Proceedings, The State of Beef Conference
November 2 and 3, 2016, North Platte, Nebraska

NEW FEEDLOT RESEARCH AND WHAT IT MEANS TO THE COW-CALF AND STOCKER SEGMENTS

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Introduction

The economic vitality of the Nebraska feedlot industry is critical to the cow-calf and overall beef industry. In Nebraska, the feedlot industry has essentially set the market for feeder cattle in the U.S. Multiple reasons make Nebraska very competitive for finishing cattle, including:

1. abundant grain supply that is often integrated into the beef operation
2. ready access to grain byproducts such as distillers grains plus solubles and corn gluten feed
3. packing capacity
4. abundant supply of high-quality feeder cattle from Nebraska and north
5. dry climate (most of the time) especially relative to other corn producing states, and
6. generally, small to medium-sized feedyards (<15,000 head capacity) spread across the entire state.

In February, 2014, Nebraska surpassed Texas with more "cattle on feed," which is a monthly picture or census of cattle in feedyards. There is seasonal variation but Nebraska has continued to have similar cattle-on-feed numbers with Texas over the past couple of years. What will be of interest is where the cattle go to be fed once some of the retention is realized in greater feeder cattle supply. With all that said, the feeding industry has experienced numerous months of large losses if the cattle were not forward priced or some type of risk protection was used to minimize losses. This is not sustainable and is reflected in the large decrease in feeder cattle price this fall. Unfortunately, each segment of the beef industry is often profitable at the expense of another segment. Currently, the retail/packing segments are profitable at the expense of the producers and feedyards. If history repeats itself, this will change and profitability will return to the feeding sector, but likely at the expense of decreased input costs for feeder cattle. This will impact the cow-calf sector.

Our feedlot program at the University of Nebraska-Lincoln focuses on numerous areas of research. We have two primary research feedyards with 100 pens at the PHREC (Panhandle Research and Extension Center) near Scottsbluff and 148 research pens at the ENREC (Eastern Nebraska Research and Extension Center, formerly ARDC) near Mead. Some of the "systems" calves from the GSL cowherd are fed and followed at WCREC in North Platte. We are blessed to be able to attract many of the brightest students to UNL for graduate research programs and benefit from a long tradition of excellence in this area. Another attribute of our program has been

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a long history of positive collaborations and interactions. Thus, this paper reflects the contributions of our group. These research areas include (not in any specific order):

1. Utilization of grain milling byproducts, and optimizing their use by feedlot cattle
2. Impact of nutrition and management on environmental challenges such as nutrient management and greenhouse gas emissions
3. Methods to improve starch utilization while decreasing acidosis which include new hybrids, grain processing, grain adaptation programs, and general biology of ruminal acidosis
4. Improving the use of underutilized and economical feed substitutes as possible such as increasing use of corn residue, primarily through silage in feedlot cattle
5. Optimizing production systems of cow to finish operations and optimizing production systems from weaning to market
6. Nutrient requirements, particularly related to protein and mineral nutrition of finishing cattle
7. Nutritional impact on food safety concerns such as pathogenic bacteria
8. Growth promotants and technologies that improve growth
9. Emerging issues such as welfare response to environmental stresses and impact of housing, natural feed additive uses, and emerging or new byproducts that develop

This paper and presentation will focus on highlighting corn silage research for growing and finishing cattle, which may also influence some cow-calf operations. As always, the annual Nebraska Beef Report (available online at http://beef.unl.edu or hard copy) provides an update on research projects that are timely and focused on the feedlot industry and other segments.

Use of corn silage in growing/finishing situations

Corn prices have been variable the past few years and were more expensive and now less expensive with bountiful production. As a result of the expensive grain times, we have initiated a few different research programs to address silage. Early on, grain was expensive ($5/bu or more), distillers grains (wet or modified) were relatively inexpensive as a percentage of grain price (70 to 90% on a dry-to-dry basis), and corn residue (baled stalks) were relatively inexpensive ($50 to $70/ton). As a result, research focused on how to use more residue and distillers grains and less corn grain. Our research for finishing cattle has focused on increasing use of corn silage as a method to decrease corn usage. The questions were if you decrease corn inclusion, will performance be maintained or will feed conversion get worse? Even with some depression (increase) in F:G, will cost of gain be more competitive?

Corn silage inclusion for finishing

With increased price of corn grain, corn silage may be a more economical feed to replace a portion of the corn grain in beef finishing diets. Research 40 years ago focused on the impact of different corn silage to corn grain ratios. It was not uncommon in that time period to finish cattle on corn silage-based diets. A summary done by the University of Minnesota suggested silage could be fed at 40 to 60% inclusion and still be economical, although feed conversion was poorer (i.e., elevated).

With the increased usage of distillers grains, our questions were whether this research area needed to be revisited. Three feedlot experiments have focused on feeding elevated amounts of corn silage (varying) in diets with distillers grains (varying). In the first experiment, we fed 15, 30, 45 or 55% corn silage with diets that contained 40% distillers grains and two additional diets with 45% corn silage and no distillers and 30% corn silage with 65% MDGS (Burken et al., 2013a). As corn silage increased in the diet within diets containing 40% MDGS, ADG decreased linearly and F:G increases linearly (Table 1). Within diets containing 45% silage, feeding 40% MDGS resulted in better ADG and F:G compared to feeding corn as you would expect. We concluded that feeding more (i.e., 30 to 45%) than traditional amounts of silage (i.e., 15%) may be economical (Burken et al., 2013b) despite slightly lower ADG and poorer F:G. This study design does not really answer though whether feeding greater amounts of silage works better today (with distillers in the diet) compared to historical data.

Two additional experiments were conducted with exactly the same treatment design. The first one was with fall yearlings that were large when they started and fed during poor weather (cold and wet; Burken et al., 2014). The second experiment was conducted over the summer with summer-fed yearlings (Burken et al., 2015). The treatment design was five treatments designed as a 2×2 plus 1 factorial. We fed either 15 or 45% corn silage in diets with either 20 or 40% corn silage along with a control diet that contained 40% MDGS and 5% corn stalks. In the first experiment, cattle fed the control performed similarly to the 40% MDGS with 15% corn silage suggesting the roughage source (stalks or silage) did not impact performance (Table 2). Feeding 45% silage decreased ADG and increased F:G compared to feeding 15%. However, the change in ADG and F:G was less when diets contained 40% MDGS as compared to 20% inclusion of MDGS.

In the second experiment with the same design, steers fed the control diet had numerically lower ADG and greater F:G compared to cattle fed 15% silage along with 40% MDGS suggesting that stalks were not as good of a roughage source as the corn silage. Steers fed 45% silage ate more than cattle fed 15% silage (Table 3) regardless of MDGS inclusion. Steers also gained less when fed 45% silage at both inclusions of MDGS as compared to 15% silage and so F:G was greater or poorer when silage was increased. However, no interaction was observed between silage inclusion and MDGS inclusion. Feeding 45% corn silage with 40% MDGS increased F:G by 5.4% compared to 15% silage in diets with 20% MDGS. Feeding 45% corn silage with 20% MDGS increased F:G by 5.9% compared to 15% silage, or about the same amount.

Should feeders use more than 15% corn silage to replace expensive grain? The answer to this question depends on economics. Much of the previous work on feeding silage used incorrect economics, including some of our own work. How silage is priced relative to corn grain is quite complex and will be discussed (see Klopfenstein paper below). The data suggest that shrink and applying nutrients back onto silage acres dramatically affects the economic outcomes for silage. But if manure is accounted for correctly and shrink is well managed (less than 15%), then feeding elevated amounts of silage (i.e., greater than 15%, perhaps 30 to 40% inclusion) is economical, especially for a farmer feeder.

Table 1. Effect of corn silage and MDGS inclusion on cattle performance and carcass characteristics (Burken et al., 2013a).

	Treatment[1]						*P*-value[2]			
	15:40	30:40	45:40	55:40	30:65	45:0	Lin.	Quad.	30	45
DMI, lb/day	23.15	22.77	22.70	21.92	21.66	22.26	0.01	0.45	0.01	0.30
ADG, lb[3]	4.04	3.92	3.76	3.53	3.62	3.55	<0.01	0.19	<0.01	0.02
Feed:Gain	5.73	5.81	6.03	6.21	5.98	6.28	<0.01	0.33	0.12	0.04
12th-rib fat, in	0.55	0.53	0.52	0.43	0.50	0.49	<0.01	0.09	0.29	0.29
Marbling Score[4]	556	557	543	532	547	539	0.13	0.52	0.55	0.85

[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.

[4]Marbling Score: 400=Slight00, 500=Small00.

Table 2. Effect of corn silage and MDGS inclusion on cattle performance and carcass characteristics with large yearlings (Burken et al., 2014).

	Treatment[1]					*P*-value[2]			
	Control	15:20	15:40	45:20	45:40	F-test	Int.	Silage	MDGS
DMI, lb/day	29.1	29.5	28.7	29.5	29.8	0.48	0.24	0.34	0.47
ADG, lb[3]	3.70[ab]	3.95[a]	3.64[b]	3.44[b]	3.62[b]	0.09	0.08	0.06	0.59
Feed:Gain[3]	7.87[ab]	7.46[a]	7.87[ab]	8.55[c]	8.20[bc]	0.01	0.08	<0.01	0.71
HCW, lb	864	877	858	849	858	0.12	0.09	0.08	0.57
12th-rib fat, in	0.47	0.47	0.50	0.47	0.48	0.65	0.82	0.65	0.20
Marbling Score[4]	540[b]	583[a]	548[b]	554[b]	532[b]	0.03	0.54	0.05	0.02

[1]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 62% dressing percentage.

[4]Marbling Score: 400=Slight00, 500=Small00.

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

Table 3. Effect of corn silage and MDGS inclusion on cattle performance and carcass characteristics with summer yearlings (Burken et al., 2015).

	Treatment[1]					*P*-value[2]			
	Control	15:20	15:40	45:20	45:40	F-test	Int.	Silage	MDGS
Performance									
DMI, lb/day	27.6	26.5	26.8	27.3	27.1	0.13	0.41	0.08	0.86
ADG, lb[3]	4.69	4.62	4.79	4.54	4.58	0.11	0.19	0.01	0.06
Feed:Gain[3]	5.88[bc]	5.71[ab]	5.59[a]	6.02[c]	5.92[c]	<0.01	0.63	<0.01	0.09
Carcass Characteristics									
HCW, lb	893	887	898	879	882	0.18	0.41	0.02	0.13
LM area, in^2	13.2	13.2	13.1	13.2	12.8	0.62	0.39	0.38	0.16
12th-rib fat, in	0.66	0.64	0.70	0.64	0.64	0.43	0.27	0.24	0.26
Calculated YG	3.83	3.75	3.98	3.71	3.85	0.54	0.66	0.44	0.10
Marbling Score[4]	450	437	459	454	431	0.74	0.12	0.72	0.98

[1]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=Slight00, 500=Small00.

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

Corn silage traits

I conducted a literature search for silage hybrid and beef cattle, as well as searches on kernel processing and silage. Of the first 80 articles that I evaluated (I did not go through the 20,800 results obtained in 0.7 seconds), 3 were focused on beef cattle and over 60 focused on dairy with the rest either agronomic focus, or nonsensical. Silage is well researched in dairy cattle nutrition, and less researched for beef cattle. This approach is somewhat logical if evaluating silage for finishing cattle as silage inclusion in diets is relatively low (traditionally less than 15%). However, for elevated inclusions in finishing diets and for growing programs where silages comprise the majority of the diet, research on different silage production methods, hybrids, kernel processing, storage methods, etc. are warranted and needed.

The dairy nutrition literature may not apply to beef cattle responses in many cases. The dairy cow is consuming very large amounts of feed (50 lb of DM or more). The passage rate is very high in dairy cows which can limit ruminal digestibility if particle size or grain processing is not optimized. Beef cattle will consume 50% or less of DM compared to dairy cows, which leads to much slower passage rates. These inherent differences may interact with the responses commonly observed in the dairy literature. The best example is grain processing. Finely ground dry corn has been shown to improve starch digestion in dairy cows, yet lead to acidosis and no production improvements in finishing beef cattle. The different response is presumably due to passage rate differences. With that said, here are some general statements related to corn silage traits.

1. Genetically enhanced hybrids (GMO) for agronomic traits such as herbicide tolerance or Bt tolerance that have been evaluated show clearly nutritional equivalence and no impact on performance or digestibility (Folmer et al., 2002, Vander Pol et al., 2005; Erickson et al., 2003; Grant et al., 2003).
2. Data on kernel processing of silage that has been fed to beef cattle are very limited. Numerous evaluations, including meta-analyses (Ferraretto and Shaver, 2012), have been conducted with dairy cattle (Johnson et al., 2002; Ebling and Kung, 2004). In general, kernel processing shows positive attributes for ruminal starch digestion and digestibility in general, but not greater milk yield, especially fat corrected (Ferraretto and Shaver, 2012).
3. Harvest maturity has been evaluated for impact in dairy cattle (Wiersma et al., 1993; Filya, 2004; Der Bedrosian et al., 2011; Johnson et al., 2002; Ferraretto and Shaver, 2012), and some for beef cattle (Andrae et al., 2001).
4. Hybrids and hybrid trait differences (endosperm traits and *bmr* traits) have been fairly well researched in dairy cattle (Ebling and Kung, 2004; numerous others), and some in beef cattle (Keith et al., 1981; Tjardes et al., 2000).

Harvest timing

Challenges for many producers is targeting the correct harvest window and accurately predicting whole plant silage DM at harvest. Challenges include equipment and time for the accurate harvest window, weather conditions at harvest (too wet, or quick drying conditions in the late summer), and custom harvester availability during silage harvest windows. What may be most critical are the moisture/DM contents at harvest to ensure optimum feeding. As Jim MacDonald’s paper eludes to, we recently evaluated ensiling and feeding dryer silage to see if allowing for more grain (i.e., harvesting silage later at a greater DM) would improve performance when fed to both growing and finishing cattle.

Silage was harvested at either 37 or 43% DM and ensiled in silo bags. Fermentation was good in both cases based on different organic acids and pH (Table 4). While comparisons cannot be made statistically, the dryer silage had less NDF/ADF and more starch. The two silages were fed to either growing cattle (Hilscher et al., 2016a) or to finishing cattle (Hilscher et al., 2016b). Steers fed 88% corn silage-based growing diets with either DM of silage ate the same, but steers fed 37% DM silage had greater ADG and lower (better) F:G compared to steers fed dryer silage (Table 5). This was surprising as we hypothesized that with more starch and less fiber, the dryer silage would improve gain and efficiency. These same silages were fed to finishing steers at either 15 or 45% of the diet. No interactions were observed between silage inclusion and silage DM (Table 6). For finishing cattle fed either 15 or 45% silage, the DM of the silage did not impact DMI, ADG, or F:G (or any carcass characteristics). As expected and presented earlier, feeding 45% silage decreased ADG and increased F:G compared to feeding 15% silage (on a carcass-adjusted basis). Harvesting silage later (dryer) improves total yield and does impact nutrient characteristics of the silage, but appeared to not impact performance of finishing cattle and actually resulted in slightly poorer performance of growing steers fed 88% silage-based growing diets. Similar research has been observed in dairy cattle (Wiersma et al., 1993; Filya, 2004; Der Bedrosian et al.,2011; Johnson et al., 2002; Ferraretto and Shaver, 2012). Ferraretto and Shaver (2012) concluded from their meta-analysis that digestibility of corn silage (starch, fiber, and OM) was generally greatest with silages with DM between 36.1 and 40.0, which also had similar milk yield to silages fed with DM between 32 and 36. Once silage was greater than 40% DM, milk yield was lowered compared to wetter silages, despite total tract digestibility being greater for dryer silage. Based on the literature and our research with growing and finishing cattle, we suggest targeting a DM for silage between 36 and 40. Our experience is that most producers start a bit too wet or are forced to start too early due to weather, equipment availability, timing, etc. Waiting until silage is a bit dryer than traditional start times appears to enhance total yield and results in less grain yield “drag” compared to corn grain yield at maturity (i.e., black layer). The greatest challenge is still predicting whole plant silage DM while the crop is standing in the field. While grain filling markers are useful (milkline), there is still considerable variation in whole plant DM at similar milkline. Wiersma et al. (1993) observed up to 7 percentage unit differences in DM concentration across years and across hybrids at the same kernel milkline. I agree with their conclusion though that no other useful measures are available yet today as an alternative predictor of silage DM.

Table 4. Nutrient and fermentation analysis of 37 and 43 % DM silage

	37 DM		43 DM	
Item	Mean	C.V.[1]	Mean	C.V.[1]
DM[2]	37.3	(3.2)	42.7	(3.9)
CP	7.51	(3.6)	7.50	(1.2)
NDF, %	31.55	(17.5)	28.88	(5.7)
ADF, %	21.38	(15.8)	18.63	(17.9)
Starch, %	35.4	(16.7)	40.8	(5.0)
Sugar, %	2.6	(19.6)	2.5	(8.7)
pH	3.88	(1.3)	3.85	(1.5)
Lactic acid, %	3.11	(26.9)	4.14	(28.1)
Acetic acid, %	3.98	(21.5)	2.81	(27.1)
Propionic acid, %	0.51	(26.8)	0.28	(54.3)
Butyric acid, %	< 0.01	(0.0)	< 0.01	(0.0)
Total acids, %	7.61	(10.5)	7.22	(3.3)

1. C.V. = coefficient of variation and is calculated by dividing the standard deviation by the mean and is expressed as a percentage.
2. DM was calculated using weekly samples and oven dried for 48 h at 600 C.
3. All other samples are based on monthly composites, and analyzed at Dairyland Labs (St. Cloud, MN) and Ward Labs (Kearney, NE).

Table 5. Effects of delayed silage harvest on growing steer performance

	Treatments[1]			
Item	37% DM	43% DM	SEM	*P* - value
Initial BW, lb	597	597	3.8	0.92
Ending BW, lb	846	826	6.7	0.04
DMI, lb/d	18.0	17.9	0.3	0.93
ADG, lb	3.19	2.93	0.07	0.01
Feed:Gain[2]	5.63	6.11	-	<0.01

[1]Treatments: steers were fed 88% of either 37 or 43% DM corn silage.
[2]Analyzed as gain:feed, the reciprocal of F:G.

Table 6. The effects of delayed silage harvest and increased inclusion of silage on feedlot performance and carcass characteristics of yearling steers

	Treatments[1]							
	15 % corn silage		45% corn silage			*P*-value		
Variable	37% DM	43% DM	37% DM	43% DM	SEM	Int.[2]	Inclu[3]	DM[4]
Feedlot performance								
Initial BW, lb	938	942	938	942	1.1	0.77	0.87	< 0.01
Final BW[5], lb	1,353	1,375	1,325	1,334	17.4	0.69	0.04	0.49
DMI, lb/d	27.8	29.0	28.7	29.6	0.8	0.77	0.17	0.19
ADG, lb	3.89	4.05	3.61	3.69	0.21	0.75	0.04	0.55
Feed:Gain[6]	7.16	7.15	7.96	8.02	-	0.76	<0.01	0.94
Live Final BW, lb	1,393	1,425	1,387	1,405	24.4	0.75	0.54	0.41
Carcass characteristics								
HCW, lb	853	866	835	841	14.5	0.69	0.04	0.49
Dressing percentage, %	61.1	60.8	60.2	59.8	0.56	0.93	0.06	0.62
LM area, in^2	13.07	12.81	13.14	12.92	0.21	0.86	0.54	0.23
12^{th}-rib fat, in	0.52	0.55	0.51	0.51	0.04	0.51	0.28	0.65
Marbling score[7]	516	498	491	493	21.4	0.49	0.31	0.70

[a,b,c] Means with different superscripts differ ($P < 0.05$).

[1.] Treatments: 15% silage 37 % DM = 15% inclusion of 37% DM silage, 15% silage 43% DM = 15 % inclusion of 43 % DM silage, 45% silage 37% DM = 45 % inclusion of 37% DM silage, 45% silage 43% DM = 45 % inclusion of 43% DM silage; all diets contained 40% MDGS

[2.] Silage inclusion X Silage DM interaction

[3.] Main effect of silage inclusion comparing 15 and 45% of diet DM

[4.] Main effect of silage DM comparing 37 and 43% DM silage

[5.] Final BW calculated based on HCW / common dressing percent of 63%

[6.] F:G was analyzed as gain to feed.

[7.] Marbling score 400 = small^{00}, 500 = modest^{00}

Use of Corn Silage in Growing Diets

Growing cattle perform well on corn silage-based diets if protein supplementation is done correctly. Recent research suggests the amount of bypass protein (rumen undegradable protein or RUP) is lower than previously estimated. The grain in silage is very wet high-moisture corn as it absorbs and becomes similar to moisture of silage and the protein is mostly degradable (RDP). The forage portion is similar to other forages in that most of the protein in the forage portion is RDP. As a result, most silage growing programs in the past have not been sufficient in protein, which limited growth potential from the energy in silage. We have recently revisited this concept. Two experiments were conducted evaluating response to bypass protein when supplemented with concentrated sources of RUP. In the first trial, up to 10% supplemental RUP was added in 2.5% unit increments (Table 7; Hilscher et al., 2016). Steers gained more per day and had better F:G as RUP supplementation increased. The responses were statistically linear, which suggests we did not reach the requirement for metabolizable protein. In a followup study (Table 8; Oney et al., 2017), up to 13% supplemental RUP was fed to growing cattle fed silage-based (85%) growing diets. Again, ADG and F:G improved linearly (based on statistics) but the response was the greatest the first 37 days with the lighter cattle responding better to RUP supplementation. The response was much less marked for ADG and not observed for F:G during the last 45 days of the growing period. To maximize the energy utilization from silage for growing calves, protein supplementation is essential, and that source needs to provide RUP. Distillers grains are the most cost-effective source of RUP available today.

Harvesting and storing high quality corn silage is crucial and a focus of our research program. With high quality corn silage and a little bit of protein calves can grow at a rate approaching 3 lb/d. Providing bypass protein (in the form of DGS) will increase that gain beyond 3.5 lb/d. More research is needed to evaluate all possible ratios of corn silage and distillers grains and the impact on growing/finishing cattle. When do cattle start to finish versus just growing requires more research work as well. In addition, kernel processing and optimizing the harvest window will help ensure optimum harvest technique and timing and if these issues impact performance. More data will be available soon addressing these issues as well as evaluating brown midrib silage for beef cattle.

Table 7. Effects of increasing RUP in silage based growing diets on steer performance

	Treatments[1]					*P* - value	
Variable	0%	2.5%	5.0%	7.5%	10%	Lin.	Quad.
Initial BW, lb	595	597	597	596	600	0.98	0.60
Ending BW, lb	791	824	855	842	868	< 0.01	0.88
ADG, lb	2.51	2.91	3.31	3.15	3.43	< 0.01	0.82
Feed:Gain	6.74	6.26	5.71	5.52	5.35	< 0.01	0.57

[1] Adapted from Hilscher et al. (2016). All cattle were fed 88% corn silage with a combination of RDP and RUP supplements to achieve either 0, 2.5, 5.0, 7.5, or 10% supplemental RUP (% of diet DM). The RUP source was a blend of Soypass + Empyreal in the final diet.

Table 8. Effects of increasing RUP in silage based growing diets on steer performance

	Treatments[1]					*P* - value	
Variable	0%	3.25%	6.5%	9.75%	13%	Lin.	Quad.
Initial BW, lb	605	606	604	608	604	0.99	0.86
d 1-37							
Interim BW, lb	692	707	713	730	729	0.03	0.26
ADG, lb	2.34	2.74	2.96	3.29	3.38	< 0.01	0.06
Feed:Gain	6.45	5.62	5.24	4.83	4.48	< 0.01	0.10
d 38-83							
Ending BW, lb	808	833	829	864	857	0.01	0.17
ADG, lb	2.52	2.74	2.51	2.92	2.78	0.10	0.28
Feed:Gain	6.58	6.76	7.30	6.33	6.54	0.64	0.86

[1] Adapted from Oney et al. (2017). All cattle were fed 85% corn silage with a combination of RDP and RUP supplements to achieve either 0, 3.25, 6.5, 9.75, or 13% supplemental RUP (% of diet DM). The RUP source was a blend of Soypass + Empyreal in the final diet.

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