Final Technical Report

FCEB Project #6

Final report

August 2024

1. Project Title and principal investigator contact information:

Title: Association between residual feed intake and fertility-related measures in young bulls.
Project number: FCEB No: 6.
Award number: AWD15833
Proponent:
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Research team: Brad Daigneault (Co-PD/PI), Nicolas Di Lorenzo (Co-PD/PI), Jose Dubeux (Co-PD/PI), Joao Bittar (Co-PD/PI)

2. Significance:

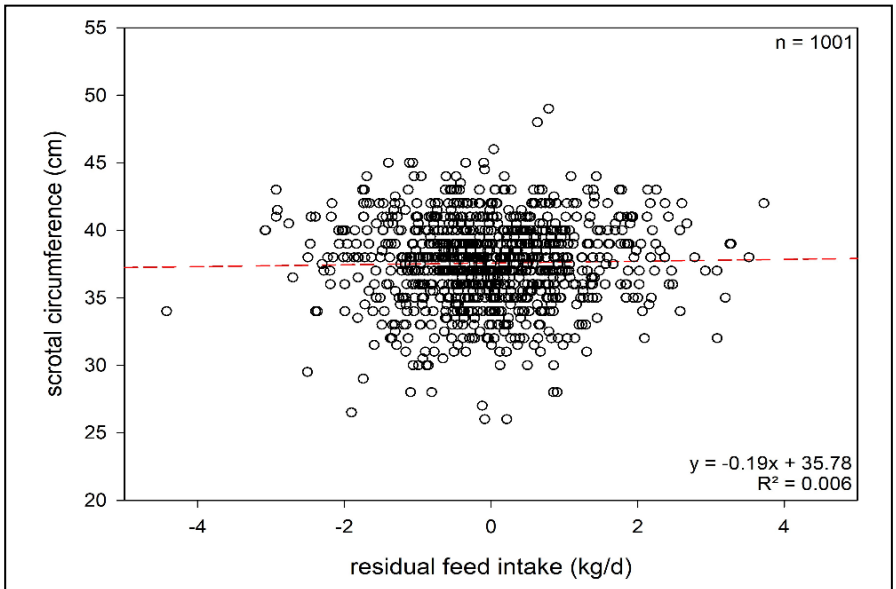

Figure 1: Correlation between Residual Feed Innate and scrotal circumference in young bulls consigned into the Florida Bull Test from 2010 to 2020 (n = 1001).

Improving feed efficiency will provide economic (Herd et al., 2003) and environmental (Food and Agriculture Organization of the United Nations, 2013) benefits to the beef industry. High-feed efficiency animals have a similar overall performance with lower feed intake, reduced input cost, and increased profitability than feed inefficient animals. Therefore, identifying and selecting animals with high feed efficiency is crucial and a priority for the beef industry. It has been calculated that around 80% of the beef industry's production costs are related to feeding animals. This means that finding animals that can eat less but produce the same amount of meat as their counterparts can increase the producers' profits and the industry's efficiency. Therefore, beef cattle breeding programs have emphasized genetic selection for improved feed efficiency through RFI (Berry and Crowley, 2013).

However, there is contradictory information regarding the impact of selecting bulls for negative RFI (feed efficient) over their reproductive performance and fertility. Wang et al. (2012) suggested that a greater proportion of young bulls failing the sperm motility assessment were classified as

having superior feed efficiency. Also, Fontoura et al. (2016) reported that feed-efficient bulls have features of delayed sexual maturity, and Hafla et al. (2012) observed a negative association between feed efficiency and semen quality based on sperm morphology evaluation. On the other hand, others have reported no association between RFI and reproductive-related measures (Borges et al., 2023; Bruinjé et al., 2019; Rossi et al., 2022). Moreover, using data from the Florida Bull Test program (n = 1001; years 2010 – 2020), we could not determine any association between RFI and scrotal circumference or RFI and result of the BSE. Figure 1 shows a regression line constructed between RFI and scrotal circumference. The R2 correlation between RFI and scrotal circumference was <0.1, signifying that the equation line does not provide a good fit (no relation) between RFI and scrotal circumference. Moreover, when we divided the bulls into quartiles according to their RFI (Table 1), we could not find any differences in scrotal circumference or the result of the BSE test (satisfactory, deferred, or unsatisfactory) when comparing bulls on the first quartile (efficient) with bulls on the fourth quartile (not efficient).

Table 1: Results of the breeding soundness examination in bulls divided into first and fourth quartiles according to their Residual Feed intake (RFI). One thousand-one bulls were consigned to the Florida Bull test (2010-2020).

	RFI (kg/d)	n	Satisfactory n (%)	Deferred n (%)	Unsatisfactory n (%)	Scrotal circumference (cm)
1st quartile	-1.28 ± 0.03	257	209 (81%)	44 (17%)	4 (1%)	37.58 ± 0.2
4th quartile	1.34 ± 0.04	255	202 (79%)	47 (18%)	6 (2%)	37.20 ± 0.35

To evaluate sexual maturity and fertility in bulls, veterinarians use measurement of scrotal circumference and other biometrics that are highly associated with daily sperm production and semen quality (Barth and Ominski, 2000), such as sperm motility (Walker et al., 1982) and sperm morphology (Martig and Alquimist, 1969). Computer-Assisted Semen Analysis (CASA) has been used to evaluate seminal characteristics objectively. CASA allows the evaluation of new variables such as average path velocity, curvilinear velocity, straight-line velocity, straightness, linearity, the amplitude of lateral head displacement, and beat cross frequency, which have been related to reproductive performance in a stronger way than regular sperm motility and sperm morphology. Therefore, we aim to use BSE and CASA to evaluate the fertility status of bulls with divergent RFI status.

3. Specific aims:

This proposal explores the association between residual feed intake (RFI) and fertility-related measures in young beef bulls. Our specific aims are:

- Estimate dry matter intake and RFI in crossbreed bulls.
- Perform a complete breeding soundness examination at the beginning and end of the feeding test.
- Measure sperm viability, quality, and motility on seminal samples.

This proposal addresses the FCA Research Priorities #5 (Herd nutrition) and #7 (Bos indicus Genetics) by focusing on the feed efficiency variation and its association with bulls' fertility. We hypothesize that selecting animals for low RFI (Feed-efficient) will impact breeding soundness and seminal characteristics.

4. Approach:

Performance test: we counted with the support of Deseret Cattle and Citrus (DCC) for the present experiment. We used 60 animals from DCC that were consigned to our Feed efficiency Facility. On arrival (Day -14), bulls were weighed and placed in the feed efficiency facility to collect individual intake data. A 21-day acclimation period to the diet and facilities will precede a 56-day feeding trial. The daily feed intake was recorded for each bull, and by the end of the test, average daily gain, gain-to-feed ratio, and residual feed intake were estimated. Bodyweight was collected every two weeks before daily feeding.

Figure 2: Sixty Brangus bulls from Deseret Cattle and Citrus and Consigned at the NFREC Feed efficiency barn were successfully included in the study.

Breeding soundness evaluation and collection of seminal samples: On days 0 and 56, a complete Breeding soundness evaluation (BSE) was performed (Figure 2). Complete evaluation of testicles, accessory glands, penis, and the general status of the animals was evaluated. Seminal samples were collected with electroejaculation. Seminal samples were immediately assessed for morphology (Figure 3) and motility, which were to be later diluted using a UFLOW extender (patent in progress). This new extender was developed by one of the co-PIs (Daigneault). Diluted seminal samples were transported to Gainesville and analyzed using computer-assisted-semen-analysis (CASA-IVOS System, Hamilton Thorne, Beverly, MA) four hours after collection (Figure 4).

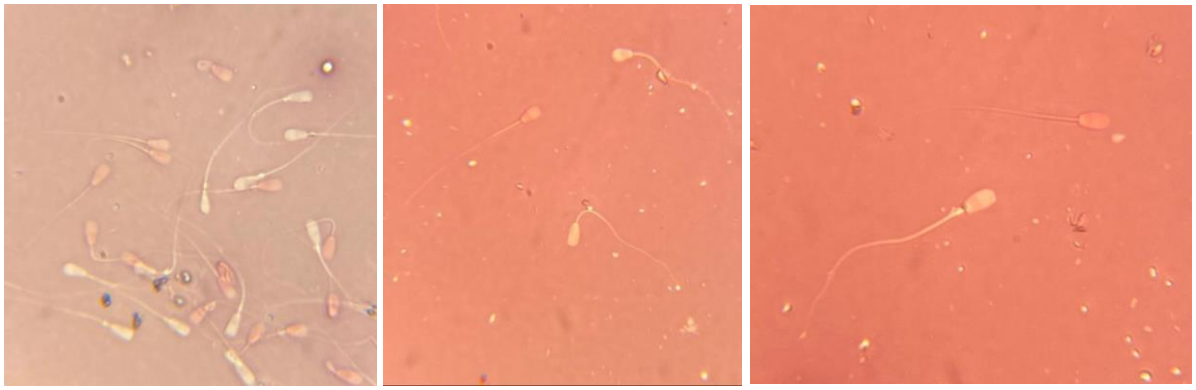

Figure 3: Representative images of the Eosin-nigrosine stain for morphological analysis and Eosin intact percentage estimation.

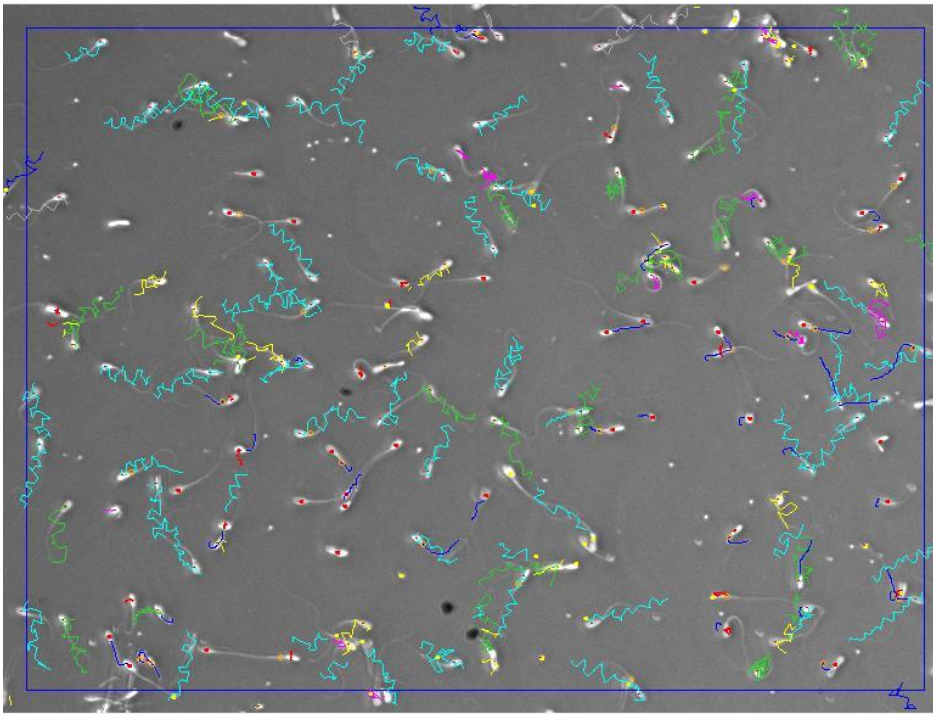

Figure 4: Representative image of the CASA analysis for diluted sperm.

Blood samples collection and plasma testosterone concentration: Blood samples were collected on days 0 and 56. After plasma harvesting, Testosterone concentration will be evaluated using IMMULITE® 2000 Xpi Immunoassay. Initially, we planned to assess plasma testosterone concentration at the College of Veterinary Medicine (Gainesville, Florida). However, their machine has been broken since January, and we haven't been able to complete this analysis.

Data analysis: The data was analyzed using least-squares analysis of variance using the GLIMMIX procedure of the Statistical Analysis System (SAS, Cary NC). The main effects included in the model will be RFI, puberty status, pen, and animal nested within the pen. For repeated measures, the animal will be considered a random effect.

5. Problems encountered and achievements:

The field portion of this study was successfully concluded in November of 2023. By the end of the study, 58 bulls were included for laboratory and data analysis, and blood and seminal samples were collected. Two bulls were removed from the experiment because they lost weight during the study. The laboratory analysis of the seminal samples has also been concluded. As previously mentioned, we have not been able to complete the Plasma Testosterone concentration analysis due to machine failures at the College of Veterinary Medicine.

6. Preliminary results:

We successfully finished the field portion of the study. Fifty-eight bulls from DCC were included for the feed efficiency test. We successfully collected blood and plasma samples on days 0 and 56. According to the feed efficiency test results, the initial BW, the final BW, and the ADG were not statistically different among RFI groups. However, the DMI was smaller for LRFI bulls than for HRFI bulls. Table 2 summarizes the performance test, where the parameters are expressed as the means ± SEM, with the corresponding P value.

Table 2. Performance test results in HRFI and LRFI bulls.

	HRFI (n= 30)	**LRFI (n= 30)**	***P* value**
Initial BW: day 0 (Kg)	358.08 ± 5.11	355.19 ± 4.91	0.36
Final BW: day 56 (Kg)	473.61 ± 6.20	467.87 ± 6.73	0.36
DMI (kg/d)	**14.33 ± 0.16**	**12.15 ± 0.18**	**< 0.001**
ADG (kg/d)	1.65 ± 0.04	1.61 ± 0.05	0.71

BW: Body weight, DMI: Dry matter intake, ADG: Average daily gain, HRFI: High residual feed intake, LRFI: low residual feed intake

Regarding reproductive traits, the main effect of group did not affect CASA-derived traits (Table 3). In contrast, MAD (P= 0.04) and TD (P= 0.014) were affected among visually evaluated traits, being smaller for LRFI bulls on both day 0 and day 56 (Table 4). A Time effect was observed in the ALH (P< 0.001) and VCL (P= 0.0004), being smaller on day 0 than on day 56 for both LRFI and HRFI bulls, and BCF (P< 0.001) and LIN (P= 0.0024), being higher on day 0 than on day 56 for both LRFI and HRFI bulls. Among CASA-derived traits, a tendency to higher values for day 56 was indicated for TM (P= 0.069) and VAP (P= 0.05). In contrast, all visually evaluated traits were affected by time except for VM (P= 0.46), which presented higher values on day 0 than on day 56 for LRFI bulls but smaller values on day 0 than on day 56 for HRFI bulls. Also, an interaction effect (group x time) was observed in LIN (P= 0.036) and PMI (P= 0.012), where

higher values were observed on LRFI than on HRFI bulls when compared on day 0, but the opposite was observed when compared on day 56. Higher values were observed on day 0 than day 56 for LRFI bulls, but the opposite was observed when HRFI was compared. Table 3 presents descriptive statistics (means ± SEM and P value) for reproductive traits and the phenotypic relation of all traits with the RFI group, time, and the interaction (group x time) for all bulls.

Table 3: CASA-derived traits (Mean ± SEM) were evaluated in diluted semen samples 4 hours after collection in bulls classified as High (HRFI) or Low Residual (LRFI) feed intake.

	Day 0		**Day 56**				
	LRFI	**HRFI**	**LRFI**	**HRFI**	**Group**	**Day**	**Group x Day**
Tot Mot	27.64 ± 5.14	27.37 ± 2.91	27.91 ± 3.68	29.26 ± 4.13	0.17	0.06	0.27
Prog Mot	20.72 ± 4.43	18.45 ± 2.56	19.15 ± 3.32	21.02 ± 3.39	0.34	0.10	0.74
ALH	4.13 ± 0.32	4.44 ± 0.20	6.96 ± 0.59	6.03 ± 0.65	0.92	<.01	0.19
BCF	36.50 ± 0.73	34.65 ± 0.91	27.13 ± 1.61	28.20 ± 1.21	0.69	<.01	0.14
LIN	64.92 ± 2.33	60.68 ± 1.21	54.55 ± 2.16	57.99 ± 1.84	0.51	<.01	0.036
STR	89.84 ± 1.36	90.80 ± 0.66	87.96 ± 1.30	90.27 ± 0.81	0.57	0.63	0.19
VAP	84.36 ± 6.50	80.44 ± 4.19	90.10 ± 5.48	91.99 ± 4.75	0.80	0.05	0.34
VCL	119.65 ± 8.79	118.80 ± 7.04	153.29 ± 10.28	147.22 ± 11.16	0.9	0.0004	0.89
VSL	83.18 ± 4.20	74.38 ± 4.25	79.64 ± 5.09	78.02 ± 5.22	0.49	0.73	0.28

Table 4: Scrotal circumference and seminal variables (Mean ± SEM) were evaluated immediately after semen collection in bulls classified as High (HRFI) or Low Residual (LRFI) feed intake.

	Day 0		**Day 56**				
	LRFI	**HRFI**	**LRFI**	**HRFI**	**Group**	**Day**	**Group x Day**
SC	29.19 ± 0.57	28.74 ± 0.43	33.60 ± 0.52	32.58 ± 0.40	0.12	< 0.01	0.79
Eosin Intact	69.07 ± 4.50	61.00 ± 4.11	54.15 ± 4.47	60.85 ± 3.58	0.90	0.04	0.01
Ini Mot	56.78 ± 3.94	44.28 ± 4.58	48.21 ± 4.73	52.14 ± 3.52	0.68	0.46	0.12
Ejac Conc	71.93 ± 9.93	70.94 ± 9.09	267.25 ± 53.94	152.57 ± 30.43	0.59	< 0.01	0.39
Major Def	29.71 ± 4.33	37.15 ± 3.17	16.30 ± 2.24	21.07 ± 2.69	0.04	< 0.01	0.72
Minor Def	9.57 ± 1.23	7.92 ± 0.99	12.38 ± 1.27	11.57 ± 1.24	0.92	< 0.01	0.81
Total Def	39.28 ± 3.53	45.07 ± 2.76	28.69 ± 2.23	32.64 ± 1.90	0.014	< 0.01	0.89

Additionally, SC was affected by the time (day 0: LRFI= 29.19 ± 0.57, day 56: LRFI= 33.6 ± 0.52; day 0: HRFI= 28.74 ± 0.43, day 56: HRFI= 32.78 ± 0.4; $P < 0.001$), but the main effect of group and the interaction (group x time) did not affect this trait.

Finally, according to the pubertal classification, 70 % of LRFI and 74 % of HRFI bulls were considered pubertal at the beginning of the experiment (P= 0.74). In contrast, 81 % of LRFI and 84 % of HRFI bulls were considered pubertal at the end of the experiment (P= 0.89). Regarding maturity, 67 % of LRFI and 71 % of HRFI bulls were considered mature at the beginning of the experiment (P= 0.63). In comparison, 74 % of LRFI and 74 % of HRFI bulls were considered mature at the end of the experiment (P= 0.70).

To this date (July 2024), the only analysis that needs to be included to complete this project is the analysis of plasma testosterone concentration. We plan to request year two funds for this grant to complete this analysis. Samples will be shipped to Dr. Ky Pohler's laboratory at Texas A&M University.

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Award Amount:	$46,016.00

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UF Award #	AWD15833
Primary Project #	P0325273
Primary Department:	60770000
Current Invoice Amount:	$23,409.59

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Materials and Supplies	$48.27	$5,539.18
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