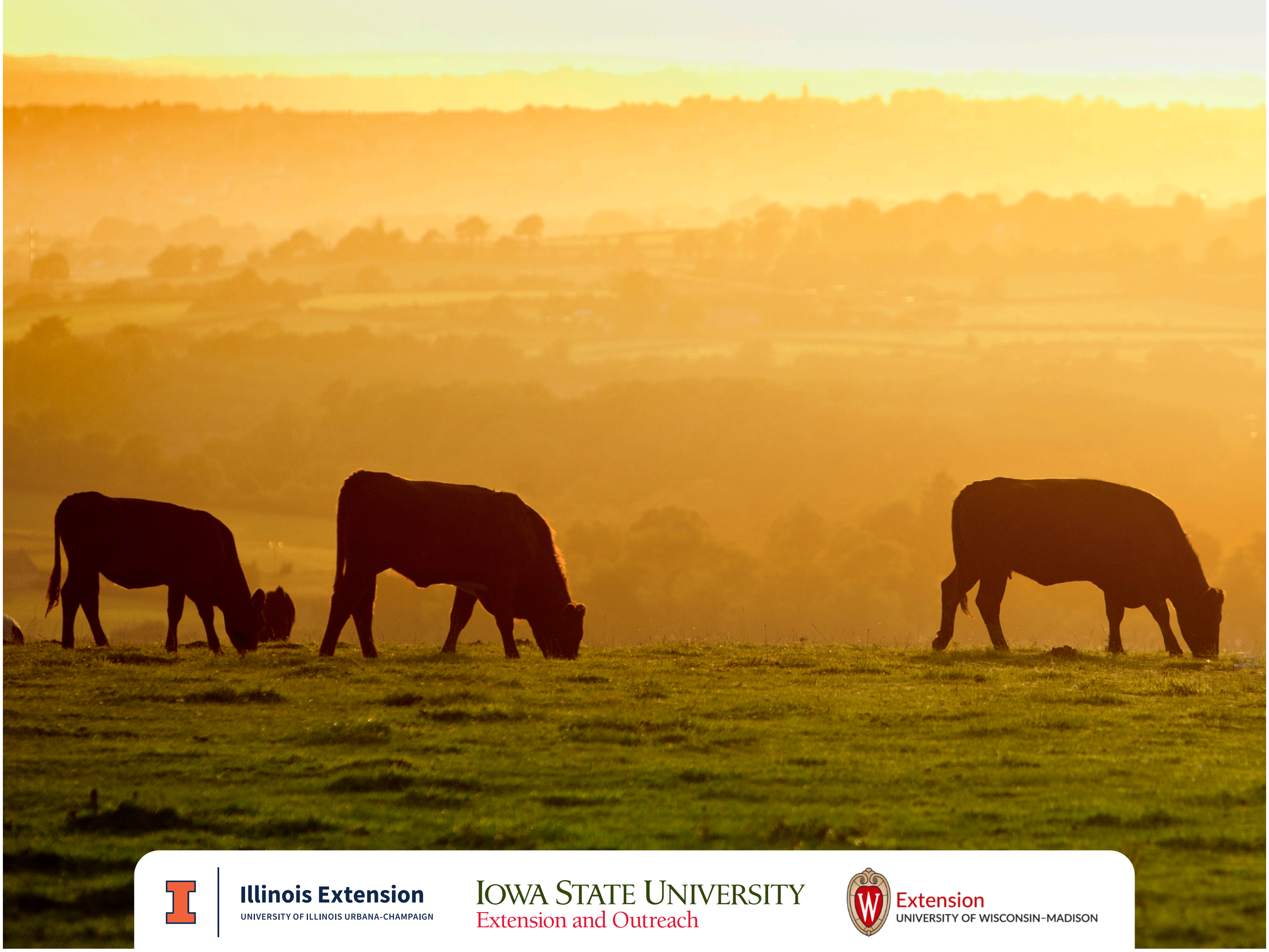
12th Annual

Driftless Region Beef Conference

January 25-26, 2024 | Grand River Convention Center, Dubuque, Iowa



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Proceedings of the 12th Annual

Driftless Region Beef Conference

January 25 - 26, 2024 – Dubuque, Iowa

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Measuring sustainability progress for beef production

Kim Stackhouse-Lawson, director, AgNext, Colorado State University, Fort Collins, CO

Take home messages

- Sustainability is complex, multi-faceted and often emotionally driven
- Climate will be a focus in sustainability for the foreseeable future, total methane emissions are increasing and baseline measurements and solutions are lacking
- The impact of animal agriculture on climate is measured and reported differently
- Corporate programs have significant supply-chain expectations
- Behind in research, we don't have a good "start here" for the supply chain

Introduction

The importance of sustainability is growing throughout the supply chain, defined by the three pillars of sustainability: economic, social, and environmental. Generally, it is imperative that the approach is holistic in nature (Figure 1), taking into account unintended consequences of decisions made within the system and how that can affect other aspects of sustainability.

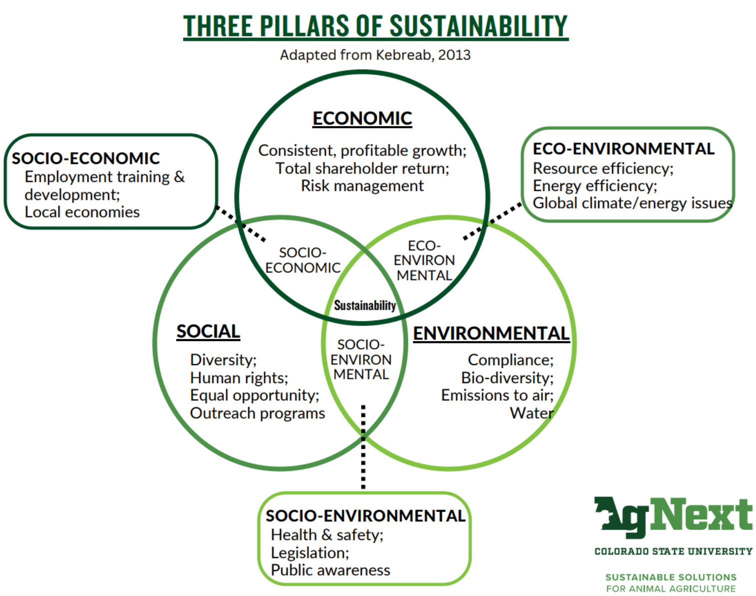

Figure 1. The three pillars of sustainability. (Kebreab, 2013)

A strong corporate sustainability program is an important business element of food companies in the U.S. and globally. Specifically, they must balance aggressive goals that are focused on reducing a specific environmental impact, like reducing greenhouse gas emissions, without sacrificing and ideally improving issues related to water quality, water use, food security, animal health and well-being, worker safety and satisfaction, impacts on public health and value chain profitability.

Most companies' sustainability programs today are holistic in nature; however, the most scrutiny to these programs is around company Net Zero commitments. Net Zero commitments include emissions from scope 1, 2 and 3 sources (Figure 2) and few companies have plans around achieving scope 3 emission reduction targets.

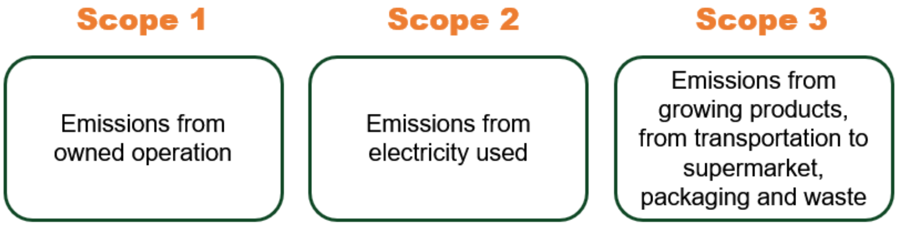

Figure 2. Definitions of scope 1, 2 and 3 greenhouse gas emissions.

Greenhouse gas emissions from animal agriculture

In the U.S., according to the Environmental Protections Agency (EPA), agriculture contributes 9.3% of anthropogenic GHG emissions, 4.4% of those emissions are attributed to animal agriculture, with the primary drivers being enteric CH4 emissions and manure emissions (Figure 3).

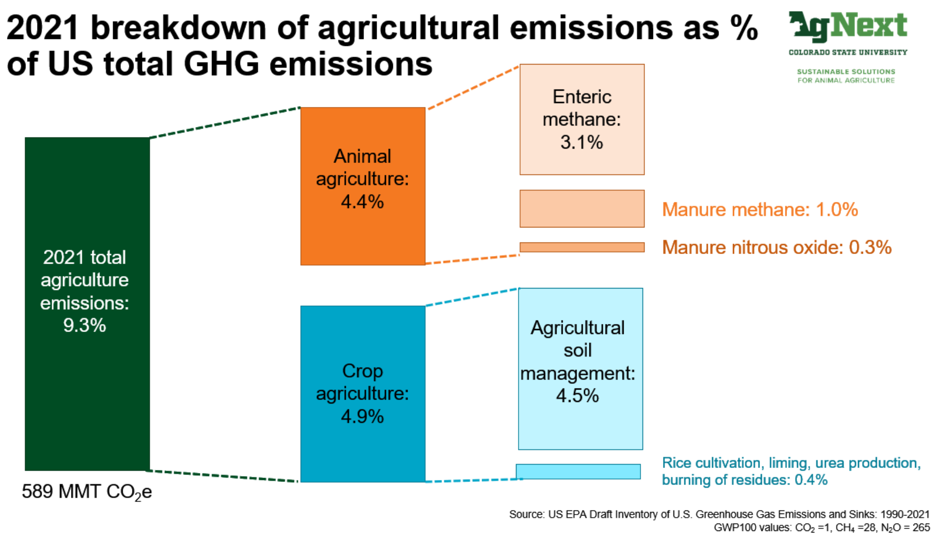

Figure 3. Breakdown of U.S. agriculture GHG emissions.

In the U.S., beef cattle are the primary contributor to enteric emissions (Figure 4) and the majority of those emissions come for the cow-calf sector (Figure 5).

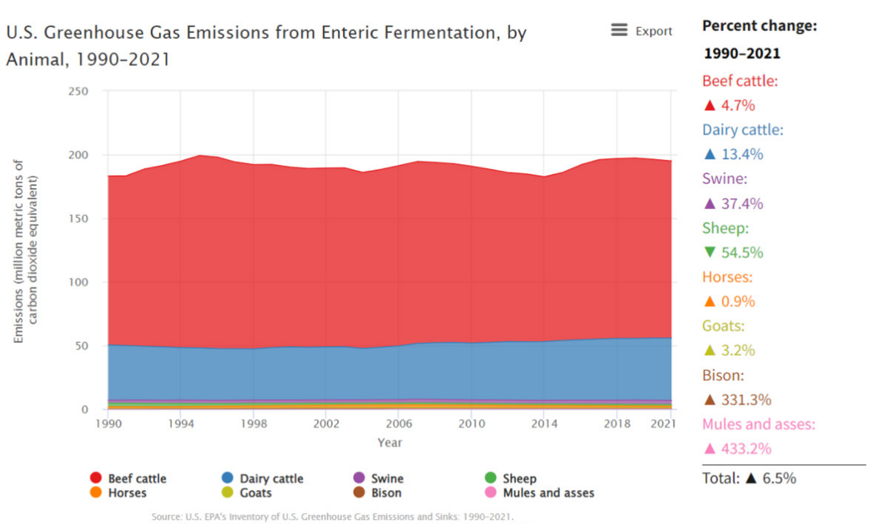

Figure 4. U.S. Greenhouse gas emissions from enteric fermentation by animal, 1990-1921 (EPA, 2022)

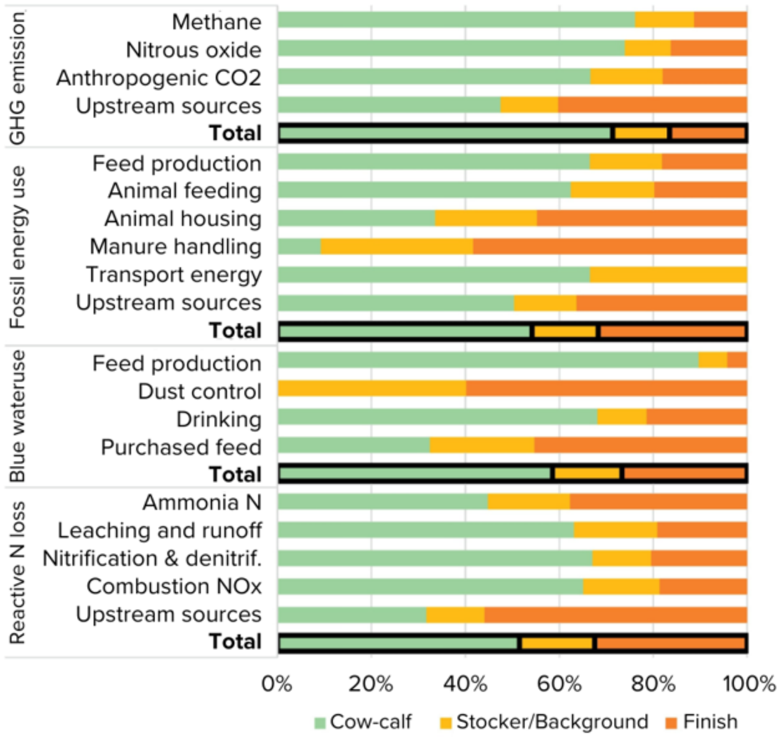

Figure 5. Environmental footprints of beef cattle production in the U.S., adapted from Rotz et al., 2019.

These enteric emissions represent a considerable contribution to both company scope 3 emissions and the methane emissions in the U.S. (Figure 6).

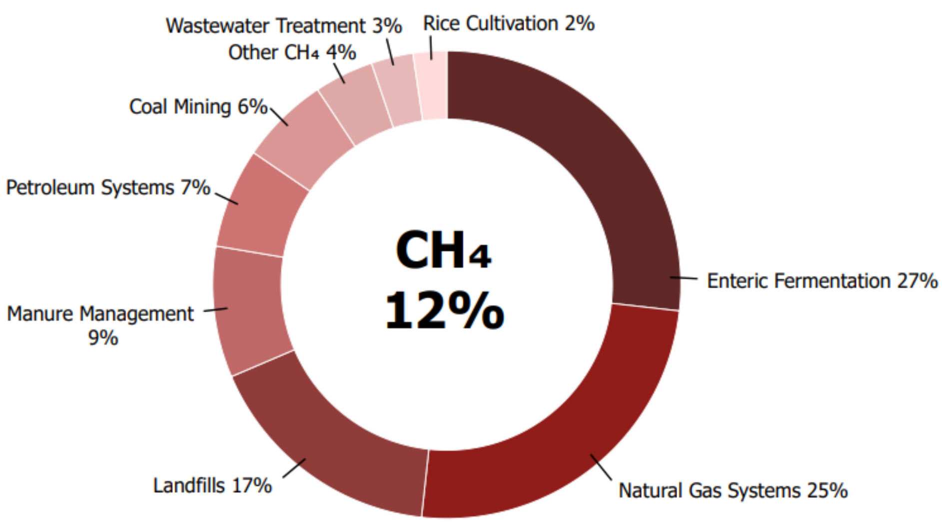

Figure 6. 2021 U.S. Sources of methane emissions, excluding methane emissions from LULUCF sector from flooded lands, forest, and grassland fires (EPA, 2022)

Solutions ready for adoption

As a result, there is increased pressure to increase enteric emissions and develop evidence, place- based solutions that not just reduce enteric emissions but also improve, or at minimum maintain the economic and social sustainability of the operation. Further, consideration must be given to how these solutions will impact system resiliency, food security and the profitability of beef producers.

At AgNext we are focused on the following related to enteric methane:

1. Better understand baselines
2. Develop and test dietary mitigation techniques
3. Understand what microorganisms are associated with high and low methane production
4. Investigate prospect of developing genetic selection tools for low methane emitting cattle

Grazing principles for successful livestock grazing management on western rangelands

Livestock grazing management in the diverse rangelands of the Western U.S. is enormously complex and an essential part of sustainability in food systems across the U.S. For more than a century, range scientists have aimed to provide usable information to producers to increase their likelihood of success. However, no concise statement of what we have learned exists. While this is largely due to the diversity and complexity of grazing management, it creates problems for producers, industry, extension, and range scientists themselves as compelling but evidence-challenged narratives fill the void. Our objective for this project was to work with the range science community to identify a set of concise, evidence-based, and adaptable principles for successful livestock grazing management on western semi-arid and arid rangelands.

We created the principles using an iterative survey and feedback process between an eight-member advisory committee and a group of >80 grazing management experts from across the west. After initial work by the advisory team, a widely distributed survey elicited lengthy responses totaling >25,000 words of wisdom about successful grazing management. We then distilled these into a set of draft principles, which were debated and revised among the advisory team. These draft principles were then returned to the initial survey respondents for further feedback. We also received feedback from >100 range professionals in a “campfire conversation” session at the 2023 Society for Range Management Annual Meeting. The advisory team further debated and revised to arrive at seven principles, structured as short memorable statements followed by paragraph-length descriptions that highlight key ideas and practices.

The seven identified principles are intended to evolve with conversation, debate, and more research. Already, we are adapting them for use in a guidebook for Colorado ranchers and have heard from extension and NRCS staff across the west that they intend to use them in outreach work. With the development of an associated checklist, these principles are ideal for use by industry organizations seeking to support successful livestock grazing management in their supply chains.

Figure 7. Short versions of the seven principles for successful livestock grazing management.

Conclusion

In summary, the sustainability landscape is complex and requires a systems approach that prioritizes each pillar of sustainability equally and considers food security alongside mitigation potential. Solutions should be co-developed with eventual adopters in the supply chain to ensure system resiliency.

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Livestock Gross Margin Insurance Cattle

Livestock Gross Margin

The Livestock Gross Margin for Cattle (LGM-Cattle) Insurance Policy provides protection against the loss of gross margin (market value of livestock minus feeder cattle and feed costs) on cattle. The indemnity at the end of the 11-month insurance period is the difference, if positive, between the gross margin guarantee and the actual gross margin. The LGM-Cattle Insurance Policy uses futures prices to determine the expected gross margin and the actual gross margin. Prices for LGM-Cattle are based on simple averages of Chicago Mercantile Exchange Group futures contract daily settlement prices and are not based on the prices you receive at the market.

A premium subsidy is available for those policies that insure multiple months during the insurance period. The subsidy amount is determined by a dollar deductible that you choose (ranges from $0-$150 in $10 increments). If you choose a $0 deductible you receive a lower premium subsidy (18 percent) and if you choose the highest deductible of $150 you receive a higher premium subsidy (50 percent). The premium is due at the end of the coverage period. LGM premiums depend on your marketing plan, coverage you choose, deductible level, and futures and price volatility.

Availability

LGM-Cattle is available in all counties in all states.

Causes of Loss

LGM-Cattle covers the difference between the gross margin guarantee and the actual gross margin.

LGM-Cattle does not insure against:

- Cattle death;
- Unexpected increases in feed use; or
- Anticipated or multiple-year increases in feed.

Buying a Policy

You can sign up for LGM-Cattle each week and insure all of the production that you expect to market over a rolling 11-month insurance period. LGM-Cattle is sold on the Thursday of the week when the coverage prices and rates are posted on the RMA website and ends at 9:00 AM Central Time of the following day. Your premium payment is due at the end of the insurance period. If expected gross margins and feed prices are not available on the RMA website or if the Thursday of the sales period is a federal holiday, LGM-Cattle will not be offered for sale for the insurance period.

Where to Buy Livestock Insurance

All multi-peril livestock insurance, including Catastrophic Risk Protection policies, are available from private insurance agents. A list of livestock insurance agents is available on the RMA website by using the **rma.usda.gov/Information-Tools/Agent-Locator-Page.**

Useful Links

LGM Coverage, Rates, and Margin Values: **rma.usda.gov/Information-Tools/Livestock-Reports**

Premium Calculator: **ewebapp.rma.usda.gov/apps/costestimator/**

Approved livestock agents and insurance companies: **rma.usda.gov/Information-Tools/Agent-Locator-Page**

Related AMS online livestock reports: **marketnews.usda.gov**

This fact sheet gives only a general overview of the crop insurance program and is not a complete policy. For further information and an evaluation of our risk management needs, contact a crop insurance agent.

Buying a Policy (continued)

The insurance period contains the 11 months following the sales closing date. For example, the insurance period for the January 29 sales closing date contains the months of February through December. Coverage begins the second month of the insurance period, so the coverage period for this example is March through December.

To enroll, you must sign up on Thursday each week. You must also submit an application with a target marketings report for the cattle.

Indemnity Payments

The indemnity at the end of the 11-month insurance period is the difference, if positive, between the gross margin guarantee and the actual gross margin. If the actual gross margin is less than the expected gross margin (minus the deductible) for the insurance period, an indemnity may be payable.

Definitions

Actual Marketings - The total number of slaughter-ready cattle sold by you for slaughter for human or animal consumption in each month of the insurance period and for which you have proof of sale. Actual marketings are used to verify ownership of cattle and determine approved target marketings.

Actual Total Gross Margin - The target marketings for each month of an insurance period multiplied by the actual gross margin per head for each month of that insurance period and totaled.

Deductible - The portion of the expected gross margin that you choose not to insure. Allowable deductible amounts range from $0 to $150 per head, in $10 increments. The deductible equals the selected head deductible multiplied by the sum of target marketings across all months of the insurance period.

Gross Margin Guarantee - The gross margin guarantee for an insurance period is the expected total gross margin for an insurance period minus the deductible times the total of target marketings.

Gross Margin - Market value of cattle minus feed and feeder animal costs.

Marketing Report - A report submitted by you on our form showing for each month your actual marketings of cattle insured under this policy. The marketing report must be accompanied by copies of packer sales receipts that provide records of the actual marketings shown on the marketing report.

Target Marketings - Your determination as to the number of cattle you elect to insure in each month during the insurance period.

Target Marketings Report - A report that you submit on the insurance company's form showing the target marketings for each month.

Livestock Risk Protection Feeder Cattle

Livestock Risk Protection

Feeder Cattle (LRP-Feeder Cattle) is designed to insure against declining market prices. You may choose from a variety of coverage levels and insurance periods that match the time your feeder cattle would normally be marketed (ownership may be retained).

You may buy LRP-Feeder Cattle insurance throughout the year from Risk Management Agency (RMA) approved livestock insurance agents. Premium rates, coverage prices, and actual ending values are posted online daily.

You may choose coverage prices ranging from 70 to 100 percent of the expected ending value. At the end of the insurance period, if the actual ending value is below the coverage price, you will be paid an indemnity for the difference between the coverage price and actual ending value.

Visit RMA's website to see the LRP-Feeder Cattle program's coverage prices, rates, actual ending values, and per hundredweight insurance cost (see useful links). Actual ending values are based on weighted average prices, from the Chicago Mercantile Exchange Group Feeder Cattle Index. Actual ending values are posted on RMA's website at the end of the insurance period.

Availability

You submit a one-time application for LRP-Feeder Cattle coverage. After the application is accepted, you can buy specific coverage endorsements throughout the year for up to 12,000 head of feeder cattle that are expected to weigh up to 1000 pounds at the end of the insurance period. The annual limit for LRP-Feeder Cattle is 25,000 head per producer per year (July 1 to June 30).

The length of insurance coverage available for each specific coverage endorsement is 13, 17, 21, 26, 30, 34, 39, 43, 47, or 52 weeks.

Coverage is available for:

- Calves;
- Steers;
- Heifers;
- Predominantly Brahman cattle;
- Predominantly dairy cattle; and
- Unborn calves.

You may also choose from two weight ranges - 100-599 pounds and 600-1000 pounds. LRP-Feeder Cattle insurance is available in all counties in all states.

Buying a Policy

You must buy LRP-Feeder Cattle insurance through a livestock insurance agent. You may fill out an application at any time. However, insurance does not attach until you buy a specific coverage endorsement. You may buy multiple specific coverage endorsements with one application. Your insurance coverage starts the day you buy a specific coverage endorsement and RMA approves the purchase.

Where to Buy Livestock Insurance

All multi-peril livestock insurance, including Catastrophic Risk Protection policies, are available from private insurance agents. A list of livestock insurance agents is available on the RMA website at: rma.usda.gov/Information-Tools/Agent-Locator-Page.

Useful Links

Daily LRP Coverage Prices, Rates, and Actual Ending Values: rma.usda.gov/Information-Tools/Livestock-Reports

Premium Calculator: ewebapp.rma.usda.gov/apps/costestimator/

Approved livestock agents and insurance companies: rma.usda.gov/Information-Tools/Agent-Locator-Page

Related AMS online livestock reports: marketnews.usda.gov

This fact sheet gives only a general overview of the crop insurance program and is not a complete policy. For further information and an evaluation of our risk management needs, contact a crop insurance agent.

April 2022

NCBA's Environmental Stewardship Award program and you

Jerry Huth, Huth Polled Herefords, Oakfield, WI

Key points

- Information on the NCBA Environmental Stewardship Awards Program can be found at: http://www.environmetalstewardship.org
- Applications for this year are due: March 8, 2024.
- Make sure you know your NRCS and FSA people
- Keep abreast of the opportunities that EQUIP offers.
- Watch the progress of the farm bill – contact your representatives to make sure they keep the Grazing Lands Initiative in the new bill.
- If you are in an area of DNR land and interested in grazing this land, contact them!
- Don't be afraid to mentor people, host field days and work with the Beef Council and Cattlemen's groups to promote your product.
- Tell your story!
- Contact information:

  Mary C. Anderson, DNR Conservation Agricultural and Grazing Specialist,
  Email: maryc2.anderson@wisconsin.gov. Phone: (608) 220-2935

  Josh Scharf, S&H Livestock Enterprises, LLC Ph: (920) 979-7613

  Jerry Huth, Huth Polled Herefords, W9096 County Road AS, Oakfield, WI 53065. Ph: (920) 251-0281
  Email: jerry@huthcattle.com Website: http://www.huthcattle.com.

- You are invited to the Huth Polled Herefords Dispersal Sale, Sunday, November 3, 2024.

A balancing act: Feed resources vs. herd inventory

Beth Reynolds, program specialist, Iowa Beef Center, Iowa State University Extension and Outreach, Ames, IA

How many cattle should we be running with the forage base available? There is no simple way to answer that question. The balance between the number of cattle and the forage base is constantly in motion, and flexibility is essential. After the 2023 growing season, the Driftless Region is dealing with drought ramifications and gearing up for a 2024 growing season that may very well bring continuing dry conditions. Moving forward, we each need to create, or update our drought management plan. Although each plan needs to be multifaceted and unique, most strategies involve adjustments to one of the following: herd numbers, forage supply, or feed resources. The discussion will touch on multiple strategies:

Herd numbers

- Cull and market a higher percent of the mature cow herd, and/or cull earlier in the year at a higher point in the seasonal price cycle. A higher number of replacement or first calf heifers can be retained/purchased. Because of the size difference, the younger animals require less feed (albeit higher quality feed).
- Utilize a stocker operation. Begin the year running some stockers in addition to the genetic base of the cow herds to utilize early excess pasture growth. Identify “trigger dates” and if moisture by those dates is not adequate, sell stocker cattle rather than cows in the breeding herd.

Forage supply

- Incorporate drought hardy species into perennial pasture and/or dedicate some tillable acres to a drought tolerant forage crop. Compare production costs of different forages vs corn/beans and create a timeline with deadlines to make decisions. Some warm season annuals are good examples of forage crops that may work in drought years.
- Certain perennial pasture management tasks need to be prioritized in drought years. Three priority areas include weed/brush control, soil tests before fertilizing, and adding longer rest periods for drought stressed forages.

Feed resources

- Identify additional crop residue, CRP, annual forage, or hay acres as grazing possibilities. Fence and water are the hurdles, but underutilized acres are an opportunity when drought forces high hay prices.
- Last, but not least, the most common drought plan is to buy hay. Though effective, this can be expensive. Be open to alternative feedstuffs but be realistic in what feeds your operation equipment and storage facilities can handle. Include sourcing silage as an option. Work with nutritionists and always compare feedstuff costs on a price per pound of dry, nutrient delivered. Sourced feedstuffs can be for a complete diet or used as a supplement on pasture to “stretch” grazing days. The right feed depends on the goal.

Perhaps the biggest question to ask ourselves, is why we maintain the number of cows in the breeding herd that we currently target. Is that number truly the appropriate number to maintain, or are we consistently overstocking with unrealistic expectations for what our forage supply will produce?

Recommended references

https://www.iowabeefcenter.org/forage.html

https://store.extension.iastate.edu/product/Pasture-Management-Guide-for-Livestock-Producers

Growth performance, carcass traits, and feeder calf value of beef × Holstein and Holstein feedlot steers

M. Pimentel-Concepción[1], J. R. Jaborek[2], J. P. Schweihofer[3], A. J. Garmyn1,[4], M.-G.-S. McKendree[5], B. J. Bradford[1], A. Hentschl[6], and D. D. Buskirk[1]

Holstein (HO) cattle represent approximately 23% of the U.S. fed beef supply (Berry, 2021) from surplus heifer and bull calves. Typically, HO cattle produce USDA Choice or better carcasses and provide a year-round supply of beef (Basiel and Felix, 2022). However, compared with beef steers, HO steers have less desirable feed conversions, poorer health, lower dressing percentages, and flatter muscle shape (Jaborek et al., 2023), and the decision of a major U.S. processor to no longer buy HO finished steers has further decreased their value (McKendree et al., 2021). Recently, there has been a considerable increase in the use of beef sires on low milk production dairy females in the U.S. to increase calf value and overall economic return for dairy producers (Bohnert, 2023). However, most available data regarding beef × Holstein (B×HO) cattle originate outside of North America, are more than 40 years old, or are not aligned with current U.S. production systems and breed genetics. Therefore, a study was designed to compare a B×HO and straightbred HO steer production system and calculate breakeven feeder calf values.

For this study, 150 steers (75 B×HO and 75 HO) were sourced from multiple dairies through a single Michigan calf raiser and transported to the MSU Beef Cattle Teaching and Research Center, Lansing, MI. After a 21-day pre-trial acclimation, they were randomly assigned to 1 of 20 bedded pens and fed a common starter diet until day 21, followed by a common finishing diet. After achieving similar body composition, the steers were harvested at a commercial processor on day 245 for B×HO and day 266 for HO. The experiment was a randomized complete block design with pens serving as the experimental unit. Significance was established at $P \leq 0.05$ and tendencies are discussed at $0.05 < P \leq 0.10$.

From day 0 to harvest, average daily gain tended to be 5% greater for the B×HO steers (3.75 vs. 3.63 lb/d; P = 0.07) compared with the HO steers, however, average daily dry matter intake (DMI) was the same between the breed types (23.4 vs. 23.5 lb/d; P = 0.85). The B×HO steers had 4% improved feed conversion (DMI, lb/ADG, lb) compared with HO steers (5.81 vs. 6.02; P = 0.01). Health was similar between the breed types, with no differences observed in morbidity (P > 0.75) or mortality (P = 0.57). Frame score before harvest was calculated, with the B×HO steers having a more moderate frame score, which was 1.9 units less (7.5 vs. 9.4; P < 0.01) on a 10-point scale, than the HO steers. Although final live weight tended to be less for B×HO compared with HO steers (1,368.4 vs. 1,397.8 lb; P = 0.06), carcass weights were similar between breed types (803.9 vs. 806.4 lb; P = 0.78). The B×HO steers had 20% greater longissimus muscle area (13.6 vs. 11.3 in2; P < 0.0001), a greater backfat thickness (0.47 vs. 0.31 in; P < 0.01), and a lower, more desirable, average USDA Yield Grade (2.9 vs. 3.2; P = 0.02) than HO steers. The B×HO and HO steers had similar average marbling scores (426 vs. 437; P = 0.62) and USDA Quality Grades (P = 0.53). The HO steers remained on feed for 21 days longer than the B×HO steers, resulting in a $95 greater feed cost for the HO steers ($841.06 vs. $936.48/steer; P < 0.01). This resulted in a $6.68/cwt lower cost of gain for B×HO compared with HO steers ($121.93 vs. $128.61/cwt; P = 0.03). The B×HO carcasses had a $5.65/cwt greater value ($229.06 vs. $223.41/cwt; P < 0.05), but a similar carcass revenue ($1,835.97 vs. $1,799.46/carcass; P < 0.05) when compared with the HO carcasses. Calculated breakeven feeder calf value was $37.65/cwt more for B×HO compared with HO steers ($166.29 vs. $128.64/cwt; P < 0.05). Based on their feedlot receiving body weights, B×HO and HO feeder calves purchased for this study would have been worth $627.74 and $489.60/calf, respectively. Overall, B×HO steers were more feed efficient and produced carcasses with more desirable carcass yield, resulting in greater feeder calf value when compared with HO steers. These results indicate that breeding beef sires to dairy females may result in steers capable of attaining a beef-type

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conformation which adds value over HO steers. Further research is necessary to develop optimal strategies to consistently produce B×HO carcasses with conformation and value similar to beef-type carcasses.

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Evaluation of creep feeding duration in a drylot system on cow and calf performance

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Summary

The objectives were to determine effects of creep feed duration in a drylot system on cow performance and calf performance. Spring-calving, SimAngus cows (5 ± 2 yr; n = 72) were stratified by calf age (83 ± 14 d), sex, and body weight (BW; 286 ± 37 lb) and allotted to 12 pens with six cow-calf pairs per pen. Pens were randomly assigned to 1 of 2 treatments: calves fed commercial, pelleted creep feed (14% CP) for 105 d (105dCF) or final 21 d (21dCF) prior to weaning. Cow-calf pairs were housed in concrete drylots with open-front buildings, and cows were limit-fed at maintenance. Calves were weaned on d 105, trucked 263 km to a feedlot, and fed for fed for 194 d, and slaughtered on d 300. Reproduction data were analyzed using GLIMMIX and all other response variables were analyzed using the MIXED procedure of SAS 9.4. There were no differences in cow BW, BCS, milk production, milk composition, or reproductive data. The 105dCF had greater IVDMD and there was a treatment × substrate interaction for total VFA on d 76. Within the 105dCF, there were no differences between substrates, however, within 21dCF the creep substrate yielded more total VFA. At weaning, the 105dCF calves had greater ultrasound longissimus muscle area, rib fat, and rump fat compared with 21dCF. On d 105, the 21dCF calves tended to have greater ex vivo IVDMD; however, there were no treatment differences for total VFA. The 21dCF calves had greater ADG and tended to have greater G:F during the receiving period. The 105dCF calves had greater BW at the end of the receiving period. The 105dCF calves had greater creep feed costs and weaned calf value. In conclusion, creep feed duration did not impact cow performance. The 105dCF calves had increased ADG and BW for the pre-weaning period. Creep feeding improved ruminal fermentation ex vivo, but even a short-term creep feeding duration of 21 d appears to be adequate in preparing the rumen bacterial community. The 21dCF had improved gain during the receiving and finishing phase and compensated for previous restriction, ultimately resulting in similar final carcass characteristics as well as final carcass value.

Introduction

Traditionally, cow-calf pairs graze pasture during the growing season and are supplemented harvested or purchased feeds when forage is dormant. As forage availability declines, cows are often moved to drylots to receive additional supplementation. Crop production and urbanization has contributed to a decline in pasture availability and increased land prices. Therefore, producers need to explore alternative systems to maintain cows in summer months when they would typically be grazing pasture. Drylot systems are common and are a familiar concept to producers. Drylots have been incorporated with pasture-based systems when forage availability is limited (Thomas and Durham, 1964) and are associated with decreasing cow maintenance requirements and improving overall herd management (NASEM, 2016; Lardy et al., 2017). Recent research indicated cow-calf pairs can successfully be housed in drylot systems for extended periods of time (Myerscough et al., 2022). Thus, future research needs to focus on the best management practices within these systems.

The gross income of the cow-calf industry is highly reliant on the weaning weights of calves. It is well documented that creep feeding calves in pasture-based systems has resulted in increased weaning weights (Martin et al., 1981; Prichard et al., 1989; Tarr et al., 1994). Unlike traditional pasture systems, cows in drylots rely on delivered feed to meet nutritional needs. Research has been conducted on feeding cows in these alternative systems (Shike et al., 2009); however, there is limited research exploring creep feeding practices in a drylot system. Creep feeding in a drylot system improved weaning weights (Deutscher and Slyter, 1978), but the optimum length to feed creep is unknown. In a pasture-based system, creep feeding for 3 weeks is a common practice (Lardy and Maddock, 2007). With the design of drylots, calves do not have access to forage; therefore,

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they rely primarily on milk production to meet their nutritional needs. At approximately 60 d postpartum, milk production no longer meets the requirements of the calf (NASEM, 2016). Hence, the evaluation of the ideal creep duration in a drylot system is needed. We hypothesized that long-term creep fed calves would have increased weaning weights compared with short-term creep fed calves. The objectives were to determine the effects of creep feed duration in a drylot system on cow performance and calf performance through receiving.

Methods

All experimental procedures were approved by the Institutional Animal Care and Use Committee of the University of Illinois (Protocol #22069) and followed the guidelines recommended in the Guide for the Care and Use of Agricultural Animal in Agricultural Research and Teaching (FASS, 2020).

To investigate the effects of creep feed duration in a drylot system on cow performance as well as calf performance seventy-two spring-calving SimAngus cows [5 ± 2 yr; body weight, (1460 ± 170 lb)] and their calves were obtained from the Orr Research and Demonstration Center (OARC) in Baylis, Illinois. Cow-calf pairs utilized in the trial were fed a total mixed ration (TMR) formulated to meet maintenance and maintained in 12 concrete drylot pens with open fronted buildings for 155 d prior to the start of the trial. There were 8 cows housed in each pen prior to the start of the trial.

A stratified, randomized design was used for the experiment and cow-calf pairs were stratified by calf age (83 ± 14 d), calf sex, and calf body weight [body weight, (BW); 286 ± 37 lb] and allotted to 12 pens with six cow-calf pairs (3 heifer calves and 3 steer calves) per pen. Pens were randomly assigned to 1 of 2 treatments: calves fed creep feed for 105 d (105dCF) or final 21 d (21dCF) prior to weaning. Cow-calf pairs were housed in 36 × 36 ft concrete lots allowing 217 ft^2/cow-calf pair with a 24 × 24 ft open-front building that allowed 96 ft^2/cow-calf pair for the pre-weaning period. Straw bedding was added to the open-front buildings on a weekly basis for the duration of the study. Calves had access to a 11 × 7 ft creep pen which allowed 12.9 t^2/calf. Calves had ad libitum access to commercially available, pelleted creep feed (Table 1).

Cows were limit-fed a TMR formulated at maintenance (NASEM, 2016) in 4.7 m concrete bunks (0.8 m/cow). Cows were fed 3 different TMR to account for ingredient availability and changing cow requirements (Table 2). The TMR 1 consisted of dried distillers grains, ground corn stalks, soybean hulls, ground hay, corn grain, corn silage, and mineral. The second and third TMR contained the same ingredients as TMR 1 except corn silage was removed from the diets. The calves were not excluded from the cow bunks and TMR, but with the bunk space provided and limit-feeding an energy-dense TMR, calves had minimal opportunity to consume the TMR.

At the initiation of the study cows were synchronized with a 7 & 7 Synch protocol as explained by Thomas et al. (2021). Cows were artificially inseminated (AI) on d 0. Ten days following AI, cows were exposed to a bull (1 bull/pen) that had previously passed a breeding soundness exam. Bulls remained housed with cows for 53 d and AI conception and overall pregnancy rate were determined by trained technicians utilizing ultrasonography [Aloka 500 instrument (Wallingford, CT); 7.5 MHz general purpose transducer array] on d 42 and d 96 of the study. Calves were abruptly weaned on d 105 and shipped 163 miles from the Orr Research and Demonstration Center (OARC) in Baylis, Illinois to the University of Illinois Beef Cattle and Sheep Field Research Laboratory in Urbana, IL. During the 42-d receiving period, pen assignments remained the same as the pre-weaning phase. Each individual pen was 16 × 16 ft allowing 45.2 ft^2/calf. Pens consisted of slatted floors covered by rubber mats. Calves remained in the same pen (6 calves per pen) from d 105 to d 147; this timeframe is referred to as the receiving period. All calves had ad libitum access to a receiving diet (Table 3) and were fed in a 10 ft concrete bunk.

Steers calves were implanted with Component TE-IS with Tylan (16mg Estradiol, 80mg Trenbolone acetate, 29mg Tylosin tartrate; Elanco, Greenfield, IN) on d 148. On d 148, heifers were sorted off the trial and one 105dCF calf was incorrectly assigned as a steer, so the calf was sorted off the trial with other heifers. On d 148, steers were sorted to new pens, commingled, and followed through the finishing phase; the finishing period is referred to as d 148 to d 299. Cattle received 2 common finishing diets (Table 4) for the duration of the study. Finishing diet 1 was fed from d 148 to d 237 and finishing diet 2 was fed from d 238 to d 299. On d 201, one 105dCF steer was removed and euthanized for lameness. On d 223 steers were implanted with Component TE-S with Tylan (24mg Estradiol, 120mg Trenbolone acetate, 29mg Tylosin tartate; Elanco, Greenfield, IN) and started on a finishing phase DMI and feed efficiency evaluation utilizing GrowSafe (Vytelle, Lenexa, KS). This feed efficiency evaluation was conducted from d 238 to d 298. Steers received 283.5 mg/steer/d of Ractopamine (Optaflexx, Elanco, Indianapolis, IN) from d 270 to d 299. Steers were shipped ~300 km to a commercial abattoir (Tyson Fresh Meats, Joslin, IL) on d 299 and were slaughtered under USDA inspection on d 300.

Data collection and sampling

The pre-weaning period was from d 0 to d 105. Cow BW and BCS were collected at the beginning of the pre-weaning phase (83 ± 14 d postpartum; d -1 and d 0), on d 42 (125 ± 14 d postpartum), d 84 (167 ± 14 d postpartum), and weaning (188 ± 14 d postpartum; d 104 and d 105). Consecutive day pre-weaning starting and ending weights were averaged to calculate the initial and end pre-weaning BW.

Milk production was determined on all cows by utilizing the weigh-suckle-weigh (WSW) technique 9 d prior to the pre-weaning phase and on d 76 of the pre-weaning phase [(159 ± 14 d postpartum; (Beal et al., 1990)]. The WSW conducted prior to the pre-weaning phase was utilized for baseline milk production. Milk samples were collected on d 76 on a random subset of 12 cows per treatment (2 cows per pen). Milk composition samples were collected by hand stripping (Clements et al., 2017) and analyzed at a commercial laboratory (CentralStar Laboratory, Kaukauna, WI) for percent fat, percent protein, and milk urea nitrogen (MUN).

Calf BW were collected at the beginning of the trial (83 ± 14 d age; d -1 and d 0), d 42 (125 ± 14 d age), d 84 (167 ± 14 d age), and at weaning (188 ± 14 d age; d 104 and d 105). Consecutive day starting and ending weights were averaged to calculate the initial and end pre-weaning BW. Calf average daily gain was calculated during the pre-weaning period. Calves had ab libitum access to creep feed for their allotted amount of time (105 d or 21 d). Creep bunks were monitored daily to determine feed calls and deliveries. Orts were collected weekly or as needed. Creep feed intake was determined by the difference between delivered feed and the orts collected. Supplemental gain was calculated for the 105dCF treatment from d 0-84 of the pre-weaning phase. The supplemental gain was calculated from d 0 to d 84 by subtracting the difference in ADG between the 105dCF and 21dCF and dividing by the average daily creep intake of the 105dCF calves for the first 84 d.

On d 76 an ex vivo model was used to determine the effects of creep feed exposure on ruminal fermentation utilizing a 2 × 2 factorial arrangement in a split-plot design. A subset of 16 steers (8 steers per treatment) were utilized. On d 76, at 0700, 200 mL rumen fluid was collected from each steer via esophageal tubing. Up until this point in the experiment, the 105dCF had ab libitum access to creep and the 21dCF had not had access to creep. The initial 50 mL of rumen fluid collected was disposed to eliminate saliva contamination. Rumen fluid samples were combined in a 1:2 ratio (10 mL rumen fluid: 20mL buffer) with McDougall's artificial saliva (McDougall, 1948) and placed in 50mL conicals. The substrates utilized for the d 76 evaluation were TMR 3 (Table 2) and the calf creep feed (Table 1). Conicals containing rumen fluid inoculum were combined with 0.5 g (DM basis) of substrate (TMR or creep), which was ground to 1mm with a Wiley mill (Arthur H. Thomas, Philadelphia, PA), flushed with CO2, and sealed with a rubber stopper and a one-way valve. The treatments were evaluated in triplicates and included two blanks. Conicals were placed in an incubator (Thermo Scientific, Waltham, MA) at 39°C and 100 RPM to maintain fermentation for 24 h. At the end of the 24 h, the pH was recorded using a benchtop pH meter (Accumet Basic AB15, Fisher Scientific, Hampton, NH) and 6 N HCl was added to stop fermentation. Samples were filtered through Whatman 541 paper (Cytiva, Marlborough, MA) and dried at 55°C dried (utilizing a 55°C forced air HeraTherm oven, Thermo Fisher Scientific, Waltham, MA) for 24 h and placed in a desiccator to cool to room temperature. Once cool, samples were weighed, and dry matter disappearance was recorded.

Calves were scanned on d 104 with an EVO II Medical Imaging (E.I. Medical Imaging, Loveland, CO) ultrasound machine to determine longissimus muscle area (LMA), and 12th rib fat, rump fat, and intramuscular fat (IMF) prior to weaning. The IMF and 12^{th} rib fat measurements were recorded in transverse orientation approximately 3.9 in from the midline between the 12^{th} and 13^{th} ribs.

On d 105 an ex vivo model was used to determine the effect of creep feed duration on ruminal fermentation. On d 105, calves were abruptly weaned, shipped 263 km, and rumen fluid was collected from calves once they got off the truck. Rumen fluid samples were collected from the same 16 steers from d 76 ex vivo. Leading up to the 105 d ex vivo, the 105dCF calves had been on creep for 105 days and the 21dCF calves had been on creep for 21 days. Rumen fluid was collected upon feedlot arrival (1400) and transported 6.4 km to the laboratory in a warmed, insulated container to regulate temperature and reduce oxygen exposure. Procedures and sampling were similar to the d 76 evaluation, except substrates included creep (Table 2) and the feedlot receiving diet (RD) (Table 3). The creep substrate was utilized to determine if creep duration impacted ruminal fermentation characteristics, whereas the RD was used to assess if 3 weeks is adequate in preparing the rumen bacterial community for a receiving diet.

Upon feedlot arrival, calves were weighed and maintained in the same pen group as the pre-weaning phase. Behavior observations were recorded on d 106. Cattle were fed at 0745 and behavior was observed by trained personnel blind to the treatment from 0800 to 1900. The number of calves lying, standing, walking, and eating were recorded. Behavior was recorded every 20 minutes, and 3 observations were averaged to represent each hour. For every 20-minute interval, the number of vocalizations per pen were recorded in 2-minute periods. The number of vocalizations per 2 minutes per pen were utilized to calculate the number of vocalizations/calf/h.

For the receiving period, BW were recorded on d 105, d 106, d 119, d 133, d 147, and d 148. Dry matter intake (DMI) and gain:feed (G:F) were measured on a pen basis for the receiving period with ingredient samples collected biweekly and orts collected weekly. End receiving period BW was determined by averaging a 2-d consecutive BW on d 147 and d 148. At the conclusion of the 42-d receiving period, heifers were sorted off the trial and kept back as replacement females.

Prior to the finishing phase, steers were comingled and moved to new pens. Steer BW was recorded on d 147, d 148, d 238, d 298, and d 299. Feed samples were collected every 28-d and feed refusals were collected as needed. There was no DMI or G:F data recorded from d 148 to d 237. On d 238-298 steers were on a DMI and feed efficiency evaluation. During the evaluation, DMI was recorded via GrowSafe bunks (Vytelle, Lenexa, KS) and feed efficiency was calculated for each individual steer. At the end of the finishing period, steer final BW was calculated by averaging a 2-d consecutive BW on d 298 and on d 299.

Steers were transported via commercial trucking to a commercial abbatoir (Tyson Fresh Meats, Joselin, IL). On d 300, steers were slaughtered, and trained University of Illinois personnel performed a tag transfer. Hot carcass weight (HCW) was recorded on the day of slaughter. After a 24- h chill, 12th rib fat thickness, LMA, kidney, pelvic, and heart fat (KPH), and marbling scores were collected. Dressing percent was calculated using a 4% pencil shrink. Carcass measurements were taken with Video Image Analysis (VIA) with the USDA camera system.

Economic analysis

Three-year averages were used to determine feeder calf prices as well as the premiums and discounts (NASS, 2023). Three-year price averages were used for the creep feed. Creep prices were collected from Pike Feeds (Pike Feeds Inc, Pittsfield, IL; A. P. Fritz, personal communications, March 3, 2023). Creep feeding equipment and labor costs were calculated to be $0.24/d. This cost included the price of a self-feeder sized for 30 calves with a 7-yr lifespan and included 2 h/wk of labor ($16/hr) to deliver creep. Average weaned calf price utilized was $173/cwt (NASS, 2023). The 105dCF calves were discounted $5/100 lb for being “fleshy.” A price slide of $10 for every 100 lb was utilized, therefore the 21dCF calves received a $6/cwt premium. Final carcass value was calculated for each steer using actual HCW, dressed steer price ($198.67/cwt; NASS, 2023) and appropriate discounts and premiums (NASS, 2023).

Sample analysis

Ingredient samples were composited and freeze dried in a -50°C Labconco (Labconco, Kansas City, MO) freeze dryer and ground to 1mm with a Wiley mill (Arthur H. Thomas, Philadelphia, PA) and analyzed. Ingredient samples were analyzed for dry matter (utilizing a 55°C forced air HeraTherm oven, Thermo Fisher Scientific, Waltham, MA), neutral detergent fiber and acid detergent fiber (utilizing Ankom Technology method 5 and 6, respectively; Ankom200 Fiber Analyzer, Ankom Technology, Macedon, NY), ether extract (utilizing Ankom Technology method 2; Ankom XT10 Fat Analyzer, Ankom Technology), crude protein (Leco TruMac, LECO Corporation, St. Joseph, MI), and organic matter (600°C for 12 h; Thermolyte muffle oven Model F30420C, Thermo Scientific, Waltham, MA). All feed refusals were dried (utilizing a 55°C forced air HeraTherm oven, Thermo Fisher Scientific, Waltham, MA) to determine DM.

The VFA from the d 76 and 105 d ex vivo were determined using aliquots of acidified fluid and gas chromatography (HP1850 series gas chromatography Hewlett-Packard, Wilmington, DE) on a glass column

(Erwin et al., 1961). The VFA are presented as mM and molar percentages.

Statistical analysis

Pen was the experimental unit for all cow and calf performance data. Except for reproduction, all data were analyzed using the MIXED procedure of SAS 9.4 (SAS Institute Inc., Cary, NC). All models included a random statement of pen(treatment) and the fixed effect of treatment; however, additional fixed effects and covariates included varied depending on response variable. Appropriate EPDs (Shike, 2018), dam age, calf age, calf sex, pen, and initial measurements were considered as fixed effects or covariates in the model and were determined on best fit statistics. Reproductive data were analyzed using the GLIMMIX procedure of SAS 9.4 (SAS Institute Inc., Cary, NC). The model included the fixed effect of treatment, pen, dam age, and sire with a random statement of pen(treatment).

The REPEATED statement was used to analyze calf behavior and vocalizations. All behavior data underwent a Shaprio-Wilk test to assess normality. A boxcox procedure was applied to eating behavior data to determine the appropriate transformation to meet normality. Least square means have been back-transformed for ease of interpretations. The autoregressive compound symmetry was the covariance structure selected based on the lowest AIC. Fixed effects included sex, treatment, time and the interaction of treatment and time. The least squared mean and SLICE functions of SAS were used to separate treatment means and interactions of treatment and time, respectively.

Ex vivo data were analyzed as a 2 × 2 split plot design with animal as the experimental unit. Data were analyzed using the MIXED procedure of SAS 9.4 (SAS Institution Inc., Cary, NC). The ex vivo models included the fixed effects of treatment, substrate, and the interaction of treatment and substrate. Time of rumen fluid collection, time of incubation, and initial h 0 measurements were used as covariates in the model. Effects were considered significant at $P \leq 0.05$ and trends at $0.05 < P \leq 0.10$.

Results

Cow performance and reproduction

There were no differences in cow BW or BCS detected for the duration of the study (Table 5). There were no differences for AI conception or overall pregnancy between treatments (Table 6). Milk production, milk fat percent, or MUN did not differ between treatments (Table 6).

Calf performance through weaning

There were no differences on d 0 for calf BW (Table 7). The 105dCF calves had greater BW from d 42 to 105. Calves on 105dCF had greater ADG for the duration of the pre-weaning period. The supplemental gain of the 105dCF was 0.16 for the first 84 d of pre-weaning period (Table 7). The 105dCF calves had greater DMI in week 13 compared to 21dCF calves (16.5 vs 11.2 lb/d, respectively: Table 8). However, there were no differences in DMI in week 14 and 15 between treatments.

Ultrasound measurements from d 104 are displayed in Table 9. The 105dCF calves had greater LMA. However, when adjusted for body weight there were no differences in LMA, in^2/100 lb BW. The 105dCF calves had greater 12^{th} rib fat and rump fat than 21dCF calves. There were no differences detected in IMF.

Feedlot behavior observations

Feedlot arrival behavior observations were recorded on d 106. Treatment × time effects were detected for standing, walking, and vocalizations (Figure 1). At h 0800, 0900, and 1000, more 105dCF calves were standing. However, at h 1500 more 21dCF were standing. At h 1000, more 105dCF calves were walking. However, at h 1600 more 21dCF calves were walking. At h 1000 and 1200 more 105dCF calves were vocalizing. However, at h 1800 more 105dCF tended to be vocalizing. A tendency for a treatment × time effect was detected for lying. There was a treatment effect detected for more 21dCF calves to be lying than 105dCF calves. There were no treatment or treatment × time effects detected in eating behavior.

Receiving period performance

In the receiving period, the 105dCF calves had greater BW (Table 10). There were no differences in ADG from d 105 to d 119 and d 119 to d 133. However, from d 133 to d 147, 21dCF calves had greater ADG which contributed to the 21dCF calves having greater ADG for the overall receiving period (d 105 to d 147). There were no differences in DMI for the receiving period. There were no differences in G:F from d 105 to d 119 and d 119 to d 133. The 21dCF calves had greater G:F from d 133 to d 147. Similar to ADG effect, the 21dCF calves tended (P = 0.08) to have greater G:F for the overall receiving period (d 105 to d 147).

Finishing phase performance and carcass characteristics

Although the 105dCF had greater) BW on d 148, there were no differences in BW on d 238 or 299 (Table 11). The 21dCF had greater ADG from d 148 to d 238; however, there were no differences in ADG from d 238 to d 299. Regardless, there we no differences in ADG for the overall finishing phase (d 148 to d 299). There were no differences in DMI or G:F during the finishing phase DMI and feed efficiency evaluation (d 238 to d 298). There were no differences in hot carcass weight (HCW), dressing percent backfat, KPH, LMA, LMA/ 100 lb HCW, yield grade, or marbling score between treatments (Table 23).

Economic analysis

Partial economics are reported in Table 13. The 105dCF calves had greater creep feed costs and greater weaned calf value. However, there were no differences in final carcass value.

Conclusions

In conclusion, as alternative housing systems become more common, research investigating the best management practices within these systems is warranted. Creep feed duration in a drylot system did not impact cow performance. Long-term creep feeding increased creep feeding cost as well as improved calf BW prior to weaning. However, short-term creep calves had reduced feed costs and compensated for previous restriction in the receiving period and early finishing phase. Ultimately creep feeding for 15 weeks improved calf weaning weights while creep feeding for 3 weeks effectively reduced feed costs without jeopardizing subsequent performance and carcass value.

Tables and figures

Table 1. Nutrient composition of the creep feed.

Item	Creep[1]
Analyzed nutrient content, %	
Dry matter	91.0
Organic matter	93.3
Neutral detergent fiber	39.0
Acid detergent fiber	24.0
Ether extract	3.3
Crude protein	14.8

[1]Creep feed was fed ad libitum for either 105 d or 21 d prior to weaning

Table 2. The TMR1 ration composition and proximate analysis on a dry matter basis.

Item	TMR 1	TMR 2	TMR 3[2]
Ingredient, lb			
Corn silage	7.26	-	-
Ground hay	2.42	4.18	3.52
DDGS[3]	6.82	6.82	5.94
Soybean hulls	5.5	5.5	4.84
Ground corn stalks	2.42	4.18	3.52
Dry rolled corn	2.42	5.94	4.4
Supplement[4]	0.88	0.88	0.88
Total limit-fed amount lb/d:	27.72	27.5	23.1
Number of weeks fed[5]	2	4	9
Analyzed nutrient content, %			
Dry matter	66.9	87.3	87.1
Organic matter	94.6	94.3	94.7
Neutral detergent fiber	47.2	48.6	49.2
Acid detergent fiber	26.7	28.1	28.9
Ether extract	4.6	4.4	4.8
Crude protein	13.4	12.7	14.0

[1] TMR 1, 2, and 3 were fed to cows on both 105dCF and 21dCF

[2] TMR 3 was being fed during the d 76 ex vivo

[3] Dried distillers grains with solubles

[4] Supplement contained 75% ground corn, 25% mineral premix (24% Ca, 18% Na, 8800 mg/lb Zn, 4400 mg/lb Cu, 59 mg/lb Se, 400,400 IU/lb Vitamin A, 40,000 IU/lb Vitamin D, and 400 IU/lb Vitamin E, and 385 g monensin/lb (Rumensin 90; Elanco Animal Health, Greenfield, IN)

[5] There were differences in the number of weeks diets were fed due to ingredient availability and stage of production

Table 3. Ingredient and nutrient composition and proximate analysis on a dry matter basis of the calf receiving ration.

Item	Receiving[1]	Growing[2]
Ingredient, %		
Corn silage	21	50
Dry Corn	15	15
Grass hay	35	-
MWDGS[3]	19	25
Supplement[4]	10	10
Analyzed nutrient content, %		
Dry matter	59.3	43.1
Organic matter	93.7	95.0
Neutral detergent fiber	39.1	29.3
Acid detergent fiber	20.5	15.3
Ether extract	5.5	6.9
Crude protein	15.3	15.9

[1] The receiving diet was fed ab libitum and hay was stepped down over 10 days.

[2] Calves remained on the growing diet for the remainder of the 42-d receiving phase.

[3] Modified wet distiller grains

[4] Supplement contained 83.7% ground corn, 8.4% limestone, 6.0% urea, 0.90% trace mineral salt (trace mineral salt = 8.5% Ca as $CaCO_3$, 5% Mg as MgO and $MgSO_4$, 7.5% K as KCl_2, 6.7% Cl as KCl_2 10% S as S8 [prilled], 0.5% Cu as $CuSO_4$ and Availa-4 [Zinpro Performance Minerals; Zinpro Corp, Eden Prairie, MN], 2% Fe as $FeSO_4$, 3% Mn as $MnSO_4$ and Availa-4, 3% Zn as $ZnSO_4$ and Availa-4, 612 mg/lb Co as Availa-4, 550 mg/lb I as $Ca(IO_3)2$, 330 Se mg/lb Na_2SeO_3, 4851 KIU/lb vitamin A as retinyl acetate, 3208 KIU/lb vitamin D as cholecalciferol, 48,505 IU/lb vitamin E as dl-α-tocopheryl acetate, and less than 1% CP, fat, crude fiber, and salt, 0.155% Rumensin 90 (435.6 g monensin/lb; Elanco Animal Health, Greenfield, IN), 0.1% Tylosin 40 (193.6 g tylan/lb; Elanco Animal Health, Greenfield, IN), and 0.75% soybean oil

Table 4. Ingredient and nutrient composition and proximate analysis on a dry matter basis of the steer finishing ration.

Item	Finishing 1[1]	Finishing 2[2]
Ingredient, %		
Corn silage	20	27
Dry Corn	25	22
HMC	20	18
MWDGS[3]	25	23
Supplement[4,5]	10	10
Analyzed nutrient content, %		
Dry matter	52.1	48.8
Organic matter	90.9	95.7
Neutral detergent fiber	20.2	22.4
Acid detergent fiber	8.6	10.0
Ether extract	4.5	4.5
Crude protein	16.1	15.9

[1] Finishing diet 1 was fed from d 148 – 237

[2] Finishing diet 2 was fed in GrowSafe (Vytelle, Lenexa, KS) from d 238 – 299 for the feed efficiency and DMI evaluation. Individual steer intake was recorded during this time.

[3] Modified wet distillers grains

[4] Supplement contained 83.7% ground corn, 8.4% limestone, 6.0% urea, 0.90% trace mineral salt (trace mineral salt = 8.5% Ca as $CaCO_3$, 5% Mg as MgO and $MgSO_4$, 7.5% K as KCl_2, 6.7% Cl as KCl_2 10% S as S_8 [prilled], 0.5% Cu as $CuSO_4$ and Availa-4 [Zinpro Performance Minerals; Zinpro Corp, Eden Prairie, MN], 2% Fe as $FeSO_4$, 3% Mn as $MnSO_4$ and Availa-4, 3% Zn as $ZnSO_4$ and Availa-4, 278 mg/kg Co as Availa-4, 250 mg/kg I as $Ca(IO_3)_2$, 150 Se mg/kg Na_2SeO_3, 2,205 KIU/kg vitamin A as retinyl acetate, 662.5 KIU/kg vitamin D as cholecalciferol, 22,047.5 IU/kg vitamin E as dl-α-tocopheryl acetate, and less than 1% CP, fat, crude fiber, and salt), 0.155% Rumensin 90 (198 g monensin/kg; Elanco Animal Health, Greenfield, IN), 0.1% Tylosin 40 (88 g tylan/kg; Elanco Animal Health, Greenfield, IN), and 0.75% soybean oil

[5] Supplement contained Optaflexx (Elanco, Indianapolis, IN) for the final 29 d which was mixed into the supplement at 0.625% inclusion

Table 5. The effect of creep feed duration on cow BW and BCS.

	Treatment[1]			
Item	105dCF	21dCF	SEM[2]	*P*-value
BW, lb				
d 0	1503	1555	33.88	0.18
d 42	1465	1467	6.6	0.81
d 84	1474	1483	7.04	0.27
d 105	1469	1476	6.6	0.49
BCS[3]				
d 0	6.2	6.3	0.17	0.68
d 42	6.1	6.1	0.12	0.80
d 84	6.1	5.9	0.14	0.20
d 105	6.2	6.1	0.16	0.64

[1] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning

[2] SEM: Standard error of means

[3] BCS: Body condition score

Table 6. The effect of creep feed duration on cow milk production, milk composition, and overall pregnancy rate.

	Treatment[1]			
Item	**105dCF**	**21dCF**	**SEM**[2]	***P*-value**
Milk production[3], lb/d	17.16	15.4	1.72	0.34
Milk composition[4]				
Fat %	2.7	2.4	0.70	0.75
Protein %	2.9	3.0	0.11	0.62
MUN, mg/dL[5]	7.6	6.2	1.12	0.31
Reproduction[6]				
AI conception	75	75	-	1.00
Overall pregnancy	91.7	97.2	-	0.51

[1] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[2] SEM: Standard error of means
[3] Determined by a weigh-suckle-weigh at 159 ± 14 d postpartum
[4] Milk composition samples were collected on a subset of cows via hand stripping (n=24; 2 cows per pen)
[5] MUN: Milk urea nitrogen
[6] Artifical insemination and overall pregnancy rates were determined on d 42 and d 96, respectively. Trained technicians utilized an ultrasonography [Aloka 500 instrument (Wallingford, CT); 7.5 MHz general purpose transducer array] to determine pregnancy

Table 7. The effect of creep feed duration on calf body weight (BW) and average daily gain (ADG) during the pre-weaning period.

	Treatment[1]			
Item	**105dCF**	**21dCF**	**SEM**[2]	***P*-value**
BW, lb				
d 0	308	299	5.7	0.17
d 42	425	394	5.1	< 0.01
d 84	572	495	7.7	< 0.01
d 105	629	568	7.5	< 0.01
ADG[3], lb/d				
d 0-42	3.26	2.53	0.110	< 0.01
d 42-84	3.48	2.38	0.103	< 0.01
d 84-105	2.75	3.48	0.200	0.02
d 0-105	3.23	2.66	0.066	< 0.01
Supplemental gain[4]	0.16	-	-	-

[1] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[2] SEM: Standard error of means
[3] ADG: Average daily gain.
[4] Supplemental gain was calculated for the first 84 d of the experiment by subtracting the difference in ADG between the 105dCF and 21dCF and dividing by the average intake for the 84-d period.

Table 8. The effect of creep feed duration on creep feed[1] intake during the pre-weaning phase.

Item	Treatment[2]		SEM[3]	*P*-value
	105dCF	21dCF		
DMI, lb				
Week				
1	1.1	-	-	-
2	2.0	-	-	-
3	3.1	-	-	-
4	3.3	-	-	-
5	3.3	-	-	-
6	5.5	-	-	-
7	6.2	-	-	-
8	5.7	-	-	-
9	6.6	-	-	-
10	7.9	-	-	-
11	6.8	-	-	-
12	7.7	-	-	-
13	7.5	5.1	0.42	0.01
14	8.4	7.3	0.59	0.24
15	9.7	9.0	0.33	0.39

[1] Calves were fed 14% CP commercial, pelleted creep
[2] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[3] SEM: Standard error of means

Table 9. The effect of creep feed duration on body composition prior to weaning.

Item	Treatment[1]		SEM[2]	*P*-value
	105dCF	21dCF		
Ultrasound data[3]				
LMA, square in	8.7	7.8	0.54	0.01
LMA, square in/100 lb	1.3	1.3	0.18	0.82
12th Rib fat, in	0.23	0.12	0.018	0.01
Rump fat, in	0.19	0.09	0.016	0.01
IMF, %	3.1	2.8	0.16	0.20

[1] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[2] SEM: Standard error of means
[3] An EVO II E.I. Medical Imaging machine (E.I. Medical Imaging, Loveland, CO) was used to collect ultrasound measurements on d 104 at 187 ± 14 d of age

Table 10. The effect of creep feed duration on calf body weight (BW), average daily gain (ADG), dry matter intake (DMI) and gain:feed (G:F) during the receiving period[1].

	Treatment[2]			
Item	**105dCF**	**21dCF**	**SEM[3]**	***P*-value**
BW, lb				
d 105	627	570	5.7	< 0.01
d 119	660	601	5.1	< 0.01
d 133	717	656	6.8	< 0.01
d 147	750	713	6.6	< 0.01
ADG, lb/d				
d 105-119	2.29	2.16	0.253	0.73
d 119-133	4.03	4.09	0.416	0.92
d 133-147	2.05	3.56	0.354	0.02
d 105-147	2.90	3.39	0.106	0.01
DMI, lb/d				
d 105-119	10.3	9.9	0.51	0.62
d 119-133	13.2	13.4	0.48	0.77
d 133-147	16.9	18.3	0.70	0.23
d 105-147	13.4	13.9	0.51	0.62
G:F				
d 105-119	0.10	0.10	0.012	0.86
d 119-133	0.14	0.14	0.014	1.00
d 133-147	0.06	0.09	0.009	0.03
d 105-147	0.13	0.16	0.009	0.08

[1] Receiving period performance was determined on all calves (steers and heifers)
[2] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[3] SEM: Standard error of means

Table 11. The effect of creep feed duration on calf body weight (BW), average daily gain (ADG), dry matter intake (DMI) and gain:feed (G:F) during the finishing period.

	Treatment			
Item	**105dCF**	**21dCF**	**SEM**	***P*-value**
BW, lb				
d 148	785	725	12.6	< 0.01
d 238	1188	1164	17.9	0.35
d 299	1407	1376	23.4	0.38
ADG, lb/d				
d 148-238	4.45	4.81	0.112	0.04
d 238-299	3.99	3.92	0.322	0.87
d 148-299	4.12	4.30	0.108	0.22
DMI, lb/d				
d 238-298	22.3	22.5	1.21	0.93
G:F				
d 238-298	0.17	0.17	0.009	0.93

Table 12. The effect of creep feed duration on steer carcass traits.

	Treatment			
Item	**105dCF**	**21dCF**	**SEM**	***P*-value**
Yield				
HCW, lb	849	849	20.9	0.95
Dressing, %	62.5	64.2	1.2	0.36
Backfat, in	0.52	0.49	0.038	0.64
KPH, %	1.6	1.8	0.11	0.12
LMA, in^2	13.1	14.6	0.556	0.30
LMA, in^2/100 lb	1.6	1.7	0.07	0.32
Yield Grade	3.0	2.9	0.16	0.68
Marbling Score	446	460	21.3	0.65

Table 13. The effect of creep feed duration on weaned calf and final carcass value economics[1].

	Treatment[2]			
Item	**105dCF**	**21dCF**	**SEM[3]**	***P*-value**
Creep feed costs[4], $/calf	135.94	32.59	2.546	< 0.01
Weaned calf value, $/calf	1054.66	1011.87	9.145	0.01
Final carcass value, $/carcass	1643.84	1663.27	57.50	0.74

[1] Economics were determined with 3-year averages.
[2] Calves were fed creep in a drylot for either 105 d (105dCF) or 21 d (21dCF) prior to weaning
[3] SEM: Standard error of means
[4] Creep feed costs includes labor ($0.15/calf/d) and bunk ($0.09/calf/d) costs

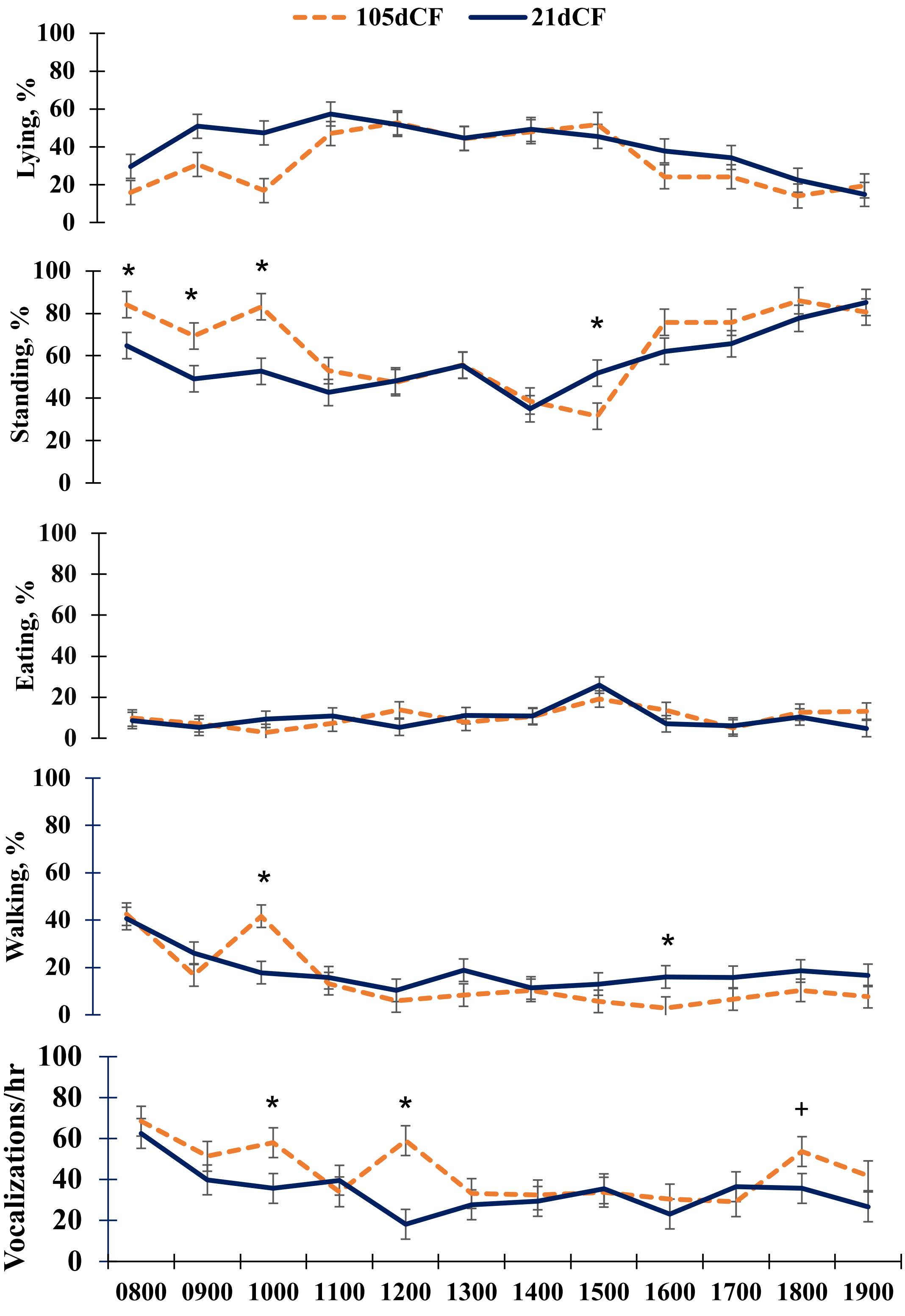

Figure 1. The effects of creep feed duration on calf behavior after weaning and shipping to feedlot (d 106). Calves were fed creep in a drylot for 105 d (105dCF) or 21 d (21dCF) prior to weaning. Significance of hour slice *P*-values are represented as: $P \leq 0.05$ defined by *, and tendencies from $0.05 < P \leq 0.10$ are defined as +. Vertical bars represent the SEM. For eating data, behavior means and SEM were back-transformed for ease of interpretation. There was treatment × time effects ($P \leq 0.03$) detected for standing, walking, and vocalizations. There tended ($P = 0.08$) to be a treatment × time effect for lying. There was a treatment effect detected ($P \leq 0.02$) for lying, standing, and vocalizing and tended ($P = 0.10$) to be a treatment effect for walking, but no treatment effects ($P = 0.43$) for eating. There was a time effect detected ($P \leq 0.03$) for each behavior.

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Feedlot biosecurity

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Biosecurity programs are implemented to reduce the transmission of pathogens between and within farms. Generally, biosecurity resources have been focused on high risk events such as a foreign animal disease outbreaks which for most Midwest feedlots are high impact but low risk events. Since feedlots are not as enclosed and population as stable as most swine and poultry operations the application of biosecurity measures has not been widely adopted. However, many biosecurity measures can be beneficial in improving the health management of feedlot cattle and personnel on a day to day basis.

The first step is to identify the goal of your biosecurity program. Work with your veterinarian and other professionals to make sure that your goal is realistic and then develop the steps to reach those goals. For example, a goal to prevent the introduction of respiratory disease is probably not attainable and will frustrate everybody trying to implement it. Once the goal is set and plan developed we then need a commitment from everyone to implement it. Making exceptions will communicate that the measures are not really that important and then breakdowns will occur.

One of the first steps for any biosecurity program is to control access to your operation. Limiting access and dictating what visitors are allowed to do establishes the ground rules for everybody. Visitor logs allow you to know exactly who was on your farm, what the purpose of visit was and what contact they had with livestock. Everyone including employees should utilize farm specific clothes and boots to prevent the introduction of pathogens and prevent them from spreading pathogens off of your farm. Many employees may have livestock or children at home that could be at risk to many pathogens that are commonly found on feedyards.

A common step in biosecurity programs is quarantine or isolation of new animals. For feedlots this practice can be modified to fit standard management practices. General recommendations such as a 60 days quarantine at least 500 yards from existing animals is not practical in feedyards. However, utilizing receiving pens can be easy adaptation to have some initial separation from other cattle while health status is confirmed. Thirty days in receiving pens that are not next to other cattle is a good management tool. If receiving pens are close to processing facility it can facilitate getting cattle vaccinated and treated during this early high risk period. This separation can reduce the spread of new viral infections to existing cattle especially if people do not go from checking cattle in receiving pen and then immediately enter other pens.

When checking pens for sick cattle you should move from low risk pens to higher risk pens or have separate people checking low risk pens then high-risk pens. If have to check high-risk pens first implement some form of sanitation before proceeding to low risk pens. Since wildlife such as rodents, starlings, raccoons, etc. can help spread pathogens some form of pest control is also important.

Sanitation can also be an important mitigation strategy to limit spread of pathogens around the farm. All medical equipment (syringes, implant guns, balling guns, stomach tubes) should be cleaned after every use to prevent spreading pathogens. Blood borne diseases such as Anaplasmosis can be spread by vaccine needles and enteric diseases such as Salmonella can be spread by stomach tubes etc. Personnel should clean their boots after treating cattle in the hospital area before going back out onto the feedyard. Tractors and loaders should be cleaned after handling manure or dead stock before they are used for other purposes on the farm. Finally, manure should be scraped out of pens regularly and all mortalities should be removed promptly.

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Heifer development: A genetic perspective

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Reproduction has the most significant economic impact on a cow-calf operation, and when replacement females are retained, heifers' efficiency and reproductive success are critical. The ability of a heifer to become pregnant, calve, and rebreed by two years of age has long-term implications for the economic viability of an operation. Development costs of heifers are a significant investment for an operation where the return on investment is only realized through her calves. A heifer who fails to calve as a two-year-old results in an economic loss for the operation. In contrast, heifers who conceive earlier in the breeding season have been shown to have greater lifetime productivity (Lesmeister et al., 1973). A heifer's age at puberty is critical for reproductive success, and failure for heifers to reach puberty during a breeding season will result in reproductive failure (Whittier et al., 2008). Therefore, producers should strive to manage heifers to reach puberty as early as possible and calve before two years of age (Cammack et al., 2009). A heifer is 12 months or older before a pregnancy observation can be recorded, delaying the culling of reproductively inferior animals. This delay in the culling of heifers who fail to breed in their first breeding season is an economic loss to a cow-calf operation (Jones et al., 2018). The identification of heifers with a higher probability of conceiving during their first calving season can have significant economic impacts on a cow-calf operation.

Genetic prediction can identify animals with a greater probability of reproductive success and lifetime productivity. Scrotal circumference was one of the first expected progeny differences (EPD) for heifer reproduction. Brinks et al. (1978) reported a negative but strong genetic correlation between scrotal circumference and age at puberty of -0.71. Through indirect selection for increased scrotal circumference, age at puberty was decreased in heifer daughters. However, the age of puberty is not the same trait as heifer pregnancy, and although it is significant to the reproductive success of a heifer, the heifer must still get pregnant. Today, many breed associations publish EPD for reproductive traits such as heifer pregnancy and cow longevity for selection on improved reproductive efficiency, allowing for direct selection for the economically relevant trait of a pregnant heifer.

Genotyping and DNA testing have become commonplace since testing has become more affordable. Incorporating DNA data into genetic evaluations for genomic-enhanced EPD (GE-EPD) increases the accuracy of the selection of animals at younger ages. This has been especially useful for traits such as heifer pregnancy that are measured later in life and have an average lower accuracy than higher reported traits such as weight traits. The advancement of genomic testing for crossbred cattle has resulted in the development of genetic testing for commercial herds. Today, commercial herds can receive results of their heifers at or before weaning for the probability of them becoming pregnant as yearlings. The early identification of reproductively inferior heifers allows producers to make culling decisions earlier and avoid the cost of developing heifers who fail to breed. The decision of what tool to use will depend on individual operation and will dictate the rate of genetic improvement.

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Fuel for the journey: Overcoming transit stress in feedlot cattle

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The interconnected yet segmented structure of the beef industry requires the transportation of cattle, a necessity that arises from the dispersed locations of various segments. The cow-calf and stocker/backgrounding sectors are spread across the U.S. to capitalize on diverse grazing opportunities. Feedlots are situated where climatic conditions favor cattle feeding or where grain and grain byproduct resources are abundant. This geographic distribution requires cattle to undergo multiple trucking events throughout their lifecycle: from the birthplace to an auction market, then to a stocker/backgrounding operation, followed by transport to a feedlot, and ultimately concluding with the transportation to a processing facility.

The prolonged periods of standing, vibrations of the trailer, and deprivation of food and water during transit contribute to muscle fatigue and oxidative stress. This requires a subsequent recovery period, which if not effectively managed, can compromise the animal's performance and welfare upon entering the feedlot. Consequently, there is a critical need for management strategies aimed at minimizing performance losses and enhancing overall welfare. Zinc and Vitamin C emerge as promising avenues in addressing these challenges, presenting encouraging results in mitigating the impact of transportation stress on cattle.

Zn and muscle fatigue

During long-haul transportation, where cattle are loaded at densities to prevent fall events and limit their ability to lie down, cattle experience prolonged periods of standing coupled with the vibration of the trailer and food/water deprivation. This combination can lead to muscle fatigue post-transit (Knowles et al., 1999; Gebresenbet et al., 2011). Muscle fatigue arises from changes in energy metabolism, driven by increased muscle energy requirements during extended periods of use.

Lactate, a common biomarker for muscle fatigue, is produced through anaerobic ATP production and glucose metabolism (Van Hall, 2010). Notably, lactate dehydrogenase, a crucial enzyme in the Cori Cycle responsible for converting pyruvate to lactate and vice versa, is Zn-dependent (Price, 1962). Lactate dehydrogenase plays a critical role in sustaining energy production to meet the muscle's energy demands during exercise (Sharma et al., 2019; Strachecka et al., 2019). Additionally, Zn enhances immune function, appetite, and growth performance, factors that can be adversely affected by transit stress.

In a study conducted by Heiderscheit and Hansen (2022), cattle supplemented with up to 120 mg of Zn/Kg DM demonstrated increased average daily gain post-transit compared to the non-Zn supplemented control group . Furthermore, the Zn-supplemented cattle exhibited a faster recover of pre-transit dry matter intake. Notably, the control group displayed greater muscle glucose and serum lactate post-transit compared to the Zn-treated group, suggesting a potentially higher demand for energy substrates in the muscle due to greater muscle fatigue. It is also notable that the Zn in the control diet was 54 mg/kg DM, already nearly two times the NASEM (2016) recommendation, and benefits of Zn supplementation were still noted. This study suggests that optimizing Zn status by supplementing Zn could serve as a practical approach to enhance overall animal welfare and mitigate transit-induced muscle fatigue.

Vitamin C and oxidative stress

The stressors associated with transportation elevate biomarkers of inflammation (Marques et al., 2012). Inflammatory pathways activated by transportation stress can induce the production of reactive oxygen species (ROS). When ROS and other prooxidants overwhelm cellular antioxidant capacity, oxidative stress ensues. Failure to manage ROS can lead to damage in cellular components such as lipids, nucleic acids, and proteins, posing detrimental implications for animal efficiency and health. Despite the natural antioxidant defense systems in cattle, transportation has been shown to depress antioxidant status, resulting in oxidative damage—an energetically costly process that heightens the risk of feedlot morbidity and overall diminished performance (Chirase et al., 2004; Cooke, 2017).

Vitamin C (Vit C), or ascorbate, serves as a primary water-soluble antioxidant and enzyme cofactor present in plasma and tissues (Combs, 2008). Cattle can synthesize Vit C from glucose in the liver, so although there is no recommendation for supplementation, stress events such as transportation can lead to decreased circulating and tissue concentrations of Vit C (Nakano and Suzuki, 1984; Padilla et al., 2006). This implies cattle may struggle to meet their Vit C requirements during stress periods like long-distance transit events. Due to its water-soluble nature, Vit C is rapidly excreted from the body, emphasizing the crucial importance of timing in its administration for effectiveness.

In a study by Deters and Hansen investigating pre- or post-transit administration of Vit C, it was found that pre-transit vitamin C injections minimized the transit-induced decline in plasma ascorbate concentrations. Additionally, there was an overall improvement in post-transit feedlot performance. Another study by Beenken, Deters, and Hansen explored how transport duration (8 hours or 18 hours) would impact oxidative stress and overall cattle performance given injectable Vit C pre-truck. While overall performance in this study was not as greatly affected by the injectable Vit C as in the previous study, there was a notable increase in plasma ascorbate on day 1 (post-transit) for the treatment group that received a Vit C than the control group. Also, serum lactate was markedly greater in cattle trucked for 18 hours vs. 8 hours, supporting the assertion that muscle fatigue increases with increasing transit duration.

Challenges and future direction

Transportation stress is an inherent challenge within the beef industry, subjecting cattle to unavoidable conditions such as feed and water deprivation, prolonged standing, and the vibrational effects of the trailer. These stressors, particularly prevalent in long-haul scenarios, contribute to the development of muscle fatigue and oxidative stress, diminishing overall performance. Mitigation strategies include promising interventions like Zn and Vit C.

Zinc supplementation shows potential in improving gain and feed intake recovery, along with reducing muscle fatigue post-transit. However, optimizing Zn application requires further research into optimal timing and duration of Zn supplementation to maximize its effectiveness.

Vitamin C, with its antioxidant properties, shows promising impacts on oxidative stress. Pre-transit administration has been shown to maintain plasma ascorbate and improve overall feedlot performance. The intricacies of its effect, particularly in long-haul transportation, needs further research to understand the physiological changes post-transit.

Addressing the challenges posed by transportation stress is crucial for improving the well-being and performance of cattle in the beef industry. Zinc and Vit C supplementation offer viable strategies for mitigating the adverse effects of transportation stress namely muscle fatigue and oxidative stress. As the industry seeks sustainable and ethical practices, continued research and exploration of innovative solutions is needed to optimize these strategies.

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