IMPROVING FEED EFFICIENCY IN THE FEEDLOT: OPPORTUNITIES AND CHALLENGES

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Introduction

Feedlots focus heavily on feed efficiency or feed conversion and evaluate pens of cattle as a tool of how well management, nutrition, weather, and cattle purchasing decisions are performing. Feed efficiency would generally be gain divided by intakes (G:F), whereas conversions generally refer to intakes divided by gains. Conversion would be more typical for discussions with producers. Regardless of which is used, intakes should always be on a DM basis. Another concern is that feed efficiency is based on gain which requires measuring initial and final weights. Body weights are important currency to use when measuring efficiency; however, these weights can have errors that impact accuracy. Live cattle weights are dramatically impacted by gastrointestinal fill. Most yards will use receiving weight or pay weight for initial body weight and fill is likely less than once cattle arrive and consume hay and water. Lastly, use of live final body weights are less meaningful than carcass weights as final prices are based on hot carcass weights, even when selling live because packers are evaluating red meat yield and dressing percent when negotiating price. Therefore, when evaluating management or nutrition in feedlots, the impact on carcass weight is the ultimate outcome. We believe targeting gain and efficiency on a carcass basis is the direction for the beef industry. Unfortunately, carcass weights are still converted back to live weights to calculate gains and efficiency.

OPPORTUNITIES

Nutritional Methods

Corn processing

Corn grain has been a staple in feedlot diets due to abundance, low prices, and serving as the cheapest source of energy. Corn is the most common grain fed in the U.S.; however, other grains can be utilized in a similar manner such as grain sorghum, barley, or wheat. Corn contains about 2/3 or 70% starch which is readily digested once the kernel is broken. Whole kernels are quite resistant to digestion in the rumen and intestinal tract of cattle unless broken due to mastication. To avoid passage of whole kernels and thus aid in starch digestion, corn grain is commonly processed. The three most common corn processing methods are dry-rolling, ensiled high-moisture, or steam-flaking. How corn is processed (and which grain source is fed) can have dramatic impacts on feed efficiency. Based on individual studies and reviews, in diets with 80 to 85% corn grain inclusion, feeding HMC is only 1 to 2% better than DRC. However, feeding SFC improves feed efficiency by 12 to 15% (Cooper et al, 2002; Owens et al., 1997).

Byproducts

Numerous summaries are available on the impact of feeding distillers grains and corn gluten feed to beef cattle. We have a summary available at our http://beef.unl.edu website. Historically, producers have been able to purchase distillers grains at 70 to 80% of corn price (DM basis). This price was considerably greater in 2013 and 2014 at 100 to 130% of corn price. The relatively strong prices on distillers grains are likely a reflection of strong demand for dry distillers (DDGS) for export and for use in non-ruminants. Our data suggest that wet distillers grains plus solubles (WDGS) has 143% the value of corn to the feedlot producer at 20% inclusion, and approximately 130% at 40% inclusion (Bremer et al., 2011; Table 1). When distillers grains are dried partially to make modified distillers grains (MDGS), the feeding value decreases to 117 to 124% of corn (at 20 to 40% inclusions). When distillers are completely dried to make DDGS, the value to the feeder is 112% of corn. The concept that WDGS results in better feed efficiency than MDGS which is better than DDGS has also been documented in individual studies (Nuttelman et al., 2011, 2013)

Other byproducts such as wet corn gluten feed, distillers solubles or syrup, and Sweet Bran all have different impacts on feed efficiency of the cattle. Predicting impact of these byproducts should be based on performance data as most experiments compare the value to corn it is replacing.

Table 1. Meta-analysis of finishing steer performance when fed different dietary inclusions of corn wet distillers grains plus solubles (WDGS), modified distillers grains plus soluble (MDGS) or dried distillers grains plus soluble (DDGS) replacing dry rolled and high moisture corn. (Bremer et al., 2011)

DGS Inclusion [a]:	0DGS	10DGS	20DGS	30DGS	40DGS	Lin[b]	Quad[b]
WDGS							
DMI, lb/day	23.0	23.3	23.3	23.0	22.4	0.01	< 0.01
ADG, lb	3.53	3.77	3.90	3.93	3.87	< 0.01	< 0.01
F:G	6.47	6.16	5.96	5.83	5.78	< 0.01	< 0.01
Feeding value, % [d]		150	143	136	130		
MDGS							
DMI, lb/day	23.0	23.8	24.1	24.0	23.4	0.95	< 0.01
ADG, lb	3.53	3.77	3.90	3.92	3.83	< 0.01	< 0.01
F:G	6.47	6.29	6.17	6.10	6.07	< 0.01	0.05
Feeding value, % [d]		128	124	120	117		
DDGS							
DMI, lb/day	23.0	24.0	24.6	24.9	24.9	< 0.01	0.03
ADG, lb	3.53	3.66	3.78	3.91	4.03	< 0.01	0.50
F:G	6.47	6.39	6.32	6.25	6.18	< 0.01	0.45
Feeding value, % [d]		112	112	112	112		

[a] Dietary treatment levels (DM basis) of distillers grains plus solubles (DGS), 0DGS = 0% DGS, 10DGS = 10% DGS, 20DGS = 20% DGS, 30DGS = 30% DGS, 40DGS = 40% DGS.

[b] Estimation equation linear and quadratic term t-statistic for variable of interest response to DGS level.

[d] Percent of corn feeding value, calculated from predicted F:G relative to 0WDGS F:G, divided by DGS inclusion.

Distillers grains plus solubles are the most common byproduct used today and some discussion is warranted. Besides whether you are using dry or wet distillers, another major factor affecting how well distillers grains work for finishing cattle is related to how corn is processed. Unlike historical corn-based diets with 80 to 85% grain where feeding SFC works best, diets that contain distillers grains do not respond similarly (Table 2). Numerous studies have illustrated that feeding distillers grains appears to fit better with diets that contain DRC or HMC, and not as well with SFC (Corrigan et al, 2009; Vander Pol et al., 2008; Buttrey et al., 2012). Feeding SFC is better than DRC with diets containing distillers solubles (Titlow et al., 2013; Harris et al., 2014) and with Sweet Bran (Scott et al., 2003; Macken et al., 2006). The conclusion is that steam-flaking corn will normally improve feed efficiency (grain based diets, diets with distillers solubles, Sweet Bran, or corn gluten feed) but steam-flaking does not improve efficiency as much when diets contain distillers grains plus solubles. It is unclear why this occurs, but is quite repeatable.

Forage Concentration

Forages fed in feedlot diets are often referred to as roughages. Forages are also routinely used for grain adaptation or the gradual (18 to 28 days) switch of cattle diets from a primarily forage-based diet to primarily a concentrate-based diet. While grain adaptation is very important, especially for teaching cattle to eat differently, the focus of this section is on the amount of forage in the final, high-concentrate finishing diet. Roughages are bulky ingredients with large shrink losses that feedlots would prefer to avoid. In general, as forage concentration is decreased in feedlot diets, feed efficiency improves. Cattle can be fed no roughage in feedlot diets. However, risk of ruminal acidosis increases and results in lower DMI,

Table 2. Effect of corn processing in diets containing increasing amounts of wet distillers grains plus solubles (Corrigan et al., 2009)[1].

	0.0	15.0	27.5	40.0
Dry-rolled corn				
DMI, lb/d [3]	22.3	22.2	21.4	21.3
ADG, lb [2]	3.64	3.77	3.87	3.92
G:F [2]	0.163	0.170	0.181	0.185
High-moisture corn				
DMI, lb/d [3]	20.1	21.0	20.2	20.0
ADG, lb [3]	3.68	3.96	3.97	3.86
G:F [2]	0.183	0.189	0.197	0.194
Steam-flaked corn				
DMI, lb/d [3]	20.2	20.2	19.8	18.8
ADG, lb [3]	3.67	3.74	3.60	3.44
G:F	0.182	0.186	0.182	0.183

[1] For ADG: Effect of corn processing method, $P < 0.01$; effect of WDGS level, $P = 0.01$, and effect of corn processing method × WDGS level, $P < 0.01$. For G:F: Effect of corn processing method, $P < 0.01$; effect of WDGS level, $P < 0.01$, and effect of corn processing method × WDGS level, $P < 0.01$.
[2] Linear effect of WDGS level within corn processing method ($P < 0.05$).
[3] Quadratic effect of WDGS level within corn processing method ($P < 0.05$)

lower ADG, and equal or often times improved efficiency. Conventional inclusions of roughage would be approximately 4% neutral detergent fiber (NDF) from the roughage source. This equates to about 7 or 8% alfalfa hay, 5% crop residues like straw or stalks, and 10 to 12% corn silage. Exchanging these roughages on an equal NDF basis is the logical approach (Galyean and Defoor, 2003; Benton et al., 2007) to maintain DMI and ADG.

There are a few examples where increasing forage will negatively impact feed efficiency, yet improve profitability. Two examples are with alkaline treated crop residues and feeding elevated dietary inclusions of corn silage. Across a series of six feedlot studies (Table 3), feeding 20% alkaline treated cornstalks (treated with 5% calcium oxide) made the cattle 2.3% less efficient (greater F:G) yet is often profitable depending on corn and cornstalks prices. We have also evaluated feeding 15, 30, or 45% corn silage in diets with distillers grains (Table 4; Table 5). Feeding 45% silage instead of 15% decreased feed efficiency by 5 to 5.5% (Burken et al., 2013a; Burken et al., unpublished) yet increased profits (Burken et al., 2013b). Most times, increased feed efficiency means increased profits, but not always.

Table 3. Summary of F:G across experiments with 20% treated stalks (TRT) compared to a 5% stalks control (CON) or not treating (NONTRT). See literature cited for trial references.

	Treatments			CON vs TRT		CON vs NONTRT
	CON	TRT	NONTRT	DIFF	% DIFF	% DIFF
Johnson calf	6.36[a]	6.22[a]	7.05[b]	-0.14	-2.2%	10.8%
Johnson yrlgs	6.42[a]	6.85[b]	7.65[c]	0.43	6.7%	19.2%
Shreck 3”	6.54	6.55	7.72	0.01	0.2%	18.0%
Peterson 40%	5.79	5.88	-	0.09	1.6%	-
Cooper	5.53	5.83	-	0.30	5.4%	-
Average					2.34%	

Table 4. Impact of feeding 15, 30, 45, or 55% dietary corn silage in diets with 40% distillers grains on feedlot performance (Burken et al., 2013a)

	Treatment					P-value	
	15	30	45	55		Lin.	Quad.
DMI, lb/day	23.15	22.77	22.70	21.92		0.01	0.45
ADG, lb[3]	4.04	3.92	3.76	3.53		<0.01	0.19
Feed:Gain	0.175	0.172	0.166	0.161		<0.01	0.33

[1]15:40= 15% Corn Silage, 40% MDGS; 30:40= 30% Corn Silage, 40% MDGS; 45:40= 45% Corn Silage, 40% MDGS; 55:40= 55% Corn Silage, 40% MDGS; 30:65= 30% Corn Silage, 65% MDGS; 45:0= 45% Corn Silage, 0% MDGS.

[2]Lin. = *P*-value for the linear response to corn silage inclusion, Quad.= *P*-value for the quadratic response to corn silage inclusion, 30 = t-test comparison of treatments 30:40 and 30:65, 45 = t-test comparison of treatments 45:40 and 45:0.

[3]Calculated from hot carcass weight, adjusted to a common 63% dressing percentage.

Table 5. Effect of feeding 15 or 45% corn silage with 20 or 40% MDGS inclusion on cattle performance and carcass characteristics (Burken et al., unpublished).

	Treatment[1]					P-value[2]			
	Control	15:20	15:40	45:20	45:40	F-test	Int.	Silage	MDGS
DMI, lb/day	27.2	26.1	26.4	26.9	26.7	0.13	0.41	0.07	0.86
ADG, lb[3]	4.32	4.26	4.42	4.19	4.22	0.11	0.18	0.01	0.06
Feed:Gain[3]	0.159[bc]	0.163[ab]	0.167[a]	0.156[c]	0.158[c]	<0.01	0.61	<0.01	0.07
HCW, lb	879	874	885	866	869	0.18	0.41	0.01	0.12

[1]Control = 5% cornstalks, 40% MDGS; 15:20 = 15% Corn Silage, 20% MDGS; 15:40 = 15% Corn Silage, 40% MDGS; 45:20 = 45% Corn Silage, 20% MDGS; 45:40 = 45% Corn Silage, 40% MDGS

[2]F-test= *P*-value for the overall F-test of all diets. Int. = *P*-value for the interaction of corn silage X MDGS. Silage = *P*-value for the main effect of corn silage inclusion. MDGS = *P*-value for the main effect of MDGS inclusion.

[3]Calculated from hot carcass weight, adjusted to a common 63% dressing percentage.

[4]Marbling Score: 400 = Small00, 500 = Modest00.

[abc]Within a row, values lacking common superscripts differ ($P < 0.10$).

Use of technology (implants and beta agonists)

For conventional beef production, numerous technologies are commonly used in the feedlot sector. The two main categories are feed additives and implants. Within both categories, there are many options. Feed additives are FDA approved and must follow legal guidelines established when they were approved, meaning no off-label use is allowed. While many are approved for growth promotion and improved feed efficiency, those label claims will be removed in the future if there is crossover to medically important additives used in human medicine.

The first common additive is ionophores. The most common ionophore fed to finishing cattle is monensin (Rumensin, Elanco Animal Health). In a recent review, feeding monensin improved feed efficiency by 2.5 to 3.5% in recent studies (Duffield et al., 2010). The second most common feed additive is tylosin (Tylan, Elanco Animal Health). Tylosin is fed to decrease liver abscesses that result from feeding high-grain diets. Feeding tylosin increases carcass weight and thus gain likely due to trim losses. The most severe abscess category (A+) causes the biggest impact on performance. In a few large summaries of databases, cattle with A+ liver abscesses had 7 to 10 lb decreases when not adhered , 26 to 30 lb decreases if adhered to the carcass (Davis et al., 2007; Brown and Lawrence, 2010). The much greater decrease in carcass weight with adhered abscesses is due to greater trim at the packing plant presumably. While intake is unknown on these individual cattle with abscesses, clearly gain is decreased. For finishing heifers, feeding MGA (melengesterol acetate) is common to suppress estrus which improves gain and feed efficiency.

Beta agonists are the other major feed additive fed to cattle at the end of the feeding period to increase carcass weights, gain, and improve feed efficiency. Two beta agonists are approved for use in the U.S.: ractopamine (tradename Optaflexx from Elanco Animal Health) and zilpaterol (tradename Zilmax from Merck Animal Health). Optaflexx was approved in 2003 to be fed at a rate of 8.2 to24.6 g/ton of diet DM and between 70 to 430 mg/animal daily for the last 28 to 42 d of the feeding period with no withdrawal time (FDA, NADA 141-221, 2003). Based on data, most feedlots will feed 200 to 300 mg/animal and target 28 days. Zilmax was approved in 2006 to be fed at a concentration of 7.56 g/ton of diet DM to provide 60 to 90 mg/animal daily for the last 20 to

40 d before harvest, with a three day withdrawal time (FDA NADA 141-258, 2006). Zilmax is not commercially available today. When it was fed, 20 days were targeted followed by a 3 day withdrawal. Because these products have dramatic increases in carcass weight and weight gain and are fed at the end of the feeding period when cattle normally have poorer feed efficiency, they dramatically improve the efficiency of the beef industry and also profitability.

Feeding Optaflexx increases carcass weights by 13.4 to 20.3 lb depending when fed at 200 to 300 mg daily to steers (Pyatt et al., 2013) with a 10 to 15% improvement in feed efficiency during the final 28 days. Feeding Zilmax for the last 20 days increases live weights by 19 lb, but increases carcass weights by 33 lb primarily by shifting bodyweight from less internal fat to greater muscle mass (Elam et al., 2009). On a live basis, there is not a dramatic improvement in feed efficiency. However, if adjusted for carcass weight gain and increased yield of red meat, feeding Zilmax dramatically improves efficiency of the beef industry as well.

The last major technology used by feedlots to improve feed efficiency is the use of implants. Steroid implants are approved to be placed in the middle third of the ear, just below the skin and slowly release hormone over a set period of days (usually 90 to 120 days but some last more 200 days). Implants can be classified into two major categories, estrogenic or combination implants and can further be classified based on strength or overall amount of steroid hormone. Combination implants provide both estrogen and trenbolone acetate (TBA) which is an analog of testosterone. There is no withdrawal on implants as the location used in the animal is discarded at slaughter although it is economically wise to use the last implant 90 to 120 days prior to slaughter to fully capture the value. Guiroy et al. (2002) summarized the impact of different implant strengths and concluded that final live body weight is increased by 40 to 100 lb depending on strength. More recently, stronger combinations and longer payout periods have likely lead to even greater increases in weights within approximately the same number of days. In general, implanting increases ADG for the entire feeding period by 10 to 15% and improves feed efficiency by 8 to 12%. Preston et al. (1990) concluded that implanted cattle require a few more days (7-10 depending on gender) to reach similar body composition or fatness. Implanting does not depress quality grades of cattle if compared at equal fatness, but does with equal days fed in the feedlot. No other technology used today in feedlot cattle has as great of a return as use of implants.

CHALLENGES

Measuring feed efficiency in pen settings

While we think about feed efficiency of individual cattle, we don't measure individual feed efficiency in feedlots. Cattle are fed in pens. While gains are estimated (note estimated due to weighing conditions) for individuals, there is no sound, scientific method for accurately predicting individual feed intakes. Obtaining individual dry matter intake is critical but is generally limited to research settings or small-scale evaluations using Calan gates, GrowSafe, or other systems. Based on these data, we know dry matter intakes vary by 20% or more within groups of "like" cattle, gains vary by more than 30%, which leads to tremendous variation in feed efficiency (+/- 20%). If feed efficiency varies by 20% from the mean, then you cannot calculate intake based on a gain measurement of individuals very effectively. While variation is good for selection purposes, variation makes comparing individuals within pens extremely difficult to predict, even with sophisticated calculations.

Age

Cattle age when entering the feedlot has dramatic impacts on performance while in the feedlot phase. Numerous comparisons between feeding yearlings versus calf-feds are available. One important component of these comparisons is whether the cattle are genetically similar or not. Normal procedures in commercial production would be large framed, heavier weaned calves would be targeted to be fed as calf-feds whereas smaller framed, lighter weaned calves are traditionally "grown" into yearlings by backgrounding and/or grazing prior to entering the finishing phase. Griffin et al. (2007) compared performance and economics of feeding calf-feds or yearlings that were not similar in genetics at weaning. Calf-feds had fall receiving weights of 642 lb in mid November whereas the group "grown" into yearlings weighed 526 lb at that time. After backgrounding through the winter by grazing cornstalks and some drylotting, grazing pasture in the summer, the yearlings were 957 at feedlot entry the following fall. This

Table 6. Cattle background impact on feedlot performance for calf-feds, summer yearlings, and fall yearlings originating from the same pool of cattle as weaned calves (Adams et al., 2010)[1].

	Calf-fed	Summer Yrlg	Fall Yrlg
Initial BW	576	789	928
DMI, lb/d	20.1[a]	25.1[b]	29.0[c]
ADG, lb	3.59[a]	4.10[b]	4.28[b]
G:F	0.179[a]	0.164[b]	0.147[c]
Hot carcass weight, lb	774	856	919

was a 7 year comparison. Yearlings ate more feed per day, had greater daily gains, but were less efficient (F:G = 6.76) than calf-feds (F:G=5.63). Yearlings finished heavier with 50 heavier carcasses at about the same fat thickness. Using similar cattle (i.e., starting with the same "pool" of cattle each fall, Adams et al. (2010) fed those cattle as either calf-fed, summer (short) yearlings, or fall (i.e., long) yearlings and compared performance (Table 6). In their study, they imposed two treatments that included either sorting or not which had little impact on performance during finishing. Evaluating just finishing performance, yearlings eat more per day, gain more per day, but are less efficient than calf-feds (Table 4). Summer fed yearlings are intermediate. Meaning reasons exist for either feeding cattle as calf-feds or growing them into yearlings including forage resources available, optimizing finish weight (i.e., carcass weight), and economics. Even though yearlings are less efficient while in the feedlot, grazing or utilizing forage is unique to ruminant production is makes these systems very economical despite poorer feed efficiency while in just the feedlot phase. Feeding yearlings also increases saleable weight per weaned calf as they "grow" frame during the backgrounding phase.

Table 6. Cattle background impact on feedlot performance for calf-feds, summer yearlings, and fall yearlings originating from the same pool of cattle as weaned calves (Adams et al., 2010)[1].

Bovine Respiratory Disease

Bovine respiratory disease (BRD) is detrimental to the cattle industry and is perceived to have large economic impacts from treatment costs and lost performance. However, many studies that evaluate the impact of BRD on feedlot cattle performance are incorrect and lead to erroneous estimates of economic impact. Numerous studies illustrate that BRD negatively impacts gains and these are based on how individuals within pens that were diagnosed with BRD (and presumably have BRD) gained compared to those not treated. Gardner et al. (1999) observed a 12% decrease in gain and 44 lb lighter carcasses for cattle treated more than once compared to not treated at all for BRD. Treating once didn't have much impact. Ranch-to-rail data from New Mexico found a 14% decrease in daily gain and 15 lb lighter carcasses for cattle treated more than once (Waggoner et al., 2007). The study with the greatest number of cattle (about 21,000 head total) was by Reinhardt et al. (2009) using cattle in Iowa feedlots. They observed a 20% decrease in daily gain for steers and a 27% decrease for heifers treated more than once versus not at all. Treating once was intermediate in their study. Cattle treated more than once were also 15 lb lighter at slaughter. All of these data are on pen-fed cattle where intakes, and thus feed efficiency, are unknown. When economics are applied, most have assumed average pen intakes which means a 20% decrease in gain translates to cattle being 20% less efficient.

Some data are available on the impact on feed efficiency with intakes measured. An excellent study was done at Oklahoma State where cattle were received and then after receiving, cattle were penned (grouped) based on whether they got treated 0, 1, 2, 3, or 3+ times during the first 60 days. If they were sick during receiving, gain decreased dramatically during the first 60 days. Interestingly, gains were very similar from day 60 to finish after being penned or grouped based on how many times they had gotten sick. Cattle consumed less feed after the receiving period if they had gotten sick so cattle were actually more efficient during finishing if they had gotten sick, and improved linearly as number of times treated increased. Clearly, the majority of BRD occurs within a few weeks of receiving (Babcock et al., 2009).

We evaluated data from our individual feeding facility at UNL (Calan gates), as well as individual feeding data from the University of Illinois using GrowSafe. In those two datasets, if cattle contracted BRD within the first 30 days (out of 120 or more total days), there was no impact on intakes, gains, or efficiency. If treated after the first 30 days on feed for BRD, cattle tended to eat less, gain less, but efficiency was the same as healthy cohorts. This suggests to us that cattle gain less and eat less when they are sick. After a receiving period (especially if only treated once or twice), gains come back some, but cattle still eat less which is interesting. Getting sick early in the feeding period or at receiving probably has little impact overall if treated and they recover (treated only once). These changes in intake and efficiency (or lack thereof) should be taken into account when applying economics to cattle that are affected by BRD. In all these studies, it is important to point out that data are based on visual observation, body temperature, and a diagnosis of BRD which may not always be 100% accurate.

Weighing conditions

Most people in the beef industry take for granted that when weights are collected, cattle weigh whatever the scale reads. While that is true, this weight may not be repeatable. The main factor affecting weights and particularly variation in weights is gut fill. How this impacts feed efficiency in feedlots is probably less of a concern, but can be a real concern when establishing a weight and price for sale of cattle (entering or leaving a feedlot) and also when calculating gains from initial and final weights. Length of time when gains are measured improves these estimates of gain. Watson et al. (2013) summarized the impact of different weighing conditions on gain estimates for growing cattle. Equalizing gut fill by limit feeding and multiple day weights improved accuracy in gain estimates for growing cattle especially when measured over short durations. The reason for being aware is that cattle that are severely shrunk when arriving at the feedlot due to transport distance and removal of feed and water for long periods of time will certainly "refill" when given access to feed and water. Using severely shrunk weights will inflate gains and make cattle appear more efficient. Likewise, using weights on cattle once fill is replenished at the yards will deflate gains some and cattle will appear less efficient. True biological efficiency of cattle is not impacted by shrink as very little carcass weight is ever lost in normal situations of shrink due to transport and handling cattle at marketing.

Carcass weight gain for efficiency

As discussed earlier, feeding Zilmax dramatically increases carcass weight (33 lb) yet only increases live weight by 19 lb compared to controls within studies. As a result, dressing percentage (carcass weight divided by live weight) is dramatically increased (usually by about 1.5 percentage units). Genetics can dramatically influence the relative amount of carcass gain compared to live weight gain. One example of this are some recent data collected at UNL using Piedmontese and active, inactive, or heterogenous myostatin allele cattle. Table 7 shows two years of data feeding calf-fed steer calves with these three genotype variations and the impact on finishing performance (Moore et al., 2013). Live gains were decreased with the inactive myostatin genetic background but when carcass-adjusted, gains were not decreases and cattle were dramatically more efficient (in both scenarios). Cattle were much leaner but dressing percentage increased 4.25 percentage units. Similar results were observed with yearling heifers finished.

The beef industry should begin evaluating efficiency on a carcass weight basis, including calculation of carcass gain (new measure of average daily gain) and feed efficiency from that gain calculation. More evidence for this is recent work illustrating the economic benefits of feeding cattle longer and larger when marketing on a carcass weight basis or grid basis because gain of carcass does not decrease at the end of the feeding period like live weight gain does (MacDonald et al., 2014). The biggest challenge is lack of accurate carcass weights at the beginning of the feeding period to use in calculating carcass gain. However, for feedlots selling cattle on a carcass weight basis, collection of live weights at the end of the feeding period when loaded for transport to the slaughter plant are meaningless as well. If not collected, an estimate has to be made for final live weight from carcass weight anyway to calculate closeouts.

Table 7. Live and carcass-adjusted BW performance, and carcass traits of calf-fed steers varying in allele copies of myostatin using Piedmontese.

	Myostatin[1]			*P* – Value[2]	
Performance traits	ACTIVE	HET	INACTIVE	Lin.	Quad.
DMI, lb/d	18.9	17.1	15.0	< 0.01	0.69
Final BW, lb[3]	1132	1099	1015	< 0.01	0.27
ADG, lb/d	2.56	2.35	2.26	< 0.01	0.43
F:G	7.30	7.25	6.67	< 0.01	0.07
Carcass-adjusted BW[4]					
ADG, lb/d	2.53	2.39	2.58	0.72	0.05
F:G	7.41	7.09	5.88	< 0.01	< 0.01
Carcass traits					
HCW, lb	712	699	684	0.18	0.93
Dress, %	63.0	63.7	67.3	< 0.01	< 0.01
Marbling[5]	597	453	283	< 0.01	0.57
LM area, in^2	12.4	14.6	15.5	< 0.01	0.05
12^{th} rib Fat, in	0.51	0.28	0.13	< 0.01	0.26

[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE)
[2]*P*-value: Lin. = linear response to inactive myostatin and Quad. = quadratic response to inactive myostatin
[3]Live BW collected on 2 consecutive d prior to shipment, shrunk 4 %
[4]Carcass-adjusted BW calculated at 63 % dressing
[5]Marbling score: 500 = SM, 400 = SL, 300 = TR, 200 = PD

Comparisons at equal body composition

Body composition influences overall feed efficiency due to the energetics of depositing fat or muscle. Some of the impact of age (calf-feds versus yearlings) is due to composition of growth. However, when cattle are not finished to the same endpoint in terms of carcass fatness, leaner animals are more efficient. Likewise, as cattle grow during finishing and deposit more fat, their efficiency (of live weight gain) decreases as well. The reason cattle efficiency is impacted by composition of gain is because it requires about the same amount of calories (energy) to deposit protein and fat in the carcass. However, muscle is about 75% water and 25% protein. As a result, muscle growth (not protein) is about 3 times greater in efficiency of growth which is logical so cattle deposit muscle first and retain energy as fat only when additional energy is consumed above that required to grow muscle. The point is that cattle sold “early” that are leaner may be more efficient than cattle fed later and at least some of the efficiency difference is due to composition of gain.

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