2012 Plains Nutrition Council Spring Conference

April 12-13, 2012
San Antonio, Texas

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Texas Agrilife Research and Extension Center
The Texas A&M System
Amarillo
THE PLAINS NUTRITION COUNCIL

2012 SPRING CONFERENCE

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RAMP
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The 2012 Plains Nutrition Council Spring Conference

Thursday, April 12
8:30 – 11:30 AM Preconference Symposium – presented and sponsored by Zinpro
11:00 AM-1:00 PM Graduate research poster presentations

2012 Plains Nutrition Council Spring Conference
1:00 PM Welcome and Introduction - Dr. Mark Miller, Mark Miller Consulting, LLC, Elk City, OK
1:10 Climatic cycles – what is in store for this year and beyond? Mrs. Evelyn Browning-Garriss, Historical Climatologist, The Browning Newsletter, Albuquerque
2:00 Drought, cattle inventories, grain usage, and demand – Are there changes in store for the industry? Dr. Derrell Peel, Oklahoma State Univ., Stillwater
2:50 Break and View Graduate Research Poster Presentations
3:20 Heat stress - contributing factors, effects and management – Dr. Terry Mader, Univ. Nebraska – Lincoln, Concord, NE
4:10 Research Update - Dr. Alfredo DiCostanzo, Univ. Minnesota, St. Paul
4:40 The revised Texas Cattle Feeders Association Beef Quality Assurance guidelines Mr. Ben Weinheimer, Texas Cattle Feeders Association, Amarillo
5:00 View Graduate Research Poster Presentations
5:30-7:30 Reception Sponsored by RAMP– Sweet Bran Cargill

Friday, April 13
8:00 AM PNC Business Meeting
8:15 Review of large pen serial slaughter trials – Growth, carcass characteristics, feeding economics – Dr. Marshall Streeter, Merck Animal Health, Cheyenne, WY
9:00 Employer’s expectations of university graduates – Results of PNC employer survey on training and qualifications - Dr. Kevin Williams, West Texas A&M Univ., Canyon
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Maintaining Beef Industry Competitiveness with Today’s High Grain Prices

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Introduction

The availability of cheap feed grain for many years influenced the structure of the beef cattle industry and the types of production systems used in very fundamental ways. These impacts are only just now being truly recognized as the industry struggles to adapt to an economic environment that has fundamentally changed and the changes appear to be permanent. These changes began as direct short run impacts on the feedlot sector but ultimately will have long impacts that will affect every aspect of cattle production.

Data from a monthly survey of Kansas feedlots demonstrates the dramatic changes that have taken place. From January, 1990 – December, 2006 the average steer feed cost of gain (COG) reported by feedlots was $52.82/cwt., with a standard deviation of 5.71. This means that two-thirds of the time over this 17 year period, the COG was between $47.11/cwt and $58.53/cwt. Corn prices jumped sharply in late 2006 and have been reflected in higher feedlot COG since 2007.

From January, 2007 through the most recent data in January, 2012, the average COG was $81.95/cwt., with a standard deviation of $11.61. Thus the COG has ranged from $70.34/cwt. to $93.56/cwt. two thirds of the time over the latest 61 month period. Feedlot COG has averaged 55 percent higher the last five years compared to the previous 17 year period and has been more volatile with a standard deviation nearly double the previous period. The lowest end of the range of one standard deviation since 2007 has been 20 percent higher than the highest end of the one standard deviation range of the period from 1990-2006.

The impacts have been even greater in the last year. The January 2011 to January 2012 average feedlot COG was $98.57/cwt. The COG was greater than $100/cwt. for the first time ever in August of 2011 and posted an all time high to date of $113.28 cwt. in the most recent data from January 2012. While it is uncertain what corn prices and thus COG will be in the future, it seems clear that it is likely to average significantly higher than the levels that prevailed for many years and under which the industry evolved to operate as it does today.

The Current Cattle Market Environment

High grain prices are affecting the cattle industry as part of a varied set of market factors. The short run impact of high grain prices can only be understood when considered against the backdrop of a unique beef cattle market situation that has been developing for a number of years.

The most important feature of the current cattle market is low cattle inventories. Total cattle inventories, and the cow herd inventory specifically, have declined 14 of the last 16 years. Several factors have contributed to this prolonged liquidation including drought in the early 2000s; the initial corn price shocks described above; U.S. and global recession and most recently, a severe drought in the Southern Plains. Notwithstanding the importance of other market factors such as domestic beef demand and growing international beef trade, it is limited cattle numbers, especially as reflected in small feeder supplies that explain record high prices for
feeder cattle at the current time and for the foreseeable future. With critically low cow numbers, rebuilding of herds and feeder cattle supplies will likely take several years.

**Short Run Impacts of High Grain Prices**

High feed prices affect feedlots most directly and immediately. Typically, the initial reaction of feedlots is to reduce feeder cattle prices. This happened in the first few months after corn prices first jumped in late 2006 and early 2007 but was thwarted by the fact that limited cattle supplies kept feedlot competition for feeder cattle keen and by the fact that the tradeoff does not work very well if high feed prices is a long term rather than a short run situation. In general, both feeder cattle and feed prices have continued to rise since 2007, and especially since 2009, both feeder cattle and corn have risen simultaneously to record high average levels.

The other short run response of feedlots is to minimize feed cost exposure by placing heavier feeder cattle in the feedlot. This is the principal short run means by which the industry reduces total feed use in the face of high feed prices. However, this effort has likewise been limited by the number and kind of feeder cattle available. Part of the declining feeder cattle supplies in recent years is a result of the long term tendency for feeding younger and lighter animals than would have been typical several years ago. The industry’s evolution to calf feeding was driven largely by cheap feeds that made feedlot gains extremely competitive to forage based cattle gains. Since 2007, despite considerable incentive to move back to yearling based feeding programs, feedlots have been forced to continue placing many lightweight calves simply because of very limited supplies of heavy feeder cattle. In 2011, this situation was exacerbated by the drought which forced the early placement of many calves. Though this helped to maintain feedlot inventories in the short run, it runs counter to the underlying economic signals of the feedlot industry.

**High Grain Prices May Result in Structural Change in the Long Run**

In addition to the short run market conditions and the responses that the feedlot industry is making or is forced to make, the long run structure of the cattle industry will also likely change in response to higher grain prices. Higher feedlot costs of gain increases the value of forage based gains as the industry shifts permanently back to more of a yearling based feeding industry. Increased value of forage based gains is a signal for stocker and backgrounders to take a bigger role in the total production of cattle by utilizing more forage prior to feedlot finishing. This is already being reflected in feeder cattle price relationships that put more value on stocker based gains in total and more value on gains at higher weights, specifically. In the coming years, as feeder supplies begin to grow, there will be even more tendency for feedlots to routinely place heavier cattle and for stocker producers to put that additional weight on feeder cattle in stocker and backgrounding programs. This is likely to lead to several changes in cattle markets:

- **Marketing of heavier feeder cattle.** Typical feedlot placement weights may increase 100-300 pounds and become much more common with market prices showing little discount on feeder cattle up to much heavier weights.
- **Changing seasonal feeder price patterns.** Over the past twenty years, feeder prices have changed such that prices tend to be highest in the middle of the year compared to previous periods where feeder prices tended to peak in the spring and be lower in the
second half of the year. These recent seasonal price patterns were a reflection of the orientation of the industry to calf feeding and as the industry reverts back to a more yearling based feeding structure, seasonal prices will likely revert also to reflect seasonal forage production with more spring price peaks.

More fundamentally, the industry will look for ways to fundamentally reduce grain use in cattle production. Over the past 40 to 50 years, the industry has greatly enhanced production and efficiency of grain-intensive production systems as a result of the market incentives embodied in cheap grains. Now the incentives have changed; the question is not “how to get cattle to eat more grain?” but rather “how to produce high quality beef using the least amount of grain?” This implies many new questions and ways of thinking about cattle production as relatively more forage intensive and less grain intensive.

Many of the new questions do not have answers yet and it will take many years for the industry and the research that supports it to see what the potential really is. Remember that it took 30 plus years for the potential of grain intensive production to be realized and this change will be no different. It is likely that cattle production in the future will value some animal genetics differently than in the past; that the types and applications of some technologies may change and many other production factors may change according to new incentives. Increased forage value places a new emphasis on the use and management of forages for increased productivity and efficiency and there will be more efforts to identify new forages and forage systems for use in cattle production.

High crop values have implications for land use and particularly for the location of forage production (and cattle production) over time. Land use patterns, particularly for perennial crops like hay and pasture, tend to adjust slowly and it will take many years for the changes to be fully realized. However, some changes are already becoming evident. Compared to 2006, harvested hay acres in the U.S. were down 5.3 percent in 2011. This reflects the general response to high corn prices as more acres are used for corn production with acreage of most other crops down over the period. The change is more dramatic in the key corn production areas of Illinois, Indiana, Iowa, Nebraska, Minnesota and Missouri where hay harvested acres in 2011 is down 10.7 percent compared to 2006. This amounts to 1.49 million of the total 3.2 million acre decrease nationwide or 46 percent of the total reduction. Pasture acreage is likely down in the region as well though such changes occur slowly and it will be some time before data is available to confirm the changes. In general, the agricultural market situation tends to favor less hay and pasture production in regions where crop production competes more for land use. This suggests a tendency for less cow-calf production in regions such as the Midwest relative to the western Great Plains and range areas of the West. Conversely, some cattle feeding advantage appears to have shifted back to the Midwest relatively to the Southern Plains based, in part, on the regional availability of by-product feeds. Purely grazing-based stocker production will be focused in the forage regions of the plains and western U.S. but confinement and semi-confinement backgrounding programs may flourish in the western Corn Belt to take advantage of the interface between seasonal grazing and the availability of by-product feeds and harvested forages.

Summary

The reality of high grain prices and other cattle markets conditions sets the stage for a very dynamic and challenging set of decisions for the next few years. Additionally, more
fundamental changes in cattle production may be occurring in response to permanently different market incentives in the future. It has often been said that the beef industry has better ability to cope long term with high grain prices than competing meat industries. That statement is true but carries huge implications for structural change in the industry. The flexibility that beef cattle have relative to monogastric species is an advantage in the face of high grain prices only if the industry makes the changes it is capable of making. In order for the beef industry to maintain the maximum degree of competitiveness in the face of high grain prices, the industry must become less grain intensive and more forage intensive which implies changes not only in the feedlot sector but also in the stocker and cow-calf sectors as well.
Heat Stress - contributing factors, effects and management

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Introduction

In the Midwest and Plain states the heat waves of 1995, 1999, 2006, 2009, and 2010 were particularly severe with documented cattle losses approaching 5,000 head each year. However, during the summer of 2011, nearly 15,000 head of cattle perished across five states as a result of heat stress. On the other extreme of environmental stress, the winters of 1992-93, 1996-97, 1997-98, 2006-07, and 2008-09 also caused hardship for cattle producers with feedlots and cow/calf operators reporting excessive losses. Economic losses from reduced performance of cattle experiencing severe environmental stress likely exceeded losses associated from cattle death by 5- to 10-fold. Use of alternative dietary ingredients and manipulation of diet constituents may need to be considered for cattle challenged by adverse environmental conditions (Mader, 2003). Use of additional water for consumption and cooling, shade, and/or alternative management strategies need to be considered to help cattle cope with heat stress. The above-mentioned weather events, in addition to mitigation strategies suggest that there is tremendous opportunity for cattle producers to minimize environmental stress in beef cattle. A greater understanding of cattle responses to weather challenges is needed for caretakers to help animals cope with adverse climatic conditions.

Nutritional Management

Feed and feeding management

Feedlot cattle fed high-energy grain-based diets generate large amounts of metabolic heat, which is usually transferred from the body to the environment using normal physiological processes. Failure to transfer this heat results in an accumulation of heat within the body and predisposes the animal to heat stress (Mader et al., 2010b; Gaughan et al., 2010). Modification of heat flux may be achieved through behavioral changes (e.g. changing position relative to the sun, shade seeking) initiated by the animal, or facilities changes (e.g. use of shade or sprinklers) and/or feed management changes (e.g., restricted feeding, use of fat or lower energy rations) initiated by the caretaker (Mader et al., 2006, 2007, 2008).

Galyean (1999) provided an excellent review of concepts and research concerning restricted or managed feeding programs. Benefits of using restricted feeding programs under hot conditions have been reported by Mader et al. (2002) and Davis et al. (2003). In addition, Reinhardt and Brandt (1994) found the use of restricted feeding programs to be particularly effective when cattle were fed late afternoon or evening vs morning. Implementing a bunk management regimen, whereby bunks are kept empty 4 to 6 hours during the daytime hours is another management strategy that could be used to minimize peak metabolic heat load occurring simultaneously to peak climatic heat load (Mader and Davis, 2004). Even though this forces the cattle to eat in the evening it does not appear to increase night-time body temperature (BT). In restricted feeding studies in which BT was measured, Mader, et al. (1999b) housed feedlot steers
under thermoneutral or hot environmental conditions. Steers were offered a 6% roughage finishing diet *ad libitum* (HE), offered the same diet restricted to 85 to 90% of *ad libitum* DMI levels (RE), or offered a 28% roughage diet *ad libitum* (HR). Steers fed the HR diet (39.7 ºC) had significantly lower BT under hot conditions than HE (40.6 ºC) and RE (48.3 ºC) fed steers, while RE fed steers had significantly lower BT than HE fed steers. The lower BT of the HR and RE fed steers would indicate that ME intake prior to exposure to excessive heat load influences the ability of cattle to cope with the challenge of hot environments and that lowering ME intake can lower BT (Davis et al., 2003). Arias et al. (2011) reported similar results, in that high concentrate feedlot diets (3.04Mcal ME/kg) promoted greater BT in the summer, while the lower energy, higher roughage diets (2.63 Mcal ME/kg) tended to produce lower BT in the winter.

**Heat increment management**

Heat production increases with digestion and metabolism. This is known as heat increment. Heat increment can be thought of as energy that must be dissipated. This is not really a problem under thermoneutral or cold environmental conditions. However, under high heat-load, in which the animal’s ability to dissipate body heat is impaired, additional body heat may be detrimental to the animal’s wellbeing. Feed ingredients differ in heat increment, largely because of differences in the efficiency of utilization of the nutrient or the end-products of digestion. For example, fibrous feedstuffs have greater heat increments (per unit of ME) than feedstuffs containing more soluble carbohydrates. In theory, it is possible to formulate diets according to heat increment but evidence on whether this practice is effective in alleviating heat stress in feedlot cattle is inconclusive. The previous discussion would suggest that in total the amount of heat generated from feeding a lower energy, moderate fiber diet is less than that generated from a high concentrate diet.

The addition of dietary fat would appear to be the best alternative for reducing heat increment, since fats have a low heat increment. However, use of supplemental fat is limited because diets containing more than 5% to 7% total fat tend to suppress rumen function, although the use of ethanol co-products does allow for use of greater total lipid levels than traditional diets. Nevertheless, the inclusion of dietary fats in dairy cow diets has been found to reduce heat load in some studies, while other studies have shown little benefit from added dietary fat (West, 1997, 1999). In general, cattle should benefit from the more energy dense diets during periods of depressed DMI. In beef cattle studies, mixed results were also found for steers exposed to high heat-load and fed grain diets high in fat (Gaughan and Mader, 2009).

**Electrolyte requirements**

Mineral requirements are expected to be greater during the summer months because of increased sweating. In addition, mineral losses occur through drooling and urination. Potassium and Na are the primary cations involved in the maintenance of the blood acid–base chemistry. Further changes in blood acid–base chemistry occur because of hyperventilation, which reduces blood bicarbonate and blood buffering capacity and increases urinary excretion of electrolytes (Sparke et al., 2001). Thus, dietary cation–anion balance (DCAB) and the dietary cation–anion difference (DCAD) may be more important than the content of the individual elements. Some benefits of supplemental K and/or Na have been found under certain environmental situations, however, if found, the benefits tend to be small (Gaughan and Mader, 2009; Mader et al., 2010a; Mader and Johnson, 2012).
Facility Considerations

Proper feedlot pen layout and design are crucial for minimizing effects of adverse climates. Mounds need to be designed, especially in the Northern Plains and Western Cornbelt of the U.S., to minimize mud problems during wet periods and enhance air-flow during hot periods. Proper design and strategic use of windbreaks is warranted (Mader et al., 1997a, 1999a). Wind barriers or other structures should not be placed near cattle in the summer in order to maximize airflow in the pen and around the animal.

Waterer space requirements

Evaporation of moisture from the skin surface (sweating) or respiratory tract (panting) is the primary mechanism used by the animal to lose excess body heat in a hot environment. Under these conditions, waterer space availability and water intake per head becomes very important. During heat episodes, Mader et al. (1997b) found that as much as three times the normal waterer space (7.5 vs 2.5 cm of linear space per animal) may be needed to allow for sufficient room for all animals to access and benefit from available water. In general, water consumption per unit of DMI in the summer is 2 times greater than in the winter.

Sprinkling systems

In addition to pen design and altering feeding regimen, sprinkling can also be effective in minimizing heat stress. Benefits of sprinkling tend to be enhanced if sprinkling is started in the morning, prior to cattle getting hot (Davis et al., 2003). These data also show significant benefits to sprinkling or wetting pen surfaces. Sprinkling of pen surfaces may be more beneficial than sprinkling the cattle. Kelly et al. (1950), reported feedlot ground surface temperatures in excess of 65°C by 2 p.m. in the afternoon in Southern California. Similar surface temperatures can be found in most High Plains feedlots under dry conditions with high solar radiation levels. Cooling the surface would appear to provide a heat sink for cattle to dissipate body heat, thus allowing cattle to better adapt to environmental conditions vs adapting to being wetted. Wetting or sprinkling can have adverse effects, particularly when the cattle get acclimated to being wet and failed or incomplete sprinkling occurs during subsequent hot days. Elevated relative humidity may also be problematic if large areas of the feedlot are sprinkled versus isolated areas in pens.

Sprinkling may increase feedlot water requirements 2- to 3-fold. In addition, mud build-up is associated with sprinkling systems. Intermittent sprinkling is recommended and constitutes 2 to 5 minute application every 30 to 45 minutes or up to 20 minute application every hour to 1.5 hours. Whether cattle that need to be sprinkled (cooled) always go to or get under the sprinklers is unknown.

Use of shade

Shade also has been found to be beneficial for feedlot cattle exposed to hot climatic conditions, however, in research conducted in Nebraska (Mader et al., 1999a) positive benefits occurred only in the early portion of the feeding period and only in cattle with wind barriers provided. In general, the response to shade occurred within the first 56 d of the feeding period, even though shade use tended to increase with time cattle were on feed. This suggests that cattle must adapt to shade or social order around and under shade before optimum shade use occurs. Although no heat-related cattle deaths occurred in this study, these results suggest that shade
improves performance in the summer when cattle are fed in facilities that restrict airflow and for cattle that have not become, or had the opportunity to become, acclimated to hot conditions.

Benefits of using shade would most likely be found in areas having greater temperature and/or solar radiation (Hahn et al., 2001). Mitlöchner et al. (2001), found excellent results to providing shade for cattle fed near Lubbock, TX. The overall economic benefit of using shade depends not only on location, but also on cost of structures and maintenance. Also, heat stress is dependent not only on temperature and solar radiation, but also on humidity and wind speed (Livestock Conservation Institute, 1970; NOAA, 1976; Hubbard et al., 1999). Adjustments for solar radiation and wind speed have also been developed and need to be considered when predicting heat stress (Mader et al, 2006). Also the effects of environmental stress are dependent on not only the magnitude and duration, but also on the rate at which environmental conditions change.

**Mitigation strategy economic analysis**

The economic effects of imposing various environmental stress mitigation strategies have been determined by Mader (2010a, b; 2011). These analyses are based on the comprehensive climate index (CCI; Mader et al., 2010a) and how the respective mitigation strategy changes apparent or “feels-like” temperature. In the summer analysis, moderate sprinkling was utilized versus heavy sprinkling in an effort to minimize the quantity of excess runoff water. Also the pen area sprinkled was kept to around 25 ft² per head. In addition to shade and sprinklers, evaluation of the use of fans (with water injection under shade) was conducted to determine the benefits of added evaporative cooling potential through the enhanced airflow under shade. In the summer analysis, performed for the SW part of the US, the performance effects of sprinkling and shade on apparent temperatures were similar even though different physiological cooling properties are involved between the two strategies. Greater amounts of water tend to have a greater benefit than shade while lesser amounts (i.e. misting) tends to have less benefit than shade.

Due to the limited heat tolerance of British crossbred cattle, they tended to have greater cost of gain (COG) than Holsteins. Thus, heat stress mitigation strategies will be more economical when imposed on the British breeds of cattle. An opposite scenario occurs under cold stress, with Holsteins having greater COG. The response to mitigation strategies were similar among breed types but with a slightly greater break-even (annualized amount that could be spent for the respective mitigation strategy) cost for the British crossbred. An analysis of Brahman cross cattle displayed a lower benefit and one-time setup costs (break-even construction cost) when compared to comparable costs for Holstein steers.

In theory, sprinkling should always produce greater heat stress relief than shade or misting due to the high heat loss associated with the evaporation process. However, limited research data in feedlot cattle suggests that shade provides a greater and more consistent performance response than sprinkling. When cattle are in very close confinement and the probability is high that water gets applied to the animal, then a more positive response to sprinkling/direct water application is found (e. g. dairy units).

**Summary**

Beef cattle are traditionally managed outdoors with exposure to natural and variable environmental conditions. Cattle are particularly vulnerable not only to extreme environmental
conditions, but also to rapid changes in these conditions. Management alternatives, such as the strategic use of sprinklers or shade, need to be considered to help cattle cope with adverse conditions. In addition to these changes, manipulation of diet energy density and intake may also be beneficial for cattle challenged by environmental conditions.

**Literature Cited**


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Update on TCFA’s New Beef Quality Assurance Program
2012 Plains Nutrition Conference

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April 12, 2012

Overview of BQA at TCFA
• 1986 - Initial BQA Program
• 1998 - Beef Safety and Quality Assurance Program (HACCP based)
• 2001 - Prohibited Proteins
• 2003 - Cattle Care and Handling Audits
• 2004 - “Clean Trucks” & Aminoglycocides Prohibited
• 2012 - Requirements for Site-Specific Feedyard BMPs and Documented Employee Training

BQA Working Group
Warren White, co-chair (feedyard manager)
Russell Goble, co-chair (feedyard manager)
Jim Simpson (nutritionist)
Dr. Tony Bryant (nutritionist)
Dr. Sam Ives (veterinarian)
Dr. Steve Lewis (veterinarian)
Dr. Ted McCollum (nutritionist)
Ben Weinheimer, TCFA staff (ag engineer)
**Timeline**

- Nov. 2011 – Feedyard Pilot Tests
- Jan. 2012 – Approved by TCFA Board
- Feb. – Mar. 2012 –
  - BQA Trainings (Feb. 28 – Mar. 29)
  - Feedyard Managers, Asst. Managers, Feedmill Managers, Cattle Managers, other employees and custom processing employees
  - Nutritionists and Veterinarians
- April 2012 – New Audit Process Begins

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**1998 BSQA**

- HACCP tables
- Training seminars
- TCFA staff audit
- Consultants’ signatures
- TCFA Certification

**2012 BQA**

- Focus on BQA principles
- Required Feedyard BMPs (Feed, Cattle & Yard Depts.)
  - Annual Training
  - Training logs
  - Records
  - TCFA staff audit
  - Corrective actions statement by fdyd. mgr.
- Consultants’ verification
- TCFA Certification

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BQA Goal

The goal of the TCFA Beef Quality Assurance Program is to ensure that all cattle shipped from this feedyard, intended for human consumption, are healthy, wholesome and meet regulatory and feedyard industry standards.

BQA Objectives

1. To follow established production standards for beef safety and beef quality that must be met at all times. Key elements include standards for feed safety and quality; cattle health and well-being, including proper use of animal health products and proper care and handling of all cattle; and maintenance of feedyard facilities.
2. Establish data retention and recordkeeping systems which satisfy FDA/USDA/EPA guidelines to allow for validation of management activities and fulfill program goals.
3. Establish best management practices (BMPs) that are tailored to represent the site-specific protocols and methods that are implemented at each feedyard.
4. Provide training and education to help participants meet or exceed BQA program guidelines and help realize the benefits of the program.
5. Provide technical assistance through TCFA BQA program staff, veterinarians, nutritionists, extension specialists and other qualified individuals working with the BQA program.

HACCP

• Hazard Analysis Critical Control Points
• Beef Safety and Beef Quality Focus
• Physical residue (i.e., broken needles)
• Chemical residue (i.e., antibiotics, pesticides)
• Biological residue
BQA Certification Process

Feedyard implements BQA Program requirements, including site-specific BMPs and employee training.

TCFA staff conducts on-site audit (annually).

If corrective actions are required, feedyard manager sends “Corrective Actions Statement” to TCFA within 30 days after the audit.

TCFA staff generates “BQA Verification Statements” for nutritionist and veterinarian to review, sign and submit to TCFA.

TCFA President & CEO signs BQA Annual Certification and sends to feedyard manager.

BQA Audit Checklist

- Feed Dept. – BMPs
- Feed Dept. – Employee Training (every employee)
- Cattle Dept. – BMPs
- Cattle Dept. – Employee Training (every employee)
- Yard Dept. – BMPs
- Yard Dept. – Employee Training (every employee)
- Cattle handling assessment
- Facilities assessment
- Feedyard Manager Corrective Actions Statement
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Online Video Resources

www.bqa.org

Appendix
Online Video Resources

www.animalcaretraining.org
Employer Expectations of Graduate Students Entering the Fed Beef Industry

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Abstract

The purpose of this study was to determine skills, knowledge and abilities needed by graduate students entering the profession of the fed beef industry as identified by industry employers. The target population of this study consisted of Plains Nutrition Council (PNC) members who make hiring decisions within the fed beef industry (N=129). This group consisted of both private industry employers and post-secondary education faculty. The survey instrument was a self-administered questionnaire adapted from Graham (2001). The instrument was designed to measure employer perceptions of graduate student preparation level upon entering the industry and to describe perceived importance of certain skill sets applicable to the profession. Other items assessed relevant course work, valued life skills, and future trends foreseen within the profession. Of 41 individual skills employers assessed for student preparation, the ability to speak a second language was the only item where students were believed to be unprepared. Fed beef industry employers who participated in this study valued the importance of integrity, honesty, and dependability over all other skills. Other skills study employers valued highly included students understanding and following directions, listening, initiative, and problem solving.

Introduction

Dacre Pool & Sewell (2007) define employability as “A set of skills, knowledge, understanding and personal attributes that make a person more likely to choose and secure occupations in which they can be satisfied and successful” (p. 280). Gurcharan Singh and Garib Singh (2008) say that employability skills are not job specific, but skills applicable across all domains as well as all levels of employment. Even though many graduates possess excellent academic qualification a major concern from employers is that many graduates do not have the right combination of skills and personal attributes (Daud, Sapuan, Abidin and Rajadurai, 2011).

In the rapidly changing business world of the 21st century, partnerships between industry and the educational institutions that produce their future employees are vitally important. Nowhere is this more critical than agriculture. To keep the competitive edge that American agriculture has in the world requires a skilled labor force. According to Graham (2001) schools are calling for reform to better prepare their students in higher order thinking skills and reasoning skills. Due to the immense increase in technology, and the rapidly changing agricultural industry; a need has developed to determine what skills the new, entry-level employee needs in order to succeed. Andelt (1997) states the more is known about the competencies required for the industry the more employable graduates there will be in the marketplace.

The Plains Nutrition Council is comprised of professionals from private consulting, cattle feeding companies, allied industries (feed, nutrition, and animal health), and research and
extension institutions. It is estimated 85 to 90% of the United States feed yard capacity is accounted for by Plains Nutrition Council members. The Plains Nutrition Council’s members have a pivotal role in helping educational institutions prepare their graduate students to be successful employees within the fed beef industry. However to best serve these students and best prepare them for their chosen profession several questions need to be addressed. How prepared for a professional career are students entering the fed beef industry? What employability skills are deemed most important to industry employers? What future trends lie ahead?

**Theoretical Framework**

Human Capital Theory served as the theoretical framework for this study. According to Oded and Moav (2002) investing in knowledge, skills, and health of workers not only benefits them as a person, it benefits the employer and potential productivity of the organization. Becker (1975) furthered this belief by declaring an investment in human capital through education and training is as important as investment in other tangible forms of capital. Higher education is not immune to this concept as by improving the overall skills of its graduates, human capital is grown (Knight & Yorke, 2003).

Harvey (2000) listed two sets of attributes employers’ desire in their employees. Communication, teamwork and interpersonal skills were described as interactive attributes required by employers. Intellect, knowledge, willingness and ability to learn and continue learning are all personal attributes needed to be successful in the ever changing work place. Harvey added the willingness to continue learning has become far more important than knowledge to employers. Simmons-McDonald (2009) furthered lifelong learning as a critical factor in the employability of an individual.

In a 2001 study of employers, Graham determined that overall university graduates are prepared to enter into entry-level positions. Yet, Graham also determined a need for graduates to better demonstrate the ability to work in groups, show leadership, dedication, and initiative. This need was theorized as “on-the-job awkwardness” which is potentially explainable by needed growth in business skills or even maturity. Graham recommended from this finding that university curriculum needed to be assessed and that continued employer feedback was necessary.

**Purpose and Objectives**

The purpose of this study was to determine skills, knowledge and abilities needed by graduate students entering the profession of the fed beef industry as identified by industry employers. The specific objectives were as follows:

1. Describe the level of preparation of skills, knowledge and abilities of graduate students entering positions in the fed beef industry.
2. Describe the importance of skills, knowledge and abilities needed of graduate students for entry-level positions in the fed beef industry.
3. Determine if difference exists, in the preparation level of skills, knowledge and abilities and the importance of skills, knowledge and abilities of graduate students to the entry-level positions in the fed beef industry.
4. Determine the value of experiential education in the preparation of graduate students for the fed beef industry.
5. Identify changing trends in the industry that will affect the preparation of graduate students for the fed beef industry.

**Methodology**

The target population of this study consisted of Plains Nutrition Council (PNC) members who make hiring decisions within the fed beef industry (N=129). This group consisted of both private industry employers and post-secondary education faculty. The survey instrument was a self-administered questionnaire adapted from Graham (2001). Section one of the instrument consisted of items to determine skills, knowledge, and abilities needed by university graduate students entering the profession of the fed beef industry. Employers rated these entry-level employees on their preparedness along with the perceived importance in six areas on a five point Likert-type scale. Part two of the survey was the importance of life experiences for entry-level positions in the Fed Beef Industry. Section three was associated with perceived growth areas for future employment. Employers rated growth areas from one being little growth to seven being significant growth. Finally, select open-ended questions were presented related to the areas that could impact the curriculum of graduate students (Graham, 2001). A panel of three university faculty and four Plains Nutrition Council Members reviewed the instrument to establish content and face validity. Chronbach’s alpha was used to calculate reliability of the instrument at .93.

Prior to the survey being administered, an introductory letter was sent to prospective survey participate explaining the purpose of the survey and its importance. According to Dillman (2000) repeated contact with respondents will increase response rates by 20-40 percent. Approximately two weeks after the introduction letter was sent, an email was sent with an online link to the survey hosted by Qualtrics.com. Three follow up emails were sent out by researchers. These emails thanked participants who had responded to the survey instrument and encouraged non-respondents their participation in the study was appreciated.

Forty-seven PNC members responded to the survey producing a 36.4% response rate. To control for nonresponse error, comparisons were made between early and late respondents as recommended by Miller and Smith (1983). Survey participants who responded within 21 days of the initial email were classified as early respondents while those completing the survey after 21 days were classified as late respondents. No statistically significant differences were found between the two groups. Data was analyzed using the SPSS® statistical package for Windows™. For the objectives of this study, means and standard deviations were used for description of the data. With objective three a mean weighted discrepancy score (MWDS) was calculated by taking the importance rating minus the preparation rating and multiplying it by the importance rating.

**Results/Findings**

**Objective One**

Objective one sought to describe the level of preparation of knowledge, skills, and abilities of university graduate students for entry-level positions in the fed beef industry. Graduate student preparation was divided into five sections titled: interpersonal skills, communication skills, computer skills, character, and technical competency. Table 1 lists all items included within the five sections.
The first section found in objective one was interpersonal skills and consisted of 16 items along with one open ended item. Fed beef industry employers rated industry graduate students entering the field as best prepared in the area of professional appearance (M=3.41, SD=.98). This was followed by open mindedness to new experiences or ideas (M=3.22, SD=.89), teamwork skills (M=3.20, SD=.82), and employee curiosity (M=3.13, SD=.89). Thirteen items produced means over 2.50 indicating new employees were perceived to be prepared in these areas. The interpersonal items with mean scores less than 2.50 were management/business skills (M=1.89, SD=.87), global awareness (M=2.36, SD=.84), and initiative (M=2.47, SD=.89).

Communication skills were listed in section two and contained eight items along with one open ended item. Survey participants deemed new employee’s as having good preparation in the ability to understand and follow directions (M=3.53, SD=.87). The next highest rated item was presentation skills (M=3.24, SD=1.15). Generated mean scores reflected graduate students to be prepared in six of eight communication items. Ability to speak a second language was rated as the least prepared communication skill with a mean of 1.43 (SD=.66).

Eight specific items and one open ended item were measured under computer skills. Ability to use the internet produced the highest mean at 4.52 (SD=.63). Word processing (M=4.09, SD=.87) and spreadsheets (M=3.91, SD=1.02) ranked second and third for preparation. Least preparation was determined to be computerized accounting systems (M=1.80, SD=.73), and computer aided design (M=2.27, SD=1.13).

Entry-level preparation looked to describe how well new fed beef employees exhibit a variety of character skills. The three items listed under character were honesty, dependability, and integrity. All three items produced similar means. Integrity yielded the highest mean at 3.56 (SD=0.99), and was closely followed by honesty (M=3.53, SD=0.92), and dependability (M=3.44, SD=0.97).

Employers participating in this study were also asked to determine the level of preparation of graduate students in the technical areas of curriculum. From this employers determined students to be most prepared in biological sciences (M=3.59, SD=.97), physical sciences (M=3.11, SD=.84), and mathematics (M=2.77, SD=.96).

**Objective Two**

Objective two aimed to describe the importance of skills, knowledge and abilities needed of graduate students for entry-level positions in the fed beef industry. With this item researchers hoped to capture the skills employers attached the most importance to with new employees. The items discussed in section one along with an additional section associated with specific coursework for graduate students were assessed by survey participants. Table 2 displays findings for all items.

For interpersonal skills thirteen items rated as very important by employers yielding a mean greater than 3.50. The interpersonal skills survey participants rated as most important were initiative (M=4.41, SD=.65), problem-solving skills (M=4.40, SD=.61), dedication to job (M=4.22, SD=.79), and decision making skills (M=4.21, SD=.66). Although all items generated means over 3.00, the least important items were determined to be global awareness (M=3.14, SD=0.76), creativity skills (M=3.39, SD=.95), and willingness to relocate (M=3.40, SD=.96).

Employers regarded listening (M=4.38, SD=.61) as the most valuable communication skill. The next highest means were produced by verbal expression in speaking (M=4.11, SD=.83), understand and follow directions (M=4.02, SD=.75), and presentation skills (M=4.00,
Ability to speak a second language ($M=2.50$, $SD=1.04$) was expressed as the least important communication skill by employers in this study.

Spreadsheets ($M=4.10$, $SD=.82$) and word-processing ($M=3.83$, $SD=.82$) were ranked as the two most important computer skills valued by survey participants. Ability to use the internet ($M=3.80$, $SD=.90$), and databases ($M=3.48$, $SD=1.09$) followed spreadsheets and word-processing. The next closest item was computer graphics with a mean of 2.56 ($SD=.98$).

The three items survey participants evaluated with character and importance all produced mean scores close to 5.00 (Extremely important). The mean scores produced for the three items were 4.96 ($SD=.30$) for integrity, 4.84 ($SD=.42$) for honesty, and 4.82 ($SD=.44$) for dependability.

In the technical areas of curriculum the employers who completed the survey instrument placed the greatest importance upon biological sciences ($M=4.30$, $SD=.77$). Mathematics ($M=4.21$, $SD=.80$) produced the second highest mean and was followed by environmental sciences ($M=3.36$, $SD=.97$).

Finally within objective two employers rated the importance of eleven academic courses for graduate students. The courses employers rated as most important to new graduate students entering the fed beef industry were nutrition courses ($M=4.58$, $SD=.63$), leadership courses ($M=3.88$, $SD=.85$), and research methods courses ($M=3.84$, $SD=.95$). The courses with the lowest means were social science ($M=2.29$, $SD=.81$), human resources ($M=2.51$, $SD=.91$), and foreign language ($M=2.77$, $SD=1.09$).

**Objective Three**

The third objective aimed to determine if difference exists in the preparation level of skills, knowledge and abilities and the importance of skills, knowledge and abilities of graduate students to the entry-level positions in the fed beef industry. An overall mean for interpersonal skills, communication skills, computer skills, character, and technical competency was calculated for preparation and importance. The difference between these two sets of numbers was also figured as a mean weighted discrepancy score (MWDS). Table 3 shows complete findings for this objective.

The section of character produced the highest overall mean score for both importance ($M=4.87$, $SD=.06$) and preparation ($M=3.51$, $SD=.05$). However, this section also had the greatest MWDS at 6.64, indicating the largest need for better preparation of graduates. The next greatest MWDS (MWDS=3.46) was found between importance ($M=3.76$, $SD=.38$) and preparation ($M=2.86$, $SD=.66$) in the area of interpersonal skills. A similar MWDS was found for the area of communication at 3.20 with an overall mean for importance at 3.72 ($SD=.38$), and an overall mean for preparation at 2.86 ($SD=.66$). The smallest MWDS between perceived importance ($M=3.06$, $SD=.82$) and student preparation ($M=3.08$, $SD=1.00$) was for computer skills (MWDS=.04)

**Objective Four**

The fourth objective of this study looked to determine the value of experiential education in the preparation of graduate students for the fed beef industry. Eight items comprised this objective and were led by general work experience ($M=3.86$, $SD=.88$) closely followed by career related employment ($M=3.70$, $SD=.88$), career related internship ($M=3.52$, $SD=.98$), and thesis/dissertation ($M=3.52$, $SD=1.27$). The four experiences employers put the least value toward were international experience ($M=2.16$, $SD=.97$), officer of a student club ($M=2.16$, $SD=.97$), officer of a student club ($M=2.16$, $SD=.97$),
active student club member ($M=2.26$, $SD=.93$), and bilingual ($M=2.65$, $SD=1.09$).
Complete results are listed in Table 4.

**Objective Five**

The fifth and final objective of this study identified changing trends in the industry that will affect the preparation of graduate students for the fed beef industry. Specifically top growth areas for employment in the fed beef industry for the next five to ten years were evaluated. Technology knowledge ($M=5.35$, $SD=.97$) was projected to have the most future growth potential. This future growth area was followed by data management ($M=4.95$, $SD=1.27$), logistics ($M=4.88$, $SD=.97$), and international relations ($M=4.67$, $SD=1.29$). The area determined to show the least future growth was cooperative extension ($M=1.88$, $SD=.96$). Table 5 highlights scores for the fifth objective.

**Conclusions**

Of the 41 individual skills employers assessed in this study, the ability to speak a second language was the only item where students were believed to be unprepared. On the other end of the scale students were felt to be most prepared in regards to the three computer skills which included use of the internet, word processing, and spreadsheets. Other items employers felt entry-level employees had received good preparation included technical competence in biological sciences, the ability to understand and follow directions in communications, and all three skills listed under character. Professional appearance and open minded to new experiences were the highest rated items measured under interpersonal skills.

Employers who completed this study rated 36 items higher in importance than preparation. Integrity, honesty, and dependability were the three skills survey participants valued as having the greatest importance. Other skills employers ranked highly were ability to understand and follow directions, initiative, and problem-solving skills. Items determined to be least important in this study included four of the eight computer skills along with the ability to speak a foreign language.

In evaluation of differences between preparation levels and importance of skills, the area of character produced the greatest separation of means. This was in spite of the fact character was determined to be the most important skill area and the area where students were believed to be best prepared. The other two skill areas which highlighted a potential need for improved education or training were interpersonal skills and communication. Less need for enhanced preparation of students was found for technical competence in curriculum and computer skills.

Employers valued general work experience and career related employment as the most valuable experiential learning opportunities students could acquire. Not surprisingly, course work was shown to be most valued for nutrition. This was followed by courses in leadership and then research methods. The projection of top growth area for employment in the fed beef industry within five to ten years showed technology knowledge, data management, and logistics as having the most potential for future growth.

**Discussion/Implications**

Fed beef industry employers who participated in this study valued the importance of integrity, honesty, and dependability over all other skills. Additionally, survey participants
believed graduate students entering the field had received good preparation in this skill area. However the greatest discrepancy between skill importance and preparation was found between these three items. With this in mind, new fed beef industry employees need not take the significance of character for granted. Further, those teaching and training future employees must remember the importance of not only teaching character skills, but also of modeling these characteristics.

Other skills study employers valued highly included students understanding and following directions, listening, initiative, and problem solving. Interestingly employers rated student preparation much higher for understanding and following directions than for basic listening skills. Still comparisons between skill preparation and importance showed a need for enhanced education and training in the areas of interpersonal skills and communication. Moreover mean weighted discrepancy scores revealed problem solving, decision making, management/business skills, and initiative as having the most room for growth within the graduate students entering the fed beef industry. Similar discrepancy was yielded for both listening and understanding and following directions.

In line with the profession, nutrition courses were ranked as most important to entry-level employees with ties to the Plains Nutrition Council. However leadership courses came in second out of the 11 course options. This was ahead of research methods, biochemistry, and statistics. In measurement of life skills fed beef employers perceived general work experience to be the most beneficial experiential learning opportunity available to students. Key growth areas for future employment were most closely connected to technology and data management.

Overall, the graduate students entering the profession of the fed beef industry are prepared. None the less, room for improved curriculum, education, and training is and always will be valid. Yet as with any profession, some amount of on the job training will be necessary to move graduate students from entry-level employee to business professional.

Recommendations

The target population of this study consisted of Plains Nutrition Council (PNC) members who make hiring decisions within the fed beef industry (N=129). This group consisted of both private industry employers and post-secondary education faculty. Forty-seven surveys were completed for a response rate of 36.4%, caution should be utilized in interpretation of results and generalizations to other populations should not occur. However based on this benchmark data it is recommended all parties involved consider the following:

1. Although employers assessed entry-level employees as prepared in the area of character, those entering the profession of the fed beef industry need to remember items associated with character ranked ahead of all other skills measured in this research. With this all business professionals should recall education of students or even employees does not just include training associated with technical skills, but also personal attributes such as honesty and integrity.
2. General work experience rated as the most valuable experiential learning opportunity by participants in this study. This information should be shared with undergraduate or even high school age students prior to entering graduate programs. Career internship opportunities should also be explored by both graduate and undergraduate students alike, based on study findings.
3. Leadership skills ranked toward the top for importance, but near the bottom for preparation of all interpersonal items. Leadership courses ranked second among eleven relevant course offerings. With this university faculty should look for curriculum opportunities to enhance leadership development of its graduate students. These opportunities could come in the form of course offerings, added responsibilities, or even extracurricular type activities. PNC members should explore potential leadership workshops at its annual conference or other educational events graduate students might attend.

4. This study provides baseline data regarding the perceptions of PNC members who make hiring decisions relative to new employees and their level of preparation for entry-level jobs. More in-depth research with employers should be performed to add to this pool of data. An additional study with new fed beef industry employees should also be conducted to analyze their self-perceived preparation level relative to their new career. Further, qualitative research methods such as one on one interview and focus groups should be considered as well. As previously stated, the more is known about the competencies required for the industry the more employable graduates there will be in the marketplace (Andelt, 1997).

5. Although entry-level employees were considered to be prepared for entry into the fed beef industry, room for improved training of graduate students was also shown. Industry employers should keep in mind all new employees no matter age or experience will require some level of training. Graduate students entering the fed beef industry should also keep in mind the value of personal initiative in learning a new career. All stakeholders should also be aware of the need for continual assessment of best educational practices for best preparation of future fed beef industry employees.

**Literature Cited**


Table 1. Employer Mean Values of Preparation of Skills

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Table 1. Employer Mean Values of Preparation of Skills (cont’d)

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Scale: 5=Thoroughly prepared; 4=Good preparation; 3=Prepared; 2=Somewhat prepared; 1=Unprepared

Table 2. Employer Mean Values of Importance of Skills

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<td>3</td>
<td>3.80</td>
<td>0.90</td>
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<tr>
<td>Databases</td>
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<td>3.48</td>
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Table 2. Employer Mean Values of Importance of Skills (cont’d)

<table>
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<tr>
<th>Computer Skills (cont’d)</th>
<th>Rank</th>
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<th>SD</th>
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<tr>
<td>Computer Control Systems</td>
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<td>Computerized accounting systems</td>
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<td>Computer graphics</td>
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<td>2.23</td>
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<tr>
<td>Computer aided design</td>
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<td>2.07</td>
<td>1.00</td>
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<tr>
<td><strong>Character</strong></td>
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<tr>
<td>Integrity</td>
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<tr>
<td>Honesty</td>
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<td>4.84</td>
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<tr>
<td>Dependability</td>
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<td>Social Sciences</td>
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<td>Humanities/ Fine Arts</td>
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Scale: 5=Extremely Important; 4=Very Important; 3=Important; 2=Somewhat important; 1=Unimportant

Table 3 Overall Mean Weighted Discrepancy Scores for Employability Skills

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<th></th>
<th>Preparation</th>
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<th>Importance</th>
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<th>MWDS</th>
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<td>M</td>
<td>SD</td>
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<td>SD</td>
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<tr>
<td>Interpersonal Skills</td>
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### Table 4. Perceived Value of Experiential Education

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<th>Table 4. Perceived Value of Experiential Education</th>
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<td>Thesis or Dissertation</td>
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<td>Bilingual</td>
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<td>Active Student Club Member</td>
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<tr>
<td>Officer of a Student Club</td>
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</tr>
<tr>
<td>International Experience</td>
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<td>0.97</td>
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</tbody>
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Scale: 1=not important; 2=somewhat important; 3=important; 4=very important; 5=extremely important

### Table 5. Changing Trends Relative to Future Employment in the Next 5-10 Years

<table>
<thead>
<tr>
<th>Table 5. Changing Trends Relative to Future Employment in the Next 5-10 Years</th>
<th>Career Areas</th>
<th>Rank</th>
<th>M</th>
<th>SD</th>
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<td>Technology Knowledge</td>
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<td>Data Management</td>
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<td></td>
<td>Logistics</td>
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<td></td>
<td>International Relations</td>
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<td>Cattle Health Assessment</td>
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<td></td>
<td>Cattle End Point Selection</td>
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<td>4.56</td>
<td>1.37</td>
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<td></td>
<td>Communications</td>
<td>7</td>
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<td></td>
<td>Education &amp; Training</td>
<td>8</td>
<td>4.33</td>
<td>1.18</td>
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<td></td>
<td>Middle Management</td>
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<td>Ingredient Procurement</td>
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<td>Equipment Knowledge</td>
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<td>Marketing Consultant on Staff</td>
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<td>Nutrition Consultants on Staff</td>
<td>13</td>
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<td>Cattle Procurement</td>
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<td></td>
<td>Veterinarian Consultant on Staff</td>
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<td>Grazing Management</td>
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<td></td>
<td>Cooperative Extension Agents</td>
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<td></td>
<td>Consumer Relations</td>
<td>5</td>
<td>4.57</td>
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</tr>
</tbody>
</table>

Scale: 1= Little Growth in this Area; 7=Significant Growth in this Area
Introduction

Cattle feeders have several methods of marketing cattle including traditional live weight basis (live), carcass weight basis (carcass), and individual carcass value basis (grid). Many feeders maintain a live selling mentality regardless of how cattle are marketed. This mind set likely leads to an emphasis on live performance and live cost of gain. Selling cattle based on increasing live cost of gain at the end of the feeding period assumes that carcass cost of gain parallels live. In addition, one assumes the cost of live gain exceeds the value of live gain at the same point in time as carcass cost exceeds carcass value. Analysis of closeout data by Hale (2011) or pens subjected to various grids by Feuz (2002) suggest that cattle sold on a carcass basis should be fed for additional days when compared with those sold live. Ultimately, converting carcass or grid marketing outcomes to a live basis does not change profitability, or lack thereof, for a particular pen or lot of cattle.

Understanding differences between live growth, carcass growth, and growth of the drop component are valuable in distinguishing how many days cattle need to be fed to optimize net return when cattle are sold either live, carcass, or on a grid. Serial harvest research studies are not a new concept. Berg and Butterfield (1968) reported how different tissue pools, muscle, fat, and bone, change through the first 24 months for Hereford and Friesian steers. Several others have investigated life time (Buckley et al., 1990) or feedlot phase (Hancock et al., 1987; Carstens et al., 1991; May et al., 1992; Johnson et al., 1996; Burns et al., 2004) changes in gross body composition. However, from a fed cattle perspective, the most important time to understand economically important changes occurs during the latter portion of the feeding period. During this time, the incremental value of gain may be exceeded by incremental daily costs (live or carcass cost of gain versus value of live or carcass weight). Hicks et al. (1987) may have been one of the first to concentrate serial harvest points at the end of the feeding period allowing investigation of the relationship between live and carcass gain and the resulting impact on feeding economics. Others have also investigated how days on feed affects the impact of various management practices on live and carcass performance in a small pen environment (Williams et al., 2008; Brandt et al., 1992; Van Koeveering et al., 1995; Haugen et al., 2004; Vasconcelos et al., 2008). As more cattle are marketed on a grid basis, understanding distribution of grid factors is of increasing importance. Large pen studies, while expensive to conduct, become important tools in understanding carcass weight, Quality grade and Yield grade distributions.

Description of Large Pen Studies

Over the previous 8 years, five large pen steer (Hutcheson et al., 2009; Streeter et al., 2008a, 2008b, 2009; Winterholler et al., 2007) and three large pen heifer (Hutcheson et al., 2004; Rathmann et al., 2012; Sissom et al., 2007) serial harvest studies have been conducted (Table 1). All but one study was conducted as a factorial to investigate the interaction between feeding
duration and beta adrenergic agonist or implant protocol responses. Surprisingly, interactions between growth performance technologies and serial harvest time were not detected in any of the factorial studies. The eighth study was conducted to determine the economics of feeding steers for various durations. Because interactions were not detected, main effect of days on feed were combined within steer and heifer studies. Most studies involved 3 serial harvest points spaced 21 days apart. One study involved 5 serial harvest points spaced 14 days apart and the final study included only 2 points 15 days apart. For all but Streeter et al. (2008b), the two point study, cattle would have normally been marketed at the middle harvest point. Because Streeter et al. (2008b) did not match days or centering of slaughter points, as in other studies, these data were not included in summaries or regression analysis. Individual measured and USDA plant data were collected for all cattle except Streeter et al. (2008b).

Serial harvest studies are a challenge to implement in a small pen environment. Conducting serial harvest studies in large pens creates numerous additional challenges. Large numbers of cattle needed to fill treatment blocks almost certainly dictate that all study blocks do not start on feed on the same day. Normally, in a non-serial harvest environment, blocks including all treatments are harvested on the same day so that the variation associated with processing plant effects, feeding conditions, and pen conditions are accounted for statistically by the effect of block. However, in a serial harvest study blocks contain all treatments, but by design, are not harvested on the same day.

### Live Performance

Live performance and shrunk final weight for steers and heifers are shown in Table 2. Final live weight changes across harvest days for steers meet expectations with shrunk live weight increasing linearly as additional days are added. Average daily gain (ADG) decreases and feed conversion increases as steers are fed for additional days. Dry matter intake was similar across days on feed. Changes in ADG, while expected, were inconsistent with a linear final weight through the serial harvest period. Presumably, final weight must increase in a quadratic manner in order for ADG to decrease with greater days on feed. However, Hicks et al. (1987) and Vasconceles et al. (2008) also detected a linear increase in final weight and a linear decrease in ADG as days on feed increased. In contrast, Van Koevering et al. (1995) observed a quadratic increase in shrunk final live weight. Perhaps the 42 day serial harvest period in the current studies was not long enough to detect the quadratic increase in live weight. If final live weight is regressed against day of serial harvest, the resulting slope of the linear line equals live rate of gain through the serial harvest period (Figure 1.). Average daily gain through the serial harvest period was 2.45 lb/d. Rate of live weight gain at the end of the feeding period was greater than most feed yard managers might expect.

Change in final weight of heifers was linear and quadratic (Table 2). Heifers reach physiological maturity at a younger chronological age than steers; consequently, one might expect a quadratic trend. Average daily gain decreased at an increasing rate while feed efficiency increased in a linear manner as days on feed increased. Buckley et al. (1990) conducted a serial harvest study with beef heifers from 2 d to 14 months of age but performance information was not included in the report. Other serial harvest heifer studies focusing on the end of the feeding period were not found. Regression of shrunk final live weight against days of serial harvest (Figure 2) was quadratic. From the beginning to the end of the serial harvest
period, live average daily gain was predicted to decrease from 2.76 to 2.20 lb/d, with a mean based on a linear relationship of 2.48 lb/d.

**Hot Carcass Weight and Carcass Transfer**

**Hot Carcass Weight**

Serial harvest allows for the determination of carcass rate of gain through the serial harvest period. One can determine period carcass gain by assuming that on day 0 all pens exhibit the same average hot carcass weights (HCW). Carcass weights noted after an additional 21 or 42 days on feed are also assumed to be representative of previously harvested treatments. Steer HCW (Table 3) increased 38 lb as serial harvest days advanced from 0 to 21 d, and 44 lb as harvest days advanced from 21 to 42 d. Heifer HCW (Table 3) increased 44 lb for the first 21 days of the serial harvest period and 32 lb for the second. When HCW was regressed against day of serial harvest on an individual study basis (Figure 1 and 2.) the slope of the linear line equals carcass rate of gain. For this group of studies steer HCW rate of gain was 2.10 lb / day; while heifer hot carcass rate of gain was 1.86 lb/d. Dressed yield (Table 3) increased linearly through the serial harvest period for steers and quadratically for heifers. Mathematically, if dressed yield increases through time, carcass growth must exceed growth of non-carcass components. Carstens et al. (1991) determined that the growth rate of the non-carcass component, including mesenteric fat, was less than the growth rate of the carcass. In addition, the fat content of the non-carcass component appeared to grow more rapidly than other non-carcass components. Buckley et al. (1990) noted that the fat content of the GI tract increased approximately 10 percentage units for each 3 months of life from 2 days (7% fat) to 14 months (54% fat) of age. The mass of visceral organs increases with increasing growth rate and appears to increase with greater energy/nutrient intake (Ferrell, 1988). Liver and digestive tract, with the exception of omental and mesenteric fat stores, would seem to grow at a rate much slower than the carcass after peak feed intake is obtained in feedlot cattle (Buckley et al., 1990). Liver and digestive tissues combine for 40 to 50% of an animal’s energy expenditures (Ferrell, 1988). How much of this energy expenditure was driven by omental and mesenteric fat deposition was not calculated.

**Carcass Transfer**

One method to quantify the effect of carcass weight gain relative to the gain of non carcass components is carcass transfer, where carcass transfer is defined as the proportion of incremental live weight gain that is captured as incremental HCW gain. Carcass transfer for the current large pen steer studies, on a period basis, was 88.6% for the first 21 day period and 87.3% for the second 21 day period (Table 3). Carcass transfer for the heifer studies was 86.6% for the first harvest interval and 65.8% for the second. Overall, carcass transfer appeared to be lower for the heifer studies than noted in the steer studies. Other serial harvest studies conducted with heifers could not be located in the literature to determine the validity of this observation. Determining carcass transfer from large pen studies on a period basis harvested through extended time periods is potentially biased by variation in processing, feeding, and pen conditions. Perhaps a more accurate approach is shown in Figures 2 and 3 where final live and HCW are regressed against day of serial harvest. The resulting slopes for the linear equations represent live and carcass rates of gain as described above. The ratio between live and carcass rates of gain equals carcass transfer. For the large pen steer studies, the ratio of carcass and live rate of
gain equals 86%, while carcass transfer for heifers was 75%, if one assumed linear shrunk live weight growth.

MacDonald et al. (2007), using a regression approach from studies with multiple live weight measurements, concluded that carcass transfer increases with days on feed until carcass rate of gain equals live rate of gain. The period data presented above does not suggest increasing carcass transfer with additional days on feed. Carcass transfer on a period basis was calculated from numerous small pen sources in the literature. Results were variable with four reports resulting in a general increase in carcass transfer as days advanced (Jesse et al., 1976; Hancock et al., 1987; Carstens et al., 1991; May et al., 1992); two reports resulting in a decrease in carcass transfer as days of harvest advanced (Brandt et al., 1992; Vasconcelos et al., 2008); and four reports demonstrating variable changes in carcass transfer as harvest day advanced (Hicks et al., 1987; Van Koevering et al., 1995; Johnson et al., 1996; Burns et al., 2004). Owens et al. (1995) noted that live weight measurements are inherently variable due to weighing conditions. The extent to which variability in carcass transfer through time is the result of weighing conditions cannot be determined. Variation would also be created by unexpected differences in the amount of omental and mesenteric fat between harvest groups. Regardless of the direction of carcass transfer responses, carcass transfer through the serial harvest period for all reports was greater than the corresponding dressed yield. Carcass transfer is an important concept for those selling cattle on a carcass or grid basis because incremental carcass cost of gain should be estimated by dividing incremental live cost of gain by carcass transfer not incremental live cost of gain divided by expected dressed yield.

**Carcass Characteristics**

Carcass characteristics included in Table 4 were limited to those which cattle feeders typically receive as premiums or discounts. Prime and Choice were combined into one category even though they represent different premium levels because the number of Prime carcasses was limited, and was not influenced by days on feed. Likewise, Yield Grade (YG) 5 carcasses were combined with YG 4 because of the limited number of Yield grade 5 carcasses observed. Yield Grade 1 and 2 carcasses are shown independently and combined. Separation of YG 1 and 2 carcasses resulted in unexpected variation in YG 1 carcasses between studies. Combining YG 1 and 2 carcasses reduced variation between studies.

**USDA Quality Grade**

Percentages of Choice or greater steer carcasses increased at a decreasing rate, while Select carcass percentages decreased at a decreasing rate as day of serial harvest advanced (Table 4). Change in Choice or greater carcasses were 9 percentage units between the first and second harvest points but only 3.4 percentage units between the second and third harvest points. Others have noted similar changes in Quality grade distribution (Hancock et al., 1987; Hicks et al., 1987; Williams et al., 1989; Van Koevering et al., 1995; Johnson et al., 1996; Vasconcelos et al., 2008). However, Brandt et al. (1992) and Haugen et al. (2004) detected no impact of advancing days on Quality grade distribution.

Percentages of Choice or greater heifer carcasses increased at an increasing rate, while percentages of Select carcasses decreased at an increasing rate as day of serial harvest advanced. As noted previously, other serial harvest studies with heifers were not found. Changes in Choice or greater is hard to reconcile with slowing live growth rate. Average YG was 2.35, 2.64 and
2.84 and backfat was 0.43, 0.51 and 0.54 in for 0, 21 and 42 days of serial harvest, respectively. Heifers, in these trials, may not have achieved adequate empty body fat (EBF) to express their genetic potential to grade Choice (Guiroy et al., 2002). Empty body fat was 27.4%, 28.6% and 29.4% for 0, 21, and 42 days of serial harvest. With the first two points at or below 29%, data would support heifers having inadequate EBF to express their genetic potential to grade Choice.

**Longissimus Muscle Area**

Longissimus muscle area (LMA; Table 4) increased for both steers and heifers as cattle were fed for more days. However, LMA as a proportion of HCW, decreased through time for both steers and heifers. This suggests that longissimus muscle growth rate may be slower than carcass growth rate. Data from other small pen serial harvest studies were used to calculate LMA/100 lb HCW. Eight studies demonstrated numeric decreases in LMA/100 lb HCW (Hancock et al. 1987; Hicks et al., 1987; May et al., 1992; Van Koevering et al., 1995; Johnson et al., 1996; Burns et al., 2004; Haugen et al., 2004; Vasconcelos et al., 2008); whereas, two studies demonstrated no apparent effect of harvest time (Williams et., 1989; Brandt et al., 1992). Concerns about large LMA are valid, but using a constant 1.80 in$^2$ per 100 lb of HCW would seem to consistently over-estimate LMA in carcasses that are larger, due to more days on feed.

**USDA Yield Grade**

Percentage of YG 1 or YG 1 and 2 steer carcasses (Table 4) decreased, while YG 4 or 4 and 5 percentages carcasses increased as serial harvest day advanced. One would expect carcasses to become fatter as days on feed increased resulting in a greater average YG and a resulting shift in YG distribution. Advancing serial harvest days resulted in a reduction in the percentage of YG 1 or YG 1 and 2 and an increase in the percentage of YG 4 or YG 4 and 5 carcasses. Haugen et al. (2004) and Vasconcelos et al. (2008) reported changes in YG distribution similar to those noted in the current studies. Heifers mature at lighter weights and younger chronological ages than steers. Typically, this observation results in YG distributions indicative of greater levels of finish for heifers compared with steers. Because steers and heifers, in these studies, were not from the same source or fed at the same time in the same locations, comparison of steers and heifers is not justified. However, one can argue that heifers used in the serial harvest studies were not fed to the same degree of finish as were the steers.

**Serial Harvest Live, Carcass, and Grid Marketing Economics**

**Economic Assumptions**

Evaluation of live, carcass, and grid based marketing required several assumptions. For steers (Table 5), a purchase weight of 712 lb at $143.50/cwt was assumed, while a purchase weight of 621 lb at $146/cwt was assumed for heifers (Table 6). Ration cost was fixed at $300/ton of DM. Final live weight was sold for $126/cwt, while the carcass price was $202/cwt (CattleFax, March 16, 2012, Issue 11: Volume XXXXIV). Because a live price of $126/cwt combined with a carcass price of $202/cwt results in an affective dressed yield of 62.7%; therefore, the carcass price was adjusted for the actual dressed yield of the 0 day serial harvest group of steers and heifers. Live and carcass weights were calculated using equations shown in Figure 1 and Figure 2 for steers and heifers, respectively. Incremental daily cost of gain for the 21 and 42 day serial harvest groups were determined by adding daily feed cost, yardage, and interest, resulting in a daily cost of $3.59/day for steers and $3.07/day for heifers. Heifer daily
cost was lower than noted with steers because heifers had a lower dry matter intake. Carcass cost of gain was estimated by assuming an initial dressed yield of 56% for steers and 55% for heifers (adapted from May et al., 1992 and Burns et al., 2004).

Grid marketing used the same base carcass price used for steers and heifers marketed on a carcass weight basis. Final carcass price was further adjusted based on discounts and premiums (Table 5) for USDA Quality Grade distribution, USDA Yield Grade distribution, and percentage of carcasses weighing greater than 1000 lb obtained from www.ams.usda.gov.mnreports/lm_ct155.txt accessed on March 20, 2012. Premiums and discounts were not tied to plant averages. Consequently, all carcasses in a premium or discount category received the premium or discount noted in Table 5. Because research studies were conducted over several years heavy weight carcass discount level were not reported at a common weight. Therefore, percentages of carcasses above 1000 lb were determined by assuming a standard deviation of carcass weight of 100 lb and a normal carcass weight distribution for both steers and heifers. Cost of production was identical regardless of marketing method employed. Differences in transportation costs, due to marketing method, were not accounted for in this example.

**Economic Outcomes**

Live and carcass cost of gain increased as steers were fed for more days (Table 7) resulting in increasing live and carcass breakeven prices. Incremental cost of live weight or carcass weight gain was constant throughout the serial harvest period because live animal and carcass growth were linear. However, incremental live cost of gain exceeded live selling price; whereas, incremental carcass cost of gain remained well below carcass selling price. Comparisons between steers sold live or on a carcass weight basis (Figure 3) demonstrate the impact of carcass transfer on net return. As steers were fed for additional days live selling had increasingly negative net return, while selling on a carcass weight basis resulted in an increasingly positive net return. The net return for steers sold live or on a carcass weight basis mirror images of the live and carcass weight gain graph illustrating carcass transfer reported by MacDonald et al. (2007). Hale (2011) compared close out information from the Professional Cattle Consultant database with two different economic conditions concluding that cattle sold live should be marketed 70 days earlier than those sold on a carcass basis. Hicks et al. (1987) and Feuz (2002) conducted economic analysis of research data concluding that cattle sold on a carcass basis should be fed for more days than those sold live.

Grid marketing resulted in a different outcome (Figure 3) where effects of increasing percentages of carcasses greater than 1000 lb resulted in a decreasing carcass value when steers were fed for additional days. Increasing serial harvest days from 0 to 21 days resulted in a modest increase in net return; however, increasing serial harvest days from 21 to 42 resulted in a dramatic reduction in net return. For steers, percentage of carcasses greater than 1000 lb becomes the limiting factor that determines if additional days can be added to the feeding period. Management of carcass weight by sorting to control variation results in an increase in net return that parallels net returns from carcasses sold on a carcass weight basis (Figure 3). Understanding variation of carcass weight provides opportunity to optimize carcass weight and net return without increasing the percentage of carcasses in excess of 1000 lb.
Cost of gain on a live or carcass basis increased with additional total days on feed or advancing days of serial harvest for heifers (Table 7). Unlike the steer serial harvest data, heifer breakeven on a live or carcass basis tended to decline with additional days on feed. Incremental live cost of gain was $116.55/cwt for the first 21 day serial harvest period staying below selling price. During the second 21 day period incremental cost of gain rose to $133.96/cwt, above the selling price of $126/cwt. Changes in live cost of gain and incremental cost of gain occur because live weight increases at a decreasing rate through the serial harvest period. Carcass cost of gain increased linearly with carcass weight. Heifers sold live tended to result in relatively flat net return. Live net returns (Figure 4) differed from those noted with steers because heifers consumed less feed resulting in a $0.52/d lower daily cost than with steers. When heifer carcasses were sold on a carcass weight or grid basis (Figure 4) parallel net returns were noted with both increasing as heifers were fed for additional days. Unlike the steer serial harvest studies, percentage of carcasses greater than 1000 lb does not limit carcass value. Recall that heifer carcasses were 100 lb lighter than steer carcasses at each serial harvest time. Similar to studies with steers, heifers were not fed to a heavy enough carcass weight to identify non-linear carcass growth. Typically, one would expect heifer carcasses to be fatter with higher average YG and a larger percentage of YG 4 and 5 carcasses than steers. That was not the case for the steer and heifer studies presented. However, one would normally expect the percentage of YG 4 and 5 carcasses to limit the number of additional days that heifers could be fed before grid adjusted carcass breakeven exceeds carcass value.

Conclusions

Large pen serial harvest studies are a valuable research tool allowing one to understand the differences between live and carcass growth rates. Live growth rate slows more than carcass growth rate at the end of the feeding period because of carcass transfer. Consequently, optimal endpoints differ substantially based on how cattle are marketed. Available steer and heifer studies have not employed long enough serial harvest periods or fed to high enough carcass weights to identify decreasing carcass growth rates. When carcass growth rate remains linear for steers and heifers factors other than cost of gain would appear to dictate when cattle are sold. For steers, carcass weight limits additional days either through negative feedback form processors in the case of carcass weight marketing or decreasing carcass value in the case of grid marketing. Carcass weight would appear to be less of a limitation for heifers. Level of fatness, however, likely creates the same limitations noted with steers and carcass weight. Opportunities exits to control carcass weight variation through sorting steers resulting in optimization of net return when marketing on a grid. Similar opportunities to reduce variation in carcass fatness of heifers appear to be more challenging.

Literature Cited

of zilpaterol hydrochloride and days on the finishing diet on feedlot performance, carcass characteristics, and tenderness in beef heifers. J. Anim. Sci. Accepted.


**Table 1. Description of large pen serial harvest studies**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Treatments</th>
<th>Pens</th>
<th>Cattle</th>
<th>Year</th>
<th>Points</th>
<th>Sex</th>
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<td>4140</td>
<td>2009</td>
<td>5</td>
<td>S</td>
</tr>
<tr>
<td>Streeter et al., 2009</td>
<td>Zilmax x Harvest</td>
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<td>3830</td>
<td>2009</td>
<td>3</td>
<td>S</td>
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<tr>
<td>Streeter et al., 2008a</td>
<td>Implant x Harvest</td>
<td>24</td>
<td>2088</td>
<td>2008</td>
<td>3</td>
<td>S</td>
</tr>
<tr>
<td>Winterholler et al., 2007</td>
<td>Optaflexx x Harvest</td>
<td>24</td>
<td>2252</td>
<td>2005</td>
<td>3</td>
<td>S</td>
</tr>
<tr>
<td>Streeter et al., 2008b</td>
<td>Zilmax x Harvest</td>
<td>20</td>
<td>5632</td>
<td>2008</td>
<td>2</td>
<td>S</td>
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<tr>
<td>Rathmann et al., 2012</td>
<td>Zilmax x Harvest</td>
<td>36</td>
<td>3266</td>
<td>2008</td>
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<td>H</td>
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<tr>
<td>Hutcheson et al., 2004</td>
<td>Optaflexx x Harvest</td>
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<td>2067</td>
<td>2004</td>
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<td>H</td>
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<tr>
<td>Sissom et al., 2007</td>
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<td>H</td>
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### Table 2. Summary of steer and heifer live performance data

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<th>Item</th>
<th>Day on Feed (Day of Serial Harvest)</th>
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<th>174 (21)</th>
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<td>712</td>
<td>712</td>
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<tr>
<td>Final wt., lb</td>
<td>Steer</td>
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<td>1318</td>
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<td>ADG, lb</td>
<td>Steer</td>
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<td>3.47</td>
<td>3.35</td>
</tr>
<tr>
<td>Feed:gain</td>
<td>Steer</td>
<td>5.57</td>
<td>5.97</td>
<td>6.15</td>
</tr>
<tr>
<td>DMI, lb</td>
<td>Steer</td>
<td>20.8</td>
<td>20.7</td>
<td>20.6</td>
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<tr>
<td>Initial wt., lb</td>
<td>Heifer</td>
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<tr>
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<td>Heifer</td>
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<td>3.34</td>
<td>3.20</td>
</tr>
<tr>
<td>Feed:gain</td>
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<td>5.10</td>
<td>5.30</td>
<td>5.49</td>
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<td>DMI, lb</td>
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<td>17.74</td>
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### Table 3. Steer and heifer HCW data

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<tr>
<td>Steer HCW lb</td>
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<td>847</td>
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<tr>
<td>Dressed yield, %</td>
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<td>63.6</td>
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<tr>
<td>Carcass transfer$^a$, %</td>
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<td>88.6</td>
<td>87.3</td>
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<td>Heifer HCW, lb</td>
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<td>707</td>
<td>751</td>
<td>783</td>
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<td>Dressed yield, %</td>
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<td>63.58</td>
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<td>64.39</td>
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<tr>
<td>Carcass transfer$^a$, %</td>
<td></td>
<td>86.6</td>
<td>65.8</td>
<td></td>
</tr>
</tbody>
</table>

$^a$Carcass transfer is the proportion of live weight gain captured as carcass gain (period change in carcass weight / period change in live weight *100).
Table 4. Summary of steer and heifer carcass characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Steer</th>
<th>Day of Serial Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Steer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice or greater, %</td>
<td>41.50</td>
<td>50.60</td>
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<tr>
<td>Select, %</td>
<td>54.20</td>
<td>47.50</td>
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<tr>
<td>LMA, in²</td>
<td>14.10</td>
<td>14.30</td>
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<tr>
<td>LMA / 100 lb HCW</td>
<td>1.74</td>
<td>1.70</td>
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<tr>
<td>Yield grade 1, %</td>
<td>21.79</td>
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<tr>
<td>Yield grade 1 &amp; 2, %</td>
<td>64.10</td>
<td>56.17</td>
</tr>
<tr>
<td>Yield grade 4, %</td>
<td>5.42</td>
<td>8.80</td>
</tr>
<tr>
<td>Yield grade 4 &amp; 5, %</td>
<td>5.87</td>
<td>10.73</td>
</tr>
<tr>
<td>Heifer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice or greater, %</td>
<td>43.90</td>
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</tr>
<tr>
<td>Select, %</td>
<td>52.68</td>
<td>50.70</td>
</tr>
<tr>
<td>LMA, in²</td>
<td>13.67</td>
<td>13.98</td>
</tr>
<tr>
<td>LMA / 100 lb HCW</td>
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<td>1.86</td>
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<td>Yield grade 1, %</td>
<td>27.05</td>
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<td>Yield grade 1 &amp; 2, %</td>
<td>75.15</td>
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<tr>
<td>Yield grade 4, %</td>
<td>1.93</td>
<td>4.35</td>
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<tr>
<td>Yield grade 4 &amp; 5, %</td>
<td>2.23</td>
<td>4.96</td>
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### Table 5. Assumptions used in economic analysis for steers

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Day of Serial Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase weight, lb</td>
<td>$143.50/cwt</td>
<td>712</td>
</tr>
<tr>
<td>ADG, lb</td>
<td>3.73</td>
<td>2.45</td>
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<tr>
<td>Incremental ADG, lb</td>
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<td>2.45</td>
</tr>
<tr>
<td>Feed efficiency</td>
<td>5.57</td>
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<tr>
<td>Incremental efficiency</td>
<td></td>
<td>8.41</td>
</tr>
<tr>
<td>DMI, lb/d</td>
<td>$300/ton</td>
<td>20.6</td>
</tr>
<tr>
<td>Final weight&lt;sup&gt;b&lt;/sup&gt;, lb</td>
<td>$126/cwt&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1269.9</td>
</tr>
<tr>
<td>HCW&lt;sup&gt;b&lt;/sup&gt;, lb</td>
<td>$202/cwt&lt;sup&gt;d&lt;/sup&gt;</td>
<td>808.2</td>
</tr>
<tr>
<td>Heavy wt carcasses&lt;sup&gt;c&lt;/sup&gt;, %</td>
<td>&lt;$21.54/cwt&gt;</td>
<td>2.76</td>
</tr>
<tr>
<td>Prime Premium</td>
<td>$15.11/cwt</td>
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</tr>
<tr>
<td>Premium Choice</td>
<td>$3.00/cwt</td>
<td></td>
</tr>
<tr>
<td>Choice-Select spread</td>
<td>&lt;$2.00/cwt&gt;</td>
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</tr>
<tr>
<td>YG 1 Premium</td>
<td>$3.38/cwt</td>
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<tr>
<td>YG 2 Premium</td>
<td>$1.46/cwt</td>
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<tr>
<td>YG 4 Discount</td>
<td>&lt;$11.38/cwt&gt;</td>
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<tr>
<td>YG 5 Discount</td>
<td>&lt;$17.46/cwt&gt;</td>
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</table>


<sup>b</sup> Final Live weight and hot carcass weights were calculated based on linear increases (Figure 1) from day 0 to day 42 of the serial harvest.

<sup>c</sup> Percentage of carcasses weighing more than 1000 lb were calculated based on projected carcass weight and a carcass weight standard deviation of 100 lb.

<sup>d</sup> CattleFax, March 16, 2012, Issue 11: Volume XXXXIV.

### Table 6. Assumptions used in economic analysis for heifers

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Day of Serial Harvest</th>
</tr>
</thead>
<tbody>
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<td>Purchase weight, lb</td>
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<tr>
<td>ADG, lb</td>
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<td></td>
</tr>
<tr>
<td>Incremental ADG, lb</td>
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<td>2.64</td>
</tr>
<tr>
<td>Feed efficiency</td>
<td>5.10</td>
<td>2.30</td>
</tr>
<tr>
<td>Incremental efficiency</td>
<td></td>
<td>6.67</td>
</tr>
<tr>
<td>DMI, lb/d</td>
<td>$300/ton</td>
<td>17.6</td>
</tr>
<tr>
<td>Final weight&lt;sup&gt;b&lt;/sup&gt;, lb</td>
<td>$126/cwt&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1114.3</td>
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<tr>
<td>HCW&lt;sup&gt;b&lt;/sup&gt;, lb</td>
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<td>708.7</td>
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<tr>
<td>Heavy wt carcasses&lt;sup&gt;c&lt;/sup&gt;, %</td>
<td>&lt;$21.54/cwt&gt;</td>
<td>0.18</td>
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<sup>a</sup> Premiums and discounts obtained from [www.ams.usda.gov/mnreports/ln_ct_155.txt](http://www.ams.usda.gov/mnreports/ln_ct_155.txt) for week of March 19, 2012 accessed March 20, 2012 (Table 5).

<sup>b</sup> Final Live weight and hot carcass weights were calculated based linear increases (Figure 2) from day 0 to day 42 of the serial harvest.

<sup>c</sup> Percentage of carcasses weighing more than 1000 lb were calculated based on projected carcass weight and a carcass weight standard deviation of 100 lb.
Table 7. Live and carcass cost of gain and incremental cost of gain

<table>
<thead>
<tr>
<th>Item</th>
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<th>42</th>
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</thead>
<tbody>
<tr>
<td><strong>Steers - Live</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cost of gain, $/cwt</td>
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<td>109.64</td>
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<td>Incremental cost of gain, $/cwt</td>
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<tr>
<td>Breakeven, $/cwt</td>
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<td><strong>Carcass</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cost of gain, $/cwt</td>
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<td>Breakeven, $/cwt</td>
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<td><strong>Heifers - Live</strong></td>
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<td>Cost of gain, $/cwt</td>
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<td>Breakeven, $/cwt</td>
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<tr>
<td>Incremental cost of gain, $/cwt</td>
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<tr>
<td>Breakeven, $/cwt</td>
<td>197.83</td>
<td>195.38</td>
<td>195.19</td>
</tr>
</tbody>
</table>

\*Carcass cost of gain was based on an assumed dressed yield of 56% for steers with an initial weight of 712 lb and 55% for heifers with an initial weight of 621 lb (adapted from May et al., 1992 and Burns et al., 2004)
Figure 1. Effect of serial harvest day on shrank final live weight, lb (SFLW = 2.4489*Day+1269.2, $R^2 = 0.7709$) and hot carcass weight, lb (HCW = 2.1050*Day+808.25, $R^2 = 0.7983$) of feedlot steers

Figure 2. Effect of serial harvest day on shrank final live weight (SFLW = -0.0081*Day$^2$ + 2.8061*Day + 1114.3, $R^2 = 0.7104$) and hot carcass weight (HCW = 1.8554*Day + 708.7, $R^2 = 0.7260$) of feedlot heifers
Figure 3. Net economic return for steers marketed live, or as carcasses in the beef or on an average USDA grid for the week of March 16\textsuperscript{th}, 2012

Figure 4. Net economic return for heifer marketed live, or as carcasses in the beef or on an average USDA grid for the week of March 16\textsuperscript{th}, 2012
Traditional and Alternative Sources of Fiber – Roughage Values, Effectiveness, and Concentrations in Starting and Finishing Diets

M. L. Galyean1 and M. E. Hubbert2
1Department of Animal and Food Sciences, Texas Tech University, Lubbock,
2Clayton Livestock Research Center, New Mexico State University, Clayton

Major Points

• Analyses of data from six experiments conducted at a single location indicated that receiving period morbidity (percentage of cattle pulled and treated) decreased slightly as roughage concentration increased in diets for newly received, stressed cattle, but there are tradeoffs between dietary roughage concentration and performance by newly received cattle. Research on the value of high-fiber, grain byproducts in receiving diets is limited, and results are equivocal. Additional research is needed on the effects of roughage source and physical form in diets for newly received cattle.

• Analyses of published data indicated that intakes of DM and NEg by feedlot beef cattle increased linearly as dietary neutral detergent fiber (NDF) concentration increased (range of approximately 7.5 to 35% NDF on a DM basis). Both total dietary NDF and NDF from only the roughage portion of the diet are effective for determining the relative value of different roughage sources in beef feedlot diets in terms of achieving equal DMI.

• Fiber in byproduct feeds like wet corn gluten feed and distillers grains dilute grain starch and might have the ability to substitute, in part, for traditional roughage; however, using the NDF concentration of these byproducts to determine roughage equivalency is not feasible. Other alternatives to traditional roughage sources include byproducts like cotton gin trash and non-traditional sources of fiber like newsprint. For such high-fiber byproducts, NDF concentration is likely to provide a means of determining equivalency to common roughage sources.

• Altering dietary roughage concentration by feeding a low concentration with intermittent delivery of higher concentrations or coarser forms might provide a means of decreasing overall roughage use without sacrificing animal health and performance, but logistics of such approaches could be a problem in large-scale operations, and data to test the validity of such practices are virtually non-existent.

• Significant research questions remain to be addressed before we will fully understand the chemical, physiological, and physical roles of roughage in feedlot diets.

Introduction

Cattle consume roughage throughout their lives. Indeed, consuming roughage is generally required for cattle to express rumination, which is one of the most noteworthy features of the family Bovidae and other families of the order Ruminantia. Most beef calves are familiar with roughage, so when they are weaned and marketed, providing long-stemmed roughage is a common practice. Once cattle are in feedlots, including a small percentage of roughage in high-grain diets helps to prevent digestive disorders like acidosis and to maximize NE intake. In their survey of 29 nutritional consultants located in the major U.S. cattle feeding areas, Vasconcelos and Galyean (2007) reported that finishing diets (DM basis) averaged 8.3 and 9% roughage in
summer and winter, respectively, with a range among the consultants of 0 to 13.5% roughage. Corn silage and alfalfa hay were the most common roughage sources. Both source and concentration of roughage affects DMI by feedlot cattle (Defoor et al., 2002), ultimately affecting ADG and G:F.

Recent drought conditions in the High Plains cattle feeding region and associated low supplies of traditional roughage sources have placed renewed emphasis on knowing how to substitute one roughage source for another and choosing the optimal roughage concentration in feedlot diets. In this paper, we will consider the role of roughage in diets for newly received cattle, the physical and physiological effects of roughage in feedlot cattle diets, the use of NDF as a means of assessing the roughage value for feedlot cattle, and potential alternatives to traditional roughages and roughage feeding practices. Readers are referred to Rivera et al. (2005) and Galyean and Vasconcelos (2008), as these papers provided much of the foundation for the present review.

Roughage in Diets of Newly Received Cattle

Although preconditioning is becoming more common, weaning and shipping cattle to locations where they will be grazed or start a feedlot-based growing and finishing program is still a normal part of marketing cattle. These activities also are critical to cattle health and performance. Bovine respiratory disease complex (BRD) is commonly associated with marketing of newly weaned, lightweight cattle, and stressful conditions associated with weaning, marketing, and transportation contribute to a greater risk of BRD. Degree of stress, previous plane of nutrition, genetics, and health history interact with exposure to viral and bacterial agents, reflecting the complex nature of BRD (Frank, 1986). Estimates suggest that BRD is responsible for approximately 75% of feedlot cattle morbidities and 50% of mortalities (Edwards, 1996). Moreover, Gardner et al. (1999) reported that steers treated for BRD had lower ADG and hot carcass weights, with fewer cattle grading USDA Choice than non-treated counterparts. More recently, Holland et al. (2010) reported that heifers treated for BRD during a 63-d receiving phase compensated during finishing when segregated by number of times treated, suggesting that most of the negative effect of BRD on performance occurs during the receiving period.

Nutritional management of stressed cattle is important because it can help provide calves the resources needed to mount an immune defense against pathogens associated with BRD. Galyean et al. (1999) and Duff and Galyean (2007) reviewed the role of various nutritional supplements and management practices in mitigating the effects of BRD. It is clear from their reviews that dietary energy concentration is an important factor affecting how beef cattle respond to a BRD challenge. Because performance during the receiving period is crucial to the economic outcome of cattle feeding (e.g., Holland et al., 2010), formulating receiving diets that result in optimal performance is critical. Energy concentration in receiving diets is most often modified by changing the roughage concentration. The approach of starting lightweight, stressed cattle on a high-roughage diet is based on the purported advantage of decreasing BRD mortality and morbidity. Conversely, the justification for starting cattle on a diet with more concentrate (less roughage) is an improvement in performance and thereby increased profitability. Thus, the challenge is to find the optimal energy concentration that provides acceptable performance without negatively affecting receiving-period morbidity and mortality. For example, Lofgreen (1979) reported that cattle received on a 75% concentrate diet, with or without long-stemmed
alfalfa hay during the first week after arrival, had greater ADG and feed intake than cattle started on hay alone. Nonetheless, Lofgreen et al. (1981) noted that although the cattle started on hay alone did not gain as well as those fed the 75% concentrate diet, they tended to have fewer total sick days than calves received on the higher concentrate diets. In agreement with the general findings of Lofgreen’s studies, Fluharty and Loerch (1996) reported that as dietary concentrate increased from 70 to 85%, DMI increased (without an increase in ADG), but in contrast to the results of Lofgreen et al. (1981), morbidity was not affected by diet. Berry et al. (2004a,b) fed newly received calves diets that were arranged in a 2 x 2 factorial (two energy and two starch concentrations) in an effort to sort out whether changes in energy per se or starch affected performance and health. Although energy concentration did not affect performance or overall morbidity, some effects on shedding of BRD pathogens were noted in response to energy concentration.

Rivera et al. (2005) used mixed-model regression methods on data from six experiments conducted by Dr. Glen Lofgreen at the New Mexico State University Clayton Livestock Research Center (CLRC) to evaluate the relationship between dietary roughage concentration (DM basis) and receiving-period morbidity, ADG, and DMI. Data from specific experiments used in their analyses were taken from various CLRC Progress Reports and are listed by Rivera et al. (2005). Results of their analyses are presented in Figure 1. Morbidity from bovine respiratory disease (BRD) decreased slightly as dietary roughage concentration increased (morbidity, % = 49.59 – 0.0675 x roughage, %; P = 0.003). Both ADG (ADG, kg = 1.17 – 0.0089 x roughage, %; P < 0.001) and DMI (DMI, kg/d = 5.34 – 0.0135 x roughage, %; P < 0.001) responded negatively to increasing roughage concentration in receiving diets. Hypothetical economic analysis performed by Rivera et al. (2005) suggested that the decreased morbidity with a 100 vs. a 40% roughage diet would not offset the loss in profit resulting from less ADG when the 100% roughage diet was fed.

Although Rivera et al. (2005) ascribed changes in receiving period performance and morbidity to altered roughage concentration, other factors such as grain source, grain processing, and protein concentration might have confounded the results. Unfortunately, because compositional information was not available in the data source, inferences made about factors other than roughage concentration are not feasible. For example, in some CLRC experiments, cattle in one treatment group were fed only native grass (prairie) hay during the receiving period, such that CP intake was likely not adequate to meet protein requirements. Conversely, the 75% concentrate, milled diets that were compared with native grass hay likely contained in excess of 16% CP on a DM basis, thereby providing more than adequate CP. Mixed-model methods used in the analysis do not account for any systematic bias introduced by confounding factors such as dietary CP concentration. As a result, the equations generated by Rivera et al. (2005) should not be assumed to be generally applicable or to have predictive ability; rather, because they do not account fully for potential confounding factors, they should be viewed as descriptive of the general effects of roughage concentration within the dataset. Despite this precaution, it is noteworthy that the conclusions one would likely draw relative to the effects of roughage concentration on health and performance from evaluation of the trials in which CP concentration might have been a confounding factor are essentially the same as the conclusions that would be drawn from trials in which only milled diets were fed and CP concentration would probably have been adequate across the range of roughage concentrations.

Based on the Rivera et al. (2005) analyses, BRD morbidity in lightweight, highly stressed cattle decreased when roughage concentration increased. This change was very small, however,
and the disadvantage in ADG and DMI that occurs when cattle are fed receiving diets with very high roughage concentrations would probably offset any positive effects of increased roughage concentration on morbidity. Not surprisingly, this conclusion is essentially the same reached by Lofgreen (1988). In a summary of his extensive work on the subject, Dr. Lofgreen suggested that the optimal strategy for starting lightweight, highly stressed, newly received cattle on feed would be to offer a 50 to 75% concentrate, milled diet. This approach generally allows cattle to perform well without economically adverse effects on health during the receiving period. Within typical receiving diets, little is known about the effects of roughage source and physical form; thus, additional research is needed to address the role of these factors.

One recent innovation in the area of starting cattle on feed has been the use of high concentrations of Sweet Bran wet corn gluten feed. In a 31-d experiment, Schneider et al. (2011) fed a control diet with 35% alfalfa, 30% Sweet Bran, and 30% dry-rolled corn and two diets (RAMP and Test Starter) with a high concentration of Sweet Bran and a minimal concentration of traditional roughage or grain to crossbred steers (initial BW = 261 kg). Overall DMI and G:F did not differ among treatments in the Schneider et al. (2011) study, and ADG was greater by steers fed RAMP vs. those fed the control diet (1.03 vs. 0.9 kg/d). Ponce et al. (2012) fed the same high Sweet Bran receiving diets as Schneider et al. (2011), but a different control diet, to two truckloads of newly received heifers (average initial BW = 184 kg). The BW at the end of the 35-d period was approximately 12 kg greater ($P = 0.002$) for Control heifers than for the average of heifers fed the 2 complete starter diets, and ADG ($P \leq 0.001$), intake of milled feed DM ($P \leq 0.001$), and G:F ($P \leq 0.001$) were all greater for Control heifers than for the average of the two high-Sweet Bran diets. The percentage of heifers treated for BRD ($P > 0.433$) did not differ among the three treatments. The control diet used by Ponce et al. (2012) did not contain Sweet Bran and consisted of approximately 48% steam-flaked corn, 20% ground alfalfa, 15% cottonseed hulls, and 8% cottonseed meal, which might partially explain the different results for the two studies. Interestingly, the ADG by cattle in both experiments for the two high Sweet Bran diets was very similar (approximately 1 kg/d).

Although the picture is perhaps unclear for lightweight, newly received cattle, diets with high concentrations of Sweet Bran seem to be an effective means of starting older, heavier (e.g., yearling) cattle on feed. MacDonald and Luebbe (2012) used crossbred steers with an initial BW of 332 kg to compare a traditional adaptation procedure (45% alfalfa, 32.5% steam-flaked corn, and 20% Sweet Bran decreased in steps of 7 d each to a finishing diet with 8% alfalfa hay, 20% Sweet Bran, and 66% steam-flaked corn) to a procedure based on starter diets with high concentrations of Sweet Bran. The four high Sweet Bran-based diets included a diet with 88% Sweet Bran and 8% alfalfa hay and three diets in which some of the Sweet Bran was replaced by cottonseed hulls. After the 21-d adaptation period, all cattle were fed the finishing diet described previously. For the overall feeding period (163 average days on feed), the 88% Sweet Bran adaptation treatment resulted in greater carcass-adjusted ADG and final BW ($P < 0.05$) than the control diet, but results were inconsistent with the adaptation diets that contained added cottonseed hulls (the same as or lower performance than the control diet). The authors concluded that an adaptation strategy based on a high concentration of Sweet Bran was a viable alternative to traditional approaches. It would be interesting to conduct additional work to compare this adaptation approach to traditional approaches in which the control diets do not include Sweet Bran or other byproducts.
Roughage in Diets of Growing and Finishing Cattle

Physical and Physiological Effects of Roughage

Gastrointestinal fill potentially limits energy intake by ruminants until diets contain a sufficient energy concentration (and associated greater digestibility) that physiological factors become the primary regulators of feed intake (Mertens, 1994). Thus, adding a fibrous, bulky ingredient that is high in NDF to a bulky, fibrous diet should decrease intakes of DM and energy. Conversely, adding a bulky, fibrous ingredient to a high-grain (low NDF) diet should increase DMI because the animal can compensate for the diluting effect of NDF by increasing DMI, thereby maintaining energy intake. A real-world application of this theory is demonstrated by consulting nutritionists who increase dietary roughage concentration during the winter to stimulate DMI (Vasconcelos and Galyean, 2007). Galyean and Defoor (2003) reviewed several applied research trials in which increased DMI associated with added roughage has been demonstrated. What is not well defined, however, are the response of NDF concentrations at which fill becomes limiting with typical feedlot diets. Diets sufficiently high in NDF to limit DMI might offer less risk from acidosis or other metabolic problems, but they are rarely viable from an economic standpoint. Thus, a practical point of interest with roughage concentration in feedlot diets is defining the concentration below the point of physical restriction, at which relatively small changes in NDF concentration caused by increasing roughage concentration or switching to a roughage with a higher fiber content increases not only DMI but also NEg intake. Such an effect of relatively small changes in NDF concentration might occur not only as a result energy dilution but because of several possible reasons, including altered ruminal or metabolic acid load, or changes in fermentation end products and digesta kinetics that favor greater DMI.

We will take a brief look at some of these possible reasons for the effect of NDF on NEg intake. Changes in gastrointestinal tract and metabolic acidity, or in the temporal patterns of acidity, could be related to the effects of NDF on DMI by feedlot cattle. Armentano and Pereira (1997) noted that chewing time and forage NDF concentration are typically related in a positive manner, which means that added roughage (and thereby greater roughage and total dietary NDF) should stimulate chewing and saliva production. The pH of the rumen reflects the balance between acid production and secretion of buffers in saliva (Allen, 1997), so increasing the NDF intake per unit of fermentable carbohydrate in feedlot diets should increase ruminal pH or decrease the time that pH is low (e.g., time below pH 5.6 or some other threshold). As a result, small increases in roughage concentration that increase salivary buffering with high-grain feedlot diets might increase intake more than expected from the compensation for energy dilution alone (Galyean and Defoor, 2003). Source of NDF (e.g., coarse roughages vs. high-fiber byproduct feeds) and the physical nature of the fiber (e.g., particle size; Allen, 1997) affect relationships between chewing activity and dietary NDF concentration. In that regard, Allen (1997) reported in dairy cows that NDF from forage, but not total dietary NDF concentration, was related to ruminal pH. Relationships between NDF (total or from the roughage portion of the diet) and chewing time, saliva flow, and ruminal pH are generally not known for typical feedlot diets, so further research will be required to determine the significance of salivary buffering as a contributor to the effects of NDF on DMI.

To our knowledge, effects of NDF source and concentration on absorption of acids from the rumen or acidity in the intestines have not been determined, but Galyean and Defoor (2003) suggested that direct effects do not seem likely. According to Allen (1997), buffering capacity of roughages would play a very minor role in the rumen, only being important at a pH less than
5; however, the potential role of roughages as a buffering agent in the proximal small intestine might need to be considered. Possible alterations in digesta flow from the rumen associated with dietary roughage could shift absorption of acids from the rumen to the intestines. In addition, water intake is positively related to DMI (NRC, 1996, 2001). Thus, if added roughage increases DMI with an associated increase in water intake, gut acidity might decrease because of the diluting effects of greater water intake (Galyean and Defoor, 2003). Timing of acid absorption also might be altered with increased water intake (Galyean and Defoor, 2003), distributing acid load more evenly over time. To our knowledge, research has yet to be conducted relative to how dietary NDF concentration affects water intake and gut acidity in feedlot beef cattle.

Infusion of propionate can decrease feed intake by ruminants (Allen et al., 2005), so changes in propionate production with high-grain, low-roughage diets might be related to effects of roughage on DMI. Armentano and Pereira (1997) reported that NDF supplied by forage in the diet is correlated positively with ruminal fluid acetate:propionate ratio in dairy cattle. Thus, the positive relationship between DMI and NDF supplied by roughage in feedlot beef cattle could reflect decreases in propionate production and absorption. Moreover, because fermentation of starch to VFA increases ruminal osmolality, which could decrease intake (Allen, 2000), effects of added roughage in mitigating changes in ruminal osmolality also might be related to changes in DMI. Nonetheless, when propionate and osmolality change, several other factors also change, resulting in potentially complex interactions that make interpretation of the effects of individual factors difficult.

The physical nature of ruminal contents is affected by roughage, even at relatively low dietary roughage concentrations. Moore et al. (1987) reported a trend for greater ruminal fill with high-concentrate diets that contained 10% cottonseed hulls compared alfalfa and wheat straw as roughages. Both Moore et al. (1990) and Poore et al. (1990) reported a trend for greater DM in the fiber mat in the rumen when cottonseed hulls was the roughage vs. alfalfa. Passage rate was greater with alfalfa than cottonseed hulls and wheat straw, which likely was the cause of differences in the ruminal fiber mat. In addition, DM was less in the ruminal fiber mat with cottonseed hulls than with wheat straw, and cattle fed wheat straw as the roughage ruminated more than those fed alfalfa and cottonseed hulls as roughages. Production of saliva should increase when cattle chew while eating and ruminating, which should increase ruminal buffering with high-concentrate diets (Owens et al., 1998). Nonetheless, greater rumination might increase mastication and subsequent fermentation of grain, thereby potentially offsetting effects of greater saliva production.

Shifts in the site of starch digestion from the rumen to the intestines might be associated with increased dietary roughage through an increased rate of passage of the grain portion of the diet (Owens and Goetsch, 1986). Cole et al. (1976) reported a trend for decreased ruminal and total tract starch digestibility for diets based on whole-shelled corn as the concentration of cottonseed hulls was increased from 0 to 7, 14, and 21% of the diet. In dairy cows fed barley-based diets with chopped vs. ground alfalfa as the roughage source (Yang et al., 2002), starch digestion was shifted from the rumen to the intestines. Unfortunately, because intestinal starch digestion is limiting in cattle (Huntington, 1997), shifting starch digestion from the rumen to the intestines typically does not result in optimal feedlot performance. Whether significant changes in site and extent of starch digestion occur within the normal range of dietary roughage concentrations commonly used in feedlot diets is not clear, and further research is needed before definitive conclusions can be drawn.
As noted by Armentano and Pereira (1997), changes in NDF concentration are associated in changes in concentrations of other nutrients, as well as changes in dietary ingredients with accompanying changes in physical characteristics. Thus, caution should be exercised in attributing changes in ruminal and metabolic acidity, fermentation end products, digesta kinetics, etc. to changes in NDF concentration alone.

**Physically Effective NDF**

Total NDF in the diet is not necessarily the best indicator of the extent to which fiber stimulates chewing activity and salivary flow. This is particularly noticeable with finely ground roughages and high-fiber, byproduct feeds (Armentano and Pereira, 1997). Adjustments for effectiveness of fiber to maintain milk fat production and optimize ruminal fermentation in dairy cattle based on particle size and characteristics of NDF that affect chewing activity were suggested by Mertens (1997), who coined the term physically effective NDF (peNDF) to describe this aspect of roughage value. Because peNDF is related primarily to particle size, geometric mean particle size is a good predictor of animal responses to peNDF (Leonardi et al., 2005). Armentano and Taysom (2005) indicated that measuring material retained on 9- or 5.6-mm screens provides a practical means for predicting the mean particle size of roughages.

How, or even whether, peNDF affects DMI by feedlot cattle is not well defined. With dairy cattle where more data are available, questions remain about the role that peNDF plays in DMI, ruminal function, and digestion. For example, altering corn silage particle size changed chewing time, but it did not greatly affect ruminal pH (Beauchemin and Yang, 2005) in dairy cows. Likewise, altering the particle size of an alfalfa silage-alfalfa hay mixture (Yang et al., 2002) and increasing particle length of corn silage (Beauchemin and Yang, 2005; Yang and Beauchemin, 2005) resulted in greater total tract fiber digestion, but had no effect on milk production. Low concentrations of roughage in feedlot diets compared with dairy diets make it less likely that differences in peNDF would affect DMI in feedlot cattle, a conclusion that is supported by the work of Defoor et al. (2002).

Figure 2 provides a summary of the possible effects of dietary roughage in beef feedlot diets (reproduced from Galyean and Vasconcelos, 2008). Although many of these factors are logically associated with the changes in DMI and ruminal fermentation when roughage sources and concentrations are altered, few direct estimates of their quantitative effects have been made. Thus, further research will be required to assess the role of these factors in utilization of roughage in beef feedlot diets.

**NDF in Feedlot Cattle Diets – Analyses of Literature Data**

Galyean and Defoor (2003) tested the practical utility of NDF concentration for determining roughage value and thereby roughage equivalency in feedlot diets by analyzing data from several published experiments (a database of 48 treatment means) in which DMI by feedlot cattle was measured in response to changes in roughage concentration and source. Their regression analyses only considered NDF supplied by roughage as an independent variable, not total dietary NDF. To expand the initial findings with NDF from roughage, Galyean and Abney (2006) calculated total dietary NDF concentrations for the dietary treatments in the database (using tabular values of NRC, 1996, 2001), and considered both total dietary NDF and NDF from roughage (both as % of DM) as independent variables in their analyses. Dependent variables were DMI (per unit of BW) and NEg intake (per unit of BW$^{0.75}$). The statistical model
included an overall fixed slope and intercept, with adjustments for random effects of the experiments as described by St-Pierre (2001). Both linear and quadratic terms for each independent variable were tested in the initial analyses, and final regression equations were used to calculate trial-adjusted data (St-Pierre, 2001), which were regressed on the independent variables using simple linear regression. The analyses of Galyean and Abney (2006) were reevaluated by Arelovich et al. (2008) with weighting for the pooled standard error of DMI in the various studies in the database. Because Arelovich et al. (2008) considered only total dietary NDF in their analyses, and weighting did not greatly affect the regression equations, the non-weighted data reported by Galyean and Abney (2006) will be discussed in this paper.

Results for the regression analyses with trial-adjusted data are reported in Table 1 and shown graphically for total dietary NDF and NDF supplied by roughage in Figures 3 and 4, respectively. Both independent variables were highly related in a linear manner to DMI per unit BW, with little difference in the results between total NDF and NDF supplied by roughage \( (r^2 \text{ of } 0.937 \text{ and } 0.920, \text{ respectively}) \). Hence, Galyean and Abney (2006) concluded that either total dietary NDF or NDF supplied by roughage would provide a practical means to formulate feedlot diets with different roughage sources to yield equivalent DMI.

### Table 1. Regression equations for trial-adjusted data between measures of dietary NDF and intakes of DM and NEg in a beef cattle literature data set (from Galyean and Abney, 2006)

<table>
<thead>
<tr>
<th>Independent variable (^2)</th>
<th>Dependent variable (^3)</th>
<th>Intercept</th>
<th>Linear effect</th>
<th>(r^2)</th>
<th>(P)-value (^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF</td>
<td>DMI/BW</td>
<td>1.5703</td>
<td>0.03005</td>
<td>0.937</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>NEg</td>
<td>64.6386</td>
<td>0.9504</td>
<td>0.797</td>
<td>0.001</td>
</tr>
<tr>
<td>NDF_R</td>
<td>DMI/BW</td>
<td>1.8562</td>
<td>0.02751</td>
<td>0.920</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>NEg</td>
<td>74.1190</td>
<td>0.7428</td>
<td>0.583</td>
<td>0.001</td>
</tr>
</tbody>
</table>

\(^1\)Treatment means from literature data (Galyean and Defoor, 2003; Galyean and Abney, 2006) were analyzed using mixed model regression methods to account for the random effects of trial, and trial-adjusted data were analyzed by simple linear regression.

\(^2\)NDF = total dietary NDF, % of DM, and NDF_R = NDF from roughage, % of DM

\(^3\)DMI/BW = DMI, % of BW, and NEg = NEg (kcal) per unit of BW, kg\(^{0.75}\)

\(^4\)\(P\)-value for the linear effect of the independent variable from the mixed-model regression analysis

In contrast to results with DMI, total dietary NDF (Figure 3; \(r^2 = 0.797\)) accounted for a greater proportion of the variation in NEg intake than NDF from roughage (Figure 4; \(r^2 = 0.583\), respectively). The linear relationships were strong in both cases, with no evidence of quadratic effects. As a result of these analyses, Galyean and Abney (2006) concluded that for determining roughage equivalency to equalize NEg intake, total dietary NDF would be more effective than NDF from roughage.

Given that the relationships between total NDF and NDF from roughage and NEg intake are linear, it would seem that adding a small percentage of roughage to high-grain feedlot diets would likely increase NEg intake. As discussed previously, perhaps increasing NDF from
traditional roughage sources benefits ruminal function by increasing salivary flow and ruminal buffering, potentially decreasing acidosis or other metabolic factors that might limit NEg intake. Despite these relationships, whether roughage can be added economically is a critical question. In practice, NEg from roughages is more expensive than NEg from grains, so producers must first determine the optimal roughage concentrations for their situation and then evaluate the economics of adding additional roughage to feedlot diets.

**Roughage Source and Concentration in Diets with Grain Byproducts**

Despite the practical importance of byproducts in cattle feeding, the role of fiber that is derived from byproduct feeds (e.g., corn gluten feed and distillers grains) for feedlot cattle is not well defined. Firkins (1997) indicated that rates of NDF digestion from byproduct fiber sources like beet pulp, gluten feed, and distillers grains are similar to or less than those from traditional forages, but these byproducts have faster rates of passage than traditional forages like alfalfa and corn silage. Thus, faster passage increases the potential to shift digestion of fiber to the large intestine. In addition, although the fiber in byproduct feeds like gluten feed and distillers grains is not lignified and thereby has a high potential extent of digestion, negative effects of starch and associated low ruminal pH in feedlot diets might decrease ruminal fiber digestion and further shift fiber digestion to the lower tract. As a greater percentage of byproduct fiber replaces starch, however, ruminal pH might be moderated, thereby decreasing negative associative effects and positively affecting fiber digestion. Given that wet gluten feed and wet distillers are fairly acidic products, however, the extent to which they moderate ruminal pH is open to question.

Feedlot producers who use digestible fiber byproducts in feedlot diets have typically determined optimal concentrations of traditional roughage in such diets by trial and error. It is relatively common with wet distillers grains and wet corn gluten feed to substitute these byproducts for grain, with little or no change in the concentration of roughage from traditional sources. Complicating the situation, differences in fibrousness are evident among byproducts. For example, based on changes in DMI when the byproducts are added to feedlot diets, fiber in wet corn gluten feed seems to have more “roughage value” than fiber in wet distillers grains. Particle size and bulk density are likely part of the issue, as wet corn gluten feed is bulkier than distillers grains; however, both these byproducts have a much smaller average particle size than traditional roughage. Given their physical (e.g., particle size and bulk density) and chemical (e.g., lignin) dissimilarity to traditional roughages, it is not surprising that the NDF content of these byproducts is not a good predictor of the effects they have on DM and NEg intakes.

Recent work at Texas Tech University (May et al., 2011; Quinn et al., 2011) was conducted to evaluate the effect of roughage concentration and source in diets with either 15 or 30% of the dietary DM as wet distillers grains. In both experiments, a non-distillers grain diet with 10% ground alfalfa hay as the roughage source was fed as a “positive” control. May et al. (2011) used a 2 x 3 factorial arrangement of treatments (plus the positive control), with the two concentrations of distillers grain and ground alfalfa hay concentrations of 7.5, 10, or 12.5%. For the overall feeding period, DMI tended (P = 0.079) to increase linearly as alfalfa concentration increased, with no indication of an interaction between concentration of distillers grain and roughage concentration (Figure 5). The response is consistent with the effects of increasing dietary roughage concentrations in finishing diets reported by Kreikemeier et al. (1990), Defoor et al. (2002), and Miller et al. (2009). Hales et al. (2010) fed 6 or 10% AH in SFC-based diets and observed increased DMI with 10% AH early in the feeding period (up to d 70), but no effect
of roughage concentration on DMI for the overall feeding period. Depenbusch et al. (2009) fed 15% wet or dry sorghum distillers grain diets with 0 or 6% AH and reported that removing roughage from the diet decreased final BW, DMI, and ADG. Thus, the roughage value of 15% wet distillers grains was not sufficient to allow complete removal of roughage from the diet. Collectively, the results of these studies suggest that diets with up to 30% of the DM as wet distillers grains respond to changes in dietary roughage concentration similar to traditional diets based on processed grain. This further suggests minimal roughage value of the fiber in wet distillers grains.

Results of the Quinn et al. (2011) study were not completely consistent with those of May et al. (2011). Quinn used the same two concentrations of wet distillers grain as May et al. (2011), but rather than different roughage concentrations, these authors used a 2 x 3 factorial arrangement with three sources of roughage (ground alfalfa hay, ground bermudagrass hay, and sorghum silage), with all the roughage sources fed to equal the NDF contributed by the alfalfa hay at 7.5% of the DM (the optimal roughage concentration in May et al., 2011 in terms of gain:feed). In contrast to the results of May et al. (2011), cattle consumed more DM (P < 0.01) when fed 15 vs. 30% wet distillers grains, and that trend was maintained throughout the experiment (Figure 5). Nonetheless, there was a distillers grain concentration × roughage source interaction (P = 0.02) for overall DMI, such that cattle fed the 15% distillers diet with sorghum silage and bermudagrass hay had greater DMI than those fed alfalfa, but with the 30% wet distillers grain diets, DMI did not differ among the three roughage sources (Figure 5). Defoor et al. (2002) reported trends for increased ADG and G:F in heifers consuming 7.1% forage sorghum silage compared with those fed 12.5% AH (the two sources were balanced for NDF, but analysis indicated sorghum silage had a greater NDF concentration than expected). Because NDF from roughage was equal among their three sources, Quinn et al. (2011) surmised that sorghum silage and bermudagrass hay had a greater peNDF than alfalfa hay. Thus, the Quinn et al. (2011) data suggest that in diets with 15% wet distillers grains, roughages with a greater concentration of peNDF might increase DMI more than would be expected based on NDF content alone. In contrast, with 30% wet distillers grains in the diet, roughage source did not affect DMI, suggesting that the NDF from distillers grain interacted in some way with the peNDF from the traditional roughage source to ablate the DMI response observed with 15% distillers grain. Uwituze et al. (2010) reported increased DMI by steers fed 25% dried distillers grain diets with corn silage vs. alfalfa as the roughage source, but dietary roughage was not balanced for NDF. In contrast to the results of Quinn et al. (2011), Benton et al. (2007) reported no differences in DMI among various roughage sources in diets based on dry-rolled corn that contained 30% distillers grains. Quinn et al. (2011) noted that the alfalfa hay used in their study had NDF and CP concentrations that were greater and less, respectively, than expected, compared with alfalfa hay values from the NRC (1996). Thus, the lesser quality of the alfalfa used in their experiment might have contributed to the differences in performance compared with the findings of May et al. (2011). Formulating roughage concentrations in finishing diets based on a target NDF supplied by the roughage rather than roughage concentration in the DM is probably preferred, as long as the optimal NDF concentration from roughage is known. Unfortunately, at this point in time, the optimal NDF from roughage is not well defined across the broad range of dietary ingredients and conditions likely to be encountered in practical feedlot production.

Diets with high concentrations of wet distillers grains do not seem to increase ruminal pH or stimulate DMI, as would be expected if the NDF in wet distillers grains was exerting effects
similar to traditional roughages. Wet corn gluten feed is a bulkier product than distillers grains, and when fed to replace 20 to 30% of grain DM in feedlot diets, DMI tends to increase, suggesting at least a different response from that noted with wet distillers grains. Parsons et al. (2007) fed 0, 4.5, or 9% alfalfa hay with 40% wet corn gluten feed. Based on DMI responses, 40% wet corn gluten feed with 0% hay resulted in DMI slightly less than a steam-flaked corn-based control diet with 9% alfalfa hay, suggesting some roughage value for wet corn gluten feed. Nonetheless, elimination of roughage in wet corn gluten feed diets did not optimize gain:feed. Based on available data for wet distillers grains and wet corn gluten feed, our best estimate is that the “roughage value” of these byproducts is minimal.

Alternatives Sources of Fiber in Feedlot Diets

Because of the severe drought in 2011, feedlots in the High Plains experienced considerable difficulty procuring traditional roughage sources like alfalfa hay and corn silage. Moreover, even when available, the cost of roughage skyrocketed. This situation led to increased use of less common (and often less costly) ingredients like ground corn stalks and cotton gin trash (ground burrs) in finishing diets. Data are available on the feeding value of some of these ingredients (corn stalks – Benton et al., 2007; gin trash – Lofgreen et al., 1980). Generally, these products can be used successfully in finishing diets when substituted on an equal NDF basis, with adjustment for differences in other nutrient concentrations (e.g., protein).

Paper products like newsprint are an option for roughage in feedlot diets that has been considered in the past. Indeed, a surprisingly large body of information is available on the feeding value of newsprint, much of it published in the 1970s. The basis for this line of work was the large supplies of waste paper products available and the desire to alleviate environmental issues related to their disposal. Although more paper is recycled today than in the 1970s, waste paper is still a major component of landfills. Thus, if paper products can be used as a roughage alternative in feedlots, the potential for a reasonably strong supply likely exists.

Daniels et al. (1970), citing previous work with feeding paper products (as early as 1935) fed ground paper (from the University of Missouri campus newspaper) to growing Holstein steers at concentrations of 8 or 12% compared with a cracked-corn diet that contained 8% cottonseed hulls. The newsprint diets contained cracked corn plus 25% molasses to improve palatability compared with 8% molasses in the control diet. Average daily gain and gain:feed did not differ statistically, but controls ate more DM and gained 0.11 to 0.14 kg/d more than cattle fed the two newsprint treatments. Dinius and Oltjen (1971) fed cracked-corn finishing diets to beef steers with 10% timothy hay, no hay, or 5 and 10% ground newsprint. Reflecting the small scale and relatively low power of the experiment, no significant differences were noted for ADG or DMI; however, ADG was 0.2 kg/d less with 10% newsprint vs. 10% timothy hay. Sherrod and Hansen (1973) fed beef heifers a control diet with 10% sudangrass hay and replaced 0, ¼, ½, or all the hay with ground newsprint (from the Amarillo Globe-News) in isonitrogenous, dry-rolled milo-based diets. Each treatment was replicated in four pens of five heifers per pen, and the experiment lasted 110 d. At replacements of hay greater than ½, ADG and DMI were significantly decreased, with corresponding increases in the feed:gain ratio.

Other wood products have been evaluated (e.g., sawdust; Cody et al., 1972), and the digestibility of paper products can be increased by chemical treatment (e.g., treatment with HCl and autoclaving; Wolf et al., 1994). Unfortunately, results with diets similar to those in use today and applications in which newsprint or other such products have been substituted on an
equal NDF basis are not available. Nonetheless, the potential use of paper products might be an area that deserves renewed interest and investigation.

**Roughage Management Strategies**

The traditional approach to adding roughage to beef cattle finishing diets is to pick a concentration and source of roughage and to feed that concentration and source for the duration of the feeding period. It might be possible to decrease overall roughage use (and thereby cost of gain when roughage prices are high) by altering the ways in which we add roughage to feedlot diets. Alternatives approaches might include: (1) feeding a low concentration of roughage (e.g., 4 to 6% of DM) with intermittent delivery of a higher concentration (e.g., increase the roughage concentration to 10% every third day); (2) feeding a low concentration of roughage and change the source of roughage intermittently (e.g., feed 4 to 6% alfalfa hay for 2 d and 4 to 6% corn stalks for 1 d); (3) increasing or decreasing the roughage concentration for extended periods during finishing (Bartle and Preston, 1992); (4) feeding a low concentration of roughage and feeding a small quantity of long-stemmed hay intermittently; and (5) various combinations of the above strategies that one might imagine or significantly alternative approaches like pot-scrubbers in the rumen (Loerch, 1991).

Certainly, feeding a lower concentration of roughage, with occasional increases in concentration or altered physical form would decrease overall roughage use. Would these approaches work, and are they superior strategies to simply decreasing the dietary roughage concentration? Unfortunately, experimental data are generally not available to determine the efficacy of such approaches. Moreover, despite being potentially useful information, funding for this type of research simply is not available, so it is not likely that answers will be available soon.

Bartle and Preston (1992) fed cattle either steam-flaked milo or whole-shelled corn with three roughage regimens that consisted of: a constant 10% cottonseed hulls throughout finishing; 2% cottonseed hulls fed from d 29 until 28 d before slaughter; and 10% cottonseed hulls fed through d 58, followed by 2% cottonseed hulls in the diet until slaughter. Overall, roughage regimen had little effect on ADG, DMI, or gain:feed ratio.

We recently evaluated the effects of infrequent feeding of a small quantity of long-stemmed alfalfa hay to finishing steers (J. Schutz, unpublished data; Texas Tech University, Lubbock). One group of steers (three pens with two steers per pen) was fed a basal finishing diet based on steam-flaked corn, with Sweet Bran wet corn gluten feed at 25% of the DM. A second group (four pens with three pens of two steers per pen and one pen with one steer) was fed the same basal diet, but they also received a once weekly feeding of long-stemmed alfalfa hay DM at 0.225% of initial BW. The cattle were fed for 114 to 135 d. Treatments did not affect (P > 0.42) initial BW (423.1 vs. 421.1 kg), final shrunken BW (583.8 vs. 570.1 kg), shrunken ADG (1.29 vs. 1.18 kg), DMI (9.29 vs. 8.70 kg), and gain:feed ratio (0.139 vs. 0.134 for hay vs. no hay, respectively). Our study obviously was very small and lacked statistical power, and as such it should be treated as anecdotal evidence. Nonetheless, the 6.7% increase in DMI of milled feed associated with feeding a relatively small quantity of hay once weekly, suggests that alternative roughage feeding strategies like the one we used might affect DMI. This could potentially allow performance to be maintained or increased, while also possibly improving the ruminal environment and overall animal health. Given the observed DMI, the quantity of hay fed weekly would equate to an increase of approximately 1.5% in the overall roughage concentration of the diet. Whether a similar increase in DMI would occur by simply increasing the dietary roughage
concentration by 1.5% is not known, but further studies designed to compare the effects of infrequent feeding of long-stemmed hay vs. increased dietary roughage should provide that answer. In addition, the management associated with an approach that requires feeding of long-stemmed hay is likely to be problem in large-scale operations, but if the net effect is financially rewarding, producers often find ways of managing logistical constraints.

Opinions, Ramblings, and Some Practical Applications

It might seem fairly obvious, but it is probably worth noting that if we did not need roughages in cattle diets we would very likely not use them. They are expensive on an energy basis, they tend to be much less consistent from one load to the next than concentrate feeds, and handling roughages is cumbersome and expensive. So why does virtually every nutritionist use them, and what might happen if we did not use them?

We have tried to put some of our thoughts about why we use roughages and what might or might not happen in their absence into visual form in Figure 6. Perhaps the most important point to make about this figure is the significance of the grain portion of the diet. It is the starch in grain and the availability of that starch that seems to be the greatest driver of the need for roughage in the diet. In a general sense, there is probably a minimal roughage concentration required for digestive tract integrity and stability of microbial populations, but that concentration seems to vary with the concentration and degree of processing of the grain portion of the diet. For example, we know from considerable history in feeding cattle that if we feed a high-grain diet, but that grain is whole-shelled corn, the concentration of roughage needed to make the system work reasonable well ranges from very little to none at all. In contrast, all-concentrate diets based on steam-flaked corn or wheat are probably too risky for even the most daring of nutritionists. Reinhardt et al. (1997) and Swingle et al. (1999) demonstrated that more intensive grain processing negatively affects feed intake, and practically, we often use feed intake as a means of identifying appropriate dietary concentrations of roughage.

Because of the relationship between roughage and processed grain starch, grain byproducts have altered the playing field by replacing grain in starting diets and thereby potentially decreasing the need for traditional roughage when cattle are adapted to finishing diets. As we have already noted, this effect of grain byproducts does not imply that they act as a source of roughages; in contrast, they simply replace starch. Similarly, dilution of energy (starch) via added roughage has long been thought to be a component of the increased DMI that is typically noted when the roughage concentration of finishing diets is increased (Galyean and Defoor, 2003).

The outstanding review by Owens et al. (1998) of the various factors affecting acidosis in cattle outlined the metabolic implications of this disorder and suggested possible alternatives to offset negative effects of both acute and short- and long-term subacute acidosis. Ørskov et al. (1979) demonstrated through intragastric infusion of nutrients that a healthy rumen can be maintained without a microbial population and solid feeds, and Loerch (1991) established that the physical effect of plastic pot scrubbers accounted for some, but not all, of the “roughage effect.” The response to pot scrubbers implies a “scratch factor” effect of roughage that might have implications for maintenance of healthy ruminal tissues, but the “scratch factor” mode of action has not been fully defined. Clearly, high-grain diets can induce very negative consequences for ruminal tissues and compromise ruminal integrity (Steele et al., 2011), and adding roughage to such diets tends to make things better.
Cattle type and management, ionophores, probiotics, and buffers are among the various products suggested to potentially offset some of the negative effects of low-roughage diets and the associated greater risk of acidosis (Owens et al., 1998). Short- or long-term days on feed, and associated intake levels and patterns, bunk management strategies, and weather fluctuations, all likely influence the optimal concentration of roughage needed to maintain intake levels over a feeding period. Perhaps the decreased variation in feed intake associated with monensin (Stock et al., 1995) reflects a “roughage-like effect” of ionophores. Although probiotics probably cannot replace roughage, they might have a positive effect on the health of ruminal and intestinal tissue. For example, Dick et al. (2012) noted greater rumen papillae length in calves given a direct-fed microbial than in control calves, and Elam et al. (2003) reported that supplementation with *Lactobacillus acidophilus* probiotics favorably altered the thickness of ileal mucosa.

So, what does it all mean? Well, it means that roughages are important in feedlot diets (which we already knew and have said before). But it also means that there is a great deal we do not understand about why roughages are important. Like so many other “routine practices” in cattle feeding, a complete understanding of the chemical, physiological, and physical effects of roughage in ruminant diets, especially highly processed grain-based diets, remains as a challenge for future scientists.

**Conclusions**

Roughage is a vital component of the diets of all classes of beef cattle. For lightweight, stressed calves, increasing dietary roughage might slightly decrease morbidity from respiratory disease, but there are clear tradeoffs between roughage concentration in receiving diets and cost and efficiency of gain. More research is needed to quantify the effects of total NDF concentration and source of NDF in receiving diets. For beef feedlot diets, even at low concentrations (typically less than 10% of the diet), roughage has important effects on saliva production and gastrointestinal tract buffering, as well as the nature of the fermentation in the rumen, digesta flow rates, and ultimately the site and extent of nutrient digestion and the supply of nutrients to the animal. These effects are associated with changes in feed intake and performance. Because both total dietary NDF and NDF supplied by roughage are closely related to DMI by feedlot cattle, roughage equivalency in feedlot diets can be achieved by formulating diets for equal NDF or NDF from roughage, but total dietary NDF is superior to NDF from roughage for predicting NEg intake. Dietary NDF concentration is therefore recommended for formulating diets based on different roughage sources to achieve equal DM and NEg intakes by feedlot cattle. Based on available data, NDF from common byproducts like distillers grains and wet corn gluten feed does not have the same effects on DMI as NDF from traditional roughage sources. As a result, we recommend that little or no roughage equivalency be assigned to the NDF in these byproducts. Alternative fiber sources like newsprint might offer opportunities when cost and availability are favorable. Management strategies that allow for alterations in the frequency or pattern of feeding different roughage concentrations or sources might allow for less overall use of roughage in feedlot diets, while maintaining animal health and performance. Significant research questions remain to be addressed before we will have a complete understanding of the role of roughage in high-grain diets.


**Figure 1.** Regression of receiving-period morbidity, ADG, and DMI on dietary roughage concentration (% of DM). Data are treatment means from six studies conducted at the New Mexico State University Clayton Livestock Research Center that were adjusted for the random effect of study (trial-adjusted; from Rivera et al., 2005).
Figure 2. Factors associated with the effects of dietary roughage concentration and source in beef cattle feedlot diets (from Galyean and Vasconcelos, 2008).
**Figure 3.** Relationships between total dietary NDF (% of DM) and trial-adjusted DM and NEg intakes by feedlot beef cattle (from Galyean and Abney, 2006). For NEg intake, values are expressed as kcal/(BW, kg^{0.75}•d).
Figure 4. Relationships between dietary NDF supplied by roughage (% of DM) and trial-adjusted DM and NEg intakes by feedlot beef cattle (from Galyean and Defoor, 2003; Galyean and Abney, 2006). For NEg intake, values are expressed as kcal/(BW, kg\(^{0.75}\)•d).
Figure 5. Effects of roughage concentration (May et al., 2011) and source (Quinn et al., 2011) on DMI by feedlot cattle. Roughage sources in Quinn et al. (2011) were fed to supply equal NDF from roughage relative to alfalfa hay.
Figure 6. Potential effects of roughage and interactions with other factors in grain-based finishing diets.
Research Updates

Oklahoma State University
Presented by C.J. Richards

Evaluation of remote temperature monitoring for detection of bovine respiratory disease and use of wet distillers grains in receiving and finishing diets C. J. Richards1, C. R. Krehbiel1, D. L. Step2, R. B. Hicks, J. L. Wahrmund1, B. K. Wilson1, C. L. Maxwell1, J. Wagner1, and B. T. Johnson1,1 Department of Animal Science and 2Department of Veterinary Clinical Sciences, Oklahoma State University

Research conducted at Oklahoma State University (OSU) in the area of receiving and feedlot cattle emphasizes nutrition and management effects on health, performance and carcass merit. Recent research has evaluated: 1) remote rumen temperature monitoring technology for detecting bovine respiratory disease (BRD) and 2) effects of byproduct feeds in receiving rations.

Additional posters presented at this meeting by OSU graduate students include: 1) a 2-year characterization of factors impacting health and performance of cattle received by OSU; 2) performance and health effects of energy density in high byproduct receiving diets; 3) replacing a portion or all of dry-rolled corn in a finishing diet with a 1:1 blend of Sweet Bran® and DDGS; and 4) effects of altering corn DDGS to sorghum-based wet distillers grains plus solubles (WDGS) ratios and inclusion of I.C.E.® in a dry-rolled corn feedlot ration containing 30% distillers grains plus solubles.


Ruminal temperature boluses have been determined by OSU and others to provide temperature measures that have a strong correlation with universally-accepted rectal temperatures in beef (Rose-Dye et al., 2011; Timsit et al., 2011; Wahrmund et al., 2012) and dairy cattle (Bewley et al., 2008). We have demonstrated that ruminal temperature is able to detect viral and bacterial exposure using challenge model with pathogens commonly associated with BRD (Rose-Dye et al., 2011). Our work has evaluated the impact of water consumption (Dye and Richards, 2008), environmental temperatures (Dye and Richards, 2007), diet (Dye-Rose, et al., 2009), and acidosis (Wahrmund et al., 2012) on ruminal temperatures. Using after the fact categories, Sims et al. (2008) demonstrated that average and daily maximum temperatures over 42-d generally decrease as rate of weight gain increases and increase as number of times treated for BRD increases.

The current experiment is our first experiment evaluating rumen temperature algorithms developed for detection of BRD in newly received calves. Parameters evaluated include calf health, receiving performance, finishing performance, carcass characteristics and lung scores. Two lots of commingled heifer calves (n = 366, mean initial BW = 535 ± 66 lb) were administered remote ruminal temperature monitoring boluses and assigned to one of three experimental BRD management methods: Pulled based on visual signs of BRD (CON), administered metaphylaxis on d 0 and subsequently pulled based on visual signs of BRD (MET), or pulled based on visual signs of BRD or elevated ruminal temperature (TEMP).

During the 56-d receiving phase, a greater (P < 0.01) number of antimicrobials were administered using MET and TEMP methods (1.37 per heifer) compared to CON (0.59 per
heifer), when metaphylactic doses for MET heifers was included. At 56 d, TEMP had 1.7% heavier ($P = 0.05$) BW than CON. Metaphylaxis increased ADG by 10.4% ($P = 0.01$) and G:F by 8.6% ($P = 0.03$) from d 0 to 56 over CON. Overall, ADG generally decreased as number of BRD treatments increased; however, overall ADG of TEMP heifers did not differ ($P \geq 0.60$) by times treated. Average ruminal temperatures were highest for CON, intermediate for TEMP, and lowest for MET during wk 1 (Figure 1). During wk 2 and 3, ruminal temperatures of MET and TEMP heifers were lower than CON. For wk 5, average temperatures were highest for MET, lowest for TEMP, and CON was intermediate but not different from the other treatments. On wk 6, MET had higher average temperatures than CON or TEMP. Temperatures were not different wk 7 or 8.

For the finishing phase, heifers identified with BRD twice began the finishing phase weighing 37 lb less ($P < 0.01$) than all other heifers. Interactions were observed between management method and number of times identified with BRD for final BW and overall ADG ($P \leq 0.02$). Final BW of CON heifers identified with BRD twice was 83 lb less ($P < 0.01$) than CON heifers never identified, while number of times identified with BRD did not affect ($P \geq 0.13$) final BW of TEMP and MET heifers. Heifers managed with CON and identified with BRD twice gained 0.35 lb/d less ($P = 0.01$) than other CON heifers while ADG of TEMP heifers identified with BRD twice was 0.24 lb/d greater ($P = 0.03$) than those never identified, and ADG of MET heifers was unaffected ($P \geq 0.12$) by times identified. Heifers identified with BRD twice had 25.1 lb lighter ($P \leq 0.04$) HCW than those identified zero or one time. Heifers not identified with BRD had 1.1% greater dressing percent ($P < 0.01$), 7.6% greater marbling score ($P \leq 0.04$), and 0.1 inch greater fat thickness ($P \leq 0.02$) compared to heifers identified once or twice with BRD. Carcass value showed a method × number of times identified interaction ($P = 0.04$), as CON heifers identified with BRD twice were valued at $92 less ($P \leq 0.02$) than those from other CON heifers, while carcass value of TEMP and MET heifers was not affected ($P \geq 0.27$) by number of times identified with BRD. Incidence of lung lesions at harvest was low and did not differ ($P \geq 0.46$) among management methods. A greater ($P = 0.03$) percentage of lymph nodes from CON heifers were classified as moderate or severe compared to MET. Results indicate that metaphylaxis and remote temperature monitoring may spare some of the detrimental effects of BRD on performance and carcass value.

**Effects of wet distillers grains plus solubles on health and performance of high-risk calves during the receiving period**


A randomized complete block design experiment utilizing 180 high-risk crossbred steers (initial BW = 467 ± 4 lb) was conducted to evaluate the effects of including WDGS in a receiving diet on steer 42-d performance and health. Experimental treatments consisted of receiving diets with inclusion of 0%, 15%, or 30% WDGS. Pen was considered the experimental unit and each treatment diet was fed to calves in 10 pens. Average daily gain ($P < 0.20$; 2.11, 2.49, and 2.51 lb/d), DMI ($P < 0.27$; 10.45, 11.35, and 11.09 lb/d), G:F ($P < 0.79$; 0.222, 0.213, and 0.212), and animals treated for BRD ($P < 0.20$; 0.19, 0.20, 0.23) did not differ among treatments for 0, 15, or 30% WDGS, respectively. During the experiment, 3 steers on the 0% treatment were diagnosed as chronically morbid with bovine respiratory disease (BRD) and were removed from the experiment. Feeding up to 30% WDGS receiving diets to high-risk calves did not negatively impact animal health or performance.

This experiment was conducted to determine performance and carcass characteristics of steers and subsequent color stability and consumer acceptability of steaks from steers fed dry-rolled corn diets containing 35% WDGS and supplemented with vitamin E. Steers of mixed Bos indicus and Bos taurus breeding (n = 199; BW = 799 ± 70 lb) were blocked by BW and assigned to 1 of 4 supplemental vitamin E (VITE) treatment levels (0 [Control], 125, 250, and 500 IU·steer⁻¹·day⁻¹), which was fed for the last 97 d of the feeding period. Steers were fed a dry-rolled corn-based finishing diet with 35% WDGS (DM basis).

Live BW and ADG were not affected by VITE (P ≥ 0.34). There was a tendency for a linear (P = 0.08) increase in carcass adjusted BW with increasing VITE. Use of carcass adjusted final BW resulted in a linear increase (P = 0.04) in ADG with increasing VITE. Pre-vitamin E and vitamin E feeding period DMI were not affected (P ≥ 0.24) by VITE, but there was a tendency (P = 0.08) for a linear increase in overall DMI with increasing VITE. No difference (P ≥ 0.29) occurred in G:F measures using live weight gains, but G:F using carcass adjusted weight gains resulted in a trend (P = 0.11) for G:F to increase linearly with increasing VITE. Hot carcass weights tended (P = 0.08) to increase linearly with increasing VITE. Vitamin E supplementation resulted in no effects (P ≥ 0.13) on measured carcass characteristics. Calculated yield grades (YG) were also not affected (P ≥ 0.37). No differences were observed in the distribution of quality grades based on marbling scores (P ≥ 0.57).

Strip loins were collected and processed 7 d postslaughter. Strip loins were faced and cut into 1-in steaks and packaged in a polyvinyl chloride overwrapped (PVC) package, a vacuum package, or modified atmosphere packages (MAP). Instrumental color measurements revealed the 250 and 500 VITE had a longer (P < 0.05) retention of redness and yellowness in steaks as compared with steaks from animals receiving less VITE. Subjective color evaluation for steaks indicated that greater VITE was more likely (P < 0.05) to maintain color stability, overall acceptability, and consumer purchase preference while decreasing percentage of discoloration. Lipid oxidation analysis indicated that steaks packaged in PVC for 7 d and MAP for 1, 3, and 7 d of retail display only remained below the 2.28 mg of malonaldehyde/kg threshold for the 250 and 500 VITE.

Data from this study suggest that vitamin E supplemented above basal requirements during the last 97 d of the feeding period in finishing diets containing 35% WDGS results in slightly positive to no impact on animal performance or carcass characteristics, but feeding at least 250 VITE will benefit retail shelf life of MAP packaged products.

Literature citations


**Figure 1.** Average daily ruminal temperature (°F) of heifers managed with three bovine respiratory disease (BRD) management methods by week. Management methods: CON, pulled based on visual signs of BRD; MET, administered a metaphylactic dose of tulathromycin at processing and subsequently pulled based on visual signs of BRD; TEMP, pulled based on visual signs of BRD or elevated ruminal temperature; n = 8 pens per method. Comparisons: M, effect of management method; W, effect of week; M×W, interaction of M and W. Means within a week without a common label differ (P ≤ 0.05).
Research Updates

Texas AgriLife Research at Amarillo
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Introduction

Research in the beef cattle nutrition program at Texas AgriLife Research at Amarillo has focused on incorporating alternative feed sources into growing and finishing diets in the Southern Plains. Efforts have focused on incorporating of crude glycerin into beef growing and finishing diets, long term use of dried distillers grains (DDG) in beef production systems, and adaptation to finishing diets using a complete starter feed.

Use of crude glycerin in steam-flaked corn-based growing diets R. G. Bondurant, M. K. Luebbe, K. Hales, N. A. Cole, J. C. MacDonald
Three Exp. were conducted to evaluate the use of crude glycerin in steam-flaked corn (SFC) based growing diets. Experiment 1 utilized 50 crossbred steers (initial BW = 621 ± 4 lb) to determine the effects glycerin concentration (0.0, 2.5, 5.0, 7.5, and 10.0% DM inclusion) on steer performance. In Exp. 2, 54 crossbred steers (initial BW = 623 ± 3 lb) were used to determine the effects of replacing SFC or alfalfa hay (ALF) with crude glycerin on animal performance. Dietary treatments consisted of 0.0% crude glycerin or 7.5% crude glycerin (CON) which replaced either ALF (REPALF) or SFC (REPSFC). In Exp. 3, in-vitro VFA concentration was determined after 48-h of fermentation comparing crude glycerin, SFC, and ALF as substrates. In Exp. 1, increasing dietary crude glycerin concentration resulted in a linear decrease in G:F (P = 0.05). Steer ADG and final BW tended (P = 0.08) to increase in a quadratic manner with 7.5% crude glycerin resulting in the greatest responses among treatments. No difference was found for final BW and DMI (P > 0.11). In Exp. 2, final BW increased 26 lb (P = 0.04) for steers fed REPALF vs. CON. Steers fed REPALF also had an increase in ADG of 0.37 lb/day (P = 0.03) vs. CON. Final BW and ADG were similar for CON and REPSFC (P > 0.51). No differences in DMI or G:F were found among treatments (P > 0.25). In Exp. 3, using glycerin as a fermentation substrate resulted in an 83% increase in total VFA concentration compared to ALF (P < 0.01), and similar total VFA concentration compared to SFC (P = 0.42). The acetate to propionate ratio was reduced 12-fold for glycerin vs. SFC (P < 0.01), and reduced 25-fold for glycerin vs. ALF (P < 0.01). Crude glycerin appears to have a minimal impact on animal performance when replacing SFC, although G:F may be reduced by up to 4.5% when including glycerin at 7.5% of the diet DM, where ADG appears to be maximized. The energy value of crude glycerin is greater than ALF but appears to be less than SFC.
Previously presented at the 2012 ASAS Midwestern Section Meetings

Crude glycerin as a replacement for roughage: Effects on receiving cattle performance, health, nutrient digestibility, and ruminal fermentation characteristics K. J. Kraich, R. G. Bondurant, J. M. Patterson, M. K. Luebbe, M. S. Brown, and J. C. MacDonald
Two experiments were conducted to determine the effects of crude glycerin (CG) concentration in steam-flaked corn (SFC) based diets as a partial replacement for roughage on feedlot
performance, heath, ruminal fermentation, and diet digestibility. In Exp. 1, 309 crossbred steers (540 ± 90 lb BW) were used in a randomized complete block design with 9 replications/treatment. Dietary treatments consisted of a SFC-based control diet (72% concentrate) without CG, a control diet with 5 and 10% CG on a DM basis replacing dietary roughage. In Exp. 2, four ruminally and duodenally cannulated steers were used in a 4 X 4 Latin Square design using similar diets to Exp. 1. In Exp. 1, dry matter intake decreased linearly ($P = 0.002$) without impacting ADG resulting in a tendency of improved feed efficiency ($P = 0.07$) with increasing levels of crude glycerin. The total number of animals receiving treatment for BRD did not differ among treatments ($P = 0.67$). There were no differences detected amongst treatments for mortality ($P = 0.58$) or the frequency of calves that were seropositive for serum antibody titers to IBR on day 28 ($P \geq 0.14$). In Exp. 2, the addition of crude glycerin linearly increased organic matter digestibility ($P < 0.01$), and decreased the ratio of acetate to propionate produced in the rumen ($P < 0.01$). Microbial crude protein production increased in a quadratic matter, with maximum microbial crude protein production occurring at 5% glycerin inclusion ($P = 0.06$). The addition of crude glycerin as a partial replacement for roughage in SFC-based diets appears to positively impact performance, nutrient digestibility and ruminal fermentation at addition levels up to 5% substitution for roughage indicate a potential alternative lower cost higher yielding ration ingredient in receiving cattle diets.

Effects of crude glycerin concentration on performance and carcass characteristics of finishing steers consuming steam-flaked corn-based diets with supplemental yellow grease

E. K. Buttrey, M. K. Luebbe, J. M. Patterson, F. T. McCollum, K. E. Hales, N. A. Cole, and J. C. MacDonald

Fifty-two individually fed crossbred steers (initial BW = 839 ± 4 lb) were used to determine the effects of crude glycerin concentration in steam-flaked corn (SFC)-based diets containing yellow grease on animal performance and carcass characteristics. Crude glycerin was included at 0, 2.5, 5, and 10% dietary DM and replaced SFC. Urea increased with increasing glycerin inclusion and replaced SFC to make the diets approximately isonitrogenous. All diets contained 9% dried distillers grains, 9% alfalfa hay, 3.5% molasses, 3% yellow grease, 1.45% limestone, and 1.05% supplement. Previous steer ADG (2.86 lb) was used as a covariate in the statistical analysis when significant. Dietary Na content increased from 0.16 to 0.45% of diet DM with increasing glycerin concentration. Final BW and DMI were not affected ($P \geq 0.11$) by crude glycerin concentration. Average daily gain decreased in a linear fashion ($P < 0.001$) with increasing levels of glycerin (3.88, 3.85, 3.74, and 3.66 lb/d for 0, 2.5, 5, and 10% glycerin, respectively). Efficiency of gain and dietary NE concentrations tended ($P \leq 0.10$) to respond in a cubic manner to glycerin levels. Fat thickness, yield grade, and percentage of empty body fat linearly decreased ($P \leq 0.02$) with increasing concentrations of glycerin however, marbling scores were not affected ($P \geq 0.12$) by glycerin level. Hot carcass weight and LM area were also not affected ($P \geq 0.26$) by glycerin concentration. The use of crude glycerin in SFC-based finishing diets with yellow grease reduced ADG and overall carcass adiposity and may result in additional days on feed to reach a similar fat endpoint.

Grain adaptation of yearling steers to steam-flaked corn-based diets using RAMP

E. K. Buttrey, M. K. Luebbe, R. G. Bondurant, and J. C. MacDonald

Three hundred six crossbred steers (initial BW = 703 ± 1 lb) were used to determine effects of adapting steers to a finishing diet using a complete starter feed (RAMP, Cargill Corn Milling,
Blair, NE) for 14 to 30 d on steer performance and carcass characteristics. The RAMP treatments were compared to a traditional step-up procedure (CON). Steers in the CON treatment were adapted from the initial diet containing 45% alfalfa hay (ALF), 32.5% steam-flaked corn (SFC), 20% wet corn gluten feed (Sweet Bran, Cargill Corn Milling), and 2.5% supplement to the final finishing diet containing 65.7% SFC, 20% Sweet Bran, 8% ALF, 3% yellow grease, and 3.3% supplement over a 22-d period. During the step-up period, concentration of ALF was reduced and SFC, yellow grease, and urea were increased. Steers assigned to RAMP treatments were adapted to the same finishing diet using RAMP fed for 14, 18, 22, 26, or 30 d. During adaptation, RAMP decreased and the finishing diet increased. Compared with CON, RAMP increased carcass-adjusted final BW (1286 vs. 1315 lb; P = 0.05), ADG (4.19 vs. 4.38 lb; P = 0.05), and HCW (819 vs. 837 lb; P = 0.05). As the adaptation period for steers consuming RAMP increased from 14 to 30 d, fat thickness (P = 0.06) and YG (P = 0.01) increased linearly. Adapting steers to a finishing diet using RAMP and increases animal weight gain during the finishing phase and reduces the total amount of roughage used by 21 to 28%.

Use of dried distillers grains throughout a beef production system: Effects on stocker and finishing performance, carcass characteristics, and fatty acid composition of beef  

E. K. Buttrey, F. T. McCollum III, K. H. Jenkins, J. M. Patterson, B. E. Clark, M. K. Luebbe, T. E. Lawrence, and J. C. MacDonald

A 2-yr study was conducted using a 3 × 2 factorial arrangement of treatments to evaluate the effects of feeding dried distillers grains throughout a beef production system on performance, carcass characteristics, and fatty acid profile of beef. Factors were wheat pasture supplement (no supplement, dry-rolled corn, and dried distillers grains; CON, DRC, and DDG, respectively) fed at 0.5% BW daily and finishing diet (steam-flaked corn based diet containing 0 or 35% DDG; SFC and 35DDG, respectively). Each yr, 60 preconditioned Hereford steers (initial BW = 436 lb ± 7) grazed winter wheat pasture with or without supplement. Gain was 8% greater for steers consuming DDG supplement compared to CON and DRC steers (P < 0.01). Following the grazing period, pastures within supplement treatment were randomly assigned to SFC or 35DDG. There was no supplement by finishing diet interaction for any performance or carcass variable of interest (P ≥ 0.41). Previous supplementation on winter wheat affected BW at feedlot entry and adjusted G:F (P ≤ 0.05) but had no effect on finishing ADG or carcass traits (P ≥ 0.12). On a carcass-adjusted basis, steers consuming 35DDG had reduced final BW, ADG, G:F, and total gain throughout the system (P ≤ 0.04) compared to SFC. Additionally, steers consuming 35DDG had reduced HCW, dressing percent, and fat thickness (P ≤ 0.03) compared to SFC. There was a supplement by finishing diet interaction (P = 0.02) for 18:0, in which cattle supplemented with DRC and fed the SFC finishing diet had the lowest concentration of 18:0 but DRC supplemented steers fed the 35DDG diet had the highest concentration. The interaction was not significant (P ≥ 0.18) for other fatty acids. Main effects of supplement and finishing diet affected (P ≤ 0.05) several other fatty acids of interest, particularly 18:2, which is associated with reduced flavor-stability of beef. The use of DDG as a supplement to wheat pasture resulted in greater ADG during wheat grazing and heavier BW at feedlot entry, but final BW was not different from CON or DRC groups. Feeding DDG at 35% DM in steam-flaked corn-based finishing diets reduced ADG, G:F, and HCW, and affected the fatty acid composition of beef.
Research Update
University of Minnesota
Presented by A. DiCostanzo

Funding Sources
- MN Agricultural Experiment Station
- Agricultural Utilization Research Institute
- MN Corn Growers Association
- MN Soybean Growers Association

Personnel Involved and Research Sites
- I. Ceconi, Ph.D. student
- G. Huber, M.S. student
- J. Jaderborg, Ph.D. student
- J. Kelzer, Adams Land & Cattle Co.
- K. McClelland, Ph.D. student
- D. Paulus, M.S. student
- J. Popowski, American Foods Group
- NWROC, Crookston, MN
- NCROC, Grand Rapids, MN
- RROC, Rosemount, MN
DGS Value as Feedstuff—Researchable Fields

- Inclusion
- Procurement
- Delivery
- Stock
- Process
- Recycling
- Quality
- Health
- Consumer health

Grain Processing
Co-products

- Yearling cattle—Angus, Angus-X, Limousin, Char-X
  - Grower diets > 60 d
  - Blocked by breed or origin
  - Individually-fed 1X through Calan-Broadbent system
  - Pen-fed 1X in a confinement facility (9 to 14 hd/pen)
  - Adapted to a finisher diet
    - Trained over 10-d period
    - [S] manipulated using CaSO₄·H₂O—23% Ca
      - [Ca] balanced using CaCO₃
  - Ingredients, diets and orts sampled weekly
  - Monthly composites—DM, CP, NDF, ADF, EE, S
  - Finished according to visual appraisal
Materials and Methods—Performance Studies
(cont'd)

- Initial BW—16 h fast
  - Interim BW—before feeding
- Final BW—HCW/Dressing percentage

- Continuous variables
  - ADG
  - Gain: feed—feed efficiency
  - DMI
  - HCW
  - LM area
  - Fat depth
  - Marbling score, 400 = small

- Discrete variables
  - Quality grade
  - Yield grade

Materials and Methods—Performance Studies
(cont'd)

- Continuous variables
  - Proc MIXED
  - Randomized block design
  - Factorial arrangement

- Discrete variables
  - Proc GENMOD

- Significance
  - \( P < 0.05 \)
  - Trends discussed at \( 0.05 < P < 0.10 \)

Feeding and Management Interventions to Mitigate high [S] in DGS

- MnO
- Roughage
- YC

110
Interaction of Dietary Roughage and Sulfur Concentration on Performance of Beef Feedlot Cattle, n = 14

Higher roughage diets may prevent negative effects of feeding high S in diets of finishing cattle.

Objective

- To determine whether greater roughage inclusion would reduce negative impact of feeding higher S concentrations on performance.

<table>
<thead>
<tr>
<th>Roughage %</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS, LR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS, MR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS, HR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS, LR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS, MR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS, HR</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Main effects**

- R Linear P = 0.01, R Quadratic P > 0.10
- S  P = 0.02
- Interaction  P = 0.93 ; SEM = 0.9

**DMI, kg/d**

- 9.94
- 10.52
- 10.66

**Roughage**

- 5%
- 10%
- 15%

**Item**

<table>
<thead>
<tr>
<th>Item</th>
<th>LR</th>
<th>MR</th>
<th>HR</th>
<th>LR</th>
<th>MR</th>
<th>HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-milled corn, %</td>
<td>45.5</td>
<td>40.5</td>
<td>35.5</td>
<td>45.5</td>
<td>40.5</td>
<td>35.5</td>
</tr>
<tr>
<td>Modified DGS, %</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Grass hay, %</td>
<td>5.0</td>
<td>10.0</td>
<td>15.0</td>
<td>5.0</td>
<td>10.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Liquid supp. 3, %</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Gypsum supp. 4, %</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Limestone supp. 5, %</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>NEg Mcal/cwt</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
</tr>
<tr>
<td>CP, %</td>
<td>17.6</td>
<td>17.6</td>
<td>17.7</td>
<td>17.6</td>
<td>17.6</td>
<td>17.7</td>
</tr>
<tr>
<td>NE, % of DM</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Ca, %</td>
<td>1.24</td>
<td>1.27</td>
<td>1.30</td>
<td>1.24</td>
<td>1.27</td>
<td>1.30</td>
</tr>
<tr>
<td>P, %</td>
<td>0.53</td>
<td>0.49</td>
<td>0.49</td>
<td>0.53</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>Fat, %</td>
<td>7.4</td>
<td>7.0</td>
<td>7.3</td>
<td>7.4</td>
<td>7.3</td>
<td>7.3</td>
</tr>
<tr>
<td>S, %</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
</tr>
</tbody>
</table>
### ADG, kg

- **Main effects**
  - R: Linear or quadratic, \( P > 0.10 \)
  - S: \( P > 0.10 \)
- **Interaction**
  - \( P = 0.96 \); SEM = 0.22

### Feed Efficiency, G:F

- **Main effects**
  - R: Linear, \( P > 0.01 \), R: Quadratic, \( P > 0.10 \)
  - S: \( P > 0.10 \)
  - Interaction: \( P = 0.98 \); SEM = 0.02

---

### Table: Effects of dietary rape oil and sulfur concentrations on carcass characteristics of beef feedlot steers.

<table>
<thead>
<tr>
<th>Item</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>( \beta )</th>
<th>( \sigma )</th>
<th>SEM</th>
<th>R Linear</th>
<th>S</th>
<th>R x S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot weight, kg</td>
<td>414</td>
<td>415</td>
<td>405</td>
<td>410 5</td>
<td>0.45 0.52</td>
<td>0.44 0.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat depth, cm</td>
<td>1.0</td>
<td>1.3</td>
<td>1.5</td>
<td>1.2 1.1 0.28</td>
<td>0.59 0.79</td>
<td>0.42 0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM area, cm²</td>
<td>98.4</td>
<td>101.0</td>
<td>99.3</td>
<td>100.6 99.3 6.5</td>
<td>0.99 0.28</td>
<td>0.47 0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling</td>
<td>4.05</td>
<td>4.05</td>
<td>4.00</td>
<td>4.01 85 0.79</td>
<td>0.49 0.46</td>
<td>0.16 0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary and Conclusion

- High dietary sulfur concentrations decreased feed intake but did not affect average daily gain or feed conversion.
- Increasing dietary roughage concentration from 5 to 15% increased feed intake and decreased gain-to-feed ratio, but did not affect average daily gain.

Conclusion

Lack of sulfur x roughage interaction suggests that there is no advantage to feeding greater concentrations of roughage in high-sulfur diets.
Diet and Nutrient Composition

- Basal diet DM contained 44% high-moisture corn, 35% wet distillers grains with solubles, 9% corn silage, 3% straw, and 9% supplement.
- Distillers grains contained approximately 34% DM, 29.5% CP, 0.8% S.
- Diet nutrient composition:
  - 2.40 Mcal NEg/kg
  - 16.5% CP
  - 24% NDF, 10.5% ADF
  - 0.9% Ca, 0.4% P
  - 6.1% fat

Performance—first 28 d

<table>
<thead>
<tr>
<th>Dietary S, %</th>
<th>Mn, ppm</th>
<th>P-values*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Initial BW, kg</td>
<td>330</td>
<td>330</td>
</tr>
<tr>
<td>d 0-8 BW, kg</td>
<td>376</td>
<td>387</td>
</tr>
<tr>
<td>DM, d 0-8, kg</td>
<td>8.48</td>
<td>7.85</td>
</tr>
<tr>
<td>ADG, d 0-8, kg</td>
<td>1.63</td>
<td>1.31</td>
</tr>
<tr>
<td>G:F, d 0-8</td>
<td>0.192</td>
<td>0.187</td>
</tr>
</tbody>
</table>

* Manganese supplemented as manganese oxide.
* P-value of the effect of S, Mn, and the S x Mn interaction.
* Standard error of the mean.

Feed Efficiency, G:F—first 28 d

<table>
<thead>
<tr>
<th>Gain:Feed</th>
<th>0.189</th>
<th>0.189</th>
<th>0.185</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS, No MnO</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>LS, MnO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS, No MnO</td>
<td></td>
<td></td>
<td>0.146</td>
</tr>
<tr>
<td>HS, MnO</td>
<td></td>
<td></td>
<td>a</td>
</tr>
</tbody>
</table>
### Overall performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Dietary S, %</th>
<th>Mn, ppm</th>
<th>P-values†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Initial BW, kg</td>
<td>331</td>
<td>319</td>
<td>331</td>
</tr>
<tr>
<td>Final BW, kg</td>
<td>615</td>
<td>518</td>
<td>588</td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>0.32</td>
<td>0.67</td>
<td>0.48</td>
</tr>
<tr>
<td>ADG, kg</td>
<td>1.23</td>
<td>1.21</td>
<td>1.38</td>
</tr>
<tr>
<td>G:F</td>
<td>0.529</td>
<td>0.541</td>
<td>0.547</td>
</tr>
</tbody>
</table>

* Manganese supplemented as manganese oxide.
† P-value of the effect of S, Mn, and the S x Mn interaction.
‡ Standard error of the mean.

### Carcass characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Dietary S, %</th>
<th>Mn, ppm</th>
<th>P-values†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>HCW, kg</td>
<td>390</td>
<td>353</td>
<td>371</td>
</tr>
<tr>
<td>Backfat mm</td>
<td>1.47</td>
<td>1.13</td>
<td>3.31</td>
</tr>
<tr>
<td>LM Area, kg/cm</td>
<td>50.0</td>
<td>71.1</td>
<td>85.0</td>
</tr>
<tr>
<td>Marbling</td>
<td>321</td>
<td>491</td>
<td>516</td>
</tr>
<tr>
<td>USDA Choice</td>
<td>86.5</td>
<td>73.2</td>
<td>80.6</td>
</tr>
</tbody>
</table>

* Manganese supplemented as manganese oxide.
† P-value of the effect of S, Mn, and the S x Mn interaction.
‡ Standard error of the mean.
§ Uncommon superscripts differ (P < 0.05). SEM = 2.6

### LM Area—Simple Effects

Uncommon superscripts differ (P < 0.05). SEM = 2.6
Manganese supplemented as manganese oxide to high-sulfur feedlot diets at 1,000 ppm had a positive impact on beef cattle growth performance through the first 28 days on feed, but the effect did not persist past 28 days. High dietary sulfur concentrations decreased DMI (19%), ADG (25%), and feed efficiency (5%) throughout the experiment and appeared to accumulate over time.

Conclusion
Manganese, as MnO, has a potential as a dietary strategy to reduce negative effects of S during the receiving period.

Effect of urea inclusion in diets containing distillers grains on feedlot cattle performance and carcass characteristics, n = 14

Diet with moderate DGS inclusion and faster fermentation grain sources (high-moisture corn) may require DIP supplementation.

Objective
Evaluate the effect of increasing DIP concentration in finishing diets based on DRC and HMC and with low DDG inclusion on cattle performance.

<table>
<thead>
<tr>
<th>Supp DIP, %</th>
<th>Dietary urea, %</th>
<th>Dietary DIP, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON, 0</td>
<td>8.0</td>
<td>1.1</td>
</tr>
<tr>
<td>LU, 0.4</td>
<td>6.4</td>
<td>7.5</td>
</tr>
<tr>
<td>HU, 0.6</td>
<td>5.4</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Uncommon superscripts differ (P < 0.05). SEM = 2.6
### Diet and Nutrient Composition, % DM

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>LU</th>
<th>HU</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRC, %</td>
<td>52.0</td>
<td>52.0</td>
<td>52.0</td>
</tr>
<tr>
<td>HMC, %</td>
<td>22.0</td>
<td>22.0</td>
<td>22.0</td>
</tr>
<tr>
<td>DMCG, %</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Grass haylage, %</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Supplement, %</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Mcal NE/kg</td>
<td>1.32</td>
<td>1.32</td>
<td>1.32</td>
</tr>
<tr>
<td>TDF, %</td>
<td>61.4</td>
<td>61.4</td>
<td>61.4</td>
</tr>
<tr>
<td>CP, %</td>
<td>15.0</td>
<td>15.3</td>
<td>15.6</td>
</tr>
<tr>
<td>Basal DIP, %</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
</tr>
<tr>
<td>UIP, %</td>
<td>7.1</td>
<td>7.1</td>
<td>7.1</td>
</tr>
</tbody>
</table>

### Performance

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>LU</th>
<th>HU</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBW, kg</td>
<td>433</td>
<td>430</td>
<td>428</td>
<td>16</td>
<td>0.53</td>
</tr>
<tr>
<td>FBW, kg</td>
<td>600</td>
<td>594</td>
<td>613</td>
<td>20</td>
<td>0.58</td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>12.6</td>
<td>12.6</td>
<td>12.9</td>
<td>0.8</td>
<td>0.73</td>
</tr>
<tr>
<td>ADG, kg/d</td>
<td>1.91</td>
<td>1.87</td>
<td>2.32</td>
<td>0.07</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Gain:Feed</td>
<td>0.154</td>
<td>0.151</td>
<td>0.267*</td>
<td>0.008</td>
<td>&lt;0.08</td>
</tr>
</tbody>
</table>

* CON: no urea added; LU: 0.4% urea added; HU: 0.6% urea added

### Carcass Characteristics

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>LU</th>
<th>HU</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCW, kg</td>
<td>354</td>
<td>360</td>
<td>372</td>
<td>12</td>
<td>0.58</td>
</tr>
<tr>
<td>Backfat, cm</td>
<td>1.09</td>
<td>1.29</td>
<td>2.22</td>
<td>0.10</td>
<td>0.56</td>
</tr>
<tr>
<td>LM, cm</td>
<td>81.9</td>
<td>81.3</td>
<td>84.5</td>
<td>2.3</td>
<td>0.39</td>
</tr>
<tr>
<td>Marbling score</td>
<td>644</td>
<td>643</td>
<td>636</td>
<td>19</td>
<td>0.49</td>
</tr>
</tbody>
</table>

* CON: no urea added; LU: 0.4% urea added; HU: 0.6% urea added

Carcass Characteristics

<table>
<thead>
<tr>
<th>CON</th>
<th>LU</th>
<th>HUP</th>
<th>SEM</th>
<th>P</th>
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</thead>
<tbody>
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</tbody>
</table>

* CON: no urea added; LU: 0.4% urea added; HU: 0.6% urea added

Modeled DIP Balance

<table>
<thead>
<tr>
<th>CON</th>
<th>LU</th>
<th>HUP</th>
<th>SEM</th>
<th>P</th>
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<tbody>
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<tr>
<td>DIP required, g/d</td>
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<td>890</td>
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<td>DIP balance, g/d</td>
<td>-81</td>
<td>54</td>
<td>125</td>
<td>2.5</td>
</tr>
</tbody>
</table>

* CON: no urea added; LU: 0.4% urea added; HU: 0.6% urea added

Summary and Conclusion

- Adding 0.6% but not 0.4% urea improved ADG and tended to improve feed efficiency
- Adding urea did not affect carcass characteristics

Conclusion

- At 20% inclusion of DGS in dry rolled- and high-moisture corn diets, a ruminal N deficit may exist that responds to > 50 g urea supplementation
**Previous Data**

- Jacob et al., 2009—numerically greater *E. coli* O157:H7 shedding (floor samples) for DDGS (5.7% and 5.0% vs 2.7% and 4.0%)
- Jacob et al., 2008a—statistically greater *E. coli* O157:H7 shedding (floor samples) for DDGS (9.0% and 7.3% vs 3.6%)
- Jacob et al., 2010—statistically greater *E. coli* O157:H7 shedding (floor samples) for 40% inclusion of DGS (15.5%, 19.2% and 18.6% vs 25.6% and 24.7%)
- Jacob et al., 2008b

**E. coli O157:H7 – Effect of DGS and Glycerin (naturally infected)**

![Graph showing the effect of DGS and Glycerin on *E. coli* O157:H7 shedding over time.](image)

**Distillers and Glycerin in Steam-Flaked Corn Diets**

![Bar chart showing the pH levels of different diets.](image)
**E. coli O157:H7 – Effect of Corn Processing and Glycerin (inoculated)**

![Graph showing the effect of corn processing and glycerin on E. coli O157:H7 growth.]

**Applications Frontiers:**

- **New co-products**
  - High-protein DG
  - Low-fat DG
  - Corn bran
    - Energy value
    - Combinations with conventional grains and other co-products
- **Implications of antibiotic utilization in ethanol production**
  - Animal effects
  - Contribution to resistance
- **Beef quality**
  - Saturated/unsaturated fatty acids
  - Impact on ground beef products

**Residues Found and Reference Values (progress report)**

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</tr>
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*Lowest concentration permitted
Effects of Bovamine® supplementation on the prevalence and concentration of *Escherichia coli* O157:H7, non-O157 O types, and performance of finishing steers  

B. C Bernhard,¹ M. A. Calle², G. H. Loneragan², M. M. Brashears², M. D. Edmonds³, E. G. Johnson³, D. R. Ware⁴, W. M. Kreikemeier⁴, and C. R. Krehbiel¹; ¹Oklahoma State University, Stillwater; ²Texas Tech University, Lubbock; ³Johnson Research, LLC, Parma, ID; ⁴Nutrition Physiology Corporation, LLC, Guymon, OK

Crossbreed steers (n = 400; 760 ± 2.0 lb) were fed during a 129 d finishing trial to determine if supplementing Bovamine® [Bov; *Lactobacillus acidophilus* NP51 (LA) and *Propionobacterium freudenrichii* NP24 (PF), Nutrition Physiology Co., LLC] would improve the prevalence and concentration of *E. coli* O157:H7, non-O157 O types, and performance of finishing steers. A completely randomized design (40 pens; 10 pens/treatment; 10 steers/pen) was used. The four treatments included: 1) No Bov supplementation (Con), 2) Boy Rumen Culture® (LD; LA 1x10⁷ and PF 1x10⁹/hd/d), 3) Boy Culture Complex® (HD; LA 1x10⁹ and PF 1 x 10⁹/hd/d), and 4) LD for the first 101 d, followed by HD for the last 28 d (LDHD). Rectal fecal samples were collected from every steer on d 129. The prevalence and concentration of *E. coli* O157:H7 was analyzed. In addition, the prevalence of non-O157 O types (O26, O111, O121, O103, O145, and O45) was evaluated. Prevalence and concentration data were analyzed in the GLIMMIX and MIXED procedures of SAS, respectively. A linear contrast that did not include the LDHD treatment was evaluated. The prevalence of O157 was low at 8-13% and not different among treatments (P = 0.73). Increasing LA concentrations from Bov supplementation resulted in a linear decrease in the concentration of O157 (P < 0.01). Increasing LA concentrations also resulted in a linear decrease in the prevalence O26 (P < 0.01), O45 (P = 0.03), and O103 (P = 0.11). The other non-O157 O types had low shedding rates (less than 10%) and were not different between treatments (P > 0.24). Initial BW was measured and final BW was calculated on a 63% carcass adjusted (CA) basis. Dry matter intake was recorded, while CA-ADG and CA-F:G were calculated. Cattle were harvested and carcass data were collected (d 130 and 131, respectively). Feedlot performance and carcass data were analyzed in the MIXED procedure of SAS. No differences were detected for d 0 BW, CA-final BW, CA-ADG, or DMI (P > 0.38). Carcass adjusted F:G tended to display a treatment effect (P = 0.14). High-dosed steers showed improved feed efficiency over the Con steers, while HD and LD supplemented steers demonstrated improved CA-F:G over the LDHD supplemented steers (P ≤ 0.10). Dressing percentage, HCW, REA, YG, and marbling score showed no differences between treatments (P > 0.23). Results of this study indicate that supplementation of Bov to the basal diet can have beneficial effects for decreasing the prevalence and concentration of *E. coli*. Increasing the LA concentration showed the greatest reductions in the concentration of O157 and the shedding of non-O157 O types. The LDHD treatment resulted in intermediate advantages in *E. coli* prevalence and concentration, very similar to the LD treatment. In this experiment, daily gain and carcass results demonstrated no advantages for Bov supplemented steers. However, feed efficiency tended to be improved by approximately 2% in the LD and HD supplemented steers.
Effect of urea inclusion in diets containing distillers grains on feedlot cattle performance and carcass characteristics  
I. Ceconi, A. DiCostanzo, and G. I. Crawford, University of Minnesota, Saint Paul

An experiment was conducted to evaluate the effect of increasing degradable intake protein (DIP) concentrations in finishing diets on feedlot cattle performance and carcass characteristics. Forty-two Angus and Angus-crossbred steers (942 ± 12 lb initial BW) were assigned randomly to one of three dietary treatments containing (DM basis) 0% (CON), 0.4% (LU), and 0.6% (HU) urea. The three treatments contained (DM basis): 52% dry-rolled corn, 12% high-moisture corn, 20% dried distillers grains (DDG), 10% grass hay, and 6% dry supplement. All diets contained 0.594 Mcal NEg/lb and 0.22% S (DM basis). Measured dietary CP and estimated dietary DIP concentrations were 14.0, 15.1, and 15.6% and 6.4, 7.5 and 8.0% for CON, LU, and HU, respectively. Estimated dietary undegradable intake protein (UIP) concentration was the same for the three treatments and averaged 7.1%. Steers were fed ad libitum once daily at 0800 using a Calan gate individual feeding system. On d 85, steers were harvested at a commercial abattoir and carcass characteristics were collected. Group dressing percentage measured 60.6%, and this value was used to adjust performance data to a common dressing percentage. Initial BW, carcass-adjusted final BW, and DMI were similar among treatments (P ≥ 0.58) and averaged 963, 956, and 952 ± 36 lb, 1,323, 1,309, and 1,351 ± 36 lb and 27.7, 27.8, and 28.4 ± 1.7 lb/d for CON, LU, and HU, respectively. Carcass-adjusted ADG was higher (P < 0.05) for HU (4.67 ± 0.16 lb) compared with LU (4.13 ± 0.16 lb) and CON (4.21 ± 0.16 lb) and was similar (P = 0.73) between LU and CON. Carcass-adjusted feed:gain was lower (P = 0.03) for HU (6.06 ± 0.38) compared with LU (6.81 ± 0.38), tended (P = 0.09) to be lower for HU compared with CON (6.53 ± 0.38) and was similar (P = 0.61) between LU and CON. Hot carcass weight, 12th rib fat thickness, LM area, marbling score, USDA yield grade, and USDA quality grade were similar (P ≥ 0.34) among treatments. Observed DIP requirements in the three treatments may have been higher than those predicted by the NRC model due to microbial efficiency being higher than predicted. A higher microbial efficiency may have been associated with actual pH (measured in a concurrent rumen fermentation study) being higher than predicted and possibly to high intakes which may have contributed to an increased rate of passage. Under the conditions of this experiment, increased DIP requirements appeared to be met by supplementing 0.6% urea to the diet, resulting in an improvement in performance compared with diets containing 0 and 0.4% urea.

Similar abstract previously published:

Effects of varying bulk densities of steam-flaked corn in diets containing Sweet Bran wet corn gluten feed on feedlot cattle performance, carcass characteristics, and apparent total tract nutrient digestibility  

Effects of the bulk density of steam flaked corn (SFC) in diets containing Sweet Bran wet corn gluten feed (WCGF) is not well-defined, but with increasing use of grain byproducts in finishing diets, this information should be important in managing feed costs. Yearling steers (n = 108; initial BW = 367 ± 1.18 kg) were housed in 27 pens (4 steers/pen) and received 3 different SFC bulk density treatments in a randomized complete block design. Bulk density treatments were
283, 335, or 386 g/L (22, 26, or 30 pounds/bushel) SFC in diets containing 25% WCGF (DM basis). Steers were fed once daily to provide ad libitum access to feed for an average of 163 d (149 d for 3 blocks and 170 d for 6 blocks). For a 5-d period before d 70 of the experiment, DMI was obtained, and fecal samples were collected from each pen for measurement of nutrient digestibility using dietary acid insoluble ash as a marker. Varying bulk densities of SFC did not affect \((P \geq 0.233)\) overall DMI, ADG, or G:F on a live- or carcass-adjusted basis. Dressing percent and longissimus muscle area increased linearly \((P \leq 0.05)\) as bulk density increased, but other carcass traits were not affected by treatments. Intakes of DM, OM, and CP during the 5-d digestion phase did not differ among bulk densities; however, starch intake increased linearly \((P = 0.004)\) as bulk density of SFC increased. Digestibilities of DM, OM, and CP tended \((P = 0.065)\) to decrease linearly, and starch digestibility decreased \((P = 0.002)\) linearly, as bulk density of SFC increased. Present data suggest that bulk density can be increased up to 386 g/L without affecting performance by finishing beef steers; however, digestibility of starch seemed to be affected negatively by increased bulk density.

**Post-extraction algal residue: Palatability and effect on forage utilization in beef cattle**

*M. L. Drewery, J. E. Sawyer, W. E. Pinchak, and T. A. Wickersham, Texas A&M University, College Station*

Post-extraction algal residue (PEAR), a co-product of biofuel production from algal biomass, has potential as a source of nutrients in livestock diets. The capacity of the beef industry (10.1 million feedlot cattle and 30.9 million beef cows) coupled with the documented ability of ruminants to utilize co-products indicates cattle operations are an ideal market for PEAR. After oil extraction, PEAR retains the protein fraction of the original biomass (20% crude protein; CP), suggesting it may be utilized as a protein supplement. An initial step in evaluating the feasibility of PEAR as a protein supplement was to determine its palatability. In experiment 1, PEAR (52% organic matter; OM, 20% CP) was blended with dried distillers’ grains (DDG; 31% CP) and cottonseed meal (CSM; 52% CP) at different inclusion levels (0, 20, 40, 60, and 100%) to develop test supplements. Steers were offered 1 kg of supplement once daily for 3 days; any refusals remaining after 1 hour were collected and weighed. Rate and completeness of consumption were measured. Supplements containing up to 60% PEAR in combination with DDG or CSM were readily consumed, 188 and 166 grams per minute (GPM), respectively. However, when 100% PEAR was fed, only 54% of steers consumed the entire supplement and the rate of consumption was 93 GPM. In experiment 2, the effect of PEAR (20% CP, 55% OM) supplementation on low-quality forage utilization was determined. Steers had ad libitum access to oat straw (4% CP, 81% neutral detergent fiber; NDF) and supplements were administered through the rumen cannula to ensure complete consumption. Treatments consisted of one of four levels of supplemental PEAR provision: 0, 0.16, 0.31, or 0.47% of BW and CSM at 0.15% of BW. Total digestible organic matter intake (TDOMI) increased quadratically \((P = 0.07)\) peaking at 1.67 kg/d when PEAR was provided at 0.31% of BW. There was no difference \((P = 0.12)\) in TDOMI between isonitrogenous levels of PEAR and CSM (0.31 and 0.15% of BW, respectively), indicating cattle provided PEAR utilized forage in a similar manner to those supplemented with CSM. Fecal and urinary N excretion increased linearly \((P < 0.01)\) with increased supplementation levels and similar N excretion was observed for PEAR and CSM treatments. Nitrogen absorption increased linearly \((P < 0.01)\) in response to increased provision of PEAR; 14.6 g of N/d was absorbed at the highest level of PEAR versus 0.64 g of N/d for the control. Negative N retention was observed for unsupplemented cattle (-9.6 g of N/d). N
retention increased quadratically \((P < 0.01)\) with the only positive observations occurring when PEAR or CSM were provided at 0.31 and 0.15% of BW, respectively (1.4 and 3.2 g of N/d, respectively). There was no significant difference \((P = 0.92)\) in the amount of N retained as a percentage of N intake between similar supplemental levels of PEAR and CSM. Our observations indicate provision of PEAR will increase forage intake, degradation, and utilization of dietary nutrients similar to CSM supplementation. Potential exists for PEAR to become a viable protein supplement; however, additional work is required to develop a marketable supplement.

**Impact of between-animal variation in performance, carcass-quality and feed efficiency on profitability of Angus-based composite steers**


Nutrition, management and genetic merit of cattle all have substantial effects on performance, efficiency of feed utilization and carcass-quality traits to create large between-animal variances in net revenue \((NR)\) of feedlot cattle. Objectives of this study were to evaluate the relative contributions of performance, feed efficiency and carcass-quality traits attributed to variation in NR, and to examine the sensitivity of changing feed and carcass prices on the proportion of between-animal variation in NR attributed to these traits. Growth and individual DMI were measured in Angus-based composite steers \((N = 508)\) fed a high-grain diet \((3.08 \text{ Mcal ME/kg DM})\) for 70 d over 3 consecutive yr. Residual feed intake \((RFI)\) was computed as actual minus expected DMI from linear regression of DMI on ADG and BW \(^{0.75}\). Steers were then fed the same diet in group pens, harvested at 1.14 cm backfat, and carcass traits recorded for quality and yield grades. Feed costs were based on actual DMI during the feed-intake measurement period, and CVDS (Cattle value discovery system) model-predicted DMI adjusted for RFI on assumption that animal ran k in RFI was maintained throughout the trial. NR was calculated as carcass value \((3-yr \text{ average carcass price and grid-formula discounts and premiums})\) minus feeder calf, yardage and feed costs \((3-yr \text{ average fixed feed prices})\) for 2008 to 2010. Steers were categorized as low, medium or high \((\pm 0.5 \text{ SD})\) NR to examine effects of NR group on performance, carcass-quality and feed efficiency traits. Overall NR \((\text{mean} \pm \text{SD})\) was -$135 \pm 54 per hd and ranged from -$417 to $55/hd. NR was positively correlated with ADG, HCW and marbling score \((0.38, 0.49 \text{ and } 0.24, \text{ respectively})\), and negatively correlated with DMI, F:G, RFI and YG \((-0.14, -0.50, -0.48 \text{ and } -0.20, \text{ respectively})\), such that steers with high NR \((> 0.5 \text{ SD above mean})\) gained 11% faster, consumed 5% less DMI and had 15% higher G:F compared to low NR steers. RFI was -0.49 and 0.55 kg/d for high and low NR steers. High NR steers had 9% heavier carcasses, lower YG \((3.1 \text{ vs } 3.3 \pm 0.1)\) and higher marbling scores \((438 \text{ vs } 392 \pm 6)\). Stepwise regression was used to determine factors contributing to between-animal variation in NR with year, DMI, ADG, RFI, F:G, HCW, marbling score, and yield grade \((\text{linear and quadratic terms})\) included as independent variables. The model to estimate NR \((\text{with F:G})\) accounted for 74% of animal variation, with performance \((\text{IBW, HCW, ADG})\), carcass quality \((\text{marbling score, YG})\), feed efficiency \((\text{DMI, F:G})\) and year explaining 26, 17, 31 and 0.23%, respectively. The model using RFI in place of F:G accounted for 73% of the variation in NR; performance, carcass quality, feed efficiency \((\text{DMI, RFI})\) and year explaining 28, 12, 32 and 0.13%, respectively. Comparison of regression models estimating NR at various ration-cost scenarios \($200, 250, 300 \text{ and } 350/\text{ton}\) revealed that the proportion of total model variance \((R^2)\) attributed to FE traits increased \((44 \text{ to } 70\% \text{ for } $200 \text{ and } $350, \text{ respectively})\), while that
attributed to performance traits decreased (39 to 14%). Altering ration costs had little impact on the proportionate variation attributed to carcass-quality traits (17 vs 15%, respectively). Results demonstrate that substantial variation in NR can be attributed to individual-animal variances in performance, feed efficiency and carcass-quality of feedlot steers of similar breed type and management background.

The effects of spoilage of wet distillers grains plus solubles on nutrient composition and performance of growing and finishing cattle. J.L. Harding, K.M. Rolfe, C.J. Schneider, B.L. Nuttelman, D.B. Burken, W.A. Griffin, G.E. Erickson, and T.J. Klopfenstein, University of Nebraska, Lincoln

Three studies evaluated the impact of spoilage of wet distillers grains plus solubles (WDGS) on nutrient composition and cattle performance. In Exp. 1, a 140-d barrel study was conducted to mimic bunker storage under ambient temperature but with no precipitation. Two barrels were weighed and sampled on d 7, 14, 28, 56, 84, 112, and 140. The samples were analyzed for DM, OM, fat, NDF, CP, and pH. An interaction between days of storage and DM, OM, and NDF recovered was observed. Spoilage increased the pH of the WDGS from 3.95 (original) to 6.72 on d 140 (P < 0.01). Spoilage over time increased (P = 0.10) from d 7 to 140 (6.35-11.70%). The amount of OM lost due to spoilage increased from 4.9% on d 14 to 22.6% on d 140 (P < 0.01).

In Exp. 2, a 130-d finishing study utilized 60 individually-fed steers (878 ± 65.8 lb) fed 3 treatments: a dry-rolled corn based diet (control) and 2 diets containing 40% WDGS replacing DRC. The WDGS was from the same ethanol plant and split equally within semi-load into either an uncovered bunker (spoiled WDGS) or a silo bag and stored anaerobically (non-spoiled WDGS). Nutrient composition of non-spoiled WDGS was 33.4% DM, 5.6% ash, 14.8% fat, 31.7% NDF, 30.8% CP, and a pH of 4.2. Nutrient composition of WDGS containing spoilage was 35.2% DM, 6.4% ash, 14.1% fat, 33.3% NDF, 30.8% CP, and a pH of 4.8. Calculations suggest 12% of DM was lost during storage in the bunker. Feeding control, non-spoiled WDGS, or spoiled WDGS did not affect DMI (P = 0.50). No differences (P ≥ 0.26) in ADG (3.05± 0.65 lb), final BW (1256 ± 99 lb), or F:G were observed between non-spoiled and spoiled WDGS treatments. However, both WDGS treatments were greater (P ≤ 0.04) in ADG and final BW, and lower in F:G than the control. An 84 day growing study utilized 60 individually fed steers (730 ± 32.9) in a 2x2 factorial in Exp. 3. Treatments were bunkered vs. bagged WDGS fed at 15 or 40% of diet DM. Diets containing 15% WDGS also had 81% grass hay, while diets with 40% WDGS had 57% grass hay. Nutrient composition of non-spoiled WDGS was 35.1% DM, 5.2% ash, 11.2% fat, 34.9% NDF, 33.1% CP, and a pH of 4.0. Composition of WDGS containing spoilage was 37.0% DM, 5.8% ash, 12.8% fat, 35.1% NDF, 35.2% CP, and a pH of 4.8. Calculations suggest that 6.0% of DM was lost during storage in the bunker. There were no level by spoilage interactions (P = 0.94). The steers fed 40% WDGS had greater DMI, ADG, and improved F:G (P < 0.01) compared to feeding 15% WDGS. Feeding spoiled WDGS decreased DMI (P < 0.01) across both levels of dietary WDGS compared to non-spoiled WDGS (16.48± 2.5 vs. 17.78± 2.0 lb/d). The diets containing spoiled WDGS had statistically similar ADG (0.92 ±0.34 vs.1.01± 0.30 lb/d) and F:G compared to diets with non-spoiled WDGS (P ≥ 0.16). Even though spoiled WDGS changed in nutrient composition over time, it did not affect performance of finishing steers. However, feeding spoiled WDGS to growing steers did decrease DMI, but had little impact on ADG and no effect on F:G.
Interaction of Dietary Roughage and Sulfur Concentration on Performance of Beef Feedlot Cattle

G. M. Huber, A. DiCostanzo, and G. I. Crawford, University of Minnesota, Saint Paul

The objective of this experiment was to determine the effect of differing concentrations of dietary roughage (R) and sulfur (S) in beef cattle feedlot diets on feedlot performance and carcass characteristics. Eighty-four Angus, Limousin, and Charolais steers (initial BW 1,016 ± 79 lb) were arranged in a randomized complete block design. Steers were fed in a Calan gate individual feeding system and treatments were arranged in a 2 x 3 factorial, with two dietary concentrations of S (0.28%, LS or 0.56%, HS, DM basis) and three dietary concentrations of R (5%, LR; 10%, MR; 15%, HR, DM basis). Steers were harvested after 134 d (block 1 and 2) and 92 d (block 3). Final carcass-adjusted BW was not affected by R, S, or their interaction \((P \geq 0.44)\), and averaged 1,413 lb across treatments. Dry matter intake increased linearly \((P = 0.01)\) with increasing R, and averaged 21.8, 23.1, and 23.5 lb/d for LR, MR, and HR, respectively. Increased dietary S concentration decreased \((P = 0.02)\) DMI, averaging 23.4 and 22.3 lb/d for LS and HS, respectively. Average daily gain was not affected \((P \geq 0.24)\) by R, S, or their interaction, and averaged 3.26 lb across treatments. Feed:gain was not affected by dietary S concentration or a S x R interaction \((P \geq 0.31)\) and increased linearly \((P = 0.01)\) with increasing R, averaging 6.59, 6.94, and 7.56 for LR, MR, and HR respectively. Hot carcass weight (910 lb across treatments), LM area (15.5 square inches), 12th rib fat thickness (0.46 in), marbling score (459), and frequency of individual USDA quality grades were not affected by R, S, or their interaction \((P \geq 0.14)\). A tendency \((P = 0.07)\) for a decrease in USDA yield grade 1 and 2 carcasses was observed with increasing R and averaged 60.8, 50.1, and 43.0% for LR, MR, and HR, respectively. No other effects on individual USDA yield grades were observed \((P \geq 0.12)\). Results suggest that increasing dietary roughage concentration increases DMI while high dietary S concentrations decrease DMI. However, no interactions occurred to suggest that performance may be enhanced by feeding increased roughage in high-S feedlot diets.

Similar abstract previously published:


Optaflexx and estradiol/trenbolone acetate implants alter live performance and carcass components of heifers during the finishing phase

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Beta agonists and steroidal growth implants have both demonstrated the ability to increase live performance and lean tissue accretion through muscle fiber growth. The objective of this study was to evaluate the interaction of ractopamine hydrochloride and timing of terminal implant administration on growth performance, carcass characteristics, and meat quality in feedlot heifers during the finishing period. Heifers (n=216; 753±43.3 lb) were purchased and transported to the Texas Tech University Beef Center in New Deal, Texas. They were arranged in a 2x3 factorial with 2 levels of Optaflexx and 3 different durations of terminal implant windows for a total of 6 treatment groups with 9 replications. Optaflexx treatment groups included 0 mg/hd/d of Optaflexx (Control, n=27) or 200 mg/hd/d of Optaflexx (OPT, n=27). Optaflexx was fed the final 28 d of the finishing period. Three different durations of terminal implant included heifers receiving an estradiol/trenbolone acetate implant, Component TE-200 with Tylan, 60 d pre-
slaughter (TI60, n=18), 100 d pre-slaughter (TI100, n=18), and 140 d pre-slaughter (TI140, n=18). Daily dry matter intake (DMI) was recorded and individual BW was collected at d 0, 40, 80, 112, and 140. No interactions were detected, so only main effects are reported. No difference was detected in DMI between OPT and Control heifers during the final 28 d. Heifers fed OPT had a greater (P<0.05) average daily gain (3.21±0.10 lb/d) and higher calculated carcass ADG (2.43±0.06 lb/d) compared to Control heifers (2.92±0.10 and 1.89±0.06 lb/d, respectively). Hot carcass weight was increased (P=0.02) in heifers fed OPT (734.8±3.60 lb) versus Control (722.5±3.60 lb). Heifers fed OPT tended to have a larger LEA (P=0.09; 13.69±0.15 in²) compared to control heifers (13.31±0.15 in²). There was no difference detected in calculated yield grade between OPT or control heifers. However, heifers fed OPT tended to have a decrease (P=0.10; 425.2±7.75) in overall marbling score compared to control heifers (407.2±7.75). During the first 40 d on trial, the average daily gain of the TI140 (4.01±0.14 lb/d) and TI100 (3.66±0.14 lb/d) groups were higher (P<0.01) compared to the TI60 treatment (3.26±0.14 lb/d). From d 40-80, the TI100 had a higher ADG (P<0.01) than all other implant treatment groups. TI60 had a higher ADG (P=0.02) than all other implant treatment groups from d 80-112. Predicted carcass ADG mirrored the live ADG differences among implant treatments. No differences in final BW or carcass parameters were observed among the three implant strategies. Slice shear was performed on OPT and implants treatments after 14 d of aging and no differences were detected. Additionally, Warner Bratzler Shear Force (WBSF) was performed on samples aged to 3, 7, 14, and 21 d postmortem. No differences (P>0.05) in WBSF were detected at d 3, 7, and 21 although at 14 d postmortem WBSF values of the OPT steaks were higher (4.12±0.12 kg) than controls (3.67±0.12 kg; P=0.02). Results from this study demonstrated that OPT, when fed to heifers, increased average daily gain, calculated average daily carcass gain, and hot carcass weight with minimal impact on carcass quality. Furthermore, this study indicated that the duration of the terminal implant window did not affect overall performance, final BW, or carcass quality.

Blended byproduct feeds in finishing rations on performance, carcass, and fecal characteristics of yearling heifers B. T. Johnson, C. L. Maxwell, B. K. Wilson, J. J. Wagner, S. L. Roberts, B. W. Woolfolk, C. R. Krehbiel, and C. J. Richards, Oklahoma State University, Stillwater
This study compared inclusion levels of a 1:1 blend of Sweet Bran® (SB) and dried distiller’s grains (DDGS) byproducts in a dry-rolled corn feedlot ration on performance, carcass merit, and fecal characteristics. Heifers (n = 108; initial BW = 324 ± 13.6 kg) were blocked by BW, randomized to treatment, and fed for 142 d. Treatments were control (CONT, 8% DDGS), intermediate with 22% SB and 22% DDGS (INTERM), and all byproduct with 44% SB and 44% DDGS (ALL). During d 28 to 55, a time of severe environmental heat with an average Temperature Humidity Index (THI) value of 80, ALL increased ADG and G:F (P < 0.02) by 12.2% and 16%, respectively. Average daily gains were similar for all other periods. There was a trend (P = 0.09) for increased overall G:F with ALL using live final BW, and increased (P < 0.01) G:F on a carcass adjusted final BW basis. Heifers fed ALL had a 1.2 percentage unit increase (P < 0.05) in dressing percentage (ALL vs. CONT). There was a trend (P = 0.08) for increases in HCW for the INTERM (3.5%) and ALL (2.5%) compared to CONT, with no other differences in carcass characteristics. These data indicate that replacing dry-rolled corn in a finishing diet with a 1:1 blend of SB and DDGS increases feed efficiency and HCW without altering ADG. Rectal fecal samples were taken every weigh period for pH, fecal scoring, and
DM content. Further analysis by treatment was compared by taking concrete bunk pad samples at every weigh period and determining sample DM and density. Fecal pH and scores increased (P < 0.05) throughout the study for ALL, indicating a more viscous structure. A linear decrease in fecal DM was noted as level of byproduct inclusion increased (P < 0.05) for each sampling period. Pad sample DM decreased linearly (P ≤ 0.05) on d 56, 112, and 142. Data indicates replacing corn with a 1:1 blend of SB and DDGS also increases fecal pH, fecal score and decreases fecal DM and DM of the pad (more water in manure on the pad/pens). During high temperatures, the ALL diet may have additional performance benefits.

The 2005 National Beef Quality Audit revealed that 1.9% of carcasses were categorized as dark cutters resulting in an estimated $168 million loss to the industry due to poor retail display properties, shorter product shelf life and poor sensory attributes. While strategies to improve animal handling and management practices have reduced the incidence of dark cutters, cases remain, and new strategies to further reduce this quality defect are necessary. Hydro-Lac® (HL) is a patented, timed event nutrition (T.E.N®) product, designed to provide essential nutrients, electrolytes, sugars, and other proprietary ingredients necessary to maintain fluid balance and performance in live cattle during periods of stress. However, the mechanisms by which HL may mediate the effects of stress on beef quality have not been evaluated. Therefore, the objective of this study was to determine the effects of HL on the incidence of dark cutting beef, glycolytic potential, and meat sensory attributes. Thirty two (n=32) Holstein steers received HL supplementation for two days prior to slaughter and thirty two (n=32) received no supplement to serve as the control (CON). Carcass data were recorded 48 hours postmortem, and a 7.62 cm section of the longissmus dorsi (LD) was removed posterior to the ribbed surface. Samples were trimmed and further dissected into 2.54 cm steaks for Warner-Bratzler shear force (WBSF) analysis and 0.6 cm slices for evaluation of glycolytic potential and pH. Lean trimmings were pooled within treatment group, coarsely ground, mixed, finely ground, and formed into 114 g patties. Patties were retail overwrapped and evaluated at day 0, 2, 4, and 7 after grinding for subjective color analysis (lean color, percent discoloration, desirability), objective color analysis (Minolta L* and a*), taste panel sensory evaluation (juiciness, rancidity, beef flavor intensity, and off flavor) and lipid oxidation. No significant differences were observed for carcass characteristics or WBSF, however HL samples were numerically lower in WBSF compared with CON samples (P = 0.1192). Although no carcasses were identified as dark cutters, HL samples revealed significantly higher glycolytic potential (P = 0.0004) and a trend for lower ultimate pH (P = 0.0559). Sensory panel evaluation of beef patties revealed no differences between CON and HL samples for lean color, percent discoloration, desirability, or beef flavor. However, CON samples showed a higher degree of rancidity (P = 0.0274) and detectable off-flavors (P = 0.0152, 0.0007 and < 0.001 for days 2, 4, and 7 respectively) compared with HL samples. No difference were observed for a*, however HL patties had significantly higher L* values (P = 0.0052, 0.0016, 0.0001, and 0.0002 for days 0, 2, 4, and 7 respectively). Additionally, lipid oxidation (TBARS) values were significantly higher (P < 0.0001) at days 2, 4, and 7 of retail storage in CON patties compared with HL patties. Collectively this study illustrates that HL inclusion in pre-harvest cattle diets increases the glycolytic potential of beef LD, reduces sensory evaluation of rancidity and detectable off-flavors and reduces lipid oxidation.
The effects of titrating corn-based dried distillers grains plus solubles with sorghum-based wet distillers grains plus solubles on yearling heifers with I.C.E.® on feedlot performance and carcass characteristics  

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This study compared performance and carcass effects of altering corn dried distillers grains plus solubles (DDGS) to sorghum-based wet distillers grains plus solubles (WDGS) ratios in a dry-rolled corn feedlot ration with 30% distillers grains plus solubles (DGS; DM basis) with inclusion of Internal Cooling Elements (I.C.E.®, Provimi North America, Brookville OH) or a ground corn placebo. Yearling cross-bred heifers (n = 150; initial BW 810 ± 36.31 lbs) were blocked by BW, implanted with Revalor H®, stratified by hide color and randomized to treatment, and fed for 125 d. On d 98, 330 mg·hd⁻¹·d⁻¹ of ractopamine hydrochloride (Optaflexx®) was included into each treatment ration and fed the final 27 d of the finishing period. Combinations of distillers grains evaluated were: 30% DDGS; 22.5% DDGS: 7.5% WDGS; 15% DDGS:15%WDGS; 7.5%DDGS:22.5%WDGS; and 30% WDGS. Also, cattle either received I.C.E.® at manufacturer’s dosage or a placebo of ground corn. There was no DGS x I.C.E.® interaction (P > 0.10). There were no differences (P > 0.54) among treatments in overall ADG, G:F, and DMI. No differences were detected in HCW, dressing percentage, marbling score, KPH or USDA Yield Grade when altering DGS source (P > 0.14). From d 1-56, calculated thermal heat index (THI) was greater than 74, indicating a period of severe heat stress. The cattle supplemented with I.C.E.® had an 8.8% improvement in ADG (P = 0.05) in the period following the heat stress (d 57-84) compared to control. Overall performance and carcass characteristics was not affected by I.C.E.® supplementation (P > 0.07). Data suggests that when fed at 30% of the finishing diet DM, corn DDGS and sorghum WDGS can be blended or exchanged with no impact on finishing performance or carcass characteristics. These data would serve as a useful tool when formulating least cost dry-rolled corn based rations. Also, more research is needed to adequately quantify the effects of I.C.E.® on animal performance and carcass characteristics during periods of heat stress. These data would indicate that perhaps the timing of supplementation of I.C.E.® is of utmost importance.

Effects of Modified Distillers Grains with Solubles and Crude Soybean Glycerin Inclusion in Beef Cattle Finishing Diets on Beef Quality  


Crossbred steers and heifers (n = 48) were assigned randomly to one of four treatments and fed individually using a Calan gate feeding system. Treatment diets were a traditional steam-flaked corn diet with no modified distillers grains or crude soybean glycerin (CON); CON with 40% modified distillers grains with solubles (MDGS); CON with 10% glycerin (GLY); and CON with 40% MDGS and 10% glycerin (MDGS/GLY). Modified distillers grains and glycerin substituted steam-flaked corn. At a mean weight of 1,300 lbs, cattle were humanely harvested at a commercial abattoir in two groups. Strip loins and shoulder clods were removed from the right side of each carcass 48 h post mortem, vacuum packaged, and stored refrigerated. Seven 1-in steaks were cut serially from the anterior end of each strip loin for further analysis. Shoulder clods were ground individually, twice through a 0.375-cm grinder plate for ground beef analysis. Treatment did not affect HCW, ribeye area, 12th rib backfat, USDA Yield and Quality Grades, or marbling score (P > 0.05). However, with the addition of MDGS, there was a higher percentage KPH (P = 0.03). Treatment did not affect vacuum purge loss (P = 0.75),
cooking loss (P = 0.40), or drip loss (P = 0.06) of loin steaks. The inclusion of MDGS decreased Warner-Bratzler shear force values (P = 0.04). Treatment had no effect on any specific fatty acids (P > 0.05), but fat from cattle fed MDGS had numerically higher percentages of C18:2 than that from cattle fed CON. There were no differences between treatments for SFA (P = 0.99) and MUFA (P = 0.53). Additionally, with the inclusion of crude glycerin, there was an increase in trans-fatty acids (P = 0.02). There were no differences between treatments for objective color values (L*, a*, and b*; P = 0.40, 0.90 and 0.64, respectively) for strip steaks. Lean color, surface discoloration, and overall appearance of strip steaks was not affected by treatment (P = 0.76, 0.97 and 0.95, respectively) for all 7 d of retail shelf life. Treatment did not affect ground beef L*, a*, or b* values (P = 0.06, 0.09 and 0.89, respectively) or subjective lean color, surface discoloration, and overall appearance (P = 0.87, 0.89, and 0.35, respectively). No treatment differences were observed for thiobarbituric acid reactive substances (TBARS) values on d 0 (P = 0.59), however the addition of MDGS did increase TBARS on d 7 (P = 0.02). CON and MDGS had higher values for consumer overall liking and texture liking of strip steaks (P = 0.02 and 0.002 respectively) in sensory testing. Treatment did not affect flavor liking (P = 0.09). MDGS/GLY had higher toughness values than CON and MDGS, but not GLY (P < 0.001). CON had the highest values for juiciness (P < 0.001). Results indicate that the addition of MDGS and crude glycerin in beef finishing diets did not negatively affect moisture loss, shear force, or color stability in strip steaks and ground beef, however, may impact sensory characteristics of beef strip steaks. 

Previously presented:

Comparing a delayed growth implant strategy to conventional feedlot practices
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Allowing stressed receiving calves to adapt the feedlot environment, increase DMI, and recover from disease prior to an initial implant could improve the animal’s response to that implant. This study used 408 crossbred heifers (440 ± 2.8 lb initial BW) of southeastern United States origin to evaluate the effects of timing of an initial growth implant on overall performance, carcass characteristics, and health of feedlot heifers. Heifers were sorted upon arrival to the processing chute into 24 pens which were randomly assigned to 3 treatments (8 pens per treatment). Treatments were 1) no implant (CON), 2) an implant at initial processing (IMP0), and 3) an implant 21 d after initial processing (IMP21). The initial implant was 140 mg trenbolone acetate and 14 mg estradiol (Revalor-H; Intervet/Schering-Plough Animal Health, Millsboro, DE), and all heifers received a terminal implant (Revalor-200) on d 126. Heifers were fed once daily a 68, 75, 82, and 91% concentrate diet from d 1 to 21, d 22 to 63, d 64 to 126, and d 127 to 222 (finish), respectively. From d 0 to 21, DMI of heifers was not affected (P = 0.34), ADG was greater (P ≤ 0.05) for IMP0 (2.27 lb/d) than CON (1.90 lb/d) and lower (P ≤ 0.05) for IMP21 (1.44 lb/d) than CON, and G:F was greater (P ≤ 0.05) for IMP0 (0.299) than CON (0.247) and lower (P ≤ 0.05) for IMP21 (0.196) than CON. From d 22 to 42, DMI of heifers was not different (P = 0.23), ADG was greater (P ≤ 0.05) for IMP0 (3.16 lb/d) and IMP21 (3.64 lb/d)
than CON (2.48 lb/d), and G:F was greater ($P \leq 0.05$) for IMP21 (0.257) than CON (0.177) and intermediate for IMP0 (0.216). From d 43 to 126, DMI was greater ($P \leq 0.05$) for IMP0 (17.6 lb/d) and IMP21 (17.8 lb/d) than CON (16.9 lb/d), but ADG and G:F were not different ($P \geq 0.43$). From d 127 to 222, DMI was higher ($P \leq 0.05$) for IMP0 (17.6 lb/d) and IMP21 (17.8 lb/d) than CON (16.9 lb/d), but ADG and G:F were not affected ($P \geq 0.12$) by treatment. For the overall feeding period (d 1 to 222), DMI was higher ($P \leq 0.05$) for IMP0 (16.3 lb/d) and IMP21 (16.6 lb/d) than CON (15.8 lb/d), and ADG was higher ($P \leq 0.05$) for IMP21 (3.08 lb/d) than CON (2.89 lb/d) and intermediate for IMP0 (2.97 lb/d), but G:F was not affected ($P = 0.25$). Heifer HCW was greater ($P \leq 0.05$) for IMP21 (711 lb) than CON (690 lb), and IMP0 (701 lb) was intermediate. No other carcass characteristics were affected ($P \geq 0.29$). Mortality and morbidity were not affected ($P \geq 0.44$). Delaying the initial implant by 21 d did not negatively affect overall feedlot performance of heifers. Greater HCW may have economical implications that depend upon how the cattle are marketed. Authors acknowledge Texas Cattle Feeders Association for funding.

**Orally Dosing Cattle with Lactipro to Accelerate Adaptation to High Concentrate Diets**

*Kevin Miller, Cadra Van Bibber-Krueger, Christian Alvarado, Celine Aperce, and Jim Drouillard, Kansas State University, Manhattan*

Three studies were conducted to evaluate accelerated adaptation to high concentrate diets following an oral dose of *Megasphaera elsdenii* (Lactipro®; MS-Biotec Inc., Wamego, KS). In study 1, crossbred heifers (n=378; 847 ± 24 lb BW) were used to evaluate the potential for placing cattle on accelerated step-up regimens following an oral dose of Lactipro®. Thirty six hours after arrival, heifers were weighed and randomly assigned to pens (54 pens 7 hd/pen). Pens were randomly assigned to one of 6 step-up regimens that employed between 1 and 5 diets. Diet 1 = 50% corn silage (CS) and 50% concentrate (Conc.; 1), diet 2 = 40% CS and 60% Conc. (2), diet 3 = 30% CS and 70% Conc. (3), diet 4 contained 20% CS and 80% Conc. (4), and the finisher contained 10% CS and 90% Conc. (F). Step-up regimens were control (1234F; no Lactipro®) and accelerated step-up regimens were 234F, 34F, 3F, 4F, and F all heifers received a 100 mL oral dose of Lactipro® ($10^9$ CFU/mL) at processing. Diets 1 to 4 were fed for 5 d each and F for the remainder of the study. Treatment tended (quadratic, $P = 0.07$) to influence DMI, with cattle on 3F and 34F having lower DMI than other groups. Heifers fed 1234F or F tended to have greater ADG (quadratic, $P = 0.10$) and were more efficient than other groups (quadratic, $P < 0.01$). Treatments did not differ with respect to liver abscess or HCW ($P > 0.10$). In study 2, crossbred steers (n = 443; 880 ± 5.3 lb BW) were used to evaluate performance and carcass traits after oral dosing with Lactipro® and placement directly onto finishing diets. Approximately 24 h after arrival, steers were weighed and randomly assigned to one of two treatments based on order of processing. Steers were placed in 24 pens containing 14 or 15 steers/pen and 12 containing 7 or 8 steers/pen. A traditional, 4-diet step-up regimen (control) utilizing 3 step-up diets (40, 30, and 20% CS and the balance as Conc.) fed for 6 d each, followed by a finishing diet (10% CS and 90% Conc.) fed for the remainder of the study was compared to a Lactipro® treatment, which consisted of a single oral drench of Lactipro® and direct placement onto the finishing diet. Diets contained steam-flaked corn and wet corn gluten feed. Lactipro® steers consumed 17% less silage than control steers over the 115-d feeding period ($P < 0.01$). Dry matter intake tended to be lower for steers in the Lactipro® group ($P = 0.07$), but gain and gain efficiency were not different ($P > 0.10$). Incidence of liver abscess and HCW were unaffected by diet regimen. In study 3, 90 steers from study 2 were utilized to
compare a traditional step-up program and oral dosing with Lactipro® followed by direct placement onto a finishing diet on digestibility during the step-up period. Processing procedures, treatments, and diets were the same as in study 2. Steers were housed on concrete surfaced pens (12 pens with 7 or 8 hd/pen). Feed intake and fecal output were determined daily for the first 24 d on feed to estimate dry matter digestibility. Fecal samples were composited for each 6 d step-up period and analyzed for protein, NDF, and starch. Dry matter intake and fecal output were lower for steers placed directly on to finishing diets \( (P < 0.01) \). Dry matter digestibility was greater \( (P < 0.01) \) for Lactipro® steers for days 7-12 and 13-18. For the first 6 d on feed, NDF digestibility was lower \( (P < 0.01) \) for Lactipro® steers. Starch digestibility was not different \( (P > 0.1) \) between treatments. Despite decreased intake during the step-up period, drenching cattle with Lactipro® at initial processing allows for cattle to be placed onto finishing diets more rapidly, while maintaining acceptable feedlot performance and carcass characteristics.

Evaluation of supplement level and supplemental protein source for growing cattle on medium quality hay W.A. Moore, B.R. Wiegand, M.S. Kerley and W.J. Sexten, University of Missouri, Columbia

96 crossbred (Angus, Red Angus, Simmental) steers (272.8 ± 53.6 kg) were used during autumn of 2011 to evaluate supplementation level and protein source on calf performance. Steers were assigned to a 2x2 factorial arrangement with two supplements at two levels in a randomized complete block design. Supplements were fed at 0.75% or 1.5% BW*hd\(^{-1}\)d\(^{-1}\) (DM basis). Supplements were balanced (BAL) for post-ruminal amino acid needs at 0.88 kg/d (0.75% BW) or 1.7 kg/d (1.5% BW) ADG using dried distillers grains plus solubles (DDGS), porcine blood meal, corn oil, soybean hulls, and AminoPlus® or non-balanced (NON) using 31.7% CP DDGS (NON). Steers were blocked by body weight (light and heavy) and stratified by farm source, sire breed and sire type (AI or natural service). Six steers were assigned to a pen replicate with four (two light and two heavy blocks) replicates per treatment with each replicate represented in pen and pasture. Fescue hay (10.6% CP, 62.8% NDF, 35.8% ADF) was offered \textit{ad libitum} in alternate bale rings. Increasing supplementation level reduced hay DMI \( (P < 0.0001) \). Supplemental feed intake was greater \( (P = 0.02) \) for BAL cattle which can be attributed to greater \( (P = 0.004) \) final body weights. Final body weight was greatest for BAL 1.5% \( (P = 0.008) \) and was not different for NON 1.5% and BAL 0.75% \( (P = 0.15) \). Final body weight for BAL 0.75% and NON 0.75% was not different \( (P = 0.72) \) while NON 1.5% was greater than NON 0.75% \( (P = 0.03) \). ADG was not different for BAL 0.75% and NON 0.75% \( (P = 0.73) \) supplement while ADG for BAL 1.5% was greater than NON 1.5% \( (P = 0.004) \). ADG for BAL 0.75% was not different \( (P = 0.14) \) from NON 1.5% while ADG for NON 1.5% was greater than NON 0.75% \( (P = 0.03) \). G:F was greater for BAL 1.5% compared to NON 0.75% \( (P = 0.005) \). Balancing post-ruminal AA was effective in increasing ADG, final body weight, and G: F for calves supplemented at 1.5% of BW.

Evaluation of feed efficiency and feeding behavior traits in performance tested bulls

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Profitability of beef systems may be improved by increasing quantity or quality of outputs, or through reductions on costs of inputs. Increased prices and volatility of feed has prompted consider interest among seedstock producers to implement selection programs focused on feed
efficiency. Multiple methods to assess feed efficiency are being used by the industry for use in selecting herd sires. Objectives of this study were to characterize feed efficiency traits (residual feed intake; RFI, residual gain efficiency; RGE) in performance-tested bulls, and to examine phenotypic relationships with feeding behavior traits and a selection index designed to identify bulls that produce profitable feedlot progeny. Performance, feed intake and feeding behavior traits were measured in bulls (n = 5,073) representing 11 breeds (3,335 Angus). Intake and feeding behavior traits were measured for 70 d using a GrowSafe system while fed a corn silage based diet (ME = 2.42 Mcal/kg DM). BW was measured at 14-d intervals, and Residual feed intake (RFI) was calculated as the difference between actual DMI and that expected from regression of DMI on mid-test BW\(^{0.75}\) (MBW) and ADG, and RGE was calculated as the difference between actual ADG and that expected from regression of ADG on MBW and DMI. Both models included fixed effects of trial (n = 12) and breed. A 2-population distribution model was fit to \(\log_{10}\)-transformed interval lengths between bunk visit events to estimate meal criterion, and compute meal traits. A multi-trait selection index (Crews et al., 2006) based on RFI, ADG and yearling BW was used to compute feedlot profit index (FPI). As expected, RFI was correlated with DMI (r = 0.63, P < 0.0001) but not MBW or ADG, whereas, RGE was correlated with ADG (r = 0.86, P < 0.0001) but not MBW or DMI. RFI was positively correlated with F:G (r = 0.42, P < 0.0001) and negatively correlated with RGE (r = -0.43, P < 0.0001). Initial BW was correlated with F:G (r = 0.30, P < 0.0001) and RGE (r = -0.15, P < 0.0001) but not RFI, indicating that lighter bulls were more efficient based on F:G and RG but not based on RFI.

Feeding bout (FB) frequency and duration were correlated with RFI (r = 0.32, 0.26; P < 0.001), but were not significant or weakly correlated (r < 0.10) with RGE and F:G. Meal criterion and duration were both correlated (r = -0.06, 0.18; P < 0.0001) with RFI, but weakly correlated with RGE or F:G. Bulls with low RFI spent less time at the feed bunk (123 vs 138 ± 0.72 min/d) and had fewer FB events (78 vs 93 ± 0.55 events/d) than high-RFI bulls. Low-RFI bulls had longer (P < 0.001) meal criterion (10.9 vs 9.8 ± 0.22 min) indicating they took longer to initiate new meals, and had shorter meal durations (223 vs 241 ± 1 min/d) than high-RFI bulls. Bulls with favorable FPI (> 105) had 15% lower DMI and 18% higher ADG than those with low FPI (<95). Bulls have distinctive feeding behavior patterns that contribute to between-animal variation in RFI. However, feeding behavior traits minimally associated with between-animal variance in F:G or RGE. Multiple trait indexes like FPI can be used to differentially select for growth and feed efficiency traits to fit specific production system goals.

The effect of feed additive and sulfur intake on rumen fluid pH and rumen gas cap hydrogen sulfide concentration in feedlot steers K. L. Neuhold\(^1\), J. J. Wagner\(^1\), T. E. Engle\(^1\), L. Domby\(^1\), and M. Branine\(^2\), \(^1\)Colorado State University, Fort Collins and \(^2\)Alpharma Animal Health, Bridgewater, NJ

Crossbred yearling steers (n = 432) were used to study the effects of Laidlomycin and Chlortetracycline (LC) vs. Monensin and Tylosin (MT) and variation in Sulfur (S) intake on rumen fluid pH and rumen gas hydrogen sulfide (H\(_2\)S) concentration. An unbalanced randomized block design using a 2 × 2 factorial arrangement of treatments was utilized. Factors included feed additive (LC vs. MT) and S concentration (constant vs. variable). The variable concentration (VAR) was intended to simulate the use of random loads of wet distillers grains (WDG). Random numbers were generated for each d of the study. High S diets (S = 0.60% of DM) were fed to VAR on d associated with an even number. Low S diets (S = 0.48% of DM) were fed to CON all d of the study and to the VAR only on d associated with an odd number.
From d 0 through 35, a high S meal supplement was fed to VAR on the appropriate d. Since variation in S concentration in WDG is driven by rate of inclusion and S concentration in distillers solubles (DS), 2 DS based liquid supplements (low S, 0.99% vs. high S, 2.35%) were used to create the constant (CON) vs. VAR S intake from d 36 through slaughter. Sulfuric acid was added to the high S DS used to obtain the intended dietary S concentration. On d 35, 70, and 105 rumen fluid and gas cap samples were obtained via rumenocentesis from a subsample (3 hd/pen and 3 pens/treatment) of steers to determine rumen fluid pH and H$_2$S concentration. The effects of feed additive, dietary S, or the interaction on rumen fluid pH were not significant ($P > 0.38$). An interaction between feed additive and dietary S treatment ($P < 0.02$) existed suggesting that the effect of feed additive on H$_2$S concentration was influenced by dietary S. Steers fed the CON diet receiving MT exhibited lower H$_2$S concentration than steers fed LC (1053 vs. 2519 mg/L). Steers fed the VAR diet receiving MT exhibited a higher H$_2$S concentration than steers fed LC (2567 vs. 2187 mg/L). Rumen H$_2$S concentration was related to rumen fluid pH suggesting that management of rumen pH is likely a key in dietary S management.

Comparing wet and dry distillers grains plus solubles in finishing cattle diets  B.L. Nuttelman, D.B. Burken, A.L. Shreck, C.J. Schneider, G.E. Erickson, and T.J. Klopfenstein, University of Nebraska, Lincoln

Three experiments were conducted to compare the effects of drying distillers grains (DG) in finishing diets. Experiment 1 utilized long yearling steers (n=171; 800 ± 66 lb) to compare the difference between wet distillers grains plus solubles (WDGS; 34.4% DM) and dried distillers grains plus solubles (DDGS; 88.7% DM). Treatments were 1) WDGS 2) DDGS, or 3) corn control (CON). Diets containing DG replaced an equal blend of DRC:HMC. Other ingredients were 5% dry supplement and 7.5% grass hay. Experiment 2 utilized calf-fed steers (n = 420; 627 ± 46 kg) and fed five different types of DG produced from the same plant: 1) WDGS – solubles were added to wet grains (34.5% DM); 2) DDGS – solubles were added to wet grains and dried (89.4% DM); 3) DDG – wet grains were dried with no solubles (90.1% DM); 4) MDGSPre – solubles were added to wet grains and dried (53.3% DM); 5) MDGSPost – wet grains were partially dried and solubles were added to the partially dried grains (42.1% DM). Steers were assigned to one of 42 pens (10 steers/pen) previously assigned to one of 7 treatments: 1) corn-based control (CON); 2) WDGS; 3) MDGSPre; 4) MDGSPost; 5) DDGS; 6) DDGS + H2O; and 7) DDG + Solubles. Distillers grains were included in the diet at 35% of the diet DM. Water was added to DDGS to bring the ingredient DM equal to the MDGSPost. Corn consisted of a 1:1 ratio of HMC:DRC, and all diets contained 4.1% grass hay, 4.1% sorghum silage, and 5.0% dry supplement. Experiment 3 was designed to contain large numbers (n=12; 1165 ± 75 lb) of observations to measure digestibility differences between 35% WDGS or DDGS, and corn control (CON). Following a 16 d adaptation period to TRT, steers were tethered for 5 d each period in stalls lined with rubber mats to contain excreted feces. Feces were collected daily, weighed and subsampled for later analysis. Basal ingredients were DRC, 7.5% alfalfa hay, 5% dry supplement. The CON and DDGS diets contained 5% molasses to prevent sorting. In both feedlot experiments, cattle fed diets containing DG had greater ADG than CON resulting in heavier HCW ($P < 0.05$). Intake and fat thickness were similar ($P > 0.24$) between treatments in experiment 1, but F:G was lowest for WDGS, intermediate for DDGS, and highest for CON ($P < 0.01; 6.85, 6.37,$ and 6.17, respectively). In experiment 2, steers fed CON had the lowest DMI ($P < 0.01$), and DDG + Solubles had the greatest DMI, but was not different from DDGS ($P =$
Cattle fed WDGS had lowest F:G, but were not different from steers fed either type of MDGS (P > 0.23). Both MDGSPre and MDGSPost gained as efficiently as DDGS + H2O (P > 0.19), but were lower than CON, DDGS, and DDG + Solubles (P < 0.03). Cattle fed diets containing DG were fatter at harvest than CON (P = 0.02). There were no differences for marbling score or LM area (P > 0.10) in either finishing experiment. In experiment 3, DM digestibility tended (P = 0.15) to be reduced for DDGS when compared to WDGS. Fiber digestibility was numerically (P = 0.28) decreased for DDGS when compared to WDGS (58.4 and 62.0%, respectively). In conclusion, diets containing DG were more efficient than corn diets. Drying the solubles onto DG does not explain the change in feeding value of DG when dried or partially dried. Dry matter and NDF digestibility were numerically reduced when WDGS are dried.

**Evaluation of barley variability in feedlots in western Canada using near-infrared reflectance spectroscopy**

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Barley is often used as the primary energy source in beef cattle production throughout western Canada. Due to its availability in the area and high nutritive value it is well suited to feedlot production. The physical characteristic of bushel (bu) weight is an important economic and physical parameter measured for barley. In this study whole barley samples (n=3,783) were scanned upon arrival to seven feedlots using near-infrared reflectance spectroscopy (NIRS) technology (InfraXact™, FOSS North America, Eden Prairie, MN). Scanned samples arrived at the feedlot September, 2011 through February, 2012. The nutritive parameters of protein, fat, dry matter, starch, ash and fiber were measured with the NIRS instrument. From the NIRS results NEm and NEg values of the barley was calculated. When available the physical measurement of bushel weight was taken for the sample by feedlot personnel and entered into the NIRS software (n=1,835). Scanned samples that reported a starch content <42.8% (6) and samples with an entered bushel weight >500 (lb/bu) (6) were considered outliers and entry errors respectively, and were removed from the statistical analysis. Starch variability data was analyzed using PROC GLIMMIX, PROC CORR and PROC REG of SAS 9.3 (SAS Institute, Cary, N.C.). The starch content of barley entering the feedlots in western Canada ranged from 43% to 67%, and there was a difference seen in the starch content of barley between feedlots. Additionally, we observed a difference in the starch content of barley arriving in different months to feedlots in western Canada. There was no correlation between starch content of barley entering feedlots in western Canada and the recorded bushel weight; however, a strong correlation between the starch content and the sample dry matter percentage was detected. Due to the variation in energy content by month and feedlot, variation in cattle performance would also be expected. Further trials should be conducted to quantify the animal health and feedlot performance response of cattle when they are fed barley with different NIRS predicted starch content, NEm and NEg.

**Bovamine® Improved Performance of Commercial Feedlot Cattle**

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There is published literature indicating that Bovamine®, a direct-fed microbial, improves performance of feedlot cattle. We had a unique opportunity to quantify these effects in a large-
pen commercial feedlot setting with cattle fed a high moisture corn- (HMC) and wet distiller’s grains- (WDG) based finishing diet. Our study was initiated to achieve multiple objectives; the objective presented here was to quantify effects of Bovamine® on performance of commercial feedlot cattle fed a finishing diet (on a DM basis: 46.4% HMC, 25.0% WDG, 17.0% corn gluten, 7.1% silage, 2.5% steep, 2.0% micro/minerals mix) during an approximately 85-day summer study period. A total of 17,148 steers (mean weight = 378.4 kg) were randomly allocated to 40 pens, which were allocated to treatments in a randomized complete block design. Blocks were defined by time of allocation as pens were filled over a seven week period. Cattle in 20 pens were fed Bovamine® (10⁶ CFU/animal/day of Lactobacillus acidophilus and 10⁹ CFU/animal/day of Propionibacterium freudenreichii), and cattle in the remaining 20 pens were not fed Bovamine®. Data were analyzed using linear mixed models with a random intercept to account for the block allocation and fixed effects of treatment. Cattle fed Bovamine® had significantly (P = 0.04) improved feed conversions (6.01 ± 0.08) and overall weight gain (130.5 ± 2.67 kg) during the study (P = 0.03) as compared to cattle that were not fed Bovamine® (6.14 ± 0.08 and 127.9 ± 2.67 kg, respectively). Bovamine® feeding also tended (P = 0.09) to improve average daily weight gain. This study provides evidence that Bovamine® improves cattle performance in a large-pen, commercial feedlot setting.

**Fate and biological activity of antibiotics used in ethanol production**  
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Antibiotics are utilized in ethanol production to control unwanted bacteria from competing with yeast for nutrients during ethanol fermentation. However, there is no published scientific information on whether antibiotic residues in distillers grains (DG) co-products from ethanol production retain their biological activity. Therefore, the objective of this study was to quantify the concentration of various antibiotics residues in DG and determine if those residues are biologically active. Twenty wet and 20 dry DG samples were collected quarterly from nine states and 42 ethanol plants in the United States. The samples were analyzed for the presence of erythromycin, penicillin, tetracycline, tylosin, and virginiamycin. Additionally, virginiamycin residues were determined using an FDA-approved method of analysis. Samples were further analyzed for biological activity by exposing the antibiotic residues to varying levels of the sentinel bacteria Escherichia coli ATCC 8739 and Listeria monocytogenes ATCC 19115. Residues that inhibited bacterial growth were considered to have biological activity. Data were analyzed using the mixed procedure of SAS 9.2. To date, 116 samples have been analyzed. One hundred percent of the samples contained penicillin residues, ranging in concentration from 0.003 to 0.186 ppm on a DM basis. Thirty-seven percent of the samples contained erythromycin residues at concentrations up to 1.046 ppm on a DM basis. Thirty percent of the samples contained tylosin residues at concentrations up to 0.020 ppm on a DM basis. Twenty-three percent of the samples contained tetracycline residues at concentrations up to 0.007 ppm on a DM basis. Additionally, 1.7% of the samples contained virginiamycin residues at concentrations up to 0.6 ppm on a DM basis. Only one residue sample inhibited the growth of E. coli at 104 CFU/g. No residues inhibited L. monocytogenes growth. Penicillin, tetracycline, and tylosin residues were higher (P = 0.006) in wet and dry DG samples from quarter three. Tetracycline residues also tended (P = 0.06) to be higher in wet DG. These data suggest that a variety of antibiotic residues are present in DG at very low concentrations. It appears that antibiotic residues in DG are inactivated during the production process.
Effects of respiratory vaccination timing and hormonal growth implant on health, performance, and immunity of newly received stocker calves  


Stress alters the immune system and vaccination during this time may reduce vaccine response; whereas, growth implants may shift metabolism to enhance tissue deposition in exchange for energy required for immune response during bovine respiratory disease (BRD) challenge. This study was conducted to determine the effects of pentavalent respiratory vaccination timing with or without a hormonal growth implant on arrival (d 0) on health, performance, complete blood count, and vaccine response in high-risk, newly received stocker calves during a 42-d receiving period. Crossbred bull and steer calves (n = 384) were weighed (initial BW = 202 ± 4.1 kg), stratified by gender, and assigned randomly to 1 of 4 treatments arranged in a 2 × 2 factorial: 1) arrival (d 0) vaccination, with implant (AVACIMP), 2) arrival vaccination, without implant (AVAC), 3) delayed (d 14) vaccination, with implant (DVACIMP), 4) delayed vaccination, without implant (DVAC). The percentage of calves treated for BRD once, twice, or thrice was 80, 50 and 20%, respectively, but did not differ (P ≥ 0.12) among treatments. Likewise, days to initial BRD treatment was not affected by vaccine timing (P = 0.66) or implant (P = 0.24). Overall ADG (d 0 to 42) did not differ due to vaccination timing (P = 0.53) or implant (P = 0.64). White blood cell count was not different (P ≥ 0.76) for all treatments, there was a cubic effect of day (P = 0.01), with levels increasing from d 0 to d 28 prior to leveling off at the end of receiving (d 42). The neutrophil:lymphocyte ratio (N:L) decreased (Linear, P < 0.0001), throughout receiving. Bovine viral diarrhea virus type 1a antibody concentrations were greater (P = 0.02) for calves vaccinated on arrival and increased over time for both vaccine treatments (P = 0.01). Results indicate a hormonal growth implant administered on arrival to high-risk stocker calves did not increase ADG. Morbidity rate was high but was not impacted by vaccine timing or implant. Vaccination on arrival increased BVDV type 1a antibody concentrations throughout receiving.

Association of inactive myostatin on performance and carcass traits in Piedmontese-influenced steers and heifers  


The objective was to investigate the potential association of inactive myostatin (IM) on live and carcass-adjusted performance, carcass traits and common endpoint adjustments of Piedmontese-influenced steers and heifers. Two years of calf-fed steers (n = 117; 590 ± 66 lb) and 2 years of yearling heifers (n = 119; 776 ± 119 lb) were individually-fed a finishing diet containing distillers grains by-products for an average of 211 and 153 d. Cattle were genotyped for 0, 1, or 2 copies of the IM allele (steers: n = 39, n = 50, and n = 28; heifers: n = 44, n = 46, and n = 29; respectively). Carcass ultrasound measurements of LM area (uLMA), 12th rib fat (uRIBF), and rump fat (uRUMF) were taken at approximately 28 d intervals over each feeding period. Data were analyzed with year as a random effect. Age did not differ (P > 0.12) among heifers, but steers age decreased linearly (P < 0.01) with 0, 1, and 2 IM copies. Therefore, age was used as a covariate for steers. Initial BW was lower (quadratic; P = 0.04) for 2 IM steers, but no difference (P > 0.51) for initial BW in heifers was present. Intakes, live final BW and ADG decreased linearly (P < 0.01) with IM allele copies for both steers and heifers. The F:G response was different by gender with F:G increasing linearly (P < 0.01) for heifers, but decreasing linearly (P
< 0.01) for steers with IM presence. Carcass weight did not differ (P > 0.17) across IM copies in steers. Carcass weight decreased linearly (P = 0.03) with IM presence in heifers, but much less so than final BW (live). Interestingly, when ADG and final BW are based on a carcass-adjusted BW, ADG did not differ among heifers (P = 0.08), and increased (quadratic; P = 0.05) for steers with greatest gain for 2 copy IM steers. As a result, a different response was observed for F:G if carcass-adjusted with F:G improving (quadratic; P < 0.01) for steers and heifers with 2 copies of IM. Dressing percent and LM area increased dramatically (quadratic; P < 0.01 and P = 0.05 for steers and heifers, respectively) with increasing IM copies. Calculated yield grade, 12th rib fat and marbling decreased linearly (P < 0.01) with IM presence for steers and heifers. Individual animal age, live BW, uRUMF, uRIBF, and uLMA traits of the ultrasound prior to harvest were adjusted to common endpoints using regressions within genotype and gender. Common endpoints of age, live BW, and uRIBF were average values of combined steers (447 d, 1043 lb, and 0.28 in, respectively) and combined heifers (583 d, 1011 lb, and 0.30 in, respectively). Although 2 copy IM cattle would take more d on feed to reach a constant uRIBF, at this constant uRIBF they would have heavier BW (live) and larger LM area compared to cattle with 0 IM copies. At a common age, IM cattle would have lighter BW, decreased fat, and increased LM area. Steers and heifers with IM will require more d on feed to reach a common live BW, but will have increased LM area and decreased fat. Inactive myostatin increases LM area, dressing percent, carcass-adjusted ADG and improves F:G when evaluated on a carcass basis. Carcasses of IM cattle are much leaner, DMI are much lower, and live BW are lower. Responses are generally similar across steers and heifers. Care should be used when comparing animals of differing IM genotypes as the endpoint used can alter interpretations. Differences in performance are likely best evaluated in terms of carcass weights or carcass-adjusted performance.

Effect of pre-finishing implant strategy and nutrient restriction on finishing performance and carcass characteristics of beef  J. Robinette1,2, R. Reuter2, P. Beck3, F. Ribeiro4, B. Stewart3, H. Gray3, J. Apple1, 1University of Arkansas, Fayetteville, 2The Samuel Roberts Noble Foundation, Ardmore, OK, 3University of Arkansas-Southwest Research and Extension Center, Hope, 4Texas A&M University-Commerce

The objective of this study was to determine the effect of implant strategy and energy balance pre-finishing on feedlot performance. Spring-born calves were weaned in the fall (n = 96) and were either placed on a high-concentrate diet immediately (Calf-Fed, n = 32), or on one of 2 growing programs (nutrient restricted, RSTR, n = 32; nutrient unrestricted, UNRSTR, n = 32). After a 60-d backgrounding period, cattle in the Calf-Fed treatment were shipped for finishing. Cattle in RSTR and UNRSTR treatments were placed on small grain pasture for 120–d before finishing with the goal of 0.45 kg and 0.91 kg ADG, respectively. One-half of each nutrient treatment group received moderate potency hormonal implants (Synovex S/H) 28 d after weaning (IMPL). Before shipment to finishing, Calf-Fed were placed on ad lib growing ration and yearlings were limited-fed growing ration to meet performance goals before being placed on pasture. At feedlot arrival, all cattle were implanted (Synovex S/H) and reimplanted at 99 d (Calf-Fed) or 81 d on feed (RSTR and UNRSTR). Daily feed intake was recorded using an individual animal intake monitoring system (GrowSafe Systems, Ltd.). Animal performance data were analyzed using PROC MIXED of SAS with animal as the experimental unit and fixed effects of sex, stocker-phase implant, and nutrient restriction. There were no interactions (P > 0.10) between IMPL and plane of nutrition. Implantation before finishing decreased ADG (P < 0.01) and DMI (P < 0.05) and improved G:F (P = 0.008) during finishing, but had no effect on
feedlot arrival BW ($P = 0.22$) or BW at slaughter ($P = 0.43$). There were no differences ($P > 0.05$) in marbling scores across treatments; however, sensory panel analysis indicates that initial tenderness was affected by implant strategy ($P = 0.03$). Cattle in the RSTR group had greater DMI than CALF-FED ($P < 0.01$) and tended ($P = 0.06$) to have greater DMI than UNRSTR. CALF-FED had a greater G:F ratio ($P < 0.01$) than RSTR and UNRSTR, which did not differ ($P = 0.80$). Restricting energy availability pre-finishing can have long-term implications on HCW and consumer acceptability of beef.

Effect of backgrounding supplementation on growth performance of beef calves fed varied soybean hull level feedlot diets  

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Fifty crossbred heifers (374 ± 24 kg BW) grazing tall fescue pasture were used to evaluate effects of previous supplementation (SUPP) on feedlot performance when fed diets with increasing soybean hull (SH) to whole shelled corn (WSC) ratios [20 (SH20), 60 (SH60), 80 (SH80), 90 (SH90), and 100 (SH100)]. It was hypothesized cattle provided SUPP during backgrounding and fed a higher SH:WSC diet in the feedlot would have suppressed performance in comparison to no SUPP and a lower SH:WSC diet. The heifers were fed for 70 days to evaluate feedlot ADG, DMI, and G:F. Heifers were blocked by entry weight with a heavy pen and light pen per diet. The heifers were stratified within feedlot diet by previous SUPP treatment. The SUPP treatments consisted of dried distillers grains fed at a DMI of 1% BW on alternate days (DDG) or a no supplementation control (CONT). All animals were provided free-choice mineral containing monensin (1600 g/ton). Feedlot diets were balanced for post-ruminal AA and RDP based on available ME. Individual DMI was measured using Growsafe Feed Intake System. A means comparison was used to identify significance. On SH20, the G:F of the CONT cattle (0.17 kg) was greater ($P=0.002$) than DDG (0.14 kg). Within SH20, SUPP had no effect ($P>0.05$) on ADG, or DMI. There was no effect ($P>0.05$) of SUPP on performance for SH60, SH80, SH90, or SH100. Between diets, the SH20 ADG (1.70 kg) and G:F (0.15 kg) were greater ($P<0.05$) than SH60, SH90, and SH100. Additionally, the SH80 ADG (1.55 kg) was greater ($P<0.05$) than SH90 and SH100. The SH80 G:F (0.13 kg) was greater ($P<0.05$) than SH90. There was no difference ($P>0.6$) in DMI between diets. Cattle backgrounded with no SUPP had greater G:F in the feedlot than cattle provided SUPP when fed a high WSC diet (diet 20). Cattle consuming WSC at a DMI of 0.4% BW (diet 80) had similar performance to cattle on a high WSC diet.

Rapidly transitioning cattle from RAMP to a finishing diet  

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Three trials evaluated rapid transitions from RAMP to a finishing diet. Trial 1 evaluated using fewer step diets and fewer days fed during transition. Steers (BW=747±32 lb) were assigned to 40 pens, with 9 or 10 steers/pen. Five grain adaptation treatments were evaluated. The control treatment involved feeding RAMP for 4 d and then transitioning to a 25% Sweet Bran finishing diet (62.5 % high moisture corn (HMC), 25% Sweet Bran, 7.5% alfalfa hay (AH), and 5% supplement) in 4 steps fed for 24 d (CON25). Treatment 2 involved feeding RAMP for 4 d and then transitioning to a 47.5% Sweet Bran finishing diet (F1; 40% HMC, 47.5% Sweet Bran, 7.5% AH, and 5% supplement) in 4 steps fed for 24 d (CON47). Three treatments involved feeding RAMP for 10 days and then transitioning to the F1 diet in 3 steps in 3 d (3-1d), 2 steps in 2 d (2-2d), 1 step in 4 d (1-4d). A second finishing diet (F2; 40% HMC, 25% Sweet Bran, 22.5%
modified distillers grains with solubles, 7.5% AH, and 5% supplement) was fed from d 29 until slaughter. Daily gain, DMI, G:F and carcass traits were similar (P>0.11) among treatments. Intake variance among d for pens was calculated for 3 time periods (P1= all d before feeding F2, P2 = first 6 d of F1, P3= first 6 d of F2). During P1, intake variance was greater (P<0.05) for CON25 compared to all other treatments and variance was greater (P<0.02) for CON47 compared to 1-4d and 2-2d. Trial 2 used 7 ruminally fistulated steers (BW=1063±109 lb) in a 35-d metabolism trial to evaluate transitioning cattle from RAMP to the F1 diet using a CON47 treatment or directly to the F1 diet without an adaptation diet (DIRECT). Steers on DIRECT treatment involved feeding RAMP for 10 d then switching to F1 on d 11. F1 was fed for 14 d for DIRECT and 6 d for CON47 and F2 was fed after F1 for 7 or 11 d. Ruminal pH and bunk weights were recorded every min during the trial. Data from P2 and P3 were used to compare the 2 treatments. Intakes were similar for CON47 and DIRECT. One steer on DIRECT had reduced DMI (50%) for 2 d with low ruminal pH and high pH variation during P2, suggesting acidosis. Eating time was greater (P<0.02) for DIRECT compared to CON47 for P2, but meals/d were similar (P=0.77). Meals/d increased (P=0.03) and eating time tended to increase (P=0.07) with DIRECT compared to 40CON during P3. During P2 or P3, DIRECT cattle had lower ruminal pH (F1, P=0.03; F2, P=0.02), and greater time below pH 5.3 (F1, P=0.03; F2, P=0.01). Magnitude of pH change and pH variance was greater (P<0.04) for DIRECT compared to CON47 for P3. Trial 3 evaluated CON47, 1-4d, and DIRECT on feedlot performance. Steers (BW=638±48 lb) were assigned to 30 pens with 9 or 10 steers/pen. Starting on d 29, steers were fed F2 and currently remain on feed, thus performance is for 39 and 91 d (reimplant). Daily gain, DMI, and G:F were not different (P>0.20) among treatments after 39 or 91 d. During P2, intake variance was greater (P=0.02) for DIRECT compared to 1-4d. During P3, intake variance was greater (P=0.02) for CON47 compared to DIRECT. Cattle started on RAMP for 10 d can be transitioned to a finishing ration containing 47.5% Sweet Bran in fewer d and/or with fewer step diets than traditional grain adaptation programs without negatively affecting performance.

**Replacing corn with alkaline-treated forages in diets containing wet distillers grains**

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Three studies were conducted to optimize use of alkaline-treated forage and distillers grains as corn replacement. Forages were treated with 5% CaO (DM basis) and moisture added to equal 50% DM. Experiment 1 evaluated 10, 25, or 40% dry-rolled corn (DRC) with varying ratios of distillers grains and lime-treated crop residues (DGCR). Sixty individually fed steers (BW=884 ±135.0 lb) were assigned randomly to 10 treatments within block. Treatments were 2 ratios of DGCR, 2 types of treated crop residue, and 3 DRC concentrations in the diet (10%, 25%, 40%; DM basis). The DGCR replaced corn and consisted of 2:1 or 3:1 ratios of modified distillers grains plus solubles (MDGS) and treated corn stover or a 3:1 ratio of MDGS and treated wheat straw. The control diet contained 35% MDGS, 5% untreated corn stover, and 56% DRC. Cattle fed diets containing at least 25% corn and 3:1 ratios of distillers grains and lime treated crop residues achieved similar ADG, F:G, and carcass merit compared with cattle fed diets containing 5% roughage and 56% corn. In Exp. 2, a finishing experiment utilizing 30 pens (12 steers/pen) of calf-fed steers (BW=822 ±24.5lb) was conducted. A 2 x 2 + 1 factorial arrangement of treatments was used. Corn stover was tub ground through a 1-in or 3-in screen and fed at 20% (DM basis) in its native form (untreated; 93.4% DM) or alkaline-treated as described in Exp 1.
A control was included that contained 5% untreated stover (3-in grindsize) and 51% corn (DM basis). Feeding treated vs untreated stover improved \( P \leq 0.02 \) final BW, HCW, ADG, and G:F. Reducing particle size improved \( P \leq 0.01 \) ADG and F:G. Cattle fed treated corn stover had similar ADG, and F:G as CON. In Exp. 3, five ruminally fistulated steers were used in an incomplete 5 x 7 Latin square design. A 2 x 3 + 1 factorial arrangement of treatments was used. One factor was crop residue type (corn cobs, wheat straw, corn stover) and the other factor was 5% CaO treatment or native form. Residues replaced DRC at 25% of the diet (DM basis). The control diet contained 10% roughage (equal cobs, straw, and stover) and 46% DRC. Treatment of cobs and corn stover increased acetate:propionate (A:P) ratio but treatment of wheat straw increased propionate which decreased A:P. No difference \( P >0.10 \) was observed for treated straw or stover compared with control (2.6) for A:P. Greater DM (73.7 vs 66.1%; \( P=0.001 \)), OM (77.0 vs 68.5%; \( P=0.001 \)), and NDF (66.8 vs 51.5%; \( P <0.001 \)) digestibilities were observed when diets contained treated compared with untreated residues. Alkaline-treated stover or straw may substitute up to 20% corn in diets containing 35% or more wet distillers grains. Reducing forage particle size, feeding a 3:1 ratio of distillers grains and treated forage, and maintaining at least 25% corn in the diet are strategies for optimizing cattle performance.

**Effect of stocker management system and rate of gain on bovine skeletal muscle developmental characteristics of beef cattle**  
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To determine the effects of stocker programs on skeletal muscle development, fall weaned Angus steers (n = 72; 259 ± 28 kg) from the Oklahoma State University cow herd were randomly assigned to 1 of 4 stocker systems. Stocker systems included: 1) grazing dormant native range (NR) supplemented with cottonseed (1.0 kg-steer\(^{-1}\)∙d\(^{-1}\)) followed by season-long grazing on summer pasture (CON); 2) grazing dormant NR supplemented with corn based supplement (1% of BW) followed by short season grazing on summer pasture (CORN); 3) grazing winter wheat pasture at high stocking density (3.0 steers/ha) to produce a moderate ADG (LGWP); and 4) grazing winter wheat pasture at low stocking density (1.0 steers/ha) to produce high ADG (HGWP). Steers continued grazing until the average BW of the treatment group reached a common BW of approximately 375 kg, at which time steers were transitioned into a common finishing diet and fed to a common backfat thickness of 1.27 cm. At the end of the stocker and finishing phases, four steers per treatment were harvested and longissimus muscle (LM) was collected for analysis. LM were cryosectioned and immunoflorescence stained. LM fiber cross-sectional area, fiber type, Pax7+ cell density, capillary density, and nuclear density were determined. At the end of the stocker period, LM fiber cross-sectional area was significantly greater for HGWP and LGWP steers \( P < 0.01 \) compared to CON and CORN steers. Additionally, CON steers tended to have more Type 1 (oxidative) muscle fibers \( P = 0.12 \). At conclusion of the finishing phase, CON steers tended to have a greater capillary density \( P = 0.14 \). These data suggest that at the end of the finishing phase, CON cattle which were allowed the lowest rate of gain during the stocker phase, tended to have skeletal muscle characteristics more favorable for marbling deposition.
Effect of energy density in high byproduct diets on health and performance of receiving calves  J. J. Wagner1, C. L. Maxwell1, B. K. Wilson1, B. T. Johnson1, C. R. Krehbiel1, D. L. Step2, and C. J. Richards1,1 Department of Animal Science and 2Department of Veterinary Clinical Sciences, Oklahoma State University, Stillwater

The objective of this experiment was to determine the effects of altering energy density in high byproduct diets on the health and performance of receiving calves. In a randomized complete block design experiment, 476 crossbred calves (initial BW = 509 ± 8 lb) were blocked by source and arrival BW before being randomly assigned to 1 of 4 receiving diet treatments. Diets were fed for 49 d. Experimental treatments consisted of: a Low-energy diet containing 20.0% dry-rolled corn, 14.8% prairie hay, 59.1% Sweet Bran® (Cargill Animal Nutrition, Minneapolis, MN) and 6.15% dry supplement (LE-DRC); the low energy diet with wet distillers grains plus solubles (WDGS) replacing corn (LE-WDGS): 20% WDGS replacing a portion of hay and Sweet Bran® (ME); or inclusion of 40% corn and 20% WDGS replacing a portion of the hay and Sweet Bran® (HE). Calves were processed on arrival, which included weighing, vaccinations, and deworming but not implanted. Bulls were surgically castrated and annotated for equal distribution across treatments. Performance data were analyzed using PROC MIXED using source and block as random variables, and health data were analyzed using PROC GLIMMIX in SAS 9.3 (SAS Institute, Cary, N.C.) using block and source as random variables. Contrasts were evaluated to compare the two low energy diets and the linear and quadratic effects of energy level. Total number of treatments for BRD were not different (P = 0.13) among treatments, but when the LE diets were combined there was a linear increase in treatments with increasing energy level. There were no differences (P > 0.10) in overall performance between the Low-energy/DRC and Low-energy/WDGS diets. There was no difference (P = 0.77) in DMI, but as dietary energy increased there was a linear increase in ADG (P = 0.03) and feed efficiency (P < 0.01). Similar to previous experiments, it appears that ADG and efficiency are improved with increasing energy density in diets for receiving calves, but negatively impact health.

Anaerobic Digestion of Finishing Cattle Manure  A.K. Watson, S.C. Fernando, G.E. Erickson, T.J. Klopfenstein, and Y. Wanniarachchi, University of Nebraska, Lincoln

Continuously stirred anaerobic digesters (n = 7, 1 L capacity) were used to compare degradation of manure from 2 cattle diets (Trial 1) and 2 cattle housing methods (Trial 2). Each day, 50 mL of effluent was removed from each digester and replaced with 50 mL of fresh manure/water slurry (9% DM; 1/20 of total digester volume). For trial 1, manure was collected from confinement cattle on a CONT diet with 82.5% dry rolled corn (DRC) or a WDGS diet with wet distillers grains plus solubles replacing 40% of the DRC. Dry matter degradation (DMD) was 42.7% for CONT and 44.9% for WDGS (P = 0.05). Organic matter degradation (OMD) was 51.0% for CONT and 52.9% for WDGS (P = 0.10). Methane production was 0.551 L/d for CONT and 0.634 L/d for WDGS (P = 0.10), equal to 0.116 and 0.137 L/g OM fed (P = 0.05). For trial 2, manure was collected from cattle in complete confinement (CONF) or open feedlot pens (FDLT) with soil surfaces. Manure OM was 88% for CONF and 26% for FDLT. During the trial, 3 digesters on the FDLT treatment failed due to ash buildup. For remaining digesters, DMD was 39.0% for CONF and 19.9% for FDLT (P < 0.01) while OMD was 46.7% for CONF and 24.8% for FDLT (P < 0.01). Methane production was 0.478 L/d for CONF and 0.229 L/d for FDLT (P < 0.01), equal to 0.103 and 0.189 L/g OM fed (P = 0.01). Manure from open lot pens is a viable feedstock if ash buildup is avoided. Microbial communities (Eubacterial and Archaeal) were identified using 454-pyrosequencing and revealed structuring of the microbial community.
based on diet (P < 0.001) in trial 1. Bacteria prevalent in WDGS digesters belonged to phylum Chloroflexi (61.42%) and Bacteriodetes (19.57%). Archaea prevalent in WDGS digesters belonged to classes Methanobacteria (97.63%) and Methanomicrobia (1.98%). Within CONT digesters, bacteria consisted of phylum Bacteriodetes (57.36%) and Chloroflexi (35.48%) while classes Methanobacteria (89.90%) and Methanomicrobia (9.62%) dominated archaea. These results suggest the microbial food chain that contributes to methane production is greatly influenced by the diet fed to cattle, and dietary manipulation may provide opportunities to increase or decrease methane production from cattle manure.

Factors influencing the subsequent receiving health and performance of “high-risk” steer and bull calves purchased at regional livestock markets in 2010 and 2011
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More variation exists in the cow-calf sector of the beef industry than any other industry segment in major meat production in the U.S. This is a result of the multitude of genetics and breeds utilized, diverse environments, varied production systems, and industry dynamics. Cow-calf producers are faced with the difficult challenge of raising calves that are efficient and profitable in a specific environment and production system while maintaining acceptability further down the chain of production by other sectors of the beef industry. When cattle buyers purchase calves, they attempt to evaluate the individual characteristics of a calf or lot of calves and utilize those characteristics as predictors of future product quality and animal performance. Numerous characteristics or factors including: lot uniformity, weight, frame score, muscle thickness, fill, body condition, health or preconditioning, age, sex, breed or genetic potential, color, and horn status can impact the value of calves marketed through livestock auctions. The true value of any given calf then is a function of some combination of these factors and the selling price reflects the evaluation and perception of the factors. Considerable research has been conducted to determine the impacts of these various factors on selling price per cwt and ultimately the overall value of a given calf (Zimmerman, 2005; Barham and Troxel, 2007; Stutts et al., 2010). However, limited research has been conducted to determine if these factors that dictate the selling price actually translate into differences in subsequent calf performance and health. Due to the lack of published data concerning the impact of these factors on subsequent performance and health, additional research is necessary to determine the effects of these factors on calf health and performance in later stages of production. The objective of this study was to determine the effects of hide color, sex, and horns on subsequent receiving health and performance of “high-risk” steers and bulls purchased at regional livestock markets in 2010 and 2011. Steers (n = 438; initial BW = 553 lbs) and bulls (n = 923; initial BW = 548 lbs) were purchased from regional livestock markets in 2010 and 2011 by a single cattle buyer. Season and lot had a significant impact on performance and health variables. Initial BW was not different when comparing bulls and steers, the various hide colors, or polled and dehorned calves. Across all hide colors, red white faced calves tended (P = 0.10) to have lower first treatment rates compared to calves of all other hide colors. Solid red calves (P = 0.05) had greater mortality than black mottle faced, black, red mottle faced, red white faced, white, or yellow calves. When only four predominant hide colors were analyzed, black and red calves had lower ADG (P = 0.02) and red calves tended to have greater mortality (P = 0.10) compared to white calves. Bull calves that were castrated subsequent to arrival had lower ADG (P < 0.01) and higher first treatment rates (P < 0.01) than
calves that arrived as steers. Calves that were dehorned subsequent to arrival had lower ADG ($P = 0.01$) compared to polled calves. These results suggest that hide color, sex, and horn status can potentially be utilized to predict future health and performance of calves during the receiving period and should be considered when purchasing calves. The effects of hide color may require additional research and evaluation on larger samples of calves. Calves that arrived at the feedlot as steers had improved performance and less morbidity than calves that arrived as bulls. Calves that were polled had improved performance compared to calves dehorned subsequent to arrival. Calves that have been castrated and dehorned prior to the stocker or feedlot phase will maximize animal performance and minimize health risks in those phases.

**Yeast cell wall supplementation alters the performance and health of beef heifers during the receiving period**

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A study was designed to determine the effect of feeding yeast cell wall (YCW) products on feedlot performance and health of newly-received crossbred heifers. Heifers (n=140; 496±20.7 lb) were obtained from commercial sale barns and transported to the Texas Tech University Beef Center in New Deal, Texas. Heifers were sorted by source (n=2) upon arrival and arranged in a completely randomized block design (35 pens; 7 pens/treatment; 4 heifers/pen). Heifers were separated into treatment groups receiving a Control Diet (CON; n=7), YCW A (2.5 g·hd\(^{-1}·d\(^{-1}\); n=7), YCW AA (5.0 g·hd\(^{-1}·d\(^{-1}\); n=7), YCW B (2.5 g·hd\(^{-1}·d\(^{-1}\); n=7), or YCW C (2.5 g·hd\(^{-1}·d\(^{-1}\); n=7) and were fed for 56 d. Daily DMI was recorded and individual BW was collected every 14 d. On d 56, cattle in treatments 1, 2, and 5 were fitted with vaginal temperature (VT) probes. Cattle were re-weighed and challenged with a subcutaneous dose (0.5 µg/kg BW) of lipopolysaccharide (LPS) on d 63 (Source 1) and d 65 (Source 2). A final body weight was measured and vaginal probes removed on d 77 and d 79. A significant source by treatment interaction was detected, and data were interpreted accordingly. In Source 1, at d 28, YCW C (628±18.0 lb) showed a greater increase in BW compared to CON (600±18.0 lb), YCW AA (602±18.0 lb), and YCW B (600±18.0 lb; $P=0.03$). YCW C exhibited a higher BW at d 42 compared to all other treatments ($P=0.02$). From d 0 to 28, YCW C (4.63±0.226 lb) had higher ADG compared to CON (3.64±0.226 lb); YCW AA (3.75±0.226 lb), and YCW B (3.66±0.226 lb; $P=0.03$). YCW C showed improved ADG from d 0 to 42 compared to all other treatments ($P<0.01$). DMI was improved for YCW C compared to all other treatments ($P=0.04$) for d 0 to 42. Cumulative F:G was lower for YCW B (4.24±0.096 lb) compared to YCW A (3.83±0.096 lb) and YCW C (3.80±0.096 lb; $P=0.03$). In Source 2, a linear effect for YCW A was detected from d 0 to 14 in BW, ADG, and F:G ($P = 0.01, 0.02, and 0.03$, respectively). Following the subcutaneous LPS challenge, in Source 1, YCW C exhibited greater ADG ($P<0.01$) and feed conversion ($P=0.01$) compared to YCW A (3.83±0.096 lb). There was an increase in VT in all treatments post-LPS ($P<0.01$), with YCW C (39.14±0.01°C) maintaining greater VT post-LPS than CON (38.89±0.01°C) and YCW A (38.92±0.01°C; $P<0.05$). In Source 2, no significant differences in performance were observed. There was an increase in VT in all treatments post-LPS ($P<0.01$), with YCW C (39.91±0.02°C) maintaining greater VT post-LPS than CON (38.83±0.02°C) and YCW A (38.83±0.02°C; $P<0.05$). Ambient temperature was extremely high during the last portion of this study (greater than 45°C at certain times), indicating a period of high heat stress. Collectively these data suggest that supplementation of YCW C can offer advantages in weight.
gain and feed intake as well as affect the physiological response to an immune challenge during high heat stress thereby altering feedlot performance of newly received beef heifers.