Effect of Cow Size on Offspring Feed Intake and Efficiency

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Introduction
In 2008, calf prices struggled topping the price scale at around $95/cwt for 7- weight and $110/cwt for 5 weight calves. At that time, production cost weighed on the pockets of most producers and thinking 'outside the box' brought new meaning. This 'outside the box' thinking made producers look at ways of reducing yearly production cost by adjusting winter feeding strategies with alternative feeds or by-products, utilizing alternative feeding systems and extending the grazing season. The topic of "cow size" received some attention during that time and recent data throughout the U.S. had reported large variations in cow size within a herd with little differences in offspring performance (McMurry, 2009). There are a number of factors that control cow efficiency unlike feeding feeder calves in a feedlot, such as feed/forage composition, feed delivery or grazing method, feeding or grazing environment, breed, age, genetics, stage of reproduction, and weather. Controlling these factors is almost impossible; however, some of these factors are controllable in the cow herd and in fact are part of the reason why cow size has drawn some attention.

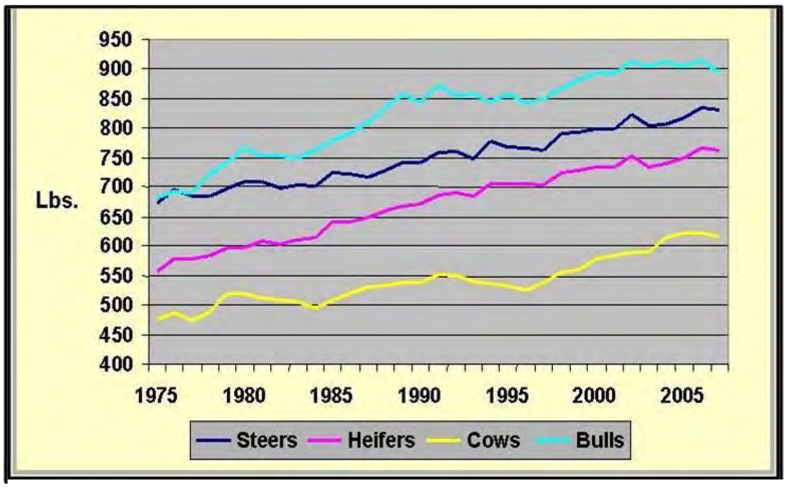
Looking at today's market, production costs are not as high on the radar list as it was 5 to 10 years ago. When we are selling feeder calves at over $160/cwt and live cattle trading over $140/cwt, it is easy to forget about the things we use to worry about such as whether I can get by without fertilizing some of my pastures or not supplementing this coming winter, hoping the cows won't get too thin. Instead, producers now are concerned about how they can increase their herd numbers to sell more calves, and are they willing to pay $2,000 for a bred commercial cow when they use to purchase one for $1,000. Things have changed in recent years and will likely be this way for several more. But historical data shows that at some point in the future, the economy will correct itself and we again will be worried about production costs. And those producers that begin improving efficiency in the herd will not be impacted as severely.

I like to use the phrase "manage as if we were in a drought every year" and the good years will be great years. Back to cow size, there is nothing complicated about the term cow size, but it has allowed us to think about cow efficiency in the herd. Beef cow size, as we refer to it, is evaluating the mature body weight of a cow (five years of age or older) at a body condition score of 5. In this paper, we will look at the impacts of cow size on forage or feed intake and utilization, and the potential impacts on offspring feed intake and efficiency, particularly in female replacement offspring.

Cow Size – A Snapshot
Over the last 30 years, U. S. cattle producers have seen a tremendous change in weaning and carcass weights. If you look at the data from the National Agriculture Statistics Service "Federally Inspected Slaughter Report", carcass weights of bulls, cows, steers, and heifers have increased some 223, 146, 144, and 194 lbs respectively from 1975 to 2005 (Figure 1). Over this span of 30 years, the cow/calf segment of our beef industry has improved weaning weights significantly. This change in production has been accomplished by a response to market demands and incorporating a number of improvements in technology. During this time, pressure from the feedlots forced producers to select more for growth and performance from calves going in and out of the feedlot. The increase in slaughter weights of bulls and

cows may not be a surprise as the increase seen in calf carcass weights reflects on the herd mates (heifers) kept as replacements that would eventually become mature cows in the breeding herd. Because there is a strong positive genetic correlation between weaning weight and mature size and carcass weights and mature size (0.80 and 0.76; Bullock et al., 1993), the mature size of our cows have increased as a direct response to the animal breeding technology used.

Figure 1: Carcass Weight of Bulls, Cows, Steers, & Heifers



National Agricultural Statistics Service – Federally Inspected Slaughter Report – 1975 to 2005 (*Adopted from McMurrry, 2009)*.

The nutrient requirements of beef cattle handbook (NRC, 1996) states that dry matter intake (DMI) increases 3 pounds for every 200 pound increase in mature cow body weight (BW), assuming milk and stage of production are constant (Figure 2). This equates to 1,095 lbs of additional intake per year for a cow that weighs 200 lbs more than her herd mate. Nutrient Requirements of beef cattle for maintenance, are based on cow size (Klosterman et al., 1968; Lemenager et al., 1980), milk production, and stage of production (ARC, 1980), with milk production accounting for 23% of the variation in maintenance requirements (Montano-Bermudez et al., 1990). Intake required for cow maintenance accounts for over 50% of the total feed energy required for beef production (Ferrell and Jenkins, 1984). Other factors are important and will affect intake and maintenance requirements, including breed, body condition (Klosterman et al., 1968; Lemenager et al., 1980), and environment (Young and Dietz, 1971).

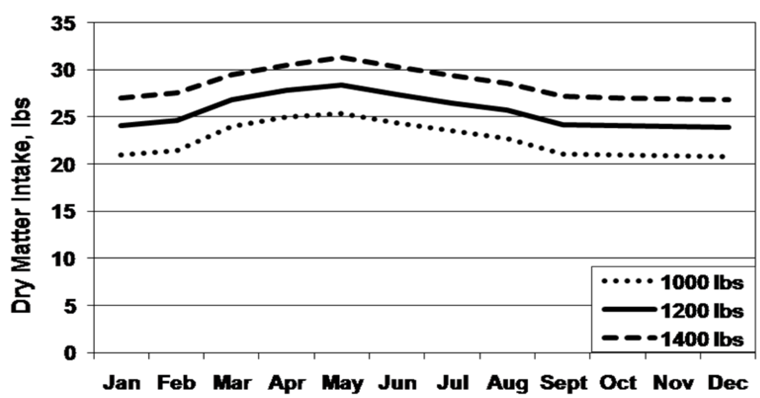


Figure 2: Monthly dry matter intake requirements for a 1,000, 1,200, and 1,400 pound beef cow based on similar milk and stage of production

It has been estimated that nationwide, the average size of mature cows is approximately 1,350 pounds. Obviously, mature cow weights in the northern states are larger because of differences in environment and climate. It is not only the average weight of the herd that is concerning, it is the deviations around the average. Researchers at the Dickenson Research & Extension Center in North Dakota reported their cow weights ranged from 856 to 1,935 lbs (Ringwall, unpublished data). These numbers could be indicative of many herds across the United States. This change in productivity has had an impact on metabolic processes in beef cows.

Clearly, greater product output per cow requires greater nutrient needs and is evident by the greater maintenance requirements of dairy and dairy cross breeds compared with beef breeds (Thompson, 1983; Solis et al., 1988). It was suggested that protein synthesis and turnover may be responsible for higher maintenance requirements of cattle that mature at heavier weights (Garrett, 1980). From the literature, we know that maintenance requirements are reported to be lower for Brahman cattle (Solis et al., 1988), while higher for Braunvieh (Ferrell and Jenkins, 1988) and Simmental cattle (Jenkins and Ferrell, 1983). However, to produce greater amounts of milk or meat, organ size and metabolic capacity must increase, subsequently impacting overall energy requirements for maintenance (Thompson et al., 1983; Jenkins and Ferrell, 1993). Estimates of feed required for maintenance of body weight dates back 20 to 30 years (Taylor et al., 1981; Jenkins and Ferrell, 1983; Solis et al., 1988) and genetic changes made over the last 30 years have significantly increased mature cow body weights. This change in cow size in turn may have affected intake and feed efficiency.

Measures of Feed Efficiency

Over the past years, several measures of feed efficiency have been used (Archer et al., 1999) to identify superior animals, feeding strategies, and genetics. Most studies to date have put emphasis on evaluating feed efficiency in young growing cattle, particularly in the feedlot sector. However, emphasis in replacement heifers, developing bulls, and mature cows is growing. For years, a measure of efficiency in an animal was determined using gross feed efficiency or a feed conversion ratio. <u>Gross feed efficiency</u> is the ratio of live-weight gain to DMI where the higher the value the more desirable. <u>Feed conversion ratio</u> (FCR) is the ratio of DMI to gain where the lower the value the more desirable. Feed conversion ratio is the most widely used method of determining feed efficiency and is typically measured as a group compared to an individual animal. Reason being, intake must be determined and most facilities/feedlots are not equipped to measure individual DMI on a daily basis. One of the downfalls of feed conversion ratio is that it does not account for maintenance requirements of an animal (Archer et al., 1999) and is negatively correlated with post weaning ADG, yearling BW, and mature cow size (Herd and Bishop, 2000).

Recently, feed efficiency research has shifted from using FCR to residual feed intake (RFI) as a means to measure feed efficiency. <u>Residual feed intake</u> evaluates the difference between actual feed intake and expected feed intake based on an animal's BW, BW gain, and composition proposed by Koch et al. (1963), and evaluates opportunities to identify animals that yield similar performance with less feed/forage. With RFI, the lower the value the more desirable. What has been determined with RFI is that it accounts for differences in maintenance requirements and is independent of BW, BW gain, and mature size (Crews, 2005). While RFI has been used primarily in evaluating feed efficiency in developing replacement males and females, little emphasis has been placed on the cow herd where maintenance requirements are important (Arthur and Herd, 2008). A study done by Texas A&M showed that developing Angus bulls and heifers selected for low RFI had a 17% decrease in feed intake compared to bulls and heifers selected for a high RFI (Ribeiro et al., 2007). It has been reported that post weaning RFI is genetically correlated to mature cow feed intake (Archer et al., 2002) and that 62% of the cows classified with a negative RFI post weaning remained negative as a mature cow (Morgan et al., 2010). As indicated, studies have reported that the genetic relationship between post weaning RFI and mature cow weight to be independent (Herd and Bishop, 2000; Archer et al., 2002; Arthur et al., 2005). So using the RFI value of a developing replacement animal is not a good indicator of predicting the mature BW of that animal. However selection for low RFI over two generations during the development phase has resulted in progeny consuming less feed without compromising performance (Richardson et al., 2001), and thus may be a way to predict intake during the mature stages of their production life.

Cow Size – Intake and Efficiency

A study was conducted in 2012 to evaluate DMI and feed efficiency during a 70 day feeding period in beef cows based on cow size. This study was conducted in a group of 38 Angus cross beef cows during their lactating (with heifer calves at side) and non-lactating period, following weaning. Based on initial BW at the beginning of the feeding period, cows were sorted into a light or heavy BW group for comparison. During the lactation feeding period, cows in the heavy BW group weighed on average 126 lbs more in BW and consumed 2.9 lbs more ryegrass baleage and hay compared to cows in the light BW group (Table 1; Walker et al., 2013). The differences observed between the light and heavy BW group cows were similar to what was observed during the non-lactating feeding period where cows in the heavy BW group weighed 143 lbs more and consumed 2.8 lbs more ryegrass hay compared to cows in the light BW group. Based on the difference in DMI observed in this study, if the difference in BW between the two groups of cows was 200 lbs, DMI would increase 4.05 lbs for every 200 pound increase in cow BW. If you look at feed to gain ratio for the two BW groups, cows in the heavy BW group had a lower feed to gain ratio during lactation. This could have explained why intake increased at a greater level for the heavy BW cows than what the NRC (1996) tells us, and milk production could have been higher for the cows in the light BW group. However, feed to gain ratio during the non-lactating period was higher for cows in the heavy BW group. This tells us that DMI requirement for cows of bigger body size during the non-lactating period may be greater than the NRC predicts.

Table 1. Effect of cow body weight on dry matter intake and residual feed intake during the lactating and non-lactating period.

	Lactating Period			Non-Lactating Period		
	Light	Heavy	*P*-Value	Light	Heavy	*P*-Value
Body Weight, lbs	1,221	1,347	--	1,232	1,375	--
Body Weight Gain, lbs	63.7	87.5	0.05	120.6	116.6	0.63
ADG, lbs	0.89	1.32	0.05	1.8	1.8	0.62
Dry Matter Intake, lbs	33.9	36.8	0.03	24.5	27.3	0.01
Feed to Gain Ratio	38.1 to 1	27.9 to 1	--	13.6 to 1	15.2 to 1	--
Residual Feed Intake	0.02	-0.02	0.89	-0.05	0.03	0.68

When we looked at RFI between cow BW groups, there was no difference in RFI value which indicates that just because heavier cows consume more DMI, actual DM consumed is not necessarily greater than the DMI required for maintenance in these heavier BW cows compared with lighter BW cows. As Crews (2005) indicated, RFI accounts for differences in maintenance requirements and is reported to be independent of BW, BW gain, and mature size. Using RFI to evaluate efficiency, thus it would be incorrect to assume that all heavier BW cows are less efficient than all lighter BW cows, based on BW and intake.

Impacts of Cow Size on Offspring Intake and Efficiency

Development of replacement heifers continues to be an intensive management system because of the cost associated with development and time lapse of receiving a return on that female (weaning her first calf no earlier than 2 ½ years of age). There is no shortage of research when it comes to development strategies and the question has always surfaced whether it was cheaper to raise or purchase replacement heifers. Depending on the year, cattle, feed, and fertilizer prices, that decision would change. However, with the current prices that the U.S. beef industry is experiencing, purchasing replacement heifers will be costly.

And with feed prices showing some relief, how closely we manage those heifers may not be as critical. However, what we manage today will affect productivity and efficiency for the rest of that animal's production life.

In a study conducted in the spring of 2013, replacement heifers were subjected to 70 days of feeding in an individual intake system consuming dry bermudagrass hay supplemented with a liquid protein supplement. These heifers, if you recall, were nursing the cows that were evaluated for intake and feed efficiency during lactation in the spring of 2012 (Walker et al., 2013). These heifers were sorted into the same light and heavy BW group as their dams were sorted during the lactation feeding period the previous year. Body weight differences between the heifers that fell into the light and heavy BW group was 28.7 lbs at the beginning of the feeding trial, approximately 80 days prior to the start of the breeding season (Table 2; Martin et al., 2014). Those heifers in the heavy BW group consumed 1.3 lbs more per day in dry matter compared to heifers in the light BW group. In addition, those heifers out of the heavy BW group gained 0.25 lbs more per day than heifers in the light BW group. A positive phenotypic relationship existed between dam mature BW and offspring DMI indicating as cow size increased offspring DMI during the developing period increased. If we look at it on a feed to gain ratio between dam BW groups, it took 9.7 lbs of forage to produce 1 pound of gain for heifers in the light BW group whereas it took 9.4 lbs of forage to produce 1 pound of gain for heifers in the heavy BW group. In addition, there was a 0.05 difference in RFI value where those heifers in the heavy BW group averaged a -0.03 RFI compared to a 0.02 RFI for heifers in the light BW group.

Table 2. Effect of cow size body weight group on female offspring dry matter intake and residual feed intake.

	Dam Body Weight Group			Residual Feed Intake Group		
	Light	Heavy	*P*-Value	Neg	Pos	*P*-Value
Body Weight, lbs	604	633	--	617	619	--
Body Weight Gain, lbs	109	127	0.01	120	116	0.63
ADG, lbs	1.6	1.8	0.01	1.7	1.7	0.62
Dry Matter Intake, lbs	15.6	16.9	0.02	15.6	16.8	0.01
Feed to Gain Ratio	9.7 to 1.0	9.4 to 1.0	--	9.2 to 1.0	9.9 to 1.0	--
Residual Feed Intake	0.02	-0.03	0.73	-0.32	0.32	0.68

When these heifers were sorted just based on RFI value (and not dam BW), BW, BW gain, and ADG at the beginning of the feeding period were similar for heifers classified as a negative RFI (-0.32) compared with heifers classified as a positive RFI (0.32). However, those heifers with a positive RFI value consumed 1.2 lbs more forage per head per day resulting in a feed conversion ratio of 9.9 lbs of forage per pound of gain compared to heifers with a negative RFI value resulting in a feed conversion ratio of 9.2 lbs of forage per pound of gain. Heifers with a negative RFI value had a 7.1% decrease in DMI over heifers receiving a positive RFI value.

Summary

Increasing cow size has a point of diminishing returns, but to what extent is still questionable. It is not uncommon to find herds in the northern climates with cows weighing in excess of 1800 pounds and herds in the southern climates with cows weighing in excess of 1500 pounds. In addition, this physiological change has had a direct impact on heifers that are retained for replacements out of these larger cows. We are learning that selection for RFI will not predict mature BW. In addition, bigger cows are not necessarily less efficient. We also learned that there is a positive relationship not only with RFI value during development and DMI as a mature cow, but also dam mature BW and offspring DMI during development. With the high cost of production in today's economy, producers cannot afford to just feed cows. In today's economic environment arguably the most valuable piece of equipment on a cow/calf operation is a good set of scales. Before you decide whether I should keep or sell my bigger cows, measure what they weigh and what they produce. Based on that and based on what your goals are for your operation, you can make the right decisions for your operation.

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