Relationship Between Feed Efficiency Measures During the Heifer Development Stage and Measures Taken During First Lactation in Purebred Angus – Final Report

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Summary and Implications

Angus first-calf heifers were evaluated for feed intake utilizing the Feed Intake Monitoring System developed at ISU. Average dry matter intake for the feeding period was 3877 pounds with difference in dry matter intakes from the lowest to the highest intake female averaging 2143 lbs over the three years of the study. During the study an average difference between the lowest and highest consuming first-calf heifer was 22.3 lbs daily to 38.4 lbs. Mixed model procedures identified significant components of a residual feed intake (RFI) model to be : initial metabolic body weight, female average daily gain, pounds of milk produced daily, days since lactation initiation, and the interaction between milk production and lactation initiation. The correlation between yearling and first-lactation RFI ranged from .44 to .77 for the three years with only one year being significant at less than the .05 level. However, when the Student T-test was conducted the conclusion was that a significantly positive correlation existed between yearling and first lactation RFI.

Introduction

Feed costs represent about 60 percent of total costs to maintain a beef cow herd in the U.S. As land continues to escalate in value, a resulting increase occurs in grazing costs, stored feeds and supplementation procedures. Past studies in the feedlot industry show that improvements in feed efficiency reduce costs of production nearly five times more than improvements in growth rate. Current research in the genetics of feed efficiency centers predominantly around growth from weaning to harvest time and fewer projects address the implication of improvements with breeding females. Additionally, no U.S. projects currently involve cattle with a historical background of selection for feed efficiency. This project is meant to address the furthering of knowledge on feed utilization in Angus females following their first calving and subsequent weaning of the calf. The purpose of the current study is to determine if heifers evaluated for feed efficiency during their growth phase from weaning to yearling have similar rankings in feed utilization for continued developmental growth and milk production during the nursing stage with their first calves.

Material and Methods

Cows used in 2008 through 2010 of this three year project were evaluated at Wardens Farm, Council Bluffs, Iowa as yearling heifers for feed intake, gain and resulting feed conversion and residual feed intake during the weaning to yearling development period. This was done using a commercially pelletted ration fed through PinPointer 4000 feed intake systems. The pellet used contained net energy for maintenance and gain of .74 and .46 mcals per pound of dry matter, respectively, with a protein content of 14 percent. Long stem, predominantly brome grass, hay was offered at 3-4 pounds daily. This was not accounted for in the feed efficiency calculations. At yearling time all heifers were evaluated for carcass traits using certified ultrasound procedures. Heifers were artificially and naturally serviced to one bull, thus reducing calf genetic variation. Average weaning and yearling performance in addition to feed intake and efficiency data is shown in Table 1.

All heifers were calved by Wardens Farm and then transported post-calving to the Iowa State University Beef Nutrition Farm, Ames, Iowa. These first-calf heifers and their calves received Radio Frequency ear IDs which work in concert with the Feed Intake Monitoring System (FIMS) as described in AS Leaflet R R2279, 2008 ISU Animal Industry Report. In addition to the feeding facility barn, the first-calf heifer pairs were managed in two drylot areas adjacent to and with complete access to the FIMS barn. The drylot grass areas measured 181’ x 100’ and 181’ x 80’ for a total of 32,580 square feet. These were closely mowed utilizing a rotary mower to eliminate grass growth so an insignificant amount of grass was available for consumption, yet it provided a cleaner and drier area for sound nursing and calf rearing. All feed fed to the heifers was offered through the FIMS with it serving as a general loafing barn with all gates kept open. Heifer pairs were allowed access to any and all FIMS bunks within six of the seven pens. The seventh pen was used as a loafing area closed off for access only by the calves.

A forage-based ration was fed ad libitum which met NRC requirements for maintenance, heifer growth and milk production levels associated with Angus genetics of this type (see Table 2). All feedstuffs were analyzed utilizing a commercial feed testing laboratory. Cow milk production was measured via a weigh-suckle-weigh technique at each weigh day where calves were removed from their dams for 12 hours starting the evening before. Both cows and calves were then weighed the next morning. The calves were allowed to nurse and then weighed again with the calf weight difference providing the estimated 12 hour milk production per cow.

At approximately 60 days post-calving heifers were bred artificially using the Co-Synch+CIDR synchronization system in 2008 and the 5-day CO-Synch+CIDR system in 2009 and 2010 and then exposed to a natural service sire for two estrus cycles or 45 days. Calves were provided with limited dry hay and a creep feed consisting of a soyhull pellet-dry distillers grain mix in the first 2 years of the trial and just dried distillers grain with hay in the third year. Creep intake increased from 1.5 to 8 pounds per calf as calves approached weaning. Weaning took place at an average age of 185 days.

Table1. Performance of heifers up to yearling time, 2007-09.

Traits	Average	Maximum	Minimum
Feed intake test			
Total dry feed intake	1957	2431	1573
Average daily dry matter intake	23.3	28.9	18.7
Test ADG	2.10	3.48	0.06
Unadjusted feed conversion	9.60	21.92	6.31
Adjusted feed conversion	9.60	20.90	6.21
Residual feed intake	-0.03	1.75	-2.39
Growth			
Birth weight, lbs	75	90	60
Adjusted 205 weight, lbs	607	713	481
Adjusted 365 weight, lbs	963	1108	799
EPDs			
Birth weight, lbs	0.5	2.5	-2.3
Weaning weight, lbs	44.0	58	33
Maternal Milk, lbs	22.9	29	15
Yearling weight, lbs	78.1	99	57
Ultrasound Carcass Traits			
Adjusted Rib eye area, sq.in.	11.45	13.6	9.2
13th Rib fat cover, in.	0.54	0.88	0.21
Adjusted % Intramuscular Fat	6.96	9.53	3.81

Table 2. Composition of rations fed during feed intake measurement.

Feed ingredient	**Period 1**	**Period 2**
Year 1 - 2008	**% on Dry Matter Basis May 28-June 22**	**% on Dry Matter Basis June 23-October 17**
Fescue hay	57.4	38.6
Soybean hulls	15.1	43.6
Wet distillers grains	17.4	9.8
Molasses	9.6	7.4
Customized cow mineral	0.5	0.5
Years 2&3 – 2009 / 2010	May 28-October 8	
Corn silage	57.1	
Fescue hay	33.0	
Modified Distillers Grain	8.6	
Urea	0.3	
Custom cow mineral	1.0	

Results and Discussion

A total of 41 first-calf heifers were transported to the ISU beef nutrition farm in late May of 2008, 2009 and 2010, and were immediately started on feed in the FIMS system. Starting in late May heifers were monitored for daily feed intake for about 140 days. Early on in the first year trial (day 21) it was determined that ration sorting was occurring, so to alleviate that problem ration reformulation was done to allow a liquid molasses addition to take place (see Table 2). In year two and three corn silage was utilized in the ration and no sorting problems were noticed. Due to ration dryness in year one some cows became habitual in flipping feed from the bunk system and adjustments to their intakes were necessary. Considerable rain fell during the month of June in year one making lot conditions challenging, yet persistent barn cleaning and bedding kept conditions acceptable. However, late in June coccidiosis went through the calves eventually causing the death of one nursing calf and weakening another such that it succumbed to respiratory disease in late August. These problems were prevented in the second and third years by including dequinate in the creep feed and aggressively treating calves intramuscularly with an antibiotic at the first indication of respiratory infection.

In year one first-calf heifers gained more than desired in body weight and increased by 1.1 in body condition score during the feeding period for an average of 7.7 (see table 3). However, in year two and three with the significant ration change the heifers had limited weight or condition score change. Milk production as determined by the calf weigh-suckle-weigh procedure averaged 8.6 lbs for a 12 hour period. Over the three years the nursing calves gained on average 2.47 lbs daily.

Table 3. Performance of 1st calf heifers during lactation, 2008-10.

Traits	Average	Maximum	Minimum
Start weight, lbs	1227	1385	1020
End weight, lbs	1305	1680	993
Weight change lbs	75	320	-95
Start body condition score	6.6	9	5
End body condition score	6.7	9	5
12 hour milk production, lbs	8.6	14.0	2.0
Beginning calf weight, lbs	200.4	288	75
Ending calf weight, lbs	526.8	696	296
Feed intake test			
Total dry matter intake, lbs	3877	6610	2200
Daily dry matter intake, lbs	29.4	46.6	17.5

Daily feed intakes for individual cows varied a great deal on a day to day basis, but also for the entire feeding period (see table 3). The average daily dry matter intake (DMI) was 29.4 pounds with a total intake of 3877 pounds for the feeding period. Of interest, of course, is the variation across the herd in total intake and how efficiently these cows convert feed into milk and calf gain. In the initial year there was over a 3100 pound difference in dry matter intakes from the lowest to the highest intake female while in year two and three there were a 1425 lb and 1900 lb difference, respectively, in dry matter intake.

Evaluation of an animal in a growing phase and then in a lactating phase with the potential of further growth introduces complexity into an analysis. Feed utilization for weight gain and feed utilization for milk output occur simultaneously and most likely have differing efficiencies of utilization which can complicate analytical methods and cloud interpretations. Individual cows may have gained, maintained or lost weight while on trial. Additionally, cows entered the trial at different days into their lactation since not all calves are born on the same day and milk production varies between cows as well. Therefore, to evaluate feed use a Residual Feed Intake (RFI) calculation was done using the yearling data and with the lactating cow data the same points of the yearling RFI were maintained along with the items involved in the lactation.

When evaluating the growing, yearling heifers the SAS mixed model identified, besides the birth or subsequent test year, the average daily gain (ADG) and the initial metabolic weight (IMW) of the animal were the items to regress over the feed dry matter intake (DMI) to allow for calculating differences or residuals from the mean projected intake. When the lactation element was added as a first-calf female, the quantity of milk produced per day (MILK), the days since lactation was initiated (DIM) and the interaction of the MILK and DIM were implemented in the regression over DMI and Table 4 summarizes their influence. This overall RFI model composed of the above mentioned variables accounted for 82 percent of the variation in DMI.

Of interest is that the significant elements of the regression analysis are exactly what is accounted for and addressed by current cattle nutritional science. Body weight (IMW), weight gain (ADG) and milk production are addressed in cattle ration energy formulation by the use of NEm (net energy for maintenance), NEg (net energy for gain) and NEl (net energy for lactation), respectively. NEm, NEg, and NEl values exist for a given feedstuff because of the different energetic efficiencies of feed utilization within the animal for maintenance, growth and milk. Our trial also indicates these same efficiency differences also exist between animals. Because year is highly significant in the model it further points out the importance of correcting for contemporary groups.

Table 4. Components of the RFI calculation.

	Prob. > ltl
Year	< 0.0001
Average Daily Gain (ADG)	< 0.0001
Initial Metabolic Weight (IMW)	< 0.0001
Pounds of Milk/day (MILK)	< 0.0001
Days since initiated lactation, (DIM)	< 0.0001
MILK x DIM	0.0006

Correlations were analyzed utilizing the mixed model procedure of SAS. Note that all correlations (table 5) were positive, and while 2006 was approaching significance only 2008 born heifers were significantly positive from a zero correlation and looking overall one would probably not consider the correlation strong. However as noted all were positively correlated so the final test may be better viewed as whether this correlation was different than zero or equal to one. A Students T-test was then conducted to test if a difference existed from zero and it did. The test indicated a probability of a greater T of less than 0.029 allowing us to conclude that there is a positive correlation existing between yearling and two year old data. When testing if this correlation is perfect comparing our results to “1” we also arrive at a similar probability of a greater T of less than 0.026 so we can conclude this correlation does not equal one or in other words is not perfect which is understandable since as yearlings we did not evaluate feed to milk conversions, a conversion that does not need to be determined by the same components directing feed to weight conversion.

Table 5. Correlation of yearling and first lactation by birth year.

	2006	2007	2008	Overall
n	12	14	12	38
Correlation of RFI between yearling and 1st lactation	0.51	0.44	0.77	0.24
Prob. >lrl under H0: Rho=0	0.09	0.12	0.003	0.15

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