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Summary and Implications

Data from this analysis suggest that concurrent selection for both average daily gain and residual feed intake (RFI) may identify beef heifers that have improved fertility and longevity without impacting growth and maternal EPDs. As the beef industry continues to focus on sustainability, and thus efficiency, identification of commercial breeding stock that fit this mold will be imperative.

Introduction

Recent emphasis on efficiency in the beef industry have resulted in a tremendous amount of research conducted on feed efficiency, particularly in the feedlot setting. There are numerous ways to measure feed efficiency including gain:feed (G:F), dry matter intake (DMI), residual gain (RG), and residual feed intake (RFI). Of these, RFI, or the difference between predicted and actual intake relative to the amount of weight and body condition gained, has become the most frequently used measure. It should be noted that a negative RFI within a contemporary group is desirable, indicating that the animal consumed less feed than predicted to achieve the gains noted in body weight and condition.

While less research has been conducted regarding RFI and breeding stock in the U.S., there are growing concerns that intensive selection for low RFI cattle may be detrimental to reproductive function and longevity in extensive environments. While most data would suggest that RFI does not impact fertility, some research has pointed to low RFI heifers being later maturing and dams to low RFI calves having longer calving intervals. Regardless, it is clear that RFI is a calculation that will continue to be utilized and directly used in selection criteria. However, a selection index that incorporates RFI and improves fertility, longevity, or both has not been well defined.

During an individually-fed feed efficiency test, a myriad of growth and efficiency indicators are either directly measured or calculated including average daily gain ADG, DMI, G:F, RFI, RG. Almost invariably, ADG and

RFI are the only traits in this list that are not correlated. Our hypothesis was heifers that are above average for ADG and below average (desirable) for RFI during yearling feed efficiency testing would have improved pregnancy rates and longevity when compared to all other contemporaries. Thus, the objective was to determine if concurrent selection for RFI and ADG may identify beef heifers that have improved fertility and longevity in the beef herd.

Materials and Methods

The experiment was conducted at the Werner Feed Efficiency Testing Center in Diagonal, IA. The retrospective analysis included 541 purebred, Black Angus heifers from 14 pre-weaning contemporary groups spanning 6 years. Both spring- and- fall born heifers were used in the analysis.

Heifers between 12 and 14 months of age were adapted to an individual feeding system (IDology Fit System, Weigh-Rite Scale Co., Somerset, IA) over 21 days with a subsequent 70-74 days testing period. Diets were roughage-based, moderate energy diets designed to target a pre-breeding weight between 60 and 65% of mature cowherd weight. It should be noted that ultrasound measurements were taken at the conclusion of the test period, and as such, backfat adjustments were utilized in the RFI calculation.

Heifers were synchronized for estrous, artificially inseminated and exposed to bulls for an approximate 60 day breeding season, annually. Annual pregnancy status and fetal age was determined via ultrasonography approximately 30 days after the conclusion of the breeding season.

It is pertinent to emphasize that heifers were not selected for based on any efficiency indicators, resulting in an unbiased dataset for this analysis. It should also be highlighted that the first contemporary group of heifers were born in 2008, and thus not all groups have 6 years of production data (i.e. this is a reducing data set).

For purposes of this study, Angus Herd Improvement Records (AHIR) for non-parent EPDs were used. Based on individual feeding data, heifers were classified as being desirable for both ADG and RFI (PASS) or other (FAIL).

Data were analyzed using the MIXED and GLIMMIX procedures of SAS for continuous and categorical variables, respectively. Heifer served as the experimental unit, with the fixed effect of classification, and contemporary group fitted in the model as a random effect.

Results and Discussion

Across the dataset, 24.4% of all heifers were classified as PASS, with contemporary group ranges of 14 to 40%. This is of particular interest as 25% is consistent with the

proportion of heifers that many producers elect to develop in any given year with anticipation of herd turnover rates between 10 and 20%.

Yearling pregnancy rate did not differ between PASS and FAIL ($P = 0.14$; Table 1). However, Pregnancy rate of females making it to two years of age tended to be greater in PASS than FAIL (85.7 vs. 75.0%; $P = 0.07$). Moreover, longevity of PASS females appeared to be greater than FAIL as a greater proportion of females from the PASS classification remained at 3 and 4 years of age when compared to FAIL ($P \leq 0.03$; Figure 1). It should be noted that the final yearling measurements were collected in 2015, and thus, many females have not had the opportunity to realize 6+ years of longevity. While not significant, likely as result of limited observations, the numerical advantage in longevity persists in the PASS females beyond 4 years of age.

Analysis of live performance revealed no differences in birth, weaning, and yearling wts. or associated ratios ($P \geq 0.15$; Table 2) between classification groups. Moreover, no differences were noted in ultrasound IMF and ribeye area

ratios at the completion of the feed efficiency period ($P \geq 0.30$).

Evaluation of non-parent EPDs suggests no differences between classifications for maternal EPDs including milk, calving ease maternal, and scrotal circumference ($P \geq 0.44$; Table 3). Marbling EPD tended to be greater in PASS females when compared to FAIL ($P = 0.10$), but ribeye EPD did not differ ($P = 0.86$). Moreover, indices of interest including dollar energy (\$EN), dollar weaned (\$W), dollar feedlot (\$F), and dollar beef (\$B) did not differ between classification group ($P \geq 0.39$).

In conclusion, these data suggest that concurrent selection for both ADG and RFI may allow producers to identify females with enhanced longevity resulting from improved fertility without impacting (positively or negatively) actual or genetic potential for growth or genetic potential for maternal traits and economic indices.

Future studies related to this data set will include production and feed efficiency analysis of progeny stemming from females in this dataset.

Table 1. Reproductive efficiency of Angus heifers differing in feed efficiency traits.

Item	Classification ¹		P-Value
	PASS	FAIL	
Yearling pregnancy rate, % (no./no.)	87.2 (116/133)	82.3 (317/385)	0.14
Pregnant 1st 21 d, ² % of those pregnant	65.5 (76/116)	67.9 (215/317)	0.68
Pregnant 1st 42 days, ² % of those pregnant	92.4 (107/116)	91.5 (290/317)	0.79
2-yr-old pregnancy rate, ³ %	85.7 (66/77)	75.0 (144/192)	0.07

¹ During a yearling feed efficiency test, females were determined retrospectively to be above average for ADG and below average for RFI within contemporary group (desirable for both traits; PASS) or undesirable for either or both ADG and RFI (FAIL).

² Of the heifers that became pregnant as a yearling, the proportion that became pregnant within the first 21 or 42 days of the breeding season, respectively.

³ Of the females that became primiparous, the proportion that became pregnant during the breeding season.

Table 2. Birth, weaning, and yearling measurements of Angus heifers differing in feed efficiency traits.

Item	Classification ¹		SEM ²	P-Value
	PASS	FAIL		
Birth				
BW, lb	73.9	73.5	1.0	0.76
BW ratio	100.6	100.3	1.1	0.78
Weaning				
BW, lb	504	508	12.1	0.53
BW, 205-d adj, lb	543	539	11.0	0.52
BW, ratio	101.7	100.2	0.9	0.15
Yearling				
BW, lb	893	902	17.6	0.54
BW ratio	100.6	100.5	0.8	0.91
Height, in	48.5	48.3	0.15	0.36
Ultrasound IMF Ratio	101.5	99.5	1.6	0.30
Ultrasound Ribeye Ratio	100.7	99.7	1.1	0.41

¹ During a yearling feed efficiency test, females were determined retrospectively to be above average for ADG and below average for RFI within contemporary group (desirable for both traits; PASS) or undesirable for either or both ADG and RFI (FAIL).

² n = 133 for PASS; n = 385 for FAIL.

Table 3. Non-parent EPDs of Angus heifers differing in feed efficiency traits.

EPD/Index	Classification ¹		SEM ²	P-Value
	PASS	FAIL		
Milk	24.3	24.3	0.5	0.86
Calving ease maternal	8.84	9.11	0.4	0.44
Scrotal circumference	0.79	0.80	0.06	0.72
Marbling	0.41	0.37	0.02	0.10
Ribeye	0.13	0.14	0.02	0.86
\$EN	-5.94	-5.41	1.6	0.61
\$Weaned	25.3	26.7	1.7	0.63
\$Feedlot	27.1	26.6	2.5	0.70
\$Beef	66.4	68.9	4.3	0.39

¹ During a yearling feed efficiency test, females were determined retrospectively to be above average for ADG and below average for RFI within contemporary group (desirable for both traits; PASS) or undesirable for either or both ADG and RFI (FAIL).

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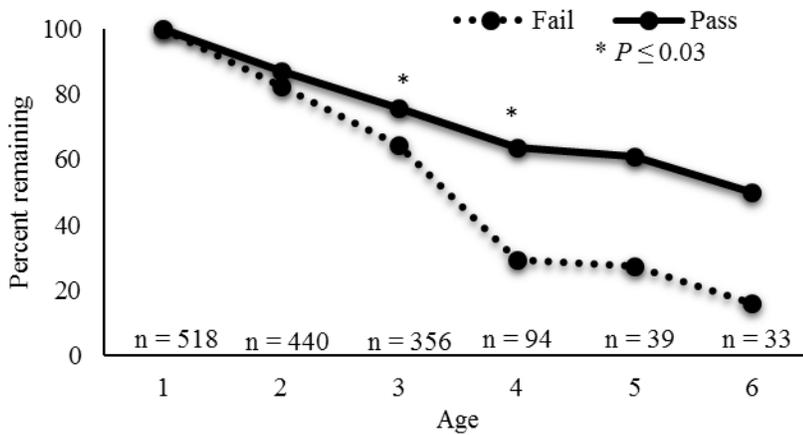


Figure 1. Proportion of Angus females differing in yearling feed efficiency traits remaining in the herd at a given age. Number of potential observations recorded for each year is listed. During a yearling feed efficiency test, females were determined retrospectively to be above average for ADG and below average for RFI within contemporary group (desirable for both traits; PASS) or undesirable for either or both ADG and RFI (FAIL).