves when they are at least 3 months of age. A whole blood sample (red top tube) was collected. After this initial D0 blood collection, the calves were administered two immunizations subcutaneously (Pyriamid®5 + Presponse and Vision®8 – BI). The health statuses of these calves will be determined, a body weight taken and all information recorded. Dr. Huo will analyze the D0 blood samples using the D2Dx™ Assay to determine a baseline response.

Seven (7) days post immunization the calves were blood sampled with a second whole blood sample draw (red top tube). Dr. Huo will analyze the D7 blood samples using the D2Dx™ Assay to classify the calves into high and low immune responder status based on the same criteria used in the adult herd.

When the calves reach an age of 205+ days after birth, they will be weaned and either sent direct to a feedlot in North Florida or sent to another ranch locally to be preconditioned to be readied for shipment to the feedlot in North Florida. On the day of weaning and shipment individual weights of the calves will be recorded and compared to the initial weight taken on the initial preimmunization processing. Those calves undergoing the preconditioning process will be lighter in weight calves and are not at optimum weight to be shipped directly to the feedlot. The first calves to be weaned will begin the first week of September 2017 as per the agreement with the ranch owner and the feedlot. This process will continue over the next 60 days until all calves have been weaned and sent to either the feedlot or to the preconditioning operation. Both groups of calves will be monitored until they are sent to slaughter or retained by the ranch owner as replacement heifers and have reached 2 years of age.

In October 2017, all of the cows will be pregnancy tested to begin the Year Two data collection of this research project. This will allow the project to further record the correlated impacts of immune response status. These reports will be documented as the cattle and the information is processed.

To date the herd has suffered the loss of the following cattle:

One (1) Adult cow found dead in March 2017 and due to the advanced stage of decomposition cause and time of death was not able to be determined.

One calf was found dead at birth in March 2017 and due to the advance stage of decomposition cause and time of death was not able to be determined. The dam (mother) of this calf was not identified.

Two (2) Adult cows were recently found mired in mud in a drying up wetlands area as reported by the herd owner. One of those cows was found dead on their discovery in this critical situation and the second cow had to be euthanized for humane reasons. This situation was caused due to the advanced dry climatic conditions (and not due to a disease) currently being experienced in the area where the project herd is located. And one adult cow was injured and died during the spring deworming of the cattle in April 2017.

Project Progress will continue to be updated as the project moves forward toward the conclusion of the project. Analysis of the production data is ongoing and will be reported as the current calves are weaned and sent to the feedlot or backgrounding operation. Please contact me if there are any questions about the project animals and this report.

Conclusion

So far all work as planned in the original proposal has been conducted as scheduled. All blood tests have been successfully completed, with data stored in electronic and hard copy version for later analysis and correlation with cattle breeding data and health analysis. We have also archived all blood samples. We will be able to conduct additional blood analysis during the second year of the project. This project has supported one Ph.D. graduate student.

Florida Cattle Ehancement Board						
Project Title:	Immune Response Test for Cattle Breeding and Health Management					
Detailed Line Item Description	QTY	Unit Price	Total	Category Totals	Explanation/Justification of Deliverable	Completion Date
Domestic travel	1	$ 1,000.00	$ 1,000.00		To attend ASM 2017 conference	7/19/2017
Total Travel				**$ 1,000.00**		
Pipet Tips	1	$ 344.32	$ 344.32		Lab supply/chemicals	7/19/2017
Goat anti-bovine IgG	1	$ 256.72	$ 256.72		Lab supply/chemicals	7/19/2017
Anti-Bovine IGG (Fc)	1	$ 779.57	$ 779.57		Lab supply/chemicals	7/19/2017
Blood collection Tubes	1	$ 485.48	$ 485.48		Lab supply/chemicals	7/19/2017
Project student poster	1	$ 21.00	$ 21.00		Lab supply/chemicals	7/18/2017
Gloves	1	$ 185.60	$ 185.60		Lab supply/chemicals	7/28/2017
Total Supplies				**$ 2,072.69**		
DVM consulting (Dr. Crews)	1	$ 18,210.00	$ 18,210.00		Cattle care, vaccination, blood draw	7/19/2017
DVM consulting (Dr. Crews)	1	$ 4,552.50	$ 4,552.50		Cattle care, vaccination, blood draw	8/31/2017
Total Consulting				**$ 22,762.50**		
PI salary	1	$ 10,695.75	$ 10,695.75		Support Dr. Qun Huo's effot	8/10/2017
PI Fringe Benefits	1	$ 2,153.74	$ 2,153.74		PI fringe benefit	8/10/2017
Total PI Salary/Fringe				**$ 12,849.49**		
GRA Salary	1	$ 8,123.84	$ 8,123.84		Graduate research assistant effort	8/10/2017
Tuition (GRA)	1	$ 1,839.69	$ 1,839.69		Graduate research assistant tuition	8/10/2017
GRA Salary / Tuition				**$ 9,963.53**		
Overhead	1	$ 5,837.79	$ 5,837.79	**$5,837.79**	**Indirect cost**	**8/31/2017**
Grand total				$ 54,486.00		

Managing Soil Health for Pasture Sustainability

Maria L. Silveira[1], Rao Mylavarapu[2], Joao M. B. Vendramini[1], Lynn E. Sollenberger[3], Jose C.B. Dubeux Jr. [4]

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1. PROJECT OVERVIEW

The concept of soil health has been receiving much attention in the United States, and ways of defining and describing soil health have been developed in different agricultural and natural systems. Although a number of commercial laboratories (mainly in the Midwestern US) are currently offering soil health assessments, selection and interpretation of indicators of soil health (measurable soil attributes) should be done at a local scale. Research is needed to evaluate, select, and implement a suite of soil health indicators that are relevant to Florida environmental conditions and soils. Although soil health assessments are gaining in popularity and are currently being promoted as tools to guide management of many types of agricultural production systems, science-based information is needed to develop and validate a soil quality framework for guiding pasture management decisions and monitoring their outcomes. Currently, limited information exists on how soil health can be used to increase productivity and resilience of perennial pasture systems in Florida. The main objectives of this project were to: 1) develop and validate a soil health tool for perennial pastures in Florida, 2) evaluate the impacts of pasture management on soil health, and 3) create educational tools to explain and disseminate information regarding the benefits of soil health in the context of sustainable pasture management. *This proposal addresses the* ***FCA Priority # 6 "Ranching Activities Impacts on the Environment).***

2. PROJECT ACTIVITIES (JANUARY – AUGUST 2017)

Producer Survey

A survey tool was developed to examine management practices associated with the participant sites. Participant sites were identified and collection of data began in May 2017. A total of 32 forage and soil samples were collected in central and south Florida during the period of May through August, 2017 (Table 1). Participant sites ranged from small scale (<50 acres) cow/calf commercial operations to relative large scale ranches (>3,000 acres). Size of the fields where samples were collected from ranged from < 10 acres to > 40 acres. Forage species included bahiagrass, bermudagrass, limpograss, perennial peanut, pearl millet, and stargrass use for hay production, haylage, green chopped, or grazed. Fertilization strategies ranged from no fertilization to multiple fertilizer applications throughout the growing season. Participants were also asked to rank their pastures into 2 categories: bad vs. good. Photos of selected sites are provided in Appendix 1.

Soil and Tissue Sampling and Analyzes

At each location, composited soil samples (0-6” deep) were collected and associated pasture management history (past 5 yr) was recorded. A minimum of 15 soil cores was collected from each area and combined into a composite sample for chemical, physical, and biological characterization. Additional undisturbed cores (3 per location) were collected for bulk density and root biomass determinations. Soil analysis included pH, Mehlich-3 extractable P, K, Ca, and Mg, total organic C, total N, and labile organic C, soil respiration, and bulk density.

Forage height was measure at 10 random locations in each pasture. Forage mass was estimated at locations that exhibited samples were collected and analyzed for total P, K, Mg, Ca, S, B, Zn, Mn, Fe, and Cu.

3. RESULTS SUMMARY

Soil

The predominant soil series were Myakka, Candler, Immokalee, Okeechobee, Smyrna, Wauchula, Pomona, and Bradenton fine sand (Table 1).

Soil pH ranged from 4.3 to 6.8. The majority of the samples (~65%) had soil pH below the recommended level of 5.5 for warm-season grasses (Table 2). Soil P levels were low (< 26 ppm) in approximately 80% of the samples. However, tissue P concentrations were generally (87% of the samples) above the critical level of 0.15 established for grazed bahiagrass pastures (Table 3). Approximately 50% of the samples had low soil K levels (< 26 ppm). Soil Ca, Mg, Zn, and Cu were within the typical expected concentrations for most soils in Florida. Cation exchange capacity (CEC) and bulk density were also typical of sandy soils.

Total C and N concentrations varied significantly among the various sites (0.42 to 8.9% for C and 0 to 0.62% for N). Preliminary analysis suggested that soil C and N were mainly influenced by soil type rather than pasture management. Additional laboratory characterization of selected soil C fractions (i.e., labile light C) and collection of a large number of soil samples from various soil types and management conditions are expected to elucidate whether soil C can potentially be a reliable indicator of soil health in pasture soils.

Plant Tissue

Forage height was affected by the pasture management (i.e., grazed at the time of the sample collection, mowing, etc.). Crude protein levels ranged from 3.9% (stockpiled limpograss) to 18.5% (grazed bahiagrass pasture) (Table 3). Tissue P levels were generally above the critical limit of 0.15% established for grazed bahiagrass pastures. Smallest tissue P (0.04%) and K (0.56%) levels were associated with the stockpiled limpograss. Calcium, Mg, S, and micronutrient concentrations were typical of warm-season grasses in Florida.

4. SUMMARY AND CONCLUSIONS

Results suggested that pastures and hayfields in Florida exhibited a wide range of soil chemical, physical, and biological properties. Additional laboratory analyses are currently being conducted to fully characterize the impacts of various soil types and pasture management strategies on selected soil properties. Although some characteristics are inherent of a particular soil type, we anticipate that the results from this study will provide the first critical steps to define soil health for pastures in Florida. Although full implementation of soil health framework will require coordination with local and national groups, we anticipate this study will provide the basis to develop locally-based tools to assist land managers in the development of management strategies that sustain forage production and sustainability. We hope that funds will continue to be available through the Florida Cattlemen's Beef Enhancement program to support our current efforts that address research priority # 6 "Ranching Activities Impacts on the Environment).

ACKNOLEDGEMENTS

We sincerely thank the producers for their willingness to participate in this study. We also want to extend our appreciation to county extension personnel (Bridget Stice, Ed Jennings, Lauren Butler) who facilitated the site visits and sampling. Thanks to the FCA for providing the funds to support this project.

5. PERCENTAGE COMPLETION OF PROJECT DELIVERABLES: 100%

Table 1. Detailed information about the study sites.

[1]Pasture condition was based on producer's assessment of overall pasture health (yield, persistence, presence of weeds, etc).

Sample ID	County	Species	Pasture condition[1]	Soil Series
1	Hardee 1	Jiggs bermudagrass	good	Myakka fine sand (40%); Valkaria fine sand (60%)
2	Levy 1	Bahiagrass	bad	Candler fine sand (100%)
3	Levy 2	Bahiagrass	good	Candler fine sand (100%)
4	Levy 3	Tifton 85 bermudagrass	good	Candler fine sand (100%)
5	Levy 4	Pearl millet	medium	Candler fine sand (100%)
6	Levy 5	Bahiagrass	good	Candler fine sand (27.5%); Candler-Apopka complex (34.4%); Candler fine sand (38.1%)
7	Okeechobee 1	Bahiagrass	good	Oldsmar fine sand (100%)
8	Okeechobee 2	Bahiagrass	bad	Winder sand (88%); Chobee muck (11%)
9	Okeechobee 3	Bahiagrass	bad	Floridana, Placid and Okeelanta (100%)
10	Okeechobee 4	Bahiagrass + common bermudagrass	good	Floridana, Placid and Okeelanta (100%)
11	Okeechobee 5	Limpograss	good	Samsula muck (100%)
12	Okeechobee 6	Stargrass	good	Immokalee fine sand (98.3%); Valkaria fine sand (1.7%)
13	Okeechobee 7	Bahiagrass	bad	Salerno sand (71.5%); Duette fine sand (28.5%)
14	Polk 1	Bahiagrass	medium	Wabasso fine sand (76.5%); Bradenton fine sand (20.0%); Floridana mucky fine sand (3%)
15	Polk 2	Bahiagrass	good	Bradenton fine sand (100%)
16	Polk 3	Bahiagrass	bad	Bradenton fine sand (100%)
17	Polk 4	Bahiagrass + common bermudagrass	bad	Udorthents (100%)
18	Polk 5	Bahiagrass	good	Smyrna and Myakka fine (95.6%); Huntoon muck (3.3%)
19	Polk 6	Bahiagrass	medium	Satellite sand (36.7%); Pompano fine sand (31.3%); Smyrna and Myakka fine sands (31.1%
20	Polk 7	Bahiagrass	good	Satellite sand (47.7%); Immokalee sand (13.6%); Smyrna and Myakka fine sands (38.7%)
21	Polk 8	Bahiagrass	bad	Satellite sand (71.3%); Immokalee sand (24.1%); Smyrna and Myakka fine sands (4.6%)
22	Polk 9	Jiggs bermudagrass	good	Immokalee sand (100%)
23	Polk 10	Bahiagrass	medium	Hontoon muck (3.9%); Immokalee sand (78.5%); Smyrna and Myakka fine sands (17.6%)
24	Polk 11	Bahiagrass	bad	Pomona fine sand (75.5%); Smyrna and Myakka fine sands (21.2%)
25	Polk 12	Bahiagrass	good	Smyrna fine sand (42.0%); Myakka fine sand (38.7%); Adamsville sand (11.8%); Narcoossee
26	Polk 13	Bahiagrass	good	Myakka fine sand (72.1%); Narcoossee fine sand (27.9%)
27	Polk 14	Bahiagrass	Medium	Myakka fine sand (95%); Narcoossee fine sand (5%)
28	Polk 15	Bahiagrass	good	Smyrna and Myakka fine sand (57.1%); Zolfo fine sand (42.9%)
29	Polk 16	Bahiagrass	bad	Smyrna and Myakka fine sand (97.9%); Zolfo fine sand (2.1%)
30	Osceola 1	Bahiagrass	good	Wauchula fine sand (100%)
31	Osceola 2	Bahiagrass	bad	Wauchula fine sand (60.5%); Smyrna and Myakka fine sand (21.4%); Immokalee sand (17.9
32	Osceola 3	Limpograss	Newly established	Candler sand (47.9%); Smyrna and Myakka fine sands (7.4%); Adamsville fine sand (5.4%)

Table 2. Selected soil chemical and physical properties.

Sample ID	Soil pH	Mehlich-3						CEC	Bulk Density	Total N	Total C
		P	K	Mg	Ca	Zn	Cu				
		ppm						meq/100g	g/cm3	%	
1	5.6	35	19	41	318	5	4	3	1.2	0.00	0.55
2	5.8	52	87	22	256	2	0	4	1.3	0.04	0.94
3	5.3	55	45	37	174	2	0	4	1.4	0.06	1.15
4	6.2	33	25	93	411	2	0	4	1.4	0.05	0.94
5	6.6	42	29	51	514	4	4	4	1.4	0.00	0.58
6	5.6	13	8	12	209	2	1	3	1.3	0.00	0.43
7	5	8	43	87	1929	1	0	18	0.4	0.62	8.95
8	5.6	6	18	59	973	3	0	8	1.0	0.14	2.15
9	6.2	21	53	204	2075	2	0	15	0.8	0.24	2.89
10	6.2	13	116	67	2948	3	0	19	0.8	0.33	3.83
11	5.4	13	147	153	1923	4	0	17	0.6	0.22	4.24
12	5.2	7	68	68	1314	2	0	13	0.9	0.17	3.46
13	4.9	11	67	169	1357	2	0	15	0.9	0.17	3.51
14	5.2	2	24	79	954	2	0	10	1.0	0.08	2.58
15	5.2	2	32	63	877	2	0	9	0.9	0.07	2.11
16	5.1	3	30	76	846	2	0	9	0.7	0.10	2.65
17	6.8	76	19	82	2468	55	7	15	1.1	0.07	2.14
18	4.6	4	43	86	409	4	0	9	1.0	0.06	2.52
19	4.7	2	14	36	183	3	0	4	1.1	0.01	1.27
20	4.9	2	14	33	177	2	0	3	1.0	0.00	0.85
21	5.3	44	11	28	583	17	2	6	1.2	0.04	1.48
22	5.8	26	19	53	692	5	0	6	1.0	0.04	1.27
23	5.2	5	49	57	518	3	0	6	0.8	0.04	1.57
24	5.2	4	33	28	386	2	0	6	0.9	0.02	1.36
25	5.3	7	64	109	453	4	0	7	0.8	0.08	2.12
26	6.1	9	21	190	813	2	0	8	1.0	0.08	2.26
27	4.7	2	17	40	232	3	0	5	1.1	0.03	1.55
28	4.9	4	11	34	196	5	1	4	1.3	0.01	0.96
29	4.7	2	14	29	232	2	0	5	1.2	0.02	1.35
30	4.6	3	27	44	523	2	0	9	0.9	0.13	3.16
31	4.4	2	24	35	328	1	0	7	1.1	0.09	2.49
32	4.3	4	18	34	195	1	0	6	1.0	0.11	2.93

Table 3. Plant tissue characterization.

Sample ID	Forage height	Crude Protein	P	K	Mg	Ca	S	B	Zn	Mn	Fe	Cu
	inches	%						ppm				
1	11	10.4	0.22	0.79	0.17	0.43	0.17	6.3	119	63.2	47.7	8.5
2	4	15.1	0.26	1.96	0.19	0.38	0.36	6.0	43.4	203.6	138.1	8.3
3	3	18.5	0.37	2.15	0.29	0.34	0.31	5.5	33.9	215.9	104.8	10.3
4	6	15.5	0.37	2.01	0.24	0.51	0.42	4.8	32.4	49.5	102.7	9.9
5	16	16.3	0.7	4.44	0.36	0.53	0.22	5.5	43.1	84.8	440.5	10.8
6	10	14.9	0.33	2.1	0.24	0.46	0.25	4.8	45.5	137.5	118.9	10.8
7	6	13.9	0.39	1.23	0.26	0.36	0.39	6.4	40.8	121.9	83.5	7.8
8	5	13.4	0.33	0.7	0.59	0.63	0.35	6.2	35.9	46.4	74.9	9.4
9	4	11.9	0.19	1.22	0.24	0.51	0.41	9.9	29.9	64.5	74.5	5.5
10	10	10.8	0.18	2	0.17	0.55	0.38	9.8	26.7	41.1	60.8	7.2
11	18	10.5	0.23	2.79	0.21	0.25	0.36	7.6	31.6	16.6	56.4	10.4
12	17	11.1	0.3	2.48	0.12	0.3	0.22	3.9	37.8	31.3	40.2	8.2
13	12	9.9	0.27	1.54	0.35	0.34	0.18	3.8	22.0	58.1	46.4	5.5
14	13	7.8	0.13	0.84	0.4	0.43	0.16	3.6	18.0	23.7	53.3	4.2
15	9	9.6	0.17	1.66	0.32	0.41	0.2	4.2	18.1	28.2	56.2	5.7
16	13	7.7	0.39	1.78	0.19	0.51	0.35	7.4	89.8	16.3	79.0	11.1
17	3	13.8	0.14	1.04	0.28	0.37	0.15	3.4	13.2	20.5	39.4	3.9
18	3	14.9	0.3	1.66	0.39	0.31	0.32	4.7	38.1	144.3	65.8	8.6
19	3	10.9	0.24	1	0.47	0.35	0.24	4.1	40.6	204.9	59.9	7.4
20	4	10.9	0.22	1.01	0.3	0.4	0.21	4.5	33.6	178.3	136.2	7.1
21	2	10.9	0.44	0.81	0.51	0.69	0.27	5.0	80.5	47.7	70.5	8.6
22	9	11.0	0.26	1.01	0.23	0.49	0.35	4.7	41.3	17.5	64.1	7.7
23	6	9.7	0.31	1.47	0.32	0.38	0.21	4.5	37.6	40.3	49.2	6.4
24	6	8.4	0.31	1.36	0.34	0.51	0.2	4.3	22.4	26.4	50.4	5.0
25	14	8.1	0.18	1.64	0.32	0.3	0.2	4.9	19.6	74.1	38.3	4.5
26	13	7.7	0.18	1.22	0.38	0.3	0.2	5.1	12.8	24.3	37.0	4.3
27	7	6.7	0.15	0.99	0.26	0.35	0.11	4.5	16.3	86	52.5	3.7
28	4	9.1	0.31	1	0.58	0.43	0.24	5.0	39.8	155.1	62.7	7.1
29	5	9.1	0.27	0.83	0.6	0.39	0.23	3.9	38.8	201.6	61.7	6.4
30	6	7.7	0.18	1.21	0.31	0.28	0.2	4.0	19.0	79.9	64.6	5.3
31	8	6.9	0.12	1.04	0.36	0.25	0.12	3.5	13.9	46.9	42.5	4.5
32	43	3.9	0.04	0.56	0.14	0.1	0.1	2.2	17.3	9.7	30.6	4.0

Appendix 1 – Photos of selected participant sites

BUDGET JUSTIFICATION

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND - BUDGET JUSTIFICATION					
PROJECT TITLE: Managing Soil Health for Pasture Sustainability (# P0037824)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Collection of soil, forage, and management data	N/A	100%	$ 8,550.7	soil collection and management practices survey. Items include (but not limited to): paper bags, soil cores cylinders, flags, forage clippers, auger	9/01/2017
Soil Analyses	N/A	100%	$16,217.9	laboratory supplies (reagents, filter paper, instrument consumables, gas cylinder), soil chemical, physical and biological characterization, shipping of samples for analyses	9/01/2017
Forage Analyses	N/A	100%	$3,517.4	forage analyses, shipping of samples for analyses	9/01/2017
Final Research Project Report	1			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/01/2017
GRAND TOTAL: (equal to percentage of completion)			**$28,286.00**		9/01/2017

Florida Cattle Enhancement Board Grant Final Report

Award ID: AWD01714

Title: Defining the Importance of Soil pH, Potassium, and Phosphorus in Reversing Bahiagrass Pasture Decline on Florida Cattle Ranches

Investigators: Lynn Sollenberger, João Vendramini, and Maria Silveira

Project Overview:

Perennial pasture grass decline has been identified as a significant problem in Florida. In 2015, the UF/IFAS Pasture Grass Task Force reported that pasture degradation was likely cumulative over time and that inadequate soil pH and P and K fertilization are possible causes. The task force recommended that on-ranch research be conducted to test whether liming and fertilization management can to restore declining pastures to a healthy status. Our studies are intended to assess the relative importance of appropriate liming to optimum soil pH and application of P and K fertilizer in reversing the decline of perennial grass pastures. Work was initiated under a previous grant in November 2015. Four, on-ranch sites were selected in cooperation with county extension faculty and treatments imposed throughout the 2016 growing season. In 2017, we have returned to the same pastures at each of these four ranches and carried out the experiments for the second year. Grant deliverables from the current project are below along with a statement describing completion of each deliverable.

Description of Deliverable	Progress with Deliverable as of 1 Sept. 2017
1. Plant tissue samples from the 2016 growing season will be ground and analyzed for chemical composition including K and P.	Plant tissue samples have been processed for laboratory analysis. All samples analyses have been completed and data analyzed.
2. Soil samples will be taken from each plot at each of the four sites in March 2017 and analyzed for pH, K, and P.	Soil samples were taken from each plot at each ranch during visits that occurred in March 2017. Samples were processed, submitted to the lab and analyses completed.
3. Fertilization treatments will be applied for a second year at each of the four ranches starting in March 2017, and cages will be installed to measure forage production.	Fertilization was applied at each ranch in March 2017 and cages were installed.
4. Forage production will be measured every 35 days at each ranch throughout the 2017 growing season.	Site visits have occurred at 5-week intervals starting in May 2017 and continued through August 2017 to measure forage production on each plot at each ranch.
5. Plant tissue sampling will occur every 35 days at each ranch throughout the 2017 growing season	Plant tissue sampling started in May 2017 and continued every 35 days through August 2017 from each plot at each ranch.

Project Completion: 100%

Project Summary (January – August 2017):

All deliverables are 100% completed as of August 29, 2017. A summary of expenditures is included on Page 6. Results from the 2016 growing season have been analyzed and summarized and show significant forage production responses to treatments at three of four participating ranches in the first year of this experiment. These results were discussed with cattlemen at the Levy County Cattlemen's Association spring meeting on April 20, 2017 and at the Florida Forage Workers' Tour in Citra on August 21, 2017. Results are summarized by location in the tables that follow. Each table shows the initial soil condition and the 2016 yield and tissue P and K results in response to the treatments imposed. A short summary follows each table, and an overall summary is at the end of the report (Pages 5 and 6).

Table 1. Pasco County site. At this location there were four replicates of each of eight treatments (2 levels of lime x 2 levels of P x 2 levels of K).

	pH		Mehlich-3 P		Mehlich-3 K	
Soil	4.68		7		20	
Trt.	Lime		P fertilizer		K fertilizer	
Level	No	Yes	No	Yes	No	Yes
Yield (lb/acre)	4600	4900	4580	4920	4540	4955
Tissue P (%)			0.13	0.19		
Tissue K (%)					0.77	1.11

At the Pasco County site, initial soil pH was well below the target pH of 5.5 for bahiagrass. All three of the treatments, lime, phosphorus fertilizer, and potassium fertilizer increased bahiagrass pasture yield. When plots were fertilized with P and K, plant tissue levels increased. Levels in unfertilized plots were below minimum levels recommended for optimum production (0.15% P and 1.4-1.5% K), so the yield response to addition of these nutrients supports proposed critical minimums for these nutrients in bahiagrass.

Table 2. Sumter County site. At this site there was space for only 16 plots, so the phosphorus treatment was omitted. Thus, there were four replicates of four treatments (2 lime levels x 2 K levels).

	pH		Mehlich-3 P		Mehlich-3 K	
Soil	4.74		28		38	
Trt.	Lime		P fertilizer[a]		K fertilizer	
Level	No	Yes	No	Yes	No	Yes
Yield (lb/acre)	3400	3630	---	---	3070	3960
Tissue P (%)			---	---		
Tissue K (%)					1.07	1.68

[a]The phosphorus treatment was not applied at this ranch because it was not deficient in the plot area.

In spite of low soil pH at this location, there was no significant effect of liming on bahiagrass yield, but there was a very large effect of potassium fertilization. At this location, plant tissue potassium level was below the recommended concentration for optimum growth when no potassium fertilizer was applied (1.07% vs. 1.40% when potassium was applied). Yield response to potassium fertilizer in this case supports a conclusion that when tissue potassium concentrations are below 1.4-1.5% a yield response is likely to occur.

Table 3. Hardee County Site 1. At this location, there were 32 plots, four replicates of each of eight treatments (2 levels of lime x 2 levels of P x 2 levels of K fertilizer).

	pH		Mehlich-3 P		Mehlich-3 K	
Soil	4.83		9		15	
Trt.	Lime		P fertilizer		K fertilizer	
Level	No	Yes	No	Yes	No	Yes
Yield (lb/acre)	6730	7470	7130	7080	6830	7380
Tissue P (%)			0.24	0.30		
Tissue K (%)					1.22	1.48

At Hardee County Site 1, there was a significant yield increase due to liming and to potassium fertilizer but not due to phosphorus fertilization. As observed at the Pasco site, soil pH was below target for bahiagrass and yield responded to lime. Also, tissue potassium concentrations of unfertilized plots was less than 1.4% and we observed a response of both tissue potassium and bahiagrass yield to application of potassium fertilizer. In this case, there was no response to phosphorus fertilization in spite of very low soil P, but plant tissue P of unfertilized bahiagrass was 0.24%, quite a bit greater than the proposed minimum threshold of 0.15%.

Table 4. Hardee County Site 2. At this location, there were 32 plots, four replicates of each of eight treatments (2 levels of lime x 2 levels of P x 2 levels of K fertilizer).

	pH		Mehlich-3 P		Mehlich-3 K	
Soil	5.51		6		12	
Trt.	Lime		P fertilizer		K fertilizer	
Level	No	Yes	No	Yes	No	Yes
Yield (lb/acre)	5440	5840	5710	5570	5610	5670
Tissue P (%)			0.16	0.26		
Tissue K (%)					0.44	0.87

At the Hardee County Site 2, there was no significant yield response to any of the treatments. Soil pH was very close to the target for bahiagrass which may explain lack of a lime response. Plant tissue P was above the minimum threshold recommended for bahiagrass and again there was no yield response. Plant tissue potassium, however, was well below recommended levels, but even so, there was no bahiagrass yield response to potassium fertilizer at this site. There was, however, and a doubling of grass tissue potassium concentration when potassium fertilizer was applied.

Overall Summary:

These data support the results of the survey conducted by the Pasture Grass Task Force. Specifically, producers with declining stands of bahiagrass need to pay greater attention to soil pH and potassium level in their soils. We draw this conclusion because at 75% of sites in this research there was a significant response of bahiagrass yield to added potassium and at 50% of sites there was a significant response to liming. When bahiagrass yield responses to phosphorus and potassium fertilization occurred, they were generally well associated with recommendations for bahiagrass plant tissue concentrations of these nutrients.

Data are still being collected in 2017 (one additional farm visit not included in this project will be carried out in early October), and these data will provide a longer time interval to assess degree of restoration of degraded bahiagrass pastures and longer-term forage productivity and nutritive value responses to addition of lime, and P and K fertilizers. These results will provide valuable guidance to producers to help them maintain perennial grass pastures for long-term sustainable livestock production.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Defining the Importance of Soil pH, Potassium, and Phosphorus in Reversing Bahiagrass Pasture Decline on Florida Cattle Ranches					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Sample processing and analysis of plant tissue samples from 2016 growing season	Various	100%	$16,183	Drying, grinding, bagging, labeling, organizing, and laboratory analyses of 448 samples collected during 2016, including analyses for P and K at Dairy One Laboratory and analyses for N and digestibility at the Forage Evaluation Support Laboratory. Data organization and analysis.	9/1/2017
Collection and analysis of soil samples from 2017	Various	100%	$7,977	Transportation to research sites, collection of soil samples, drying, bagging, and analyses of 112 soil samples collected during March 2017 for pH, P, K, Mg, and Ca. Data organization and analysis.	9/1/2017
Application of fertilizer treatments, cage installation and herbicide application for 2017	Various	100%	$2,133	Transportation to research sites, purchase of fertilizers and herbicide, and installation of cages at each location	9/1/2017
Measurement of forage production during the 2017 growing season through August	Various	100%	$10,953	Monthly transportation of sampling team to the research locations, sampling bags, clippers, clipper repairs, and clipping, bagging, drying, and weighing samples. Data management and analyses.	9/1/2017
Collection of plant tissue samples for analysis through August of the 2017 growing season	Various	100%	$8,498	Monthly transportation of sampling team to research location, purchase of sampling bags and clippers, field sampling, bagging, drying, and weighing samples.	9/1/2017
Final Research Project Report	1			Project report detailing research, which may include findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Indirect Cost	N/A		$5,381		N/A
GRAND TOTAL: (equal to percentage of completion)			**$51,125**		

FINAL REPORT – Project # P0038490 (FCEB # 23)

Title: Development of a puberty indication protocol for *Bos indicus*-based heifers in Florida

Principle Investigator: Dr Cliff Lamb and Nicolas DiLorenzo, North Florida Research and Education Center

Relevance to Florida Cattle Industry: Infertility that leads to failure of a cow or heifer to become pregnant and delivery a calf, results in the single largest economic loss of cow-calf production systems. Attainment of puberty in heifers prior to initiation of the breeding season is likely the single most important factor impacting when heifers become pregnant during the breeding season and, subsequently, the lifetime productivity of cows. Therefore, cow-calf producers are in need of management solutions to induce puberty to ensure the future productive potential of replacement heifers as early as possible in order to choose the best replacement heifers. Developing puberty induction strategies for the attainment of puberty in heifers should enhance longevity and lifetime production of FL beef cows.

Objective: To determine if incorporation of puberty induction strategies enhances puberty in heifers prior to initiation of the breeding season and improves reproductive efficiency of Florida beef cattle operations.

Methods: Three hundred and eighty *Bos indicus* beef heifers were assigned to one of three treatments (Figure 1): 1) Control Group (CONT; *n* = 133): Did not receive any treatment during the experiment; 2) No induction (NOIND; *n* = 123); heifers were exposed to estrus synchronization (ES) and artificial insemination (AI) using the 5-day CO-Synch+CIDR protocol; and 3) Induction (IND; *n* = 124); heifers were exposed to a puberty induction protocol consisting of a CIDR implant for 12 days and exposed to ES and AI using the 5-day CO-Synch+CIDR protocol, starting 12 days after the puberty induction protocol. Blood samples were collected at days 0, 10, 22, 34, and 39 to determine cycling status of heifers, based on plasma concentrations of progesterone.

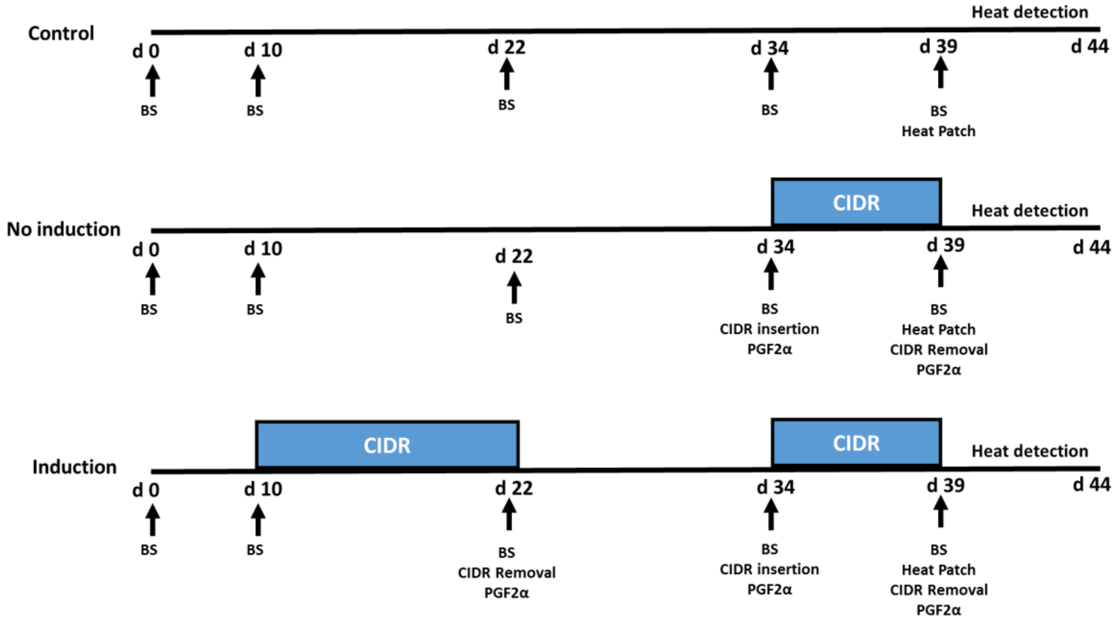


Figure 1. Schematic of treatments.

Results: Overall, body weight (BW) and body condition score (BCS) did not differ among treatments at initiation of the development period; however, BW change for the 40 days from initiation of the experiment until initiation of the breeding season resulted in the heifers assigned to the IND treatment to have greater weight loss than heifers in the CONT and NOIND treatments (Table 1). In addition, heifers assigned to the IND treatment had a greater decrease in BCS than heifers in the CONT and NOIND treatments. In comparison to CONT and NOIND treatments, the IND treatment failed to increase the percentage of heifers that were cycling at 5 days prior to initiation of the breeding season, failed to induce a greater percentage of prepubertal heifers to initiate estrus cycles by initiation of the breeding season, and failed to increase the percentage of heifers observed in estrus during the first 5 days of the breeding season.

Pearson correlation coefficients revealed that the percentage of heifers cycling at initiation of the experiment were associated with BW and with BCS change prior to initiation of the breeding season (Table 2). The percentage of heifers that were cycling 5 days prior to initiation of the breeding season were correlated to BCS change prior to initiation of the breeding season. In addition, the percentage of heifers expressing estrus during the first 5 days of the breeding season was correlated with both BW and BCS at the initiation of the breeding season.

Table 1. Mean age at attainment of puberty for Angus, Brangus, and Braford heifers.

	Treatment		
	CONT	NOIND	IND
No. of heifers	133	123	124
BW at initiation of heifer development	674 ± 27	669 ± 28	710 ± 28
BCS at initiation of heifer development	5.9 ± 0.04	5.9 ± 0.04	5.9 ± 0.04
BW change for 40 days prior to breeding season	13.3 ± 27.4[a]	13.1 ± 28.5[a]	-38.7 ± 28.3[b]
BCS change for 40 days prior to breeding season	-0.3 ± 0.04[a]	-0.3 ± 0.04[a]	-0.4 ± 0.04[b]
% cycling at initiation of treatments	32	32	47
% cycling 5 days prior to initiation of breeding season	34	34	41
% of noncycling heifers induced to cycle by treatment	24	24	29
% expressing estrus during first 5 d of breeding season	9	14	17
% noncycling heifers induced to express estrus during first 5 d of breeding season	7	11	11

[a,b] Means within a row differ ($P < 0.05$)

Table 2. Pearson correlation coefficients among feed efficiency and fertility traits for replacement beef heifers.

Item[1]	Initial BW	Initial BCS	Final BW	Final BCS	BW change	BCS change
% cycling at initiation of treatments	-0.02675	**0.10193**	0.09392	-0.01796	0.04110	**-0.10738**
	0.6046	**0.0471**	0.0693	0.7275	0.4293	**0.0367**
% cycling 5 days prior to initiation of breeding season	-0.02891	0.08406	0.00422	-0.02954	0.03167	**-0.09913**
	0.5768	0.1027	0.9351	0.5670	0.5432	**0.0542**
% expressing estrus during first 5 d of breeding season	0.01049	0.05633	**0.21009**	**0.15614**	0.02083	0.06290
	0.8391	0.2734	**<.0001**	**0.0023**	0.6888	0.2218

[1]BW = Body weight; BCS = body condition score

Conclusion: Use of a puberty induction protocol in Bos indicus beef replacement heifers failed to increase the percentage of heifers that were pubertal or expressed estrus at initiation of the breeding season; however, key fertility indicators were correlated to BW or BCS change prior to the initiation of the breeding season.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND APPLICATION					
PROJECT TITLE & FCEB #: Development of a puberty indication protocol for *Bos indicus* -based heifers in Florida - Project # P0038490 (FCEB # 23)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Chemical Analysis-Blood	1500	100%	$ 6,000.00	Immulite analysis of P4 samples (5 samples per heifer x 300 heifers x $4/sample)	9/01/2017
Ultrasound, materials and supplies to complete the assessment of puberty	300	100%	$ 6,250.00	Ultrasounding fees, ultrasounding supplies, miscellaneous materials and supplies needed to complete the assessment of puberty	9/01/2017
Research Animals (per diem)	300	100%	$ 17,914.00	Per diems for access to research animals in order to complete the study	9/01/2017
Indirect cost (12%)	1	100%	$ 3,619.68	Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/01/2017
GRAND TOTAL: (equal to percentage of completion)		100%	**$33,783.68**		

Florida Cattle Enhancement Grant
Final Report
September 1, 2017

Increasing Soil Fertility to Manage Broomsedge in Bahiagrass Pastures

Investigators: Brent Sellers, Maria Silveira, and Jonael Bosques

Award ID: FCEB 26; AWD01682

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) 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 has 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, broomsedge bluestem has not responded to application of NPK at these rates over a 4 year period, indicating that more time may be necessary to observe a decline in broomsedge bluestem density. Micronutrient applications have not resulted in a decrease in any broomsedge species over a 4 year period.

Currently, it is unknown if NPK fertilization or soil pH management will have a long-term impact on broomsedge bluestem densities, or which macronutrient is responsible for the observed reduction in bushy and purple bluestem densities in our research. Since no herbicides selectively remove these species, different management programs must be evaluated for their effectiveness. Therefore, our objectives are to determine what soil amendments will result in a reduction broomsedge density, and which macronutrient is responsible for reducing broomsedge density. 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.

Continuation of existing experiments. Three experiments were established at Ona (Range Cattle REC) and commercial ranches in St. Cloud and Arcadia in 2012 to determine the impact of soil pH and fertilizer on broomsedge density. Soil pH and initial macro- and micro-nutrient levels were determined at all three locations prior to beginning the experiments. Broomsedge density is recorded at 4 geo-referenced locations within each plot prior to the application of any soil amendments. Treatments included lime (according to soil tests) or elemental sulfur (Arcadia; annual application of 100 lb S/acre), and annual applications of NPK fertilizer (10-5-10 at 500 or 0 lb/acre) and a micronutrient mix at 25 or 0 lb/A (Frit 503G). The experiment was conducted as a factorial experiment so that all treatment levels are investigated concomitantly; each location has a total of 32 100 x 100 ft plots (8 treatments with 4 replications in a randomized complete block design).

Broomsedge density is evaluated annually by counting plants in a 10-ft diameter circle around the four geo-referenced locations of each plot; this allows for the number of broomsedge plants to be tracked at the same location in each plot over several years. Soil and bahiagrass tissue samples are collected from each plot in the fall of each year.

Effect of single macronutrients on broomsedge density. Plots were established in pastures infested with broomsedge species at Ona and Lake Placid in June, 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. Plots measure 100 x 100 ft, and each treatment is replicated 4 times in a randomized complete block design. Broomsedge density was recorded prior to beginning the experiment in geo-referenced locations within each plot, and will be recorded annually prior to fertilization. Treatments will include: 1) N (50 lb N/A) ± P (based on soil and tissue testing); 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 will also be included to be able to observe any natural changes in time due to other management imposed on the pasture. Fertilizer is applied annually in the spring (March-April) of each year, but is dependent upon environmental conditions.

Bahiagrass production will be measured in both studies by placing 4 x 4 ft exclusion cages in each plot at the time of fertilization. Bahiagrass inside each of the cages will be clipped to 2 inches above the soil surface at 30 and 60 days after fertilization. Changes in bahiagrass root biomass will also be evaluated at the end of the growing season by extracting 10 4-inch soil cores and removing soil from bahiagrass roots to obtain bahiagrass root dry matter production.

Current results.

Broomsedge density. Broomsedge density was not impacted at any of the existing locations within one year after the first application of soil amendments. A reduction in bushy bluestem density was observed following 2 years of application of NPK fertilizer ($P = 0.0047$) at the Arcadia location; applications of elemental S or micronutrients had no impact on bushy bluestem density. Bushy bluestem density in 2014 was 67% of the initial density recorded in 2012 without NPK fertilizer (Table 1), but density in plots fertilized with NPK was 43% of the initial density. The effect of NPK was similar in 2015 ($P = 0.0036$) and 2016 ($P = 0.0135$) with bushy bluestem densities declining to 33 and 35% of the initial densities recorded in 2012, respectively; however bushy bluestem increased throughout the entire study and is nearly 95% of the initial densities in 2017 (Table 1). Purple bluestem density at the Ona location was not impacted by soil amendments until 2015 when the 2012 application of lime ($P = 0.0211$) resulted 50% of the initial densities recorded in 2012 (Table 2). Purple bluestem densities were affected by both lime ($P = 0.0299$) and NPK application ($P = 0.0313$) in 2016 as densities were 47 and 48% of the initial 2012 densities, respectively. Broomsedge densities appear to have increased dramatically at this location as well as an increase was observed in nearly every plot (data not shown). No soil amendment treatment resulted in a significant reduction in broomsedge density by year five; the reason for this is unknown, but plots will be recounted this fall to ensure no false measurements were recorded. As of 2017, broomsedge bluestem densities at St. Cloud have not been affected by soil amendments (data not shown). Baseline broomsedge bluestem densities at the two new locations is fairly uniform across the entire experimental area with approximately 13 plants per 20 ft^2 (data not shown).

Table 1. Impact of NPK fertilizer on bushy bluestem density at Arcadia, FL from 2012 through 2017.

NPK[1]	2014	2015	2016	2017
lb/acre	——% of initial——			
0	67 a[2]	60 a	71 a	95 a
500	43 b	33 b	35 b	93 a

[1]10-5-10 NPK fertilizer was utilized in this experiment at an application rate of 500.

Table 2. Impact of Lime and NPK fertilizer on purple bluestem density at Ona, FL from 2012 through 2017.

Treatment[1]	2015	2016	2017
	——% of initial——		
0 Lime	87 a[2]	115 a	303 a
Lime	50 b	47 b	52 a
0 NPK	-	115 a	-
NPK	-	48 b	-

[1] Lime application rate applied in 2012 was according to soil test results. 10-5-10 NPK fertilizer was applied at 500 lb/acre.
[2] Values within each column and treatment type (Lime or NPK) followed by different letters are significantly different at P<0.05.

Acknowledgements. We wish to thank our cooperators, Gene Lollis, Deseret Cattle Company, David Ward, and Turner Cattle Company 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 2017: 100%

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Increasing Soil Fertility to Manage Broomsedge in Bahiagrass Pastures, FCEB 26					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Chemical analysis – soil	Various	100%	$ 1,620.00	Costs for materials and services to perform analysis for soil P, K, Ca, MG, S, B, Zn, Mn, Fe, and Cu	9/1/2017
Chemical analysis - soil/tissue combina	Various	100%	$ 36.00	Costs for materials and services to perform analysis for soil and plant tissue concentrations of P, K, Mg, S, B, Zn, Mn, Fe, and Cu	9/1/2017
Plot prepartion	N/A	100%	$ 14,652.08	Expenses associated with plot preparation: includes but not limited to: plot markers, equipment maintenance, blades, soil sampling equipment, sample bags, and hand clippers.	9/1/2017
Materials and supplie	Various	100%	$ 5,704.92	Costs for materials to build temporary exclusion cages and for supporting cages while in the field, fertilizer and lab supplies	9/1/2017
Indirect Cost	N/A		$ 2,549.24		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 24,562.24**		

Florida Cattle Enhancement Grant

Final Project Report

September 1, 2017

UF Project agreement number: AGR00007489

FCEB project number: 28

Project Title: Effects of dietary vitamins A, D and E sources fed peri-partum on body stores of vitamins A, D, and E and performance of beef cows and calves.

Investigators: Corwin Nelson[1], Cliff Lamb[2], Nicolas DiLorenzo[2]

[1]Department of Animal Sciences, 2250 Shealy Drive, University of Florida, Gainesville, FL 32611, cdnelson@ufl.edu, office: 352-392-1958

[2]North Florida Research and Education Center, University of Florida, Marianna

Matching Funds:

As stated in the proposal, DSM Nutrition provided matching support for 50% of the direct costs of the project. The funds from DSM will be used to complete planned activities of the project which have not been completed yet.

Project objectives: Determine the effects of level and source of dietary vitamin A, D, and E fed to Florida beef cows during the peri-partum period on:

- Body stores of vitamins A, D and E in cows and calves,
- Immune status of cows and calves, and

- Reproductive status of cows.

Background:

The fat-soluble vitamins (A, D &E) each have important and unique roles in immunity, lactation, and reproductive function of cattle[1,2]. Cattle receive adequate supplies of vitamins A and E when grazing fresh, good-quality pastures, and vitamin D from sun exposure. Therefore, it is often assumed that Florida cattle receive adequate supplies of each vitamin throughout most of the year, as compared to cattle in more northern regions. However, low-quality forages that Florida cows consume during the winter months or periods of drought are poor sources of vitamins A and E. Vitamin D synthesis in the skin from sun exposure also decreases during winter months.

Our preliminary data indicated striking deficiencies of vitamins D and E in Florida beef calves born to cows fed according to typical industry standards during the winter months. The concentration of beta-carotene, the precursor to vitamin A that also has critical functions in immunity and reproduction independent of vitamin A, remains unknown. As winter forages and stored forages are low in beta-carotene compared to fresh pasture we hypothesize that Florida cows and calves also have low beta-carotene status in the winter months. We hypothesized that increased supplementation of sources of vitamins A, D and E to beef cows during late gestation and early lactation would improve fat-soluble vitamin status of the cow and calf, thereby improving the overall calf crop through decreasing still-births and incidence of disease, along with improved reproductive performance of the cow.

Approach:

Animals and treatments: Sixty cross-bred cows located at the North Florida Research and Education Center were used for the study. Cows were assigned to one of three treatments at 250 d of gestation:

- **Control:** Supplement formulated to meet average daily intake of current National Research Council requirements of vitamins A, D, and E for beef cattle. The NRC rates meet the minimal requirement for cattle but are not believed to be adequate for optimal performance.
- **Vit1:** Supplement formulated to provide average daily intake of 100,000 IU of vitamin A as retinyl-palmitate, 40,000 IU vitamin D, and 500 IU of vitamin E. These rates are similar to typical rates fed to dairy cows and have benefits for health and reproduction.
- **Vit2:** Supplement formulated to provide an average daily intake of 100,000 IU equivalents of vitamin A as β-carotene, 40,000 IU equivalents of vitamin D as 25-hydroxyvitamin D, and 1,000 IU of vitamin E. The beta-carotene and 25-hydroxyvitamin D supplements are alternative sources that may provide added benefits compared to vitamin A and vitamin D alone.

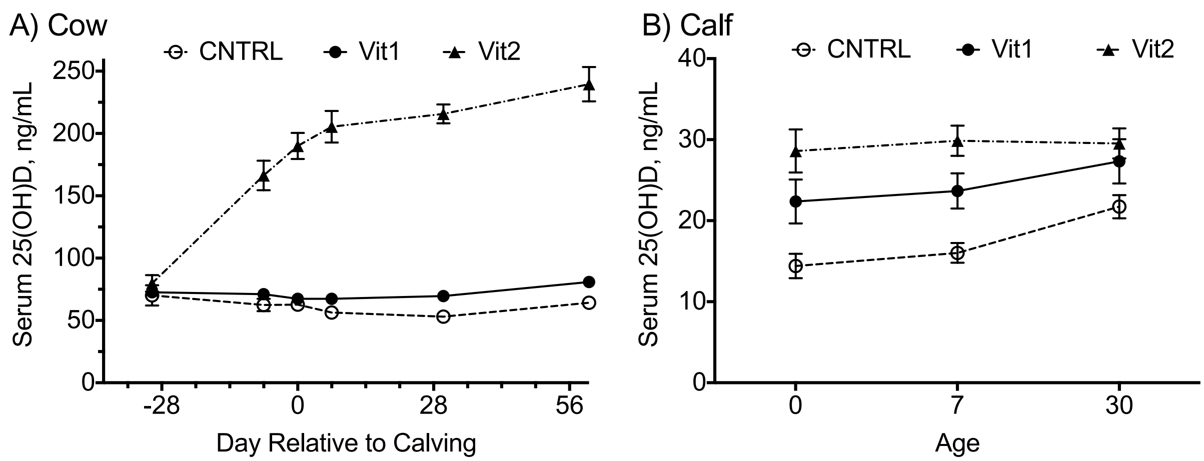
Treatments were randomly assigned to individual cows (20 cows/treatment) with cows blocked by parity. The treatments were provided 3 days per week (M, W, and F) as a top-dress and fed from 250 d of gestation to 60 days after calving.

Measurements: Blood was sampled from all cows at 0 and 21 d relative to start of treatments and 0, 7 30 and 60 d relative to calving. Blood was sampled from calves at birth, 7 and 30 d of age. Body weights also will be collected at time of blood sample collection. Colostrum was sampled from all cows at time of calving. Liver biopsies were performed on 6 cows/treatment at -30 d, -7 d, and 30 d relative to calving and 5 calves per treatment at 7 d and 30 d of age.

Concentrations of 25-hydroxyvitamin D in serum samples of cows and calves were measured as an indicator of vitamin D status. Concentrations of retinol in liver and α-tocopherol in serum will be measured as indicators of vitamin A and vitamin E status. Immune status of cows and calves was assessed by neutrophil oxidative burst capacity and blood leukocyte profiling of CD11b, CD14, CD21, and CD62L protein abundance by flow cytometry. Concentrations of IgG1, IgG2, and IgA in serum of cows and calves and colostrum samples also will be measured as an indicator of immune status. The time to return of estrus in cows will be measured as an indicator of reproductive health of cows by measuring concentrations of progesterone and estrogen in serum sampled weekly from 30 to 72 d post partum.

Current results:

Analysis of the effects of the vitamin treatments on concentrations of 25-hydroxyvitamin D in serum of cows and calves has been completed (Figure 1). Cows fed Vit1 and Vit2 treatments, along with calves born to those cows, had elevated concentrations of 25-hydroxyvitamin D in serum compared with Control cows and calves. Notably, the average serum 25-hydroxyvitamin D concentrations of Control calves was below the 20 ng/mL target threshold for cattle, confirming previous data that current winter vitamin nutrition practices for beef cows in Florida are not adequate.



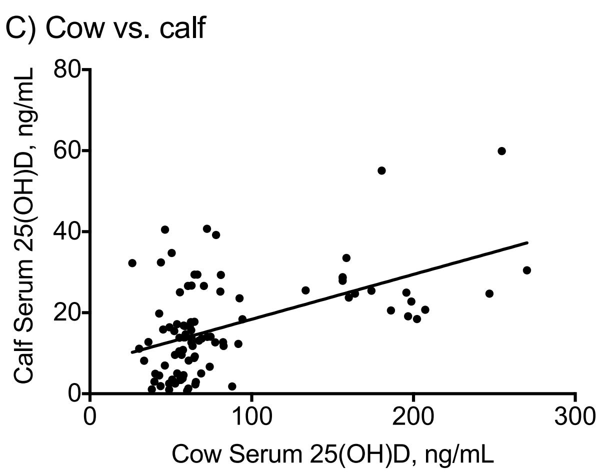


Figure 1. Pregnant beef cows at North Florida research unit were supplemented 3 times a week to provide a daily equivalent of: control (standard brood cow mineral supplement); mineral + 100,000 IU vitamin A, 40,000 IU vitamin D3, and 500 IU vitamin E (VIT1); or mineral plus 100,000 IU equivalents of vitamin A as beta carotene, 1 mg HyD, and 1,000 IU of vitamin E (VIT2). Treatments were provided approximately 30 prepartum to 60 d post partum (Dec. to March). Data represent mean serum 25(OH)D concentrations of cows (**A**) and their calves (**B**), n = 17-20/group. **C**) Serum 25(OH)D of calves was at birth was significantly correlated with that of their dams, $P < 0.05$.

Supplementation of cows with an equivalent of 40,000 IU of vitamin D_3 per day (provided in Vit1 treatment) improved vitamin D status of calves, and is an affordable (less than a tenth of a penny per day) to achieve adequate vitamin D status of cows and newborn calves in the winter months. Supplementation of cows with 1 mg 25-hydroxyvitamin D_3 per day dramatically increased concentrations of 25-hydroxyvitamin

D_3 in cows over the peri-parturient period, which has been shown to have positive benefits for health and production of dairy cows. The effects of treatments on vitamin A and vitamin E status of cows and calves will be completed using matching funds from DSM Nutrition.

The effects of treatments on blood leukocyte profiles has been completed. We did not observe effects of treatments on percentages of lymphocytes, monocytes, or neutrophils in cows, but we did observe that calves fed the Vit1 and Vit2 treatments had elevated proportions of cells that expressed the CD14 protein, a protein critical for detection of bacterial pathogens (Figure 2). In contrast, expression of CD62L, an adhesion protein, was decreased on monocytes and increased on T cells and B cells. Overall the data indicate potential improvement for recruitment of T cells and B cells to sites of infection, and potential improvement in ability of immune cells to recognize bacterial pathogens. The effects of treatments on calf serum IgG concentrations, and cow reproductive health (return to cyclicity and pregnancy rate) are still under investigation.

In conclusion, the current results support the approach of increasing dietary vitamin D supplementation of Florida beef cows during gestation in winter months from the current practice of 4,000 IU/d to 40,000 IU/d for the purpose of achieving adequate vitamin D status in their calves. Overall, the practice of increasing vitamins A, D and E in winter mineral supplements for gestating beef cows modulates immune status of their calves. Continued research with a sufficient number of cows is warranted to determine the effects of increasing supplemental vitamins A, D, and E in cow mineral supplements on health and performance of beef calves born in the winter.

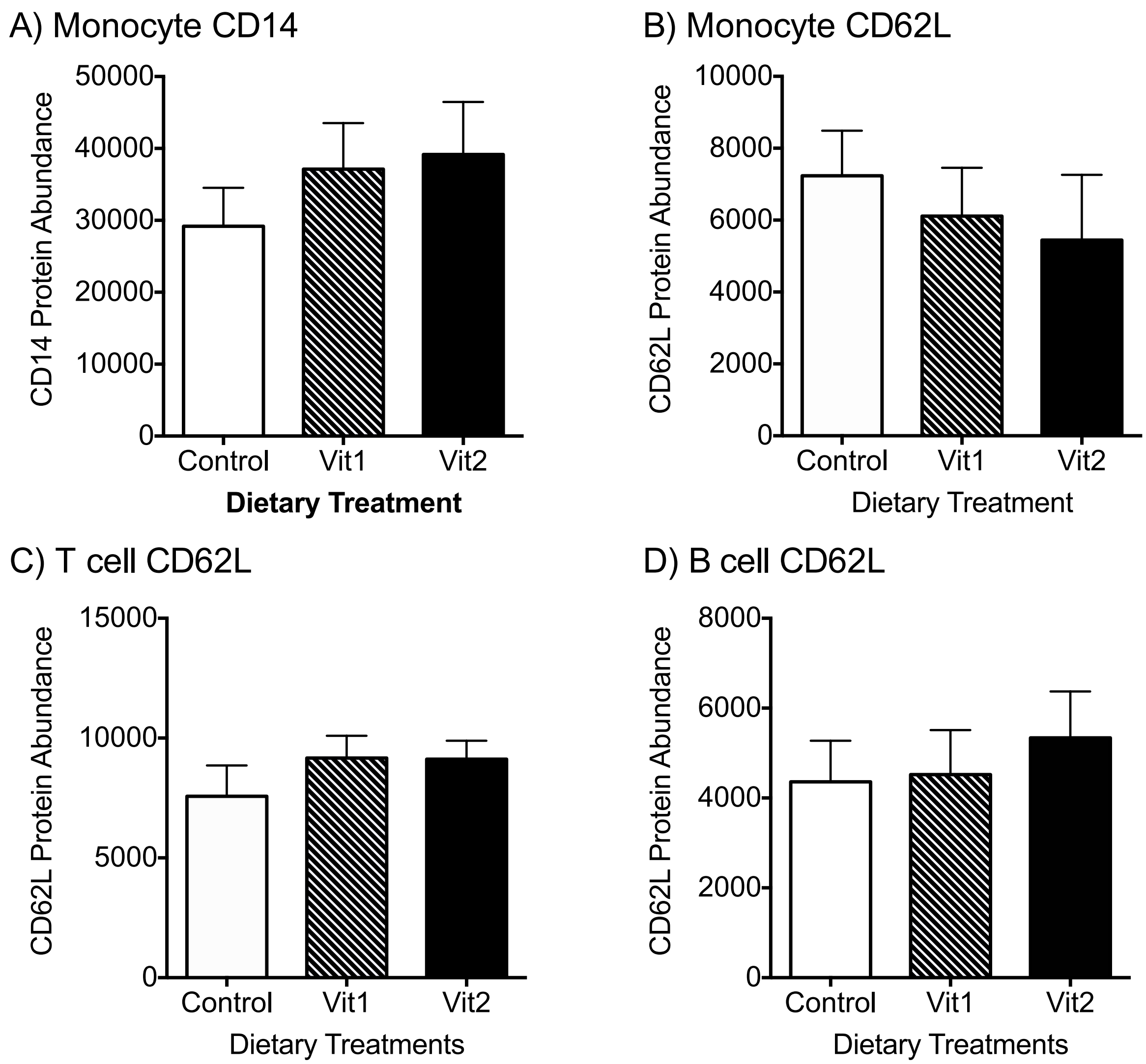


Figure 2. Data represent mean ± 95% CI expression of CD14 protein on monocytes (A) and CD62L protein on monocytes (B), T cells (C), and B cells (D) sampled from blood of 7 d old calves born to cows fed the Control, Vit1, or Vit2 treatments.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION			
PROJECT TITLE: Chemically treating forages with alkali may improve digestibility and enhance beef cattle performance - Project # P0038505 (FCEB# 29)			
DETAILED LINE ITEM DESCRIPTION	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Animal per diem	$ 6,900.00	Use of experimental cows and calves reagents for analyses	6/1/2027
Vitamin assays	$ 5,068.00	Measurement of vitamins in serum	8/1/2017
Immune assays	$ 10,077.00	Measurement of immune status indicators	9/1/2017
Progesterone and Estrogen assays	$ 4,500.00	Measurement of reproductive status of cows	9/1/2017
Materials and Supplies	$ 1,591.00	Laboratory supplies needed to perform the project	9/1/2017
Project Support and Tuition	$ 20,210.41	Support to perform the project	9/1/2017
Indirect Cost	$ 5,656.43		N/A
GRAND TOTAL: (equal to percentage of completion)	**$ 54,002.84**		

FINAL REPORT – Project # P0038505 (FCEB # 29)

Title: Chemically treating forages with alkali may improve digestibility and enhance beef cattle performance

Principal investigator

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Chris Prevatt, MS. – RCREC, Ona, FL

Significance to the Florida Cattle Industry

Improvements of 23% in the DM digestibility of bahiagrass hay in situ were observed in a pilot study conducted in our laboratory when treating bahiagrass hay with CaO. While this approach has never been attempted on a larger scale, if we obtain a 10% improvement in digestibility (very conservative estimate considering our preliminary data) with chemical treatment of hay, this represents a savings of 117,000 tons of forage for the Florida beef cattle industry because of an improved utilization of currently available feed. This was calculated assuming approximately 1 million cows in FL consuming 26 lb of hay/d for 90 d/yr (winter). This translates into savings of $9.36 million annually in feed costs in Florida only. On a producer-based scale, a 100-cow producer may save $3,105 on a 90-day hay feeding season only, due to improved digestibility of hay and/or decreased amount of hay needed to buy or produce (see Page 2 of this proposal for more details about the calculations used for this estimate).

Objective

To determine the effects of chemically treating forages with alkali on digestibility, beef cattle growth, and economics of winter feeding programs.

Materials and Methods

Two studies were designed to determine the effects of adding calcium oxide on nutrient digestibility and beef cattle performance.

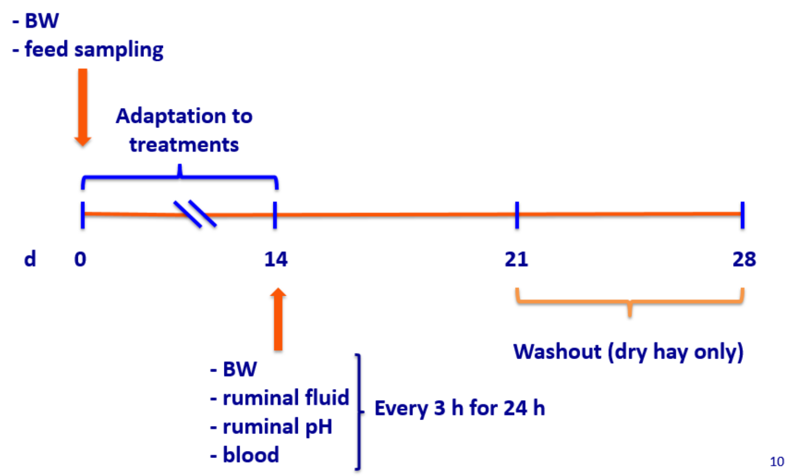
Experiment 1: Total tract digestibility of nutrients and ruminal metabolism of beef cattle consuming alkali treated bahiagrass hay.

Nine ruminally cannulated steers were used in a triplicated 3 × 3 Latin square design conducted at the UF-NFREC in Marianna. Each experimental period consisted of 14 d adaptation, 7 d collection and 7 d of washout, where steers were consuming untreated hay. The treatments wer as follows:

1) Untreated dry bahiagrass hay (D)
2) Bahiagrass hay treated with 8.9% $CaCO_3$ (DM basis) + water (to 50% moisture) (CC)
3) Bahiagrass hay treated with 5% CaO (DM basis) + water (to 50% moisture) (CO)

All steers were fed ad libitum. Both treatments 2 and 3 were formulated to contain the same amount of Ca and were incubated with their respective Ca source for 7 to 14 d before feeding. Having the same amount of Ca in each treatment eliminates any potential effect of additional Ca in the metabolic response variables. While CaO will react with the moisture to form calcium hydroxide ($Ca(OH)_2$), limestone ($CaCO_3$) should not react with water, thus no effect on forage quality was expected. Total tract digestibility of nutrients was measured by collecting feed and feces for 4 consecutive d (twice daily) and using indigestible NDF as an internal digestibility marker. On d 15 of the experimental period, ruminal fluid and blood was collected for 24 h every 3 h to measure ruminal pH, VFA and NH_3-N concentrations, and blood parameters such as blood urea nitrogen and glucose. This experiment was designed to test any potential metabolic responses from steers consuming hay treated with quicklime or limestone.

Fig. 1. Schematic of sampling schedule for Exp. 1.



Experiment 2. Effect of alkali treatment of bahiagrass on growing animal performance and economics

A total of 72 crossbred yearling heifers were used in a generalized randomized block design. Treatments will be similar as described in Experiment 2, with the exception that haylage was used instead of hay plus additional water, to mimic field conditions by using commercially produced and wrapped haylage with the addition of either CaO or $CaCO_3$. Heifers (8/pen, 3 pens/treatment) were housed at the NFREC Feed Efficiency Facility where feed intake was continuously monitored. Heifers were fed the bahiagrass hay treatments ad libitum for 70 d, and growth performance was measured as feed efficiency (RFI and feed-to-gain), ADG and initial and final

BW. A shrunk weight (16 h withdrawal from feed and water) was obtained on d 0 and d 70, and unshrunk weights were obtained every 14 d.

Results

As observed in Fig. 2, treating hay with either calcium carbonate or calcium oxide after increasing the moisture to 50%, did not affect dry matter intake (DMI) when compared to dry bahiagrass hay. The bahiagrass hay used in this study had a CP concentration of 8% and a TDN of 53%, and steers had an average BW of 1,089 lb.

Fig. 2. Intake of DM by steers fed either dry hay (DH), hay treated with calcium carbonate (CC) or hay treated with calcium oxide (CO) in Exp. 1.

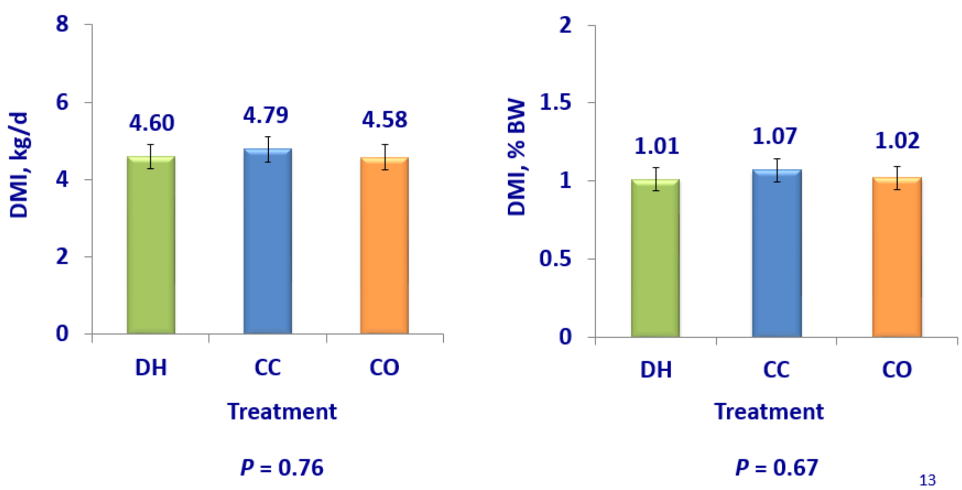
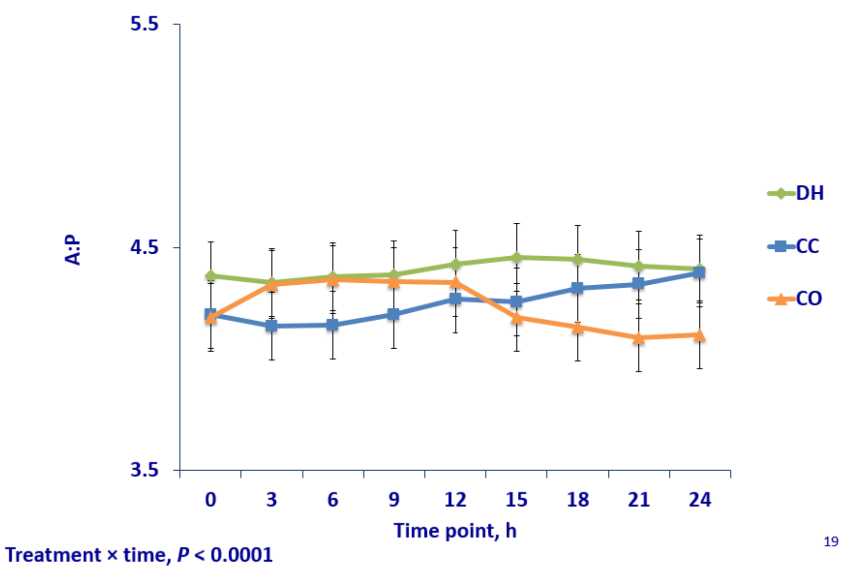


Table 1. Effects of feeding dry hay (DH), or hay treated with calcium carbonate (CC) or calcium oxide (CO) on ruminal fermentation.

Item	Treatment			SED	*P*-value		
	DH	CC	CO		TRT	TIME	TRT × TIME
Total VFA, m*M*	61.2^{b}	61.7^{b}	53.5^{a}	2.75	0.021	< 0.001	0.401
VFA, mol/100 mol							
Acetate	74.1	74.4	74.5	0.64	0.800	0.337	< 0.001
Propionate	16.9	17.6	17.9	0.68	0.376	0.105	< 0.001
Butyrate	7.7^{b}	6.8^{a}	6.6^{a}	0.26	0.002	< 0.001	0.143
BCVFA	0.7	0.7	0.6	0.09	0.450	< 0.001	0.074
A:P	4.4	4.3	4.2	0.17	0.643	0.073	< 0.001

Figure 3. Effect of feeding dry hay (DH), or hay treated with calcium carbonate (CC) or calcium oxide (CO) on ruminal fermentation on acetate-to-propionate ratio (A:P).



Conclusions: Bahiagrass hay treated with 5% CaO after increasing the moisture to 50% may reduce ruminal fermentation as indicated by decreased total VFA concentration without altering DMI. Although a potential benefit may be expected from decreased acetate:propionate ratio when hay is treated with calcium oxide in terms of growth performance, the decrease in total volatile fatty acid (VFA) may offset this benefit. Additionally, treating bahiagrass hay with calcium carbonate did not provide any benefits relative to feeding dry hay.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Chemically treating forages with alkali may improve digestibility and enhance beef cattle performance - Project # P0038505 (FCEB# 29)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and supplies to complete Experiments 1 and 2	27	100%	$ 1,960.00	Calcium oxide, limestone, bags, crucibles, tubes, needles, reagents for analyses	9/1/2017
Nutrient digestibility analyses for Exp. 1 and 2	27	100%	$ 14,740.00	Laboratory and data analyses of feed and feces to determine nutrient content and digestibilty marker concentration. Anlaysis of data and final report.	9/1/2017
Feed sample analyses for Exp. 1 and 2	18	100%	$ 630.00	Feed samples collected during the experiment and analyzed	9/1/2017
Blood and ruminal sample analyses for Exp. 1	81%	100%	$ 10,250.14	Glucose , VFA , NH3-N , BUN analyses for 81 samples in Exp. 1 (9 steers, 9 samples/steer). Statistical analysis of data and final report.	9/1/2017
Research Animals (per diem) for Exp. 1	9%	100%	$ 6,696.00	Cannulated steers for metabolism experiment housed at the Feed Efficiency Facility	9/1/2017
Research Animals (per diem) for Exp. 2	72	100%	$ 6,212.06	Growing steers group-penned and housed at the NFREC Feed Efficiency Facility	9/1/2017
Indirect Cost			$ 4,840.55		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 45,328.75**		

FCEB 32

PI: Geoff Dahl

Final Report for 2017 to Florida Cattle Enhancement Board on Brahman Herd Expansion Project at UF (UF Project P0038415); 1 September 2017

Bos Indicus genetics are a critical component of Florida cattle production and that importance extends through out the southeastern US. Resilience to heat and humidity, parasite resistance and other factors are improved with Brahman influenced crosses vs. Bos taurus animals. While the absolute percentage of Bos indicus genetics within a commercial herd will vary in Florida, almost all producers use some level of Brahman or other Bos indicus blood to generate the terminal animal of highest productivity in our environment. Despite these advantages, purebred Brahman, have some disadvantages especially in the area of carcass quality and reproductive performance when compared with Bos taurus cattle. While some progress has been made in identifying animals that express desirable genetics for carcass and reproductive performance, much more work is needed to advance this field. That advance, however, requires a larger herd of animals to use in identifying and testing genes of interest.

The unique opportunity for developing the herd of Brahman cattle has been recognized by the FCA and Brahman producers in Florida since before the closure of the USDA-ARS facility at Brooksville. Indeed, the nucleus of our herd is from the herd that was liquidated as Brooksville closed. Most recently, the FCA passed a resolution on September 8, 2016, that:

> *"The Florida Cattlemen's Association recommends that the department of Animal Sciences at the University of Florida move forward with the Bos Indicus improvement initiative. The directive is to develop selection tools for the industry in order to improve the Brahman breed with a focus on carcass quality and fertility"*

The aim of this project is to rapidly expand the Brahman herd at the University of Florida to provide a resource for studies related to improving carcass and reproductive selection. Expansion of this herd, along with collaboration with Brahman producers in Florida and elsewhere, will allow for meaningful studies related to genetic selection for improved carcass quality and reproductive performance. The first step in the project was to establish an advisory committee of Florida Brahman breeders to provide input on mating selections and general approaches for the herd expansion. That committee coordinated by Jerry Wasdin and chaired by Henry Kempfer, has met twice face-to-face since April, 2017, and had numerous phone discussions regarding the breeding program for herd expansion.

While carrying capacity at the Gainesville units is limited, we project that we can expand the herd to ~250 mature Brahman cows by internal expansion and replacement of the current herd of Angus-Brangus animals at Santa Fe/Boston farm. To accelerate the expansion we initially used some of our top Brahman females to produce embryos that we could transfer to our Angus/Brangus cows and heifers. The last update on the UF Brahman herd IVF project was on April 24, 2017. As previously reported, the first round of IVF in March resulted in 4 early pregnant recipients as diagnosed on April 24, 2017.

Since that time, in our second round of IVF, on May 14 and 15 we performed oocyte pickup (OPU) on 16 cows from our UF registered Brahman herd. 185 oocytes were collected and taken to Dr. Hansen's lab for fertilization. Due to an accident in the lab, only 45 viable embryos were formed and implanted into our recipients on May 23. This resulted in 18 early pregnancies diagnosed on June 20.

Because we had such low numbers after the first two rounds, we decided to purchase frozen embryos to attempt a third round for the Spring 2017 breeding season. 45 sexed female embryos were located and purchased from Southern Cattle Co. These were put into our recipients on June 20. They were pregnancy checked on 7-20 and resulted in 25 early pregnancies (~90% female). In summary, from the IVF program we produced 47 early pregnancies, some of which we expect not to go to term. We feel we'll get around 40 live calves out of the Spring 2017 embryo work, and many of those will be heifers. With the additional funding provided to our project in July of 2017, we have produced additional embryos to be placed in December of 2017 and Spring of 2018. We currently have 147 frozen sexed female embryos produced in Texas. These embryos have use production-based donor cows from a Texas ranch (Kallion Farms) with a combination of AI sires being used in our UF program from various producers in Florida and out of state.

Also, from our breeding program at the Beef Research Unit, we have pregnancy tested the Brahman herd with the following results: Through AI and natural service, we have 62 pregnant mature cows (94 %), 15 pregnant 2 yr. old heifers (100%), and 11 pregnant yearling heifers (44%). Of these we will need to cull approximately 5 cows and heifers for disposition or other serious production problems, but should still have around 83 pregnant females for the 2018 Spring calving season.

Overall, there are approximately 47 IVF pregnancies (several sexed, female), and 88 natural and AI pregnancies produced to make registered Brahman calves. Taking into account necessary culling and expected embryonic loss, we are projecting around 123 purebred calves born in 2018, with a good supply of frozen embryos in store for the 2018 breeding season (and late 2017). We will also be attempting to make more fresh IVF embryos from our own donors in 2018, and have more experience and knowledge gained this year which should help us have better results next year.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION				
PROJECT TITLE: 32 Expanding the UF Brahman Herd				
DETAILED LINE ITEM DESCRIPTION	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and Supplies	100%	$ 31,324.92	Purchase of materials and supplies for reproductive procedures and care and handling of the Brahman cowherd	9/1/2017
Embryo Production and Transfer	100%	$ 94,615.26	Expenses associated with the production and transfer of embryos	9/1/2017
Final Research Project Report			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Indirect Cost		$ 15,065.31		N/A
GRAND TOTAL: (equal to percentage of completion)		**$ 141,005.49**		

Florida Cattle Enhancement Fund
Final Report
September 1, 2017

Relating Growth to Beef Tenderness and Thermotolerance of Brahman steers

Investigators: Tracy Scheffler, Chad Carr, and Jason Scheffler
Department of Animal Sciences, University of Florida; Gainesville, FL 32611
Award ID: FCEB 34, AWD01717

Background and Specific aims

Properties related to muscle function and metabolism in the live animal influence development of meat quality attributes. Specifically, the calpain-calpastatin system influences muscle growth and protein turnover in the live animal, and it is also the major system governing tenderization of beef. Bos indicus cattle possess elevated calpastatin content in muscle, which diminishes protein degradation and results in tougher beef. Several genetic markers for calpain and calpastatin have been identified and validated for selection, but variation in tenderness remains a problem in Brahman cattle. Although increased calpastatin is a well-documented phenomenon, the regulation of its content in muscle and its physiological significance to thermotolerance in Brahman cattle is poorly understood. Therefore, *our goal* is to better understand the relationships between growth, the calpain-calpastatin system, tenderness, and heat tolerance, in order to *improve beef quality and enhance value of Bos indicus cattle.*

Our objectives are to

- determine if we can generate differences in calpastatin content and tenderness by selecting Brahman steers with different growth rates
- assess the relationship between growth, calpastatin content, and thermotolerance by subjecting steers to heat stress.

Completion of these objectives will improve our understanding of the relationship between growth, tenderness, and heat tolerance in Brahman steers by

- Determining contribution of protein degradation to differences in growth rate
- Relating animal and muscle growth to beef tenderness
- Defining if growth rate or calpastatin content impacts heat tolerance

Understanding the relationships between growth, tenderness, and heat tolerance may lead to management and selection strategies that can enhance postmortem tenderization, without sacrificing thermoregulatory capacity of Bos indicus breeds.

Approach

Animals. Purebred Brahman steers for this study were selected from the University of Florida herd. Calves were born between mid-December 2015 and early March 2016, and weaned from their dams in August. A corrected 205 day weight was calculated; approximately 60 days later, calves were reweighed and allocated to the “high” or “low” growth group based on the weight difference from the 205 day corrected wt and the 60 day subsequent actual wt. In order to maintain similar genetic background, high and low growth steers were paired by sire. In April 2017, steers (n = 6 pair) were moved from Beef Research Unit to the Beef Teaching Unit (BTU) to acclimate steers to handling. Subsequently, two pairs were eliminated for poor temperament. In late May, steers were transported to environmental rooms at the UF Animal Science (ANS) building for the heat challenge portion of the experiment.

Environmental rooms and heat challenge. Steers were housed in individual pens (26.5 ft^2) in temperature-controlled chambers in two mirrored rooms, with 4 pens per room. Two high and low growth steers (two pairs) were represented in each room. Steers were given 19 d for acclimation at thermoneutral temperatures (average ~80°F; 80% relative humidity, RH) prior to treatment. The experiment was initiated on d 0; wall mounted heaters were used to increase room temperature (average ~95°F, 55-60% RH). Steers were subjected to high environmental temperatures for 16d. Room temperature and relative humidity were logged every 5 min using HOBO data logging devices (Onset Computer Corporation; Bourne, MA; Fig. 1). At the conclusion of the heat challenge period, steers remained at the ANS building for 3 d (d 17-19; ~83°F, 80% RH) for post-treatment data collection. Subsequently, steers were returned to the UF Beef Teaching Unit for the finishing phase.

Management. Throughout the study, cattle were provided water ad libitum via individual water bowls with paddles; water flow meters recorded the running total of water consumption for each bowl. Daily water intake was calculated based on the change in water flow between values recorded at 0830 on consecutive days. Bermudagrass hay was provided ad libitum. Commercial feed was offered at 1.2% body weight per day in two feedings (0830 and 1700 daily) and top dressed with mineral supplement as directed; any feed remaining at the following feeding was weighed.

Sample collection. Respiration rate and rectal temperature were measured three times daily (0800, 1200, and 1700). Respiration rate was determined by counting flank movement over a 30 s interval and converting to breaths/min. Rectal temperature was assessed using a digital thermometer with probe inserted approximately 4 inches into the rectum (Ag Medix AG-102 thermometer; accuracy ±0.1°F). Temperature was also measured using calibrated data loggers (thermocrons or I buttons; Embedded Data Systems; Lawrenceburg, KY) positioned on the tail vein, approximately 3 inches from the anus; loggers recorded temperature every 10 min.

Muscle biopsies. In order to evaluate changes in muscle proteins related to heat challenge, muscle biopsies from the loin (*longissimus*) were obtained on d 0, immediately prior to initiation of heat challenge; and on d 16 at conclusion of heat challenge period. Blood was also collected at d 0 and d 16.

Results

Animal performance. In order to establish low and high growth groups, steers were separated based on post-weaning growth performance. Thus, the low and high growth groups exhibit differences ($P < 0.05$; Table 1) in weight at weaning and 73 d after weaning (10/20/16). These differences have continued throughout the study. However, post-heat challenge rate of gain is not different between the groups.

Temperature and Respiration. Temperature and respiration rate were monitored for 5d prior to initiation of heat challenge to establish baseline values. Compared to baseline, average daily rectal temperature was elevated ($P < 0.05$) on days 0, 2 to 7, 10, 11, and 13 to 16 during the heat challenge period. Temperature tended ($P = 0.06$) to be greater than control on d 8. From d 0 to 8, average temperature was approximately 0.5°F greater than baseline, and from d 9 to 16, average temperature was more variable but roughly 1.0°F higher than before the heat challenge. Therefore, prolonged exposure to elevated environmental temperatures caused a significant increase in rectal temperature, supporting that heat loss mechanisms of growing Brahman steers were unable to fully compensate for increased heat load. Temperature was also evaluated after exposure to high environmental temperature; rectal temperatures on d 17 differed from baseline ($P < 0.05$), and curiously, were numerically lower than the during the acclimation period. Similarly, respiration rate differed from baseline on days 1 through 16 of the heat stress period. Exposure to elevated environmental temperatures resulted in respiration rate increasing more than two-fold.

Feed and water intake. Intake of commercial feed in the heat challenge period was not different than baseline. Consumption of hay could not be accurately determined, but appeared to decline during heat challenge. As expected, water intake increased during the heat challenge period. Steers consumed approximately 50% more water during heat challenge than during the baseline period.

Table 1. Weight (lbs) of steers selected for low and high growth groups.[1]

	Weight (lbs)			
Date	Low	High	SE	*P*-value
8/8/16	435.0	522.5	21.1	0.03
10/20/16	531.3	667.5	28.4	0.01
6/13/17	783.8	882.5	16.8	0.004
6/29/17	810.0	893.8	20.1	0.03
8/21/17	947.5	1022.5	17.8	0.02

[1]Steers were weaned on 8/8/16 and selection for high and low growth groups was made on 10/20/16. Heat challenge was initiated on 6/13/17 and concluded on 6/29/17.

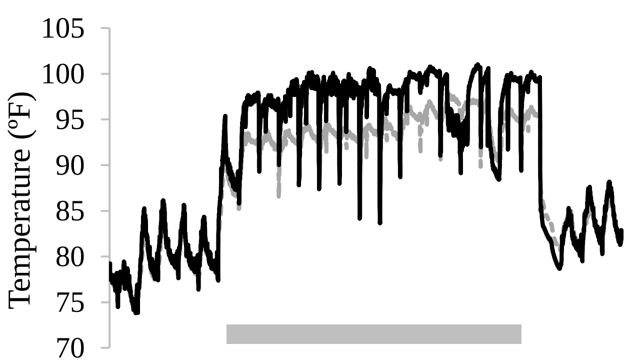


Figure 1. Temperature in environmental rooms (black and gray lines) throughout the experimental period. The gray bar represents the heat challenge period.

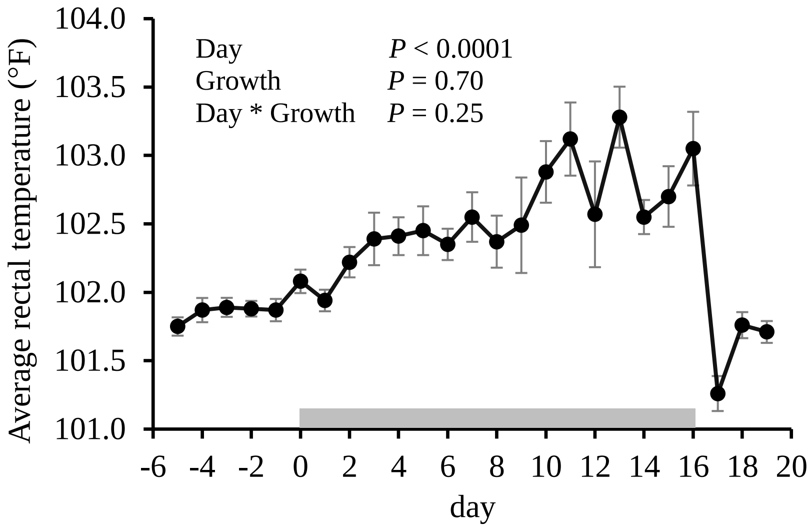


Figure 2. Average rectal temperature of steers throughout the experimental period. The gray bar represents the heat challenge period.

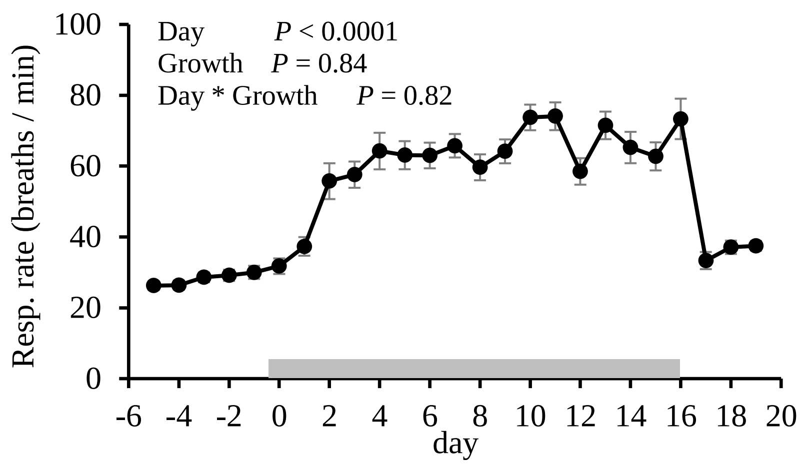


Figure 3. Average rectal temperature of steers throughout the experimental period. The gray bar represents the heat challenge period.

Current status and next steps

Steers are currently at the UF BTU and are being fed a standard corn-protein finishing diet. Weights range from 900-1050 lb (8/21/17). Steers are targeted for slaughter at 0.4 inches subcutaneous fat. Based on weights and rate of gain, anticipated slaughter date has been rescheduled for January 2018. Additional loin samples will be collected at harvest (within 1h after slaughter), and at 8h, 24h and 14d postmortem. This information will be used to establish relationships between growth performance, calpastatin, heat tolerance, and tenderness.

A replication of this experiment is planned for spring 2018. Purebred Brahman steers were recently weaned, and post-weaning growth will be assessed in roughly two months.

Budget for Florida Cattlement Enhancement Fund
Project: FCEB 34
Relating Growth to Beef Tenderness and Thermotolerance of Brahman steers

Detailed line item description	**Qty**	**Unit price**	**Total**	**Explanation/Justification**	**Completion date**
Animals - lost value	4	$1,250	$5,000.00	Opportunity cost; potential lost revenue due to castration of higher quality bulls	9/1/2017
Animal care	various	various	$22,765.00	Costs for materials for animal transportation, care, handling, feeding during trial; costs for personnel to oversee study (graduate student) and personnel to acclimate animals to handling, feed and monitor animals and clean rooms	9/1/2017
Animal feed	various	various	$2,815.00	Pasture per diem and feed during study	9/1/2017
Animal experiment - sample collection	various	various	$5,035.00	Costs for monitoring facility and animal temperature, includes i-buttons and data loggers; muscle biopsy equipment & services; slaughter fees & product devaluation	9/1/2017
Laboratory analyses	various	various	$32,515.00	Costs for materials and supplies for processing muscle samples, histology, Western blot, & tenderness analyses; equipment for sample processing (centrifuge); and personnel to conduct analyses	9/1/2017
Materials & supplies	various	various	$760.00	Heaters for environmental rooms, scale	9/1/2017
Final report					9/1/2017
Grand total			**$68,890.00**		

Title: Development of a Diagnostic Test for Ovarian Follicular Dysplasia (OFD)
Principal Investigator: Tim D. Braden, Auburn University
Date: Sept 1, 2017

This is the final research report from the above work. Although funding and duration of work was planned for 12 months, due to delays from the funding source, this time-frame was compressed to 4 months.

Summary of Findings

The overall goal of this research is to characterize and develop a diagnostic test for OFD, as well as disseminate our findings. To this end, a variety of samples were collected this year in order to identify differences between affected and unaffected cows. Collection of ovarian tissue (post-mortem) confirmed differences found previously in the population of ovarian follicles between affected and unaffected cows. The sizes of these follicles are too small to be detected with in vivo ultrasound procedures, but mineralization was found to be prominent in affected cows. Ultrasound testing from this year suggests that OFD at levels 2, 3 and 4 may be identifiable (see below).

Analysis of metals from liver samples, collected post-mortem, revealed some dramatic differences between affected and unaffected cows. Levels of sodium, cadmium, copper, and barium appear to have potential for diagnostic value in identifying affected and unaffected cows. While there is a correlation between these liver metal concentrations and OFD, it is unknown if this is a cause or an effect of OFD.

DNA has been collected from several tissues (blood, ovary, uterus, cheek, vagina) as well as body fluids (blood, saliva) of affected and unaffected cows. Preparation of those samples for genomic and endocrine analyses has not been completed, but materials have been secured for this purpose. Due to the delay in securing funding, these samples have not yet undergone genomic analyses, and funds for this portion of the project were not encumbered.

Dissemination of our results have been provided to owners of the animals used in these studies. Moreover, six presentations of our results have been made at local, national, and international meetings attended of professionals in the animal industries affected by this disorder. A draft manuscript, to be submitted to an international pathology journal, has been prepared.

An estimate of categorized expenditures (direct costs only) is attached to the end of this document.

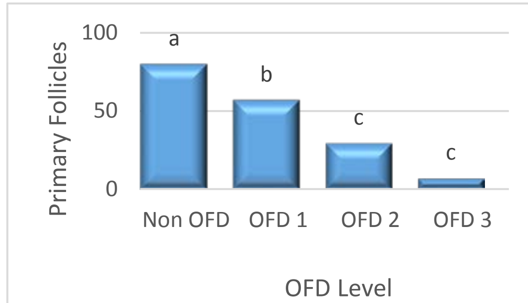
Detailed Results

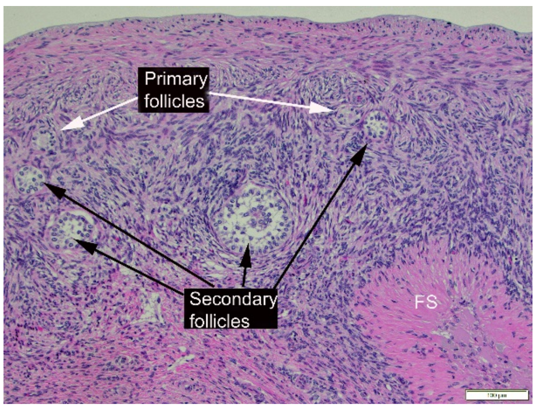
We sampled cattle from 2 ranches in Florida. A third was scheduled, but due to the delay in funding, we were unable to reschedule sampling from this ranch. For these ranches, we obtained samples from cows and heifer including: blood samples, saliva samples, cheek swabs, vaginal swabs, and ultrasound of the reproductive tract. Thirty cows and heifers were followed to slaughter, and tissues were collected (ovaries, uterine biopsy, liver biopsy, etc). Histological analysis of the ovarian tissues indicated that OFD was diagnosed in 10/15 (66.7%) and 14/15 (93%) in the first and second ranches respectively.

Ovarian Characteristics

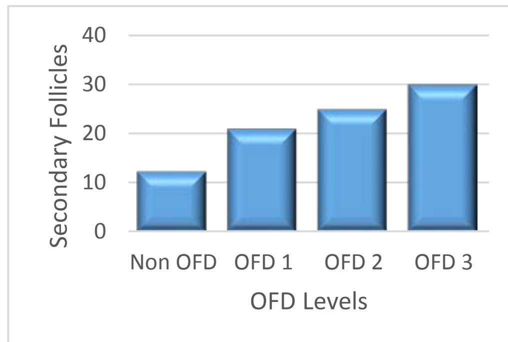
Data from analysis of ovaries identified the following characteristics based on the severity of the OFD diagnosis:

Primary follicles are ovarian follicles that have just begun to grow. They can only be identified by microscopic evaluation of the ovaries. These data indicate that as the severity of OFD increases, the number of these small ovarian follicles is decreased. For this and all following graphs, bars with different letters are statistically significantly different.

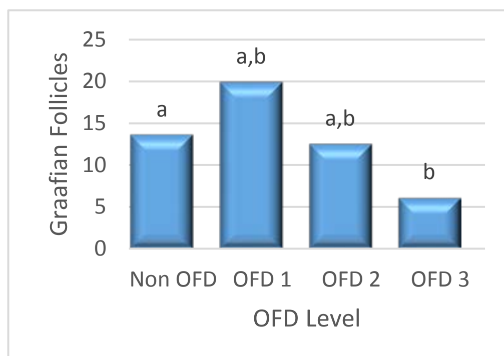




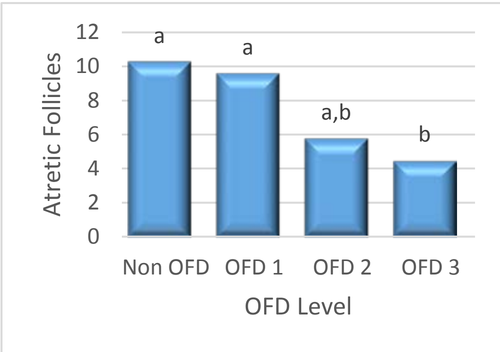
Secondary follicles are ovarian follicles that are in the early phases of growth. They can only be identified by microscopic evaluation of the ovaries. There data, while not showing statistically significant differences, indicate a trend accumulation in OFD affected cows. An accumulation of this size of ovarian follicles, and them not progressing, would lead to decreased and/or lack of fertility.

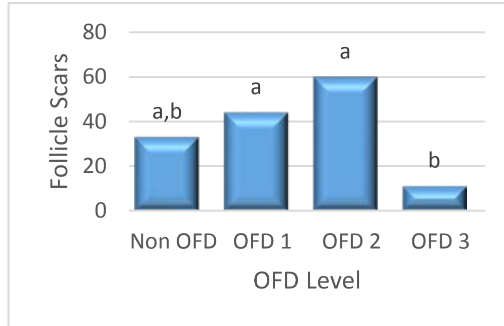


Graafian follicles are ovarian follicles which have accumulated a fluid filled compartment, and are in the final stages of development. These follicles can be seen with the naked eye, and many can be detected by ultrasound evaluation of the ovary in vivo. In severe cases of OFD, the number of the maturing follicles is decreased which would impair fertility.

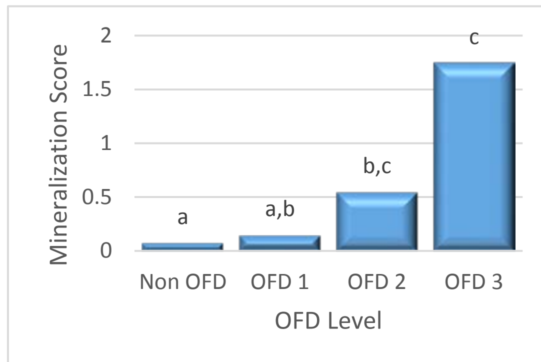


Atretic follicles are ovarian follicles which are not viable, and have begun to deteriorate. With severe cases of OFD, the number of atretic follicles is decreased. This decrease is likely due to the lack of follicles maturing appropriately, therefore, the pool of deteriorating follicles is also decreased.





Follicle scars are the remnants of ovarian follicles that have undergone atresia (deterioration). In this study, the number of follicle scars was reduced in the most severe cases of OFD. This is likely due to the lack of follicles undergoing the maturation process, therefore, there is a reduced pool of follicles that will undergo atresia.

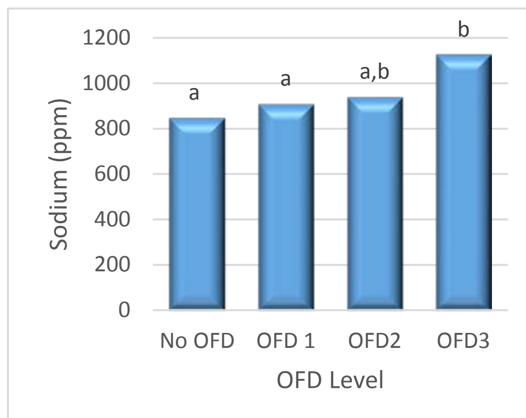


The ovaries were scored on their level of mineralization after removal from the animal. As we have identified previously, the mineralization of ovaries is increase with increasing severity of OFD.

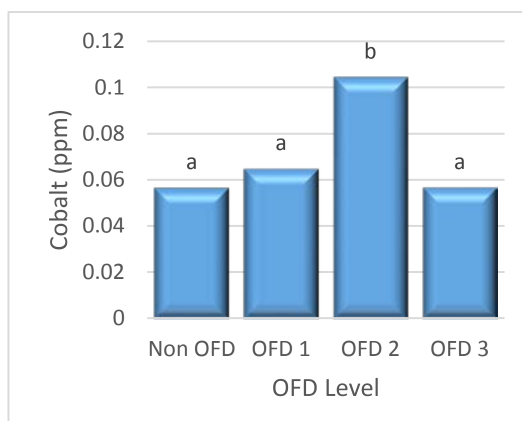
Additional ovarian characteristics are presented in the Appendix. These were characteristics not found to be affected by OFD and/or are similar to those identified above

<u>Metal Analyses</u>

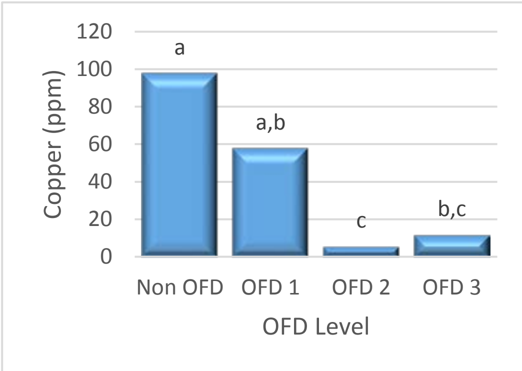
Liver samples from cows and heifers were analyzed for a number of metals. Significant findings are identified below. Bars with different letters are statistically different in the following graphs.



Levels of sodium were related to the severity of OFD with more severe cases exhibiting higher levels of sodium in the liver.

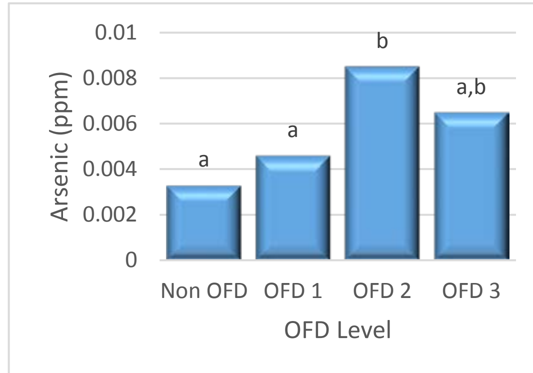


Levels of cobalt were dependent upon the severity of the OFD diagnosis with OFD level 2 exhibiting the highest cobalt in the liver.

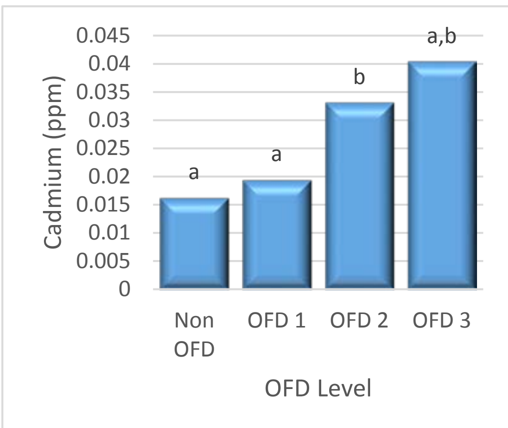


The levels of copper in the liver were related to the severity of the OFD with OFD levels of 2 and 3 having the lowest quantities compared to no OFD and slight severity.

The liver levels of arsenic were also associated with severity of OFD.

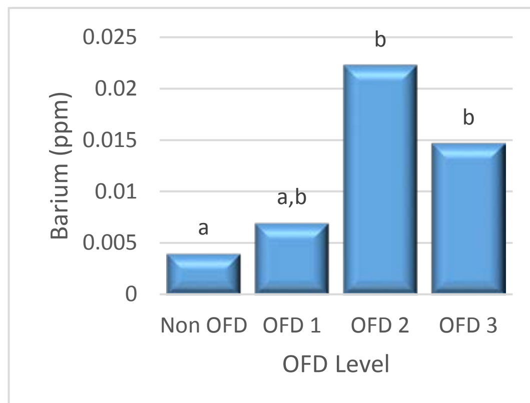


Generally, higher levels of arsenic were associated with diagnosis of more severe OFD.

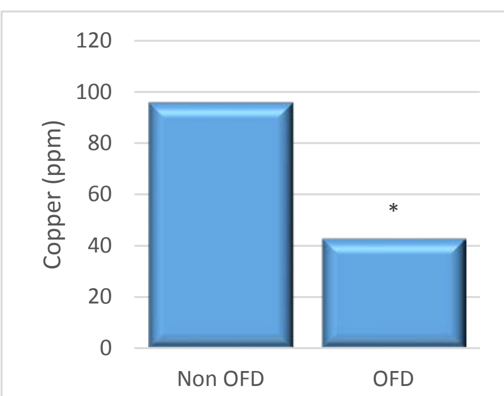


In addition, cadmium levels in the liver were increased in more severe cases of OFD.

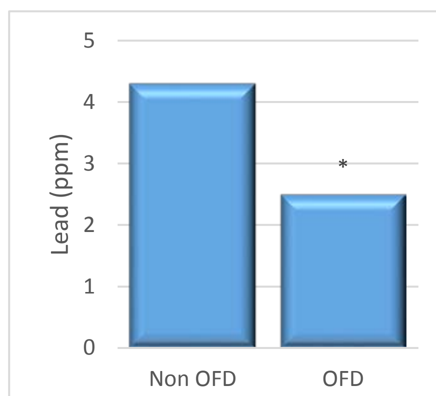
Barium levels in the liver were also associated with more severe cases of OFD.



When considering development of a diagnostic test for OFD, comparing liver levels of metals between animals with and without OFD was also considered. When this type of comparison was made, liver levels of copper and lead were identified as being different between unaffected and affected animals. An asterisk indicates significant differences between Non OFD (unaffected) and OFD (affected) animals.



Remaining data related to analyses of liver metals is included in the Appendix.



Ultrasound Results

All cows utilized in this project were scanned ante-mortem and graded for OFD via ultrasound. Ovaries collected at the slaughter house were ultrasounded post-mortem. Type 3 and Type 4 ovarian follicular dysplasia (OFD) can reliably identified and graded with ultrasound ante-mortem and post-mortem. Ovaries with Type 3 and 4 OFD have decreased numbers of Graffian follicles which can be noted on ultrasound. Additionally, significant mineralization within the ovary can also be visualized via ultrasound. Abnormal folliculogenesis occurs with OFD. The abnormal follicular development can result in calcium influx within the follicle resulting in mineral deposits within the ovary. Then areas of mineralization can be seen throughout the ovary on histologic analysis and ante-mortem via ultrasongraphy. The areas of mineralization appear hyperechoic, similar to bone density on the ultrasound. Ovarian cysts, small chronic cystic follicles (approximately 0.5 to 1.0 cm) and mucometra can all be associated with OFD and visualized via ultrasound. Ultrasound is a valuable tool in detect sentinels within a herd ante-mortem. There are a number of good quality ultrasounds available. The Ibex EVO ultrasound with the 8.5 MHZ 66mm linear array transducer was utilized in this research project. This ultrasound provides greater detail and visualization than many of the older ultrasounds. It appears that ultrasound can detect grade 2 OFD cows as well if an 8 to 10 MHZ ultrasound is utilized.

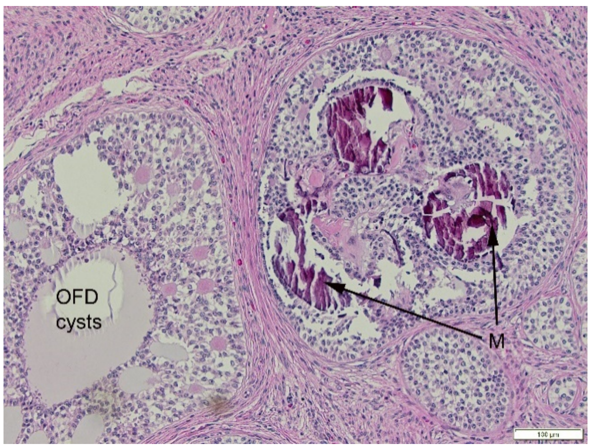


Image 1. The histologic image (left) and two ultrasound images below (image 2&3) are of 11S. The cow, 11S, was diagnosed via ultrasound ante-mortem and histologically independently as having a grade 4 OFD.

Image 2. The trans-rectal ultrasound image is the right ovary from 11S. The multiple areas of mineralization are present in the ovary along with decreased numbers of Graffian follicles indicative of a grade 4 OFD cow.

Image 3. The trans-rectal ultrasound image is the left ovary . There are multiple areas of mineralization, and small cystic areas seen in the ovary indicative of a grade 4 OFD cow.

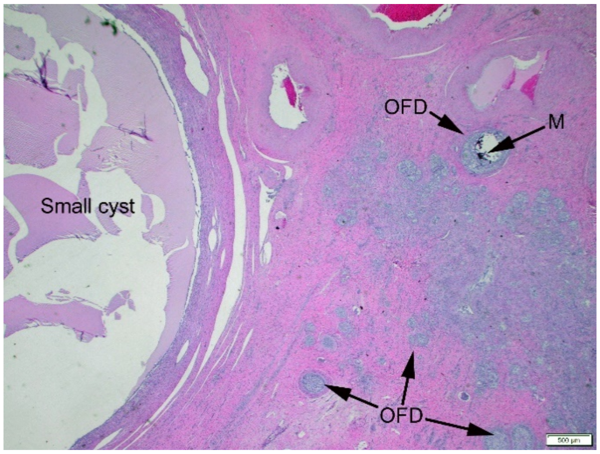
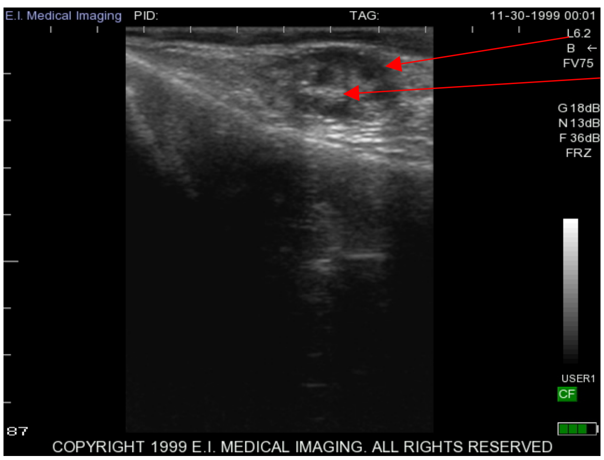
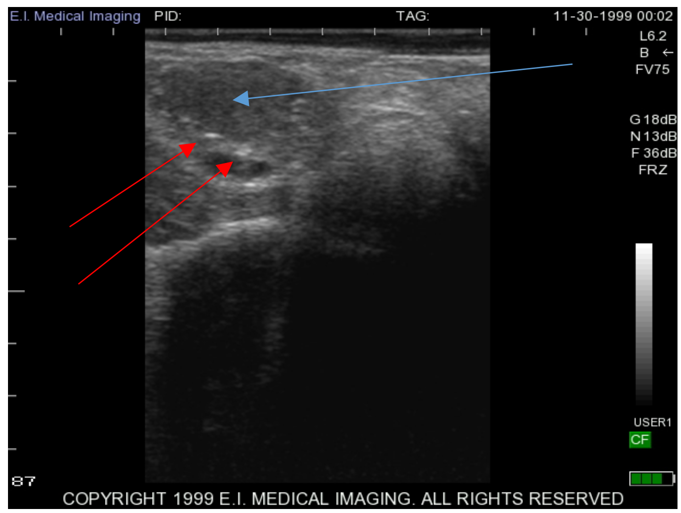


Image 4. The histologic image (left) and two ultrasound images below (image 5&6) are of 8S. The cow, 8S, was diagnosed via ultrasound ante-mortem as having a grade 2 OFD. The histologic analysis was confirmed that the cow had grade 2 OFD.

Image 5. The image shows a cow with grade 2 OFD. There are early cystic follicles (red arrows) with small areas of mineralization in the echoic rim. The cow was diagnosed with grade 2 OFD via ultrasound and was confirmed via histological analysis (Image 4).

Image 6. The image shows a cow with grade 2 OFD. There is a corpus luteum (blue arrow) with small areas of mineralization. The cow was diagnosed with grade 2 OFD via ultrasound and was confirmed via histological analysis (Image 4).





<u>Pathogen Analyses</u>

Analyses of several pathogens for each cow, including bovine viral diarrhea virus, have been completed and communicated to the appropriate ranches. No specific relationship between OFD and any tested pathogens have been noted.

<u>Survey Results</u>

Surveys have been completed for 3 ranches. The data are being compiled. Concern has been voiced regarding the use of low quality plastic feed tubs. Of note, several ovarian genes associated with OFD are also associated with endocrine disruptors derived from the environment.

Hormone Analyses

Blood and saliva samples have been collected from cattle sampled this year. Additionally, blood is being sampled from some normal cows in Alabama for comparison, and we have blood samples archived from previous studies. While the hormonal analyses are not completed at this time, the materials to quantify inhibin and activing as potential diagnostic aids for OFD have been purchased. Analysis is awaiting the final blood collection from normal cows for comparison, and will be completed with no additional costs required.

DNA Analyses

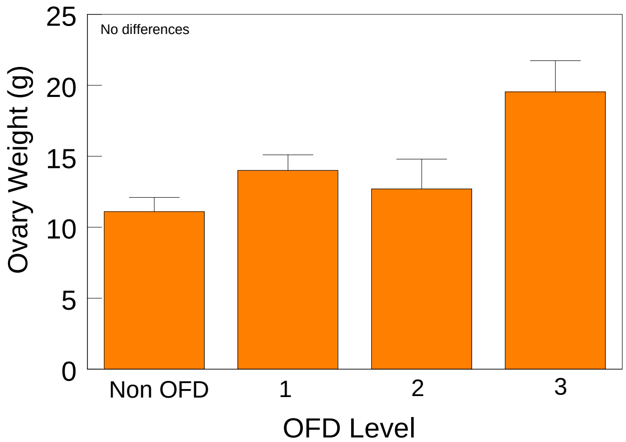
Whole blood, buccal (cheek) swabs, vaginal swabs, and uterine tissues have been collected from experimental animals. Similar tissues are being collected from normal animals for comparison. The materials for purifying the DNA have been purchased. Some DNA samples have been purified to date, but as not all tissues have been collected, analysis of the DNA has not been performed from these experimental or control animals. While purification of DNA for genomic analyses will be completed with no additional costs required, the actual genomic analyses cannot be completed without additional support. Funds allocated for these analyses have not been encumbered.

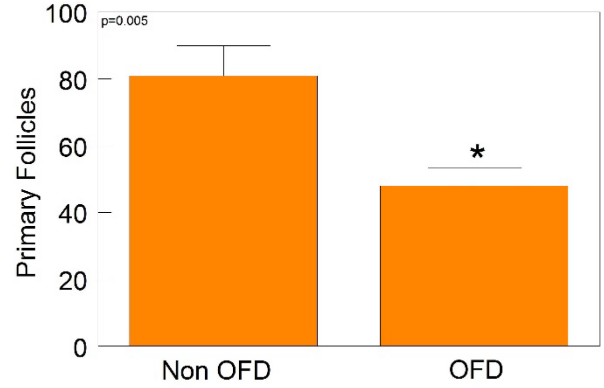
Dissemination of Information from these studies.

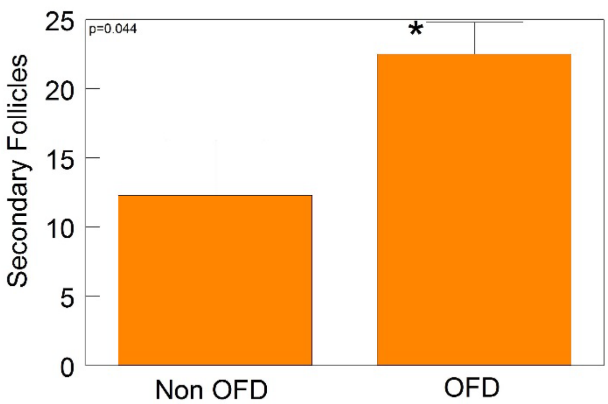
1. Ranches from which these samples were taken have been informed of the results of the study. Results of the presence or absence of numerous reproductive pathogens have also been reported to the ranches and their veterinarians.
2. "Assessment of Ovarian Follicular Dysplasia utilizing ultrasound and histologic examination." Presented to the International Embryo Transfer Society.
3. "Characterization of Ovarian Follicular Dysplasia (OFD) in five Florida beef herds." Presented to the College of Veterinary Medicine, Auburn University.
4. "Histological characteristics of Ovarian Follicular Dysplasia (OFD) observed through ultrasound in Florida beef herds." Presented to the American Association of Bovine Practitioners. Charlotte, NC.
5. "Bovine ovarian follicular dysplasia (OFD) and beyond." Presented to the College of Veterinary Medicine during the Annual Conference, Auburn University, AL.
6. "Evaluation of diagnostics for ante-mortem testing of ovarian follicular dysplasia (OFD) in cattle." Presented to the Society for Theriogenology, Fort Collins, CO.
7. "Genetic comparison of Florida beef cows with and without ovarian follicular dysplasia (OFD)." Presented to the American Association of Beef Practitioners, Omaha, NE
8. A draft manuscript has been prepared for publication of OFD pathology.

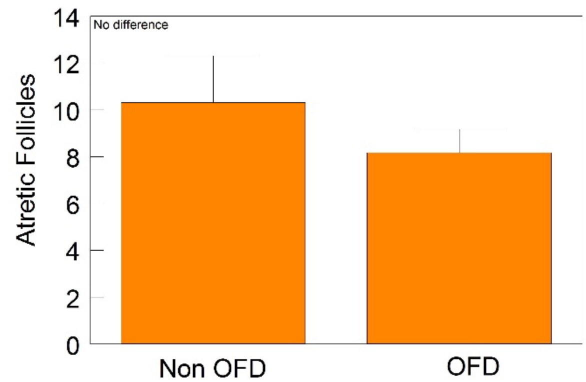
Appendix:

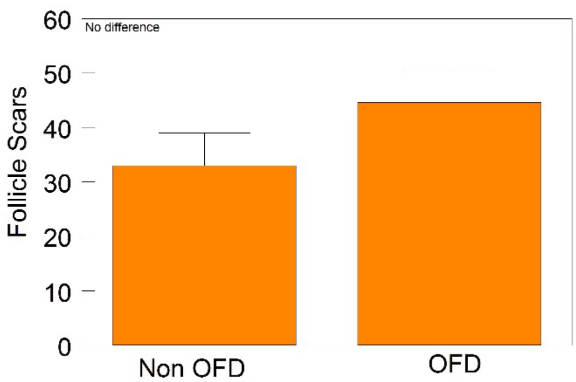
<u>Ovary Characteristics</u>
An asterisk indicates statistical difference between groups.

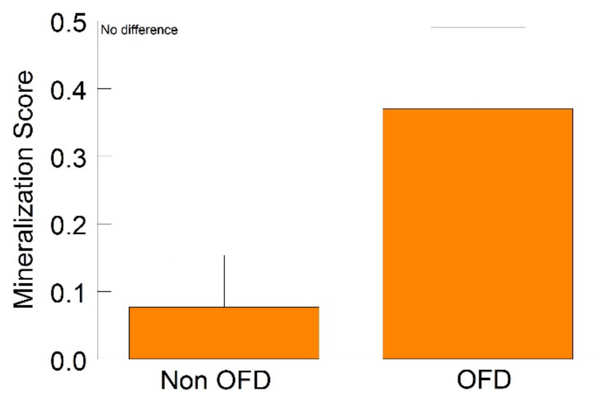




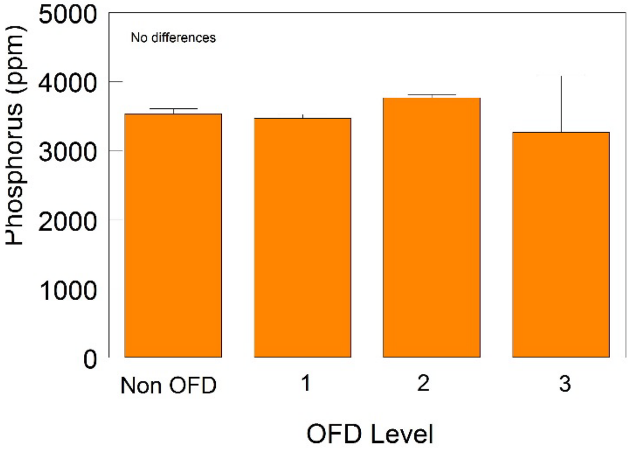


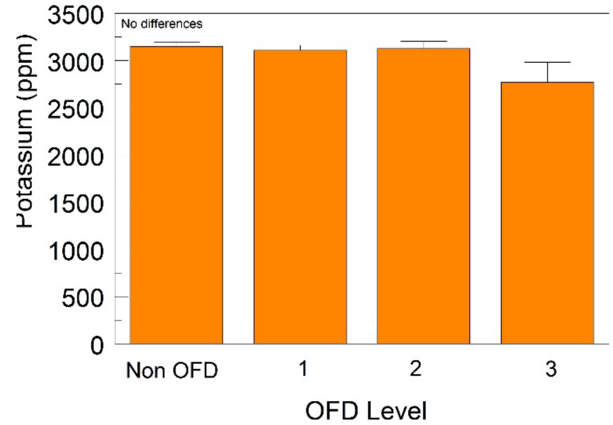


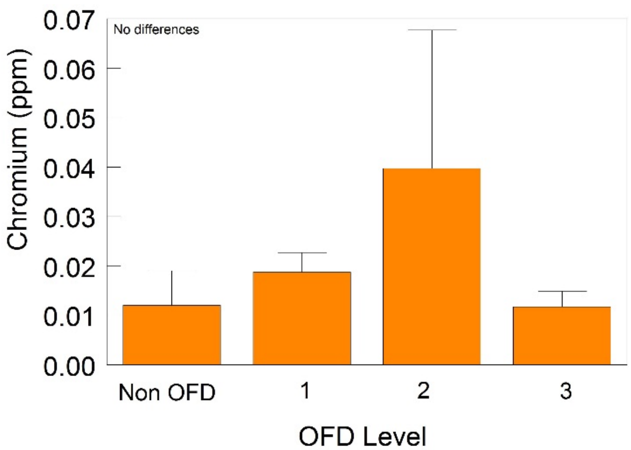


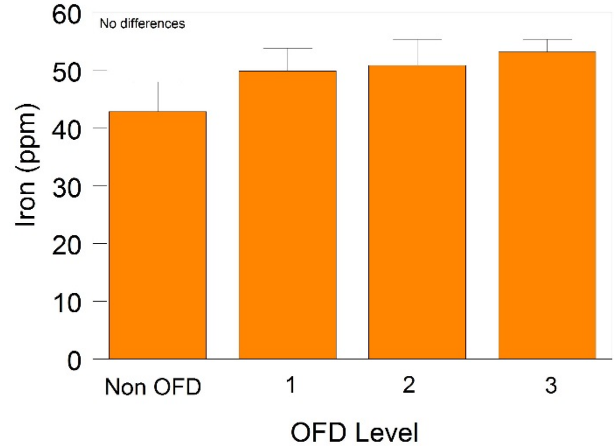


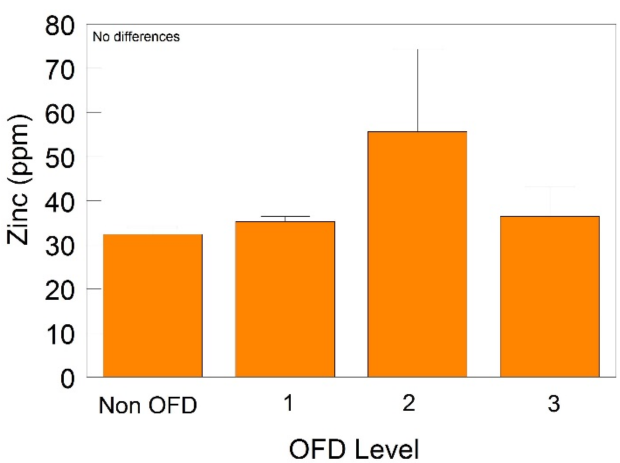
Metal Analyses

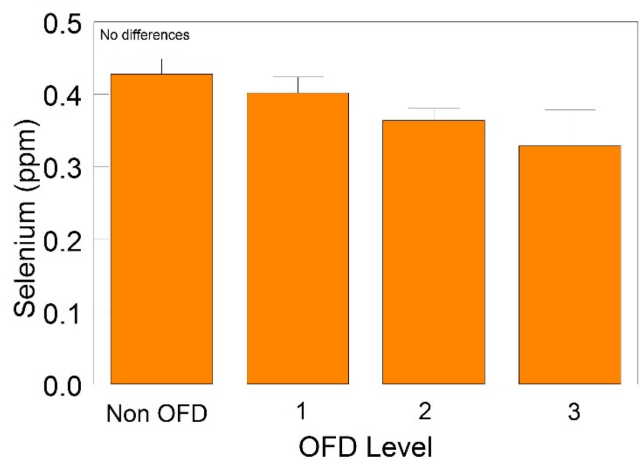


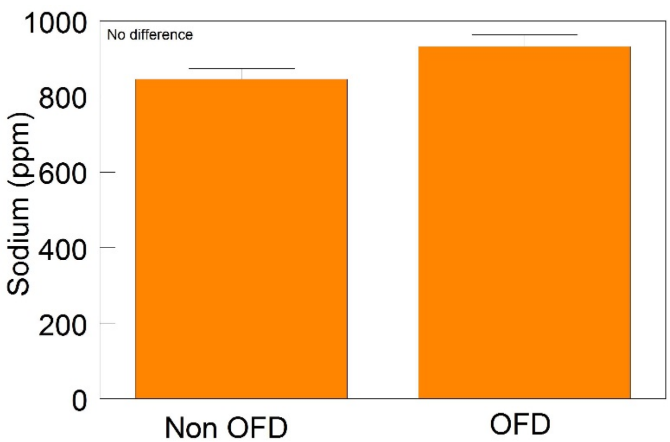








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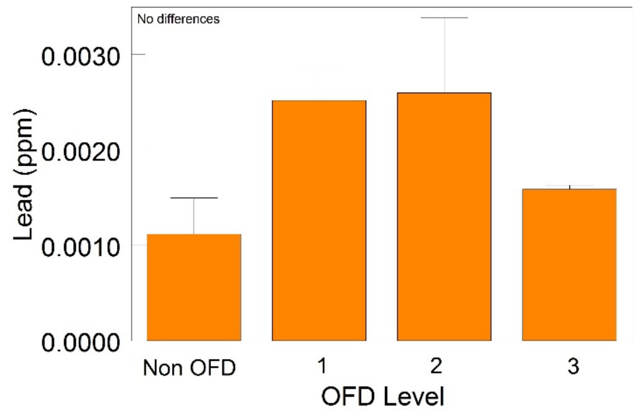
800
1000
Non OFD
OFD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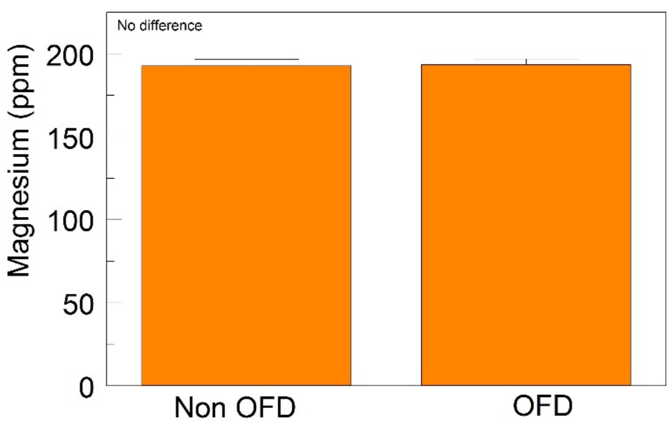
2
3
OFD Level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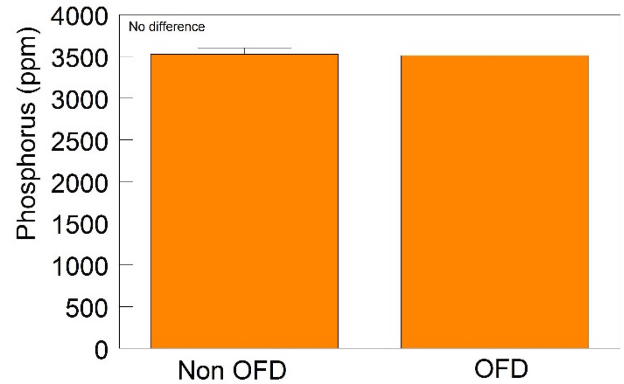
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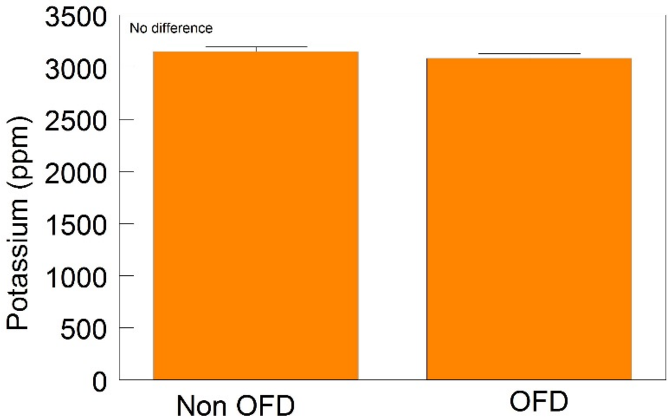
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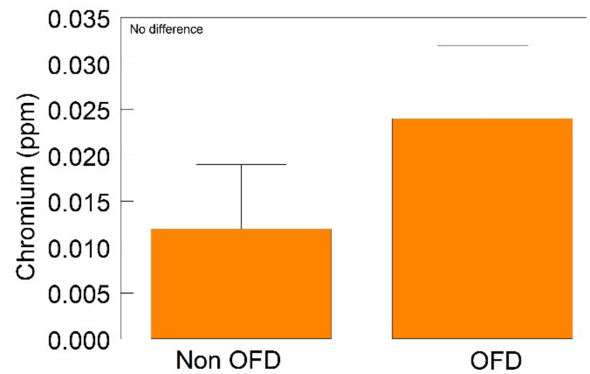
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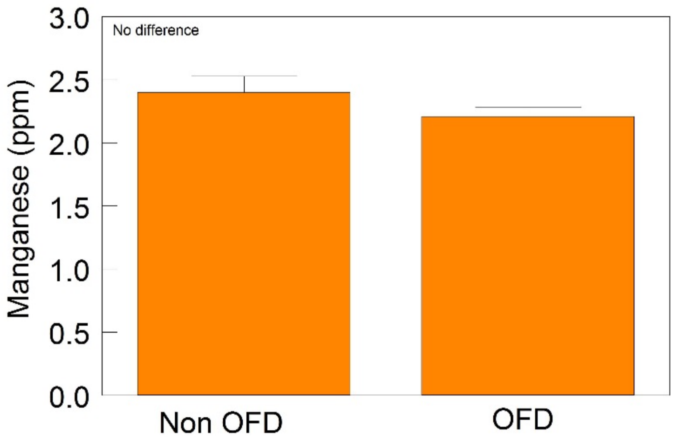
OFD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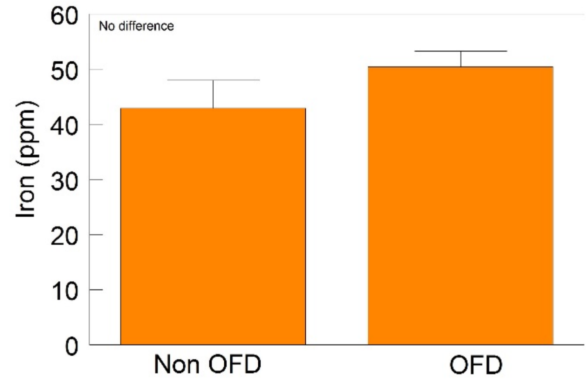
OFD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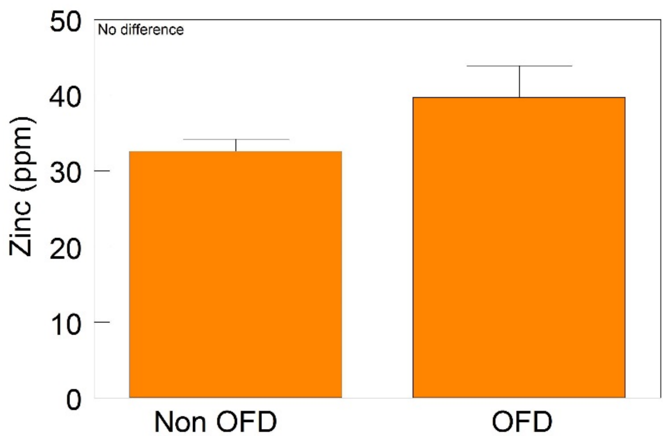
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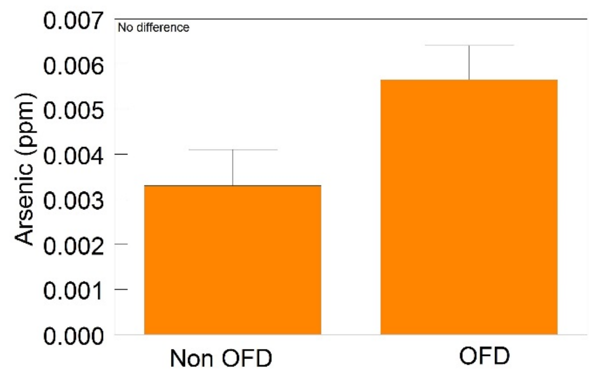
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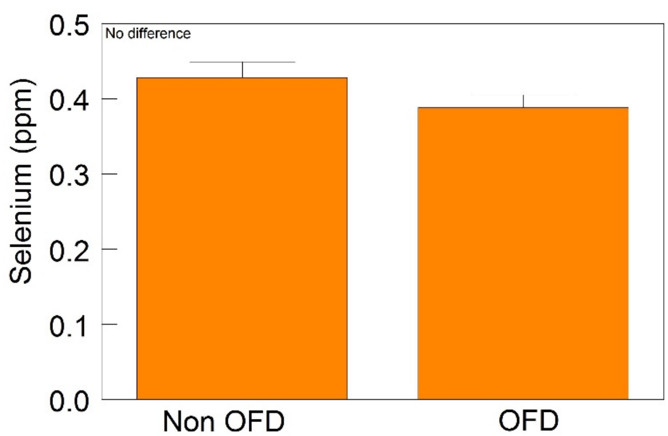
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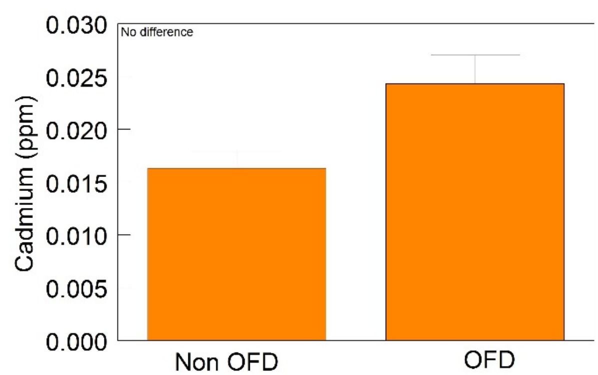
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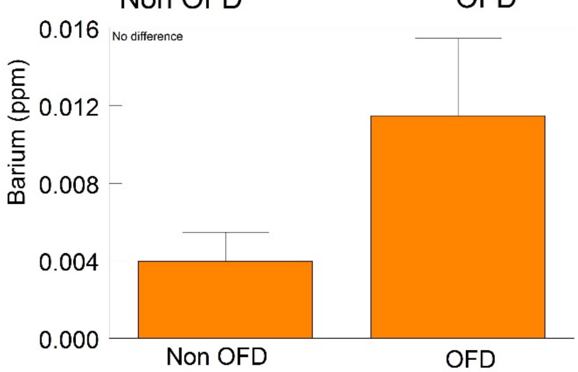
OFD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0.000
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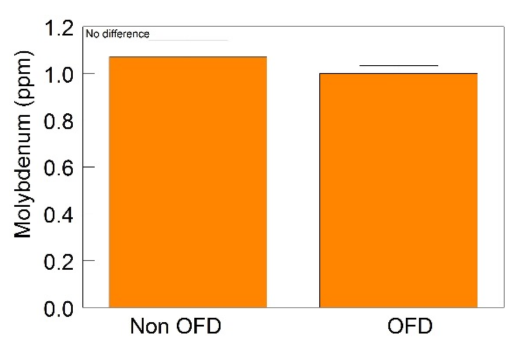
OFD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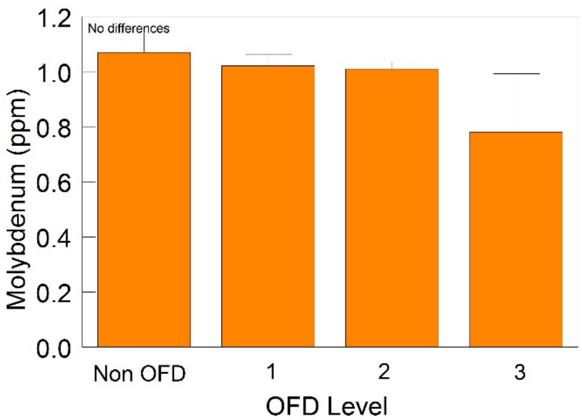
0.4
0.2
0.0
Non OFD
OFD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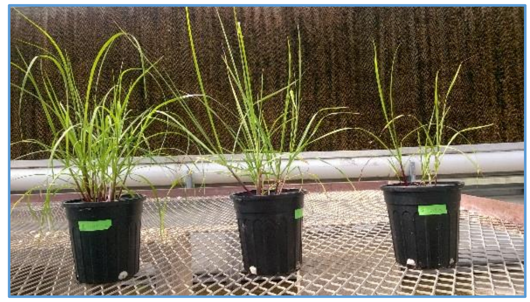
Molybdenum (ppm)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Non OFD
1
2
3
OFD Level

Florida Cattle Ehancement Board					
Project Title:	Development of a Diagnostic Test for Ovarian Follicular Dysplasia (OFD)				
Detailed Line Item Description	QTY	Unit Price	Total	Explanation/Justification of Deliverable	Completion Date
General Laboratory Items					
Hormone Assays	125	$100.00	$12,500.00	Activin/Inhibin Assays	9/1/2017
Supplies	5	$999.99	$4,999.95	General Supplies	9/1/2017
Diagnostics					
Histology	30	$1,000.00	$30,000.00	Ovary and other tissue structure analyses	9/1/2017
Elemental	47	$96.84	$4,551.48	Tissue elemental analyses	9/1/2017
BVDV	30	$100.00	$3,000.00	Disease monitoring	9/1/2017
Ranch Services					
Veterinary Services	3	$2,999.99	$8,999.97	Veterinary assistance for sample collections	
Survey	3	$100.00	$300.00	Data on cattle management	9/1/2017
Normal Animals	7	$2,200.00	$15,400.00	Normal bovine tissues	9/1/2017
Ranch Services	3	$1,500.00	$4,500.00	Ranch assistance in tissue collections	
Equipment					
ultrasound	1	$18,295.00	$18,295.00	high resolution ultrasound for diagnostics	6/15/2017
Personnel	Costs incorporated into costs listed above				9/1/2017
Graduate Student					
2 Faculty					
Grand total			$102,546.40		



Options for phosphorus fertilization and retention in bahiagrass pastures
FDACS Contract No. 24122, 2017 Final Report

UF UNIVERSITY of FLORIDA

Options for Phosphorus Fertilization and Retention in Bahiagrass Pastures

Florida Department of Agriculture and Consumer Services
Office of Agricultural Water Policy

FDACS Contract No. 24122, 2017 Final Report

Investigators: Dr. Cheryl Mackowiak (Lead PI), Dr. Vimila Nair (Co-PI), Dr. Jose Dubeux (Co-PI), and Dr. Ann Blount (Co-PI)

UF-IFAS North Florida Research and Education Center, Quincy, FL 32351

For further information, please contact:

Cheryl Mackowiak, Associate Professor, NFREC, Quincy (850) 544-7126; echo13@ufl.edu

September 07, 2017

BACKGROUND

Pursuant to the Florida Watershed Restoration Act (FWRA), section 403.067(7)(c)3, F.S., the Florida Department of Agriculture and Consumer Services (FDACS), Office of Agricultural Water Policy (OAWP), develops, adopts, and assists with the implementation of agricultural Best Management Practices (BMPs) to protect and conserve water resources. This project addressed Florida's cow/calf BMPs and more specifically, the following Florida Cattlemen's Association (FCA) 2016 research priorities: 1) biosolids and alternative fertilizer sources, 6) fertilization impacts on the environment, and 9) land application of biosolids environmental impact, as it relates to fertilizer P.

Many soil types are characterized by greater plant-available P located near the soil surface, and decreasing P concentrations with depth. In contrast, the Spodosols will often have greater subsoil P found in association with the spodic horizon (Chakraborty et al., 2011). This is why a surface (0 to 6 inches) soil sample may test as deficient for soil P, while the plant tissue report may prove adequate, as is often the case with bahiagrass. However, many ranchers are concerned that they may not have adequate soil P to support optimal bahiagrass growth. Additionally, the vast majority of bahiagrass root mass (as with most other plant species) where much of plant P is taken up, is located in the surface (0 to 6 inches) soil. The concern is whether bahiagrass pastures can capture soil P fertility at lower depths than what we typically measure for fertilizer recommendations.

The soil P test is designed for testing the surface soil (typically 0 to 6 inch depth). It provides no assessment of the P storage capacity or P reserve in surface or subsoils to support a plant's P requirement over time. Neither does it estimate soil vulnerability to P leaching losses. The soil phosphorus storage capacity (SPSC) methodology (Nair and Harris, 2014) was adapted for Florida's acid mineral soils, based on earlier findings on the relationship between P and [Fe+Al] (Nair et al., 2004). Using the same soil extraction method (Mehlich-3) that is used in soil test reporting, soil P, aluminum (Al), and iron (Fe) measurements are included to calculate the P storage capacity of our surface and subsoils. It works well, in part, because the soil Al and Fe minerals in Florida soils control soluble P release. Those soils with a positive SPSC rating will tolerate additional P inputs, while those with a negative rating are beyond the P storage capacity of the soil and therefore are prone to P leaching or movement into the environment.

Another development is that the UF-IFAS soil analytic laboratory recently changed from using the Mehlich-1 to Mehlich-3 soil extraction method for their soil reporting, resulting in greater amounts of P measured in most soils. Care was taken to assure scientifically sound adjustments to the soil P interpretation but further validation of the new extractant is required for bahiagrass. The tissue P testing requirement for bahiagrass provides some insurance against the possibility that soil P interpretations are over- or underestimated for different soil types.

Grasslands are one of the most environmentally friendly agricultural systems in the state and bahiagrass may have a relatively lower P fertilizer demand than other perennial grass hay options. This translates potentially to improved conservation of P reserves and reduced P fertilizer costs. Additionally, the capture and recovery of P from waste water treatment plants to be converted to Class AA biosolids, a slow-release fertilizer, is another means of P conservation at the state level. Demonstration and verification of a P efficient system, using scientifically sound metrics, as exemplified by experimental testing and demonstrations on Florida ranchlands, is needed. The data and on-farm evaluations helps provide area ranchers evidence that with a minimal amount of soil P management and tracking, their pastures will be productive while becoming more nutrient efficient and thereby, economically more effective.

Our overall goal was to improve bahiagrass nutrition and production through sustainable soil P fertility management by addressing the four Rs of nutrient stewardship: Right source, Right rate, Right time, and Right place. More specifically, we continued with research efforts initiated and funded by the FCA in 2016 (Objectives 1 and 2) and built upon those results (Objectives 3 and 4).

OBJECTIVES

1. Complete the tissue and data analyses from the 2016 column study testing different P sources on bahiagrass P uptake, P fertility, and soil phosphorus storage capacity of Spodosols and Ultisols.
2. Complete the tissue and soil analyses from the 2016 omission plot study located at Silver Spurs Ranch that provided an assessment of which macronutrients were limiting forage production and continue with a second, final year of testing in 2017.
3. Test N by P fertilizer rates, soil type, and bahiagrass cultivar interactions on yield, P uptake, soil P fertility, and soil P storage capacity.
4. Compare mineral P and biosolids single application vs split applications on bahiagrass response, soil P fertility, and soil P storage capacity at Silver Spurs Ranch.

OBJECTIVE 1 (planted vs unplanted soil columns of bahiagrass)

Materials and Methods (Obj 1): This experiment tested six P fertilizer sources using two soil types (Spodosol and Ultisol) in unplanted vs. planted columns. The Ultisol testing was an add-on to the original proposal in 2015 and resulted in data on P behavior in Central and North Florida soils with greater inherent P fertility and P fixing ability. The two soil types were 1) an Ultisol, Orangeburg series, Fine-loamy, kaolinitic, thermic Typic Kandiudults and 2) a Spodosol, Myakka series, Sandy, siliceous, hyperthermic Aeric Alaquods. Orangeburg was from NFREC, Quincy, FL and Myakka was from the Silver Spurs Ranch, Keenansville, FL. The Orangeburg soil was taken from the A and upper B horizons (approximately 0 to 12 inch depth), while the Myakka soil was collected in two parts, the surface A horizon (0 to 6 inches) and the subsoil (Bh horizon at approximately 12 inch depth). The soils from each location filled 42 (4-inch diameter x 12-inch deep) PVC columns. The soils were air-dried and passed through a 2 cm screen, then used to fill the plastic sleeve of 4-inch diameter x 12 inch deep PVC columns. Approximately 2 inches of inert gravel were placed at the bottom of each slit sleeve to aid with drainage. The Bh horizon soil occupied the lower 6 inches, while the A horizon soil occupied the upper 6 inches of each column for the Spodosol. In the case of the Ultisol, the entire 0-12 inch depth was uniformly mixed.

Seven different P treatments were tested (applied at 40 lbs P_2O_5 ac^{-1} rate) with and without plants (and 3 replicates; n=84). The fertilizer treatments were as follows: 1) control (no P), 2) triple super phosphate (TSP), 3) class AA biosolids from Tallahassee (BAA1), 4) class AA biosolids from Jacksonville (BAA2), 5) class B biosolids from Tallahassee (BioB or BB), 6) biochar created from class B Tallahassee biosolids (Biochar or Char), and 7) struvite (a recovered mineral from wastewater treatment, Ostera, Vancouver, CA). The act of pyrolyzing (burning under moderate heat (~400 ^oC) and low oxygen conditions) results in a charcoal-like product that can be used as a soil amendment and slow-release fertilizer. Struvite ($NH_4MgPO_4 \cdot 6H_2O$), is a mineral that can be synthesized from the wastewater of human (via waste water treatment plants) or animal (waste lagoons) origin. It has attributes similar to other mineral (i.e., TSP, MAP, DAP, etc) fertilizers. All treatments received similar applications of nutrients other than P, regardless of P source or soil type, to assure that other nutrients were not limiting. The P fertilizer treatments were mixed in the upper 2 inches of soil prior to planting.

Half of the columns were planted with bahiagrass (*Paspalum notatum* (Flugge) cv Pensacola transplants that were initiated in shallow, plastic flats 4 to 6 weeks prior to transplanting. The remaining columns were not planted to better understand the interaction of plants with soil P. Soil moisture was manually monitored, using a portable soil moisture measuring device. Watering of the unplanted columns was managed to simulate rain events, to better estimate production season effects. Watering of the planted columns was managed to maintain soil moisture between 40 to 80% of field capacity (averaging two to three 200 ml DI water applications per week during maximum growth). All columns contained a drain valve for collecting leachate, if overwatered. Only previous to the first clipping was there leachate to collect. Greenhouse temperature averaged 24 C day/ 20 C night and RH averaged 70% day/75% night.

Beginning 13 April 2016, planted columns were clipped to a 2-inch stubble height. The tissue was weighed, dried (60 C for 7 days) and dry mass determined. The tissue was ground to pass through a 2-mm screen, digested in concentrated HNO_3 and 30%H_2O_2 (Jones, 1989), and analyzed for plant essential nutrients, including P via ICP-OES. Two more clippings occurred (5 May, 15 June) and a final harvest (tops and roots) on 18 July.

At the final harvest, planted columns had the plants separated into shoots and roots, dried, weighed, ground, and analyzed, as described above. Roots were rinsed with deionized water to removed surface soil, prior to drying. The soil from the columns was segmented into 4, 3-inch depth sections. Roots were separated from each section and weighed separately. The air-dried soils were analyzed for Mehlich-3 extractable nutrients (including P, Fe, and Al) and water soluble P. Leachates were analyzed for N and P content.

Data were analyzed using PROC MIXED in SAS (SAS for Windows V 9.4, SAS Institute, 2009, Cary, NC, USA). Fixed effects included fertilizer treatment and soil depth. Blocks were considered as random effect. The LSMEANS were compared using the PDIFF procedure adjusted for Tukey's test. Differences were declared significant at $P \leq 0.05$.

Results (Obj 1): The amount of fertilizer P available for plant uptake during a growing season can be qualitatively estimated by addressing the fertilizer P composition, such as fertilizer total P and Mehlich-3 (M3) available P. Product total P varied, as expected, by product type, on a dry mass basis (Fig. 1-1). Mehlich-3 extraction method uses, among other things, dilute acid and chelate to solubilize P forms that are not readily available by water extraction alone. It is interesting to note that the proportion of struvite mineral P was not as soluble as TSP P, which was the most soluble, in fact, nearly all of the TSP was extracted via M3 (Fig. 1-1). The proportion of Class B biosolids extracted by M3 was greater than it was from Class AA2 biosolids, whereas the biochar derived from class B biosolids had a much lower proportion of M3 extractable P. Based upon these data, the relative amount of P available to plants receiving these different P sources would be TSP>> Class B biosolids>struvite, Class A Biosolids1 or 2>>biochar derived from biosolids. When the products were applied to the column soils, it was at equivalent total P rates, not M-3 extractable P rates, which is similar to how a farmer would estimate application rates.

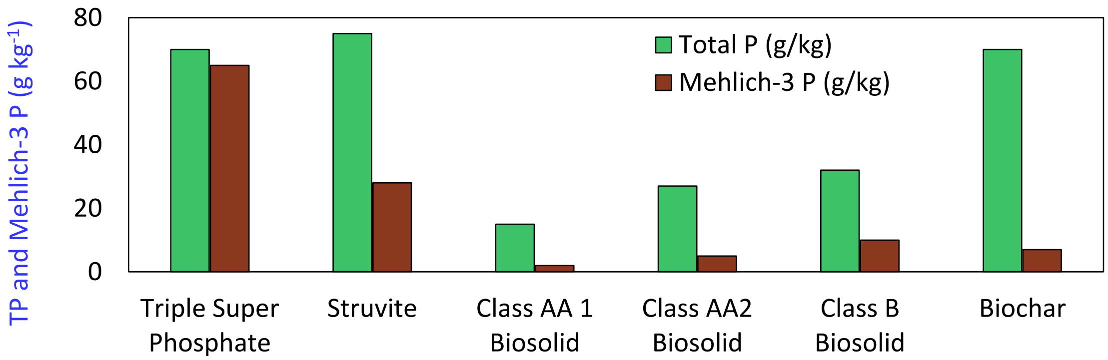


Fig. 1-1. Fertilizer product composition based upon Total P and Mehlich-3 extractable P.

Prior to the first bahiagrass clipping, water would occasionally leach from the bottom of the columns. This excess water was collected weekly and analyzed for orthophosphate (PO_4^-P) (Fig. 1-2). The amount of leachate that was collected from the bottom of the columns was about 30% greater from columns containing Ultisol soil than Spodosol soil. Even so, more leachate P was often collected from columns containing Spodosol soil (Fig. 1-2). Additionally, the unplanted columns tended to leach more P than planted columns, regardless of soil type. Among treatments, the TS Class AA biosolids and the Biochar biosolids had P leaching loss amounts similarly low losses to the untreated Control (Fig. 1-1).The total amount of P found in the leachate accounted for a small fraction (<1%) of P that was applied to the columns as fertilizer. In the case of the Control treatment, it represents the inherent soil P susceptible to leaching, prior to any P applications. After a few weeks of experience and guidance from a portable soil moisture probe, water was metered to avoid water leaching from the columns.

There were interactions between soil type and treatment for the total seasonal above-ground biomass yields with the Ultisol soil supporting generally greater growth. Therefore, the treatments were compared within each soil type. The struvite treatment resulted in the greatest total bahiagrass yields, followed by the TSP and all of the biosolids treatments. The control (no P additions) had the lowest amount of biomass, while the biochar treatment had yields similar to the Control and TSP treatments (Fig. 1-3). The TSP treatment resulted in the greatest growth in the Ultisol soil, but the Class B biosolids also had similarly high production (Fig. 1-4). As with the Spodosol soil, the control (no P applied) performed relatively poorly.

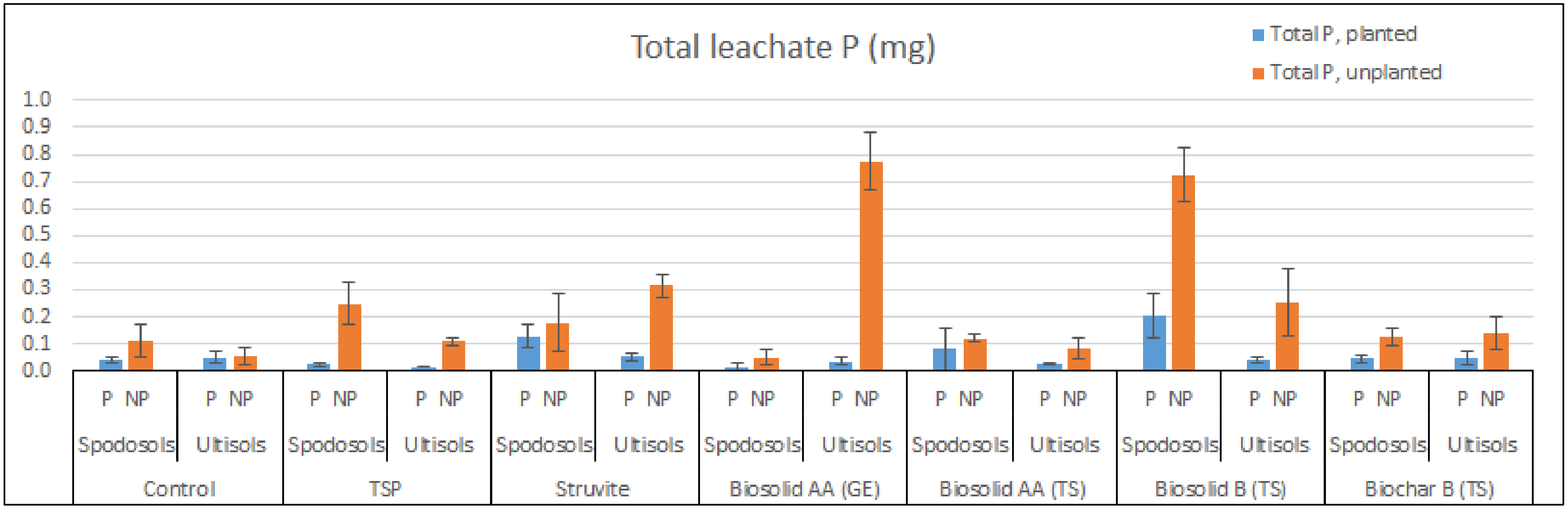


Fig. 1-2. The total amount of P in leachate recovered from the columns (both, planted and unplanted). Trends show a fairly similar risk of P losses from the columns containing Spodosol soil or Ultisol soil. However, there appeared to be a greater risk of P loss in unplanted versus planted columns. More P was collected from some unplanted biosolids treatments than from other treatments, but among planted columns, the leachate P amounts were fairly similar. Each colored bar represents the mean of three replicate columns and the vertical bars represent the standard error of each mean. Biosolid AA (GE)=Class AA biosolids 1 and Biosolid B (TS)=Class AA biosolids 2.

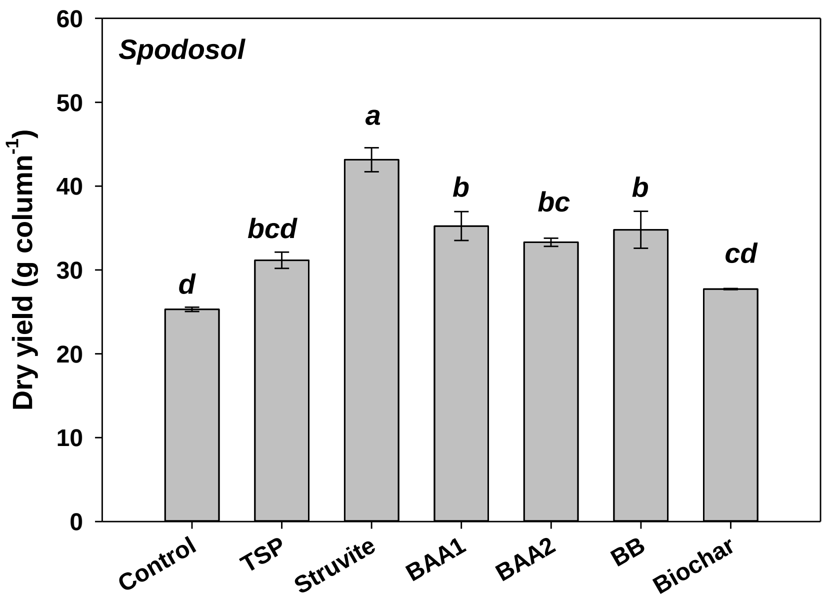


Fig. 1-3. Phosphorus fertilizer treatment effects on total seasonal yields of bahiagrass grown in a Spodosol soil. Each colored bar represents the mean of 3 replicates and the vertical bars represent the standard error of each mean. Bars sharing the same letter, are not significantly different at alpha=0.05.

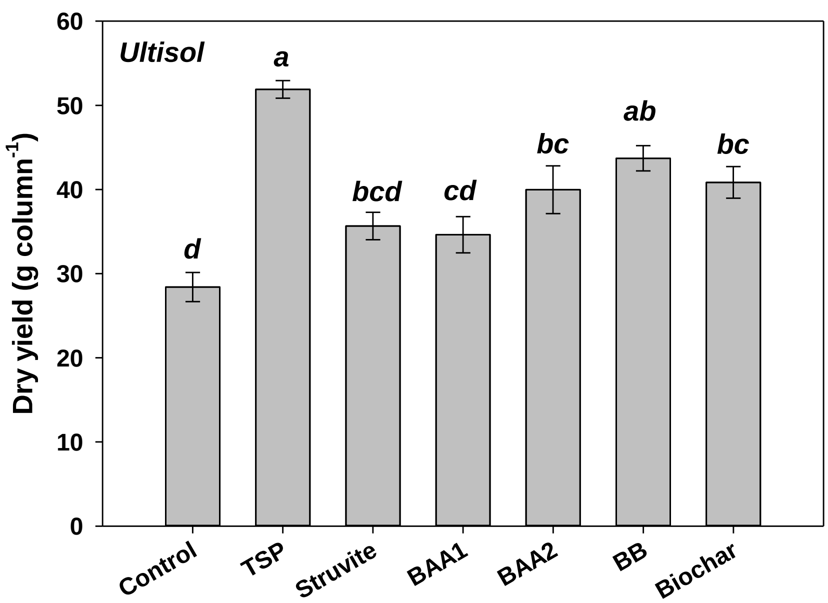


Fig. 1-4. Phosphorus fertilizer treatment effects on total seasonal yields of bahiagrass grown in an Ultisol soil. Each colored bar represents the mean of 3 replicates and the vertical bars represent the standard error of each mean. Bars sharing the same letter, are not significantly different at alpha=0.05.

Based upon biomass accumulation and tissue P content, P uptake by the above-ground forage was calculated and compared. There were no soil interactions so data from both soil types were combined (n=6) and compared by P treatment. The amount of P removed from the soil was similar among all of the columns receiving P fertilizer, regardless of the source. Additionally, the Class B biosolids treatment took up more P in biomass than the Control (no P additions) treatment (Fig. 1-5).

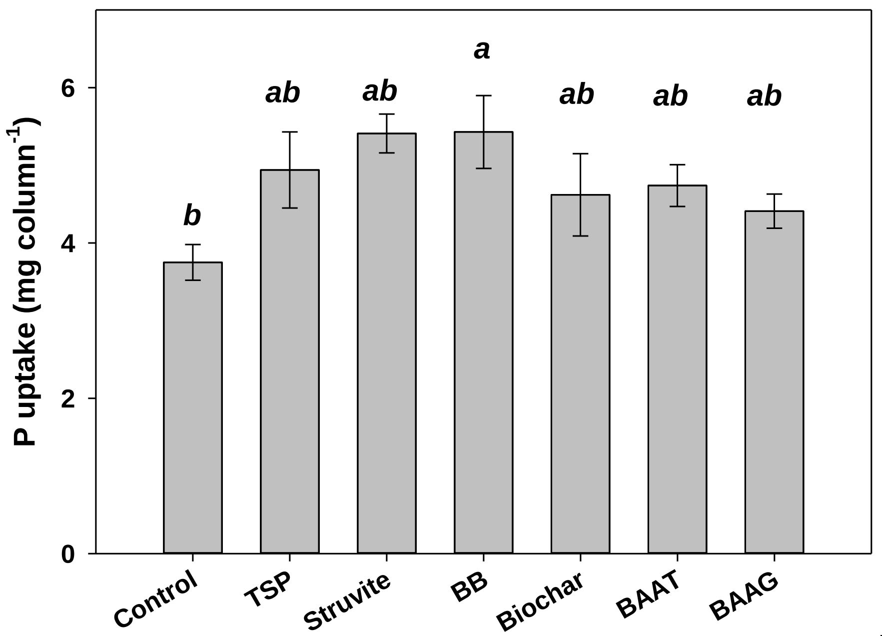


Fig. 1-4. Phosphorus uptake into above-ground biomass of bahiagrass grown under different P fertilizer treatments. Each colored bar represents the mean of 6 replicates and the vertical bars represent the standard error of each mean. Bars sharing the same letter, are not significantly different at alpha=0.05.

What P is not taken up by the plants may be susceptible to leaching or erosion losses to the environment. At the conclusion of the study the soils were analyzed for water soluble P (WSP), since it is the form most susceptible to movement into the environment. Soils from the unplanted columns will be discussed. Similar data will be generated from the planted columns in the coming weeks. The soils were separated by depth increments to compare relative differences in potential P migration through the column.

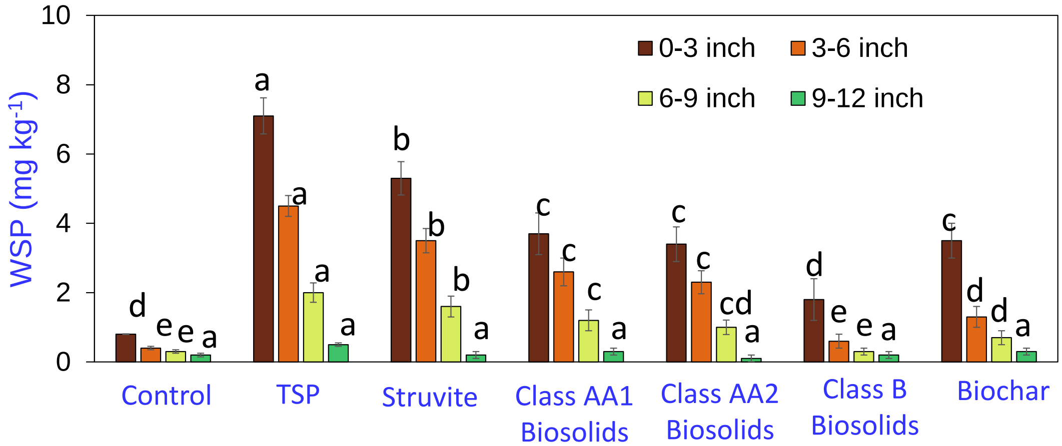


Fig. 1-5. Phosphorus fertilizer treatment and depth effects on water soluble P in a Spodosol soil, under different P fertilizer treatments. Each colored bar represents the mean of 3 replicates and the vertical bars represent the standard error of each mean. Bars sharing the same letter at a given depth, are not significantly different at alpha=0.05.

The concentration of WSP declined with soil depth in the Spodosol soil from unplanted columns, regardless of P fertilizer source (Fig. 1-5). In the upper 6 inches, the TSP and struvite treatments had the greatest WSP concentrations, while Class B biosolids and Control (no P applied) had the lowest. At 9-12 inch depth, all treatments had similarly low WSP (Fig. 1-5). A similar response pattern was observed with the Utlisol soil (Fig. 1-6).

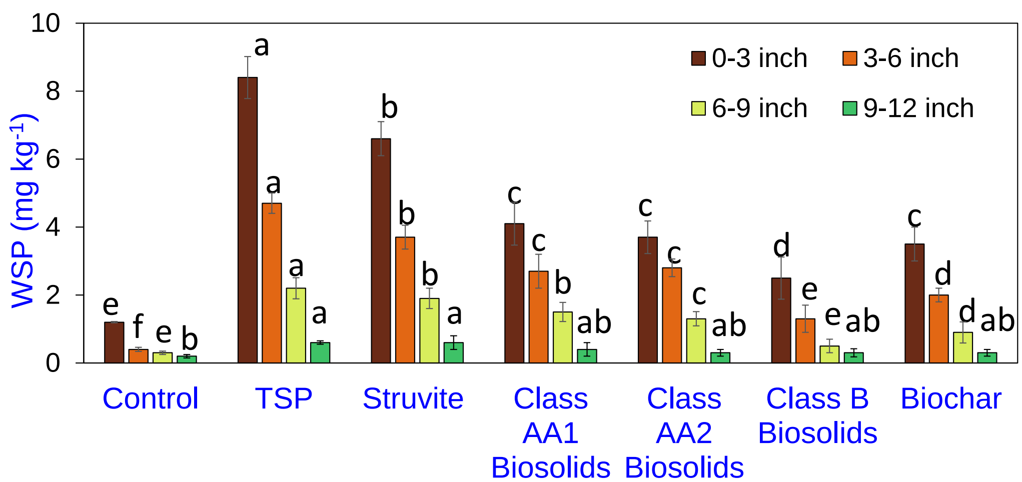


Fig. 1-5. Phosphorus fertilizer treatment and depth effects on water soluble P in a Spodosol soil, under different P fertilizer treatments. Each colored bar represents the mean of 3 replicates and the vertical bars represent the standard error of each mean. Bars sharing the same letter at a given depth, are not significantly different at alpha=0.05.

Another approach to assessing the potential for soil P losses to the environment is to address the soil P storage capacity (SPSC) of the soil profile. The SPSC requires measurements of soil P, Fe, and Al. In this study, Mehlich-3 extractions were used. Additionally, soils from unplanted versus planted were compared, in order to determine if plants would impact SPSC.

Unplanted columns using Spodosol A horizon soil (depths from 0 to 6 inches) had negative SPSC values, even for the Control soil that did not receive P inputs (Fig. 1-6). There were some response differences among P treatments, where TSP resulted in a much more negative SPSC value at the 0-3 inch depth than other treatments. However, any negative value, regardless of degree, implies P losses to the environment, since the soils contain more P than it can hold against the forces of rainfall or irrigation events.

The planted Spodosols greatly increased their SPSC values. Positive SPSC values imply that the soil can receive additional P with reduced risk of P loss. In the case of the 0-6 depth, it calculates to only a few pounds per acre. The SPSC for Spodosols at the 6 to 12 inch soil depth was made up of the Bh (or Spodic) horizon. This soil type contains ample Al and some Fe. These constituents in acid soils help bind labile P, which protects against P leaching losses.

The Ultisol soils responded similarly to the Spodosols, in terms of TSP and struvite applications, where highly negative SPSC values were created in the upper 3 inches (Fig. 1-6). This also continued into the 3-6 inch depth, as well. It is interesting to note that in planted Ultisol columns that there were some instances where the planted columns under in the Control and Biosolids B treatments had more negative values than their unplanted counterparts (Fig. 1-6). This needs to be addressed further to determine if there is a natural cause of if it is an artifact of something else. Soil phosphorus storage capacities close to zero (either positive or negative) suggests that there is little or no additional P storage available and therefore additional P inputs have a high risk of moving off-site.

Discussion (Obj. 1): Regardless of soil type, the tested bahiagrass productivity often increased with additional P fertilizer inputs. It did not matter much what fertilizer source was used. Plants grown in the Ultisol soil took up somewhat greater amounts of P (5.3 ± 0.2 mg P versus 4.2 ± 0.2 mg P), compared to the Spodosol soil. Regardless of these minor differences, the P amounts represented approximately 8 to 10% of the entire fertilizer P applied to the soil, regardless of P source. If the control plants removed 3.8 mg P and subtract that value from each of the fertilizer treatments (assuming they also were taking up soil derived P), then the amount of P contributed by the fertilizers becomes much less, regardless of P treatment. There appears to be a loss of efficiency where the plants benefit from the fertilizer P but they leave much of it in the soil, where it becomes susceptible to movement off-site. The goal is to provide ample soil P to plants for uptake while minimizing these P losses.

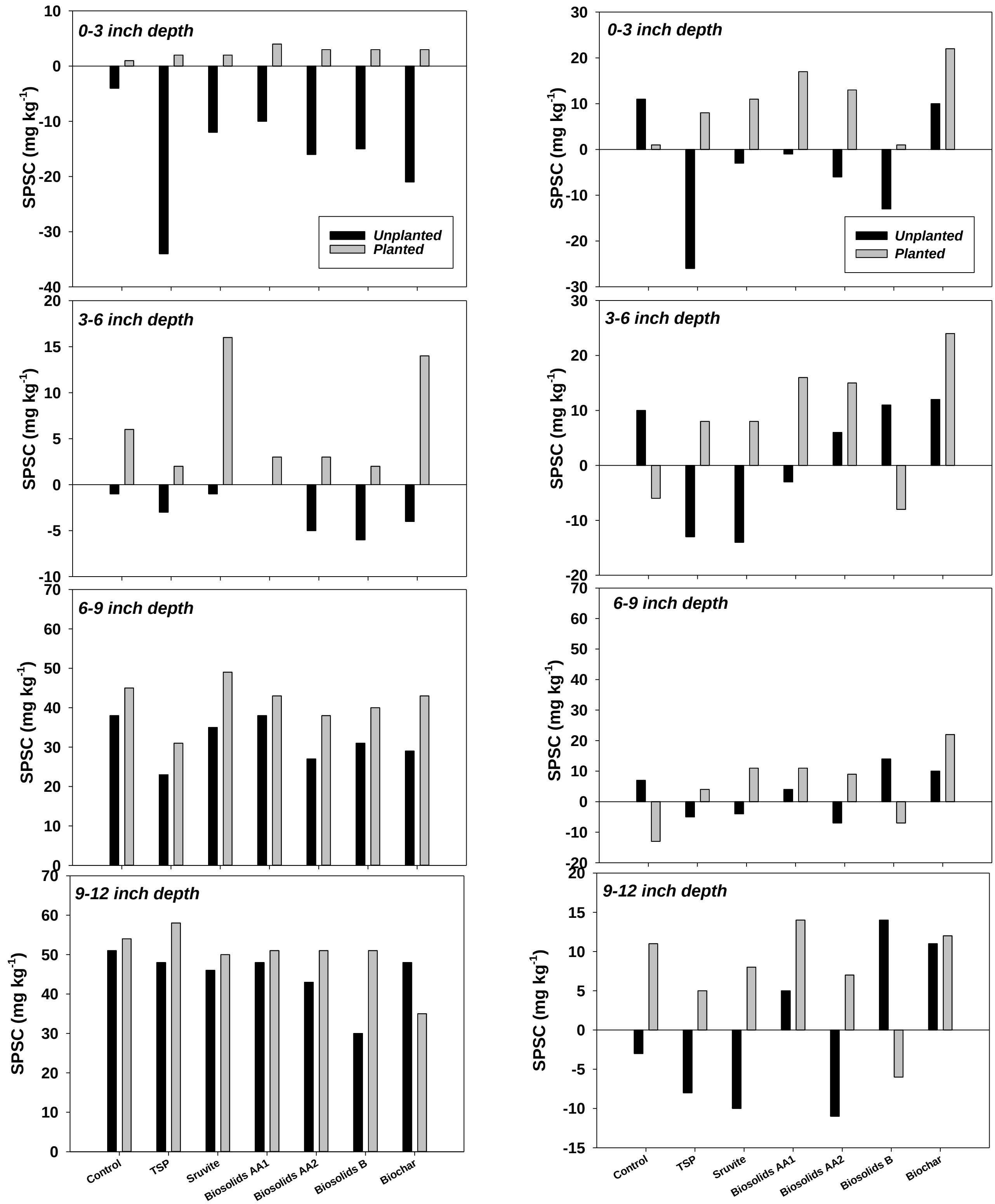


Fig. 1-6. Phosphorus fertilizer treatment and depth effects on soil P storage capacity (SPSC) in a Spodosol soil (left panels) and an Ultisol soil (right panels), under different P fertilizer treatments. Each colored bar represents the mean of 3 replicates. Negative SPSC values represent soils that are prone to P losses.

Water soluble P was greatest in the upper 6 inches of soil. Unfortunately, in the case of the Spodosol, these soils can hold only the smallest amounts of P without it being prone to loss from rainfall or irrigation. The spodic Bh and underlying Bt horizons often have the capacity to hold a large P reserve which is available to bahiagrass, if they have the roots there to capture it. When the seasonal high water table expands into the soil horizons above the spodic layer, that soil P is extremely susceptible to moving with the water, often resulting in surface and subsurface lateral losses off-site. The good news is that plant uptake can remove large amounts of soil P into biomass. Some of that P gets converted into organic P that is not as readily leached into the environment. In order to maximize P uptake, the plants need to be managed for optimal and sustainable growth.

OBJECTIVE 2 (fertilizer omission plots)

Materials and Methods (Obj 2): Test plots (20 x 10 ft) were established at the Silver Spurs ranch (27.881 N, -81.052 W), April 01, 2016, to test and demonstrate fertilizer effects on pasture bahiagrass productivity. This approach was based upon site-specific nutrient management (SSNM), using omission plots that did not compare individual fertilizer nutrient additions against an untreated control, but rather, a single nutrient factor was omitted from plots receiving ample amounts of complete fertilizer. These replicated treatments were compared against a well-fertilized control treatment and a Class AA biosolids treatment. An untreated check plot was included, as well. This technique was developed to test and demonstrate on-farm rice fertilization effects and is a promising technique for on-farm use world-wide (Dobermann and Cassman, 2002).

The test location hosts flatwood soils or Spodosols. More specifically, the test site had Sandy, siliceous, hyperthermic Aeric Alaquods or Myakka series (NCSS, 2016), as described by Soil Survey Staff (2016). Soil characteristics are given in Table 1. Treatments consisted of the following: 1) A complete fertilizer treatment that received N, P, and K fertilizer (80 lbs N acre^{-1} as NH_4NO_3, 40 lbs P_2O_5 acre^{-1} as triple super phosphate, and 40 lbs K_2O acre^{-1} as a blend of KCl (75% K_2O) and KMag (25% K_2O rate). The KMag also provided 10 lbs S acre^{-1} and 5 lbs Mg acre^{-1}. The N-P-K rates were equivalent to those prescribed by UF-IFAS when soils test low for these nutrients, regardless of the actual measured fertility. The remaining treatments were: 2) -N treatment, 3) -P treatment, 4) -K treatment, 5) class AA biosolids plus K_2O, and 6) check (no fertilizer applications). This equated to a total of 6 treatments replicated 3 times (n=18). Fertilizers were reapplied after the first cutting in June, 2016, the first cutting in May, 2017, and the second cutting in July, 2017. A third and final cutting is scheduled for September, 2017.

Table 1. Soil characteristics from Omission test plot location, Kenansville, FL.

pH	CEC	P	K	Ca	Mg	S	B	Fe	Zn	Mn	Cu
	meq/100 g	ppm									
4.9	8.51	19	64	790	49	8	0.44	60	0.30	1	0.40

The site was managed as pasture until the time of testing. At that time, temporary electrical fencing was installed, in order to better assess bahiagrass yields due to fertilizer inputs without short-term interference by cattle. During the winter, prior to spring green-up, cattle broke into the study area for a time. The forage was harvested 06/15/2016, 08/24/2016, 5/18/17, and 7/11/17, to assess forage yield differences. Harvest 1 consisted of 2 composited samples from a 0.25 m^2 square, while the second and third samplings were taken from a single 0.25 m^2 square per plot. The fourth sampling was taken by mowing a 48" long by 21" strip from each plot, using a manual mower and bag. Following sampling, the remaining forage was cut with a hay cutter, manually raked, and removed. A push mower with bag attachment was used to stage the area to 3 inch stubble height across the entire field site and plots re-fertilized with amounts, as listed above. The sampled forage was dried (60 C for 7 days), weighed, and ground to pass through a 2mm sieve. Tissue samples were sent to a commercial lab (Waters Agricultural Laboratories, Camilla, GA) for crude protein and nutrient composition.

Two piezometers (pressure transducers, auger with extensions, and casings) were purchased but were not installed, as of 08/31/2016. Standing water early in the season and other activities near and at the site, made it somewhat impractical for installation during the summer. The piezometers will be situated in line of expected subsurface flow (10 ft depth) this fall. One will be stationed near the omission plots or P trial and the other southeast by at least 200 ft. The actual installation locations will be coordinated with the Silver Spurs staff, as they plan for drain tile and other land disruptive activities. The data from both types of equipment can complement related activities related to assessing water quality and its movement by staff.

Data were analyzed using PROC MIXED in SAS (SAS for Windows V 9.4, SAS Institute, 2009, Cary, NC, USA). Fixed effects included fertilizer treatment and harvest date. Since there was fertility treatment x harvest date interactions, harvest dates were analyzed independently. Blocks were considered as random effect. The LSMEANS were compared using the PDIFF procedure adjusted for Tukey's test. Differences were declared significant at $P \leq 0.05$.

Results (Obj 2): Bahiagrass forage responded to lack of some fertilizers with reduced growth ($P < 0.001$), by the first harvest in June, 2016 (Fig. 2-1). The lowest yields were with the Check (no fertilizer) and –N plots, while other treatments were similarly greater in yield (Fig. 2-1). Plots receiving biosolids had yields that straddled the higher and lower yielding plots. Again, the lowest yielding plots in August were the Check and –N treatments, while all other treatments were similarly greater, by over 100% (Fig. 2-2).

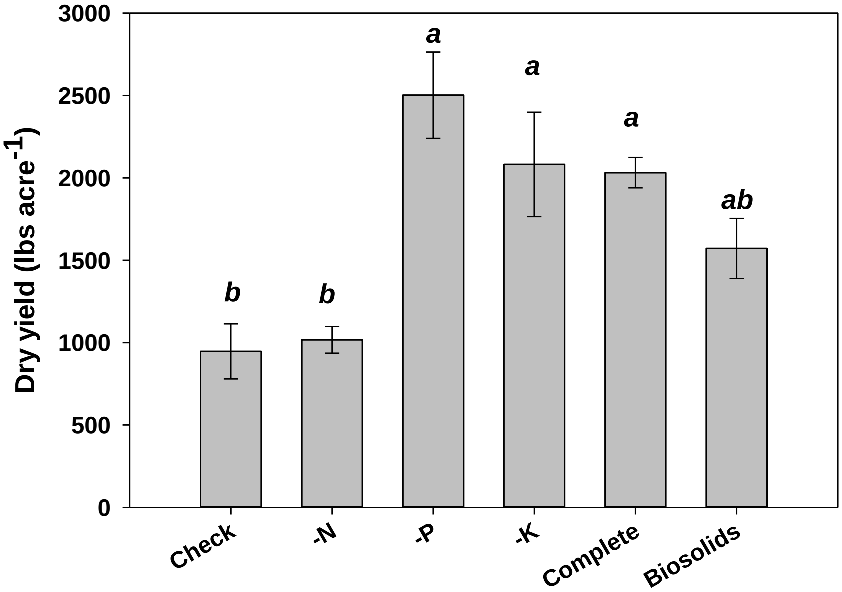


Fig. 2-1. Dry forage yields from 6/15/2016, as affected by fertility treatments. Bars represent means ± standard errors. Bars sharing the same letters are not significantly different.

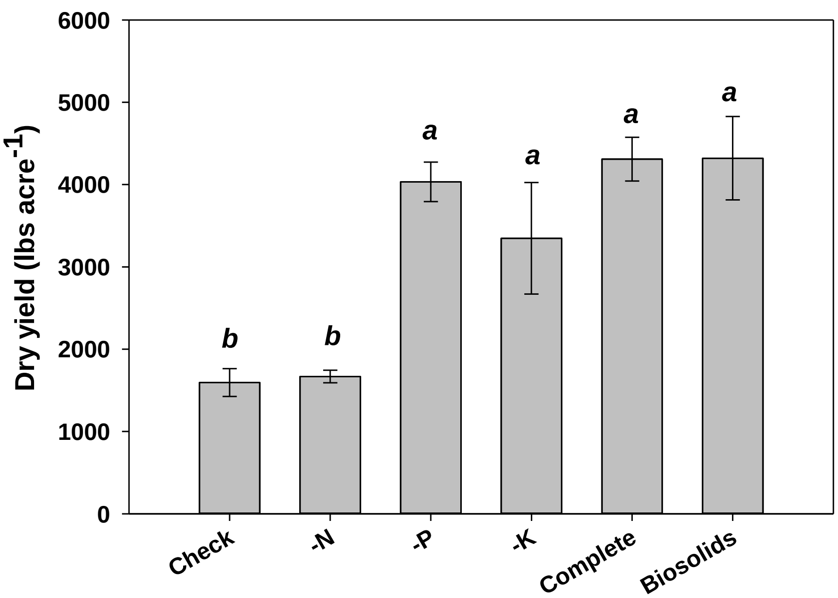


Fig. 2-2. Dry forage yields from 8/24/2016, as affected by fertility treatments. Bars represent means ± standard errors. Bars sharing the same letters are not significantly different.

Since the August, 2016 harvest until the May, 2017 harvest, the forage had not been intentionally grazed (cows/horses broke to the plots for a short time during the winter). Yields with the May harvest relied on over-wintering nutrients in the soil. With the May harvest, the –K treatment resulted in less forage than the –P treatment, that was among the most productive (Fig. 2-3). By the July, 2017 harvest, it was becoming clear that the K depleted plots (-K treatment) were beginning to lose significant forage production (Fig. 2-4). It is expected that this trend will continue with the next (final) forage harvest scheduled for September, 2017.

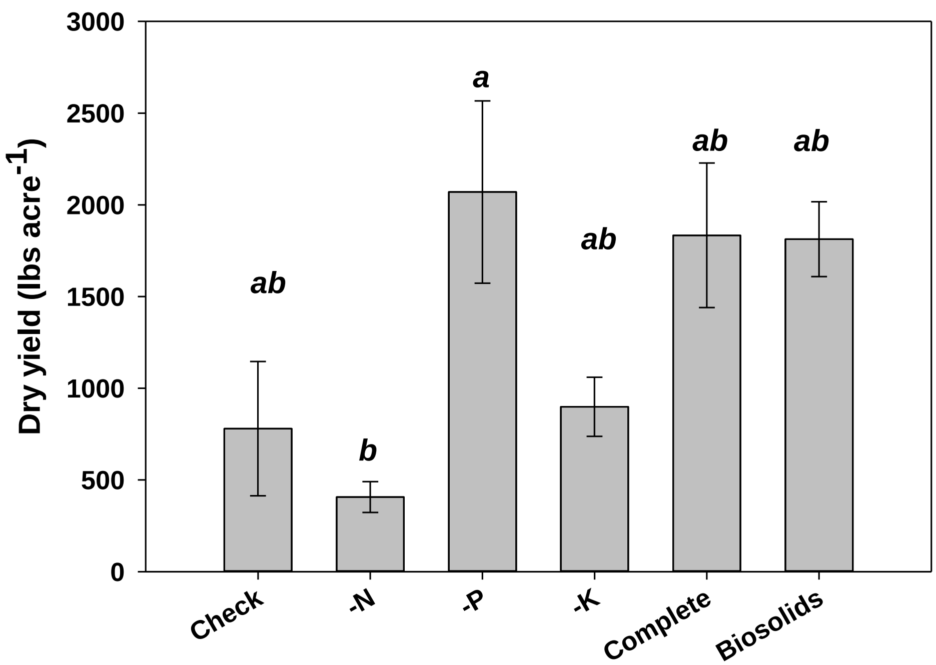


Fig. 2-3. Dry forage yields from 5/18/2017, as affected by fertility treatments. Bars represent means ± standard errors. Bars sharing the same letters are not significantly different.

Tissue N, P, and K concentrations were graphed and compared to suggested sufficiency levels (levels that support at least 80% production). There is no official sufficiency values available specifically for bahiagrass, so for purposes of this discussion (other than P at 1.5 mg kg^{-1} or 0.15%), values for similar grasses were used as guides. Often times major (macro) nutrient deficiencies can be assessed by tissue analyses. However, there are situations where conditions other than low soil fertility result in low tissue nutrient concentration values and sometimes even high values can occur that is not related directly to excess soil fertility.

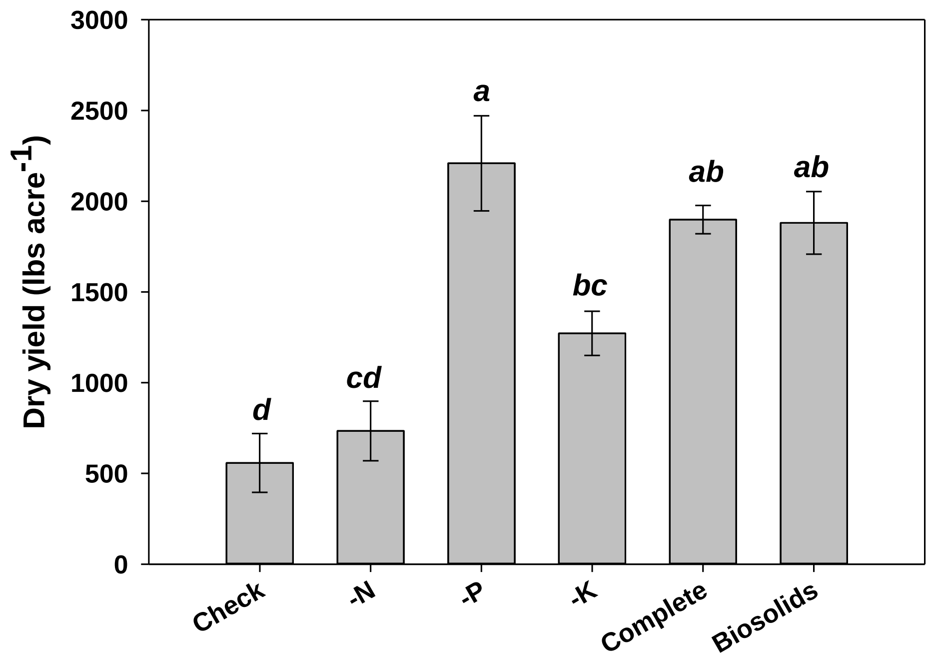


Fig. 2-4. Dry forage yields from 7/11/2017, as affected by fertility treatments. Bars represent means ± standard errors. Bars sharing the same letters are not significantly different.

A N sufficiency of 15 g kg^{-1} (1.5% N or 9.37% crude protein) was used to represent productive bahiagrass. Tissue N was similar among fertility treatments in June, 2016 and May, 2017, when all treatments were well below 15 g N kg^{-1} (Fig. 2-5). In August, 2016 tissue values represent approximately 5 to 6% crude protein and hardly adequate to maintain livestock. In comparison, tissue N concentrations increased in June 2016 and July 2016, when bahiagrass is actively growing. The Check (unfertilized) and –N treatments remained similarly low in tissue N and it was reflected in the lower production, which is not surprising. Grasses respond to N fertilization with increased growth, as N is the most limiting nutrient to plant growth under many different environments.

The lack of P fertilization via the –P treatment increasingly resulted in lower tissue P concentrations with harvests after June, 2016 (Fig. 2-6). This suggests that the plants had mined the more easily accessible P that was available to them. By May, 2017, the –P treatment had tissue values of <1 g kg^{-1} (or 0.1%). However, it had no deleterious impact on forage production and even without P fertilization, the –P treatment increased its tissue P content to values above critical sufficiency of 1.5 g P kg^{-1} or 0.15% (Fig. 2-6).

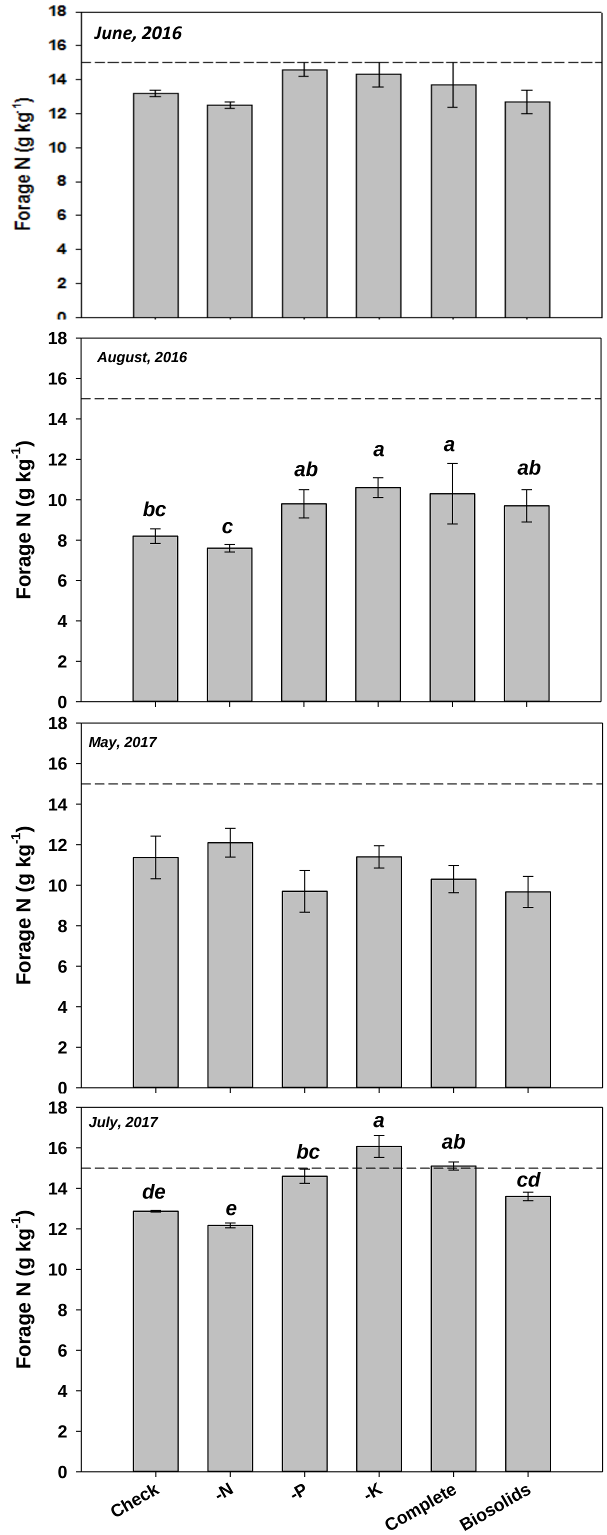


Fig. 2-5. Forage N concentrations from 2016 and 2017, as affected by fertility treatments. Shaded bars represent means ± standard errors. Bars sharing the same letters are not significantly different within a given harvest. The dash reference line provides an estimate of a potentially low sufficiency limit at 15 g N kg^{-1}.

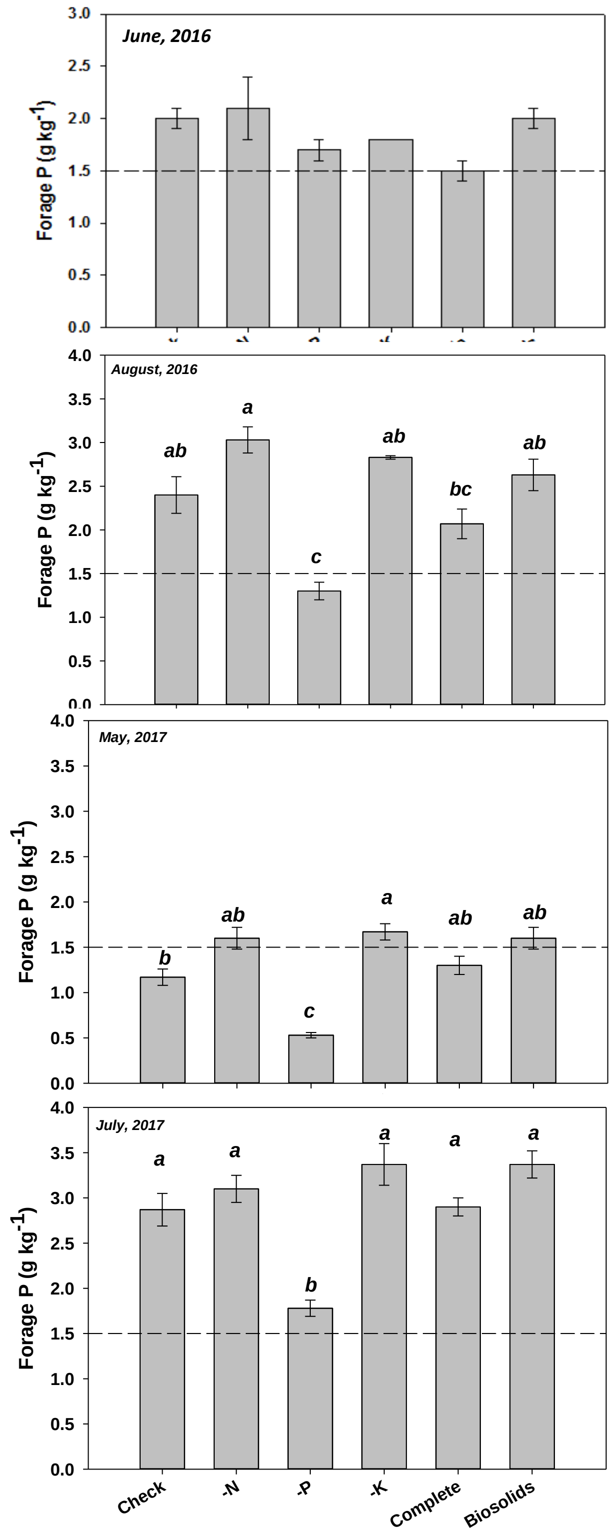


Fig. 2-6. Forage P concentrations from 2016 and 2017, as affected by fertility treatments. Shaded bars represent means ± standard errors. Bars sharing the same letters are not significantly different within a given harvest. The dash reference line provides an estimate of a potentially low P sufficiency limit of 1.5 g P kg^{-1}.

The lack of K fertilization via the –K treatment greatly lowered tissue K concentrations over time (Fig. 2-7). However, with the May, 2017 harvest, tissue from all fertilized plots had forage tissue K far below the sufficiency value of 12 g kg^{-1} (or 1.2%). Unlike N, the production losses from lack of K fertilization were slower to express itself, but with increasing soil depletion, it became clear that low K soil fertility was impacting yield with increasing harvests.

Discussion (Obj 2): For a second year, the omission plots clearly show that at this test location, N was the most limiting nutrient for forage production. In comparison, a lack of K fertilization often impacted yield but not to the same extent as a lack of N fertilization had, nor was it as severe. In contrast, depleted tissue P had absolutely no negative impact on forage yields, even at times when forage P fell below suggested sufficiency levels. It is interesting to note that with the May sampling, N, P, and K tissue content was low, regardless of fertilization treatment. The harvested tissue was from forage that had not been cut since the previous August. Additionally, it had been a dry winter and the grass did not grow. Old, weathered leaves (rank grass) are noted to lose nutrition over time if they are not cut or grazed to promote new growth.

It is interesting to note that a lack of P fertilizer often expressed itself as lower tissue P content but it never reduced forage production. In fact, it trended as one of the most productive treatments. Even without P additions, the plants seemed to have access to soil P reserves. In the greenhouse column study, we found as much total P in plants not receiving inputs as plants that received P inputs. The same response seems to have happened in the field. There is a small amount of P in the surface soils but a much larger reserve in the Spodic horizon, which is within 20 inches of the soil surface at this location. However, based upon the almost consistently lower tissue P values in plants with access to the Spodic P source, it suggests at least two different conditions, 1) the critical P sufficiency value is set higher than is necessary to support high bahiagrass production and 2) this bahiagrass is limited to how much P it can capture from the Spodic horizon and must rely more on P reserves closer to the soil surface. Grasses, as well as many other forage species, concentrate the majority of their root mass near the soil surface. Traditionally, it was accepted that plants predominantly took up soil P near the soil surface. It is only more recently that the lower soil depths have been considered major sources of P nutrition for bahiagrass. Further study is required to better assess P limits on long-term bahiagrass growth and sward longevity.in the field. However, it is becoming increasingly clear that for this location, greater forage growth can be obtained through increasing N and perhaps K fertilization practices.

Other plant essentially nutrients were measured and plots receiving Class AA biosolids tended to have higher tissue S concentrations. Although all plots received additional S via mineral fertilizer, tissue S sometimes dropped below sufficiency, but not so for the biosolids treatment. Sulfur helps protect against disease and helps with N nutrition.

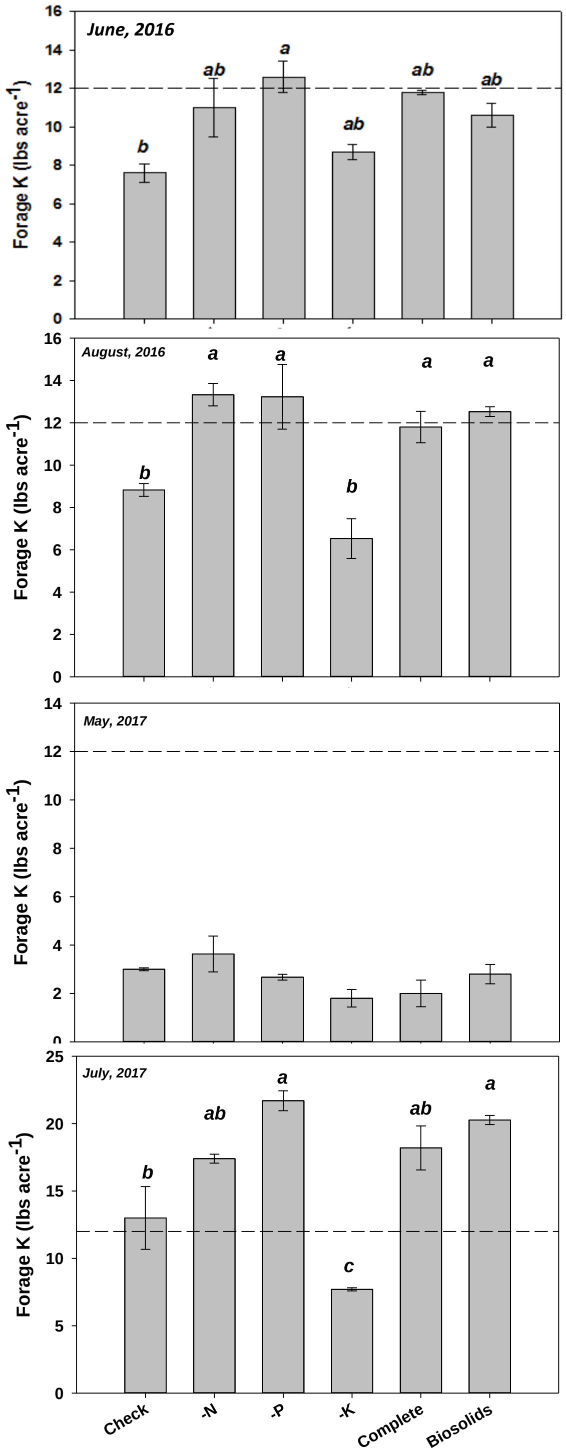


Fig. 2-7. Forage K concentrations from 2016 and 2017, as affected by fertility treatments. Shaded bars represent means ± standard errors. Bars sharing the same letters are not significantly different within a given harvest. The dash reference line provides an estimate of a potentially low sufficiency limit at 12 g K kg^{-1}.

Objective 3 (P and N fertilizer dose-responses)

Materials and Methods (Obj 3): We tested 'UF Riata' response to 0, 30, 60, and 120 lbs P_2O_5 ac^{-1} and 0, 60, and 120 lbs N ac^{-1}, using 1 kg pots filled with two of the same soil types that were used for the greenhouse column study (Objective 1). The soils were Ultisol at low inherent P fertility (Tifton series), Ultisol at high inherent P fertility (Orangeburg series), and a Spodosol A horizon with a low inherent P fertility (Myakka series). Other major (macro) nutrients were applied as a solution to ensure there were no other interfering nutrient limitations. Soil micronutrient fertility was not adjusted. The N fertilizer was applied as ammonium nitrate and the P as TSP. Fertilizers were thoroughly mixed with the soil and allowed to incubate in the greenhouse for a week prior to transplanting bahiagrass, cv Riata seedlings that were germinated in soilless potting mix. A plastic saucer was placed under each pot to limit the potential for nutrient loss from watering events. Greenhouse temperature averaged 24 C day/ 20 C night and RH averaged 70% day/75% night. Plants were grown over several weeks prior to destructively harvesting to gather biomass production and soil composition data.

The tissue was weighed, dried (60 C for 7 days) and dry mass determined. The tissue was ground to pass through a 2-mm screen, digested in concentrated HNO3 and 30%H2O2 (Jones, 1989), and analyzed for plant essential nutrients, including P via ICP-OES. Roots were rinsed with deionized water to removed surface soil, prior to drying. The air-dried soils were analyzed for Mehlich-3 extractable nutrients (including P, Fe, and Al).

Data were analyzed using PROC MIXED in SAS (SAS for Windows V 9.4, SAS Institute, 2009, Cary, NC, USA). A 4 x 3 factorial experimental design was used. Fixed effects included P and N treatments. Blocks were considered as random effect. The LSMEANS were compared using the PDIFF procedure adjusted for Tukey's test. Differences were declared significant at $P \leq 0.05$.

Results (Obj 3):The was a clear relationship between P and N fertilization on plant growth response, where increasing P or N resulted in increasing forage biomass for all three test soils (Fig. 3-1, left panels). In the case of the low inherent P Spodosol, increasing P fertilization all the way to 120 lbs P ac^{-1} (listed as P in Fig. 3-1), had no effect on forage yield, even as N fertilizer rates increased. However, by applying 30 lbs P_2O_5 ac^{-1} (P in Fig. 3-1, left panel), forage production increased significantly. Increasing N fertilization from 60 to 120 lbs N ac^{-1}, resulted in no greater forage production unless P was also increased to 120 lbs P_2O_5 ac^{-1}.

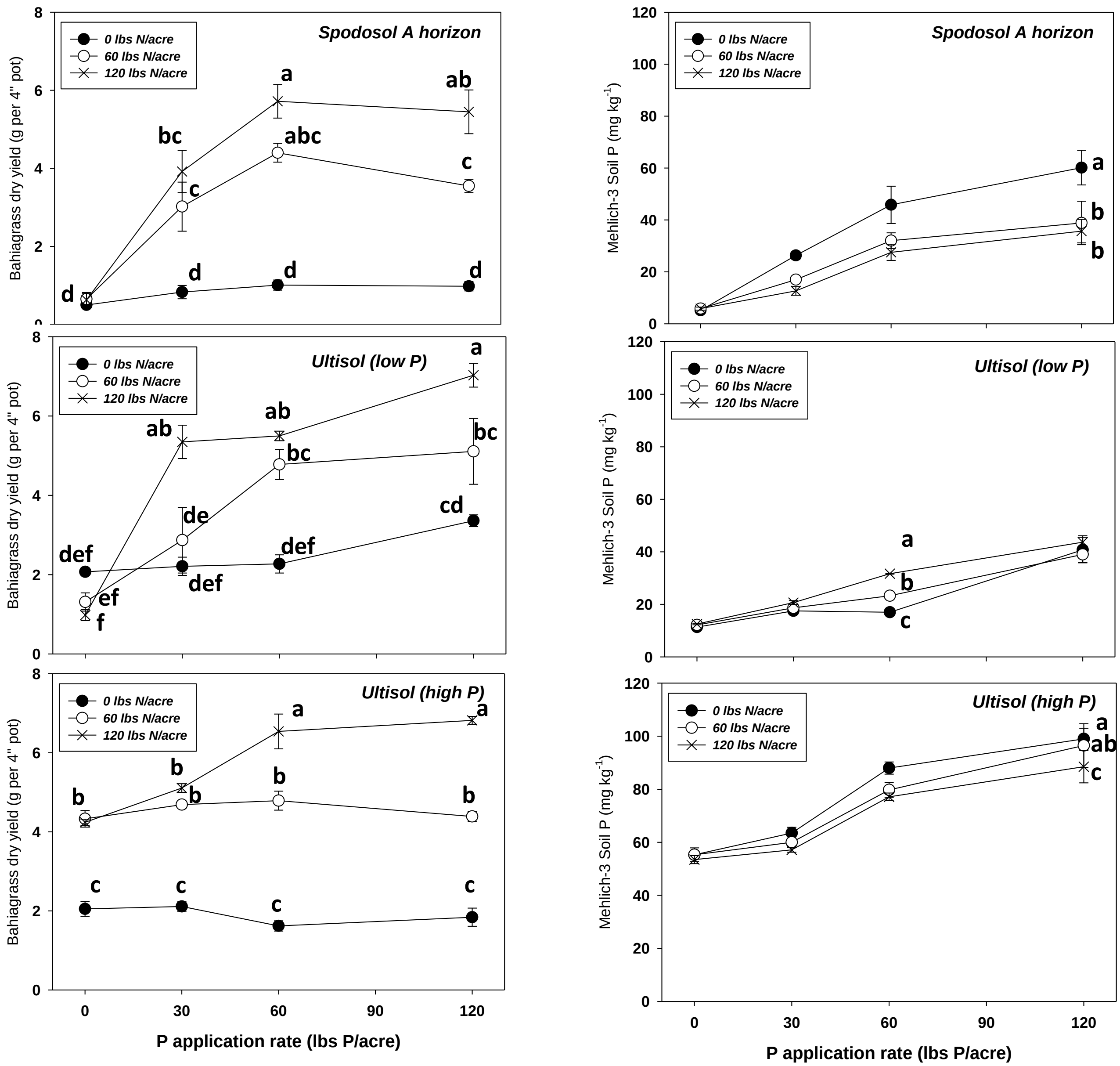

Spodosol A horizon
Ultisol (low P)
Ultisol (high P)
0 lbs N/acre
60 lbs N/acre
120 lbs N/acre
Bahiagrass dry yield (g per 4" pot)
Mehlich-3 Soil P (mg kg-1)
P application rate (lbs P/acre)

Fig. 3-1. Phosphorus by N fertilizer rate effects on forage production (left panels) and soil P fertility (right panels), using three three different Florida soil types. Each syymbol represents the mean of 3 replicates ± standard errors. Symbols sharing the same letters are not significantly different N rate at each P rate. Where there is one letter near two or more symbols, they all share the same letter or level of significance (left panels). The letters on the right panels represent differences assessing the N main effects only, rather than differences among N rates at each tested P rate.

Forage grown in the low inherent P Ultisol resulted to fertilization rate responses similarly to the Spodosol, where increasing P rates had no effect on forage growth without concomitant additions of N fertilizer (Fig. 3-1, left panels). The Higher P Ultisol had a similar response, as well. However, forage growth under zero N application rates was twice as great with the two Ultisol soils than the Spodosol soil type. The 60 lbs P_2O_5 ac^{-1} application rate resulted in the greatest forage production when N was applied at 60 or l20 lbs N ac^{-1} for either Ultisol soil type. Increasing P fertilization rates further, to 120 lbs P_2O_5 ac^{-1}, resulted in no additional forage production under any of the soil types, even when N fertilization was increased to 120 lbs N ac^{-1}. It cannot be determined from this experiment if higher N application rates would have increased forage production further. It is likely that it would, but fertilizer use efficiency (FUE) would drop considerably and often such high N rates are economically limiting.

As one might expect, there was generally a negative relationship between forage growth response and soil P concentrations at the end of the study period, except all soil types accumulated soil P with increasing P fertilizer application rates (Fig. 3-1, right panels). Greater forage production resulted in greater soil P uptake. The low soil P Spodosol and had similar inherent M-3 P values (0 P application rate), but the relative rates of P remaining in the soil with increasing N additions were more clearly defined in the Spodosol system. The high inherent P Ultisol also performed much like the Spodosol soil, except that it had inherently more P to begin with (merely a shift in response).

Discussion (Obj 3): These data demonstrate that applying P fertilizer without adequate N fertility will likely not increase bahiagrass yields. Unfortunately, it is not always easy to know if your N soil fertility is adequate, since Florida labs do not analyze for soil N fertility. However, plants are visually responsive to N fertilizer and one can, with practice, become familiar with the signs that the forage may benefit from additional N fertilizer applications. Additionally, UF-IFAS has provided N recommendations for many different crops, including bahiagrass. Following these recommendations will likely provide adequate guidance towards productive forage nutrient management. The heavier soils demonstrated some production benefit by increasing N application rates from 60 to 120 lbs N ac^{-1}. However, it should be noted that it comes at an economical and environmental cost. In many Florida pasture systems, N application rates are targeted at approximately 50 lbs ac^{-1}. This is a good baseline since it lessens the risk of N leaching from a single high application rate and it won't break the pocketbook.

We proposed to further address P and N fertility interactions in the greenhouse with different bahiagrass cultivars (Pensacola, Argentine, and Riata) and soil types (Spodosol A horizon with inherent low P, Spodosol A horizon with inherent medium P, Ultisol A horizon with inherent low P, and Ultisol A horizon with inherent medium P). To better understand the response to fertility.

Objective 4 (On-farm soil P source and rate trial)

Materials and Methods (Obj 4): This study was initiated in 2017 at the Silver Spurs Ranch in Kenansville, FL, where the Omission plot testing is located (Objective 2). This location has a Myakka (Spodosols) soil series with low soil test P in the A horizon and medium soil test P in the spodic (Bh) horizon that resides within two feet of the soil surface. This site illustrates the risks many ranches in the region face when fertilizing with P. Data from FCA funded column study demonstrated that P source affected both, yield and soil P storage capacity (SPSC). Additionally, plants in the column study significantly increased the SPSC through P uptake. Forage production is maximized from June through July, when day-lengths are longest. It seems reasonable that bahiagrass may gain the most benefit from nutrient inputs during that period of maximum forage growth, particularly when applying a sparingly available nutrient, such as P.

The treatments were as follows: 4 P sources (40 lbs P_2O_5 application) 1) triple super phosphate or TSP, 2) struvite (recycled from municipal waste water treatment, 3) Class AA biosolids, and 4) biochar from biosolids, which equates to a total of 39 plots. We also included a check treatment (no P additions). The 3 P application times were as follows: 1) single application in May (Early), 2) single application after the first cutting in July (Late), and 3) split application of 50% in May and 50% after first cutting in July. Other macronutrients (N, K, S, Mg) will be normalized among treatments, based upon respective fertilizer nutrient content, to supply 50 lbs N, 40 lbs K_2O, 20 lbs S, and 11 lbs Mg per acre.

Initial soil samples were collected from each 10 ft x 20 ft plot at 3 soil depths (A horizon or 0-6 inces), E horizon (6-12 inches) and upper Bh horizon (approximately 18 to 24 inches (taking a 6 inch depth sample). Soils were air-dried and passed through a 2-mm screen. The samples were analyzed for soil fertility and Al as M-3 extracts.

Over the coming year, we will develop a set of sequential soil P extractions to better assess soil P forms, impact on soil P fertility and environmental impact. This will aid in our understanding of P contributions from the various P sources by identifying the P forms in the soil pre and post fertilization. Soils will be sampled again in the fall, following the final seasonal harvest of 2017 and 2018.

The site was managed as pasture until the time of testing. At that time, temporary electrical fencing was installed, in order to better assess bahiagrass yields due to fertilizer inputs without short-term interference by cattle. The forage was harvested 7/11/17 and will again in Sep, 2017, to assess forage yield differences. The forage sampling was taken by mowing a 48” long by 21” strip from each plot, using a manual mower and bag. Following sampling, the remaining forage was cut with a hay cutter, manually raked, and removed. A push mower with bag attachment was used to stage the area to 3 inch stubble height across the entire field site and plots re-fertilized with amounts, as listed above. The sampled forage was dried (60 C for 7 days), weighed, and ground to pass through a 2mm sieve. Tissue samples were sent to a commercial lab (Waters Agricultural Laboratories, Camilla, GA) for crude protein and nutrient composition. At the end of Year 2, rhizomes + roots (approximately 1 square foot and 4 inches deep) will be sampled for dry yield and nutrient content.

Data were analyzed using PROC MIXED in SAS (SAS for Windows V 9.4, SAS Institute, 2009, Cary, NC, USA). Fixed effects included fertilizer treatment, harvest date, and soil depth. Blocks were considered as random effect. The LSMEANS were compared using the PDIFF procedure adjusted for Tukey’s test. Differences were declared significant at $P \leq 0.05$.

Results (Obj 4): As of the time of the first forage sampling, the late P application had not been applied, as it was scheduled for after the first forage harvest, which happened on 7/11/17. Therefore, the late P application plots should have biomass yields similar to the Check (no P applied) plots for the July harvest (Fig. 4-1). There were no P treatment effect differences among P sources or timing. This is not unusual, as the response to P fertilizer typically takes longer than a few weeks.

Nitrogen fertilization as total N was equivalent among P treatments, and this is reflected in the tissue concentrations, where averaged approximately 15 g kg^{-1} or 1.5% (9.4% crude protein). Crude protein above 9% is generally considered adequate for bahiagrass pastures. The forage P concentrations also did not differ significantly among the P fertilizer treatments, which is somewhat similar to what we experienced with early plot sampling in previous P application studies, such as the Omission plot study (Objective 2). Even so, there seems to be a trend of slightly higher tissue P from the TSP early and split applications and perhaps a trend of lower P in the biochar treatment. If this holds, then tissue P concentrations will reflect this in later samplings.

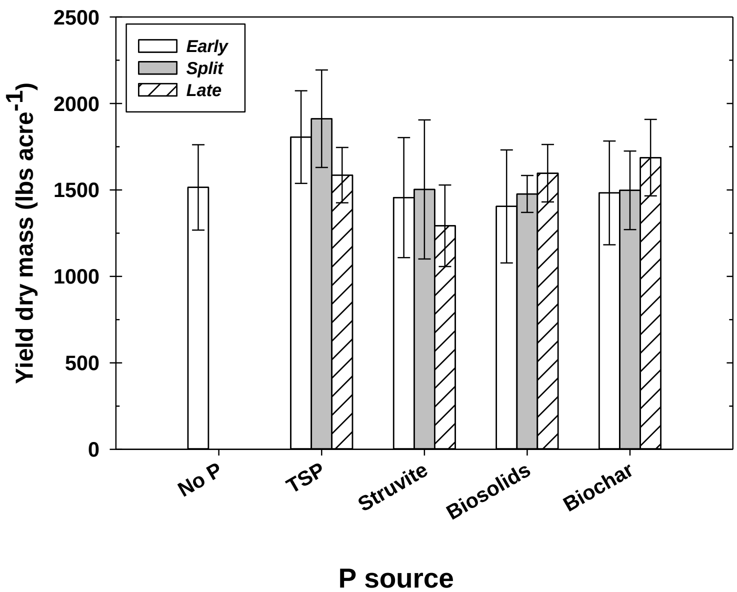


Fig. 4-1. Forage yield from 7/11/17 harvest, as affected by fertility treatments. Broad bars represent means ± standard errors.

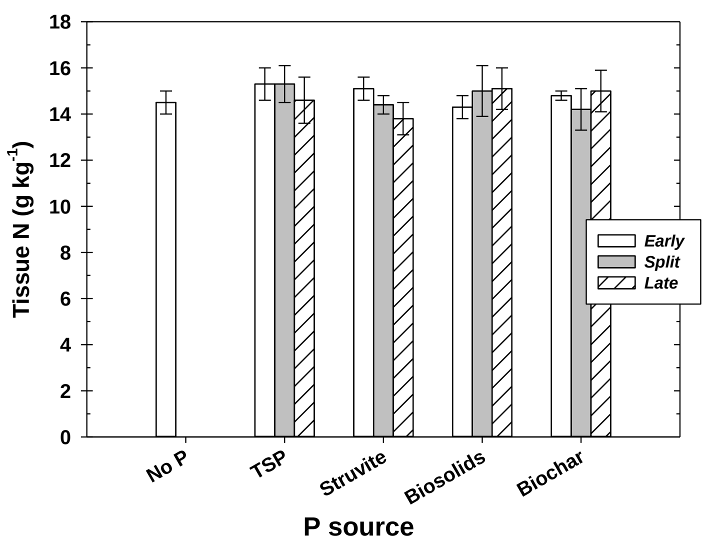


Fig. 4-2. Forage tissue N concentrations from 7/11/17 harvest, as affected by fertility treatments. Broad bars represent means ± standard errors.

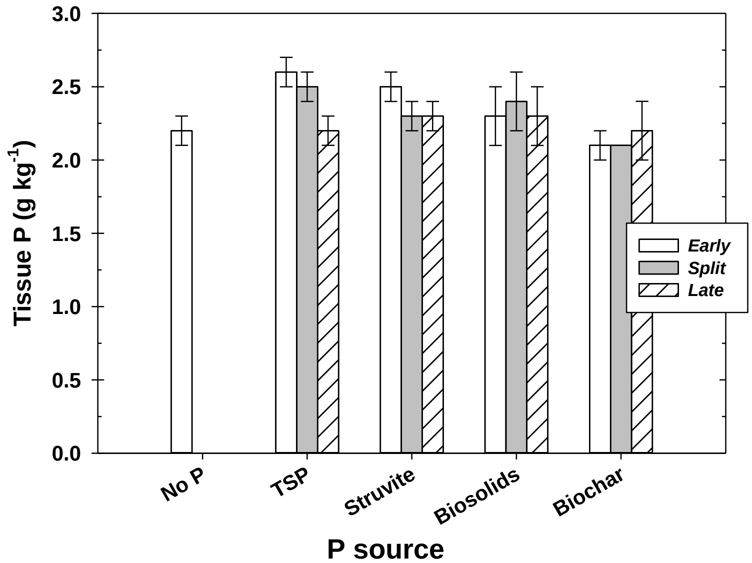


Fig. 4-3. Forage tissue P concentrations from 7/11/17 harvest, as affected by fertility treatments. Broad bars represent means ± standard errors.

The forage K concentrations were similar among fertilizer treatments, as one would expect, since all treatments received the same quantity of K. The late Biochar treatment K value appears to trend higher but statistically it is no higher than the other treatments. Since at this stage it received no more nutrients than the No P control.

The initial soil M-3 extracted soil nutrients were as follows: In the A horizon (0-6 inch depth), P and K were 31.0 ± 13.9 and 44.4 ± 42.0 ppm, respectively. In the E horizon (6-12 inch depth), P and K were 16.3 ± 22.5 and 15.0 ± 15 ppm, respectively. In the Bh (spodic) horizon (18 or greater depth), P and K were 243 ± 120 and 15.8 ± 9.9 ppm, respectively. Soil pH at all sampling depths were between 5 and 5.5.

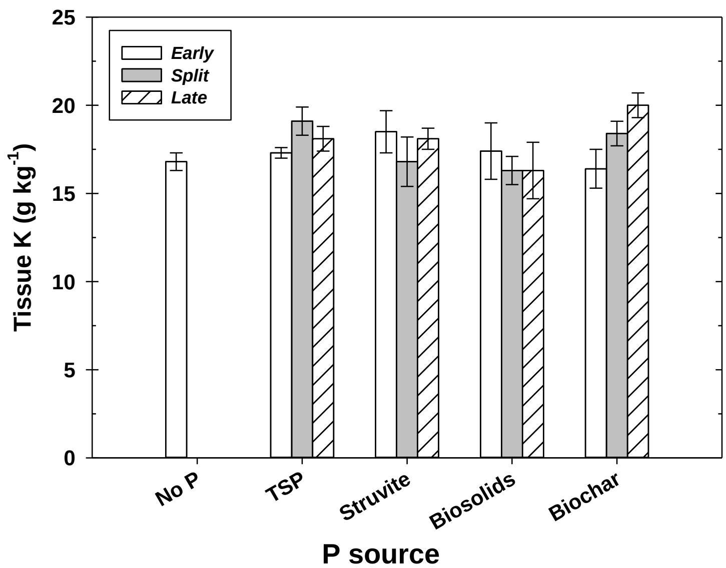


Fig. 4-4. Forage tissue K concentrations from 7/11/17 harvest, as affected by fertility treatments. Broad bars represent means ± standard errors.

Discussion (Obj 4):

At this early stage, there is not much to ponder about results, other than response to P fertilizer applications in the field typically take several months to express itself, as we have observed with past field studies. The soil samples were collected from each plot to better monitor fertility variability. It is noted by the relatively high standard deviation values, that there is a fair amount of nutrient variability in the surface soils (0-6 inches). The relative variability decreases in the Bh horizon, where distubances are less. We look forward to the second 2017 harvest and those planned for 2018.

DELIVERABLES

Objective 1: The final samples were analyzed as planned and data is being compiled into publications to refereed journals. In addition, data from this objective was presented as a poster at the UF Soil and Water Sciences Department annual symposium last September This was followed by an abstract that was submitted to Soil Science Society of America meetings in Phoenix AZ last November (see Appendix for details).

Objective 2: Omission plot testing has nearly completed its second and final season. Forages were sampled 4 times, with a final sampling scheduled for September, 2017, along with final soil samplings with depth. Results from this work will be developed into an EDIS publication to aid county agents and others on how they might test for suspected, chronic nutrient deficiencies in their fields and pastures.

Objective 3: We completed the sampling and analyses of three soil types and 1 bahiagrass cultivar at different rates of P and N fertilization in the greenhouse. Due to labor shortages and a delay in funding, we were late in initiating a second study. However, over the next year, we will be able to meet our objectives and complete all four testing schemes. When completed, we will have a thorough response surface to better understand the interaction of P and N fertilization and its potential effects on the three main bahiagrass types grown in Florida (a low-input, diploid, a low-input tetraploid, and a highly productive diploid). These data will be published in research and extension publications over the course of the next 12 to 18 months.

Objective 4: We initiated the P source and rate field trial at Silver Spurs as projected. However, we were unable to recruit a MS student to the project since the supporting funding was not expected to cover beyond 2017. We will continue to look for opportunities to fund a student to help with this work and also rely on Oseola extension staff to assist with work at the Silver Spurs Ranch. An extension meeting is planned for this fall, where updates on our efforts being funded by FCA and particularly the work at Silver Spurs Ranch will be highlighted.

Budget Expenditure Summary

The large majority of the anticipated budget for 2017 was to be used to support a MS student to address the proposed objectives. Due to funding complications we were unable to develop that position. The FCA funding did not get into place until April, 2017. Additional staffing changes in my program and a university-level hiring freeze led to more delays in hiring new labor to support the project. Most of the labor deficit has been resolved over the past couple of months. This has led to a large surplus in budgetary funds to be returned to the sponsor.

Of the approximately $21,300 in expenditures for 2017, roughly 60% was used towards labor costs, another 30% was used for materials and supplies, including analyses, and the remaining 10% was used for travel to Silver Spurs and trips related to trainings and associated FCA forage-related interests in the region. See Table 2.

Further Reading

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Appendix . Presentations related to Objective 2.

Abstract and poster to UF Soil and Water Sciences Symposium, September 2016.

Use of biosolids in reducing phosphorus loss from Florida agricultural soils

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Alternate sources of phosphorus (P) fertilizer are needed to secure the potential supply shortage of global P reserves. Biosolids, a by-product of municipal wastewater treatment, is an attractive source of slow-release fertilizer P but there are concerns that biosolids are being over-applied on grazing lands in central and south Florida, and thereby impacting water resources. A five-month column experiment was conducted in a greenhouse with two Florida soils, a Spodosol (Myakka) and an Ultisol (Orangeburg) and six different P sources (triple super phosphate or TSP, struvite, Class AA1 and Class AA2 biosolids, Class B biosolids, and biochar made from Class B biosolids). The soil P storage and release patterns in the two soils were determined. A P-loss risk assessment, based on a threshold P saturation ratio (PSR; a molar ratio of Mehlich-3 extractable P to [Fe+Al], beyond which P release increases sharply) was determined. The soil P storage capacity (SPSC) was calculated using the threshold PSR to assess potential environmental P-loss risk. Mehlich-3 P, Fe and Al, and water soluble P (WSP) at a 1:10 soil: solution ratio was analyzed at experiment termination (20 weeks). The amount of releasable P was lower in columns receiving biosolids than the two inorganic P fertilizers (TSP and struvite) and P loss from struvite was lower than from TSP. The soils receiving Class B biosolids retained more P than soils receiving Class AA biosolids or biochar made from Class B biosolids, regardless of soil type. This study confirms that release of P from agricultural soil can be reduced by substituting biosolids and other recoverable P (biosolids-derived biochars and struvite from wastewater treatment) for conventional P fertilizers. Increasing their use may help reduce reliance on global P reserves.

Abstract and poster to Soil Science Society of America, November, 2016.

Soil phosphorus storage capacity in Florida soils receiving fertilizer alternatives

Biswanath Dari[1], C.L. Mackowiak[1], Vimala Nair[2], J.P. Shirley[1]

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Global phosphorus (P) supplies are dwindling and thus there is a need to identify and develop alternative P fertilizer sources. Even so, P-impacted soils are also a concern and threaten water resources in some agricultural regions of the U.S., including south Florida. Slow-release, P fertilizer recovered from municipal waste water treatment as biosolids, have been used in the past and new products, such as struvite, are being developed. Assessing their impact on land found in Florida agricultural areas will help in the continued development of Best Management Practices (BMPs) and provide data for land and water managers tasked with minimizing P impacts in sensitive areas. A column experiment was conducted in greenhouse using two different agricultural soils (Spodosols and Ultisols) at Quincy, Florida. The aim of this study was to test Class B, Class AA, and biochar prepared from class B biosolids as organic P sources, compared to inorganic P fertilizer sources (struvite and triple super phosphate) mixed with two different soils on P retention and ortho-P release in unplanted soil columns. A P loss risk assessment, using a threshold P saturation ratio (PSR; a molar ratio of Mehlich-3 extractable P to [Fe+Al], beyond which P release increases sharply) was also determined. The soil P storage capacity (SPSC) was calculated using threshold PSR to assess potential environmental risk. After 12 weeks, the unplanted columns were analyzed for Mehlich-3 P, Fe, Al, and water soluble P (WSP). The PSR and SPSC values were calculated. Water soluble P, an indicator of releasable P in soil following rainfall/irrigation events was: TSP>struvite>biosolids>control (unfertilized soil). Results suggest that biosolids and biochar derived from biosolids might make a suitable P fertilizer alternative, due to reduced short-term P availability in soils.

Table 2. Summary of expenditures and percent completion for 2017.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND APPLICATION					
PROJECT TITLE & FCEB #: Options for Phosphorus Fertilization and Retentionin Bahiagrass Pastures #24122					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Sample preparation and chemical analysis (Objective A)	258	100	$ 6,330.87	Expenses associated with tissue preparation (grinding) and analyses (plant essential nutrients in tops and roots)	9/01/2017
Sample preparation and chemical analysis (Objective B)	90	65	$ 4,259.87	Expenses associated with harvests, tissue preparation (grinding) and analyses (plant essential and soil fertility). A final, season-end (September 2017) forage harvest, soil collection (2 depths), and analysis is anticipated.	9/01/2017
Experiment initiation, management, and chemical analysis (Objective C)	135	60	$ 4,698.32	Expenses associated with harvests, tissue preparation (grinding) and analyses (plant essential nutrients in tops and roots), and soil anaylyses for P, Fe, Al. One of two expected 2017 trials was completed. Second was initiated.	9/01/2017
Experiment initiation, management, and chemical analysis (Objective D)	195	100	$ 6,023.81	Expermiental site was prepared, initial soil samples(3 depths) collected and two forage harvests completed.	9/01/2017
Final Research Project Report		100		Project report detailing research, which includes results, conclusions and future research needs	9/01/2017
GRAND TOTAL: (equal to percentage of completion)			**$21,312.87**		

Florida Cattle Enhancement Grant
Final Report
September 1, 2017

Optimizing Herbicide Rates for Wiping Smutgrass and Impacts of Rainfall and Non-structural Carbohydrates on Smutgrass Control

Investigators: Brent Sellers, Jose Dias, and Jason Ferrell

Award ID: FCEB 39; AWD01685

Background. Giant smutgrass [*Sporobolus indicus* (L.) R. Br. var. *pyramidalis* (Beauv.) Veldkamp] is native to tropical Asia, but has become a problematic weed in improved and native perennial grass pastures in central and south Florida. Control of giant smutgrass can be achieved with 1.0 lb/ha 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). Within the first year after hexazinone application, control of giant smutgrass often exceeds 90%, but it often becomes reestablished to original densities within 3 years after treatment. Additionally, hexazinone application costs approximately $40-50/acre for this level of giant smutgrass control. Hexazinone is not an option for smutgrass control near sensitive oak species, and control of smutgrass clumps in these areas is limited to spot-treatment with glyphosate.

Recent advances in wick-wiping devices, such as the roto-wiper, have resulted in the renewed interest in using this equipment for selective control of weedy species in pastures, especially smutgrass. Information necessary to use this equipment effectively and efficiently is needed to optimize smutgrass control. Operators of this equipment have been utilizing different concentrations of either glyphosate or hexazinone with various results. Therefore, determining the optimum rates for glyphosate and hexazinone is needed.

Although wiping smutgrass with either glyphosate or hexazinone is a potential tool for some growers, broadcast applications of hexazinone are likely to continue. Previous research (Mislevy et al. 2002) and preliminary results from 2016 indicate that rainfall is a major component of smutgrass control with hexazinone. Many pasture-level failures have been attributed to limited or excessive rainfall following hexazinone application; however, the amount of rainfall necessary to achieve optimum results is not well understood. The addition of adjuvants that purportedly decrease herbicide leaching is one option to help aid in achieving satisfactory results using hexazinone after large rainfall events. Therefore, research is needed to understand the effect of rainfall on smutgrass control following hexazinone application, and the use of specialized adjuvants to potentially decrease leaching.

Another component of smutgrass management may be related to plant physiology. Many have reported that total non-structural carbohydrates (TNC) in plant crown tissues are directly related to the level of control with herbicides (Kalmbacher et al. 1993; Mislevy et al. 1999; Mullahey and Cornell 1994; Wilson et al. 1975). Nearly all research to date has indicated that hexazinone should be applied from July through September for optimum smutgrass control, and this has always been correlated with timely rainfall needed for hexazinone incorporation into the soil solution. However, timely rainfall is often received in September, and control failures have been observed following September hexazinone applications. Therefore, smutgrass crown TNC concentrations may also be an indicator for timely hexazinone applications to obtain optimum control.

Approach.

Wiping experiment. Plots were established in smutgrass-infested bahiagrass pasture near Bowling Green to validate the appropriate glyphosate and hexazinone rates for use in large-scale field wiping systems. A hand-held wiping system (Wagner Smart Roller™) was utilized for wiping herbicide onto individual smutgrass plants on August 17, 2017. The experiment was conducted using a randomized complete block design with four replications using a 2x8 factorial treatment arrangement of two herbicides ([1] glyphosate; [2] hexazinone) and eight herbicide rates (0.0312, 0.0625, 0.125, 0.25, 0.5, 1, 2 and 4 times the X rate). The X rate for weed wiper applications with glyphosate was a concentration of 20% v/v; and for hexazinone the X rate will be 50% v/v. Since there is very little information regarding the use of hexazinone in wipers, the X rate were based on previous experience and research using older wick-type weed wipers as well as price. A nontreated control was also included. Smutgrass control will be visually estimated at 30, 60, and 365 days after treatment (DAT). These data will be utilized to determine the appropriate rates of these herbicides for use in a separate large-scale demonstration and research plots using anticipated funding through USDA-NRCS.

Effect of rainfall on hexazinone activity. Greenhouse and field experiments are being utilized to examine the effect of rainfall on smutgrass control with hexazinone. Field experiments are being conducted by applying hexazinone at 0.5, 0.75, and 1.0 lb/acre onto 10 x 90 ft plots, replicated four times in a randomized complete block design. Herbicide treatments are applied weekly, beginning in April and ending in October, and visual estimations of smutgrass control are recorded 30, 60, and 365 days after treatment. Since rainfall cannot be predicted in the field, greenhouse experiments will be utilized to determine the amount of rainfall needed for optimum hexazinone activity and minimal leaching; two experiments will be conducted. In the first experiment, smutgrass are being grown in gallon-size pots filled with soil collected from the field. Plants will be at least 15 inches tall and 4 to 6 inches in diameter prior to treating with hexazinone at 0, 0.56, 0.75, and 1.0 lb/acre with and without Grounded. After herbicide application, rainfall will be simulated at 0, 0.25, 0.50, 1.0, 2.0, 4.0, and 8.0 inches. Smutgrass control will be estimated visually at 15 and 30 DAT, and by recording live biomass at 30 and 60 (regrowth) DAT. In a second greenhouse experiment, the same hexazinone treatments as in the first greenhouse experiment will be utilized. However, rainfall will be delayed by 0, 3, 7, 14, and 21 days after application to determine the longevity of hexazinone activity if rainfall is not received immediate after application of hexazinone. Currently plants are in the growing phase in the greenhouse and no treatments have been applied.

Total non-structural carbohydrates. Four smutgrass plants are dug monthly from at least 5 locations throughout central and south Florida and will be continued over a 2 year period in conjunction with participating county faculty. Once plants are dug, fibrous roots and top growth will be removed prior to placing plant samples on ice for transport to the laboratory. Once at the laboratory, plants will be processed further by removing all but 1 inch on top and bottom of the crown and placed in a freezer until all samples have been collected. Once all samples have been collected, they will be removed from the freezer, dried at constant temperature and ground for TNC analysis. A rapid analysis technique will be utilized for TNC concentration as described by Zhao et al. (2010).

Results. No significant results have been obtained to date in these experiments. Weekly applications of hexazinone to correlate rainfall with hexazinone efficacy was initiated near Ona. We continue to apply these treatments past the date of this report. As expected, our initial results show that without rainfall hexazinone does not adequately control smutgrass, and excessive rainfall (> 3 inches) within a week following application also results in reduced efficacy (data not shown). Final results for this experiment will be available by June, 2018. We expect data to look similar to that recorded in 2016 (Figure 1), however, efficacy was reduced significantly in early 2017 due to early season drought.

Acknowledgements. We wish to thank our cooperators, Al Holland, Gene Lollis, and Michael Spears for allowing us to conduct this research on their ranch. Additionally, county extension faculty including Lindsey Wiggins, Christa Kirby, Bridget Stice, Aaron Stam, Lauren Butler, Sonja Crawford, and Colleen Larson have been assisting through smutgrass clump collection for TNC analyses.

Percentage of Completion for 2017: 100%

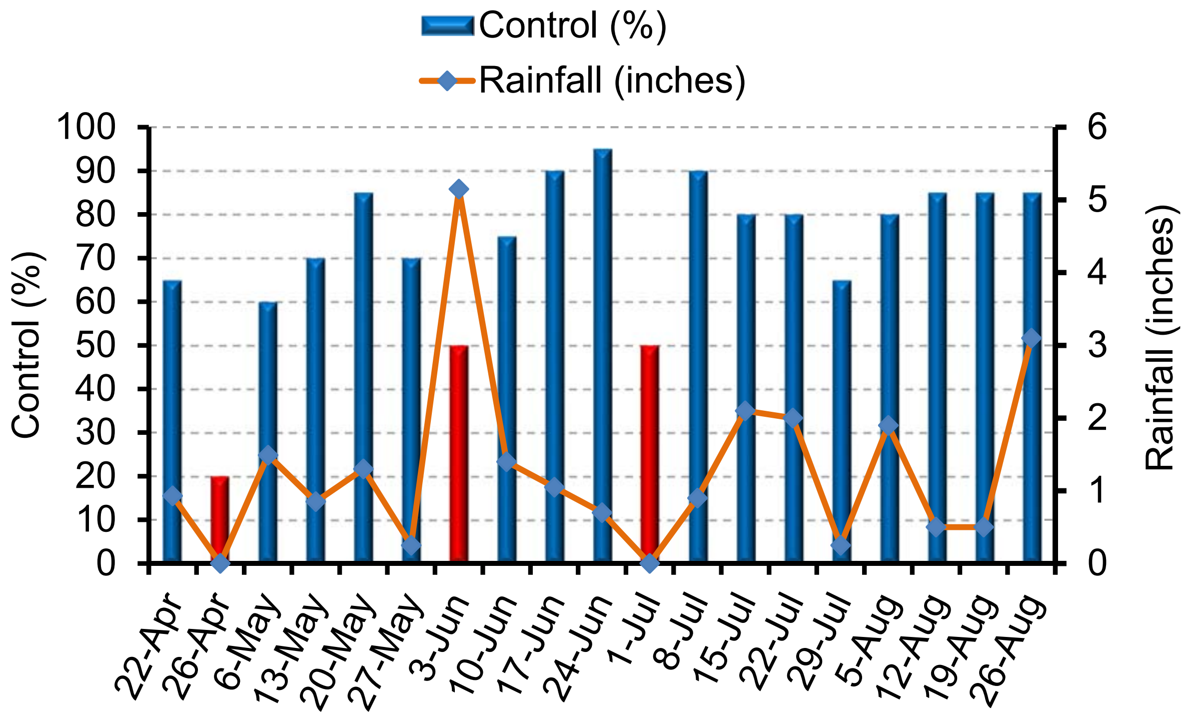


Figure 1. Impact of rainfall on hexazinone efficacy in 2016. Hexazinone was applied weekly at 2 qt/acre and rainfall was recorded for each week after application.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Optimizing Herbicide Rates for Wiping Smutgrass and Impacts of Rainfall and Non-structural Carbohydrates on Smutgrass Control, FCEB 39					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Herbicide	9	100%	$ 399.54	Herbicides were purchased for use in wiping experiments; Velpar at $80/gallon (2.5 gallons) and Glyphosate at approximately $18/gallon (7.5 gallons) were purchased.	9/1/2017
Materials and Supplies	n/a	100%	$ 3,780.05	Lab, greenhouse, and field supplies including hand wiping devices (small plot wiper applications), rainfall data loggers	9/1/2017
Plot preparation	n/a	100%	$ 17,491.24	Expenses associated with plot preparation: includes but not limited to: plot markers, fuel, sampling supplies, tape measures, rainfall data loggers, and sampling supplies.	9/1/2017
Equipment maintenance	n/a	100%	$ 155.72	Repairs for sprayer and wiping devices.	9/1/2017
Indirect Cost	N/A		$ 2,523.43		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 24,349.98**		

Florida Calf Loss – Final Report 2017

PI Contact Details: Raoul Boughton, Assistant Professor: UF Range Cattle REC, 3401 Experiment Station Ona, 33875 Florida. rboughton@ufl.edu Ph: 863 735 1314.

Co-PI: Liz Steele, DVM. **Co-PI:** John Yelvington, DVM **Collaborators**: Alex Johns, Cliff Coddington, Gene Lollis, Wes Carlton, and FDACS – Bronson Animal Disease Diagnostics Laboratory, USFWS and FWC.

Summary

In year 1 (2017) of the study we have secured all the equipment and supporting supplies to undertake calf loss studies on three ranchers, one more set than initially planned. The first of these ranches has had gateway tower equipment set-up completed, equipment tested and footprint of sensor readability mapped. Initial herd has had baseline samples taken and palpation completed by ranch employed veterinarians. The second ranch will be set-up in September 2017 and the third ranch December 2017. Our initial timeline included a spring calving in 2017 but we adjusted the timeline of objectives and rearranged spending across our multi-year project due to the inability to have equipment on hand for the spring calving season. During Phase 1 of study we also identified several improvements that needed to be made with equipment so as to increase our capability and logistical ease to follow calf loss. The manufacturing company has made refinements to equipment, improving function to allow greater coverage and ease of recovery in a beef cow-calf pastured system. Furthermore, we have made improvements for sampling procedures and increased the extent of testing available to the project through BADDL. In addition we have secured the full use of a 4x4 Chevrolet truck on permanent loan from the US Fish and Wildlife Service for the project, and the Florida Wildlife Commission and USFWS staff associated with predator identification of livestock kills have agreed and been given permission to support the project with confirmation of calf loss kills for the project with onsite visits. The support and encouragement of multiple agencies to gain the most informative and accurate results from this project is a testament to the willingness and collaborative support that is being invested to improve our knowledge of the difficult issue of calf loss in the livestock industry.

Objectives:

Each phase listed below comes from the original submission. Updates on each phase have been discussed if occurring in year 1 of study.

Phase 1: A test of the birthing sensory equipment needed to undertake the study was implemented September 2016 and completed January 2017 (funded in kind with materials and time by Medria INC, Ridge Large Animal Veterinary Services, Buck Island Ranch and UF RCREC).

This test at Buck Island Ranch showed that the sensor equipment deployed in the birthing canal of cows is retained for the period needed for the study (90-120 days), with constant temperature logging, and calving alerts sent to tracking website and via text messaging using gateway base station (cellular modem), with no connection failures. There were several sensors that failed 30-60days into the test and were identified as faulty due to a battery power regulator modification, this modification has since been replaced and fixed. During phase 1 several important concerns were raised about sensor and gateway capabilities, relating to spatial coverage of base station and ability to find sensors in the field once expelled.

Concern 1: Spatial Coverage

Keeping in mind that the original equipment had been designed for an "*in barn*" scenario, the coverage of the base tower gateway was of concern after initial implementation and testing suggesting a maximum limit of quarter mile from gateway. A typical size 250-400ac pasture was requested and we are pleased to say that updated technology has allowed a footprint measurement of 600acres, about half mile from central base tower gateway. In addition to this increased footprint we were concerned about "dead zones" or areas were dense vegetation may block sensor signals to gateway, and the system now includes an ability to add moveable repeaters that can be placed to improve signal function from sensors to tower and improve coverage. The repeaters can also be used to increase the footprint by another quarter mile.

Concern 2: Sensor Retrieval

After the test study it was obvious the hardest issue to solve in an open pasture system was location of sensor and the associated birthing event. The "*in barn*" version does not require tracking of sensor to find calf. The sensors are now fitted with two features to allow their recovery in a pasture situation. The first is a visual signal in the form of a bright red LED light. The light can be seen from half a mile away and is an excellent tool at night when most calves are born. The second is a blue tooth receiver that allows connectivity to any blue tooth device. Currently the distance of use is about 50-75 yards but by the end 2017 the tool will allow detection of sensors from 300 yards away. There was discussion to use GPS locators but these are costly to add to the sensor and have high battery consumption that in turn severely reduces the lifespan of the re-usable sensors.

Phase 2: Year 1 of study will be used to solve any methodological issues and only require equipment and staff to implement two cattle ranches at a time (repeatable in spring and fall to cover 4 ranches total).

This phase was modified to be implemented on three ranches in fall of 2017. During Phase 1 of study and now in Phase 2 we have worked on implementing the field based gateway tower, acquiring multiple sets of equipment, implementing the first ranch set-up at Big Cypress, fine-tuning calf loss procedures and sample collection with BADDL, registering with Department of Interior for use of VHF frequencies, coordinating with Florida Wildlife Commission and US Fish and Wildlife Service to undertake and support suspected predator caused calf loss site reports.

Initial Set-Up Big Cypress

The Big Cypress location ended up being our first set-up because of the timing of calving being earlier than our other two sites. The site is situated south east of the Big Cypress Seminole township and abuts the Big Cypress National Preserve north of Interstate 75. Set-up began in July 2017 after equipment arrived. A two day instrumentation set-up and test was performed by John Balbian (JMB cow monitor), Emmanuel Monier (JMD cow monitor France), Dr Raoul Boughton (RCREC) and Alex Johns (Seminole Beef). During this process complications connecting with AT&T were solved, location of tower decided, and footprint of signal read measured. In August of 2017 Dr Boughton completed the set-up of tower equipment and migrated full set-up onto 100% solar power (Figure 2).

Figure 1: Big Cypress Calf Loss location – Mary Jene Koenes ranch with tower location (red star), cross fencing (black lines) and boundary fence roads along which tower footprint was recorded and 100% successful in communication (area 380acres).

Figure 2: Final set-up of gateway tower on Big Cypress ranch fully operational on solar power (right upper panel), mounted on power pole specially erected by Heath Crum (Seminole Beef) and crew (left panel). Arrival of first batch of new LED red light sensors (right bottom panel)

Birthing system sensors and gateway equipment, ear tag mortality tracking and logger system equipment purchases, utv support vehicles, materials needed to observe calves at night, and materials for sampling, immobilization, and data storage have been accrued to support three set-ups and sampling of calves and cows for these three ranches (see attached budget justification). First calves are expected on the ground in October and will continue into April for these three ranchers.

Ear-tag VHF Transmitters Frequencies

An unknown issue raised itself when we applied to register for 330 independent VHF frequencies for each unique calf. There were not that many frequencies available in Florida in the research bandwidth. The Department of Interior listed over 60 active research projects in Florida. It is important to have unique frequencies and no overlap of projects in the same area. In the end we were able to identify 110 unique frequencies (i.e., on set-up) and those frequencies would be repeated three time. The disadvantage 110 frequencies is calving pastures cannot not be within 10 miles of each other, and equipment cannot be shared among sites due to duplication.

BADDL increased testing

Through support and feedback from BADDL we have adjusted our sampling so it will include an initial herd health test, where 25 of the 110 pregnant cows will have tests to asses general herd health. These will include cellular blood counts, blood chemistry profiles, and cervix swabs. An increased panel of tests has been organized for calves and cows depending on the field conditions under which they were found dead (See Appendix I for test list). Not all tests will be run on every calf. For example if a calf was observed healthy, nursing and no physical signs of distress, and later found killed with evidence of a predator (e.g., showing hemorrhaging, bruising, bite wounds, evisceration), a narrower set of health and disease sampling will be undertaken.

USFWS and FWC Commitments

In addition to funding from the FCEB and support from BADDL, the project has garnered support from the conservation and wildlife community, with USFWS providing a 4x4 Chevrolet truck for the lifetime of the project, and USFWS and FWC through there predator biology core group are providing services to identify predators from suspected calf kills. The team follows a phone tree of six biologists to ensure full coverage including weekends. For any suspected predator kill we are also collecting DNA swabs from bite wounds to help confirm physical evidence (see Appendix II). This is of high importance as there is concern among the community of correct identification of kills solely by physical description of carcass and site.

Next Steps

As we move into the full set-up and monitoring stage of the project our number one priority is securing great field staff to undertake observations, tagging and sampling. This has been achieved for the Big Cypress location and is in process for Longino and Buck Island as those site come online in Fall of 2017. Careful and timely planning of dead calves and samples to BADDL is of utmost importance and continued conversation and improvement of logistics in the field will be undertaken where needed. At the completion of the fall/winter calving season a summary report for the Cattleman's Quarterly will be written based on initial findings and datasets from these three ranchers. The next three herds will then be implemented for the next round of calf loss studies.

Phase 3: On successful implementation of phase 2, a doubling of equipment and staff to implement the study on four ranches during spring and fall calving, for the 2nd and 3rd year will be undertaken to increase sample size.

We will be modifying phase 3 based on funding being reduced for the second year of this multi-year project. We will maintain our sample size to three rather than four ranchers. This will require the currently budgeted staffing, accommodation and vehicle expenses, and diagnostic costs.

Phase 4: In future collaborations with ranch industry partners the expensive equipment can used for up to another 5 years on targeted calf loss questions in the field on ranches.

Yet to be implemented

Educational Objectives

In addition to above phases of monitoring ranch calf loss, the following educational objectives were prepared to be implemented across the multi-year study.

1. The technology used and tested for this project will be shared with cattleman of Florida through the Florida Cattleman's Livestock Journal (2017).

An initial technology report was written by Dr Boughton in The Florida Cattleman and Livestock Journal, Oct 2016, titled Technology and Florida Calf Loss - Ona Report. A second talk was given as a research update report at the RCREC. Further updates on technology will be provided as Dr Boughton's next report in the The Florida Cattleman and Livestock Journal.

2. In depth results of the calf loss study will be updated to the cattleman each year of the study through at quarterly and annual meetings, in appropriate committees and events. (2017, 2018 and 2019)

Expected first results of calf loss to be available February 2018 for first ranch setup at Big Cypress, second ranches will follow shortly afterwards.

4. A projects page will be added to rangeland wildlife program website highlighting the study and ongoing findings. This page will be shared with extension agents, ranchers and UF/IFAS.

Done

5. During implementation and data collection phases of the project, in conjunction with collaborating ranchers, ultrasound and sensor deployment workshops will be offered for interested ranchers.

To be conducted as deployment occurs starting in fall 2017.

6. Results will be used to publish an EDIS extensions series on common causes of calf loss in Florida and disseminated to extension agents and ranchers to help with calf loss management. This will be a calf loss cause report to be used as a guide by ranchers and agents (2018, 2019).

To be implemented 2018-2019

7. As dataset grows we will publish results in appropriate industry media, Florida Cattleman and Livestock Journal, National Cattleman's Beef Magazine, as well as to scientific peer reviewed journals; American Association of Bovine Practitioners, Society for Theriogenology, Journal of the American Veterinary Medical Association, and Journal of Wildlife Management. A minimum of three research papers will be published –

    1. Calf Loss Causes in Florida

2. Technology to track early calf loss

3. Predator calf loss as a component of total calf loss

To be implemented 2018-2020

8. Results will be presented at the Range Cattle Research and Educational Center (Ona) Field Day every 18months, at which there is up to 200 attendees.

To be implemented 2018-2019

9. Results will also be presented at county cattleman associations in conjunction with extension livestock agents.

To be implemented 2018-2019

10. In year 2 and 3 of the study an on ranch workshop day will be undertaken with cattleman to discuss findings of the study and suggest management solutions to reduce calf loss. At these workshops we will identify willing participants for follow-up on the success of implemented activities.

To be implemented 2018-2019

11. Specific information collected during the study will also be used in several other documents including A Rancher's Guide to Identifying Predator Attacks on Livestock and a Video guide on how to use birthing sensors in cattle.

To be implemented 2018-2019

Appendix I

Table 1: Proposed list of possible assays and diagnostic tests to be performed on calves.

Abortion Cause	Specimen of Choice	Assay	Typical Fee
Calf Necropsy	Fresh carcass or live calf	Necropsy	$50
Calf Euthanasia	Live calf	Necropsy	$30
Spinal cord examination (juvenile lymphoma/other)	Fresh carcass		$25
CBC	EDTA blood (will also look for hemoparasites)	CP	$0
Histopathology (including several segments of Skeletal muscle)	Fixed tissues	H	0
IBR virus (BHV-I)	Fixed fetal tissues and placenta Paired maternal sera	H, IHC, S	Serology $7.50 each ($15 pair) IHC $15 tentative (not yet available)
BVD virus	Ear notch Paired maternal sera (RT)	H, PCR, S	Serology $4.50 each ($9 pair) PCR $17

Bluetongue Virus	Fixed fetal tissues and placenta Pooled Fresh spleen, heart, brain, Paired maternal sera (RT)	PCR, S	Serology $7 each ($14.00 pair) *TVMDL PCR $30*
Neospora caninum	Fixed fetal tissue Maternal sera (RT) (Herd basis)	H, IHC, S	Serology $8. IHC $15 tentative (not yet available)
Sarcocystis cruzi	Fixed fetal tissue (brain, heart, liver, placenta)	H	0
Mycoplasma/ureaplasma ?	Placenta, gastric contents, lungs, kidney	Culture?	$28 TVMDL PCR
*Ruminant abortion panel LSI Vetmax -Coxiella brunetii, -Chamydophila spp, -Listeria monocytogenes, -Salmonella spp, -Campylobacter fetus, -Leptospira pathogenic strains, - Anaplasma phagocytophila, -Bovine Herpes 4	Placenta, vaginal and cervical swab	PCR	$25 / sample submitted

Leptospirosis	SEE PCR PANEL IFO* *Paired maternal sera (RT)*	PCR S	PCR PANEL calf Serology $15 materal sera
Bovine Herpes virus type 4	SEE PCR PANEL IFO*	PCR	PCR PANEL
Salmonella sp	SEE PCR PANEL IFO*	PCR	PCR PANEL
Anaplasma phagocytophila	SEE PCR PANEL IFO*	PCR	PCR PANEL
Coxiella brunetii (Ricketsia)	SEE PCR PANEL IFO*	PCR	PCR PANEL
Listeria monocytogenes	SEE PCR PANEL IFO*	PCR	PCR PANEL
Brucella abortus	Fixed fetal tissues and placenta Fresh fetal stomach contents, liver, lung, spleen, placenta Maternal sera	Culture, S	Serology 0 Culture $40
Histophilus somni	CSF, Brain, liver, kidney,	Bact. Culture (selective culture media)	0

Tritrichomonas foetus	Fresh placenta, stomach contents, lung InPouch Trich sample of Preputial and vaginal fluid	PCR	$17
Chlamydophila spp.	SEE PCR PANEL IFO*	PCR	PCR PANEL
Campylobacter fetus var. venerealis	SEE PCR PANEL IFO*	PCR	PCR PANEL
E. coli (Endotoxin) (secondary to mastitis)	Fetal tissues and stomach contents	Culture	0
Trueperella pyogenes	Fetal stomach contents	Culture	0
<u>Mycoses</u> (Aspergillus, Absidia, Mucor, Rhizopus)	Fixed placenta and fetal tissues Fresh placenta and fetal tissues (stomach contents, lung)	Culture	0
Chlamydophila abortus *Chlamydophila pecorum*	SEE PCR PANEL IFO	PCR	PCR PANEL
<u>Toxic plants</u>	Locoweed (Oxytropis or Astragalus sp), Broomweed (Guttierrezia microcephala), Coumarins from rat poison, moldy sweet clover, and other grasses.	Division of Plant industry	0

Pine Needles (Isocupressic acid) USDA poisonous plant research lab. Logan, Utah. Contact Dale Gardner	Pine needle analysis. abomasal fluid, thoracic fluid, serum		0
Nitrate	serum, ocular fluid		$20
Nutritional deficiency (Selenium, Vitamin E, Iron, other) Trace nutrient elements or toxic (Se ,Cu,Zn, Fe, Mo, Mn). *Will detect trace as well as toxic minerals & heavy metals*	Fetal liver or maternal blood/serum Fetal liver preferred		$45

* Serology is the preferred method for specific diagnosis of brucellosis.
VI-Virus isolation; PCR—Polymerase chain reaction; IHC-Immunohistochemistry; S-Serology; FA-fluorescence antibody test; H-Histopathology

Appendix II

DNA Trace Evidence Collection Protocol

Supplies: Every Depredation Investigator shall have access to and maintain the following supplies:

- Package of sterile latex gloves
- Individually Packaged Cotton Swabs
- 10 2ml vials of ETOH
- 20 Small Paper Coin Envelopes

Procedure

1. Put on latex gloves. WARNING: If you frequently handle predators (e.g., bears, Florida panthers, bobcats), insure you do not wear clothes or other gear that may be contaminated with DNA (i.e., hair, blood, etc.). This could lead to contamination of samples and incorrect designation of predator involved in an incident.
2. Identify wounds believed to be from the predator (if possible ignore claw wounds). Puncture wounds from canine teeth are preferred sites for DNA collection. Feeding wounds are secondary sites that should be considered as well.
3. Remove cotton swab from packaging
4. Swab the entire wound area for approximately 20 seconds (avoid coating the swab in blood if possible and for large feeding wounds limit swabbing to a 10 cm x 10 cm area). For puncture wounds, focus swabbing around the perimeter of the wound and in the center. For feeding wounds, focus on the edge of any flesh that has been sheared by the predator or on tips of ribs/bones that have been chewed.
5. Place swab in paper envelope and break off shaft (break off enough to ensure the envelope can be closed and sealed)
6. Repeat this process for an additional 2 swabs. Place swabs collected from different locations in different envelopes.
7. Repeat the above sampling at the same locations with 3 swabs dipped in ETOH prior to swabbing. Store these ETOH swabs in separate envelopes from the dry swabs.
8. Do not seal envelopes with saliva. Use tape upon returning sample to the office.
9. Label envelope with the incident number generated through the WIMS system (if applicable), date, time, incident location, UTM coordinates, swab collection location on animal, and whether the swab location was a killing bite or feeding location or unknown, and whether swab was dipped in ETOH or not prior to collection.
10. Provide envelopes to FWC Panther staff for cataloging. Samples should be stored either in freezer or in a storage container with desiccant beads.
11. FWC Panther Staff will submit the samples weekly to the National Genomics Center for Fish and Wildlife Conservation in accordance with the procedures established with the lab. Samples will be mailed via FedEx Ground.
12. Once the lab notifies FWC of the results, the Panther Team will update the DNA database with any pertinent results.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND APPLICATION

PROJECT TITLE & FCEB #: Florida Calf Loss | FCB #41

DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Set-up 1: Equipment Purchases and Testing (Big Cypress Ranch)	1	100%	$ 62,829.50	Birth sensor equipment, base station and antenna for birthing sensor communciation and relay through to cellular gateway for communication and data sending to website and text messaging of calving events. Unique VHF eartags for mortality sensing of tagged calfs after birth, base station datalogger and antennas for 24hr monitoring of mortality signals. Dataplan for cellular gateway and communcitions support. Pasture vehicle (UTV) for tracking down births, tagging calves and collecting samples.	9/01/2017
Set-Up 2: Equipment Purchase and Testing (Longino Ranch)	1	100%	$ 62,176.21	Birth sensor equipment, base station and antenna for birthing sensor communciation and relay through to cellular gateway for communication and data sending to website and text messaging of calving events. Unique VHF eartags for mortality sensing of tagged calfs after birth, base station datalogger and antennas for 24hr monitoring of mortality signals. Dataplan for cellular gateway and communcitions support. Pasture vehicle (UTV) for tracking down births, tagging calves and collecting samples.	9/01/2017
Set-Up 3: Equipment Purchase and Testing (Buck Island Ranch)	1	100%	$ 51,834.21	Birth sensor equipment, base station and antenna for birthing sensor communciation and relay through to cellular gateway for communication and data sending to website and text messaging of calving events. Unique VHF eartags for mortality sensing of tagged calfs after birth, base station datalogger and antennas for 24hr monitoring of mortality signals. Dataplan for cellular gateway and communcitions support. Pasture vehicle supplied by Boughton Lab.	9/01/2017
Materials for sampling 240 calves and 240 cows	480	100%	$ 8,900.20	Needles, Vials, Biopsy Syringes, Vacutainers, Coolers, Freezer packs, Long-term storage vials and racks, sanitization liquids and materials	9/01/2017
Immobilazation and Equipment for night observations	2 sets	100%	$ 7,466.08	Projector for firing annesthetics darts, immobilaztion drugs, binoculars and field lights for undertaking safe observation of calves, and collection of samples from both cows and calves.	9/01/2017
Field tough data storage	1	100%	$ 2,944.58	Toughbook computer for field data collection on site in chute and for lead field research assistant data management and entry	9/01/2017
Final Research Project Report	1			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/01/2017
GRAND TOTAL: (equal to percentage of completion)			**$196,150.77**		9/01/2017

Forage Breeding and Genomics Lab

Agronomy Department

University of Florida

FCA Grant

Title: "Development of Improved Forage Cultivars and Management Systems for Florida Conditions"

PI's: Esteban Rios, Patricio Munoz, Kenneth Quesenberry, Joao Vendramini, Jose Dubeux.

August 31st 2017

Summary

The Florida Cattle Enhancement Board awarded funds to the PI's listed above to perform research on three specific areas: 1) Reintroduction of white clover into South Florida pastures; 2) Development of a high quality alfalfa variety and management system adapted to central-north Florida conditions, and; 3) Development of high quality and high yield bermudagrass/stargrass cultivars.

Proposals were awarded in January 2017, and the award delivery for this specific proposal was delayed until June 2017 due to changes in PI's in the Forage Breeding Program at UF. Nevertheless, we were able to move forward with all the projects and the status for each specific aim will be updated in this report.

Due to the delay in award delivery for our proposal, we had some funding for year 1 that was not spent on personnel. Therefore, after obtaining approval from FCA representatives, we were able to use $25,000 from this specific grant for the purchase of a NIRS instrument to measure forage quality samples. The total cost for the Foss2500F spectrometer was $56,153.20. We leveraged matching funds from the Dean of Research in IFAS (Dr. Jackie Burns) to cover the remaining balance. The instrument was purchased and it is currently being calibrated (this process will take some days until we get trained on using the instrument properly). Nevertheless, all the forage quality measurements for the experiments described in this proposal will be run using this instrument. We have kept all samples harvested in 2017 dried and ground, and they are ready for quality analyses. We appreciate the willingness from FCA representatives who allowed this one-time budget adjustment to purchase this valuable instrument.

Specific Aims under the Winter Forage/Legumes

1. Reintroduction of white clover into South Florida pastures

2. Development of a high quality alfalfa variety and management system adapted to central-north Florida conditions.

3. Development of high quality and high yield bermudagrass/stargrass cultivars

Aim 1

Approach:

A series of three-year establishment and persistence field trials will be conducted in large areas in collaboration with Deseret Ranches to determine the right variety(ies) and management practices needed for establishing and maintaining white clover pastures in south and central Florida. Additionally, these trials will be used for breeding and development of new better-adapted varieties of white clover for the south.

Status:

Percent of the work completed in year 1: 50% (the establishment of the plots projected for October 2017 will represent the other 50%).

The award was release after the optimal time to establish white clover (October/November); therefore, during summer we traveled to Deseret Ranches and met with Mr. Erik Jacobsen and Mr. Clint Richardson. We identified an area of about 60 acres that will be used to establish 2 projects in October 2017 (see below). Soil tests indicated that pH is not a limiting factor and we did not have to apply lime in the selected area. Seed planting is scheduled for October 2017. The area is currently planted with bahiagrass, and the entire area will be grazed to allow planting in October.

1. Project 1: We will test 3 cultivars in a grazing study (Ocoee: nematode-resistant; Osceola: nematode-susceptible; and Durana: active summer-growing). The experiment will be planted as a RCBD with 3 replicates. Each experimental unit will have ~5 acres. Defoliation will be managed through grazing, and we will evaluate establishment, biomass production, nutritive value, persistence and nematode pressure. Seed has been purchased for the three cultivars and is ready for planting in October.
2. Project 2: breeding/variety trial. Five varieties will be tested in Citra, FL and in Deseret Ranches. The same three cultivars described above (standard commercial cultivars) and two breeding populations selected in our program (Late-Ocoee and a multi-leaf population). Seed from Late-Ocoee and Multi-leaf was increased during summer in a seed company farm located in Idaho (Picture 1). We expect to receive clean seed at the end of September, and the seed will be used for the experiments. The experimental design will be a RCBD with 4 replicates and it will be planted in both locations. We will harvest biomass (under cutting), and measure persistence, nutritive value and nematode resistance.

Figure 1. White clover seed increases in Idaho during the summer 2017. Exclusion cages are used to ensure purity and avoid pollen contamination. Seed production during summer in Idaho allows us to make selections in Florida during the spring, and produce seed of those selected plants for planting the following fall season, increasing the speed for cultivar development.

Anticipated Outputs:

1 – Determination of recommended practices **to establish and maintain** white clover cultivars in central/south Florida pastures.

2 – Development of new cultivars better adapted to central and south Florida. We will test the new breeding lines in two locations against current commercial varieties for two additional years before formal release, as University of Florida requires. We expect that cultivars might perform differently in both locations, and therefore we will make selections for central and for south Florida.

Aim 2

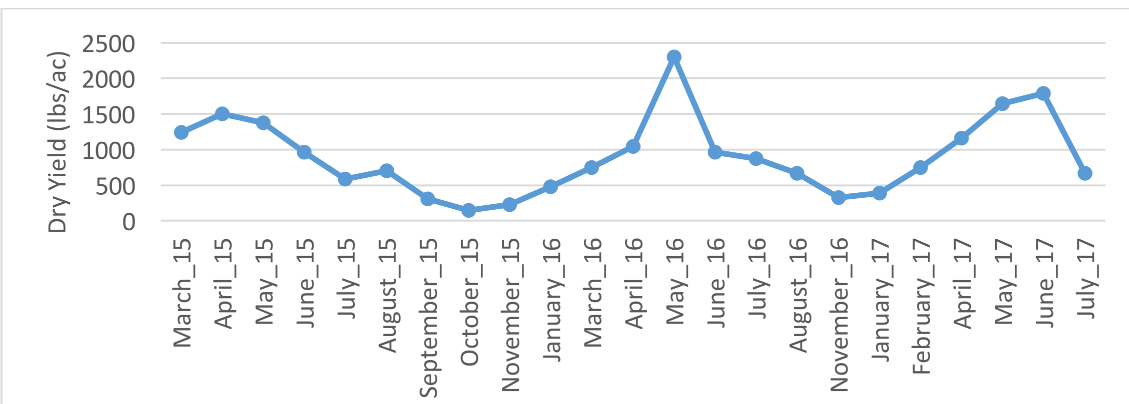
Approach:

We will conduct a series of trials over a three-year period to ascertain the right management practices to establish and maintain high yielding stand of high quality alfalfa in central-north Florida. We have developed improved material better adapted to Florida conditions and we need to test in multiple locations for at least 3 years under monoculture and mixture stands.

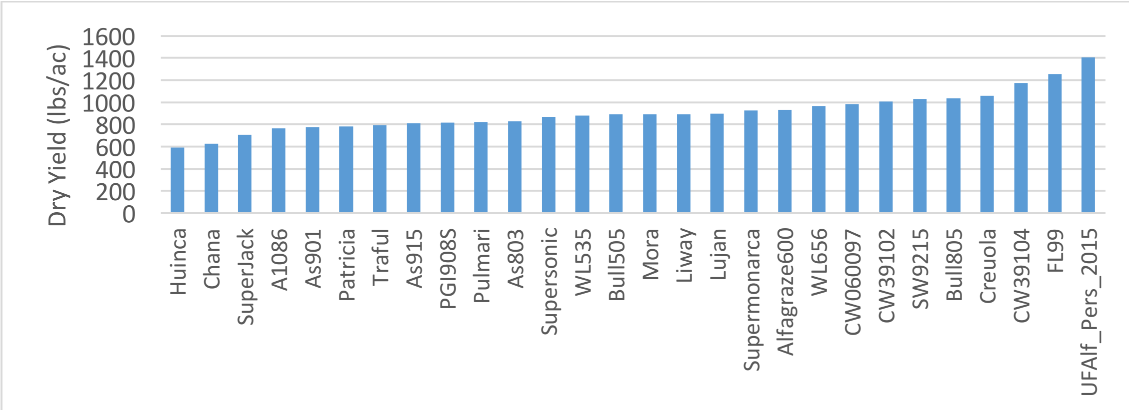
Status:

Percent of the work completed in year 1: 100%

We continue collecting data on monoculture alfalfa stands that were established in the Fall 2014. Our data demonstrates that adapted alfalfa cultivars can persist in Florida for up to three years in pure stands (Figure 2A and B). Our selected breeding line (UFAlf_Pers_2015) exhibited the highest yields (Figure 2B) and persistence. We need data on a multi-location trial prior a cultivar release (UF-IFAS policy); therefore, we established another variety trial in Citra, FL (January 2017) and Marianna, FL (December 2016).



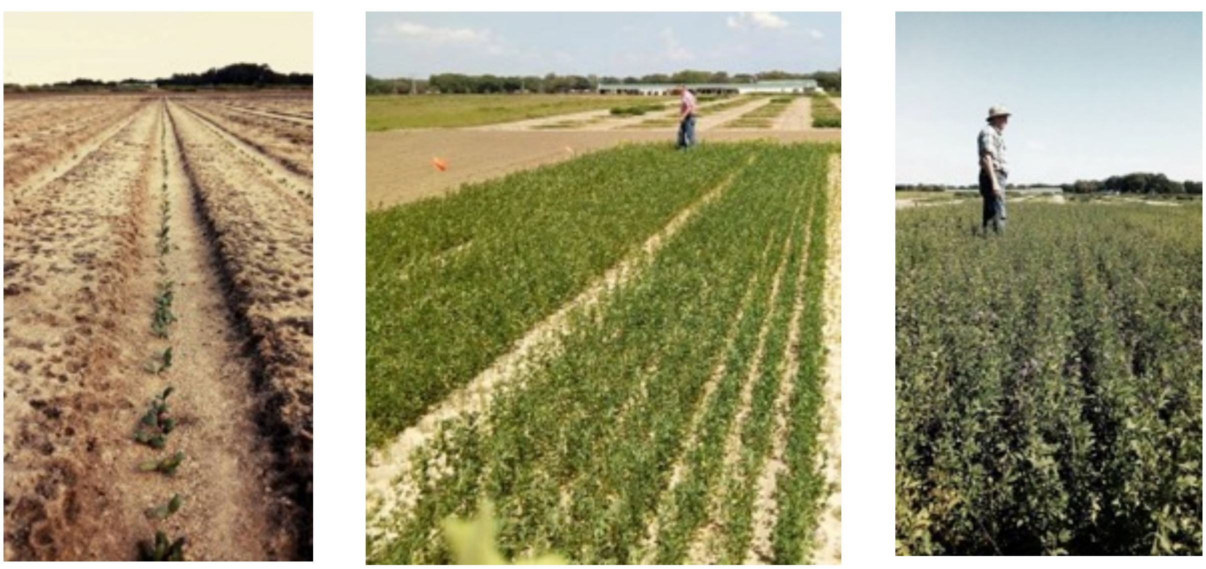
A



B

Figure 2. Alfalfa monoculture stand planted in Citra, FL in the Fall 2014. Dry matter yields across 28 varieties in 23 harvests (A), and average dry matter yield per harvest by variety (B). The last graph shows that varieties developed in Florida (FL99 and UFAlf_Pers_2015) produced higher yields than other commercial cultivars. We will continue collecting data in this experiment for another year, to determine if we can obtain high yields beyond 3 years.

The two new variety trials under pure stand conditions were established in Citra and Marianna, FL (Figure 3). The experiments were harvested in April 2017 for the first time in both locations and a total of 3 harvests were performed in Citra and 4 harvests in Marianna. Data for each location is presented below.



January 27th 2017 March 30th 2017 April 18th 2017

Figure 3. Alfalfa monoculture stand planted in Citra, FL on 01/27/2017 and harvested for the first time on April 18th 2017.

Location: Citra

Experiment Description

1. Site

    Location: CITRA -Plant Science research and Education Unit (Citra)

    Coord. Latitude 29° 24' 16" N, Longitude 82° 10' 17" W

2. Experimental design

    Design: Randomized Complete Block Design

    Plot size: length 4.6 m by width 1.8 m

    Number of Replicates: 6

    Treatments: 4 Varieties (Bulldog805, Amerstan901, FL99 and UF2015_ALFPers.

    Bulldog805 and AmerStan901 are established varieties, developed outside Florida that can be obtained commercially.

    FL99 is a discontinued Florida variety developed in the 90's that cannot be obtained commercially anymore.

    UF2015_ALFPers is a new experimental variety developed by the UF Forage breeding program that is being tested. This variety will be released for commercial production if results of testing are favorable.

3. Planting

    Date: 01/19/17

    Method: cone planter

    Seeding rate (lb/ac): 22 lb/ac (30% more when seed coated)

4. Harvest (5 cm stubble height)

First harvest in the spring (April 25th 2017) conducted at the bud or early-bloom stage (approximately 10% of the plants with flowers)

5. Data analysis

    Software: R

    Model: yield = block + cultivar + error

6. Results

    All the alfalfa varieties had similar dry matter productivity dry matter production in the first and second harvest, while for the third harvest Ameristand901 produced significantly lower yields (Figure 4).

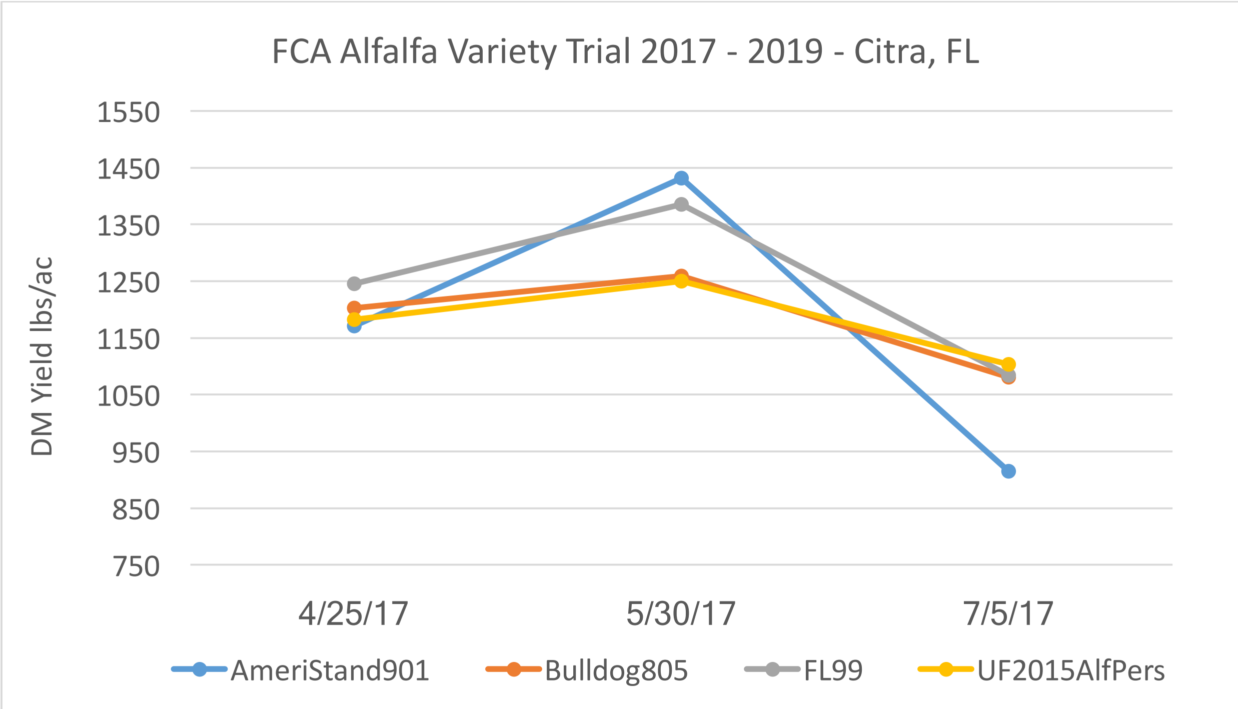


Figure 4. Alfalfa dry matter yield for the variety trial located in Citra, FL.

Location: Marianna

Experiment Description

1. Site
   Location: Marianna, FL – North Florida Research and Education Center (NFREC). Dr. Jose Dubeux.
2. Experimental design
   Design: RCBD

   Treatments: 3 Varieties (Bulldog805, FL99 and UF2015_ALFPers).

   Plot size: length 3 m by width 1.8 m.

   Number of Reps: 4
3. Planting
   Date: 12/01/16

   Seeding rate (lb/ac): 28 lb/ac (30% more when seed coated)
4. Harvest (5 cm stubble height)

First harvest in the spring (April 18th 2017) conducted at the bud or early bloom stage (approximately 10% of the plants with flowers).

5. Data analysis
   Software: R

   Model: yield = block + cultivar + error

6. Results
   The alfalfa germplasm had similar dry matter productivity (Table 1), with average DM yield of 1,172 kg DM ha^{-1} $harvest^{-1}$.
   Table 1. Dry matter production of alfalfa germplasm in Marianna, FL

Variety	Dry matter production (kg ha^{-1} $harvest^{-1}$)
Bulldog 805	1100 a[§]
FL 99	1300 a
UF 2015 Experimental Line	1117 a
Standard Error	234

[§]Average across four harvests and four blocks

There was an effect of the harvest date on alfalfa production. The harvest in July 2017 resulted in greater alfalfa production than the other harvests (Table 2).

Table 2.

Harvest date	Dry matter production (kg ha^{-1} $harvest^{-1}$)
4/18/2017	993 b[§]
5/23/2017	916 b
7/12/2017	1993 a
8/23/2017	787 b
Standard Error	209

[§]Average across three varieties and four blocks

<u>Conclusion for alfalfa monoculture:</u>

In both locations, the monoculture alfalfa variety trial was successfully established and the firsts harvests showed no significant differences among cultivars, which was expected for the first year. Even though cultivars were not statistically different for yield, we would expect to find differences in yield and persistence in the long term, as the experimental line UF2015_ALFPers was specifically selected from FL99 for improved persistence and yield under Florida conditions (Figure 2).

For the second part of this aim (testing alfalfa in mixture with bermudagrass), the bermudagrass stands (Tifton85) were established in summer 2017 in Citra, FL (Figure 5) and the overseeded of alfalfa will be planted in October 2017 with the same 4 varieties (recommended planting dates for alfalfa in FL). The lower alfalfa yields observed in our monoculture studies (Figure 2A), and the well-known forage yield distribution of bermudagrass and bahiagrass suggests that a mixture of grass/legume has potential to provide forages 365 days in Florida.

Figure 5. Tifton85 springs being planted at the Plant Science Research and Education Unit, Citra, FL in August 2017.

Expected Outputs

1 – Determination of recommended practices to establish and maintain alfalfa both as a pure stand and as in mixture with bermudagrass.

2 – Development of a new variety better adapted to the Central-North Florida. After the data is collected in both locations, we will formally release the new variety (UFAlf_Pers_2015).

Aim 3

Approach

We will conduct a series of experiments in the period of three years to determine the best bermudagrass cultivar for south, central and north Florida conditions. We will test 6 selected breeding lines plus 4 current commercial cultivars. Experimental lines exhibiting improved traits in each of the three areas will be increased by the second year with collaboration of local producers.

Status:

Percent of the work completed in year 1: 100%

Land preparation on each site was conducted in the Spring 2017 in Ona, FL (Dr. Joao Vendramini), Marianna, FL (Dr. Jose Dubeux) and Hague, FL (Dr. Esteban Rios). Bermudagrass plugs were propagated for each genotype (Figure 6 A) and they were used for establishing the experiments on each location. The experiment located at the Agronomy Forage Research Unit in Hague, FL was planted on April 27th 2017 (Figure 5 B), under a RCBD with 10 genotypes and 4 blocks (1.8 x 4.6 m plot size). The same experimental design was used in Ona and Marianna where the experiments will be planted in May 2017. Biomass yield, nutritive value and Bermudagrass Stem Maggot ratings will be taken once the plots are well established in 2018 and 2019.

A B C

Figure 2. Bermudagrass plug (A), experiment established at Hague, FL on April 27th 2017 with 4 plugs per block (B), and staging of the plots in August 2017.

Expected Outputs:

1 – Development of better-adapted cultivars with increase yield and better forage distribution across the season.

2 – Development of cultivars with good tolerance to Bermudagrass Stem Maggot.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Development of Improved Forage Cultivars and Management Systems for Florida Conditions					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Clover seed (Aim 1)	5	100%	$ 5,000.00	lab consumables (reagents, filter paper, plastic containers, instrument parts), syringes, soil moisture sensors, tubes, vacuum pump	9/1/2017
Alfalfa seed (Aim 2)	1	100%	$ 919.02	field supplies. Items include (but not limited to): paper bags, soil core liners, batteries	9/1/2017
Plant propagation, plot establishment, maintenance, harvest and postharvest sample processing	1	100%	$ 15,000.00	purchase of commercial fertilizer and biochar for the field study	9/1/2017
Land charge and equipment charges from PSREU, Citra (Aims 2 and 3)	1	100%	$ 2,400.00	soil, plant tissue, biosolids, and biochar characterization, shipment of samples for analysis	9/1/2017
Land and equipment charges Ona, FL (Aim 3)	1	100%	$ 2,000.00	soil water release curve characterization	9/1/2017
Land and equipment charges Marianna (Aims 2 and 3)	1	100%	$ 2,000.00	project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/1/2017
Foss2500F NIRS	1	100%	$ 25,000.00		
Indirect Cost	N/A		$ 5,972.24		N/A
GRAND TOTAL: (equal to percentage of completion)			**$ 58,291.26**		

Identifying Differences in Selenium and Copper Requirements among Brahman (*Bos indicus*) and Angus (*Bos taurus*) Cattle

Investigator: John Arthington, Professor and Center Director
UF/IFAS, Range Cattle Research and Education Center, Ona

Specific Aims:

Recent research reveals that Brahman cattle make more frequent visits to the mineral feeder with a larger percentage of visits during the hottest hours of the day compared to Angus cattle. We seek to identify specific in selenium **(Se)** and copper **(Cu)** requirements of Brahman and Angus cattle. The goal of this research is to enable producers and supplement manufacturers to better address the mineral nutrition of these two distinctly different cattle breeds. This proposal addresses two Research Priority areas; (7) Animal Herd Nutrition – Minerals and (10) *Bos indicus* Genetics.

Approach:

The proposed study was conducted at the University of Florida – IFAS, Range Cattle Research and Education Center (RCREC), Ona. Sixteen pregnant Brahman and Angus (n = 8/breed) cows were allocated into partially covered drylot pens (8 pens/breed; 2 cows/pen) and enrolled in a 90 day sulfur-induced, depletion protocol. This will be achieved by supplementing a wheat middlings-based range cube fortified with calcium sulfate in amounts to provide 50 g sulfur daily. Samples were on day 0, 30, 60, and 90 of depletion. Following depletion, cows were underwent Se and Cu repletion over a 60 day period by Cu-sulfate and Se-selenite supplementation in amounts to provide 75 and 2 mg/day, respectively. Samples were collected day 0, 30, and 60 of repletion. Copper and Se status were assessed by direct and indirect measures. Direct measures included blood and liver analysis of Cu and Se including Se- and Cu-dependent enzyme function via glutathione peroxidase (Se) and ceruloplasmin (Cu) measures. Indirect measures include Cu- and Se-dependent gene expression analysis.

Update Report (100% Completion of Funded Objective):

Awarded funds were spent to purchase materials and supplies required to assess mineral status among cows enrolled in the Se and Cu depletion phase of this study.

Our results imply that Brahman cows retain tissue stores of both Se and Cu more efficiently than Angus when consuming a sulfur antagonist. The rates of sulfur used in this study are not abnormal for some Florida production situations. Over 90 days of sulfur feeding, Angus cows lost liver tissue Cu stores at a rate of 0.67 mg/kg DM daily, but Brahman cows actually accumulated liver tissue Cu (0.91 mg/kd DM daily). At the end of depletion, Brahman cows had sufficient Cu status, but Angus cows were marginally deficient (liver Cu = 152 vs 81 mg/kg DM; SEM = 18.2; $P = 0.029$). Similar to Cu, Brahman cattle had greater liver Se concentrations at the end of the 90 day depletion period (0.82 vs. 0.63 mg/kg DM for Brahman and Angus cows, respectively; SEM = 0.063; $P = 0.047$).

These findings were unexpected and suggest that Brahman cattle may be better able to protect themselves from Cu and Se deficiency compared to Angus cattle when consuming a sulfur antagonist.

Budget Justification:

Materials and Supplies. These expenses involve the purchase of materials and supplies for the collection and analysis of soft tissue, serum, and whole blood for measurement of Cu and Se concentrations, enzyme function and gene expression.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND APPLICATION

PROJECT TITLE & FCEB #: NA Cattle Mineral Study; John Arthington

DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and Supplies for Assessing Cow Mineral Status	64	100%	$ 6,000.00	Purchase of laboratory supplies for the collection and analysis of blood and liver tissue. Purchase of Cu and Se-dependent gene primers.	9/01/2017
Research Animals (per diem)	16	100%	$ 2,000.00	Expenses associated with housing, feeding, and care of cattle over 90 days	9/01/2017
Final Research Project Report				Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/01/2017
GRAND TOTAL: (equal to percentage of completion)		100%	**$8,000.00**		

2017
FLORIDA BEEF COUNCIL
FINAL REPORT

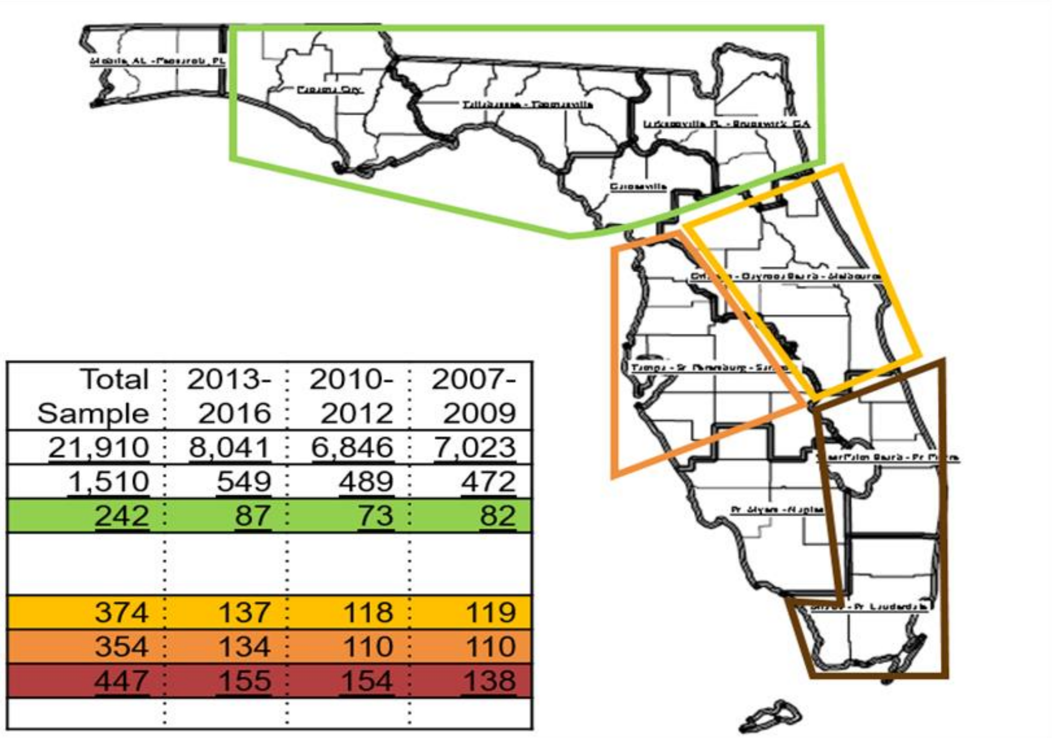
FLORIDA Beef COUNCIL

CONSUMER BEEF INDEX (CBI)

- The Florida CBI was funded through the Florida Cattle Enhancement Board
- The CBI is designed to
  - Track changes in consumers' perceptions of, and demand for, beef relative to other meat proteins
  - Monitor consumer impressions of beef that could be attributed to the industry's communication and advertising efforts
  - Monitor areas of relative strength and potential vulnerability for beef sales
  - Help guide Florida communication strategies
- FBC can compare results of this study to previous CBI research and track consumer opinion shifts.

CBI METHODOLOGY

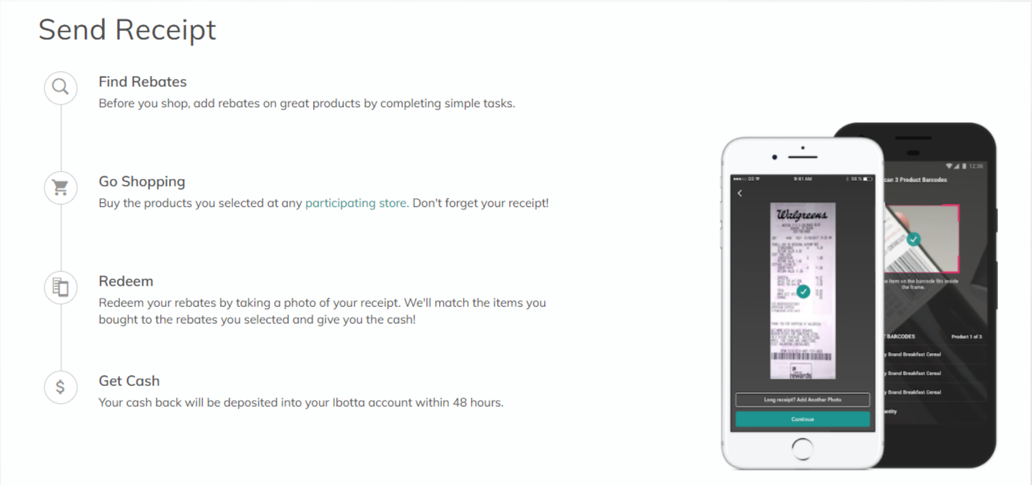
- The 2016 Scorecard includes
  - Comparisons of 2013-2016 results in the state of Florida and for select metropolitan areas versus national results
    - North
    - Orlando
    - Tampa
    - Southeastern
  - Trends for 2013-2016 versus previous periods

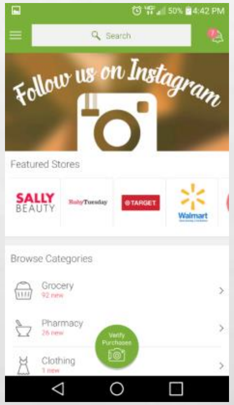


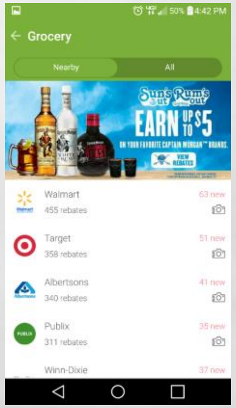
Total Sample	2013-2016	2010-2012	2007-2009
21,910	8,041	6,846	7,023
1,510	549	489	472
242	87	73	82
374	137	118	119
354	134	110	110
447	155	154	138

IBOTTA

- Funded by the Florida Cattle Enhancement Board
- Retail Couponing App that gives customers rebates for purchases
    - Customers must complete a task in order to receive rebate
        - Watch a video, take a questionnaire, view a recipe card, etc.



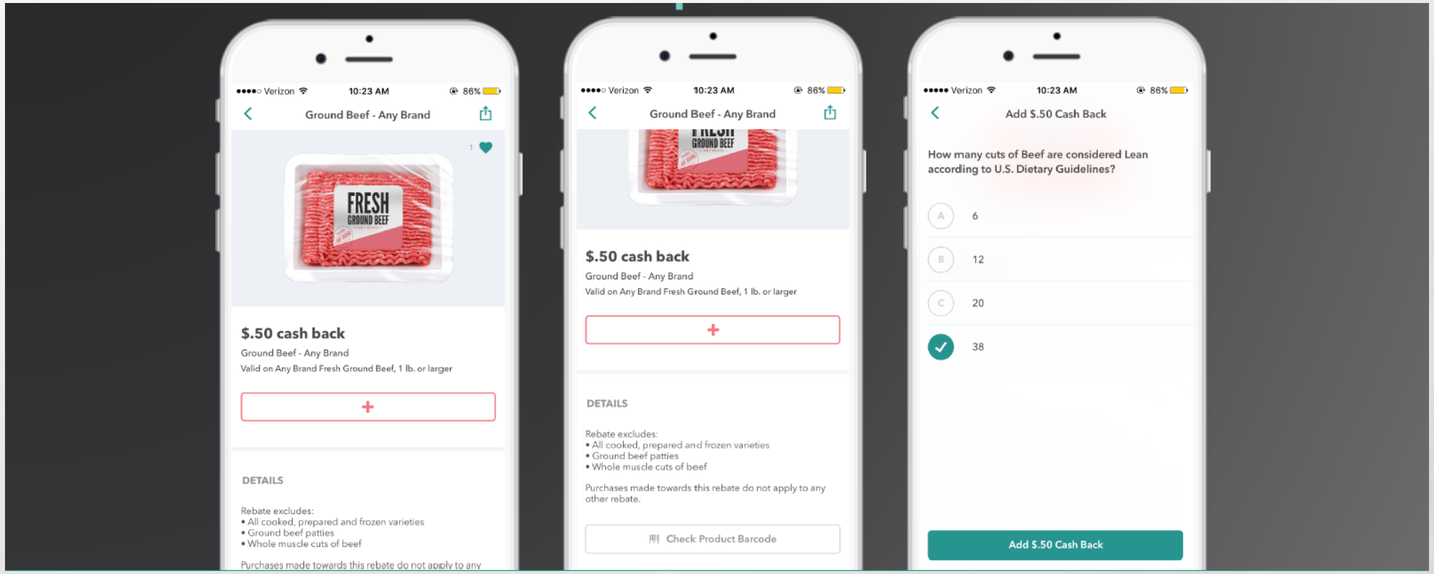




FLORIDA Beef COUNCIL

IBOTTA OFFERS

- Valentine’s Day 2017
  - February 8th to March 6th
  - $1.00 Rebate
    - Questionnaire
- Summer Grilling 2017
  - May 17th to June 9th
  - $1.25 Rebate
    - Trivia
- Ground Beef 2017- Live
  - August 25th- ? (LIVE)
  - $0.50 Rebate
    - Nutrition Fact



IBOTTA CAMPAIGN RESULTS

Campaign	Valentines Day 2017	Summer Grilling 2017	Ground Beef 2017
Duration	4 weeks	4 weeks	Live as of 8/25
Task	Survey	Recipe	Nutrition Fact
Offer	$1.25 cash back	$1.00 cash back	$0.50 cash back
Results			
Brand Impressions	4,190,584	2,304,466	1,811,348
Brand Engagements	58,201	54,395	65,214
Redeemed Rebates	21,667	21,449	22,781
Pounds Moved	23,660	23,476	24,831
Redemption Rate	37%	39.40%	34.93%
Total $	50,000	50,000	26,192.60
Cost per Impression	$0.01	$0.02	$0.01
Cost per Engagement	$0.85	$0.92	$0.40

Ground Beef Campaign is still running due to Hurricane Irma. $23,807.40 remaining, campaign will end once it reaches a total of $50,000

*Ibotta average redemption rate is 23%

** Pounds moved figured at 1.09 pounds per Rebate

HEARST

Funded by Florida Cattle Enhancement Board

Goals

- Educating Floridians on the benefits of beef in a conversational and engaging environment
- To reach your primary audience: women + millennials between 25-40 living throughout
- In addition to educating Floridians, you want to engage and create awareness of:
    - Recipes
    - Videos
    - Tips
    - Social Interaction
    - Educational Materials
- To reach potential consumers during high beef consumption months or holidays:
    - Valentines Day
    - Easter (Spring)
    - Memorial Day
    - Summer Grilling (July 4th)
    - Tailgating

FLORIDA Beef COUNCIL

HEARST

Core Audience

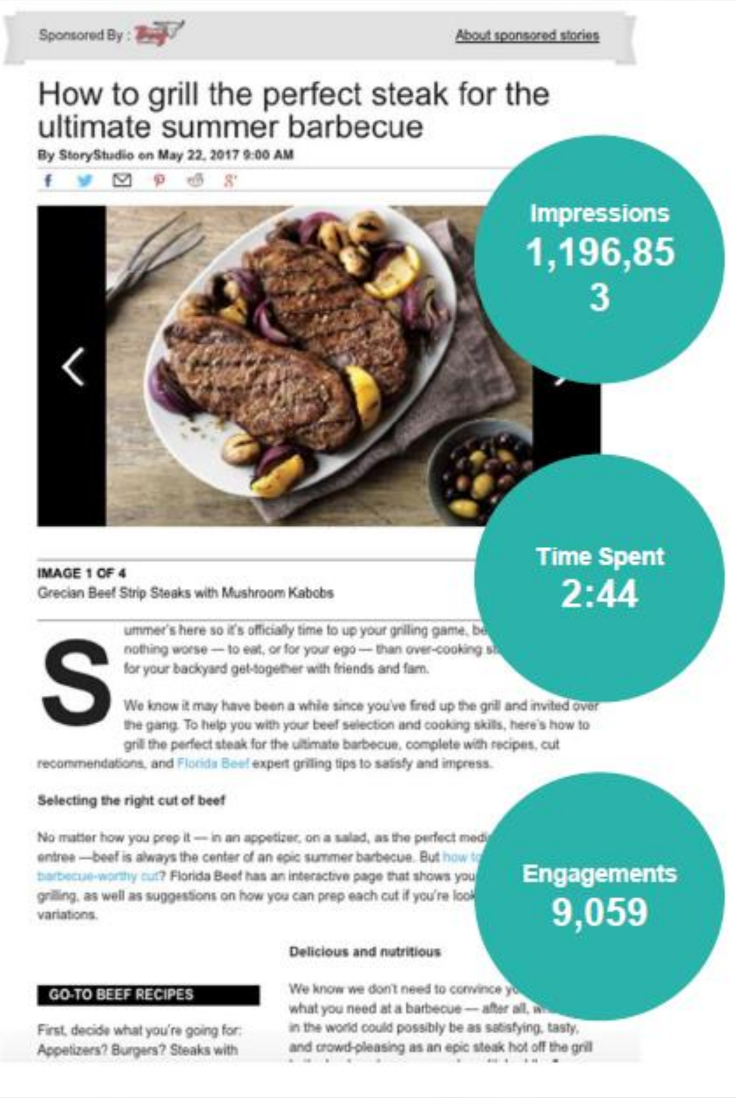
- 6 month campaign Geo-targeted ads to: Orlando/ Tampa DMA's
  - Desktop/ mobile/ tablet high impact display targeted to:
    - Women, 24 -40
    - Millennial moms
    - Households with Kids
    - Interest – cooking
    - Interest – food & wine
    - Epicureans
    - Foodies
    - Interest – health/nutrition
    - Desktop site re-targeting to drive engagement

Native

- 4 custom stories using custom content (Easter, Summer Grilling, Tailgating and Holiday)
- Incorporate Florida Beef Council Social Media Feed, Cooking Recipe Video, Poll and custom Article written by Story Studio
- Promotion (value added): impressions of onsite traffic driving * approximately 4 million impressions promoting the native content
- 27,778 Guaranteed Engagements (Boosts engagement with story Demo, DMA, County targeting

HEARST NATIVE STORIES

- Valentines Day
    - 1/20 – 2/14
    - 11,982 Engagements
    - 1,887,445 Impressions
- Summer Grilling
    - 5/22 – 7/4
    - 9,059 Engagements
    - 1,196,853 Impressions
- Tailgating themed
  - “Hosting a tailgate party?”
    - 8/14 – 9/15
    - 13,890 Engagements
  - “Five healthy bites to eat while watching the game”
    - 8/28 – 9/15
    - 13,890 Engagements



HEARST
CORE AUDIENCE

- Spring Campaign
  - 3/1/ - 4/15
  - 707,205 Impressions
- Memorial Day Campaign
  - 5/1 - 5/31
  - 706,998 Impressions
- Summer Grilling
  - 6/1 - 7/31
  - 1,414,604 Impressions
- Tailgating themed
  - 8/1 – 9/15
  - 700,000 Impressions

HEARST IBOTTA DIGITAL

- Digital Advertising
  - Geo-targeted ads
  - Mobile Ticker
  - Facebook Newsfeed
- 8/31 – 9/15
- 1,747,760 Impressions

TELL OUR STORY

KILROY AGENCY AND PYPER YOUNG

Funded by Florida Cattle Enhancement Board

Goals

- Promote and educate consumers in Florida about the Florida Cattle World
    - Values, ethics, purpose, and its people
- Increase positive consumer opinion
    - Environmental Stewardship
    - Animal health/welfare
    - Sustainability
    - Generational/ historic family heritage

Objectives

- To establish a clear, cohesive and compelling brand platform, strategy, and tactics to reach and educate consumers on cattle ranching
- To engage the target audience with this compelling messaging and interact with them, while building awareness
- Utilizing social and digital media to reach consumers and increase engagement with Florida Beef Council Website and Facebook page

FLORIDA Beef COUNCIL

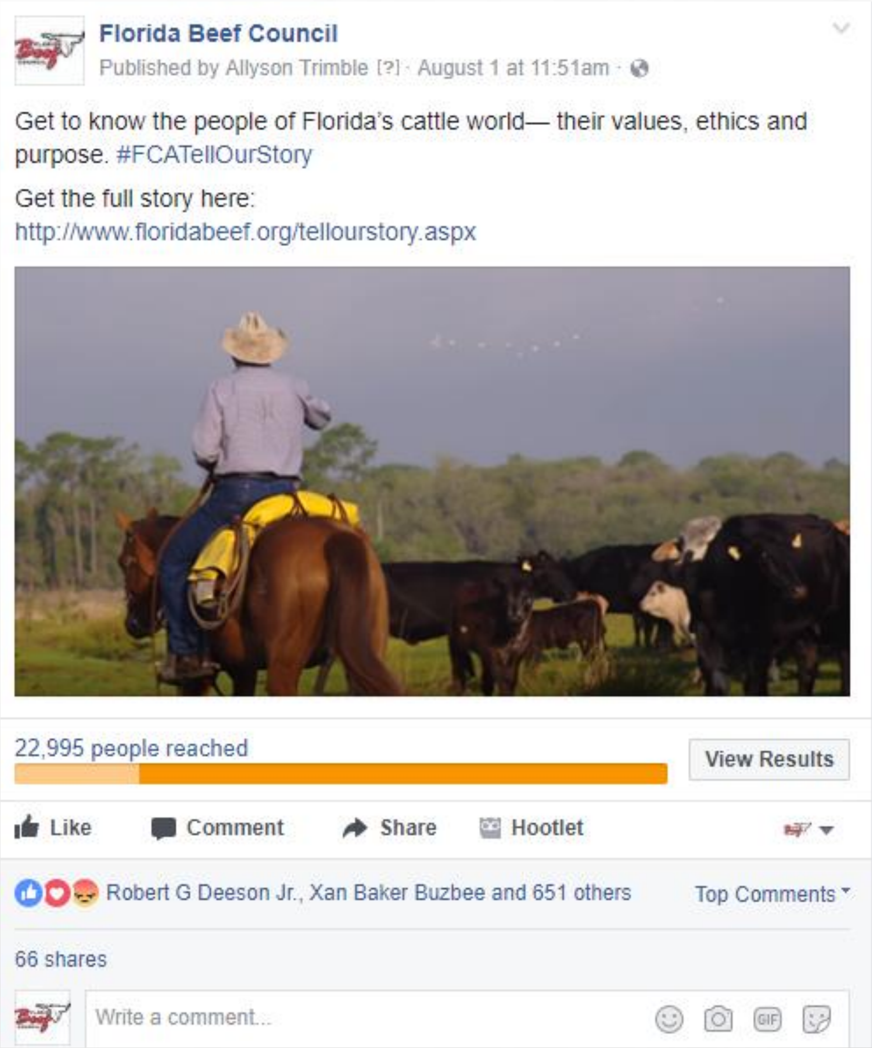
TELL OUR STORY

Target Audience

- Florida residents, non-cattle industry
- Adults 25-54
- Social media users
- Online Shopper
- Meat Eaters
- Exclude vegetarians, vegans, PETA, etc.
- Key Market:
  - Primary: Tampa, Orlando Miami
  - Secondary: Jacksonville, West Palm Beach, Tallahassee

TELL OUR STORY

- 2.5 Million Gross Impressions
  - Video Ads (Facebook & Instagram)
    - 1.42 Million Impressions
    - +1,800 Facebook Page Likes
  - Boosted Posts (Facebook & Instagram)
    - 559,000 Impressions
  - Video Pre-Roll
    - 567,119 Impressions
    - 425,888 Unique Impressions
  - Keyword Search
    - 11,615 Impressions



FLORIDA Beef COUNCIL

2017
FLORIDA BEEF COUNCIL
FINAL REPORT

Families in Motion

Florida State Scorecard 2016

Funded by The Beef Checkoff
and the Florida Beef Council

PELEGRIN RESEARCH GROUP

Table of Contents

BACKGROUND AND OBJECTIVES – STATE SCORECARDS

- The national Consumer Beef Index (CBI) is designed to:
  - Track changes in consumers' perceptions of, and demand for, beef relative to other meat proteins.
  - Monitor consumer impressions of beef that could be attributed to the industry's communications and advertising efforts.
  - Monitor the areas of relative strength and potential vulnerability for beef sales.
  - Help guide national communication strategies.

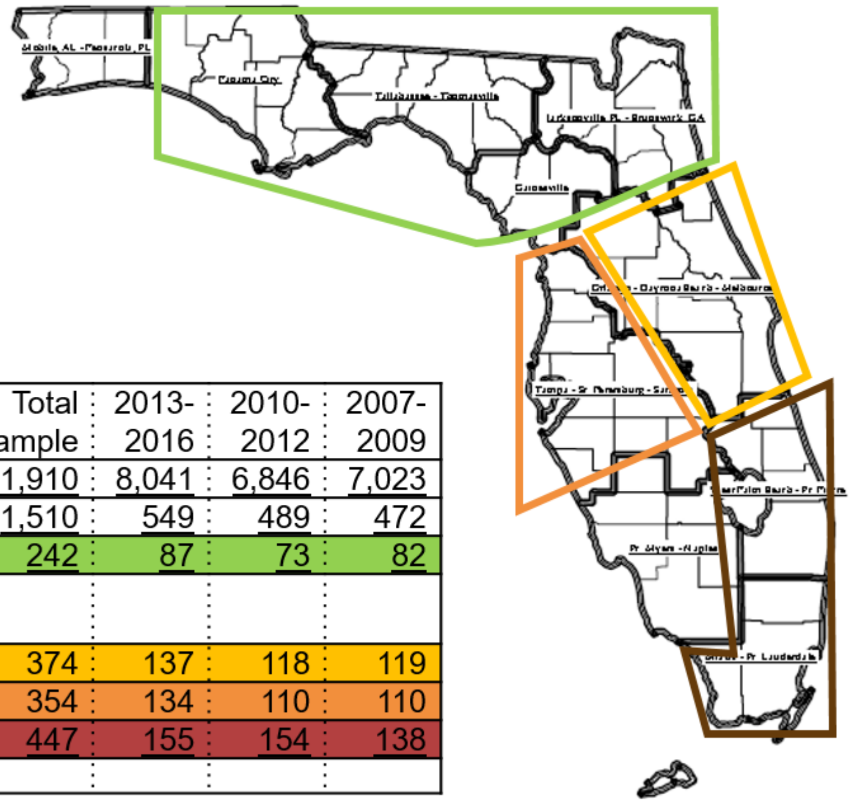
- CBI tracking surveys have been conducted semi-annually for over ten years among 13-65 year old U.S. consumers.

- Determining the key dimensions on which state and metro areas differ from national trends enables state boards to:
  - Pinpoint unique areas of strength or vulnerability for beef within their geographies.
  - Identify specific regional competitive challenges.
  - Tailor in-market communication strategies to the local culture.

METHODOLOGY

- The 2016 Florida State Scorecard includes:
  - Comparisons of 2013-2016 results in the state of Florida and for select metropolitan areas (and groupings) versus national CBI results.
  - Trends for 2013-2016 versus previous periods of 2010-2012 and 2007-2009, where sample size permits.

- State and metropolitan area results are weighted to match the current census figures for age and gender in each geography.



CBI master sample – DMA groupings	Total Sample	2013-2016	2010-2012	2007-2009
U.S. National	21,910	8,041	6,846	7,023
State of Florida	1,510	549	489	472
Northern DMAs *-Gainesville, Jacksonville, Panama City, Tallahassee*	242	87	73	82
Orlando DMA	374	137	118	119
Tampa DMA	354	134	110	110
Southeast DMAs *-Miami, W. Palm Beach*	447	155	154	138

Executive Summary

Statewide

- Florida consumers are continuing to cut back on their beef consumption, paralleling the trend nationwide.
  - Average beef servings are now less than two (1.7) per week, significantly lower than the national average (1.9 servings per week).
  - The proportion of Floridians having beef at least once a week has dropped from three-quarters (73%) to only two-thirds (66%).
  - Preference for beef as a top meal choice is *lower* than the national average (68% vs. 73%) and there is a higher-than-national preference for fish (58% vs. 52%).
  - Fewer Florida consumers are positive about beef (Bucket 2s) and more are somewhat negative (Bucket 3s) than consumers in other regions.
- These patterns are ***not*** a result of dietary "extremists."
  - The proportion of self-described vegetarians is down to 5% from 9% previously, and only one in five (21%) Florida consumers are intentionally restricting their red meat intake.
  - Involvement with beefitswhatsfordinner.com matches national levels.
- Floridians are more concerned than other U.S. consumers about production issues related to beef being raised with hormones/antibiotics and beef production's effect on environmental sustainability.
  - More Florida consumers are also shopping for hormone- and antibiotic-free beef (about one-in-five).

EXECUTIVE SUMMARY & CONCLUSIONS

Statewide (continued)

- Heavy chicken usage (3+ times a week) is higher than national (53% vs. 46%) and interest in chicken as a top meal choice has increased significantly.
- It appears the changing landscape is being driven both by beef's prices and by a general move towards "balance" (meaning variety) in Americans' diets.
  - Florida households have significantly lower than national median incomes and are more likely than in the rest of the nation to buy their beef from Walmart and/or moderate priced restaurants, in addition to other channels.
  - Beef is increasingly preferred for being pleasurable to eat and matches national value perceptions, but chicken is still increasingly preferred in Florida for its value for the money.
- In a period when consumers have increased the number of product characteristics being considered highly important – both Florida-wide and nationwide – the residents are still very satisfied with beef performance at home and their local restaurants (matching national levels), with particular improvement in perception of the tenderness of restaurant beef entrees.
- In addition to the trend continuing of more beef meals being made at home, there is increased confusion about picking the right cuts of beef.

North

- Residents in the northern part of the state are still "average" consumers of beef, but are down significantly over the past decade to two (instead of three) servings of beef per week.
  - This region is polarized, with higher-than-national levels for very positive Bucket 1s (35%) **and** also the more skeptical Bucket 3s (24%).
- Chicken usage has remained higher than the national average and preference for chicken as a top choice has steadily increased.
  - In addition, positive perceptions of chicken (Bucket 1) are significantly higher than the national average.
- There are also more heavy pork users (3+ times a week) in the northern part of the state.

Orlando

- Orlando residents, consistently moderate beef eaters, are now matching the new (lower) national average of about two servings of beef per week.
  - They are heavier than average U.S. markets in their chicken consumption, but are **not** more likely to be vegetarians, **nor** more likely to restrict their red meat intake.
  - They are increasingly buying hormone-free and antibiotic-free beef.
- These mid-state consumers are particularly demanding of food service meals, and are (among others) increasingly looking for value, safety and taste/nutrition balance when they order beef at restaurants.

Tampa

- Tampa area consumers have a low and declining frequency of beef usage (currently 1.4 servings per week versus 1.9 nationally and 1.7 statewide).
- Although consumption of chicken and fish in Tampa are not as heavy as the rest of the state, attitudinally, they are increasingly "top choices" for main meals.
- Those in Tampa are increasingly concerned about food safety when dining out and more concerned about the use of hormones in beef production practices.

Southeast

- Those living in the southeastern region of Florida also have beef less often than the national norm, while continuing to eat chicken frequently.
  - Beef is lower than national as a top meal choice.
- Although the southeast has higher-than-average beef Bucket 3s, positive perceptions of beef (Buckets 1 and 2) have increased significantly – closing some of their gap versus national.
  - Reflecting this polarization, preference for beef over chicken ***and*** preference for chicken over beef both increased significantly, with fewer neutral consumers.
- This region's consumers are buying more grass-fed beef and eating more of their beef meals in restaurants than do consumers in other regions.
- Pork perceptions are extremely negative (Bucket 4) for significantly more consumers here compared to national norms, with decreasing use as well.

- **Consumption**
- Perceptions of Beef and the Competition
- Consumer Profile
- Appendix

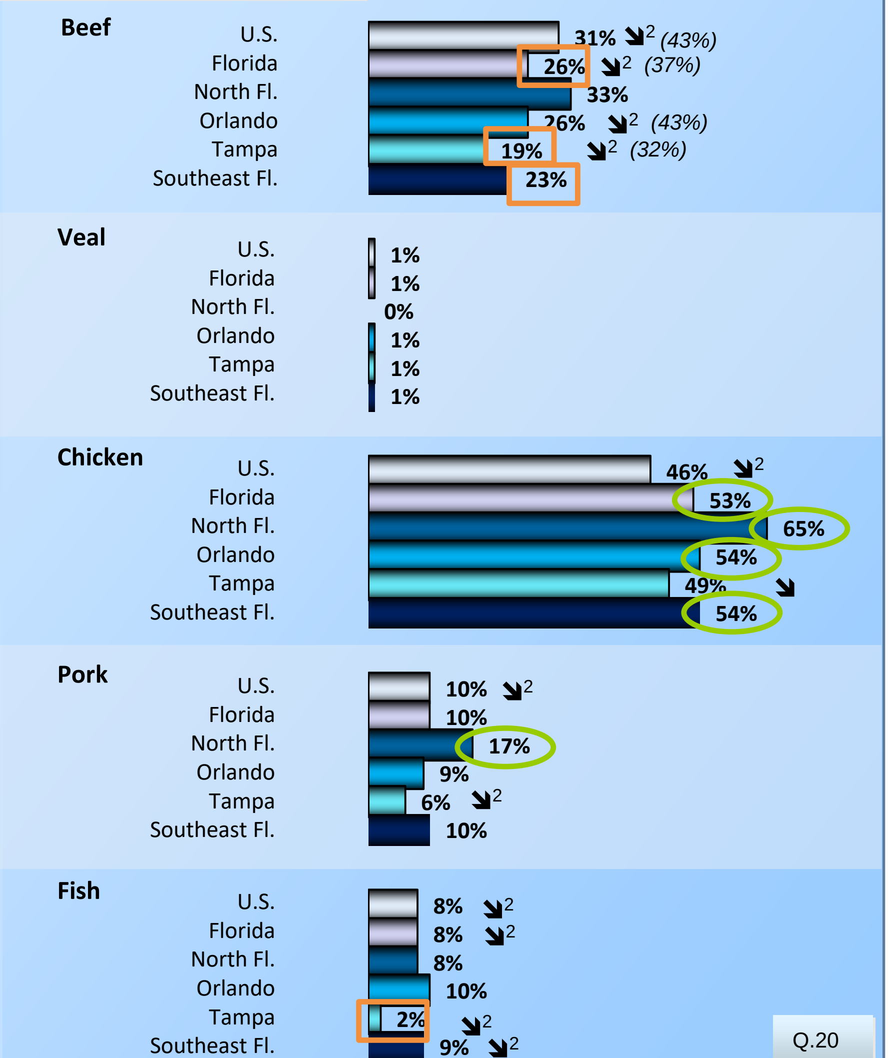
Key – Result differences, at 90% confidence, are highlighted for a geographic area in this Scorecard when:

- **Results are significantly higher or lower than national level.**
-
- **The 2013-2016 results show an increasing (➚) or decreasing (➘) longer-term trend, superscripted to indicate the trend extends across the two previous periods back to 2007-2009 (➚²/➘²).**
- **For selected trends, the level from the period beginning that trend (whether 2010-2012 or 2007-2009) is shown in *(italics).***

2013-2016 CBI Sample Sizes: Total = 8,041; Florida= 549; Northern DMAs = 87; Orlando DMA = 137; Tampa DMA = 134; Southeast DMAs = 155

How Many and How Often

Eat 3+ Times Weekly

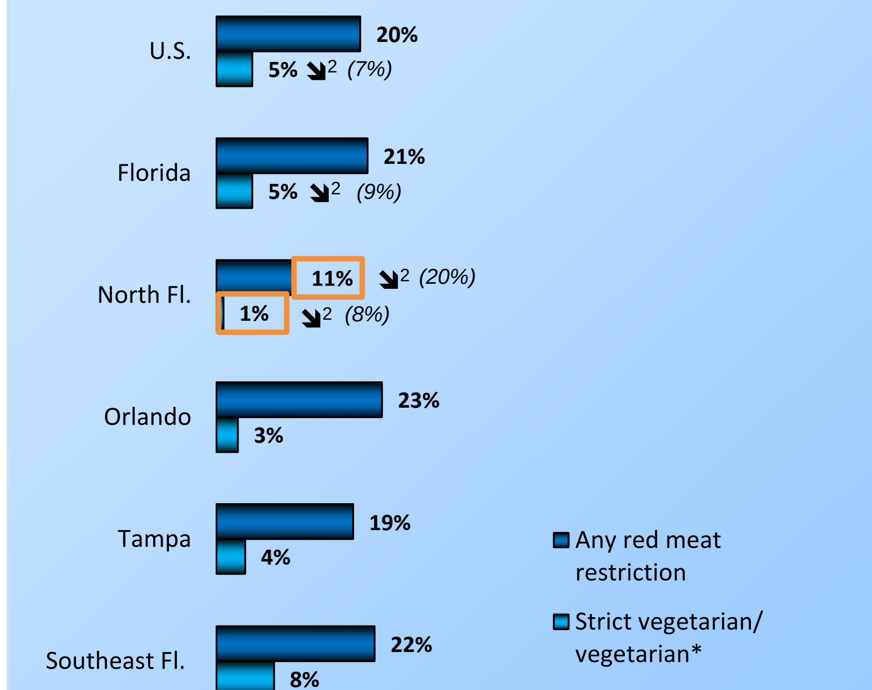


Frequency – Average Weekly Beef Servings

U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
1.9 ↘2 (2.6)	1.7 ↘2 (2.1)	2.1 ↘2 (2.8)	1.9	1.4 ↘2 (1.8)	1.5

Q.20

Diet Description



***Including vegetarians eating any combination of chicken/poultry, fish, eggs and/or dairy products … but not any red meat**

Q.17

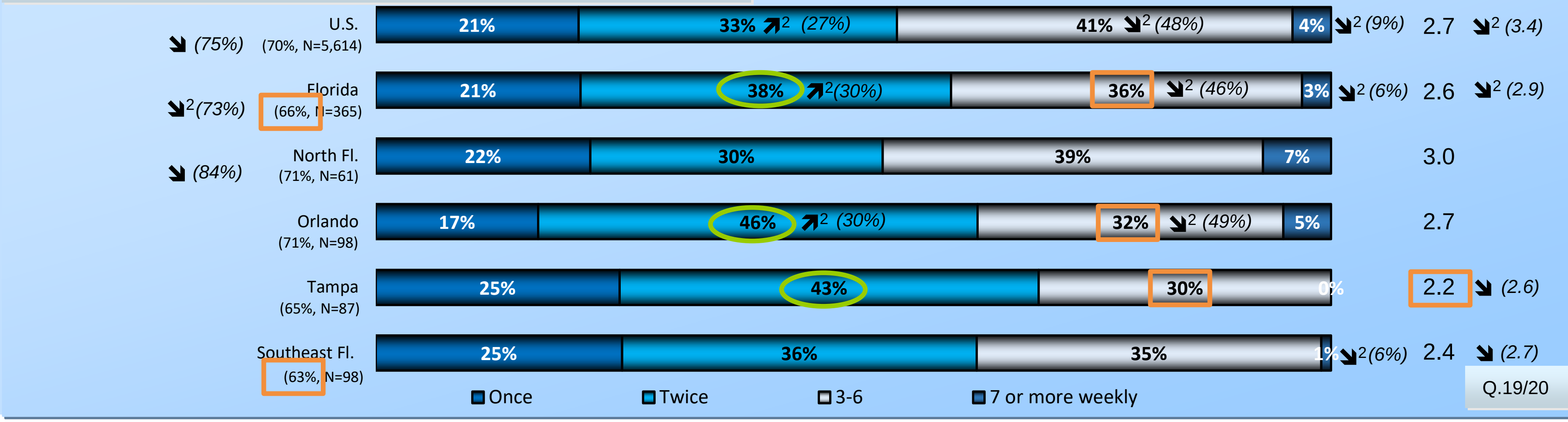
Note: Full question text detailed in Appendix

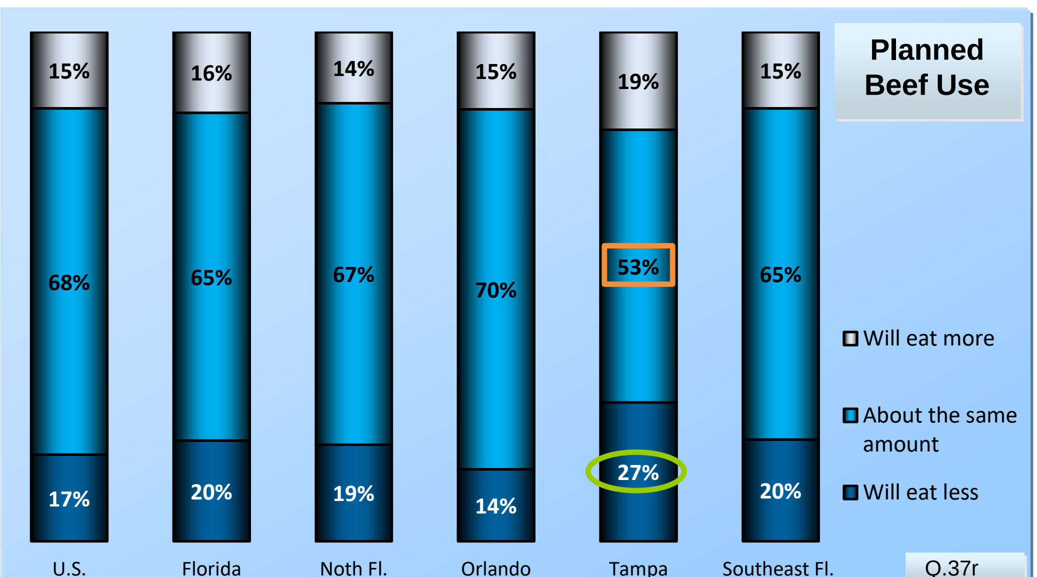
Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend (**↗↘**) and/or higher/lower than non-segment (↑↓)

Beef Involvement

Consumption Frequency – Those Eating Beef Weekly





Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Beef Use Detail

Importance In Decision To Use More Beef

Extremely/Very Important	U.S.	Florida*
You continue to really enjoy and prefer the taste of beef	80%↗	77%
A beef meal is quick and easy to prepare	70%	72%
More times when beef fits the occasion best	68%	63%
Beef's become more of a family favorite	66%	65%
Stores are selling beef at a great price	64%↗	69%
Better availability of the cuts you like	61%↗	62%
Learned new ways to prepare beef	59%	61%
Looking to add protein to your diet	60%↗	64%
Grilling more often	58%	54%
Seeing that lean beef fits a healthy diet in dietary recommendations	56%	59%
Less worry about beef being safe to eat	52%↗	55%
Gotten less concerned about its price	49%	49%
Hearing news about beef's healthiness	48%↗	49%
Became tired of other meats	46%	41%
Base: Those planning to eat more	**(1,208)**	**(82)**

Q.38d

Importance In Decision To Use Less Beef

Extremely/Very Important	U.S.	Florida*
Limiting the fat in your diet	64%	56%
Other meats just seem healthier	63%↗	54%
Cutting back for health reasons	63%↗	62%
Limiting the cholesterol in your diet	60%↗	47%
Too expensive relative to other meats	51%↗	47%
You are more concerned about its price	50%↗	47%
Trying to eat more plant-based protein	50%↗	53%
Concern about the "factory farming" methods used in the beef industry	48%↗	49%
Other meal options preferred to beef taste	43%↗	44%
More worried about beef safety	42%↗	44%
Hard to digest	37%↗	39%
Discovered new recipes not using beef	34%	29%
The Federal Dietary Guidelines suggest	32%	27%
A family member wants to eat less beef	28%↗	26%
A steak dinner takes too long for many nights of the week	25%	21%
Using the grill less often	25%↗	21%
Base: Those planning to eat less	**(1,406)**	**(107)**

Q.38f

***Sufficient sample state-wide only**

Specialty Beef Purchases

	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Specialty Beef Products in Past 6 Months (Net)	49%↘	47%	43%	40%	49%	50%
Hormone-free beef or beef-based products	17%↗[2]	21%↗	21%	21%↗[2]	18%	21%
Antibiotic-free beef or beef-based products	14%↗[2]	18%↗	14%	20%↗[2]	15%	18%↗
Organically raised beef or beef-based products	16%	17%	19%	11%	15%	23%
Naturally-raised beef or beef-based products	22%↘	21%↘[2]	13%↘	16%↘	21%	27%
Grass-fed beef or beef-based products	22%↗[2]	20%↗[2]	18%	16%	17%	23%↗[2]
Locally raised beef or beef-based products	18%	9%	10%	7%↘	13%	9%
Base: Split sample	(5,012)	(352)	(56)	(77)	(96)	(95)

****Penetration rather than case volume share**

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend (**↗↘**) and/or higher/lower than non-segment (↑↓)

Q.48

Current Beef Use

Purchase Channels*

	Penetration						Share of Past 10 Servings					
	U.S.	Flor-ida	North Fl.	Orlan-do	Tampa	South-east Fl.	U.S.	Flor-ida	North Fl.	Orlan-do	Tampa	South-east Fl.
Supermarket (Natural, Traditional) (Net)	72%	76%	71%	70%	78%	76%	42%	42%	51%	36%	42%	40%
Traditional grocery stores	64%	72%	68%	65%	75%	72%	36%	37%	46%	32%	38%	35%
Natural specialty grocers	19%	18%	11%	16%	19%	22%	6%	5%	6%	4%	4%	6%
Walmart	37%	42%	42%	46%	41%	39%	16%	18%	21%	17%	17%	15%
A club/warehouse store	23%	20%	6%	29%	25%	17%	7%	6%	1%	9%	6%	5%
A butcher/meat market	16%	13%	10%	12%	22%	15%	5%	4%	5%	4%	9%	4%
Other mass merchandiser	8%	9%	4%	14%	9%	10%	2%	2%	2%	3%	1%	2%
Drug/convenience/99 cent	6%	9%	0%	11%	12%	11%	1%	1%	0%	2%	2%	2%
A local, direct source (farmer/rancher, CSA)	6%	5%	0%	3%	8%	7%	2%	1%	0%	0%	2%	1%
Food Service (Net)	57%	59%	48%	57%	46%	69%	21%	23%	20%	22%	18%	29%
Fast food/sandwich shop	41%	41%	41%	37%	35%	48%	11%	11%	14%	6%	9%	14%
Moderately price (Chili's, Applebee's. Outback)	27%	32%	25%	36%	23%	35%	5%	7%	5%	8%	5%	8%
Quick casual (Chipotle, Panera, food trucks)	17%	17%	8%	23%	14%	20%	3%	3%	1%	4%	2%	3%
"White tablecloth" dining	7%	8%	1%	10%	6%	12%	1%	1%	0%	2%	1%	2%
School or work cafeteria	5%	5%	1%	10%	2%	7%	1%	1%	0%	1%	1%	2%
Stadium, hotel, rec/travel	4%	5%	2%	5%	3%	4%	1%	1%	0%	1%	0%	1%
Home delivery (Net)	4%	4%	1%	6%	4%	4%	1%	1%	0%	1%	1%	2%
Base: Beef eaters	**(5,748)**	**(383)**	**(60)**	**(100)**	**(85)**	**(111)**	**(5,748)**	**(383)**	**(60)**	**(100)**	**(85)**	**(111)**

Q.40

***New channel definitions from 2014**

Note: Full question text detailed in Appendix   Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(➚➘)** and/or higher/lower than non-segment (↑↓)

- Consumption
- **Perceptions of Beef and the Competition**
- Consumer Profile
- Appendix

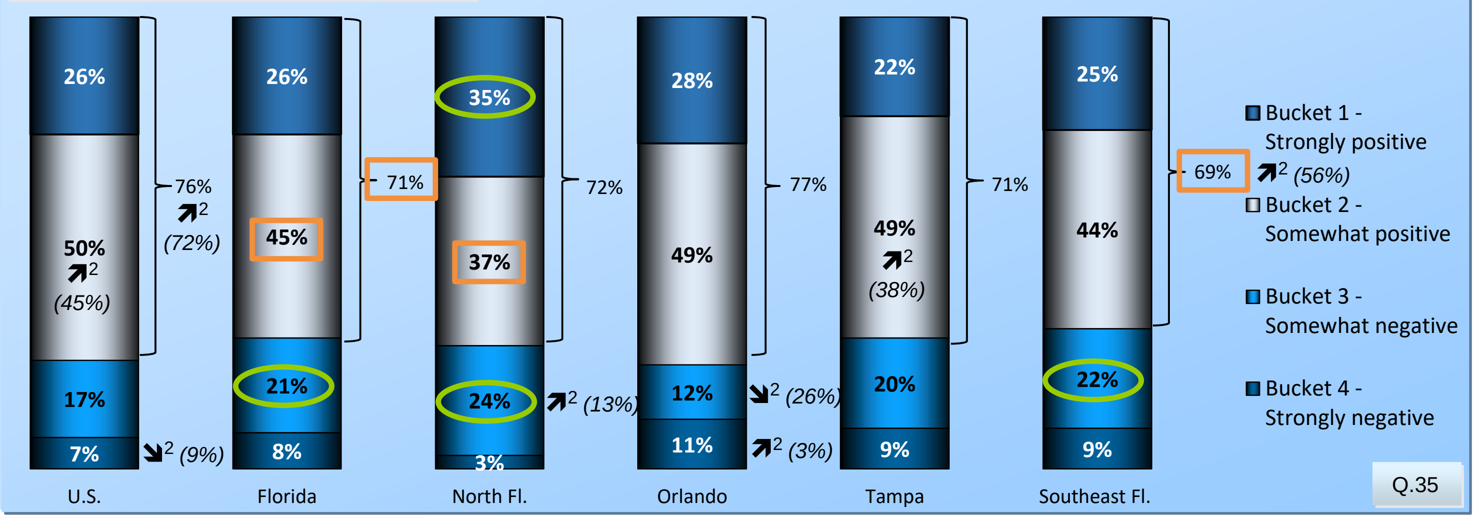
Key – Result differences, at 90% confidence, are highlighted for a geographic area in this Scorecard when:

- Results are significantly higher or lower than national level.
-
- The 2013-2016 results show an increasing (↗) or decreasing (↘) longer-term trend, superscripted to indicate the trend extends across the two previous periods back to 2007-2009 (↗²/↘²).
- For selected trends, the level from the period beginning that trend (whether 2010-2012 or 2007-2009) is shown in *(italics).*

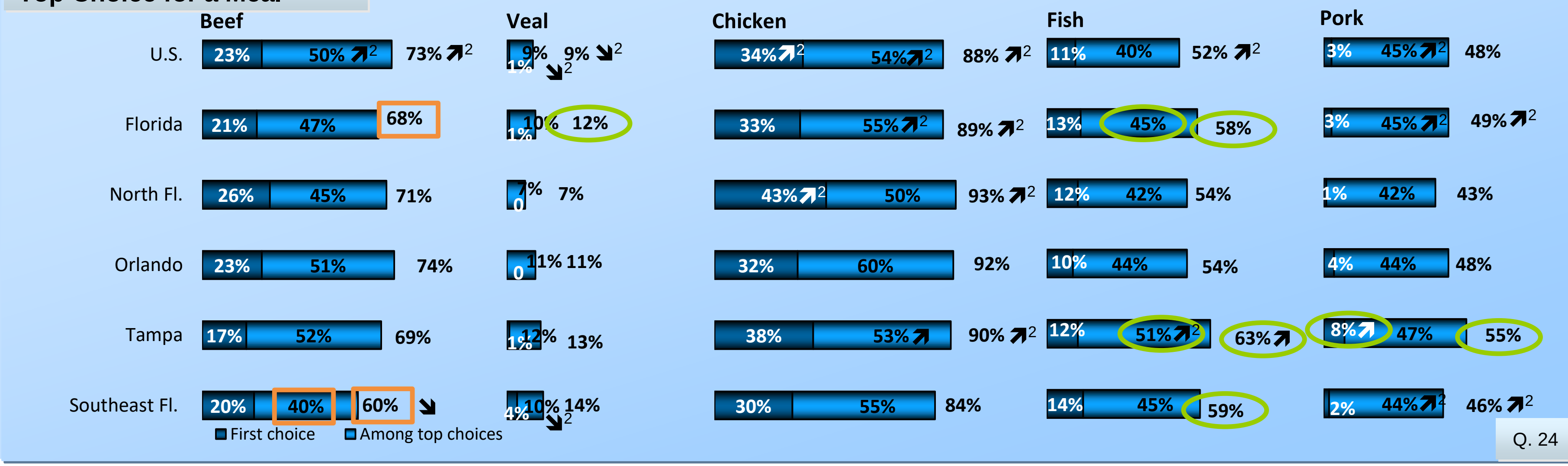
2013-2016 CBI Sample Sizes: Total = 8,041; Florida= 549; Northern DMAs = 87; Orlando DMA = 137; Tampa DMA = 134; Southeast DMAs = 155

Perceptions of Beef

Strength of Beef Perception



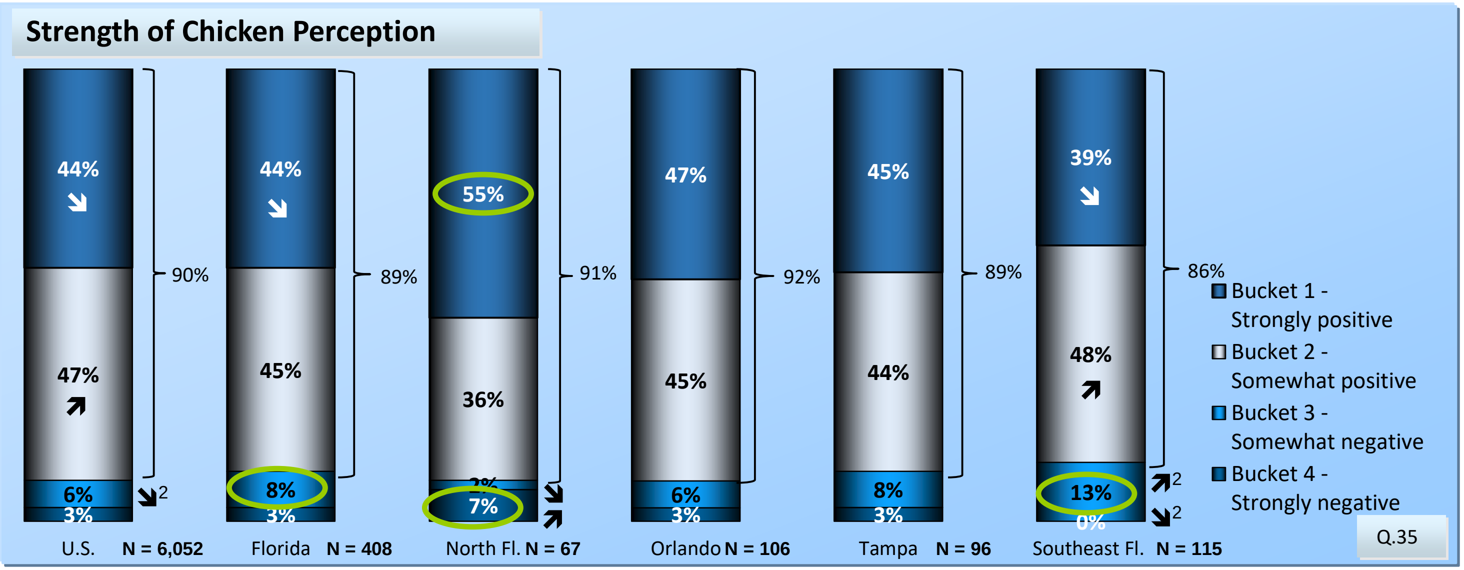
Top Choice for a Meal

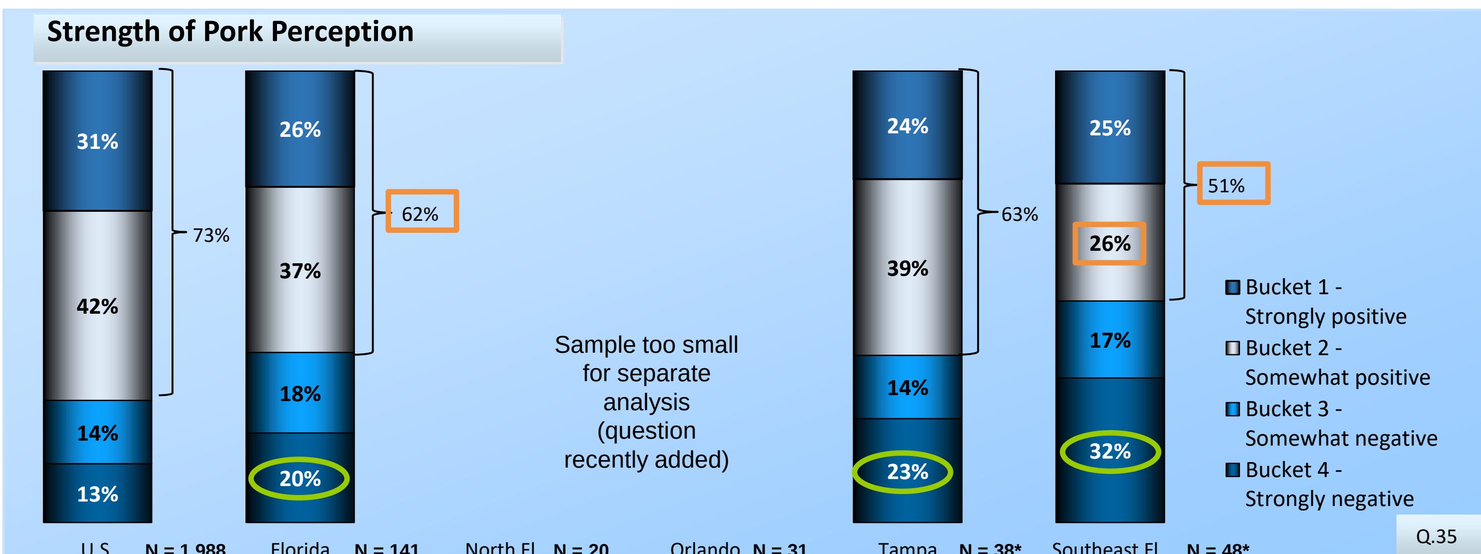


Note: Full question text detailed in Appendix   Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend (↗↘) and/or higher/lower than non-segment (↑↓)

Perceptions of Competition

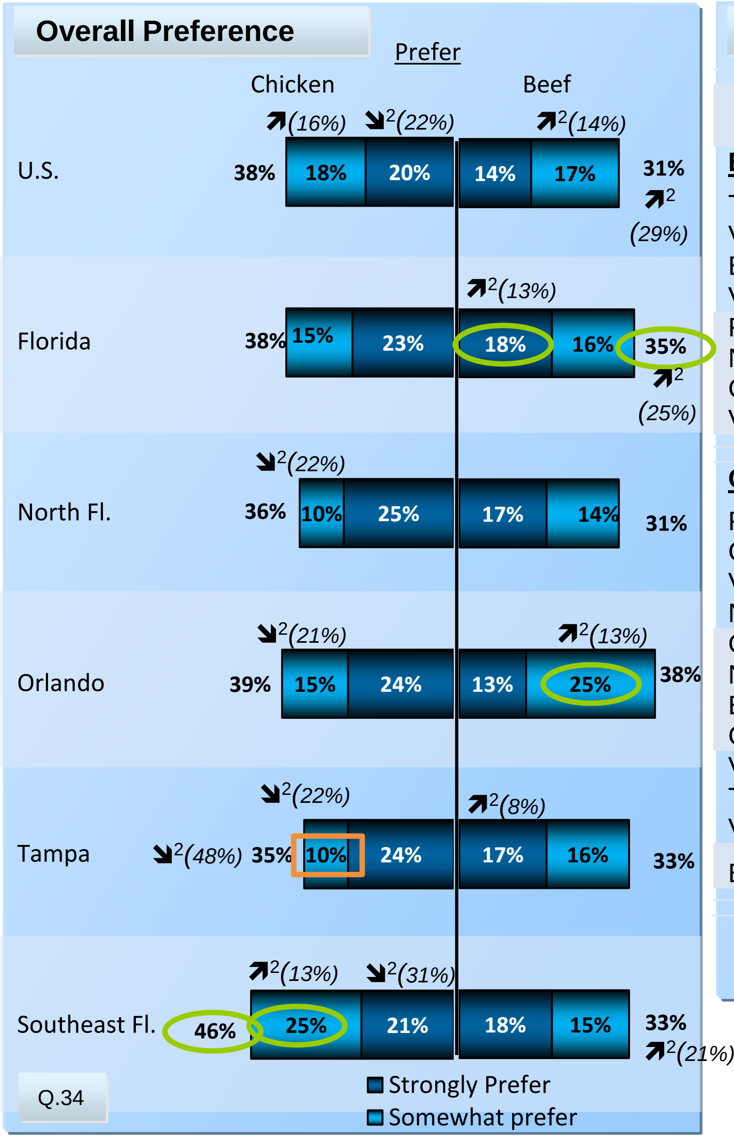




Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend (**↗↘**) and/or higher/lower than non-segment (↑↓) *Caution: small base <50

Beef Versus Chicken



Key Comparative Differences

	U.S.	Florida	North Fl.	Orlando	Tampa	South-east Fl.
Beef is Better						
Taste	31%	32%	26%	35%	30%	35%
Very pleasurable to eat	23%	23%↗[2]	17%	28%↗[2]	17%	25%↗[2]
Ease of preparation	16%↘	18%	17%	18%	20%	15%
Versatility	12%↘	10%	14%	14%	8%	8%↘[2]
Fat content	12%↘	14%	21%↗[2]	17%	8%↘[2]	13%
Nutritional content	10%↘	11%	8%	15%	13%	9%
Good any night of the week	10%	11%↗[2]	12%↗[2]	8%	16%↗[2]	10%↗[2]
Value for the money	9%↘	11%	10%	10%	8%	10%
Chicken is Better						
Fat content	64%↗	63%	57%	61%	68%	65%
Calorie content	57%↗	59%	57%	58%	64%	62%
Value for the money	57%↗	62%↗	49%	67%↗	61%	65%
Not feeling guilty eating it	44%↘	45%	30%↘[2]	40%↘	50%	53%
Good for kids	40%	40%	34%	43%	44%	43%
Nutritional content	36%	36%	32%	39%	42%	37%↘
Ease of preparation	29%	30%↘[2]	31%	36%	28%	30%
Good any night of the week	29%	28%↘	22%	33%	19%↘	31%
Versatility	26%	27%	23%	24%	27%	31%
Taste	19%↘[2]	25%	20%	24%	26%	27%
Very pleasurable to eat	17%↘	23%	24%	19%	23%	26%↗[2]
Base:	(6,052)	(408)	(67)	(106)	(96)	(115)

Q.37

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

What Consumers Want

At Home

Extremely/Very Important	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Great tasting	90%↗[2]	94%↗[2]	91%	97%↗[2]	97%	86%
Good value for the money	84%↗[2]	86%↗[2]	91%	92%↗[2]	85%	79%
Extremely safe to eat	84%↗	85%↗[2]	97%↗[2]	86%↗[2]	88%	74%
Fits a moderate food budget	75%	73%	NA	NA	NA	NA
Ideal balance of good taste and good nutrition	74%↗[2]	77%	79%	82%	74%	71%
You know how to prepare it well	73%↗[2]	73%	71%	82%↗	75%	69%
Provides energy and fuel for the body	70%↗[2]	72%	75%	71%	73%	69%
Great source of protein	69%↗[2]	71%	77%	79%↗	71%	60%↘[2]
Options that are quick and easy to prepare	66%	64%	56%	72%↗	65%↘	61%
Always tender	66%	69%	63%	72%	77%	64%
Variety of meal options	64%	63%↘	58%	73%	66%↘	54%↘
Excellent total package of nutrients	62%↗[2]	63%	62%	75%↗	60%	52%
Easy to pick the right cut	62%	61%↘[2]	58%	69%	62%↘	63%
Is a food that can be eaten every day	59%↗	56%	43%	74%	61%	53%
Not contribute to heart health problems	59%	58%↘[2]	63%	59%	59%	50%↘
Fits well with a health-conscious diet	57%	55%	61%	57%	56%	51%
Has many lean cuts available	55%↘	58%↘[2]	56%	57%	63%	56%
Low in saturated fat	52%↘	51%↘	52%	50%	59%	45%↘
Animals are humanely raised	53%↗[2]	54%	49%	55%	59%	52%
Animals raised without the use of hormones	51%	53%	57%	55%	62%	45%
Antibiotics used responsibly	49%	51%	53%	46%	56%	46%
Animals are sustainably raised	47%	51%	NA	NA	NA	NA
Low impact on the environment	44%	43%↘[2]	41%	42%	41%	46%
Base:	**(4,020)**	**(276)**	**(51)**	**(68)**	**(58)**	**(80)**

Issues monitor

Q.13a

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (**↑↓**)

What Consumers Want

At a Full Service Restaurant

Extremely/Very Important	U.S.	Florida	North Fl.*	Orlando	Tampa	Southeast Fl.
Great tasting	93%↗	92%↗	96%	90%	86%	96%
Good value for the money	85%↗[2]	90%↗	90%	96%↗	83%	92%↗[2]
Extremely safe to eat	84%↗[2]	88%↗	84%	91%↗	93%↗[2]	84%
Has lots of menu options you like	77%↗	79%	74%	79%↗	83%	76%
Fits a moderate food budget	75%	77%	NA	NA	NA	NA
Ideal balance of good taste and good nutrition	69%↗[2]	69%	63%	74%↗	64%	72%
Always tender	68%	70%	61%	70%	72%	68%
Provides energy and fuel for the body	61%↗	67%↗	63%	70%	65%	72%
Great source of protein	58%↗[2]	62%↗[2]	59%	68%↗[2]	57%	64%
Good for special occasion meals	56%	61%	61%	69%↗	61%	57%
Not contribute to heart health problems	54%	61%	54%	68%↗	60%	62%
Excellent total package of nutrients	53%	57%	43%	65%	55%	61%
Has many lean cuts available	51%	55%	46%	59%	60%	50%
Fits well with a health-conscious diet	50%	54%	45%	59%	50%	60%
Is a food that can be eaten every day	49%	53%	NA	60%	39%	54%
Low in saturated fat	47%↘[2]	50%	40%	59%	44%↘[2]	54%
Animals are humanely raised	52%↗[2]	56%↗	49%	65%↗[2]	58%↗[2]	48%
Animals raised without the use of hormones	50%	56%	50%	55%	61%	56%
Antibiotics are used responsibly	49%	53%	42%	59%	58%	53%
Animals are sustainably raised	45%	58%	66%	57%	79%	50%
Base:	**(4,021)**	**(273)**	**(36*)**	**(69)**	**(76)**	**(75)**

Issues monitor

*Caution: small base <50

Q.13b

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Beef Performance

At Home

	Completely/Somewhat Agree	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
	Great tasting	90%↗[2] *(85%)*	87%	93%	84%↘[2] *(96%)*	91%	81%↘ *(91%)*
	Great for grilling	89%	90%	91%	90%	93%	84%
	Great source of protein	86%↗[2] *(82%)*	83%	86%	84%	79%	81%
	Provides energy and fuel for the body	83%↗[2] *(77%)*	80%	81%	82%	71%	83%
	Variety of meal options	83%↗ *(78%)*	81%	91%	72%	78%	80%
	You know how to prepare it well	82%	83%	88%	85%	77%	81%
	Options that are quick and easy to prepare	81%	79%	75%	85%	83%	72%
	Good for special occasion meals	81%↗[2] *(76%)*	79%	94%	75%	81%	70%↘ *(85%)*
	Easy to pick the right cut	79%↘ *(81%)*	79%↘[2] *(87%)*	79%	82%	79%	74%↘ *(87%)*
	Has many lean cuts available	78%	76%	77%	84%	76%	71%↘ *(83%)*
	Ideal balance of good taste/nutrition	74%↗[2] *(67%)*	72%	82%	72%	68%	70%
	An excellent total package of nutrients	65%	64%	65%	70%	64%	59%
	Extremely safe to eat	63%↗[2] *(56%)*	66%	75%	70%	65%	59%
	Good value for the money	60%↘ *(64%)*	62%	62%	62%	70%	59%
	Fits a moderate food budget	59%	65%	NA	NA	NA	NA
	Is a food that can be eaten every day	52%	47%↘ *(58%)*	62%	43%	37%	40%
	Fits well with a health-conscious diet	48%	45%	50%	44%	49%	38%
	Low in saturated fat	31%↘ *(34%)*	34%	46%↗ *(35%)*	28%	39%↗ *(20%)*	28%
	Not contribute to heart health problems	29%	27%	34%	21%	23%	31%
	Gets boring	24%	28%	27%	19%	38%	34%
Issues monitor	Animals are humanely raised	42%↘ *46%)*	44%	52%	39%	47%	44%
	Low impact on the environment	34%↘ *(39%)*	37%↘ *(48%)*	31%	37%	35%	44%
	Antibiotics are used responsibly	33%↘ *(37%)*	35%	40%	37%	38%	37%
	Base:	**(4,020)**	**(276)**	**(51)**	**(68)**	**(58)**	**(80)**

Q.32a

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Beef Performance

At a Full Service Restaurant

Completely/Somewhat Agree	U.S.	Florida	North Fl.*	Orlando	Tampa	Southeast Fl.
Great tasting	88%↗[2]*(84%)*	86%	91%	83%	89%	86%
Great source of protein	86%↗[2]*(80%)*	86%	79%	92%↗*(80%)*	87%	85%
Has lots of menu options you like	83%	84%	96%↗*(78%)*	83%	87%	81%
Provides energy and fuel for the body	82%↗[2]*(77%)*	78%	88%	76%	77%	78%
Good for special occasion meals	81%↗[2]*(75%)*	82%↗[2]*(75%)*	84%	76%	81%	**88%↗[2]*(66%)***
Has many lean cuts available	75%	72%	84%	75%	75%	69%
Ideal balance of good taste/nutrition	71%↗[2]*(66%)*	70%	64%	71%	70%	75%
An excellent total package of nutrients	63%	64%	69%	65%	61%	70%
Good value for the money	60%↘*(64%)*	60%	65%	62%	58%	66%
Fits a moderate food budget	58%	54%	NA	NA	NA	NA
Always tender	57%	64%↗[2]*(54%)*	65%	62%	67%	67%↗*(45%)*
Is a food that can be eaten every day	52%	51%	57%	51%	43%	54%
Low in saturated fat	30%	32%↗[2]*(25%)*	36%	32%	37%	36%
Not contribute to heart health problems	28%↘*(30%)*	32%	38%	33%	32%	36%
Gets boring	23%	27%	16%	29%	24%	32%
Animals are humanely raised	39%↘*(43%)*	38%	48%	42%	35%	33%
Low impact on the environment	34%↘*(37%)*	38%	42%	37%	40%	41%
Antibiotics are used responsibly	33%	35%	42%	36%	33%	38%
Base:	**(4,021)**	**(273)**	**(36*)**	**(69)**	**(76)**	**(75)**

Issues monitor (Animals are humanely raised; Low impact on the environment; Antibiotics are used responsibly)

*Caution: small base <50

Q.32b

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Interest Focus

Areas of Concern/Interest

Pay particular attention to	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Hormones in beef	17%	24%	Sample too small for separate analysis	17%	27%	20%
Antibiotics in beef	16%	21%		13%	23%	15%
Beef and e-coli	15%	15%		8%	12%	17%
Saturated fat in beef	13%	16%		15%	15%	13%
BSE ("Mad Cow Disease")	12%	16%		7%	15%	16%
Beef and heart disease	12%	11%		8%	7%	13%
Beef and salmonella	12%	16%		11%	15%	20%
GMO feed being used for cattle	12%	15%		9%	15%	13%
Base:	(2,994)	(217)	(31)	(56)	(50)	(65)

Q.46

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (**↑↓**)

Beef Value For the Money

	U.S.	Florida	North Fl.	Orlando*	Tampa*	Southeast Fl.*
Hamburger/ground beef bought at the grocery store						
Too expensive and definitely not worth it	15%	17%	Sample too small for separate analysis	15%	18%	12%
Expensive but worth it	30%	29%		32%	34%	27%
Just about right	46%	46%		43%	44%	49%
Inexpensive and worth it	6%	7%		10%	2%	12%
So inexpensive that you worry about its quality	3%	2%		0%	2%	0%
Meal with hamburger or ground beef at a restaurant						
Too expensive and definitely not worth it	12%	12%		3%	8%	22%
Expensive but worth it	20%	17%		14%	18%	17%
Just about right	56%	55%		64%	56%	50%
Inexpensive and worth it	8%↘	10%		10%	9%	8%
So inexpensive that you worry about its quality	5%	6%		9%	9%	3%
Steak bought at the grocery store						
Too expensive and definitely not worth it	25%	26%		19%	24%	19%
Expensive but worth it	43%↗	46%		42%	52%	55%
Just about right	29%↘	25%		32%	22%	22%
Inexpensive and worth it	2%	2%		5%	0%	4%
So inexpensive that you worry about its quality	2%	1%		2%	2%	0%
Steak meal at a restaurant.						
Too expensive and definitely not worth it	24%	23%		22%	17%	24%
Expensive but worth it	50%↗	47%		47%	49%	43%
Just about right	24%↘	26%		28%	26%	33%
Inexpensive and worth it	1%	2%		2%	3%	0%
So inexpensive that you worry about its quality	1%	2%		2%	5%	0%
Base: Split sample (2015/6)	**(2,548-54)**	**(166-7)**	**(27-29)**	**(38-42*)**	**(40-46*)**	**(45-47*)**

*Caution: small base <50

Q.48x1-4

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (**↑↓**)

- Consumption
- Perceptions of Beef and the Competition
- **Consumer Profile**
- Appendix

<u>Key – Result differences, at 90% confidence, are highlighted for a geographic area in this Scorecard when:</u>

- Results are significantly higher or lower than national level.
-
- The 2013-2016 results show an increasing (↗) or decreasing (↘) longer-term trend, superscripted to indicate the trend extends across the two previous periods back to 2007-2009 (↗²/↘²).
- For selected trends, the level from the period beginning that trend (whether 2010-2012 or 2007-2009) is shown in *(italics).*

<u>2013-2016 CBI Sample Sizes</u>: Total = 8,041; Florida= 549; Northern DMAs = 87; Orlando DMA = 137; Tampa DMA = 134; Southeast DMAs = 155

Lifestyles

Lifestyle Attitudes

Top 3 box (8-10)	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
You cook meals frequently	52%↗[2]	50%↗[2]	57%↗[2]	51%	51%	48%
You are willing to try new beef cuts and recipes	45%	46%	55%	51%	42%	40%
Meal enjoyment is more important than healthiness	41%↗[2]	41%	60%↗[2]	47%↗	38%	37%↘
You really are a "meat and potatoes" person	38%↗[2]	38%↗[2]	51%↗	36%	34%	37%
Cooking is a way you express your creativity	37%	38%	41%↗[2]	45%↗[2]	37%	39%
You feel you want to live life to the fullest	36%	34%	40%	35%	36%	30%
You pay particular attention to the nutritional value of foods	35%↗[2]	36%	43%↗[2]	38%	31%	34%
You often make changes to improve the healthiness of your lifestyle	33%	32%	35%	35%	29%	32%
It feels like you're always struggling to keep your head above water financially	31%↘	32%	40%	33%	26%	37%
Not enough hours in the day	27%	23%	32%	27%	23%	20%
You mainly eat natural foods	21%↗[2]	21%	28%	22%↗[2]	20%	21%
People often seek out your advice about food or food purchases	20%	22%	20%	24%↗[2]	22%↗[2]	24%
You are very health conscious	19%↘	17%↘	24%	17%	15%↘	16%↘

Q.49

Lifestyle Behavior

Past Week	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Used the Internet to find out specific information	63%	63%	69%	63%	60%↘	65%
Ate a meal on-the-go	36%↘[2]	34%↘[2]	42%	34%↘[2]	29%	35%
Barbequed	21%↘[2]	22%↘[2]	25%	15%↘	26%	24%
Cooked a meal just for the fun of it	22%↘[2]	28%	30%	37%↗	20%↘	28%

Q.50

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Consumer Demographics

General Demographics

	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Female*	52%	51%	51%	51%	52%	52%
Male*	48%	49%	49%	49%	48%	48%
Any children	41%↘	42%	36%	45%	43%	45%
Full-time employed	45%↗	44%	42%	45%	48%	44%
Average household size	2.8	2.8	2.6	2.7	2.8	2.8

Q.1b, 6, 53, 51

Household Income

	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Under $24,000	18%	19%	26%	17%	20%	17%
$24K to under $48K	27%	29%	33%	27%	27%	32%
$48K to under 87K	32%	34%	27%	42%	38%	29%
$87,000 or more	23%	18%	14%	14%	15%	22%
Average (000)	$61.8↗	$55.9	$49.6	$56.1	$55.1	$58.8
Base:	**(7,048)**	**(473)**	**(72)**	**(113)**	**(117)**	**(139)**

Q.57

Household Type

	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Living with:						
Significant other or spouse	50%↘2	49%	42%	50%	61%	41%
A child/children	31%↗2	30%	26%	34%↗2	31%	31%
Parent(s) or guardian(s)	21%↗2	23%↗2	22%	25%	17%	28%↗2
Living alone	19%↗	18%	24%	18%↗	17%	18%
Roommate or roommates	6%↘2	6%	7%	5%	5%	3%

Q.3

Age*

	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
Millennials (13-32)	36%	38%	44%	39%	35%	42%
Gen-X (33-46)	26%	30%	28%	33%	32%	29%
Baby Boomers (47-65)	37%	32%	28%	28%	33%	29%

Q.1a

Education

↗↗2↘↘2	U.S.	Florida	North Fl.	Orlando	Tampa	Southeast Fl.
No college	26%↘	25%	23%	27%	24%	23%
Some college	24%↘2	24%↘	23%	28%	30%	19%
College graduate	34%↗2	36%↗	38%	33%	34%	37%↗
Post graduate work	17%↗2	15%	16%	12%	12%	21%
Base:	**(7,968)**	**(543)**	**(87)**	**(137)**	**(130)**	**(153)**

Q.59

***Sample weighted to match census profile of state and metro areas**

Note: Full question text detailed in Appendix   Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (↑↓)

Website Involvement

(Page 1 of 2)

	U.S.	Florida	North Fl.	Orlando*	Tampa	Southeast Fl.*
allrecipes.com						
Visited in past 6 months	40%	37%	Sample too small for separate analysis	42%	Sample too small for separate analysis	33%
Visited over 6 months ago	15%	17%		22%		11%
Heard of, but not visited	16%	18%		15%		16%
Never heard of	29%	28%		21%		40%
foodnetwork.com						
Visited in past 6 months	39%	37%		46%		43%
Visited over 6 months ago	15%	18%		15%		12%
Heard of, but not visited	33%	33%		37%		23%
Never heard of	14%	12%		2%		22%
beefitswhatsfordinner.com						
Visited in past 6 months	6%	7%		4%		7%
Visited over 6 months ago	4%	4%		5%		5%
Heard of, but not visited	28%	28%		24%		27%
Never heard of	62%	62%		67%		61%
Base (2016):	**(1,965)**	**(149)**	**(21)**	**(39*)**	**(31)**	**(48*)**

*Caution: small base <50

Q.37s14

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(↗↘)** and/or higher/lower than non-segment (**↑↓**)

Website Involvement

(Page 2 of 2)

	U.S.	Florida	North Fl.	Orlando*	Tampa	Southeast Fl.*
incredibleegg.org						
Visited in past 6 months	4%	5%	Sample too small for separate analysis	4%	Sample too small for separate analysis	9%
Visited over 6 months ago	4%	3%		7%		2%
Heard of, but not visited	29%	36%		38%		28%
Never heard of	62%	56%		51%		61%
meatrecipes.com ***(Non-existent site)***						
Visited in past 6 months	5%	7%		7%		14%
Visited over 6 months ago	3%	5%		3%		0%
Heard of, but not visited	12%	10%		6%		11%
Never heard of	80%	78%		84%		75%
eatchicken.com						
Visited in past 6 months	5%	7%		4%		8%
Visited over 6 months ago	2%	1%		0%		0%
Heard of, but not visited	13%	14%		6%		19%
Never heard of	81%	78%		90%		74%
porkbeinspired.com						
Visited in past 6 months	4%	4%		4%		9%
Visited over 6 months ago	3%	5%		5%		5%
Heard of, but not visited	12%	14%		2%		16%
Never heard of	81%	77%		90%		71%
Base (2016):	**(1,965)**	**(149)**	**(21)**	**(39*)**	**(31)**	**(48*)**

*Caution: small base <50

Q.37s14

Note: Full question text detailed in Appendix Selected previous period (2010-12) results shown in italics

Key: Significant change in ongoing trend **(➚➘)** and/or higher/lower than non-segment (**↑↓**)

- Consumption
- Perceptions of Beef and the Competition
- Consumer Profile
- **Appendix**

QUESTION TEXT

Q.1a: What is your age?
Q.1b: What is your gender?
Q.3: Are you currently living with a parent(s) or guardian(s), roommate(s), a significant other /spouse, children or alone?
Q.6: How many children are in your household in each of the following age groups?
Q.13a: How important is each of the following when choosing whether to have beef, chicken, fish, pork or other main dish alternatives for dinner at home?
Q.13b: How important is each of the following when choosing whether to have beef, chicken, fish, pork or other main dish alternatives for dinner at a full-service restaurant such as Applebee's, Olive Garden, Chili's, TGI Friday's, Outback, Lone Star, etc.?
Q.17: Which of the following statements best describes your own diet?
Q.19: Thinking about all of your meals, how frequently do you eat each of the following types of food?
Q.20: [For each type eaten at least once a week, ask:] How many times did you eat this type of food in the past week?
Q.24: Which of the following best describes your overall attitude towards each of these foods?
Q.32a: How much do you agree or disagree with each of the following statements when eating each food type at home?
Q.32b: How much do you agree or disagree with each of the following statements when eating each food type at a full-service restaurant such as Applebee's, Olive Garden, Chili's, TGI Friday's, Outback, Lone Star, etc.?
Q.34: Overall, thinking about beef and chicken, which do you prefer to eat for dinner?
Q.35/36/36a: Considering all you know about beef/chicken/pork, would you say the positives of beef/chicken/pork strongly outweigh the negatives, the positives of beef/chicken/pork somewhat outweigh the negatives, the negatives of beef/chicken/pork somewhat outweigh the positives or the negatives of beef/chicken/pork strongly outweigh the positives?
Q.37: For each of the factors listed below, please indicate whether you think that beef is better than chicken, that chicken is better than beef or that the two are about the same.
Q.37r: Looking forward, do you plan to eat more, less or about the same amount of each of the following food types?
Q.38d/f. How important is each of the following in your decision to eat more/less beef?
Q.40: Thinking of the last 10 times you personally ate beef, where – to the best of your knowledge – did the beef come from?
Q.46: Thinking about beef specifically, how much attention do you pay to each of the following?
Q.48: In the past six months, which of the following products have you intentionally bought?
Q.48x1-4. Which statement best describes the value for the money of a steak meal/ meal with hamburger or ground beef at a restaurant? … steak/hamburger/ground beef bought at the grocery store?
Q.49: Using a scale of "0" to "10," how much do you agree or disagree with each of the following statements?
Q.50: Select how long it has been since you…? (Past week, month, 2-3 months, past year, over a year, never)
Q.51: In total, including yourself, how many people live in your household?
Q.53: Please tell me which of the following best describes you? (work status)
Q.57: Which of the following best describes your total annual household income before taxes?
Q.59: What was the last level of education you completed?

Florida State Scorecard 2016

Funded by The Beef Checkoff
and the Florida Beef Council

Ibotta Campaign Performance

Campaign	Valentines Day 2017	Summer Grilling 2017	Ground Beef 2017
Duration	4 weeks	4 weeks	Live as of 8/25
Task	Survey	Recipe	Nutrition Fact
Offer	$1.25 cash back	$1.00 cash back	$0.50 cash back
Results			
Brand Impressions	4,190,584	2,304,466	1,811,348
Brand Engagements	58,201	54,395	65,214
Redeemed Rebates	21,667	21,449	22,781
Pounds Moved	23,660	23,476	24,831
Redemption Rate	37%	39.40%	34.93%
Total $	50,000	50,000	26,192.60
Cost per Impression	$0.01	$0.02	$0.01
Cost per Engagement	$0.85	$0.92	$0.40

Ground Beef Campaign is still running due to Hurricane Irma. $23,807.40 remaining, campaign will end once it reaches a total of $50,000

*Ibotta average redemption rate is 23%

** Pounds moved figured at 1.09 pounds per Rebate

AM - External CPG Campaign Overview Metrics

[Open in Looker]

Note - This data may differ from your final invoice

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List of Contracts

	List of Contracts
1	Live: Florida Beef Council - Q3 2017 (ID = 6124)
2	Expired: Florida Beef Council - Q2 2017 (ID = 5238)
3	Expired: Florida Beef Council_Q1_2017 (ID = 4498)
4	Expired: Florida Beef Council_Summer Grilling_2016 (ID = 2688)

List of Campaigns

	List of Campaigns
1	Expired: Florida Beef Council - Redemption - Q1 - 2017 (ID = 12130)

List of Offer Groups

	List of Offer Groups
1	Expired: Steak | $1.00 (ID = 36656)

(Data will properly display below when a contract, campaign, or offer group is selected)

Contracts - Florida Beef...

(Data will properly display below when a contract, campaign, or o...

Start Date

2017-02-08

Start Date

End Date

2017-03-06

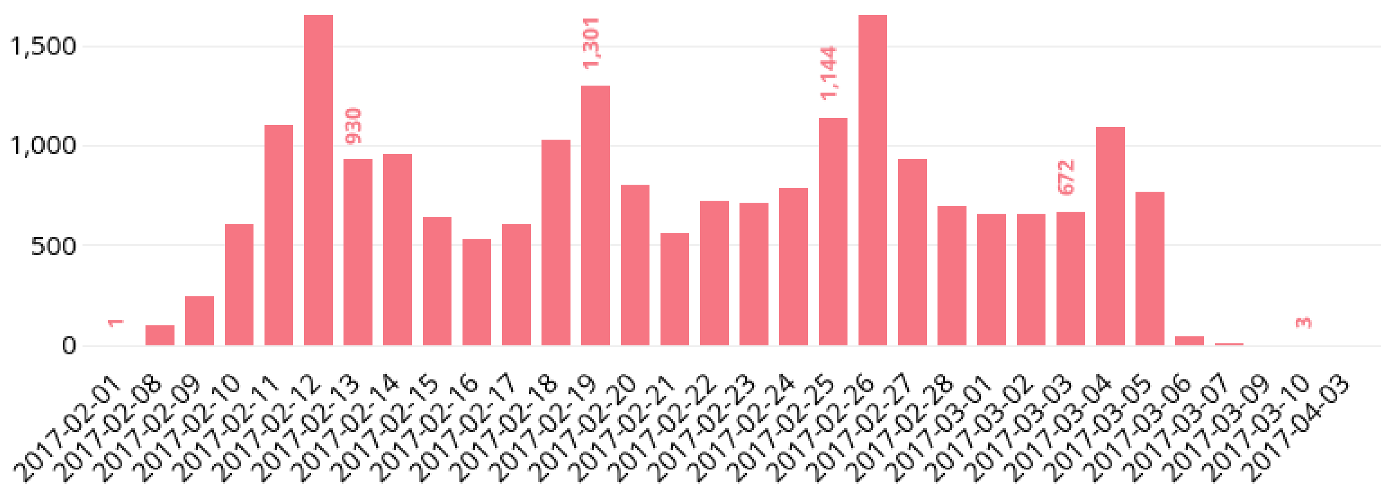
End Date

Status

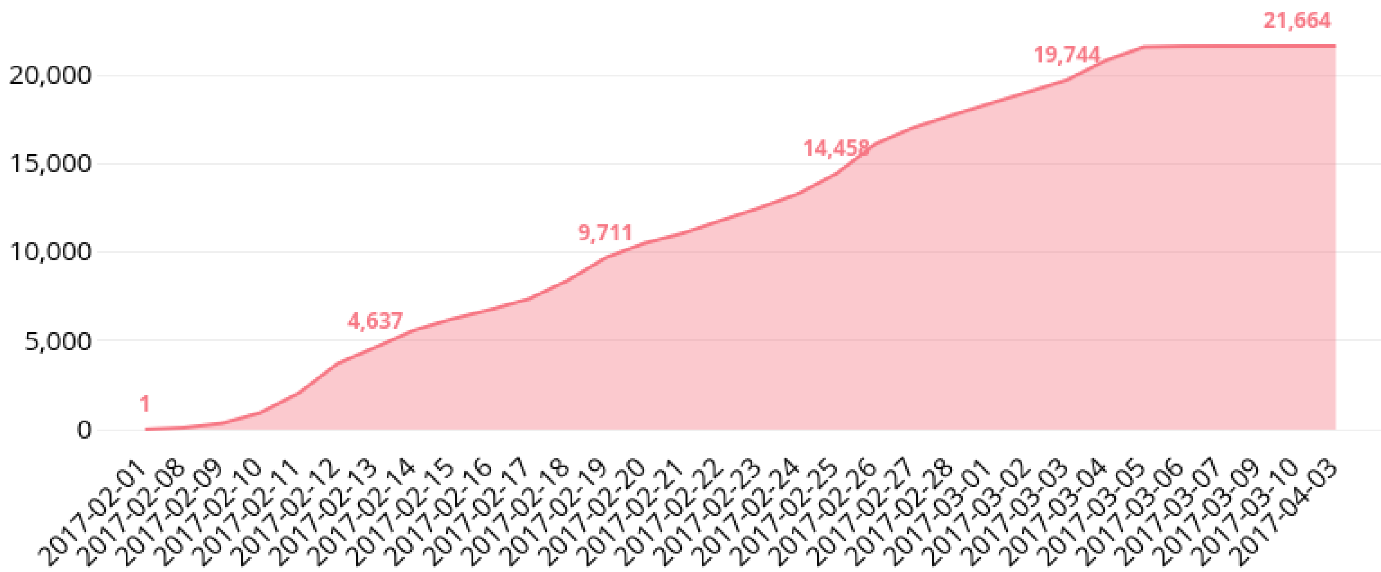
EXPIRED

Status

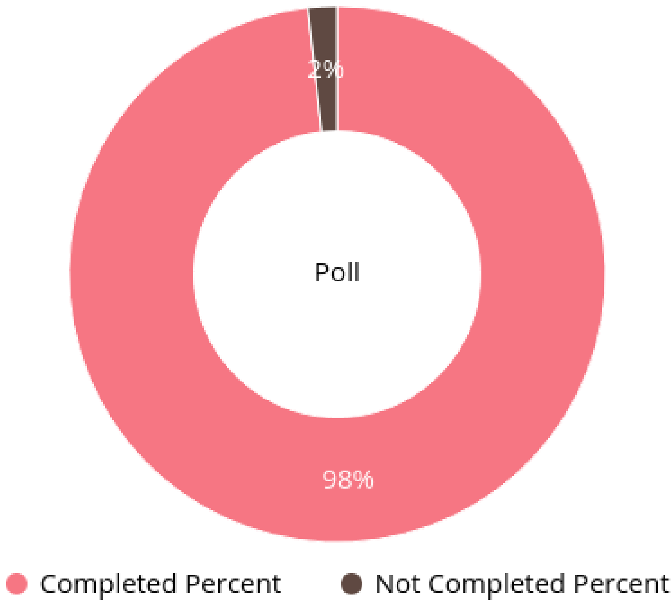
Redemption Breakdown



Cumulative Performance



Engagements - % Completions by Type



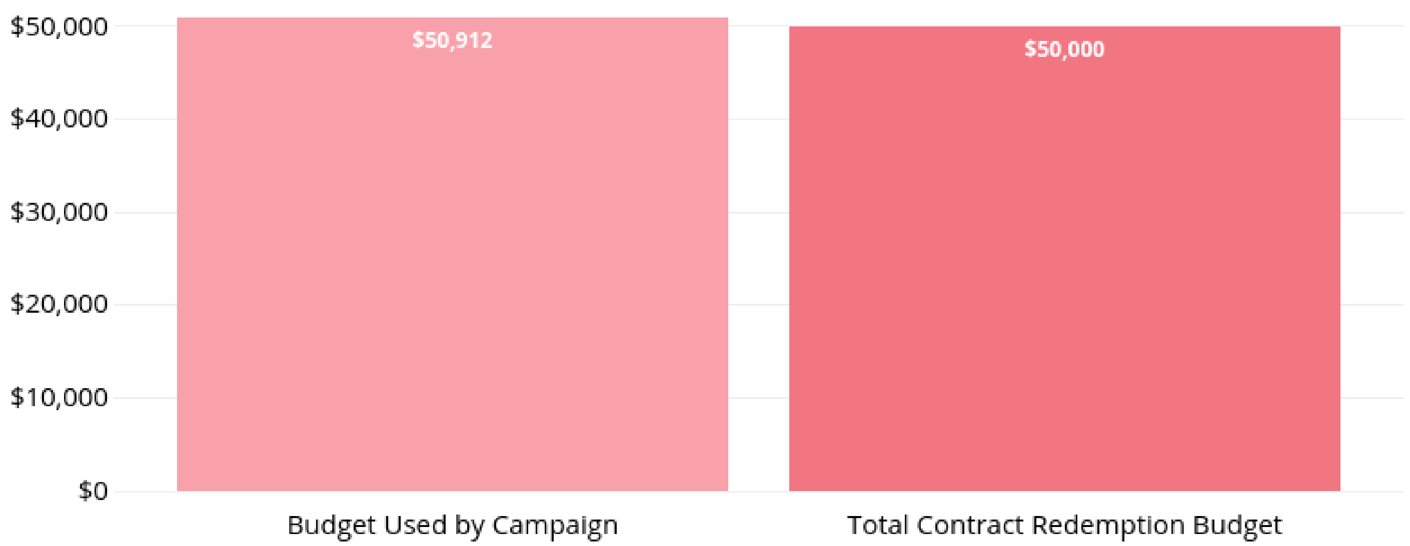
Total Contract Budget

Total Contract Non Redemption Budget Details

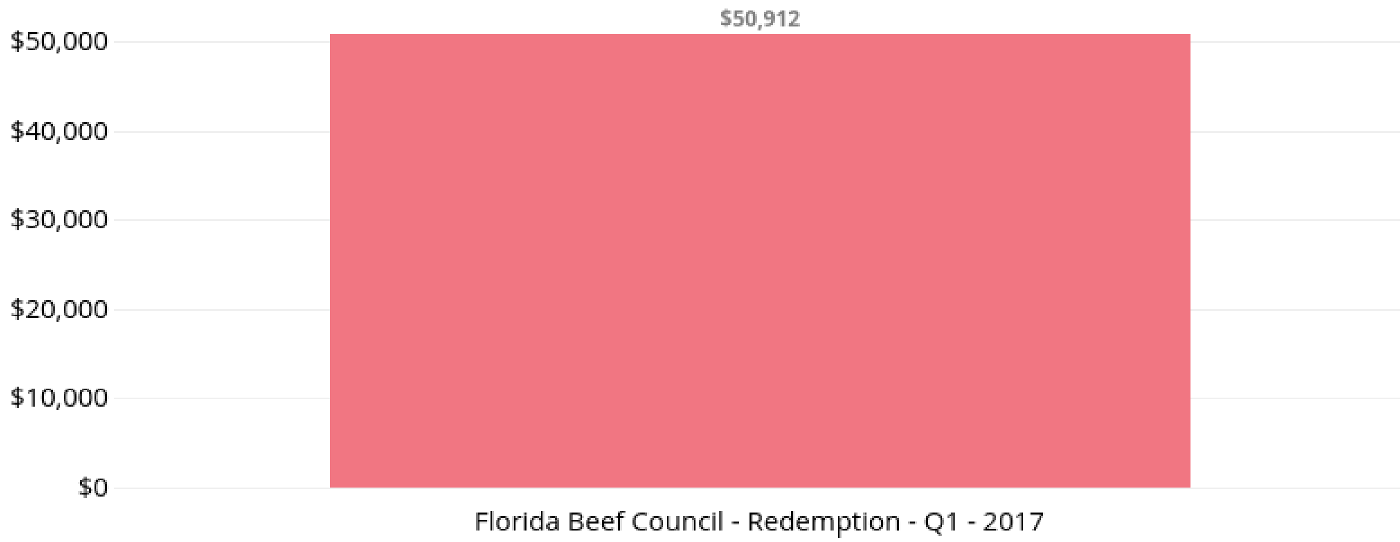
$

4498

Total Contract Redemption Budget by Campaign



Redemption Budget Used by Campaign by Offer Group



Total Brand Impressions

4,209,466

Total Brand Impressions

Completed Brand Engagements

58,200

Completed Brand Engagements

Redemption Budget Used

$50,911.75
Redemption Budget Used

Rebates Redeemed

21,665
Rebates Redeemed

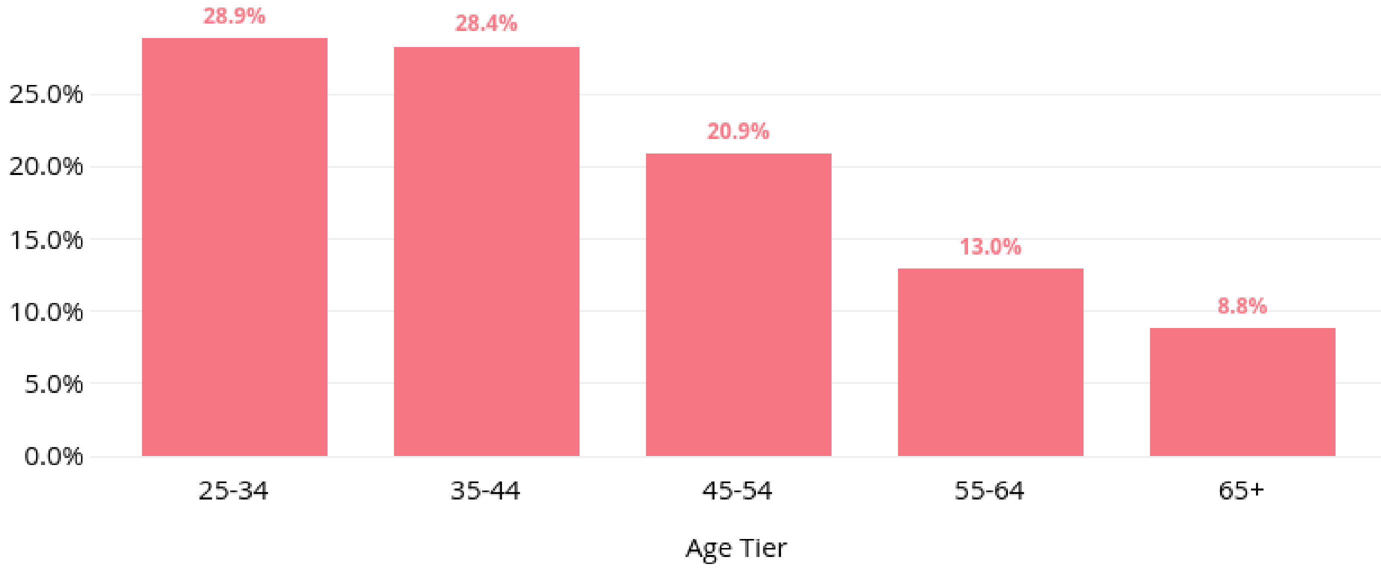
Redemption Events

21,665
Redemption Events

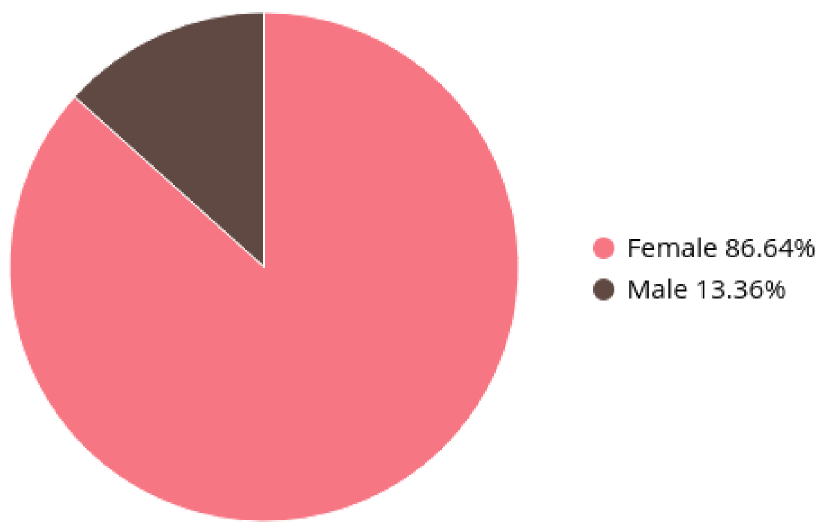
Redemption Event Rate

37.22%
Redemption Event Rate

Redemptions by Age

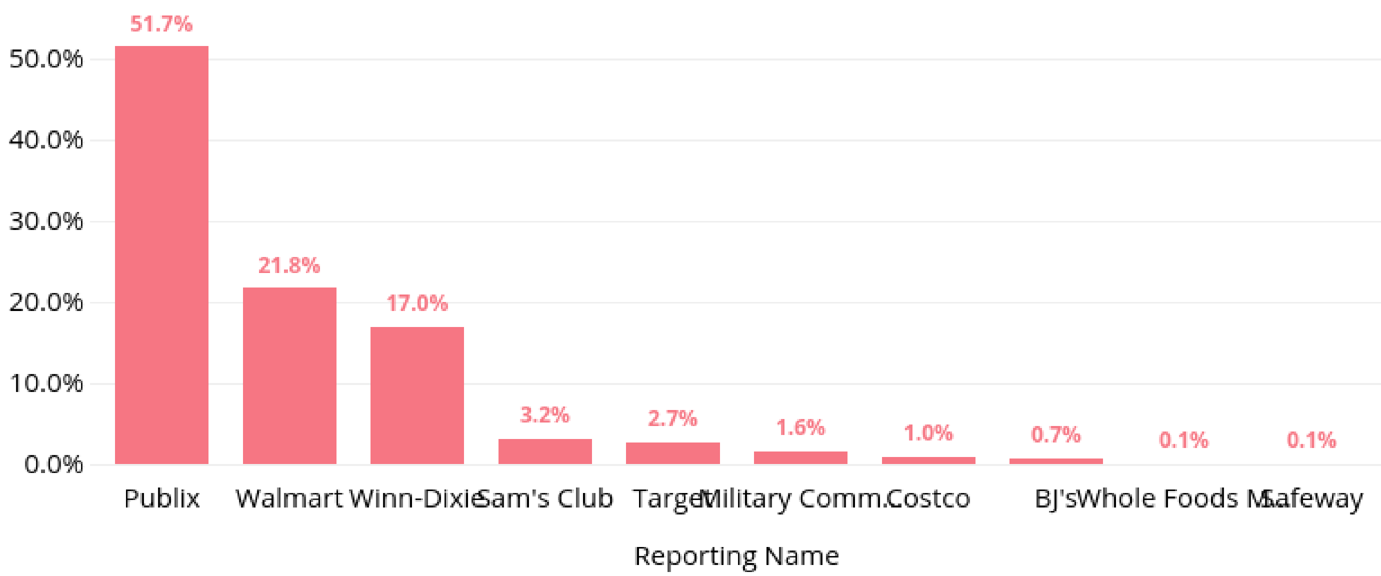


Redemptions by Gender



Redemptions by State

Redemption Percent by Top Retailers

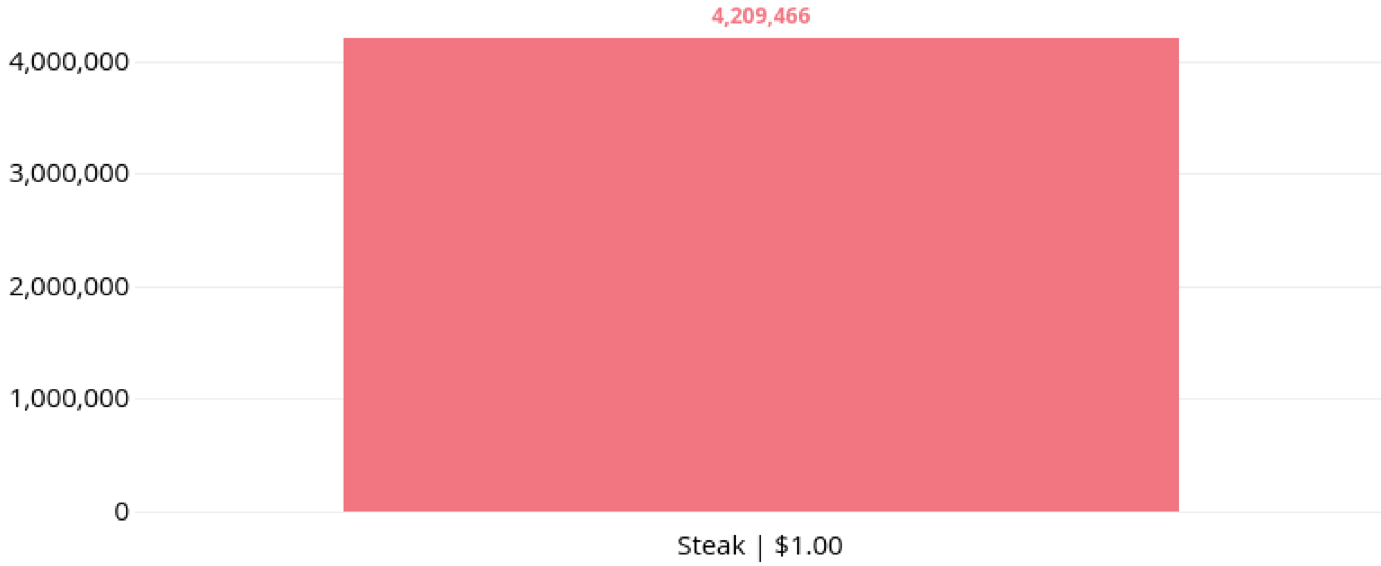


Rebate Breakout

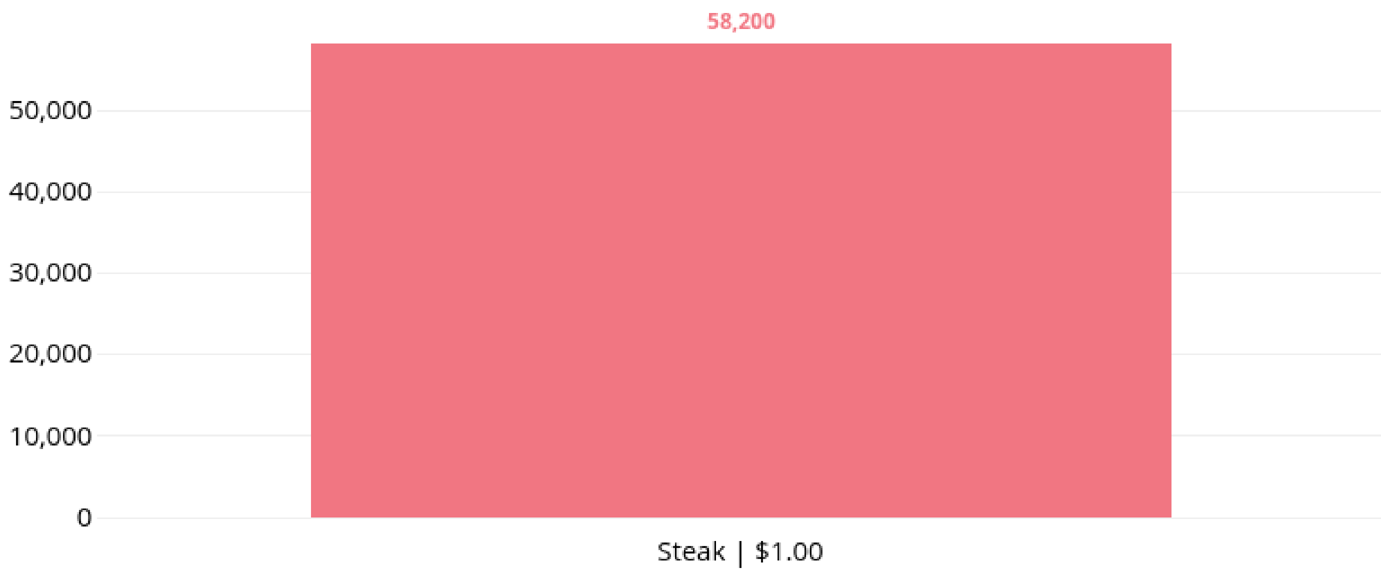
Rebate Breakout

Rebate Breakout

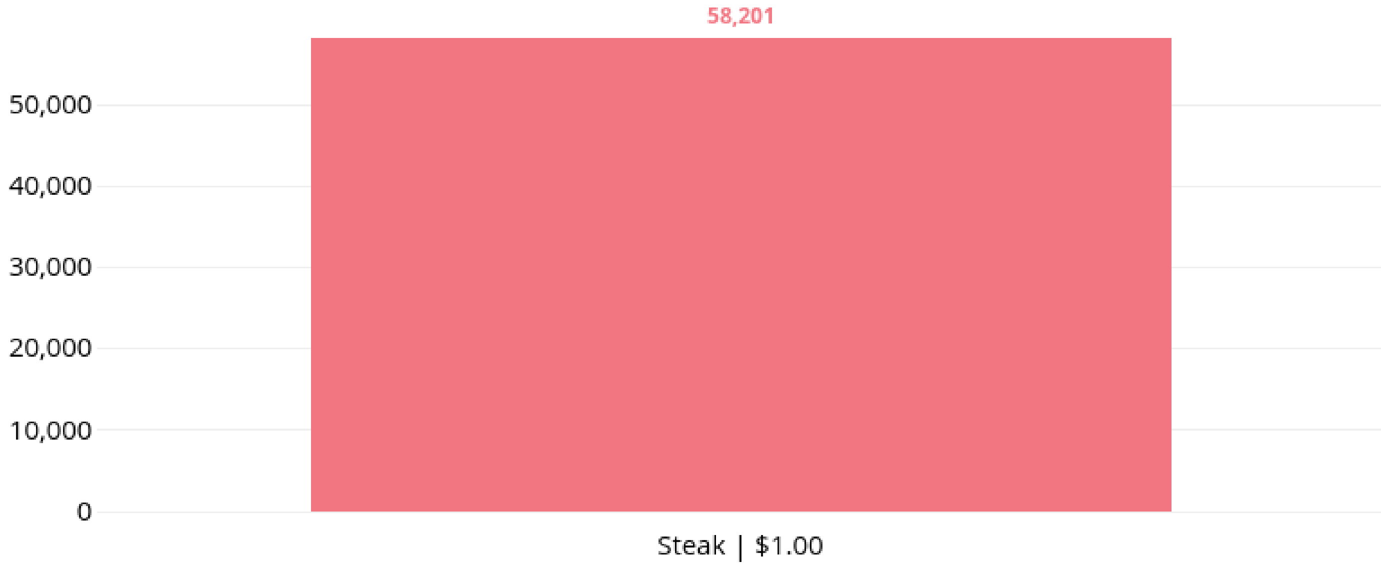
Total Brand Impressions By Rebate



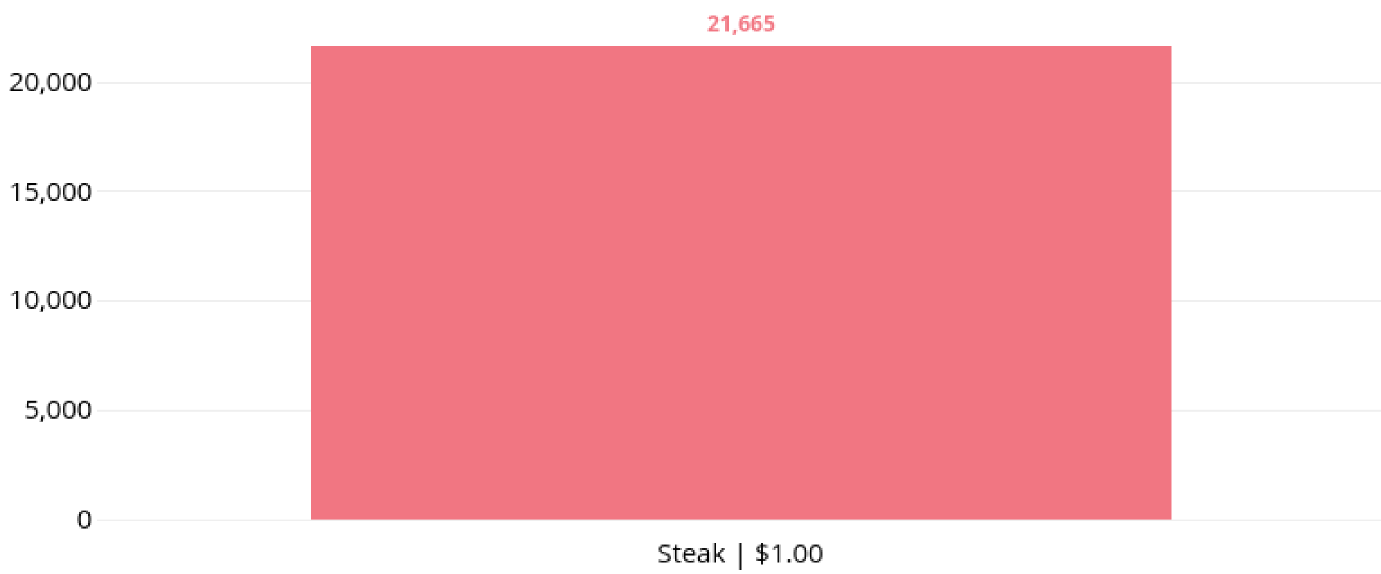
Total Brand Engagements By Rebate



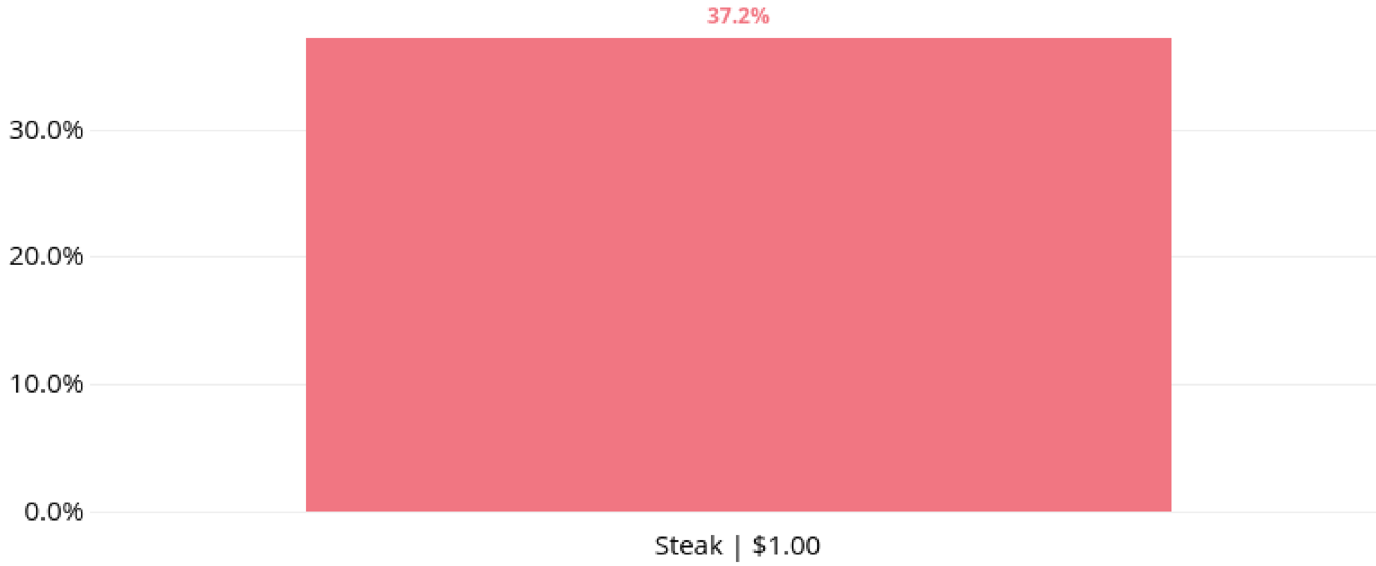
Total Unlocks By Rebate



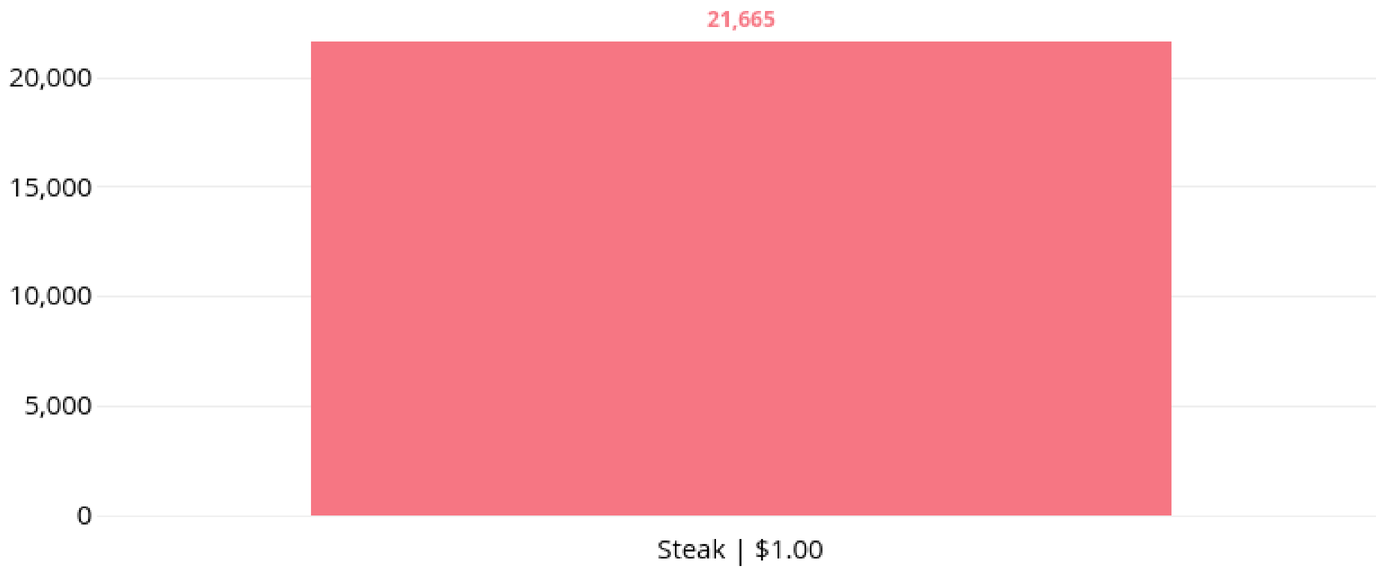
Redemptions By Rebate



Redemption Rate By Rebate



Units Sold By Rebate



Bonus Section Start

Bonus Section (If Applic...

Bonus Section Start

Bonuses Started

No Results

Bonus Descriptions

	ID	Name ^	Description
1	0	No bonus	You do not currently have a bonus associated with this campaign. If you would like to add a bonus to your campaign, please talk to your Ibotta Account Manager

Bonuses Completed

0

No bonus

Name

Bonus Completion Rate

0.0%

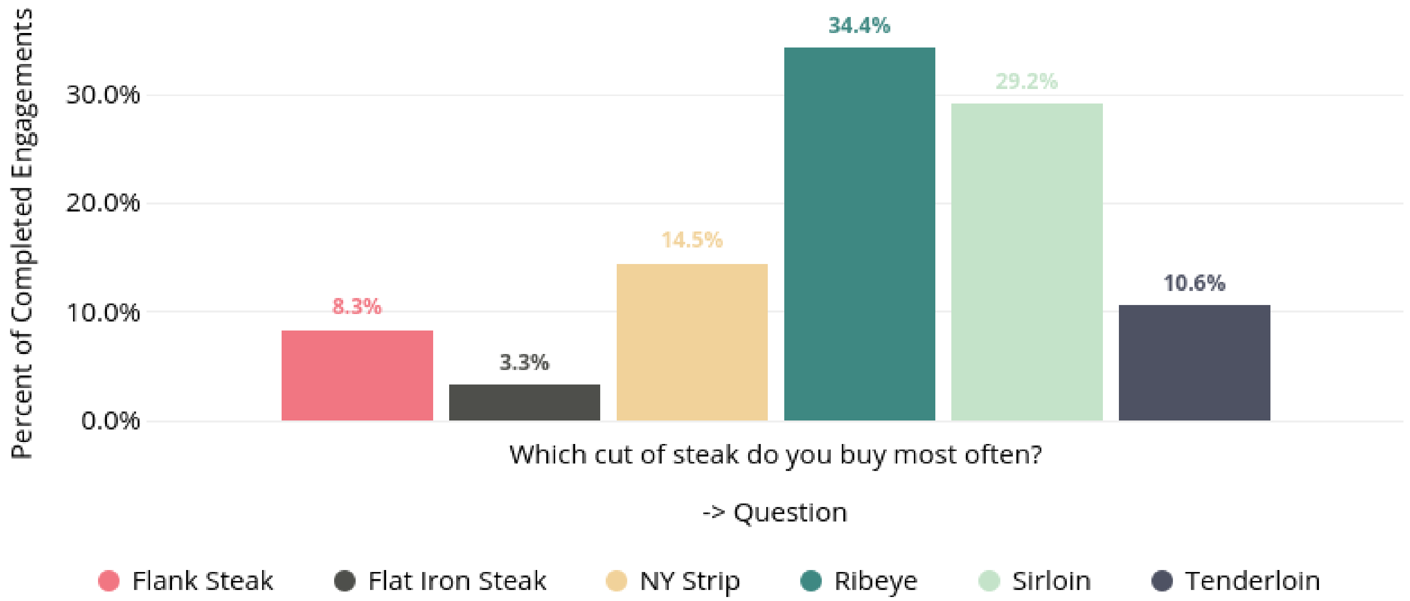
No bonus

Name

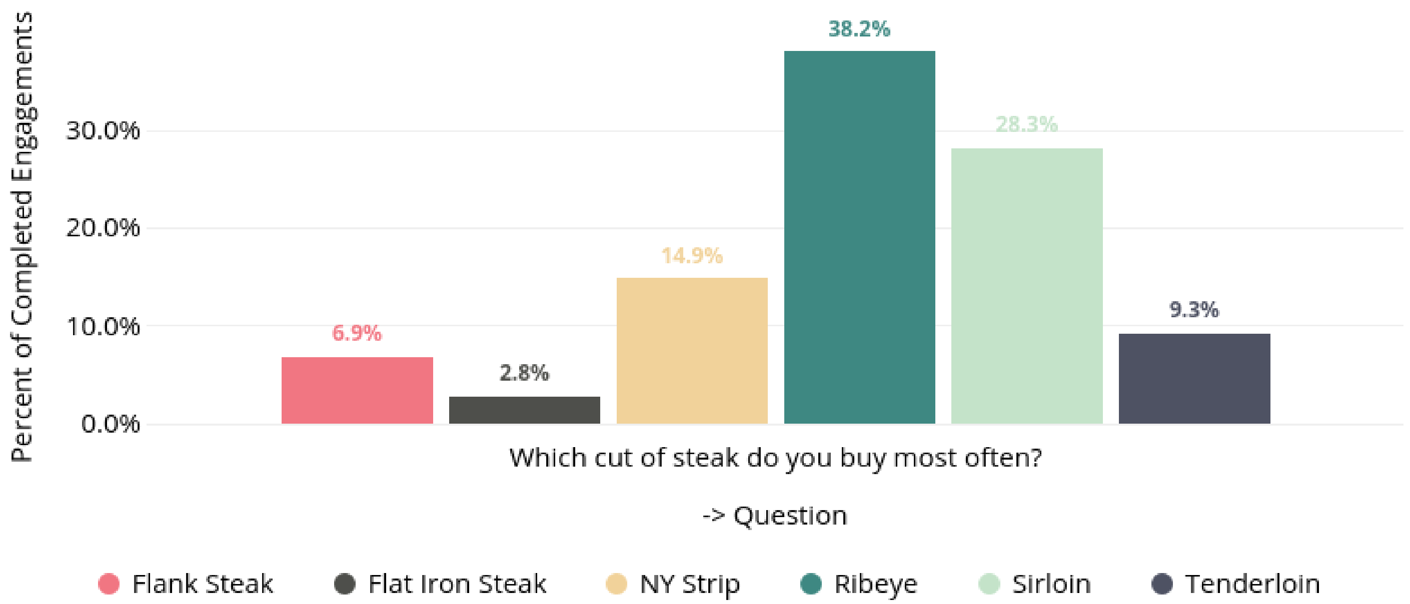
Choose a Question to Populate Chart Below

	External CPG Overview Dash Question
1	Which cut of steak do you buy most often? (Campaign ID = 12130) (Offer Group ID = 36656) (Offer Reward ID = 115164)

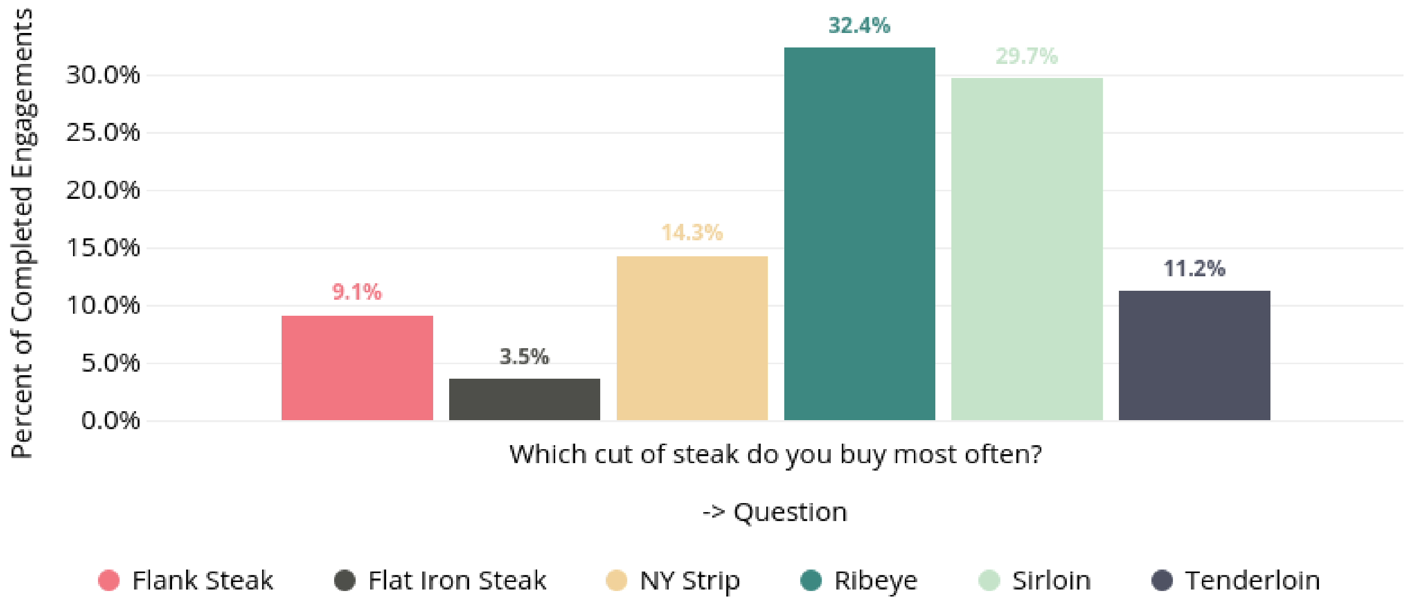
Selected Question Responses - Total Responses



Selected Question Responses - Purchasers



Selected Question Responses - Non Purchasers



Want to Learn More? Click Below!

	Learn More Links Cpg **Learn More CPG**
1	Consumer Surveys
2	Data Licensing
3	External Media Targeting
4	On-Platform Media

AM - External CPG Campaign Overview Metrics

[Open in Looker]

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3	Expired: Florida Beef Council_Q1_2017 (ID = 4498)
4	Expired: Florida Beef Council_Summer Grilling_2016 (ID = 2688)

List of Campaigns

	List of Campaigns
1	Expired: Florida Beef Council - Redemption - Q2 - 2017 (ID = 14658)

List of Offer Groups

	List of Offer Groups
1	Expired: Steak | Summer | Non | $1.25 (ID = 43879)
2	Expired: Steak | Summer | New | $1.00 (ID = 43878)
3	Expired: Steak | Summer | Past | $0.75 (ID = 43877)

(Data will properly display below when a contract, campaign, or offer group is selected)

Contracts - Florida Beef...

(Data will properly display below when a contract, campaign, or o...

Start Date

2017-05-15

Start Date

End Date

2017-06-09

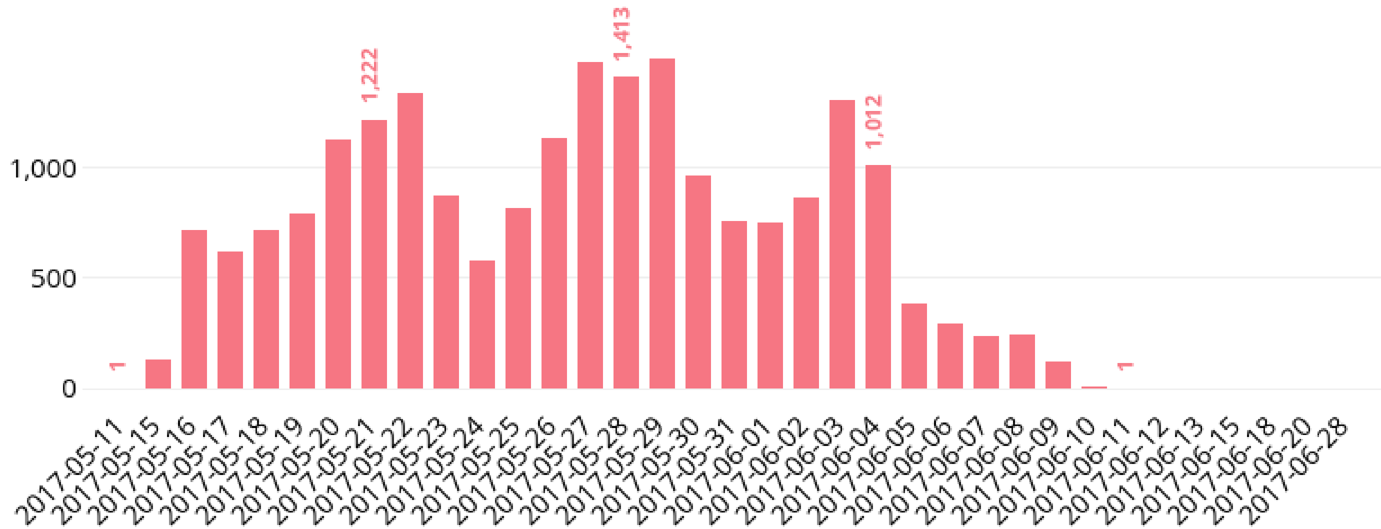
End Date

Status

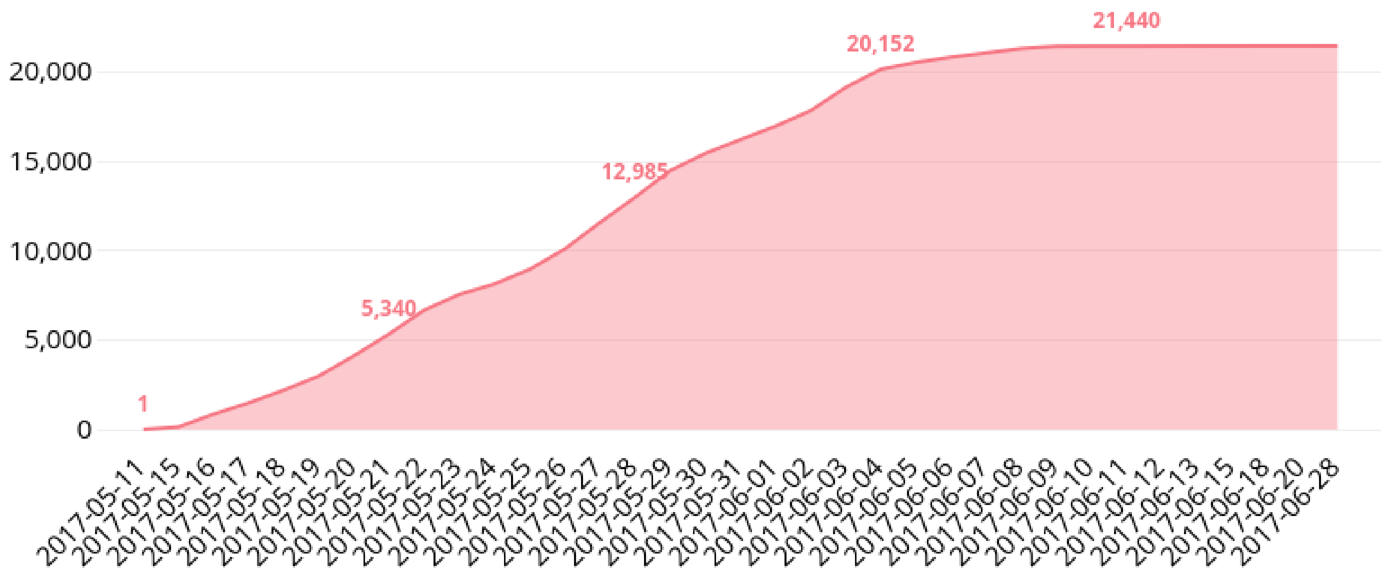
EXPIRED

Status

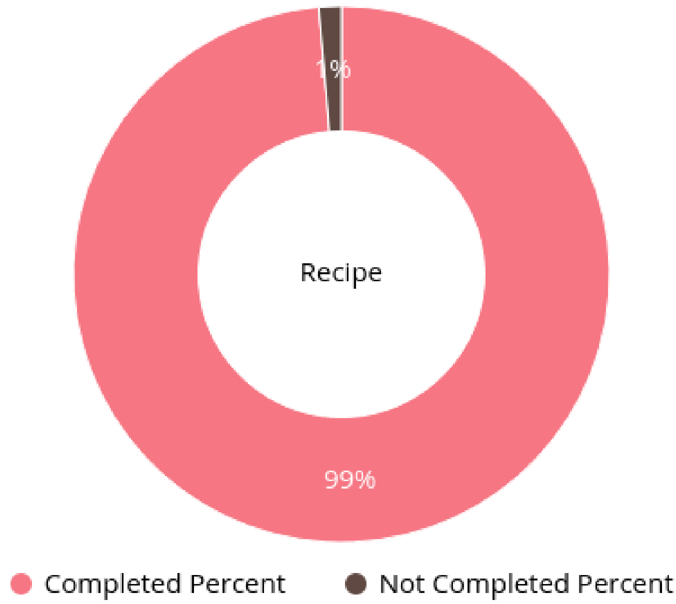
Redemption Breakdown



Cumulative Performance



Engagements - % Completions by Type



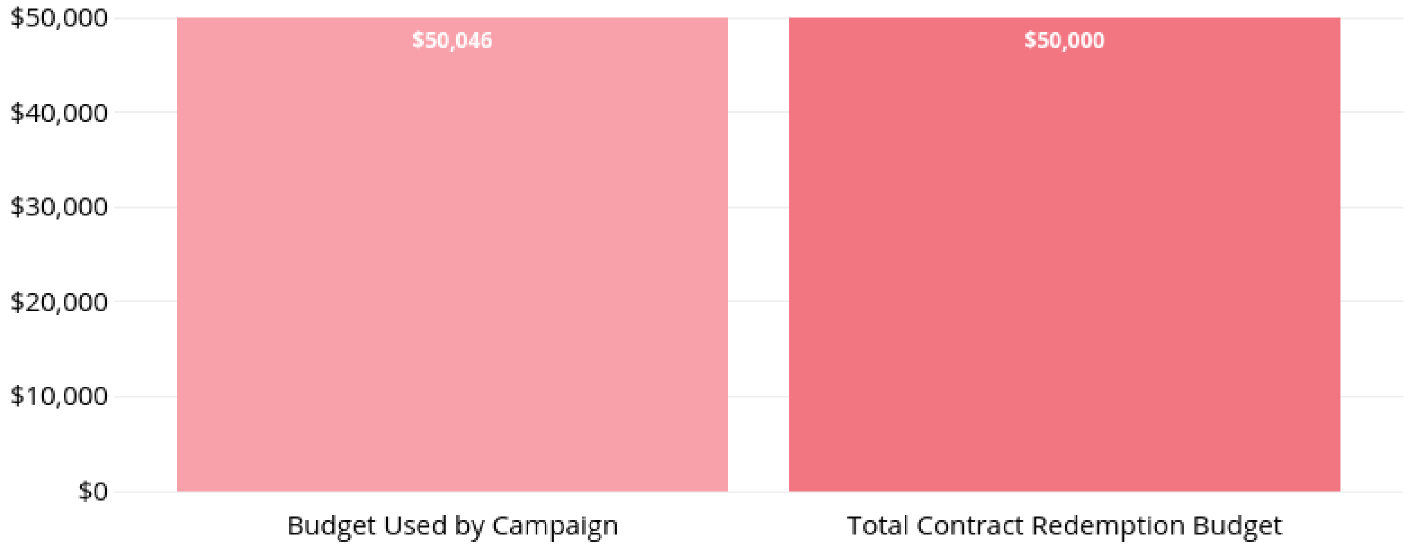
Total Contract Budget

Total Contract Non Redemption Budget Details

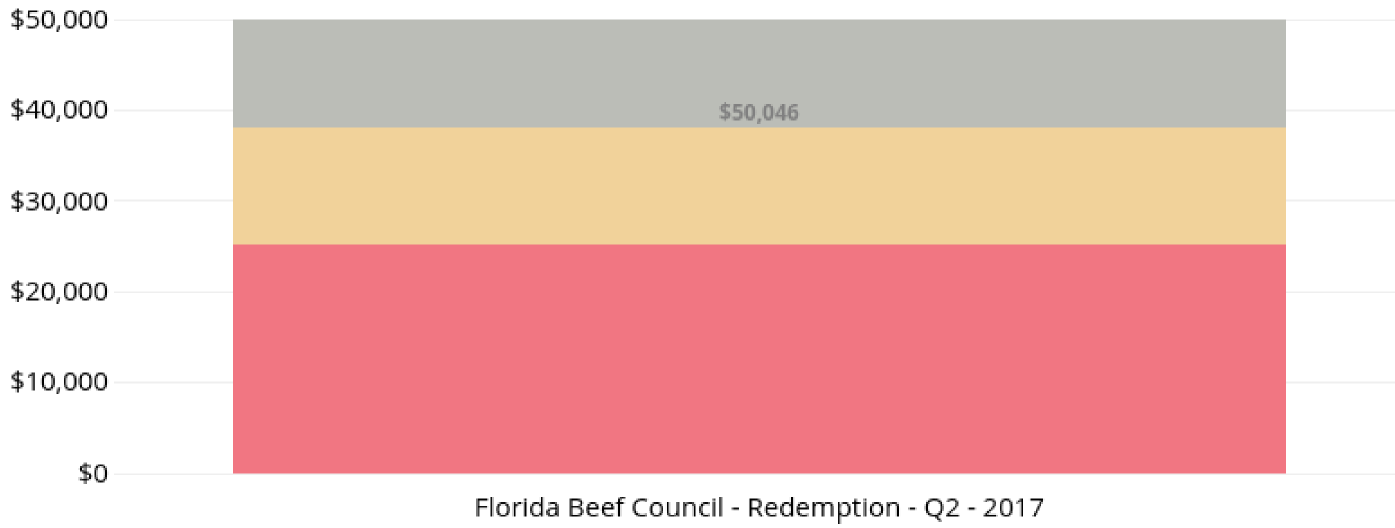
$

5238

Total Contract Redemption Budget by Campaign



Redemption Budget Used by Campaign by Offer Group



Total Brand Impressions

2,305,736

Total Brand Impressions

Completed Brand Engagements

54,394

Completed Brand Engagements

Redemption Budget Used

$50,045.85

Redemption Budget Used

Rebates Redeemed

21,452

Rebates Redeemed

Redemption Events

21,452

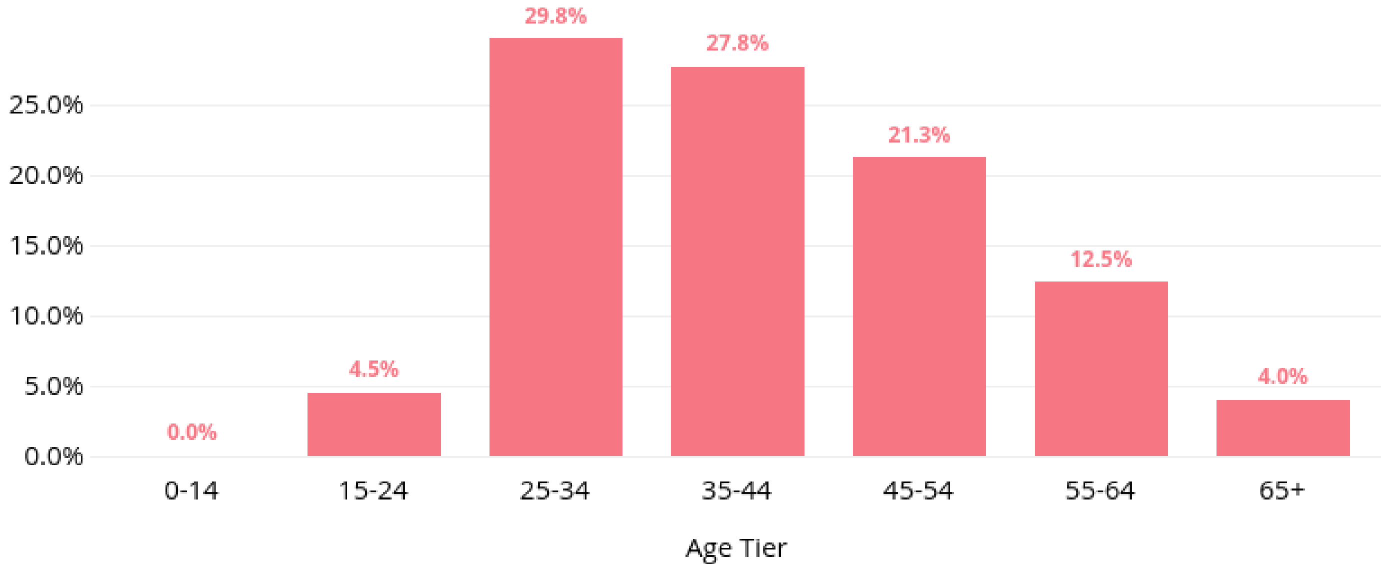
Redemption Events

Redemption Event Rate

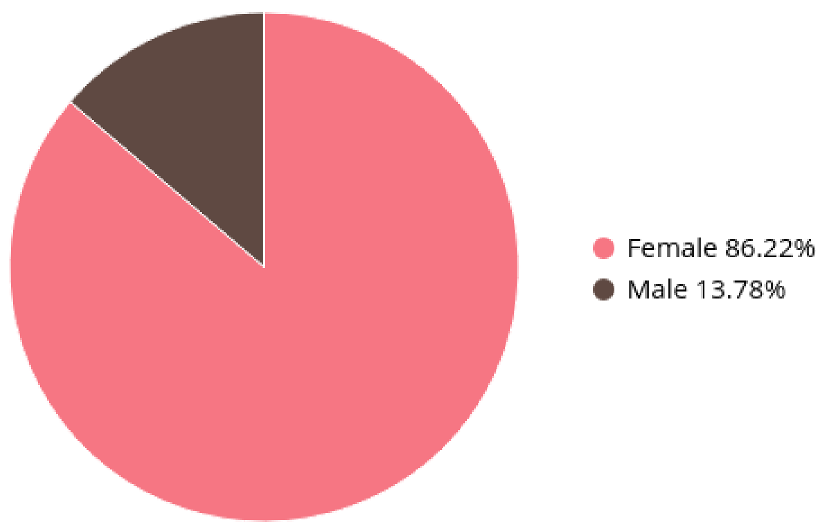
39.44%

Redemption Event Rate

Redemptions by Age

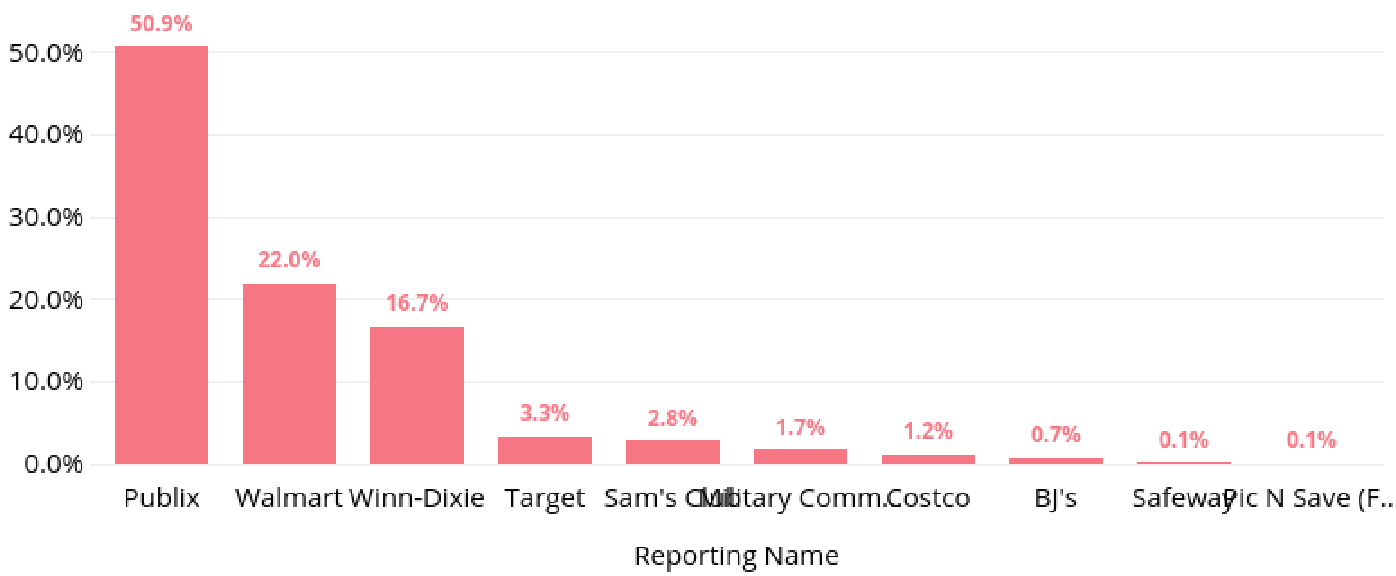


Redemptions by Gender



Redemptions by State

Redemption Percent by Top Retailers

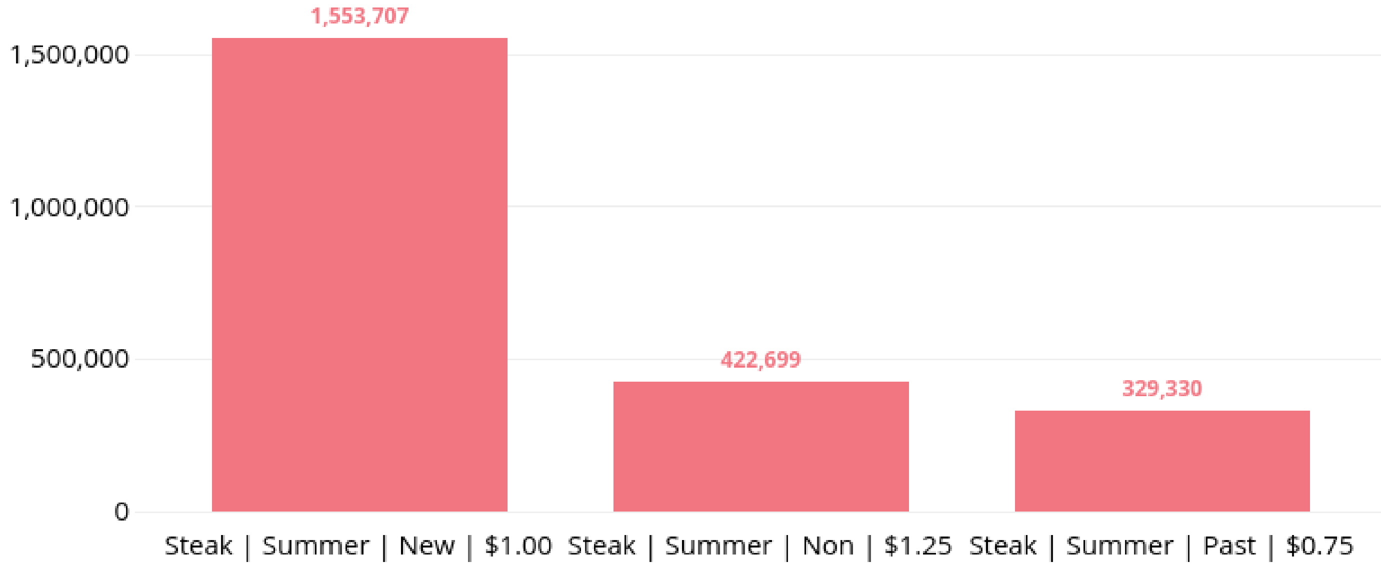


Rebate Breakout

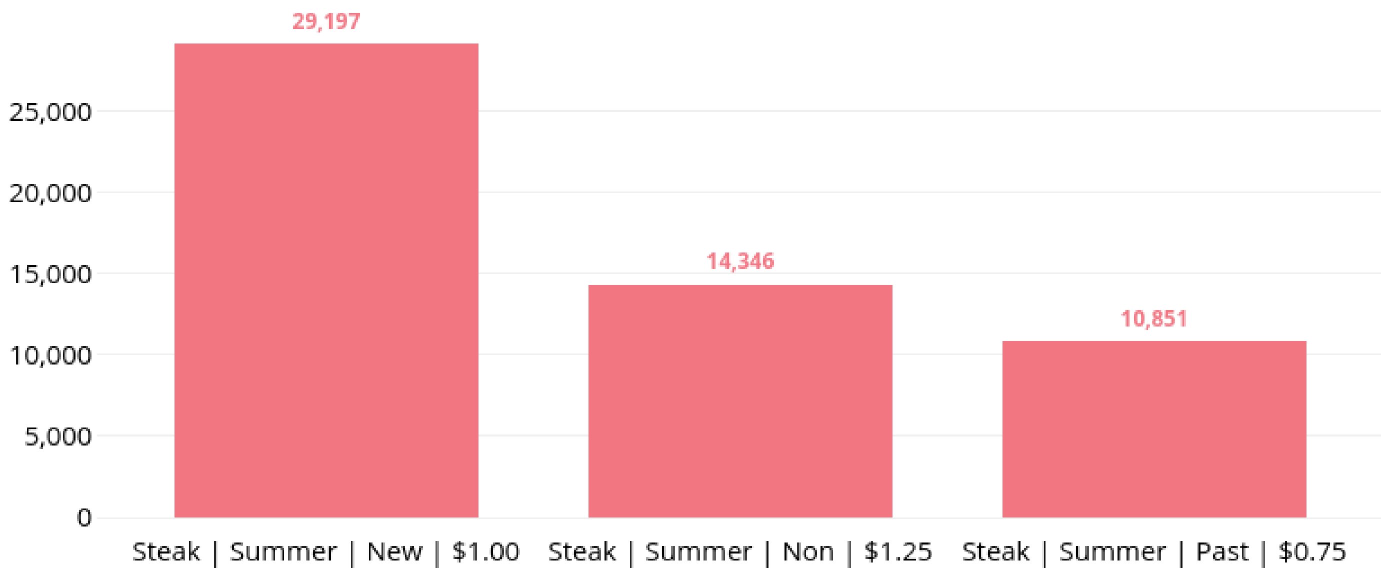
Rebate Breakout

Rebate Breakout

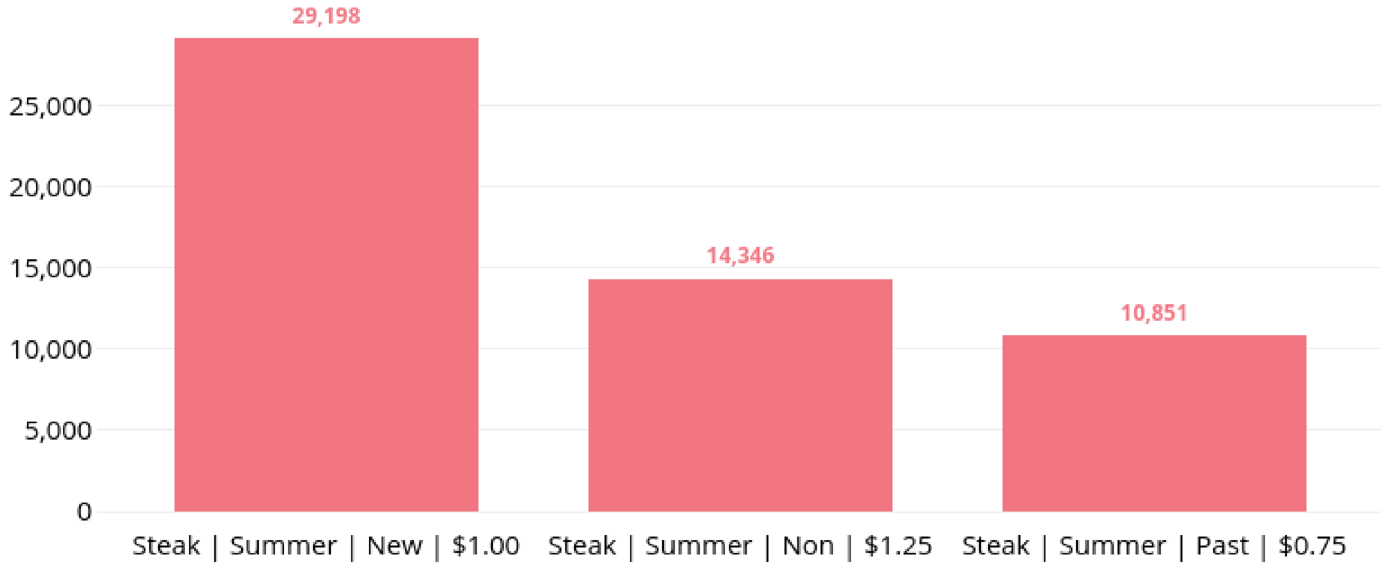
Total Brand Impressions By Rebate



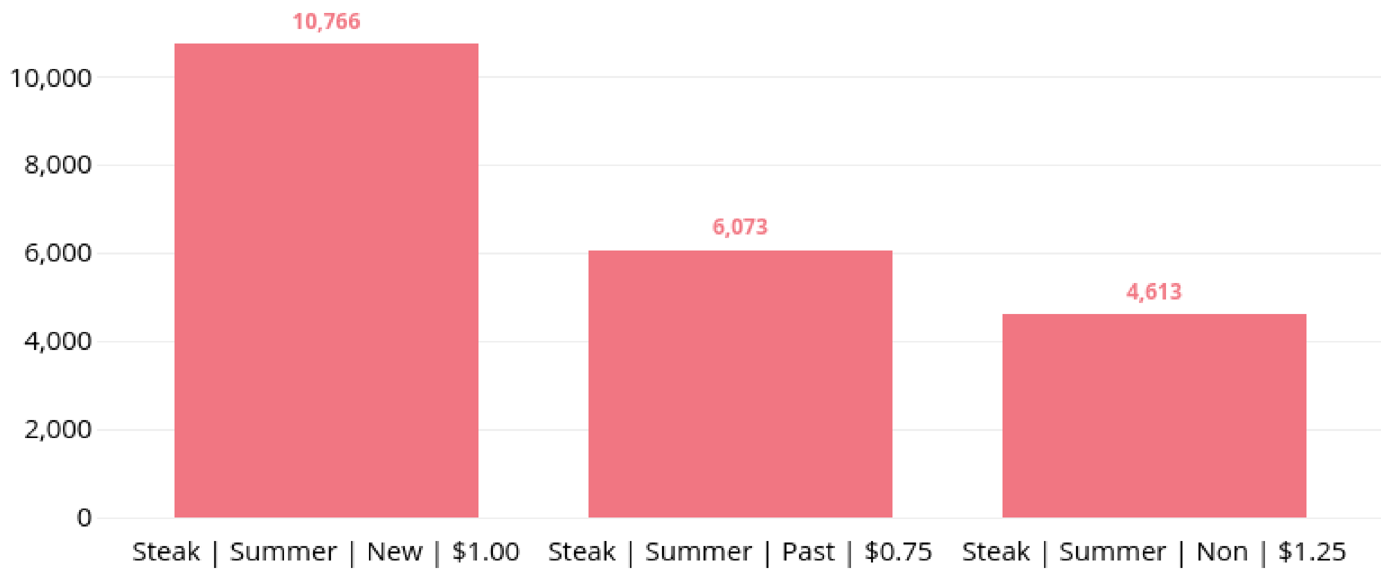
Total Brand Engagements By Rebate



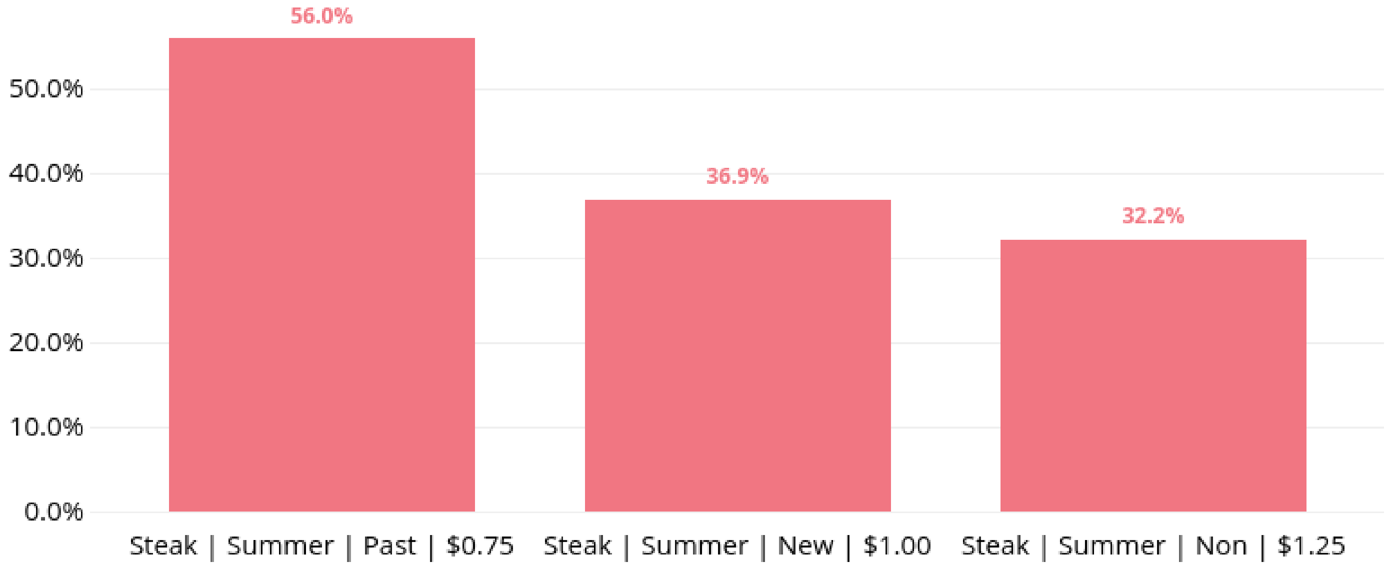
Total Unlocks By Rebate



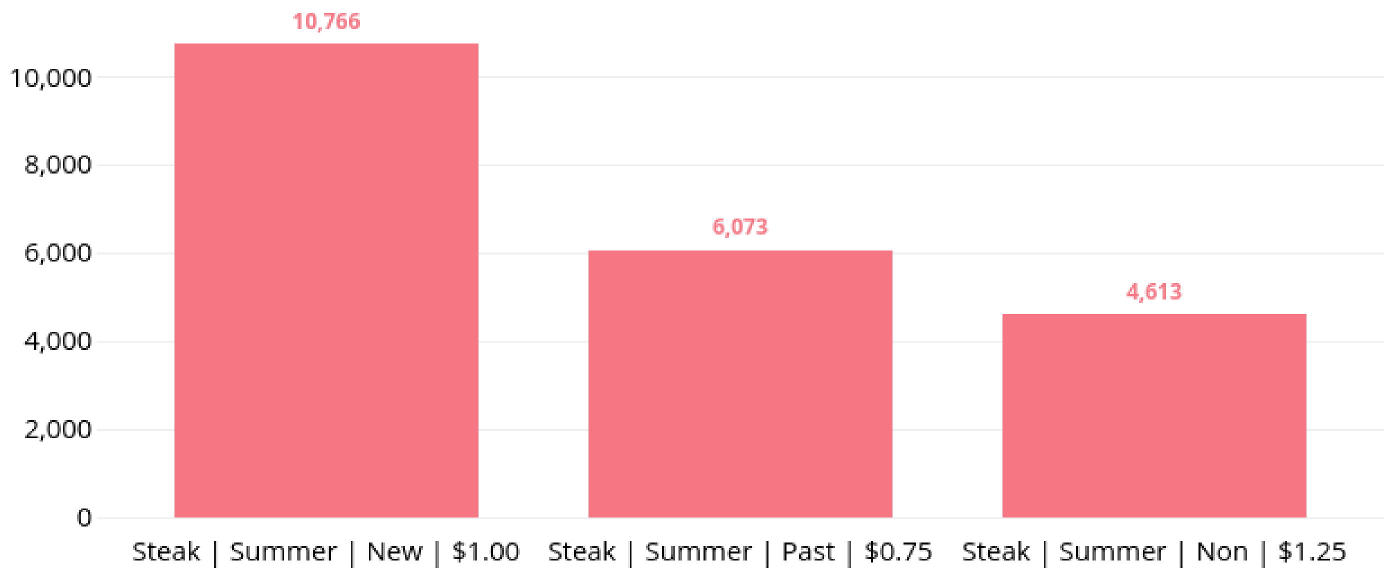
Redemptions By Rebate



Redemption Rate By Rebate



Units Sold By Rebate



Bonus Section Start

Bonus Section (If Applic...

Bonus Section Start

Bonuses Started

No Results

Bonus Descriptions

	ID	Name ^	Description
1	0	No bonus	You do not currently have a bonus associated with this campaign. If you would like to add a bonus to your campaign, please talk to your Ibotta Account Manager

Bonuses Completed

0

No bonus

Name

Bonus Completion Rate

0.0%

No bonus

Name

Choose a Question to Populate Chart Below

No Results

Selected Question Responses - Total Responses

No Results

Selected Question Responses - Purchasers

No Results

Selected Question Responses - Non Purchasers

No Results

Want to Learn More? Click Below!

	Learn More Links Cpg **Learn More CPG**
1	Consumer Surveys
2	Data Licensing
3	External Media Targeting
4	On-Platform Media

AM - External CPG Campaign Overview Metrics

[Open in Looker]

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3	Expired: Florida Beef Council_Q1_2017 (ID = 4498)
4	Expired: Florida Beef Council_Summer Grilling_2016 (ID = 2688)

List of Campaigns

	List of Campaigns
1	Live: Florida Beef Council - Redemption - Q3 - 2017 (ID = 17775)

List of Offer Groups

	List of Offer Groups
1	Live: Ground Beef | $0.50 (ID = 50508)

(Data will properly display below when a contract, campaign, or offer group is selected)

Contracts - Florida Beef...

(Data will properly display below when a contract, campaign, or o...

Start Date

2017-08-25

Start Date

End Date

∅

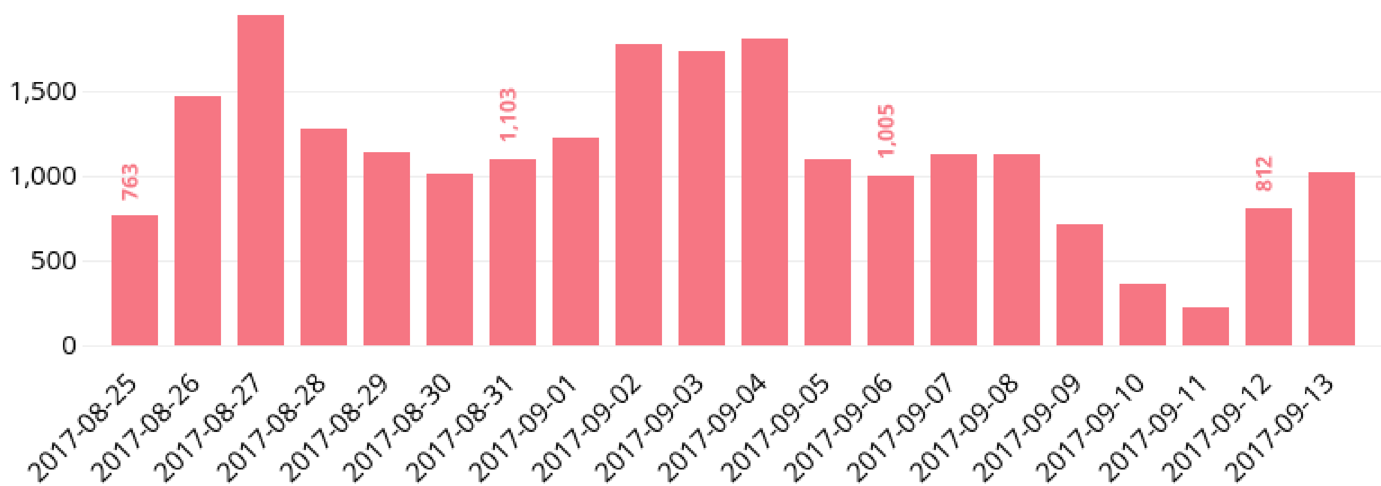
End Date

Status

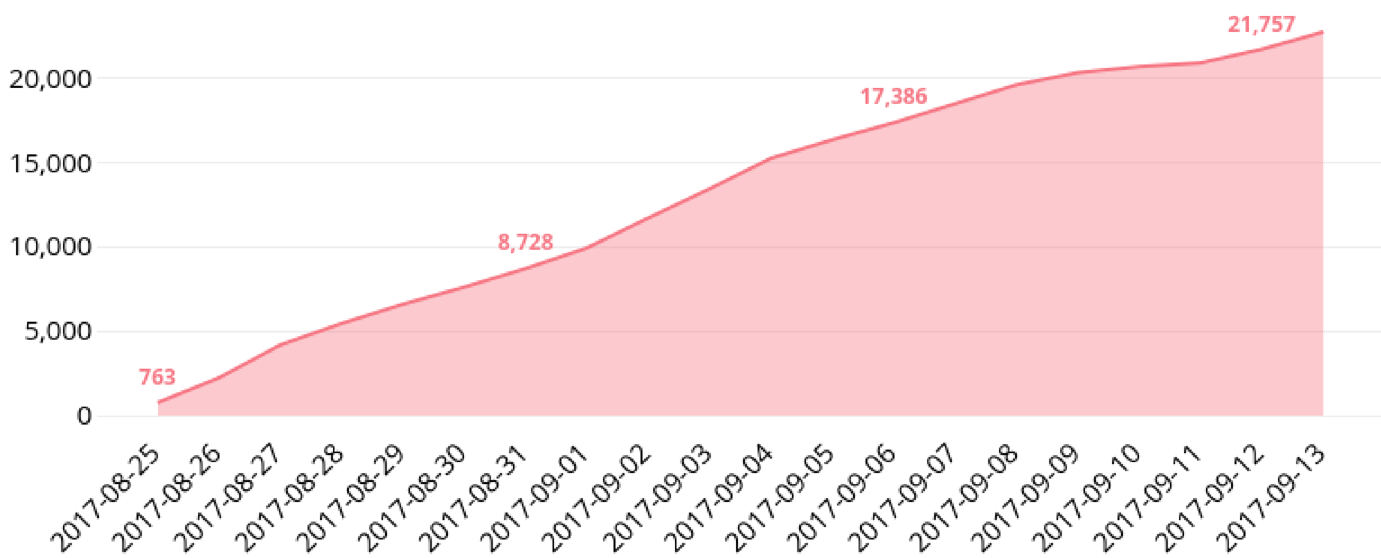
LIVE

Status

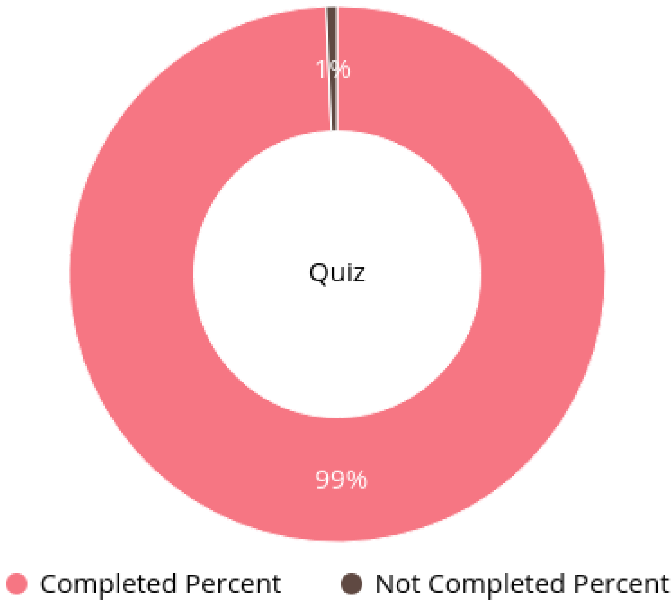
Redemption Breakdown



Cumulative Performance



Engagements - % Completions by Type

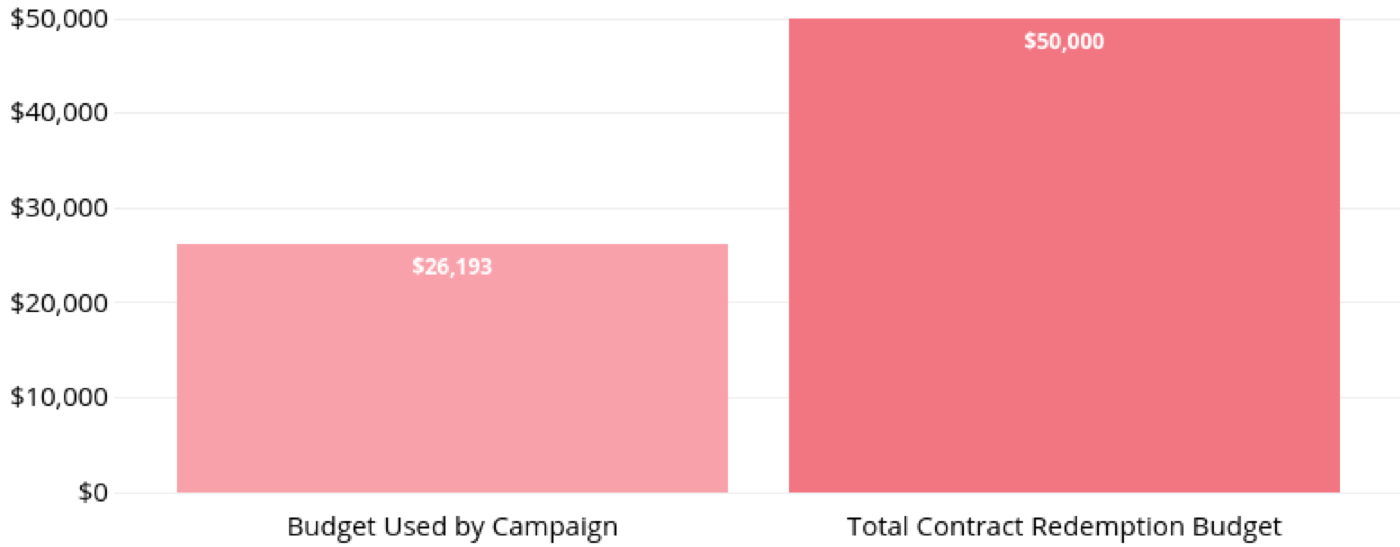


Total Contract Budget

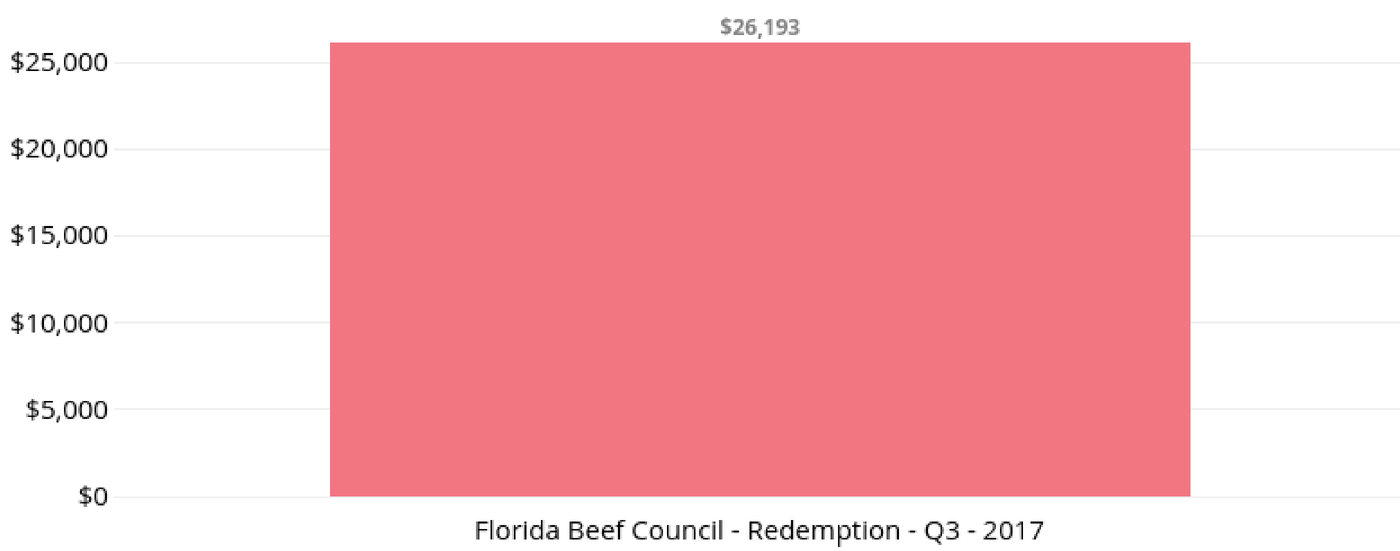
Total Contract Non Redemption Budget Details

No Results

Total Contract Redemption Budget by Campaign



Redemption Budget Used by Campaign by Offer Group



Total Brand Impressions

1,811,348

Total Brand Impressions

Completed Brand Engagements

65,214

Completed Brand Engagements

Redemption Budget Used

$26,192.60

Redemption Budget Used

Rebates Redeemed

22,780

Rebates Redeemed

Redemption Events

22,780

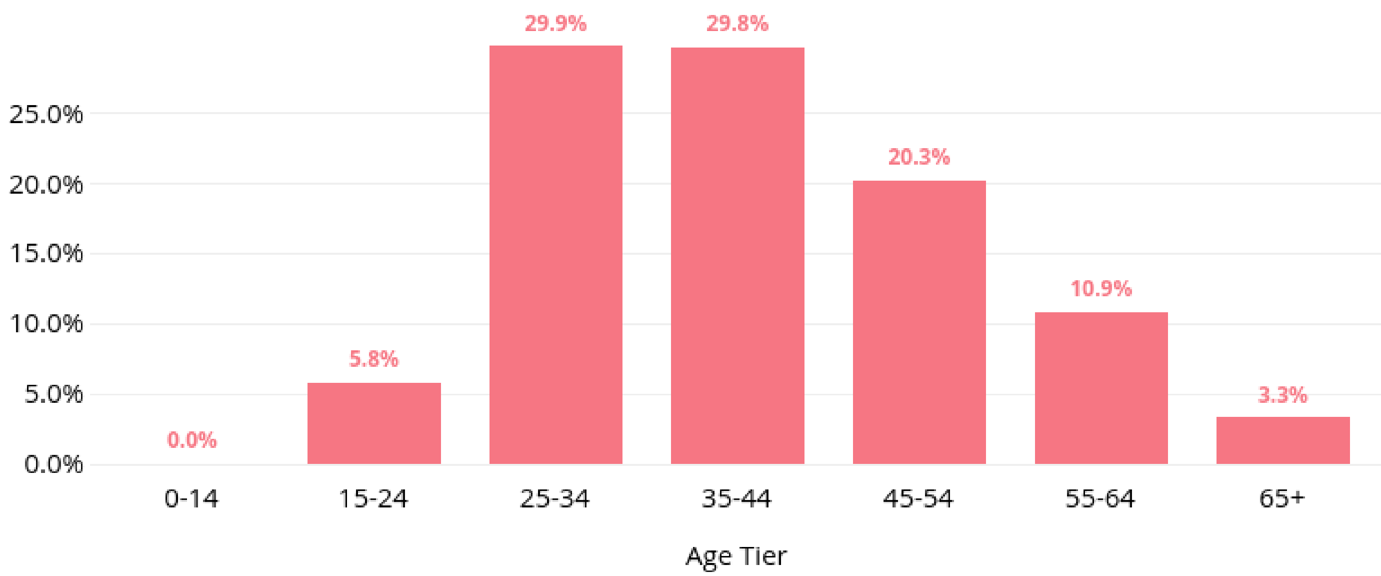
Redemption Events

Redemption Event Rate

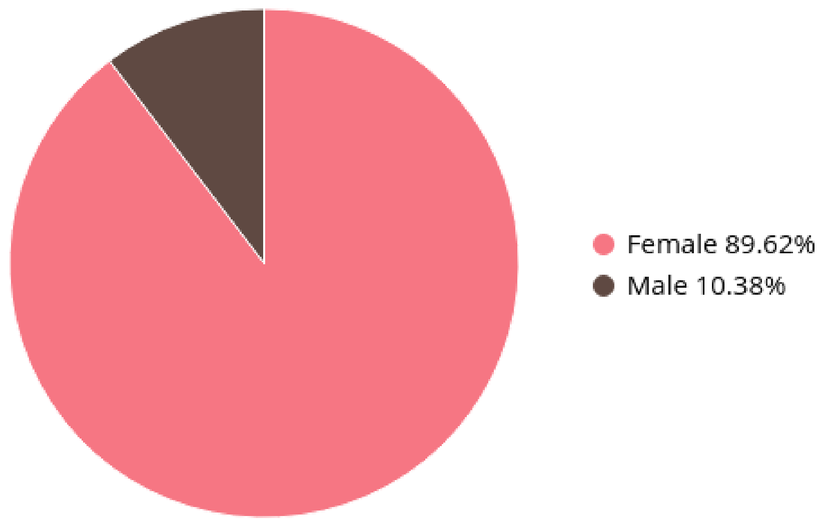
34.93%

Redemption Event Rate

Redemptions by Age

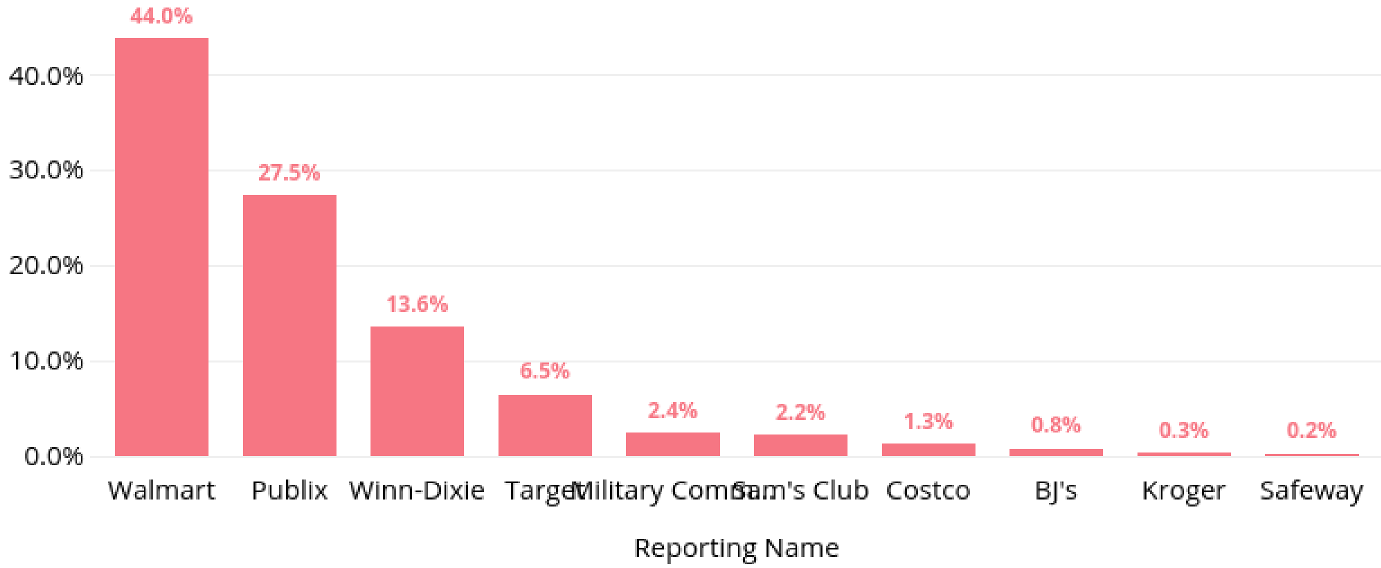


Redemptions by Gender



Redemptions by State

Redemption Percent by Top Retailers

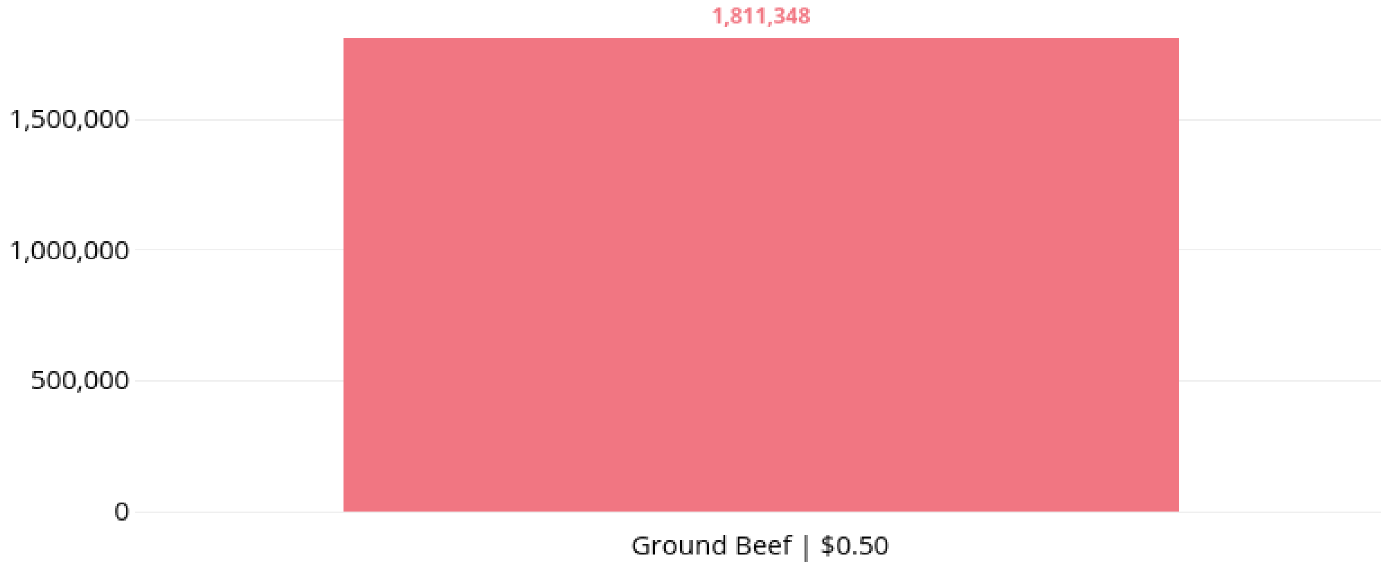


Rebate Breakout

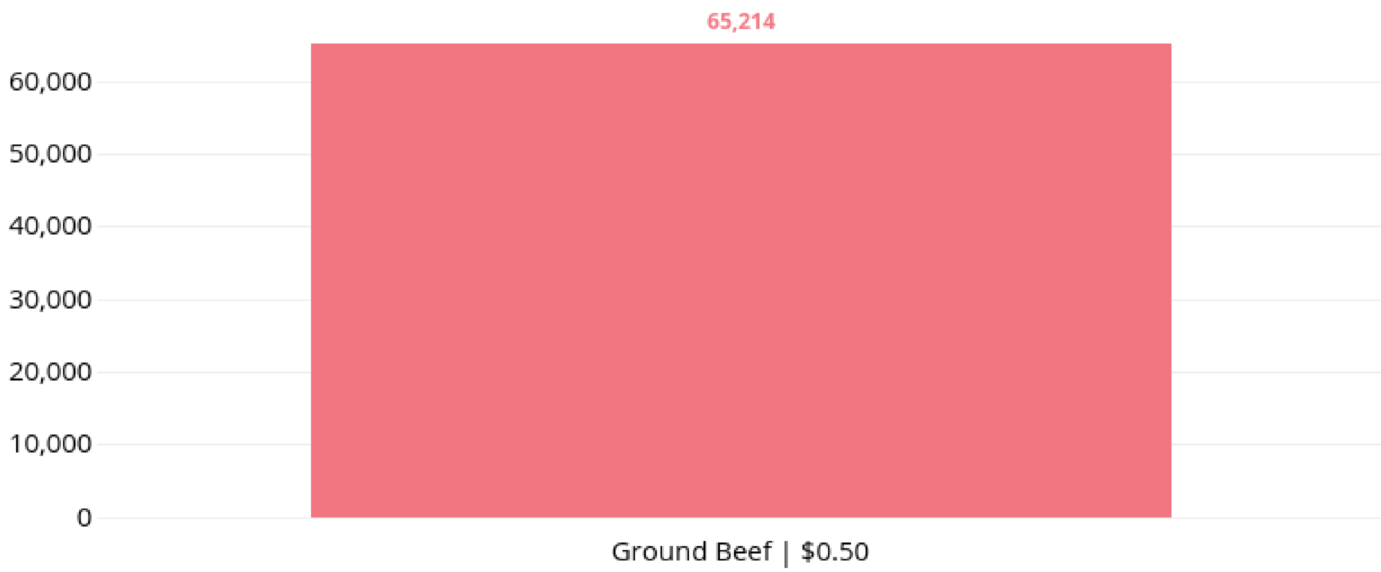
Rebate Breakout

Rebate Breakout

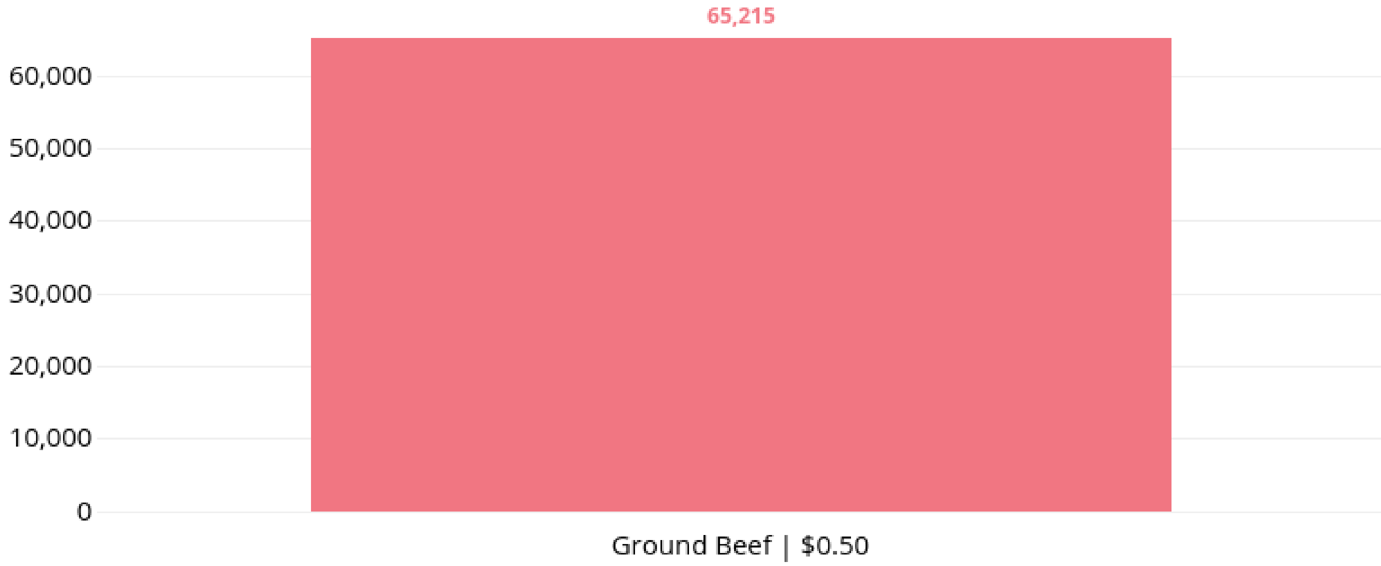
Total Brand Impressions By Rebate



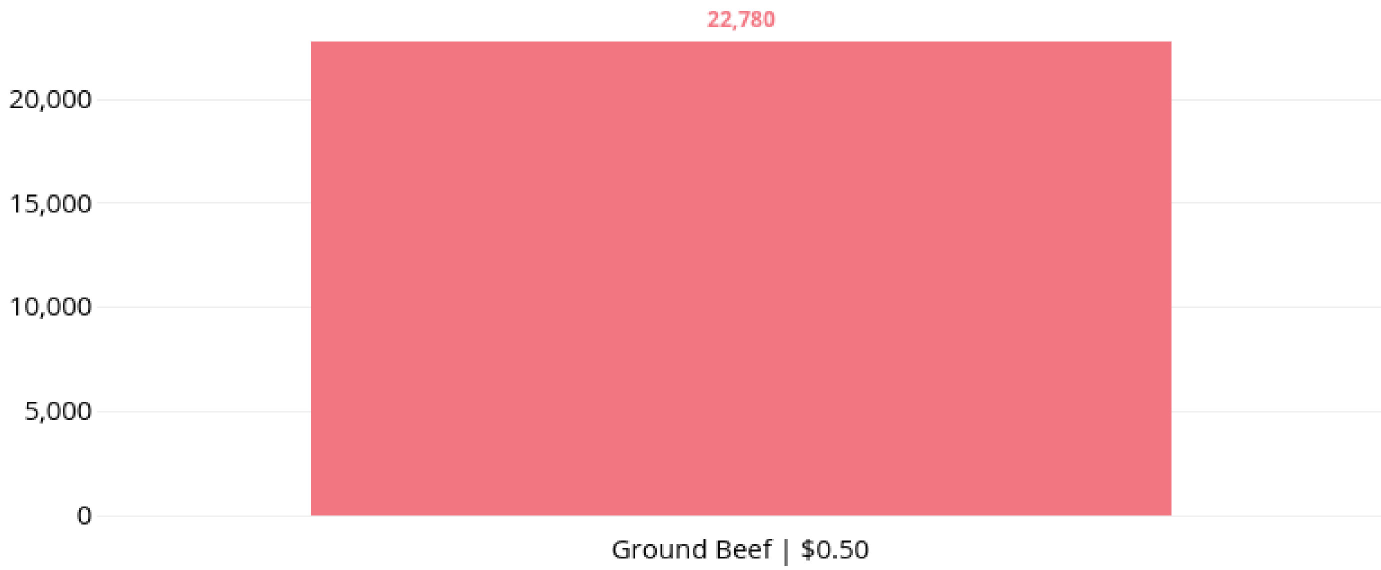
Total Brand Engagements By Rebate



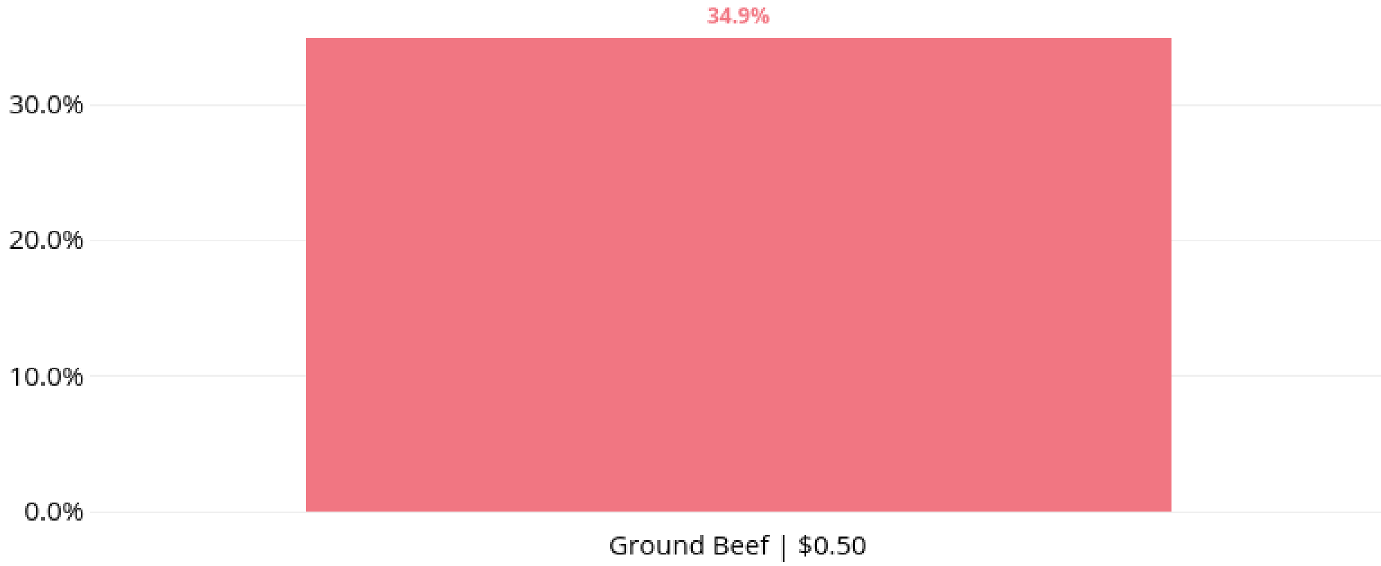
Total Unlocks By Rebate



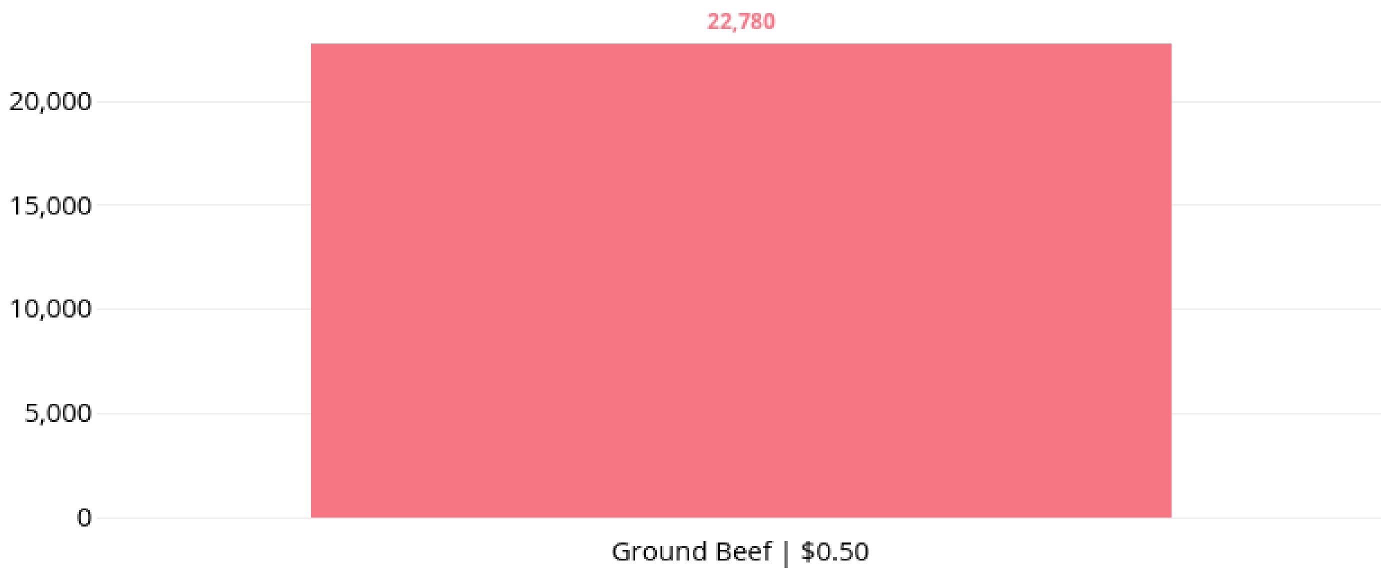
Redemptions By Rebate



Redemption Rate By Rebate



Units Sold By Rebate



Bonus Section Start

Bonus Section (If Applic...

Bonus Section Start

Bonuses Started

No Results

Bonus Descriptions

	ID	Name ^	Description
1	0	No bonus	You do not currently have a bonus associated with this campaign. If you would like to add a bonus to your campaign, please talk to your Ibotta Account Manager

Bonuses Completed

0

No bonus

Name

Bonus Completion Rate

0.0%

No bonus

Name

Choose a Question to Populate Chart Below

No Results

Selected Question Responses - Total Responses

No Results

Selected Question Responses - Purchasers

No Results

Selected Question Responses - Non Purchasers

No Results

Want to Learn More? Click Below!

	Learn More Links Cpg **Learn More CPG**
1	Consumer Surveys
2	Data Licensing
3	External Media Targeting
4	On-Platform Media

2017 CAMPAIGN PROGESS REPORT

HEARST *digital*

Florida Beef Council Campaign Goals

- Educating Floridians on the benefits of beef in a conversational and engaging environment
- To reach your primary audience: women + millennials between 25-40 living throughout Florida with focus on Orlando and Tampa DMA's
- In addition to educating Floridians, you want to engage and create awareness of:
  - Florida beef recipes
  - Videos
  - Tips
  - Social interaction and
  - Educational materials
- To reach potential consumers during high beef consumption months or holidays such as:
  - Valentine's Day
  - Easter (Spring)
  - Memorial Day
  - Summer Grilling (July 4th)
  - Tailgating

Connecting Beef Consumers with Relevant & Engaging Content

Florida Beef Council will receive the following:	

Elements:	Core Audience
	6 month campaign Geo-targeted ads to: Orlando/ Tampa DMA's
	• Desktop/ mobile/ tablet high impact display targeted to:
	    • Women, 24 -40
	    • Millennial moms
	    • Households with Kids
	    • Interest – cooking
	    • Interest – food & wine
	    • Epicureans
	    • Foodies
	    • Interest – health/nutrition
	• Desktop site re-targeting to drive engagement
	Native
	• 4 custom stories using custom content (Easter, Summer Grilling, Tailgating and Holiday)
	• Incorporate Florida Beef Council Social Media Feed, Cooking Recipe Video, Poll and custom Article written by Story Studio
	• Promotion (value added): impressions of onsite traffic driving * approximately 4 million impressions promoting the native content
	• 27,778 Guaranteed Engagements (Boosts engagement with story Demo, DMA, County targeting available)

Total Guaranteed Impressions:	3,500,000
Total Guaranteed Engagements:	27,778 (*Hearst uses as many promotional impressions needed to reach guaranteed Engagements)
Total Campaign Investment:	$88,000 net

Planning the perfect Galentine’s Day

Campaign Performance 1/20 – 2/14

Story 1

Link:

[Planning the perfect Galentine's Day]

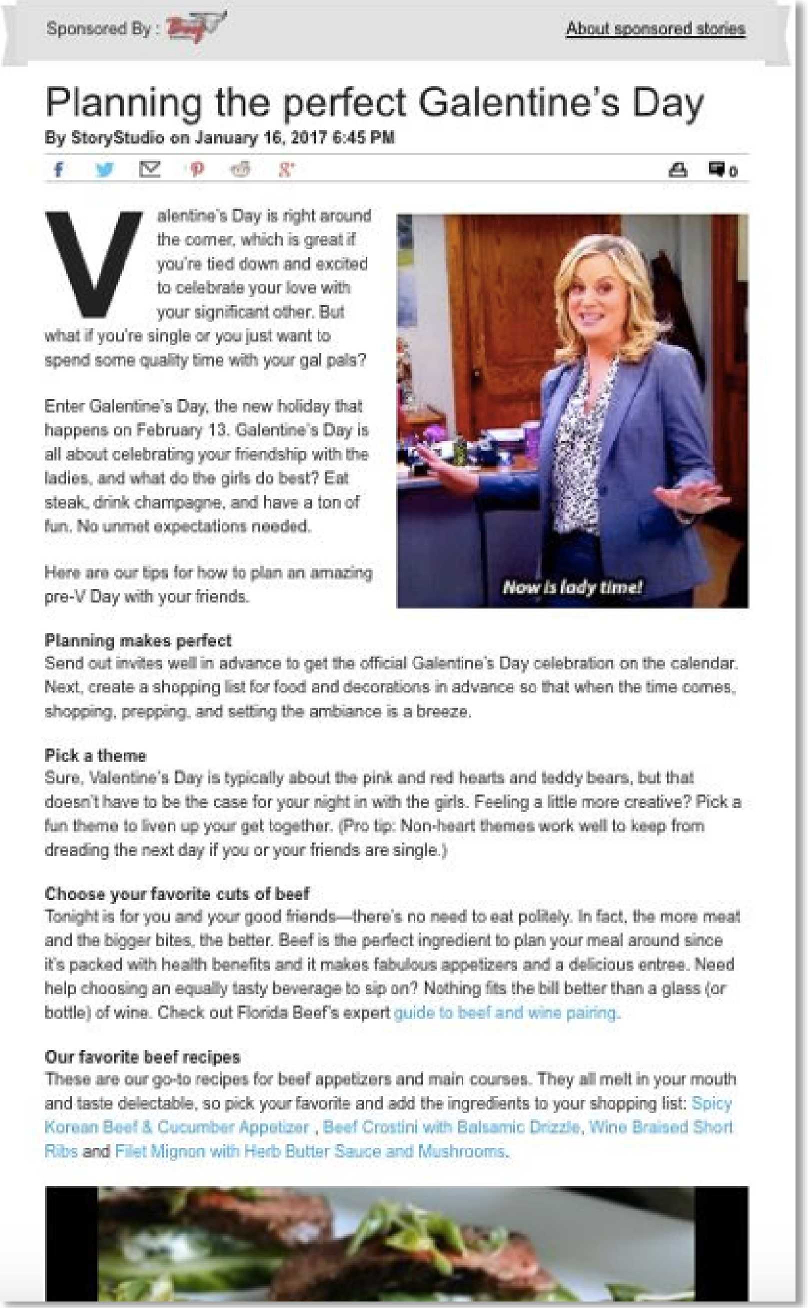
Flight:

January 20, 2017 – February 14, 2017

Performance Overview:

The Story reaching Floridians across the state with 1.8 million impressions. The Florida Beef Council's **custom story earned a total of 11,982 brand engagements.**

With an average time of 2:44 minutes spent on the page, 160% higher than the desktop benchmark of 1:03 minutes and 209% higher than the mobile benchmark of 53 seconds, the story has proven to be both interesting and valuable to readers.



Sponsored By :

About sponsored stories

Planning the perfect Galentine's Day

By StoryStudio on January 16, 2017 6:45 PM

Valentine's Day is right around the corner, which is great if you're tied down and excited to celebrate your love with your significant other. But what if you're single or you just want to spend some quality time with your gal pals?

Enter Galentine's Day, the new holiday that happens on February 13. Galentine's Day is all about celebrating your friendship with the ladies, and what do the girls do best? Eat steak, drink champagne, and have a ton of fun. No unmet expectations needed.

Here are our tips for how to plan an amazing pre-V Day with your friends.

Now is lady time!

Planning makes perfect

Send out invites well in advance to get the official Galentine's Day celebration on the calendar. Next, create a shopping list for food and decorations in advance so that when the time comes, shopping, prepping, and setting the ambiance is a breeze.

Pick a theme

Sure, Valentine's Day is typically about the pink and red hearts and teddy bears, but that doesn't have to be the case for your night in with the girls. Feeling a little more creative? Pick a fun theme to liven up your get together. (Pro tip: Non-heart themes work well to keep from dreading the next day if you or your friends are single.)

Choose your favorite cuts of beef

Tonight is for you and your good friends—there's no need to eat politely. In fact, the more meat and the bigger bites, the better. Beef is the perfect ingredient to plan your meal around since it's packed with health benefits and it makes fabulous appetizers and a delicious entree. Need help choosing an equally tasty beverage to sip on? Nothing fits the bill better than a glass (or bottle) of wine. Check out Florida Beef's expert guide to beef and wine pairing.

Our favorite beef recipes

These are our go-to recipes for beef appetizers and main courses. They all melt in your mouth and taste delectable, so pick your favorite and add the ingredients to your shopping list: Spicy Korean Beef & Cucumber Appetizer , Beef Crostini with Balsamic Drizzle, Wine Braised Short Ribs and Filet Mignon with Herb Butter Sauce and Mushrooms.

REACH Impressions 1,887,445

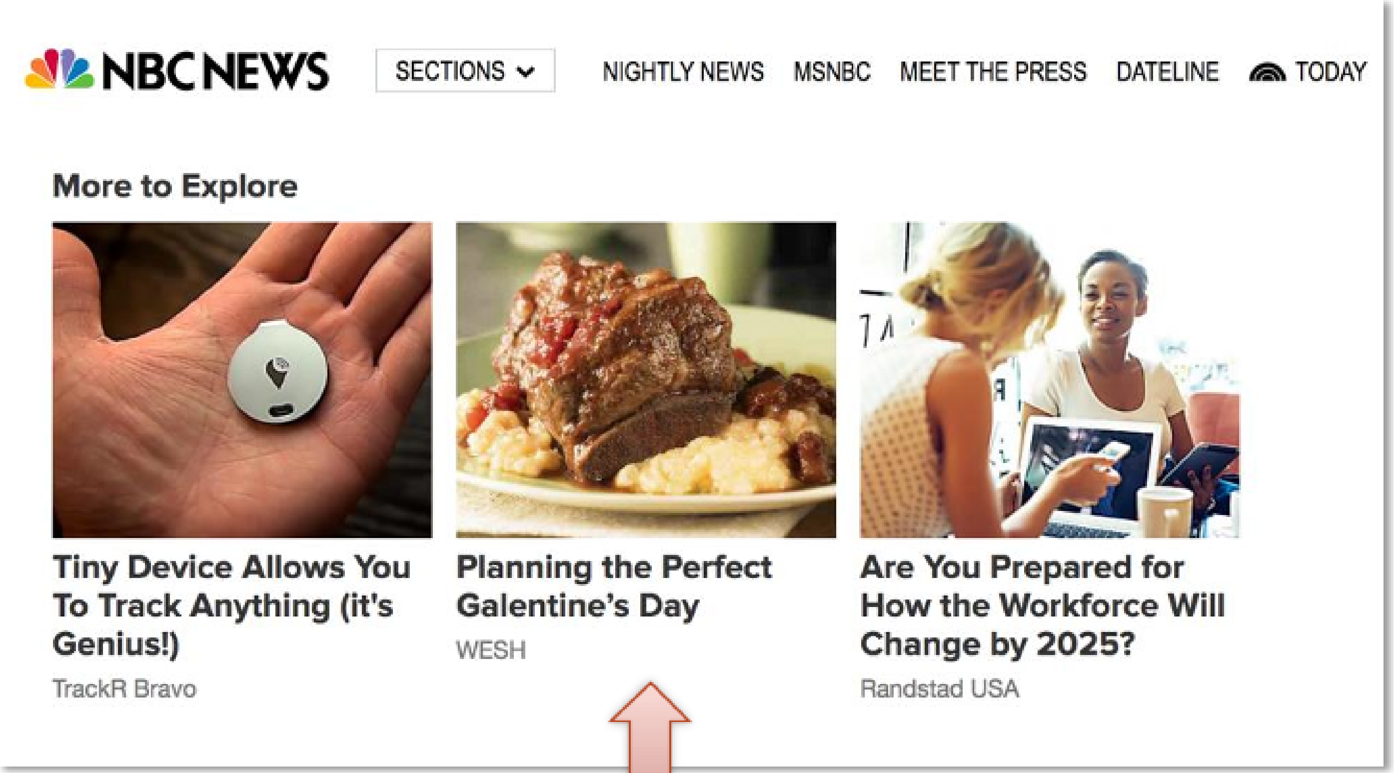
Time Spent w/ STORY 2:44

Engagements 11,982

Scroll Depth 52%

FBC Story Promoted to Targeted Audience on High Profile Publications and Platforms

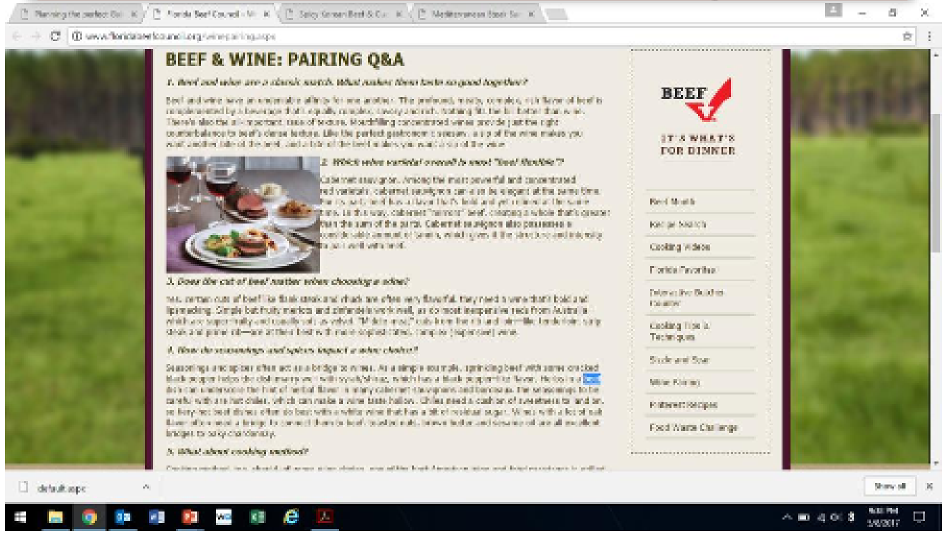
- Story featured within native placements on sites including CBS, Huffington Post, NBC, MSN, Bloomberg and USA Today.



Native Story Interactive Contents

Interactive Article

Live Links to Beef & Wine Pairing Q & A



Live Links to Beef Council Recipes

Who did the Florida Beef Council Story REACH…

- 35% of readers were on a mobile phone
- 45% of readers were on a desktop computer
- 20% of readers were on a tablet

Geo Breakout

Orlando 52%

Tampa 24%

Miami 14%

Deltona 6%

Other 4%

Age Breakout

18-24	25-34	35-44	45-54	55-64	65+
37%	28%	10%	8%	7%	12%

- 63% of readers were female
- 37% of readers were male

THE STORYSTUDIO

Summer Grilling

Campaign Performance 5/22 – 7/4

Story Studio: Summer Grilling

In partnership with StoryStudio, Florida Beef has been able to tackle it's main KPI's – **awareness & engagement** – in an impactful way through a custom story.

Story Link:

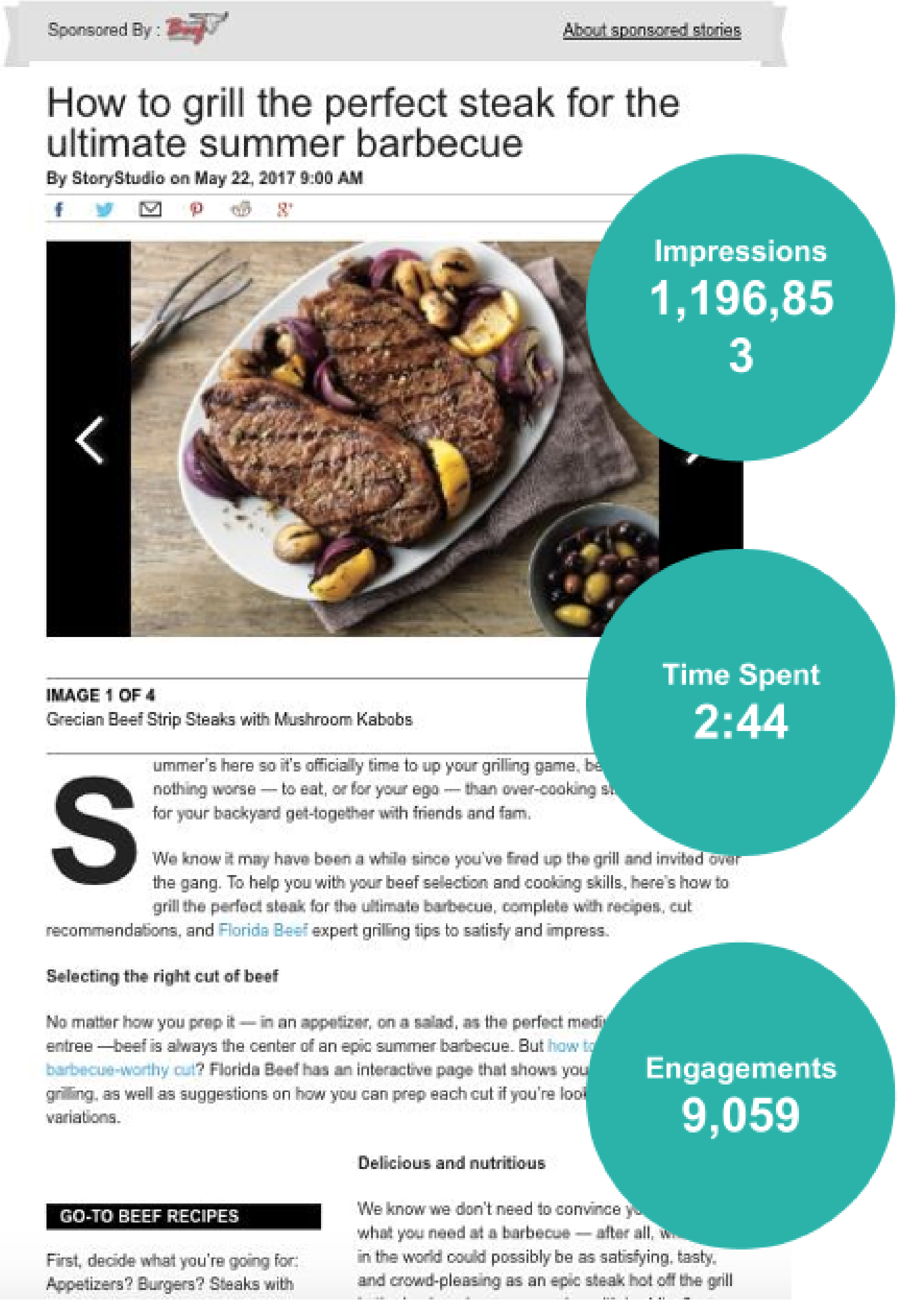
How to grill the perfect steak for the ultimate summer barbecue

Flight: May 22, 2017 – July 4, 2017

Performance Overview:

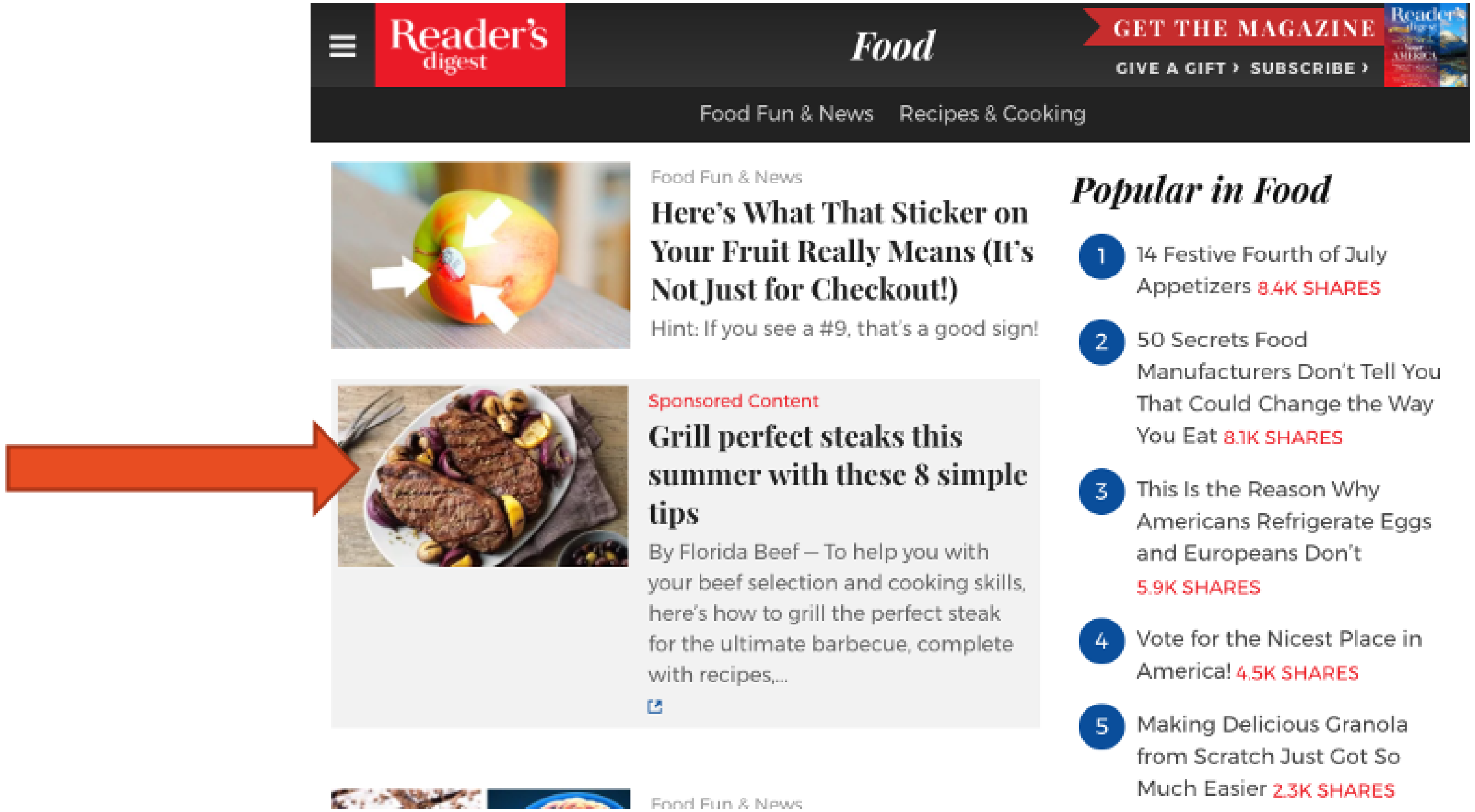
With over **1.19M impressions**, Florida Beef's custom story earned a total of **9,059 unique brand engagements**.

With an **average time of 2:44 minutes** spent on the page, higher than the desktop benchmark of 1:03 minutes and the mobile benchmark of 53 seconds, the story has proven to be both **interesting and valuable** to readers.



Story Studio: Additional Reach

- Story featured within native placements on sites including CBS, Huffington Post, NBC, MSN, Bloomberg, Saveur, FoodBeast, and USA Today.



Story Studio: Summer Grilling

Device Breakout

84% of readers were on a mobile phone

5% of readers were on a desktop computer

11% of readers were on a tablet

Top Cities

- Orlando
- Tampa
- Ocala
- The Villages
- Sanford
- Deltona
- Palm Bay

Gender Breakout

64% of readers were male

34% of readers were female

Age Breakout

18-24	25-34	35-44	45-54	55-64	65+
9%	20%	19%	20%	15%	17%

THE STORY STUDIO

Upcoming Florida Beef Council Native Stories…

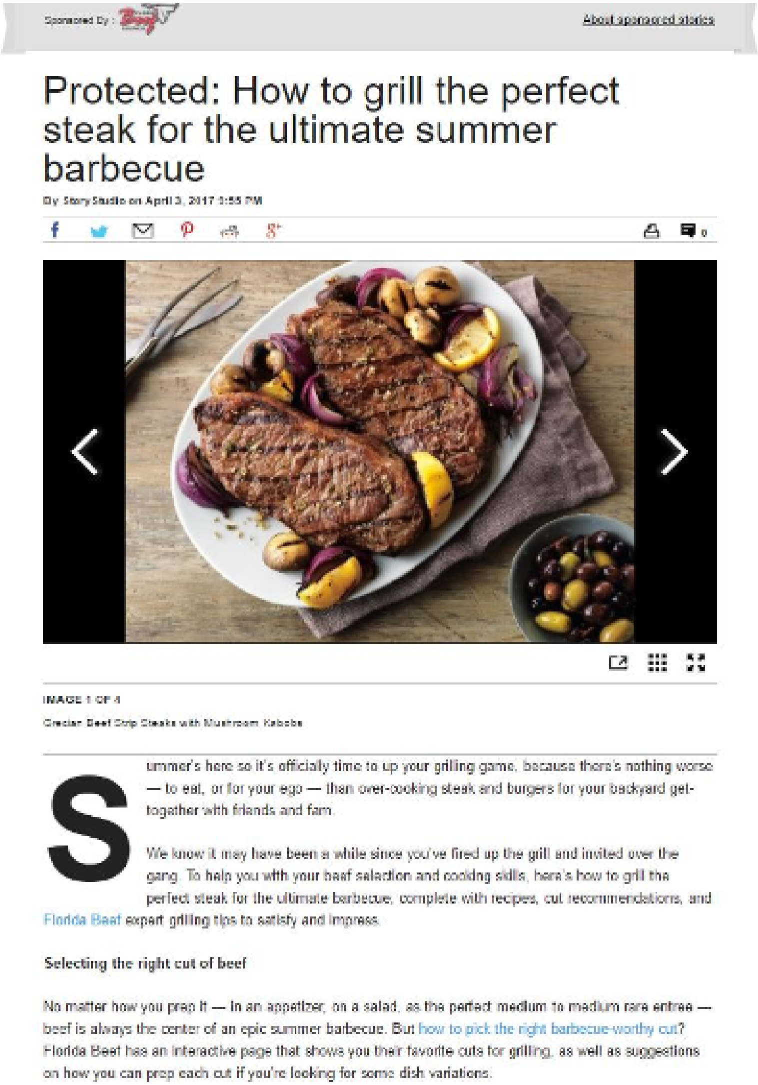
Stories May- September 2017

Story 3: Hosting a tailgate party? Scoremajor points with these easy beef appetizers (8/14 – 9/15)

- http://www.htvnativeadsolutions.com/wesh/2017/04/04/hosting-a-tailgate-party-score-major-points-with-these-easy-beef-appetizers/

Story 4: Five healthy bites to eat while watching the game (8/28-9/15)

http://www.htvnativeadsolutions.com/wesh/2017/08/14/five-healthy-bites-to-eat-while-watching-the-game/



Sponsored By :

About sponsored stories

Protected: How to grill the perfect steak for the ultimate summer barbecue

By StoryStudio on April 3, 2017 5:55 PM

IMAGE 1 OF 4

Grecian Beef Strip Steaks with Mushroom Kabobs

Summer's here so it's officially time to up your grilling game, because there's nothing worse — to eat, or for your ego — than over-cooking steak and burgers for your backyard get-together with friends and fam.

We know it may have been a while since you've fired up the grill and invited over the gang. To help you with your beef selection and cooking skills, here's how to grill the perfect steak for the ultimate barbecue, complete with recipes, cut recommendations, and Florida Beef expert grilling tips to satisfy and impress.

Selecting the right cut of beef

No matter how you prep it — in an appetizer, on a salad, as the perfect medium to medium rare entree — beef is always the center of an epic summer barbecue. But how to pick the right barbecue-worthy cut? Florida Beef has an interactive page that shows you their favorite cuts for grilling, as well as suggestions on how you can prep each cut if you're looking for some dish variations.

HEARST
core audience

Reaching the Millennial Mom

Spring Campaign Performance 3/15 – 4/15

Core Audience: Spring Campaign

Spring Campaign Overview:

- Cross platform (desktop/ mobile/ tablet)
- Geo-targeted to: Orlando & Tampa DMA's
- Target Audience:
    - Females, 25-44
    - Millennial moms
    - Children in HH
    - Interest - cooking
    - Interest - food & wine
    - Epicureans
    - Foodies
    - Interest - health/nutrition
- 700,000 guaranteed impressions between 3/15 – 4/15

IMPRESSIONS SERVED	CLICKS	CTR
707,205	474	.07%

Here's what we saw in the Spring 3/15 – 4/15 campaign

- Overall campaign engagement with is strong with a .07% CTR
  - *Industry average is between a .05 - .10% CTR*
- Mobile was our best performing platform with a .10% CTR
- The 320x50 creative size saw the strongest engagement with a .09% CTR
- Orlando slightly outperformed Tampa; .07% CTR vs .06% CTR

Recommendations for next campaign:

- Utilize more mobile and 300x250 and mobile 320x50 creative.
- The Florida Beef Council placed retargeting pixels on website on 5/9/17 to offer more in-depth consumer updates.

Reaching the Millennial Mom

Memorial Day Campaign Performance 5/1 – 5/31

Core Audience: Memorial Day Campaign

Campaign Overview:

- Cross platform (desktop/ mobile/ tablet)
- Geo-targeted to: Orlando & Tampa DMA's
- Target Audience:
    - Females, 25-44
    - Millennial moms
    - Children in HH
    - Interest - cooking
    - Interest - food & wine
    - Epicureans
    - Foodies
    - Interest - health/nutrition
- 700,000 guaranteed impressions between 5/1 – 5/31

IMPRESSIONS SERVED	CLICKS	CTR
706,998	510	.08%

Here's what we saw in the Memorial Day 5/1 – 5/31 campaign

- Overall campaign engagement with is strong with a .08% CTR
  - *Industry average is between a .05 - .10% CTR*
- Mobile was our best performing platform with a .10% CTR
- The 320x50 creative size saw the strongest engagement with a .09% CTR

Optimization Made:

- Excluded keywords across our entire campaign.
  - Block any words associated with types of protein other than beef, as well as "vegetarian" and "vegan."

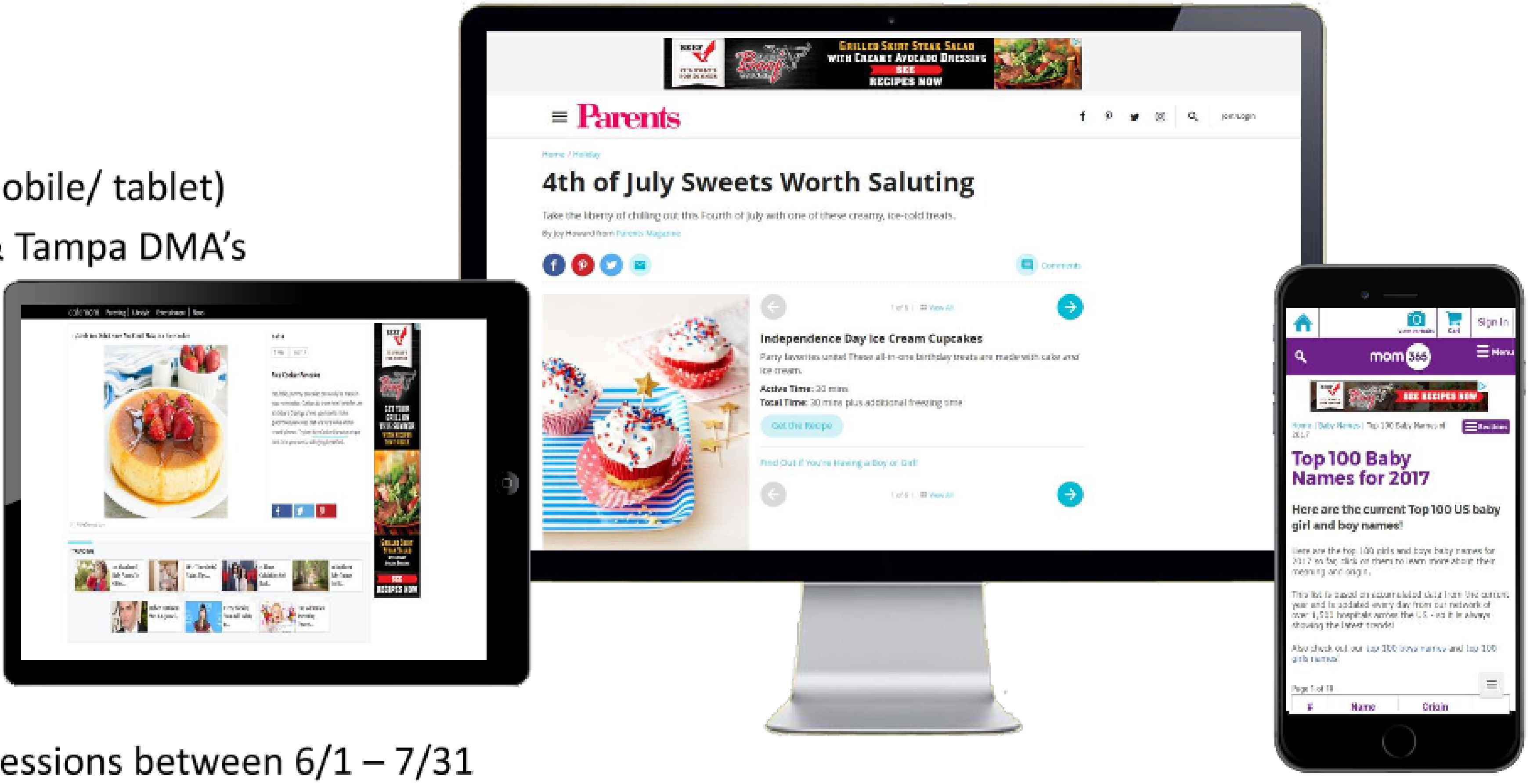
Reaching the Millennial Mom

Summer Grilling Campaign Performance 6/1 – 6/30

Core Audience: Summer Grilling

Campaign Overview:

- Cross platform (desktop/ mobile/ tablet)
- Geo-targeted to: Orlando & Tampa DMA's
- Target Audience:
  - Females, 25-44
  - Millennial moms
  - Children in HH
  - Interest - cooking
  - Interest - food & wine
  - Epicureans
  - Foodies
  - Interest - health/nutrition
- 1,400,000 guaranteed impressions between 6/1 – 7/31



IMPRESSIONS SERVED	CLICKS	CTR
1,414,604	1,456	.10%

Here's what we are seeing…

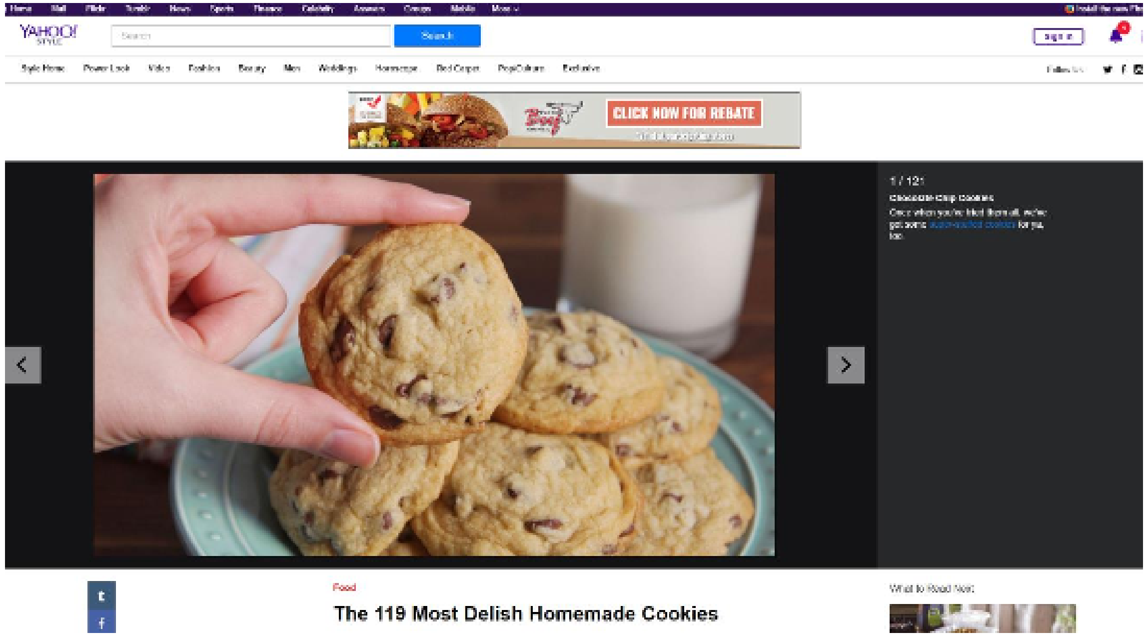
- Overall campaign engagement with is strong with a .10% CTR
  - *Industry average is between a .05 - .10% CTR*
  - *Display Benchmarks (Google)*
- Mobile was our best performing platform with a .12% CTR
- The 320x50 creative size saw the strongest engagement with a .12% CTR
- Custom story received over 9,000 engagements with users spending almost 3 mins on the page

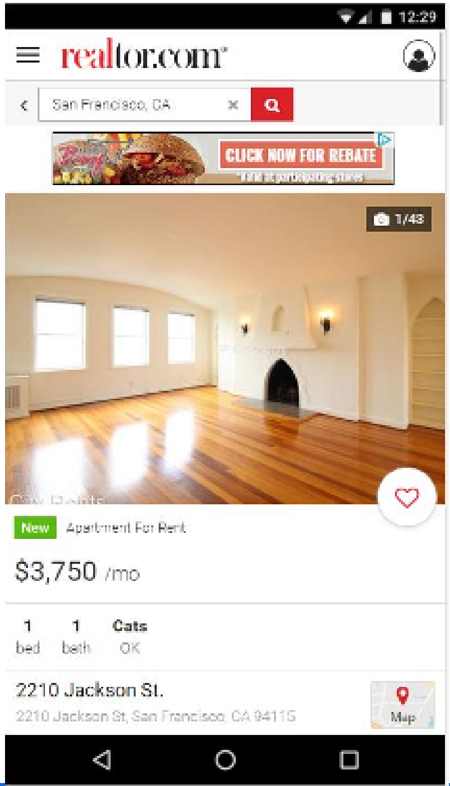
Optimization Made:

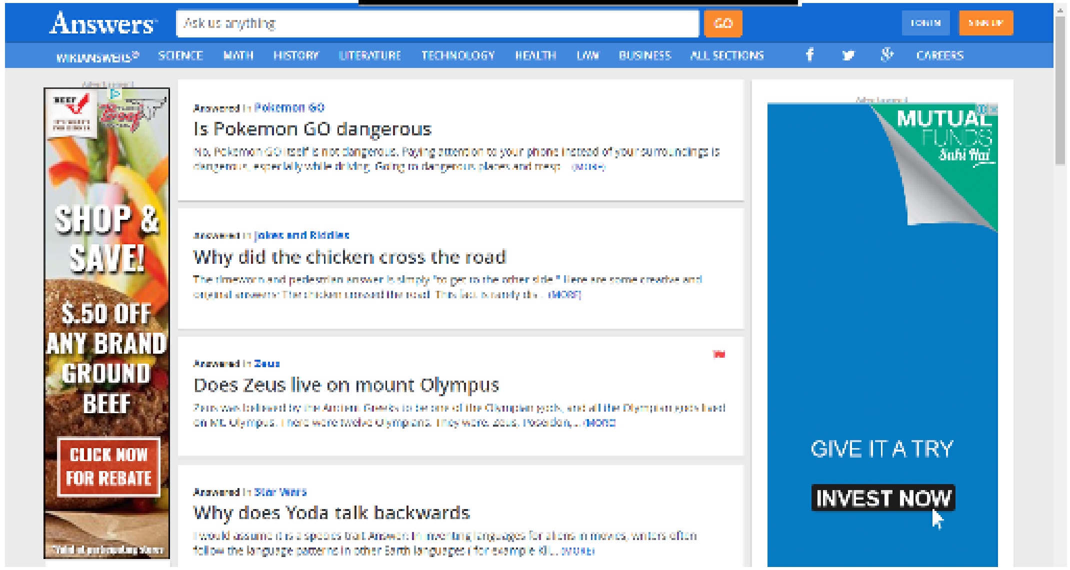
- Excluded keywords across our entire campaign.
  - Block any words associated with types of protein other than beef, as well as "vegetarian" and "vegan."

Rebate Core Promotion Campaign

- Beef Rebate: August/September

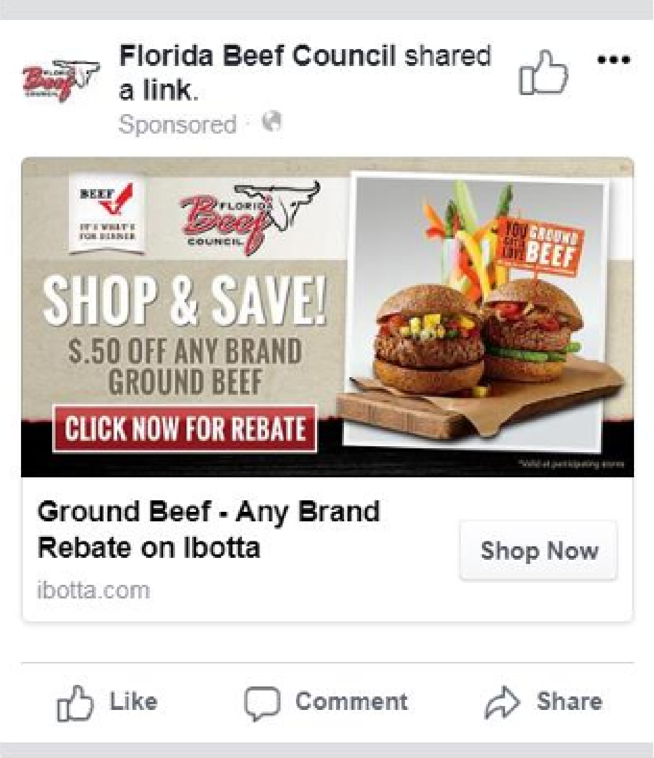






Social

Facebook Newsfeed – Desktop & Mobile



THE STORY STUDIO

HEARST
core audience

2017 Campaign Summary

Core Audience 2017

	Campaign	Campaign Run Dates	Guaranteed Impressions	Impressions Delivered	Clicks	CTR (click thru rate)	CREATIVE Completion	Campaign Completion	Investment
January	-	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-	-
March/ April	Spring	3/13 – 3/31	700,000	707,205	474	.07%	100%	100%	$ 5,600
May	Memorial Day	5/1 – 5/31	700,000	706,998	510	.08%	100%	100%	$ 5,600
June /July	Summer Grilling	6/7/17-7/31	1,400,000	1,414,604	1,456	.10%	100%	100%	$11,200
August	Tailgating	8/1 – 8/30	700,000	700,000	TBD	TBD	100%	100%	$5,600
INVESTMENT $28,000									

August/Sept.	Beef Rebate	8/25/17-9/15/17	1747,760	TBD Hurricane IRMA	TBD Hurricane IRMA	TBD Hurricane IRMA	100%	99%	$15,000
INVESTMENT $15,000									

TOTAL INVESTMENT Including Rebate $43,000

Story Studio (Native) 2017

	Campaign	Campaign Run Dates	Guaranteed Engagements	Delivered Engagements	Creative Completion	Campaign Completion	Investment
January/ February	Valentine's Day	1/16 – 2/13	6,945	11,982	100%	100%	$15,000
March	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-
May / June/ July	Summer Grilling	5/22 – 7/4	6,945	**9,059**	100%	100%	$15,000
August/ September	Tailgating (2 articles)	8/14 – 9/15	**13,890**	**13,890**	100%	100%	$30,000
October	-	-	-	-	-	-	-
TOTAL INVESTMENT $60,000							

HEARST digital

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PYPER YOUNG
BRANDING & ADVERTISING

KILROY AGENCY
BRANDING, DIGITAL, PR & SOCIAL

FLORIDA CATTLEMEN'S ASSOCIATION

"Tell Our Story"

Campaign Recap, Sept. 14th, 2017

ASSIGNMENT GOALS

- Promote and educate consumers in Florida about the Florida cattle world
  - Values, ethics, purpose and its people
- Increase positive consumer opinion
  - Environmental stewardship
  - Animal health/welfare
  - Sustainability
  - Generational/historic family heritage

ASSIGNMENT OBJECTIVES

- To establish a clear, cohesive and compelling brand platform, strategy, and tactics to reach and educate consumers on cattle ranching
- To engage the target audience with this compelling messaging and interact with them, while building awareness
- To utilize social and digital media to reach consumers and increase engagement with the Florida Beef Council website and Facebook page

TARGET AUDIENCE

- Florida residents, non-cattle industry
- Adults 25-54 with female skew
- Social media users
- Online shoppers
- Meat eaters
- Exclude: vegetarians, vegan, PETA, etc. (for this campaign)
- Key markets:
  - Primary: Tampa, Orlando, Miami
  - Secondary: Jacksonville, West Palm Beach, Tallahassee

AD CAMPAIGN RECAP

P|Y

KILROY AGENCY

BRANDING, DIGITAL, PR & SOCIAL

KEY INSIGHTS

- The campaign received more than 2.5 million gross impressions during the flight
- It generated significant traffic to Florida Beef Council's website with the majority being new visitors
- Video pre-roll ads were well optimized and delivered high completion rate - so we know we were able to deliver the whole message
- Paid advertising on Facebook significantly increased engagement
- Simultaneously running video ads and boosted posts had the biggest impact and the most viral exposure
- While not an objective, we increased Facebook page followers by +1,800 - allowing for future communications

SOCIAL MEDIA

Facebook/Instagram video ads

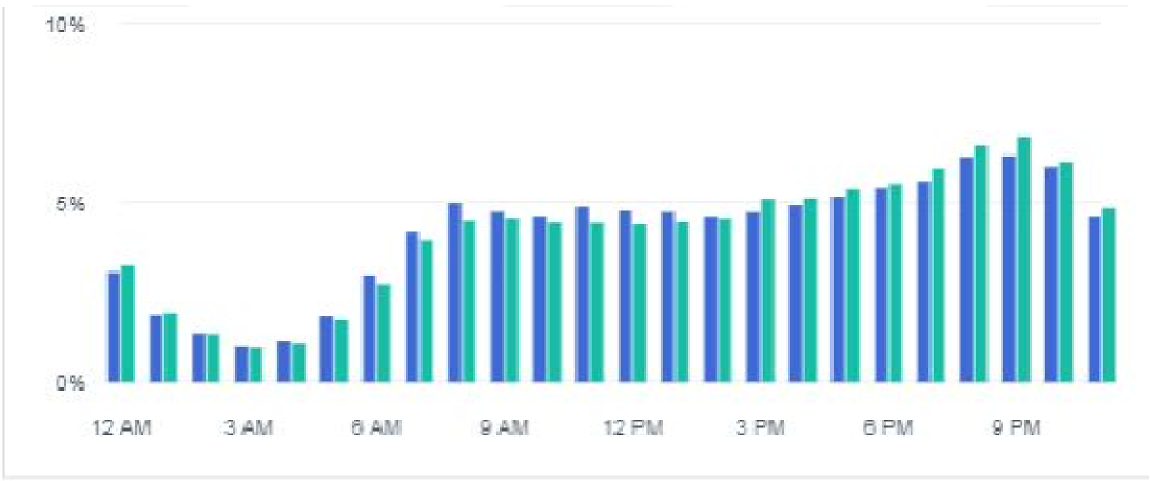
- Began on July 1st with the :60 “Day in the Life” video. Additional videos were rotated in and then pulled the older ones out of the mix, so we always had two or three running to allow for variety and frequency without redundancy.
- As of now, our video ads have delivered over 1.42 million gross impressions reaching over 385k in the target demo, with an average frequency of 3.22.
- 9,063 clicks with a .73% click thru rate (CTR).
- Link clicks is the top performing engagement with 1,755 persons.
    - 1,338 Post reactions
    - 264 Shares
- Have increased Facebook page likes by +1,800 since July 1st.
- We continued to improve the average viewing time - especially once the shorter video lengths were introduced.

SOCIAL MEDIA

Facebook/Instagram video ads

Age & Gender

Time of day



PY KILROY AGENCY BRANDING, DIGITAL, PR & SOCIAL

SOCIAL MEDIA

Facebook/Instagram Ad Examples

Florida Beef Council
Published by Allyson Trimble [?] · August 11 at 1:06pm ·

It's not Friday rush hour without a traffic jam! Cattlemen face their own unique kind of traffic jams. #FCATellOurStory

●●○○○ AT&T LTE 5:32 PM 65%

Instagram

floridabeef
Sponsored

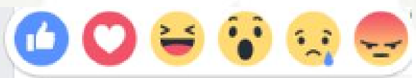
Learn More

566 views

floridabeef Florida cattlemen are passionate about their livelihood just like you. They value hard work, family time and preserving Florida's land... more

SOCIAL MEDIA

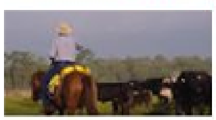
Facebook/Instagram Boosted Posts

- Using the same target audience, we boosted 11 organic posts ranging from videos to photo/info content - all driving traffic to Florida Beef Council website.
- Our boosts have delivered over 559k gross impressions reaching over 182k in the target demo, with an average frequency of 3.07.
- 8,335 clicks with a 1.49% click thru rate (CTR).
- Post reactions  are the top performing action with 4,790 persons.

SOCIAL MEDIA

Florida Cattlemen's Association

Facebook/Instagram Boosted Posts - best performing posts by reactions

Post	Reactions	Comments	Engagement	Reach
Florida Beef Council The beef community works hard every day to produce high-quality beef for Americans. #FCATellOurStory  (Post) July 24, 2017 1:50 pm	1,344	29	6.2%	27,662
Florida Beef Council Get to know the people of Florida's cattle world— their values, ethics and purpose. #FCATellOurStory Get the full story here: http://www.floridabeef.org/tellourstory.aspx  (Post) August 01, 2017 11:51 am	713	8	4.3%	22,995
Florida Beef Council Florida cattlemen are passionate about their livelihood just like you. They value hard work, family time and preserving Florida's land. #FCATellOurStory Learn more at: http://floridabeef.org/tellourstory.aspx  (Post) August 03, 2017 11:42 am	606	12	2.1%	59,957

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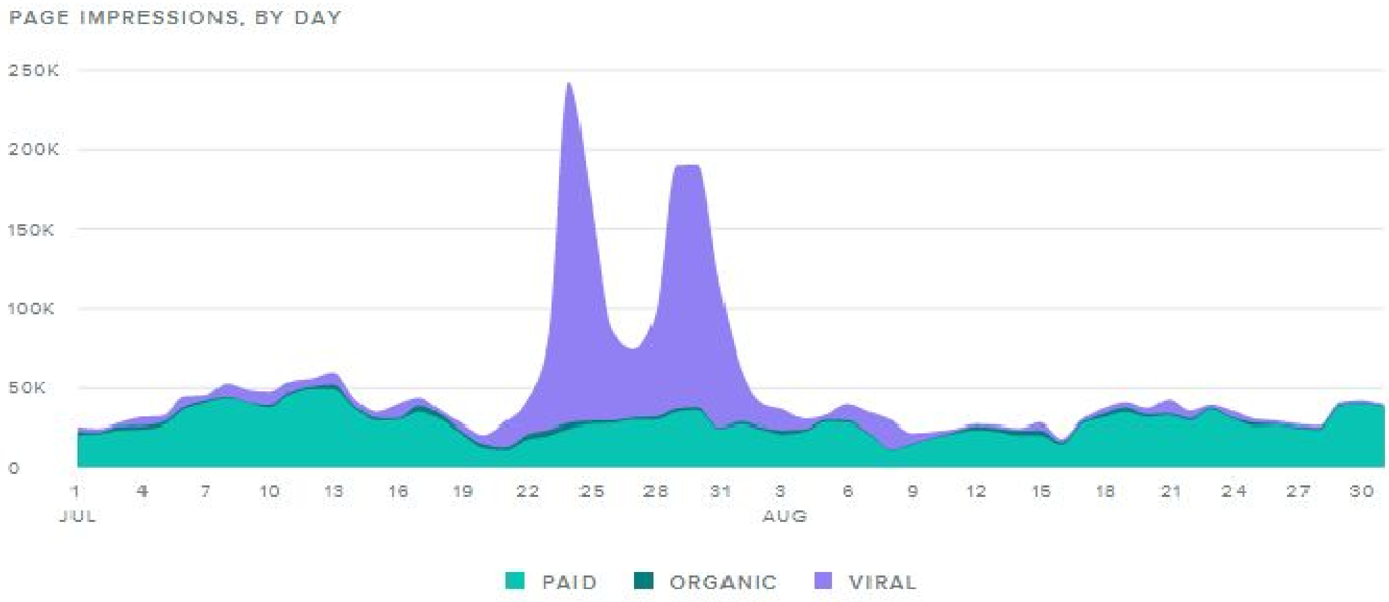
SOCIAL MEDIA

Facebook/Instagram Boosted Posts - Impressions



Impressions Metrics	Totals
Organic Impressions	100,196
Viral Impressions	1,300,879
Paid Impressions	1,712,376
Total Impressions	**3,113,451**
Users Reached	**2,402,356**

Total Impressions increased by

▲448.0%

since previous date range

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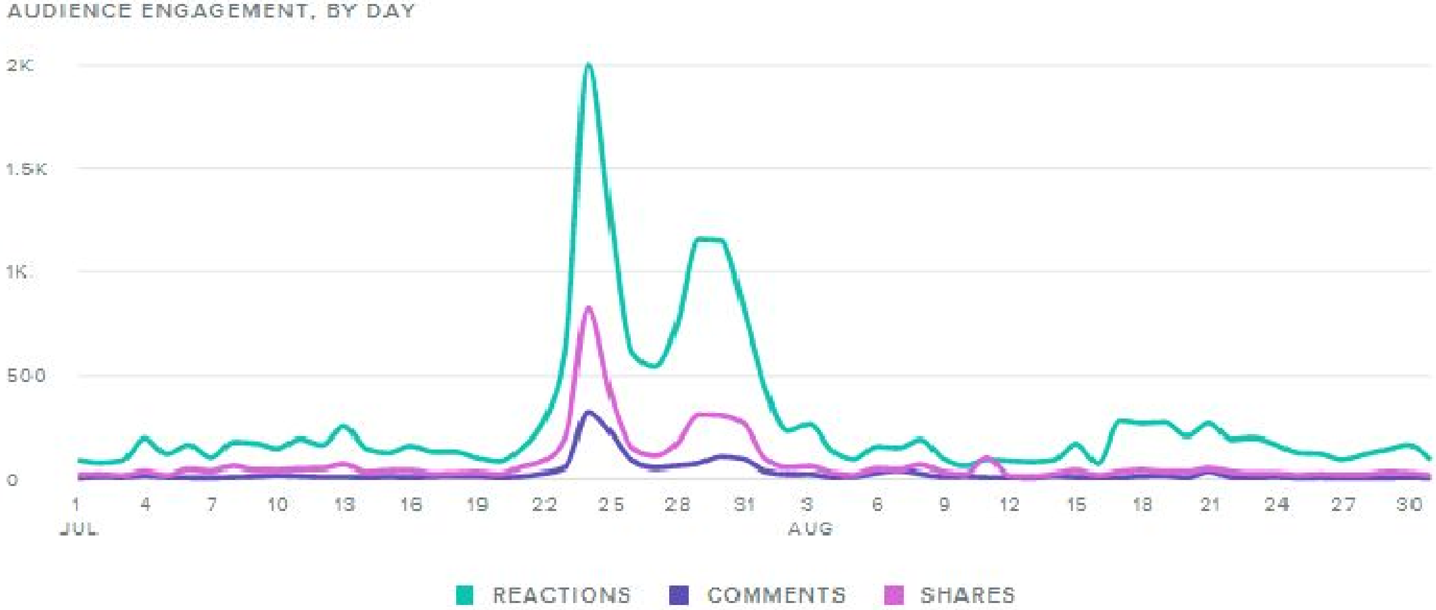
SOCIAL MEDIA

Facebook/Instagram Boosted Posts - Engagement



Action Metrics	Totals
Reactions	16,917
Comments	1,420
Shares	4,407
Total Engagements	**22,744**

Total Engagements increased by

▲179.9%

since previous date range

VIDEO PRE-ROLL

Video ads that appear prior to viewer consuming video content online

- Went live on July 5th with three :30 ads rotating equally
- Ads are optimized for completion so viewers are forced to watch the entire video before their content plays
- 567,119 gross impressions - 425,888 were unique
- Video ad received 543 clicks, .1% CTR
- 81 percent viewed entire video (benchmark 65%)
  - 75% completion rate = 83%
  - 50% completion rate = 87%
  - 25% completion rate = 91%
- “Where are all the Cowboys” continues to get the most clicks: 177
- Retargeting pixel was implemented on Florida Beef Council’s website on July 13th - these video ads are performing at 1.27% CTR.

VIDEO PRE-ROLL

Top websites:

- aol.com
- bettycrocker.com
- cnn.com
- dailymotion.com
- espn.com
- foodnetwork.com
- foxnews.com
- ibtimes.com
- lifescript.com

KEYWORD SEARCH

- Went live July 20th
- 11,615 gross impressions served, 289 clicks, 2.49 CTR
- Average position 1.19 (ideal 1-3)
- Best performing keywords:
  - Florida cattle ranchers
  - Florida cowboys
  - Florida cattlemen

P|Y KILROY AGENCY
BRANDING, DIGITAL, PR & SOCIAL

KEYWORD SEARCH

- Tampa and Orlando are top performing markets

DMA	Clicks	Impressions	CTR
Tampa	101	4,352	2.32%
Orlando	70	2,831	2.47%
West Palm	35	1,250	2.80%
Miami	31	1,300	2.38%
Jacksonville	31	1,262	2.46%
Tallahassee	21	620	3.39%
Total	289	11,615	2.49%

KEYWORD SEARCH

Best performing ads:

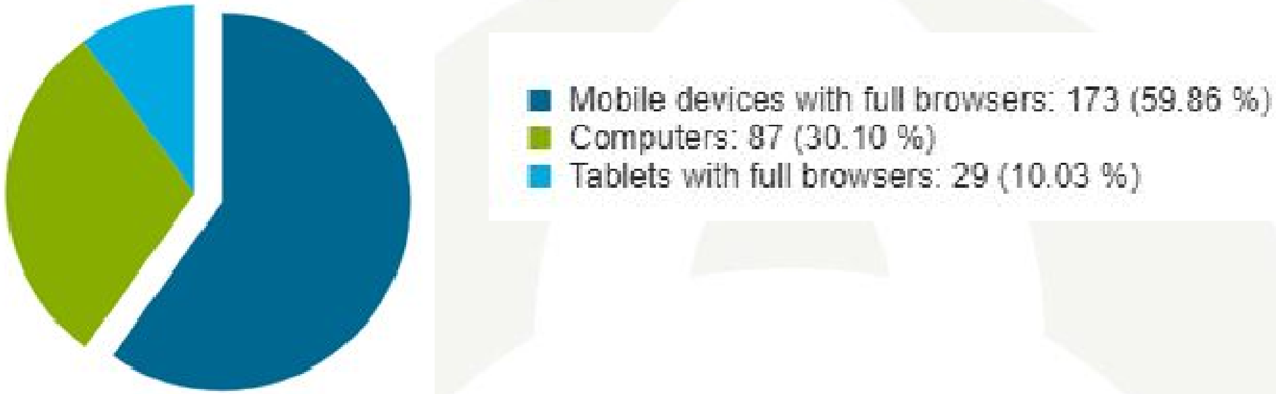
Florida Cattlemen - "Tell Our Story"
floridabeefcouncil.org/Contact/Tampa-St_Pete
A Video Series That Shares The Ethics
And Values of Florida's Cattle
Ranchers.

Florida Cattlemen Video Series - "Tell
Our Story"
floridabeefcouncil.org/Contact/Tampa-St_Pete
Shows the life of FL cattle ranchers,
their care for the land & family
values.

Florida Cattlemen - "Tell Our Story"
Video Series
floridabeefcouncil.org/Contact/Greater_Orlando
Florida Cattlemen Share Their Values,
Ethics, Purpose and People.

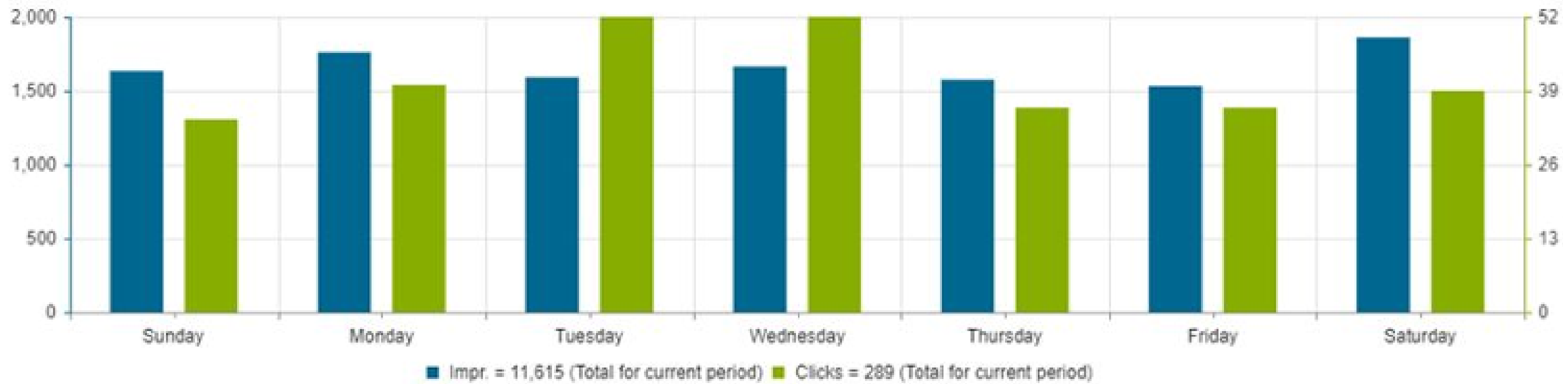
KEYWORD SEARCH

Clicks By Device Type



Impressions & Clicks By Day

July 5, 2017 - September 4, 2017



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GOOGLE ANALYTICS

Saw spike in website traffic immediately with the "Tell Our Story" page receiving 2,502 pageviews, 33 percent of the overall pageviews.

Page	Pageviews	Unique Pageviews	Avg. Time on Page
	7,457 % of Total: 100.00% (7,457)	6,513 % of Total: 100.00% (6,513)	00:01:37 Avg for View: 00:01:37 (0.00%)
1. /tellourstory.aspx	2,502 (33.55%)	2,340 (35.93%)	00:02:28
2. /	886 (11.88%)	796 (12.22%)	00:01:03
3. /cattleinflorida.aspx	835 (11.20%)	646 (9.92%)	00:01:21
4. /tailgating.aspx	664 (8.90%)	558 (8.57%)	00:01:41
5. /summergrilling.aspx	614 (8.23%)	529 (8.12%)	00:03:02
6. /beefchoices.aspx	211 (2.83%)	187 (2.87%)	00:01:53
7. /raisingbeef.aspx	199 (2.67%)	157 (2.41%)	00:01:45
8. /fbcstaff.aspx	120 (1.61%)	98 (1.50%)	00:01:19
9. /foodservice.aspx	93 (1.25%)	80 (1.23%)	00:01:36
10. /countycattle.aspx	87 (1.17%)	83 (1.27%)	00:03:02

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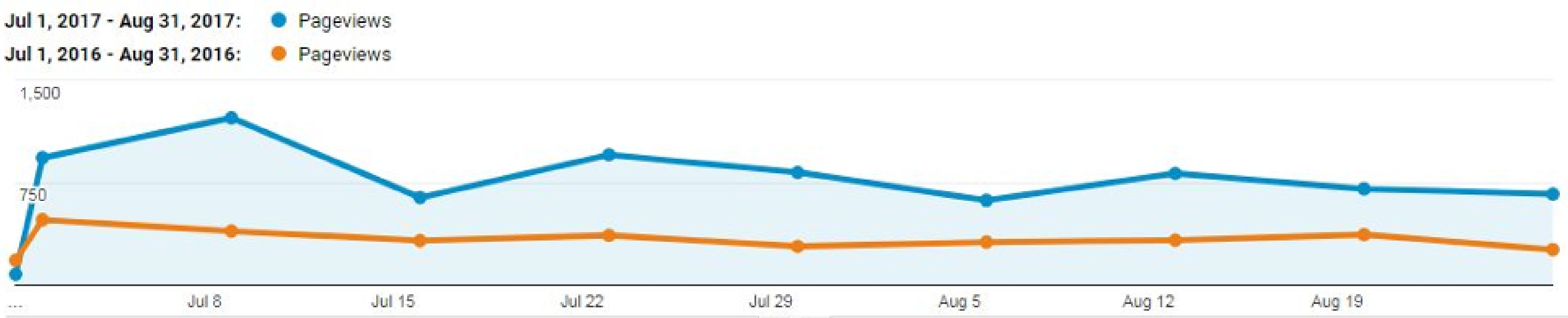
GOOGLE ANALYTICS

Unique pageviews have increased 137% from same time period one year ago.



GOOGLE ANALYTICS

Majority of web traffic resulted from the paid ads - Facebook video ads continued to have the highest referral

Default Channel Grouping	Acquisition		
	Sessions	% New Sessions	New Users
	6,024 % of Total: 100.00% (6,024)	88.03% Avg for View: 88.03% (0.00%)	5,303 % of Total: 100.00% (5,303)
1. (Other)	1,771 (29.40%)	87.58%	1,551 (29.25%)
2. Organic Search	1,053 (17.48%)	86.51%	911 (17.18%)
3. Direct	1,035 (17.18%)	90.43%	936 (17.65%)
4. Referral	992 (16.47%)	83.47%	828 (15.61%)
5. Social	877 (14.56%)	92.70%	813 (15.33%)
6. Paid Search	296 (4.91%)	89.19%	264 (4.98%)

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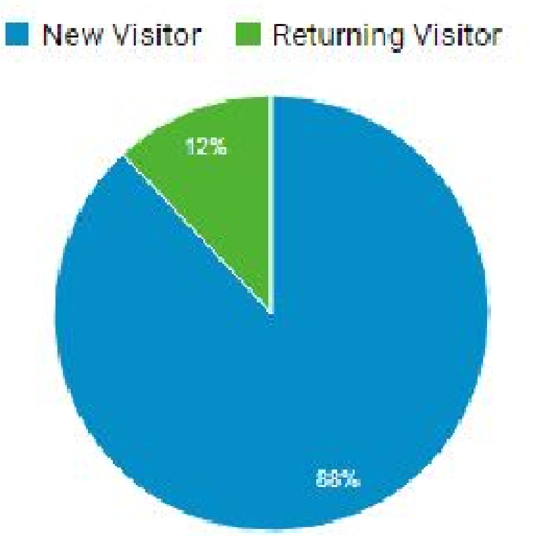
GOOGLE ANALYTICS

Majority of traffic were new visitors, and they are on mobile devices.



Device Category	Acquisition		
	Sessions	% New Sessions	New Users
	6,024 % of Total: 100.00% (6,024)	88.03% Avg for View: 88.03% (0.00%)	5,303 % of Total 100.00% (5,303
1. mobile	**3,924** (65.14%)	87.79%	3,445 (64.96%
2. desktop	**1,473** (24.45%)	88.73%	1,307 (24.65%
3. tablet	**627** (10.41%)	87.88%	551 (10.39%

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NEXT STEPS

P|Y

KILROY AGENCY
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NEXT STEPS

- Develop additional content to continue to tell this story
  - Interviews with ranchers
  - Profiling ranching families
  - Specifics on what they do to help sustainability
  - Statistics
- Find ways to be more engaging
  - More content meant for sharing, tagging, reacting to, etc.
  - More localized content about cattle farming - by State, County, City
- More collaboration with internal team
- Optimize for mobile

THANK YOU!

P|Y

KILROY AGENCY
BRANDING, DIGITAL, PR & SOCIAL

Final Report for Florida Cattle Enhancement Board Funded Project "P9"

Name of Requesting Entity: Miami-Dade County

Address: 111 NW 1st Street City: Miami St:__ Zip: 33128

Project Coordinator (Name & Title): Sen. Javier Souto, Miami-Dade County Commissioner (former member Florida House & Senate)

Phone: 305.222.2116 Cell Phone: 305.793.0052 Email: district10@miamidade.gov

Project Title: Miami International Agriculture, Horse and Cattle Show

Project Start Date: April 14, 2017 Project End Date: April 16, 2017 Total Funding Requested: $ 25,000

Miami-Dade County will host the "2017 Miami International Agriculture and Cattle Show" on April 14- 16, 2017 at the Ronald Reagan Equestrian Center at Tropical Park, Miami-Dade County, Florida. (Intersection of 826, Palmetto X-Way & Bird Rd, SW 40th Street.) The show is going on its 10th year, it has been a great success all these years (over 50,000 persons on a weekend, on average). The show is now recognized in all the important countries in Latin America, and many counties in the world. The show is a proven winner. From the very beginning this show has been highly connected with the Florida Department of Agriculture and the USDA (United States Department of Agriculture) to try to help them with all their promotions and projects including the expansion of uses of Florida produced beef and beef products. Our show, is a trade show also, and there is a display of goods and literature from both mentioned departments, plus displays and also selling activities conducted by various companies, individuals and businesses from our state. There is a live auction via Internet with buyers from many parts of the United States and the world. This show is sanctioned by ABBA (American Brahman Breeders Association) as a "point show". The show's aim is to promote research and high-tech applications and in all agricultural related endeavors specially those having to do with agriculture in Florida. The strong point of the event is the exhibit and competition of beef breeds, emphasizing the Brahmans, Brangus, Angus, Santa Gertrudis and Senepol breeds. Furthermore, the show promotes the research and use in Florida, and similar areas in the world, of crosses of different breeds, for example: Brahman + Angus + Charolais; Angus + Brahman + Senepol; Brangus + Senepol + Charolais; Santa Gertrudis + Brangus + Senepol. Etc. to maximize "heterosis" and efficiency in the utilization of our natural resources, and adaptation of the animals to our real situation vis-à-vis climate and pests, mosquitoes, ticks, other insects and dangers present in our ambience.

The Florida Department of Agriculture and Consumer Services Division of Marketing (FDACS) has funded this event for a number of years. For the 2017 event FDACS asked the Florida Cattle Enhancement Board (FCEB) to fund this project. The Miami International Agriculture, Horse and Cattle Show, was executed in April of 2017, they received (and spent) $25,000 from the FCEB per their request and in compliance with the direction of FDACS.

Money Granted from the FCEB	$25,000
Granted Money Used to Execute the Event	$25,000
Percent Completed	100%

Purvis Gray & Company

P.O. Box 141270 Gainesville, Florida 32614
(352) 378-2461

CATTLE ENHANCEMENT BOARD, INC.
800 SHAKERAGE ROAD
KISSIMMEE, FL 34744

Invoice No. 31452
Client No. 03256.0
Date: Friday, August 18, 2017

Final Billing

Preparation of Independent Auditors' Report and Financial Statements for the Year Ended June 30, 2017

Audit Planning, Preliminary Audit Work, Auditors Reports, and Final Fieldwork Performed Through Delivery of Final Financial Statements

Current Amount Due $ 10,000.00

Approved
8/23/17 J Holland

RECEIVED AUG 2 2 2017

Net due and payable upon receipt. A finance charge of 1-1/2% per month will be added to the balance over 30 days past due, which is an annual percentage rate of 18%.

*****To Ensure Proper Posting to your account, please return this portion with your payment*****

CATTLE ENHANCEMENT BOARD, INC.
Client No. 03256.0
Invoice No. 31452

Amount Paid $____________

Purvis Gray & Company

P.O. Box 141270 Gainesville, Florida 32614
(352) 378-2461

CATTLE ENHANCEMENT BOARD, INC.
800 SHAKERAGE ROAD
KISSIMMEE, FL 34744

Invoice No. 31464
Client No. 03256.0
Date: Wednesday, August 23, 2017

Final Billing

Preparation of Return of Organization Exempt From Income Tax, Form 990, for the Year Ended June 30, 2017

Current Amount Due $ 2,000.00

approved.
J. Hadley
8/29/17

Net due and payable upon receipt. A finance charge of 1-1/2% per month will be added to the balance over 30 days past due, which is an annual percentage rate of 18%.

*****To Ensure Proper Posting to your account, please return this portion with your payment*****

CATTLE ENHANCEMENT BOARD, INC.
Client No. 03256.0
Invoice No. 31464

Amount Paid $____________

RECEIVED AUG 29 2017

~~RECEIVED AUG 29 2017~~