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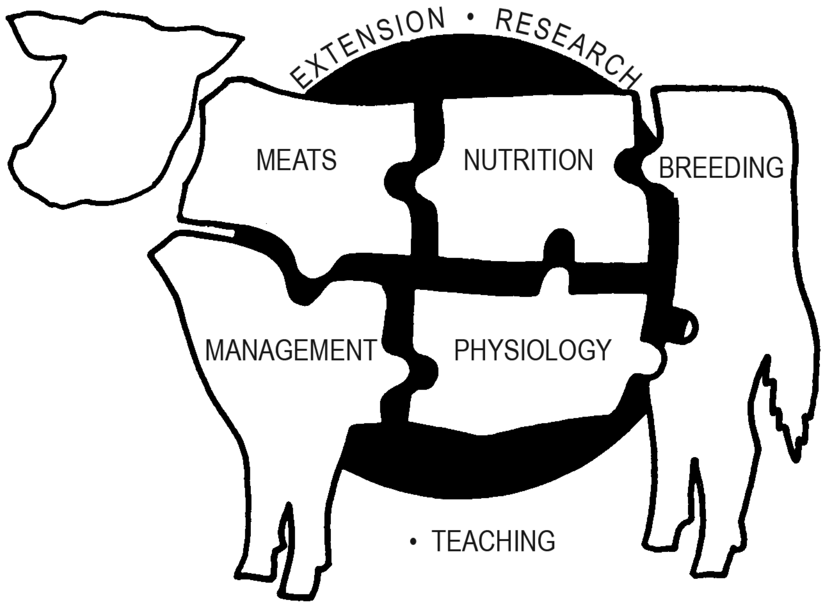

Agricultural Research Division
University of Nebraska Extension
Institute of Agriculture and Natural Resources
University of Nebraska–Lincoln

2025 Beef Cattle Report

University of Nebraska Lincoln

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Artificial Insemination of Beef Heifers with Multi-Sire Semen

Dempster M. Christenson
Jordan M. Thomas
Daniel J. Kelly
Rick N. Funston

Summary with Implications

This study compared pregnancy rates of beef heifers artificially inseminated with multi-sire semen to single-sire semen. It was hypothesized pregnancy rates resulting from multi-sire semen would be increased compared to single-sire semen. Heifers were artificially inseminated with semen from one of three single-sires or semen from a combination of the same three sires. Pregnancy rates did not significantly differ. Paternity testing suggests sire parentage can be unequal when semen is mixed from multiple sires. In summary, producers can expect similar pregnancy rates using single-sire and multi-sire semen, but progeny may have unequal sire representation.

Introduction

Multi-sire (aka. heterospermic or sperm pack) semen is rarely used for artificial insemination (**AI**) when assignment of paternity is important, and the value of genotyping is low. However, previous studies reported pregnancy success increased 11–13 percentage points in heifers inseminated with multi-sire semen compared to single-sire AI. This increase is believed to be the result of interactions between compounds in seminal plasma and sperm from different sires and natural differences in optimal viability of sperm between sires, which may optimize matching of peak sperm and ovum viability, improving conception rates.

A breeding soundness exam is normally used to screen for poor quality semen but fails to identify differences between good quality semen samples that further bolster pregnancy rates to AI. Producers choosing a sire from an AI catalog thus are not able to choose the most prolific sire. Considering the economic importance of generating pregnancies early in the breeding season, producers would likely consider the use of mixed sperm from multiple sires if this would result in greater pregnancy response to AI. The objective of this study was to compare pregnancy rates of beef heifers artificially inseminated with semen from three sires in a single straw to single-sire semen.

Procedure

A ranch North of Sutherland, NE utilized 441 (762 ± 64 lb) and 398 (737 ± 57 lb) Angus crossbred spring calving beef heifers in 2022 and 2023, respectively. Estrus was synchronized with the melengestrol acetate—prostaglandin $F_{2\alpha}$ timed-AI protocol (Figure 1). Melengestrol acetate (**MGA**; 0.5 mg/heifer per day) was mixed into the total ration provided in drylot for fourteen days and then withdrawn. Nineteen days later, 2 ml prostaglandin $F_{2\alpha}$ (**PG**; Lutalyse HighCon, Zoetis, Parsippany-Troy Hills, NJ) was administered, body weight was recorded, and estrus detection patches (Estrotect™) were applied to identify behavioral estrus before AI. Patch scores were recorded 72 hours after PG administration (1 = <25% removed, 2 = 25 to 50% removed, 3 = >50% removed) and the responses were compared by treatment. Patch scores less than three were recorded as not express-

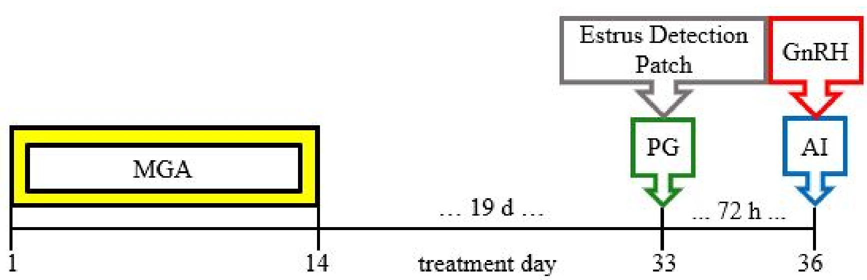

Figure 1. Melengestrol acetate—prostaglandin $F_{2\alpha}$ (PG) timed artificial insemination protocol used for synchronization of estrus in beef heifers. Melengestrol acetate is fed from Day 1 to 14 and PG is administered on Day 33 along with an aid to detect estrus. Heifers are inseminated on Day 36 and heifers not exhibiting estrus are administered gonadotropin releasing hormone. Beef Reproduction Task Force; BeefRepro.org.

ing estrus and were administered 2 ml gonadotropin releasing hormone (Factrel, Zoetis).

Three black Angus bulls were chosen for AI from the ABS Global (DeForest, WI) AI directory based on several criteria: non-relation to each other and the heifers, availability for simultaneous collection, ranch management choice, and consistent prior AI success as a sire owned by ABS Global. One collection was made from each bull (1, 2, 3) and allotted to either the single-sire treatments (**SS1, SS2, or SS3**; n = 135, 139, and 136, respectively) or the multi-sire (**MS**; n = 428) treatment, which contained a one third sample from each bull. ABS Global collected semen, diluted to a sperm concentration of 44 mil/ml, stored the sample in 0.5 ml semen straws, and froze them in liquid nitrogen for thawing on breeding day. A breeding soundness exam was performed on all three bulls, their individual semen, and the MS semen, which determined sperm morphology, motility, and survivability exceeded industry standards.

Treatments were administered 72 hours after PG administration in a repeating series of the three SS and MS treatments utilizing 10 semen straws for each SS and 30 straws for MS as heifers entered the chute. Unrelated bulls were introduced 7 days after AI and remained with the heifers for 29 days. Pregnancy rate to AI was determined by fetal aging performed by an experienced veterinarian using ultrasound 85 ± 4 days post AI. Body weight was also recorded at this time. After parturition, calves were genetically tested to determine sire paternity using an ear punch tissue sample (Quantum Genetix, Saskatoon, SK, Canada).

Data were analyzed using PROC GLIMMIX of SAS 9.4 (Cary, NC USA). Heifer was the experimental

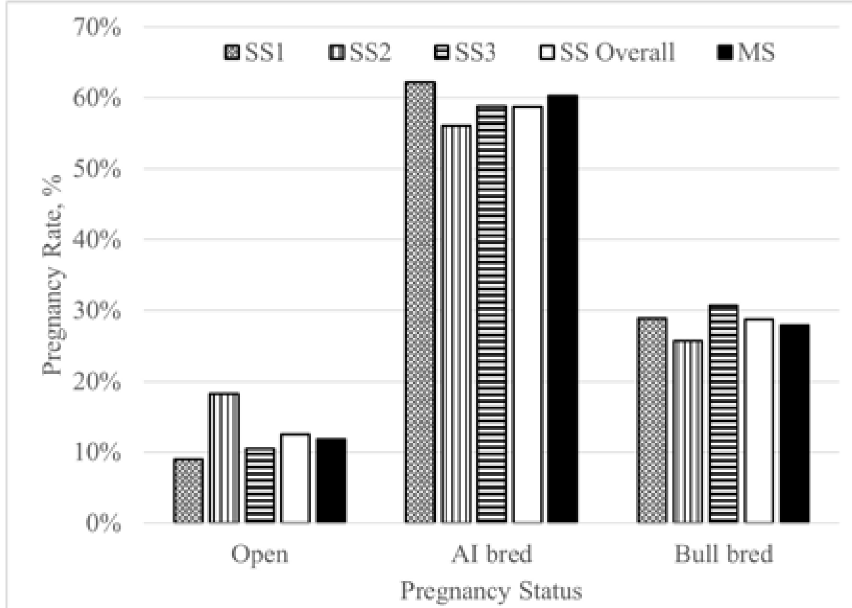

Figure 2. Pregnancy rate to artificial insemination of semen from three bulls, their average, and a combined semen sample by pregnancy status. One collection was made from each bull (1, 2, and 3) and allotted to the single sire treatments (SS1, SS2, or SS3) or combined to form the multi-sire (MS) treatment, which contained a one third sample from each bull, for artificial insemination of heifers.

unit. Pregnancy status and estrus response were analyzed as a response to each SS treatment, each SS treatment and the MS treatment, or the combined SS treatments and the MS treatment using contrast and estimate functions. Estrus response was included as a covariate due to its effect on pregnancy rate. Data were considered significant at $P \leq 0.05$ and a tendency if $P \leq 0.10$ and $P > 0.05$.

Results

Body weight at PG administration and pregnancy determination were not significantly different among treatments ($P \geq 0.60$). Average daily gain between these time points was not significantly among treatments ($P = 0.97$). The percentage of heifers detected in estrus did not significantly differ among treatments (SS1 = 72%, SS2 = 79%, SS3 = 77%, MS = 69%; $P = 0.10$), but were significantly different between the SS (76%) and MS groups ($P = 0.05$). Estrous expression significantly differed between heifers that became pregnant to AI and those that did not ($P < 0.01$). Due to the known influence of estrus expression on pregnancy rate, estrus response was included as a covariate effect of pregnancy rate. Pregnancy rate to AI was not significantly different among treatments (SS1 = 62%, SS2 = 56%, SS3 = 59%, MS = 60%; $P = 0.79$; Figure 2) and did not significantly differ between SS (59%) and MS treatments ($P = 0.66$). Contrasts between treatments pregnancy rate to AI was not significantly different ($P \geq 0.34$). Paternity was determined in 150 MS calves and confirmed in 142 SS calves. Within the random sample of the MS treatment population, Bull 1 sired 13%, Bull 2 sired 44%, and Bull 3 sired 43%. Bull 1 tended to be less successful than Bull 2 or 3 ($P = 0.06$ and $P = 0.06$, respectively). It is quite surprising to see such a disparity between the bulls given the pregnancy rate of each sire in the SS treatments were similar.

The final pregnancy rate after AI and natural breeding after the 36-day breeding season was 88% in both years. Although final pregnancy rate did not differ among treatments (SS1 = 91%, SS2 = 82%, SS3 = 90%, MS = 88%; P = 0.10), heifers randomly assigned to SS2 had significantly less final pregnancy rate than SS1 (P = 0.03) and tended to have less final pregnancy rate than SS3 (P = 0.07) and MS (P = 0.06). This suggests random assignment of treatment to heifers may have influenced final pregnancy rate by heifers assigned Bull 2, or Bull 2 may have influenced final pregnancy rate. Neither of these options are reflected by paternity rates within the MS treatment group.

Conclusions

Methods that increase pregnancy rate to AI in heifers increase the productivity of the herd by increasing the lifetime productivity of those heifers and their progeny while decreasing the costs associated with development of heifers who take more time and feed to produce a calf. A greater number of observations from this ongoing research may provide further insight on the effects of multi-sire treatment on heifers from multiple years. Current results indicate pregnancy rate to AI with MS and SS treatment is not significantly different, but the percentage of calves from each sire within the MS treatment tended to be. However, more research is required to solidify these conclusions and understand what unexplored interactions may be influencing these results.

Dempster M. Christenson, research technician and graduate student

Jordan M. Thomas, assistant professor, Animal Science (University of Missouri)

Daniel J. Kelly, producer, Sutherland, NE

Rick N. Funston, full professor, animal science, West Central Research and Extension Center, North Platte, NE

Impact of Overwinter Gain on Growth and Reproductive Performance in March-born Heifers

Josie N. Crouch
J. Travis Mulliniks
Jacki A. Musgrave
Kacie L. McCarthy

Summary with Implications

Heifers developed to lower rates of overwinter gain may reduce development costs without growth and reproduction impacted. A 3-yr study was conducted to evaluate different overwinter rates of gain on heifer growth rates, reproductive, and economic performance. Heifers were managed together and individually supplemented (January-May) with dried distillers grains to achieve either a low (0.75 lb/d) or high (1.50 lb/d) average daily gain. At breeding, high gain heifers were heavier than low gain heifers. Average daily gain and body condition score were similar between treatments. Overwinter treatment did not impact attainment of puberty, pregnancy rates, or the percentage that gave birth in the first 21-d. Net returns were $31.26 greater for low heifers compared to high heifers, suggesting that average daily gain will have a greater return after considering development costs. Results indicate developing heifers to a lower rate of gain may reduce input costs and provide flexibility determining an overwinter supplementation rate and overall rate of gain.

Introduction

Replacement heifers are the next generation in the cow herd, where future herd productivity can be affected by selection and management decisions. Heifers should conceive early in the breeding season, calve early in the calving season, and be bred to calve by the age of two. Producers have been encouraged to develop heifers at growth rates that promote attainment of puberty prior to breeding, since age at puberty is an important trait. However, challenges may arise to meet nutrient demands and gains when cattle are consuming low-quality forages. Previous research has shown that both overnutrition and undernutrition during the postweaning period can be detrimental to heifer performance and longevity. Some research has suggested that developing heifers at slower or restricted rates of gain during the postweaning period has a potential economic benefit, reducing feed costs, without negatively impacting heifer production or reproductive performance. Therefore, the objectives were to evaluate the impact of rate of overwinter gain on pre- and post-breeding growth rates, reproductive, and economic performance in March-born yearling heifers.

Procedure

Data were collected from March-born Red Angus x Simmental crossbred heifers (n = 182) at the University of Nebraska, Gudmundsen Sandhills Laboratory (GSL) from 2020 to 2022. Heifers were stratified by body weight (BW) averaged across 3 consecutive days collected in January and randomly assigned to one of two treatments. Heifers were fed dried distillers grains at two different rates to achieve either: 1) a low overwinter average daily gain (ADG) at 0.75 lb/d (LO, n = 106) or 2) a high overwinter ADG at 1.50 lb/d (HI, n = 76). Each year, heifers were managed together, and the dried distillers grain supplement was offered daily using a C-Lock Super SmartFeed supplement feeder. The C-Lock Super SmartFeed unit is a solar-powered, automated, precision feeder that stores data in a cloud-based interface to allow users to determine individual heifer supplement intake and the number of heifer visits to the feeder. Supplementation began in January and ended in May averaging 111-d. To achieve targeted gains, heifers were allotted supplement intakes at 2.2 lb for LO gain heifers and 4.4 lb for HI gain heifers. The actual average daily intake for LO gain heifers in years 1, 2, and 3 was 1.31 ± 0.11, 1.04 ± 0.13, and 1.38 ± 0.14 lb/d, respectively. Average daily intake for HI gain heifers was 2.93 ± 0.14, 2.15 ± 0.15, and 2.71 ± 0.14 lb/d in year 1, 2, and 3, respectively.

To determine the proportion of heifers that attained puberty prior to breeding, two blood samples were collected 10-d apart prior to breeding and serum was stored for progesterone analysis. A heifer was considered pubertal when serum progesterone

Table 1. Input prices used in the enterprise budget for developing heifers on two different rates of gain overwinter.

	Treatment	
Item	LO[1]	HI[2]
Heifer development supplement, $/heifer	34.34	72.01
Input prices, $/heifer		
Weaned heifer purchase price, lb	1.66	1.66
Nonpregnant heifer price, lb	4.39	4.39
Pregnant heifer price, heifer	1,816.12	1,816.12
Grazing fee, AUM[3]	36.42	36.42

[1]LO heifers were offered a dried distillers grain supplement to achieve 0.75 lb/day rate of gain.

[2]HI heifers were offered a dried distillers grain supplement to achieve 1.50 lb/day rate of gain.

[3]Grazing fee for North (Sandhills) sub-state region; AUM = animal unit month.

concentrations were greater than 1 ng/mL at both collection time points. Heifers were synchronized with a single intramuscular injection of prostaglandin F2α 5-d after bull placement (1:20 bull to heifer ratio) for a 30-d breeding season. Pregnancy status was diagnosed in October by an experienced veterinarian via a portable ultrasound machine approximately 100-d following bull removal, where open heifers were sold as cull heifers. Heifer BW was collected at the start of the trial (January), breeding (May), pregnancy diagnosis (October), and pre-calving (February). Heifer body condition score (BCS; 1 = emaciated, 9 = obese) was recorded at pregnancy diagnosis and pre-calving by a trained technician. The calving season was identified as the first day that three or more heifers gave birth and was used to determine the percentage of heifers that gave birth in the first 21-d of the calving season. Within 24 hours, all calves were tagged, weighed, and received a 7-way clostridial vaccine.

Hypothetical enterprise partial budgets were calculated to determine the economic returns generated when 100 heifers were developed in each development method using pregnancy rates and BW from the experiment. Because the experiment was a 3-year scenario, the budget is an average of the 3 years. All inputs used to generate the budget are listed in Table 1. Based on the Nebraska Farm Real Estate Market Highlights average lease price in the North region (Sandhills), a grazing fee of $36.42 per animal unit month (AUM) was assessed. The cost of supplementation included the delivery cost to GSL. The cost associated with purchasing a weaned heifer as a replacement, the revenue generated from selling nonpregnant heifers, and although pregnant heifers were retained, a value was assigned to pregnant heifers to determine input prices. Market values were sourced from the USDA market news for the specific region and year.

Data were analyzed using the PROC MIXED and PROC GLIMMIX procedures of SAS 9.4 (SAS, Cary, NC) as a completely randomized design with heifer as the experimental unit. The initial model included fixed effects of treatment and year, and covariate CDATE. The main effect of treatment, year, and the interaction between treatment and year were included in the model. Puberty status, pregnancy rate, and percent calving within first 21-d of the subsequent calving season were analyzed using a binomial distribution. All other response variables were considered normally distributed. Data are presented as LSMEANS, and significance was determined at $P < 0.05$ and tendencies were considered at $P > 0.05$ and $P \leq 0.10$.

Results

As expected, heifers fed at a higher rate, had a greater ($P < 0.01$; Table 2) ADG from January to breeding; however, ADG was similar ($P \geq 0.35$) from breeding to pre-calving. No treatment × year interaction was observed for heifer BW ($P \geq 0.78$) or BCS ($P \geq 0.17$). Heifer BW at breeding was heavier ($P < 0.01$) in HI heifers compared to LO heifers, where HI heifers weighed 813 lb and LO heifers weighed 788 lb, which reflects the differences observed in ADG. There were no differences ($P = 0.16$) in heifer BW between LO and HI treatments after breeding at pregnancy diagnosis, this response suggests compensatory gain occurred for LO heifers and reduced any BW differences. Additionally, treatment did not ($P = 0.57$) impact pre-calving BW, where heifers averaged 975 ± 8 lb between both treatment groups. Furthermore, there were no differences ($P \geq 0.12$) in heifer BCS at pregnancy diagnosis and pre-calving with heifers in adequate condition, averaging a BCS of 5.9.

No treatment effects ($P = 0.38$) were observed for the percent cycling prior to breeding between the LO (32%) and HI (39%) treatment groups. Although the percentage cycling prior to the breeding season was low, heifer pregnancy rates averaged 86% with no differences

Table 2. The effect of overwinter rate of gain on heifer growth and reproductive performance and calf performance.

Item	Treatment		SEM	*P*-value
	Lo[1]	Hi[2]		
Heifer BCS[3]				
Pregnancy diagnosis	6.0	6.0	0.02	0.16
Pre - calving	5.9	5.8	0.03	0.12
Heifer BW, lbs.				
Weaning[4]	535	534	5.51	0.84
On Trial[5]	550	552	4.25	0.74
Breeding[6]	788	813	7.13	< 0.01
Pregnancy diagnosis[7]	916	934	9.76	0.16
Pre-calving [8]	972	978	9.16	0.57
Heifer ADG, lbs				
January to Breeding	1.55	1.70	0.02	<0.01
Breeding to Pregnancy diagnosis	1.09	1.03	0.05	0.40
January to Pregnancy diagnosis	1.36	1.42	0.03	0.11
Pregnancy diagnosis to Pre-calving	0.39	0.32	0.05	0.35
Calf BW, lbs.				
Birth	59	60	1.00	0.70
Cycling, %[9]	32	39	-	0.38
Pregnancy rate, %	85	87	-	0.72
Calve first 21d, %[10]	88	88	-	0.86
Calving date, Julian date	70	68	1.20	0.48

[1]Lo heifers were offered a dried distillers grain supplement to achieve 0.75 lb/day rate of gain.

[2]Hi heifers were offered a dried distillers grain supplement to achieve 1.5 lb/day rate of gain.

[3]Body condition score (1 = emaciated to 9 = obese).

[4]Body weight collected at the time of weaning (weaning time ranges from October—December).

[5]Body weight collected in January after supplementation had started.

[6]Body weight collected during the breeding season in June.

[7]Body weight collected at pregnancy diagnosis in October.

[8]Body weight collected pre-calving in February.

[9]Percent of heifers that had progesterone values ≥ 1 ng/ml at both blood sample collections prior to the breeding season.

[10]Percent of heifers that calved within the first 21-days of the calving season (start of calving season was determined when three calves were born on the same day).

Table 3. Treatment × year interaction for subsequent calving date on March-born range heifers achieving different overwinter rates of gain.

Item	Year	Treatment		SEM	*P* - value
		LO[1]	HI[2]		
Subsequent calving date, Julian date	2020	$67^{a,c}$	$60^{b,c}$	3	0.01
	2021	69	72^{d}	3	0.22
	2022	73^{d}	73^{d}	3	0.91

[1]Lo heifers were offered a dried distillers grain supplement to achieve 0.75 lb/day rate of gain.

[2]Hi heifers were offered a dried distillers grain supplement to achieve 1.50 lb/day rate of gain.

[a,b] For each interaction, means in rows with different superscripts differ (P ≤ 0.05).

[c,d] For each interaction, means in columns with different superscripts differ (P ≤ 0.05).

(*P* = 0.72) between treatments. This agrees with previous research that found postweaning ADG before breeding minimally impacted heifer pregnancy rates (*2008 Nebraska Beef Cattle Report*, pp. 5–7; *2010 Nebraska Beef Cattle Report*, pp. 8–10). Furthermore, the percentage that gave birth in the first 21-d were similar, averaging 88% (*P* = 0.86). Calf BW at birth averaged 60 lb with no differences between treatments (*P* = 0.70). A treatment × year interaction (*P* = 0.03, Table 3) was observed for calving date. In Year 1, HI heifers gave birth 7-d earlier (*P* = 0.01) than LO heifers. In Years 2 and 3, calving date was similar (*P* ≥ 0.22) between overwinter treatments. At the start of the supplementation period (January), in Year 1, heifers were consuming forage that was lower in crude protein (CP = 4.4) and lower total digestible nutrients (TDN = 53.6), indicating poor nutritional quality. This suggests supplementation may be beneficial to offset protein and energy deficits, aiding to meet nutritional needs. During this time, by design, HI gain heifers were consuming more supplement, ultimately receiving greater proportion of protein and energy from the dried distillers grain. Although there was no interaction, in Year 1, HI heifers had a 14% increase in the proportion of heifers that attained puberty prior to breeding, which may have improved fertility and allowed heifers in Year 1 to become pregnant earlier.

Enterprise budget for cost and net return of developing heifers at two different overwinter rates of gain are presented in Table 4. When evaluating the economics of this study, producers should acknowledge the cattle market prices and cost of supplementation delivery were specific to the location of the study and may vary geographically. Net returns were

Table 4. Enterprise budget for cost and net return of developing heifers at two different overwinter rates of gain.

	Treatment	
Item	LO[1]	HI[2]
Gross return, $		
Nonpregnant heifers price	23,359.00	26,628.55
Pregnant heifers price	154,370.20	158,002.44
Total	177,729.20	178,246.91
Cost, $		
Heifer purchase cost at weaning	40,291.79	40,169.20
Heifer development cost		
Grazing[3]	13,474.17	13,474.17
Supplement	3,434.33	7,200.67
Total	57,200.29	60,844.03
Net returns, $	120,528.91	117,402.88
Net returns, $/heifer developed	1,205.29	1,174.03

[1]LO heifers were offered a dried distillers grain supplement to achieve 0.75 lb/day rate of gain.

[2]HI heifers were offered a dried distillers grain supplement to achieve 1.50 lb//day rate of gain.

[3]Grazing fee for North (Sandhills) sub-state region.

$31.26 greater per heifer in LO compared to HI treatments. This suggests there is an opportunity to lower input costs by reducing the amount of total supplementation when developing replacement heifers during the post-weaning period, without detrimental impacts to performance.

Conclusion

From this study, it can be concluded that heifers developed to a lower rate of gain were lighter at breeding; however, low gain heifers experienced compensatory gain that resulted in no differences in BCS or BW after breeding. Additionally, supplementing heifers targeted at two overwinter rates of gain did not influence the percentage that attained puberty, were pregnant, or gave birth in the first 21-d of the calving season. Because there was no difference in reproductive performance, developing heifers at a lower rate of gain may provide an economic advantage with a greater net return when compared to higher development rates. Since BCS, BW at pregnancy diagnosis and pre-calving, and reproductive performance were similar between overwinter treatments, there is an economic advantage to developing heifers to a lower rate of gain. This study implies that producers may have flexibility when determining overwinter supplementation rates and overall rate of gain.

Josie N. Crouch, Graduate Student

J. Travis Mulliniks, previous Associate Professor, Animal Science, University of Nebraska- Lincoln West Central Research and Extension Center, North Platte, NE

Jacki A. Musgrave, Research Technician

Kacie L. McCarthy, Assistant Professor, Animal Science, University of Nebraska- Lincoln, Lincoln, NE

Impact of Pre- and Post-breeding Supplementation on Performance of May-born heifers

Josie N. Crouch
J. Travis. Mulliniks
Jacki A. Musgrave
Kacie L. McCarthy

Summary with Implications

This 3-year study compared growth, reproductive performance, and economics of May-born yearling heifers that either received 2.00 lb/ heifer/ per d of a dried distillers grain supplement from pre-breeding (July) through breeding (August) or no supplement. Supplementation was offered approximately 24 days before breeding, averaging 55 days total. Heifer body weight was unaffected by supplementation. Supplementation increased average daily gain until pregnancy diagnosis, but no differences were noted after pregnancy diagnosis. Providing dried distillers grain increased the percentage of heifers that were cycling before breeding; however, no differences in pregnancy rates, percent that gave birth in the first 21 days, calving date, or calf body weight at birth were observed. Heifers without supplementation had a $17.38 greater net return than supplemented heifers. This study implies providing dried distillers grain during the pre-breeding and breeding period increases pre-breeding attainment of puberty and average daily gains with no impact to other reproductive measures or body weight gains.

Introduction

To achieve maximum profitability, heifers should conceive early in the breeding season, calve early in the calving season, and be bred to calve by the age of two. Therefore, emphasis should be placed on heifer development management strategies that promote attainment of puberty prior to the start of their first breeding season. The forage quality of upland native range generally peaks in June with a steady decline from July until November (*2019 Nebraska Beef Cattle Report*, pp. 21–23). The growth patterns and quality of forage will likely have young females in May-calving systems in a metabolizable protein and energy deficit during the breeding season in August, due to a decline in crude protein (CP) and total digestible nutrients (TDN). Rumen microbes have their own specific protein requirements to maintain activity and growth. These microbes also synthesize microbial protein for the ruminant to use from dietary Nitrogen and energy feedstuffs, which is crucial to aid in the ruminant's overall protein supply. When grazing cattle are consuming diets that fall below 7% CP, microbe activity is limited; ultimately leading to reduced microbial populations, decreased fermentation and intake due to feeds staying in the rumen longer, and microbial protein synthesis being compromised. Since metabolizable protein, is composed of microbial protein and rumen undegradable protein (RUP) that bypasses the rumen, providing RUP supplementation to grazing cattle in the Sandhills during periods when forage quality is historically low may help offset these deficits. As mentioned previously, within May-calving systems, forage quality is on a steady decline during the August breeding season. Since RUP supplementation has shown to increase reproductive performance, strategically providing supplementation during times of greater challenge, such as lower quality forage prior to (July) and during the breeding season (August) may counteract these challenges, improving reproduction. The objective of this study was to determine the impact RUP supplementation prior to and during the breeding season has on heifer growth rates, reproductive performance, and calf body weight (BW) at birth.

Procedure

A 3-year study was conducted at the University of Nebraska, Gudmundsen Sandhills Laboratory (GSL), near Whitman, Nebraska and utilized 191 May-born Red Angus x Simmental crossbred heifers. Heifers were stratified by pre-breeding BW and randomly assigned to one of two treatments: 1) receive 2.0 lb/day (lb/d) of dried distillers grains (**SUPP**, n = 60) or 2) receive no supplement (**NoSUPP**, n = 131). Heifers were weaned in October to November. After weaning each year, heifers were managed together and offered a dried distillers grain supplement to achieve an overwinter gain of 0.75 lb/d prior to treatment initiation. Supplementation was offered via a C-Lock Super SmartFeeder beginning approximately 24-d prior to the start of breeding in July through the breeding season (August) for an average of 55-d of supplementation. In Year 1, SUPP heifer average daily intake was 1.29 ± 0.06 lb/d. In Years 2 and 3, the average daily intake was 1.62 ± 0.06 lb/d and 1.68 ± 0.05 lb/d, respectively. Heifers initially assigned to the SUPP treatment that did not voluntarily consume their allotted supplement were retrospectively added to the NoSUPP treatment for analysis, which resulted in the differences in number of heifers per treatment group.

Prior to the start of the breeding season, two blood samples were collected 10-d apart to determine cyclicity. A heifer was considered pubertal if concentrations of serum progesterone were greater than 1ng/mL at both collections. In August, heifers were synchronized with a single prostaglandin F2α administration 5-d after bull placement (1:20 bull to heifer ratio) for a 30-d natural service breeding season. Heifer BW was collected pre-trial (May), pre-breeding (July), breeding (August), pregnancy diagnosis (October), and pre-calving (April). At pregnancy diagnosis and pre-calving, a trained technician collected heifer body condition score (BCS; 1 = emaciated, 9 = obese) via palpation. In October, pregnancy was determined by an experienced veterinarian via a portable rectal ultrasonography machine approximately 100-d post bull removal. Nonpregnant heifers were sold as cull heifers. The first day three or more calves were born was identified as the start of the calving season and was utilized to determine the proportion of heifers that gave birth in the first 21-d. Within 24 hours, the calf was tagged, weighed, and received a 7-way clostridial vaccine.

Table 1: Input prices used in the enterprise budget.

	Treatment	
Item	NoSUPP[1]	SUPP[2]
Heifer development supplement, $/heifer	0.00	20.99
Input prices, $/heifer		
Weaned heifer purchase price, lb	1.66	1.66
Nonpregnant heifer price, lb	4.39	4.39
Pregnant heifer price, heifer	1,816.12	1,816.12
Grazing fee, AUM[3]	36.42	36.42

[1]NoSUPP heifers received no supplementation prior to or during the breeding season.

[2]SUPP heifers were offered 2.0 lb/heifer/d of a dried distillers grain supplement.

[3]Grazing fee for North (Sandhills) sub-state region; AUM = animal unit months.

Hypothetical enterprise partial budgets (Table 1) were used to identify the economic returns produced when 100 heifers were developed in each development method using pregnancy rates and BW from the experiment. The budget is an average of the 3 years when the study was conducted. Heifer development was considered a different enterprise than the cow-calf operation. Average lease price in the sandhills was determined using the Nebraska Farm Real Estate Market Highlights, with a grazing fee of $36.42 per animal unit month (AUM). The cost of supplementation was calculated to include the cost delivered to GSL. Additionally, the cost associated with purchasing weaned heifers, revenue generated from selling nonpregnant heifers, and although pregnant heifers were retained, a value was assigned to determine input costs. Market values were sourced from the USDA market news for the specific region and year.

All data was analyzed using the PROC MIXED and PROC GLIMMIX procedures of SAS 9.4 (SAS, Cary, NC). Heifer was identified as the experimental unit in a completely randomized design. The term CDATE was determined to avoid variation in when the heifer was born. The model included the main effect of treatment, year, and the interaction between treatment and year. Puberty status, pregnancy rate, and the percent calving within the first 21 d were assumed binomial distributions. Any other response variables were considered normally distributed. Significance was determined when $P < 0.05$ and a tendency was determined at $0.05 < P \leq 0.10$.

Results

No treatment × year interactions ($P \geq 0.10$; Table 2) were observed for heifer BW at all measurement points. Supplemented heifers had a greater ($P = 0.02$) average daily gain (ADG) from breeding to pregnancy diagnosis than NoSUPP heifers. Providing a dried distillers supplement during the breeding season may be advantageous to increase protein and energy consumption while grazing Sandhills upland range starting in July when forage metabolizable protein and net energy for maintenance starts declining during breeding. However, pre-breeding and breeding supple-

Table 2: The effect of pre-breeding and breeding supplementation on heifer and calf performance.

	Treatment			
Item	NoSUPP[1]	SUPP[2]	SEM	*P*-value
Heifer BCS[3]				
Pre-calving	5.7	5.7	0.05	0.89
Heifer BW, lb.				
Weaning[4]	436	445	8.77	0.37
Pre-trial[5]	582	580	7.12	0.83
Breeding[6]	721	728	7.89	0.49
Pregnancy diagnosis[7]	805	821	9.46	0.15
Pre-calving[8]	937	952	12.68	0.34
Heifer ADG, lb.				
Pre-trial to Breeding	2.30	2.44	0.05	0.01
Breeding to Pregnancy diagnosis	0.87	0.99	0.04	0.02
Pre-trial to Pregnancy diagnosis	1.43	1.56	0.03	<0.01
Pregnancy diagnosis to Pre-calving	0.64	0.68	0.04	0.47
Calf BW, lbs.				
Birth	60	57	1.37	0.20
Cycling, %[9]	67	86	-	<0.01
Pregnancy rate, %	64	68	-	0.65
Calve first 21d, %[10]	99.9	99.8	-	0.35
Calving date, Julian date	133	136	2	0.26

[1]NoSUPP heifers were not offered any supplementation during trial period.

[2]SUPP heifers were offered 2.0 lb/heifer/d of dried distillers grains during trial period.

[3]Body condition score (1 = emaciated to 9 = obese).

[4]Body weight collected at the time of weaning (weaning time ranges from October—December

[5]Body weight collected prior to the start of supplementation in May.

[6]Body weight collected during the breeding season in July.

[7]Body weight collected at pregnancy diagnosis in October.

[8]Body weight collected pre-calving in April.

[9]Percent of heifers that had progesterone values > 1 ng/ml at both blood sample collections prior to the breeding season.

[10]Percent of heifers that calved within the first 21-d of the calving season (start of calving season was determined when three calves were born on the same day).

Table 3. Treatment × year interaction for body condition score (BCS) at pregnancy diagnosis on May-born range heifers receiving dried distillers grains or no supplementation.

		Treatment			
Item	Year	NoSUPP[1]	SUPP[2]	SEM	*P*-value
Pregnancy diagnosis BCS[3]	2020	5.9[c]	5.8[c]	0.05	0.19
	2021	6.0[d]	6.0[d]	0.05	0.49
	2022	5.8[a,c]	5.9[b,d]	0.05	0.02

[1]NoSUPP heifers were not offered any supplementation during trial period.

[2]SUPP heifers were offered 2.0 lb/heifer/d of distillers grain during trial period.

[3]Body condition score (1 = emaciated to 9 = obese).

[a,b] For each interaction, means in rows with different superscripts differ ($P \leq 0.05$).

[c,d] For each interaction, means in columns with different superscript differ ($P \leq 0.05$).

mentation did not ($P = 0.47$) impact ADG from pregnancy diagnosis to pre-calving...; (Table 3). A treatment × year interaction ($P = 0.02$) for BCS at pregnancy diagnosis occurred where in year 3, SUPP heifers (5.9) had a greater BCS than NoSUPP heifers (5.8); however, this significant difference in BCS is not biologically different. In years 1 and 2, heifer BCS at pregnancy diagnosis was similar ($P > 0.19$). Heifer pre-calving BCS was not ($P = 0.89$) impacted by pre-breeding and breeding RUP supplementation.

Before the start of breeding, a greater ($P < 0.01$) percentage of SUPP heifers (86%) were cycling compared to NoSUPP heifers (67%); however, supplementation did not ($P = 0.65$) influence pregnancy rates. Supplementation did not ($P = 0.35$) influence the percentage of heifers that gave birth in the first 21-d. Additionally, calving date between both groups was not influenced ($P = 0.26$) by previous supplemental treatments. Calf BW at birth averaged 59 lb. with no differences ($P = 0.20$) between treatment groups.

Enterprise budget data is presented in Table 4. Supplemented heifers had a net return of $17.38 less than NoSUPP heifers. Since a heifer cannot get bred until she has reached puberty, for producers, this could serve as a low-cost management strategy that can be used when increasing the percentage of cycling heifers would be beneficial. For producers, this may be considered beneficial in cases where the breeding season needs to get altered (breeding earlier or pulling bulls from pasture early) due to drought or other environmental conditions.

Table 4: Budget for cost and return from developing heifers by providing a dried distillers grain supplement prior to and during breeding or no supplement.

Item	Treatment	
	NoSUPP[1]	SUPP[2]
Cost, $		
Heifer purchase cost at weaning	32,946.02	33,615.00
Heifer development cost		
Grazing[3]	6,677.00	6,677.00
Supplement	0.00	2,099.48
Total	39,623.02	42,391.48
Gross return, $		
Nonpregnant heifers price	56,104.20	49,870.40
Pregnant heifers price	116,231.68	123,496.16
Total	172,335.88	173,366.56
Net returns, $	132,712.86	130,975.08
Net returns, $/heifer developed	1,327.13	1,309.75

[1]NoSUPP heifers received no supplementation prior to or during the breeding season.

[2]SUPP heifers were offered 2.0 lb/heifer/d of dried distillers grains

[3]Grazing fee for North (Sandhills) sub-state region

Conclusion

Although providing RUP supplementation increased pubertal heifers prior to breeding, other reproductive measures, heifer BW, and pre-calving BCS were not impacted by supplementation. Over the 55-d supplementation period, BW and ADG were not different between the treatment groups, and both treatments had adequate body condition at pregnancy check and pre-calving. This suggests that although supplementing RUP prior to and during the breeding season can increase attainment of puberty, the impact on overall reproductive performance and growth is limited.

Josie N. Crouch, Graduate Student

J. Travis Mulliniks, previous Associate Professor, Animal Science, University of Nebraska- Lincoln, West Central Research and Extension Center, North Platte, NE

Jacki A. Musgrave, Research Technician

Kacie L. McCarthy, Assistant Professor, Animal Science, University of Nebraska- Lincoln, Lincoln, NE

Effects of Allocation Frequency on Cattle Performance and Forage Utilization when Swath Grazing a Sorghum-Sudangrass Hybrid in Eastern Nebraska

Thomas E. Aquino
Mary E. Drewnoski
Pedro Henrique J. Fernandes

Summary with Implications

A sorghum-sudangrass hybrid was swath grazed by growing steers (529 ± 18 lb) from November 2023 to January 2024. Treatments were offering new forage once (1X) or twice (2X) per week to determine the effect of allocation frequency on animal performance and forage utilization. Average daily gain was not impacted by treatment (1X = 0.45 ± 0.1 lb/day, 2X = 0.45 ± 0.1 lb/day). Pre- and post-graze biomass samples were collected to estimate forage utilization, which was not different between treatments (1X = 57.1 ± 3.6%, 2X = 61.1 ± 3.6%). However, there was a difference in carrying capacity with the more frequent allocations having greater carrying capacity compared to the less frequent allocation (6.8 vs 5.8 AUM/ac for 2X vs 1X, respectively). In other words, cattle allocated new forage 1X used more acres than 2X when grazed for the same number of days. For producers considering swath grazing as a winter-feeding strategy, the management practice of allocating new forage more frequently had the ability to increase the carrying capacity of the field by 17%. This is likely due to decreased trampling loss when cattle were allocated new forage more frequently.

Introduction

Winter feeding is challenging for cattle producers due to high labor and feed costs. One option to consider is swath grazing. Swath, or windrow, grazing is the process of cutting forage, leaving it in windrows, and allowing cattle to graze these windrows in the winter. When compared to other winter-feeding strategies, swath grazing can reduce winter feeding costs by mitigating the need to bale and transport hay. Additionally, previous literature indicates swath grazing has the potential for increased utilization compared to grazing stockpiled standing forage. Grazing windrows across a field can also lead to more uniform distribution of manure and waste as opposed to being concentrated around hay feeding sites. Research has been conducted with swath grazing a variety of forage types (warm season annuals, sub-irrigated meadows, etc.). However, there are no clear recommendations on allocation frequency. An objective of this study was to determine the impact of allocation frequency on animal performance and forage utilization. Another objective was to evaluate the change in quality of swathed sorghum-sudan forage over the winter.

Procedure

This experiment was conducted at the University of Nebraska-Lincoln Eastern Nebraska Research, Extension, and Education Center (ENREEC) near Mead, Nebraska.

Crop information

The crop field utilized was approximately 38 acres seeded with a sorghum-sudangrass hybrid, Canex ® Brown mid-rib (BMR) 210 Hybrid Sweet sorghum on June 16, 2023. Half of the field was seeded with the recommended rate of 35 lb/ac and the other half was planted with a double rate of 70 lb/ac. Prior to planting, the field was fertilized with 40 lb/ac of nitrogen from urea (46-0-0). The crop was stockpiled over the growing season and the first frost (< 32° F) occurred on October 7, 2023. On November 3, 2023, the crop was mowed and left in windrows to cure in the field. The mower was 15 ft wide and swaths from the mower were not combined.

Paddock design

The field was subdivided into 8 paddocks blocked (n = 4) by location in the field with 2 blocks per seeding rate (Figure 1). Paddock within block was assigned randomly to allocation frequency. Paddocks were constructed parallel to the windrows with new forage being offered via an advancing front fence. Cattle grazed perpendicular to the windrows in a strip grazing style. Within each seeding rate, 1 block contained 10 windrows and 1 contained 11 windrows.

Forage Sampling Procedure

Pre-graze forage mass was evaluated on11/9/2023, and again on 12/19/2023. Samples were taken from

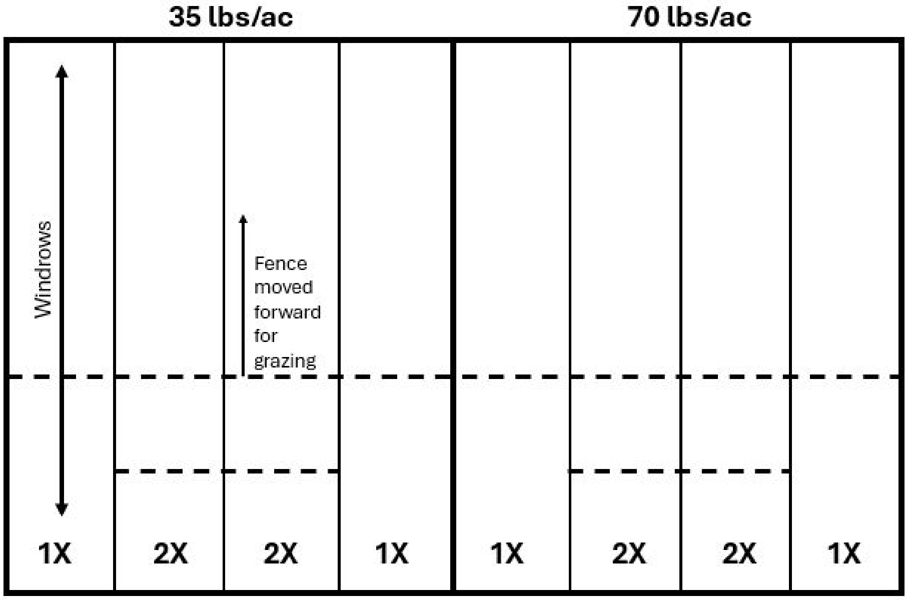

Figure 1. Illustration of field design. There were 8 paddocks with half the field (4 paddocks) planted with sorghum-sudangrass at a seeding rate of 35 lb/ac and the other half at 70 lb/ac. Paddocks were paired (blocked) by location and assigned randomly to forage allocation frequency (1 time per week; 1X or 2 times per week; 2X). Dashed lines represent the movement of the front fence for allocation of new forage by strip grazing. Windrows ran perpendicular to front fence movement for allocations.

24 points throughout the field (3 samples per paddock) to estimate forage mass. A 1-foot (12 inch) section of a windrow was cut and removed. The sample collected represented a 1 ft by 15 ft section of the field. The collected samples were placed in paper lawn litter bags and transported back to the lab for further processing. To determine the dry matter (DM) forage mass, samples were dried at 140° F in a forced air oven until they reached a constant weight. Post-graze samples were collected on 12/19/2023 and 2/5/2024 from a 1-foot x 15-foot area. Post-graze samples were taken from the same windrows as the pre-graze samples and dried using the procedure described above. Forage utilization was calculated as: (pre-graze biomass—post-graze biomass)/ pre-graze biomass. One quality sample was also taken from an ungrazed area of each paddock approximately every 2 weeks during the grazing period (11/9/2023, 11/22/2023, 12/8/2023, 12/19/2023 and 1/4/2024). These samples were used to determine the change in crude protein and digestible organic matter content of the forage over time.

Grazing

Prior to, and upon completion of, the grazing period cattle were limit-fed at 2% body weight for 5 days. Cattle were then weighed for 2 consecutive days. This procedure was used to equalize gut fill and determine initial and ending body weight. Sixty growing steers (529 ± 18 lb) were stratified by body weight and assigned randomly to groups, which were then randomly assigned to paddocks (7–8 steers/paddock). This resulted in an equal total animal body weight per swathed area. New forage was offered to groups in a strip grazing style with advancing front fence either once (1X) or twice (2X) each week. Allocations amounts were adjusted as needed, based on visual appraisal of the post grazing forage mass. Due to the low quality of the forage (5% CP), supplemental protein tubs (Country Lane, manufactured by Ragland, Moberly, MO) were supplied ad libitum (24% CP of which 16% was non-protein nitrogen). Cattle were turned out in mid-November and grazed for 64 days until mid-January. Cattle were removed from the field due to snow cover and the inability to access the forage. At trial termination, the acres grazed, number of steers and number of grazing days were used to calculate carrying capacity (AUM/ac) for each individual paddock.

The stockers used for this experiment grazed approximately 11 acres of the field. After the snow melted, the remaining 27 acres were grazed by dry cows resulting in 5.3 AUM/ac of grazing, this was not included in the carrying capacity estimates.

Data were analyzed with SAS 9.4 (Cary, NC) using the PROC Mixed procedure. Paddock was the experimental unit with fixed effects of allocation, seeding rate, date and their interactions included in the model. Block (location in the field) was considered a random effect. For forage quality analysis, repeated measures of date was used.

Results

There was a tendency ($P = 0.10$) for forage yield to be greater in the 70 lb/ac seeding rate (7,618 ± 487 lb/ ac) vs. 35 lb/ac (5,996 ± 487 lb/ac). There was no difference ($P = 0.89$) in pre-graze biomass across allocation frequency (Table 1). There was an allocation frequency by seeding rate interaction ($P < 0.01$) for forage offered with 1X (23.4 lb/steer/d)

Table 1. Effect of frequency of strip grazing swathed sorghum-sudangrass by allocating new forage with an advancing front fence either 1 (1X) or 2 (2X) times per week on utilization and performance of growing steers.

	Allocation Frequency			
	1X	2X	SEM	*P*-value
Pre-graze biomass lb/ac	6,777	6,832	393	0.89
Post-graze biomass lb/ac	2,846	2,599	159	0.35
Forage utilization, %	57	61	3.56	0.48
AUM/ac[1]	5.80	6.80	0.40	0.05
Initial body weight, lb	528	528	0.510	0.64
End body weight, lb	565	563	5.26	0.52
ADG, lb	0.45	0.45	0.100	0.93

[1]AUM = animal unit month; equal to a 1,000 lb animal grazing for 30.5 days

Table 2. Effect of sampling date of nutritive value of sorghum-sudangrass swathed in early November (11/3/2023).

	11/9/23	11/22/23	12/8/23	12/19/23	1/4/24	SEM	*P*-value
CP, %	5.0	5.4	5.1	5.5	5.4	0.16	0.19
DOM, %	61.7	59.8	56.3	54.0	48.4	0.01	<0.01

being offered more ($P < 0.01$) than 2X (17.3 lb/steer/d) within the 35 lb/ac seeding rate, but no difference ($P = 0.31$) in forage offered due to allocation within the 70 lb/ac seeding rate (1X 18.6 lb/steer/d, 2X 18.1 lb/steer/d). Overall, forage utilization was not different ($P = 0.48$) between treatments (Table 1). While utilization remained unchanged, the carrying capacity, represented as AUM/ac, increased by 17% with the more frequent 2X allocations of new forage. The increase in carrying capacity can be attributed to a decrease in trampling loss by the more frequent allocation. Gain of steers was not impacted by allocation frequency ($P = 0.93$) with an ADG of 1X being 0.45 ± 0.1 lb/day and 2X being 0.45 ± 0.1 lb/day.

Forage Quality

There was no change ($P = 0.19$) in crude protein content of the forage throughout the trial (Table 2) with CP averaging 5.3%. In terms of energy, there was a noticeable decline in digestible organic matter over time ($P < 0.01$) with forage in early November being 61.7 % DOM while in early January DOM of the forage had declined to 48.4 %. The loss of DOM can be attributed to weathering loss from the swathed forage being exposed to rain/snow in the field.

Conclusions

The most notable outcome of this study was the 17% increase in carrying capacity (AUM/ac) associated with the more frequent twice a week allocation of forage. Pre-graze biomass and overall forage utilization did not differ across the allocations, meaning that the increase in carrying capacity was attributed to the allocation frequency. It is assumed that the 2X allocation resulted in less trampling loss by cattle. While the crude protein content of the forage was consistent over winter, there was a roughly 14 percentage unit decrease in DOM due to the windrows being exposed to the elements. For producers considering swath grazing, it is important to remember that increasing the frequency of allocation has the potential to increase carrying capacity.

Thomas E. Aquino, graduate student

Mary E. Drewnoski, associate professor, animal science

Pedro Fernandes, graduate student

Effect of Forage Allocation on Steer Performance when Grazing Cereal Rye

Shelby L. Davies-Jenkins

Abigail M. Sartin

Daren D. Redfearn

Mary E. Drewnoski

Summary with Implication

Cereal rye is the most common cover crop planted today. With its good winter tolerance and rapid spring growth during a gap in perennial pasture productivity, it is an attractive forage source in early spring. Unfortunately, optimum stocking rates and how they are related to forage biomass availability are unknown. The study objective was to understand the effect of forage allowance on steer performance when rotationally grazing fall-planted cereal rye in spring. Stocking rate was negatively correlated with pounds of forage offered. Surprisingly, amount of forage offered related to average daily gain. Growing steers grazing cereal rye gained 2.01 ± 0.31 lb/d. This was likely due to the high forage nutritive value throughout the season which was a result of the rotationally grazed system. Thus, for ~750 lbs steers, stocking rates between 630 and 2,300 lbs BW/ac (1 to 3 hd/ac) will result in similar average daily gain in rotationally grazed cereal rye systems. Therefore, stocking at the higher end of this range will likely result in the best economic return.

Introduction

Cereal rye is the most common cover crop planted in the United States today. With good winter tolerance and rapid spring growth, cereal rye can fill the early spring grazing gap in pasture productivity and availability. Few data exist regarding how to best manage grazing of rye in the Midwest. The stocking rate is the relationship between the number of animals and the total land area used over a specified time. This is an important relationship to optimize because it is generally accepted that as stocking rates change, there is a tradeoff between individual animal gain and total gain per acre. To a certain extent, as stocking rates increase, individual animal performance decreases while total gain per acre increases. If stocking rates become greater than the carrying capacity of the forage present, both individual animal gain and gain per acre will suffer. Rotational stocking, commonly referred to as rotational grazing, involves the utilization of recurring periods of grazing and rest among a few paddocks managed as a single unit over a period of time. Rotational grazing can allow for a more complete utilization of forage and greater control over daily forage consumption throughout the grazing period thereby increasing the carrying capacity. When using cereal rye as a forage resource, there is a limited window for grazing. Pressure to get cash crops planted typically results in termination of the rye earlier than what the forage would ideally allow. Therefore, optimum stocking rates in relation to forage mass need to be identified and utilized to ensure cost-effective management. Thus, the objective is to evaluate the effect of forage allowance on steer performance when rotationally grazing fall-planted cereal rye in the spring.

Procedure

This study was conducted over 4 years (year 1: 2020 to 2021, year 2: 2021 to 2022, year 3: 2022 to 2023, and year 4: 2023 to 2024), at the University of Nebraska Eastern Nebraska Research, Extension, and Education Center near Mead, Nebraska. Prior to experiment initiation, steers (n=170) were limit fed a diet of 50% Sweet Bran and 50% alfalfa hay for 5 days at 2% of their body weight (BW). Steers were then weighed for 3 days consecutively and stratified by BW. Steers initially weighed 744 lbs, 825 lbs, 766 lbs, and 705 lbs for years 1, 2, 3, and 4 respectively. Due to different pasture sizes, groups consisted of 5 to 30 hd depending on the year and desired stocking rate. Replicates within years 1 and 2 had similar stocking rates throughout at 3 steers/ac (year 1) and 2.5 steers/ac (year 2) which resulted in a stocking rate of 2,231 and 2,062 lb BW/ac. To create variation, replicates in year 3 steers were stocked anywhere between 0.8 and 2.0 steers per acre, resulting in a stocking rate of 684 to 1,569 lb BW/ac with an average stocking rate of

1,088 lb BW/ac. In year 4, 2 replicates were stocked at 1.4 steers/ac and 2 were stocked at 1.9 steers/ac, for an average stocking rate of 1,419 lb BW/ac. Overall, a range of 0.8 to 3.0 steers/ac (which translates to 684 and 2,231 lbs BW/ac) was utilized for this study.

The experimental unit (EU) was steer group (n = 18), with three groups per year in years 1 and 2, eight groups in year 3, and 4 groups in year 4. Pasture size ranged from 1.67 ac to 16.09 ac. Pastures were divided into paddocks for rotational grazing. Groups in years 1 and 2 were rotated between 2 paddocks, groups in year 3 were rotated between 2 to 5 paddocks, and groups in year 4 were rotated between 5 to 7 paddocks. This resulted in an average stocking density of 4,463, 4,127, 3,727, and 4,919 lb BW/ac for years 1, 2, 3, and 4 respectively. Stocking densities were similar between replicates for years 1 and 2, however, in year 3 it ranged from 2,443 to 6,402 lb BW/ac and from 4,636 to 5,188 in year 4. Cereal rye (VNS in years 1 and 2 and Elbon in year 3 and 4) was planted at 88 lb/acre on September 22nd for both years 1 and 2, 70 lb/ac on October 24th in year 3, and 75 lb/ac on September 23, 2023 in year 4.

In year 1, grazing was initiated on April 3, 2021 when forage height was 4.03 ± 0.55 inches, and cattle were rotated when average pasture height fell to 1.6 ± 0.39 inches. In year 2 it was initiated on April 6, 2022 with cereal rye reaching 4.9 ± 0.15 inches. Steers were rotated when pasture height averaged of 3.6 ± 0.10 inches. Due to the later planting date and drought, grazing cereal rye in year 3 was initiated on May 4, 2023. Forage height at turnout in year 3, was variable between replicates for an average of 5.1 inches and a range of 4.1 to 5.9 inches of standing height. Residual standing height when groups were rotated averaged at 4.0 ± 0.62 inches. In year 4, forage height at turnout occurred when average forage height reached 6.4 ± 0.07 inches. Cattle were rotated when forage height fell to an average of 3.2 ± 0.61 inches. In year 2 on day 9, a lack of biomass in the treatment pastures caused all cattle to be pulled and limit-fed the same diet of 50% Sweet Bran and 50% alfalfa hay for 6 days, after which grazing resumed. The length of the grazing season achieved was 14 days for 2 replicates and 21 days for 1 replicate in year 1, 18 days in year 2, 21 days in year 3, and 52 days in year 4.

Time spent grazing each paddock was similar in year 1 and year 2 with an average of 4.9 days in year 1 and 4.5 days in year 2 with a minimum of 3 days and a maximum of 6 days in both years. In year 3, however, steers spent an average of 6.3 days on each paddock with a minimum of 1 day on a paddock and a maximum of 13 days. Steers in year 4 averaged a similar amount of time (4.3 days) on each paddock as years 1 and 2, however, this time steers spent a minimum of 1 day and a maximum of 7 days on each paddock.

Following grazing termination, steers were again limit fed for 7 to 8 days the same diet of 50% Sweet Bran and 50% alfalfa hay, with the steers being weighed on the last three consecutive days. Gains achieved during the final limit feeding period and the 6 day pull off in year 2 were subtracted from grazing performance estimations. Based on the nutritive values and amount offered of the alfalfa hay and Sweet Bran mix, the beef cattle nutrient requirement model (NASEM, 2016) predicted gains of 2.45, 2.29, 1.83, and 2.00 lb/d in years 1, 2, 3, and 4 respectively, during the limit feeding period. Thus, 17.15, 13.74, 12.30, and 12.00 lb were subtracted from the ending BW of the steers in years 1 through 4, respectively. During the 6-day pull-off period, gains were predicted at 2.43 lb/d, therefore an additional 14.58 lb were subtracted from the final BW in year 2.

Just prior to the initiation of grazing for each rotation, paddocks were measured for forage biomass and nutritive value by collecting randomly, ten (years 1 and 2) or 20 (year 3 and 4) heights and clipping to ground level three (years 1 and 2) or four (year 3 and 4) 5.3 ft^2 areas. Samples were then dried to a constant weight at 140°F and weighed for dry matter (DM) mass and subsequently ground and analyzed for forage nutritive value.

The average dry weight of the clippings was used to calculate the forage mass in the paddock when the steers started grazing. This was divided by the number of steers and the number of days the steers spent in the paddock to obtain the forage DM offered per steer and as a % of BW using the average BW. A weighted average of each of the rotations into a new paddock was then obtained for the forage DM offered by multiplying this number by the percent of the grazing season they spent in the paddock and then summing these numbers across the grazing season. This number represents how much forage a steer was offered each day on average as a % of BW over the grazing period.

Analysis for forage nutritive value included crude protein (CP) using NIR (year 1 and year 2) or combustion (year 3 and 4) and digestible organic matter (DOM) utilizing the in-vitro tube method. Briefly, DOM was determined by incubating samples for 48 hours in buffered rumen fluid to determine in vitro organic matter

Table 1. Range of cereal rye biomass and nutritive value at paddock entry, weighted across the grazing season, and then averaged across the 3 study years.

Variable	Average	Std Dev	Minimum	Maximum
Forage Mass, lbs/ac	895	288	348	1486
Forage Height, in	8.3	3.3	3.3	12.9
DOM[1], %	68.9	2.3	65.5	74.0
CP[2], %	22.3	4.6	15.9	31.3

[1]DOM = Digestible Organic Matter, a proxy for TDN (energy)

[2]CP = Crude Protein

Table 2. Range of growing steer performance when grazing cereal rye in early spring across over a 3-year period.

Variable	Average	Std Dev	Minimum	Maximum
Initial BW, lb	759	39.2	703	831
Final BW, lb	814	28.6	763	866
ADG, lb	2.02	0.31	1.39	2.53

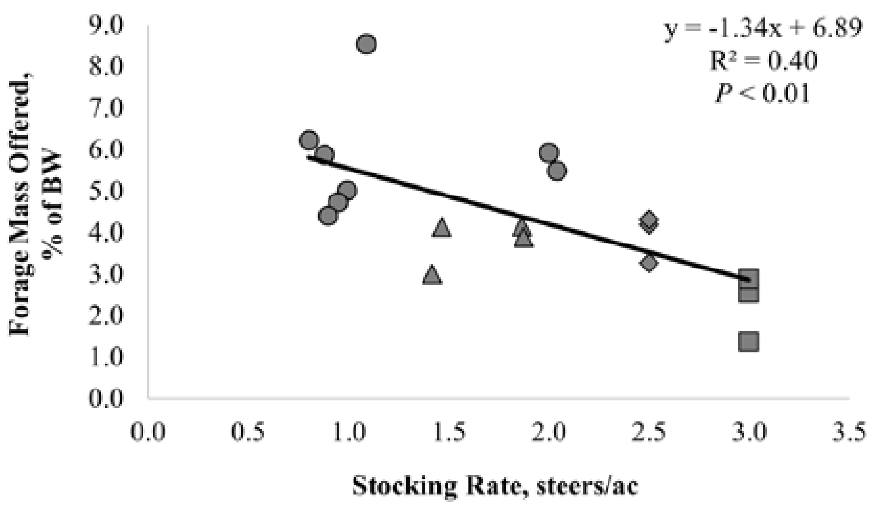

Figure 1: The effect of stocking rate (hd/ac) on forage mass offered (lb DM/day/100 lb BW) where squares represent year 1, diamonds represent year 2, circles represent year 3, triangles represent year 4, and the solid line represents the relationship between observed responses.

digestibility (IVOMD). This was then multiplied by the organic matter of the sample resulting in DOM as a % of DM. Digestible organic matter serves as a proxy for total digestible nutrients (TDN), providing an estimate of the energy content of the forage. The rye was primarily immature and thus CP and DOM over the 3 years were quite high at 69% DOM and 23% CP (Table 1).

Data were analyzed using the regression procedure of SAS to test for linear relationships between stocking rate and forage offered to determine if stocking rate effectively changed forage availability. Then, regression was used to test for linear relationships between average daily gain and forage offered to determine if average daily gain was changed by forage allocation. Finally, the regression procedure was also utilized to test for a linear relationship between total gain per acre and forage offered. The effect of year on ADG was evaluated using the mixed procedure of SAS.

Results

On average, steers weighed 759 lb (range of 703 to 831 lb) at the initiation of each grazing season and 814 lb (763 to 866 lb) following grazing termination. Average daily gains (ADG) from 1.39 to 2.53 lb/d were observed throughout the 4 years with an average of 2.02 lb/d (Table 2). The ADG was not different (P = 0.97) among years and averaged 2.07 ± 0.20, 1.97 ± 0.20, 2.00 ± 0.12, and 2.06 ± 0.17 lb/d for years 1, 2, 3, and 4 respectively.

Due to the difference (maximum of 128 lb) in average initial steer size each year's calculations were made on a % of BW basis when determining forage offered. Forage offered followed a moderate (R^2 = 0.40) negative linear relationship (P < 0.01) to stocking rate (Figure 1). In other words, an increase in stocking rate, will result in a decrease of the amount of forage offered to each steer per day. Across the 18 groups, steers were offered an average of 4.4 ± 1.62 % of BW with a maximum of 8.8 % and a minimum of 1.4 %. However, there was no correlation (P = 0.77) between the amount of forage mass offered and steer ADG (Figure 2). To evaluate the impact of forage mass offered on gain per acre, a 27-day grazing season was used as this represented the average amount of time that groups were grazing. In this study, termination of grazing was a factor of needing to plant either (soy-

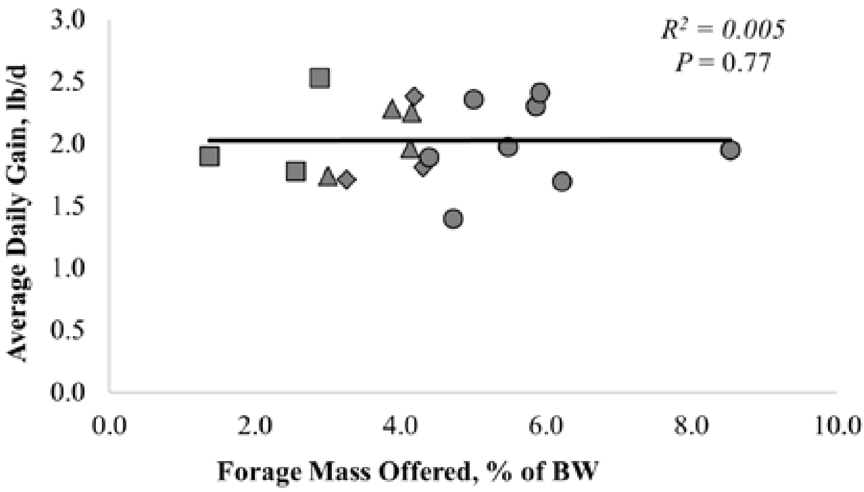

Figure 2: The effect of forage mass offered on ADG where squares represent year 1, diamonds represent year 2, circles represent year 3, triangles represent year 4. There was no relationship between forage mass offered and ADG, the solid line represents the overall ADG of 2.02 lb/d achieved across years.

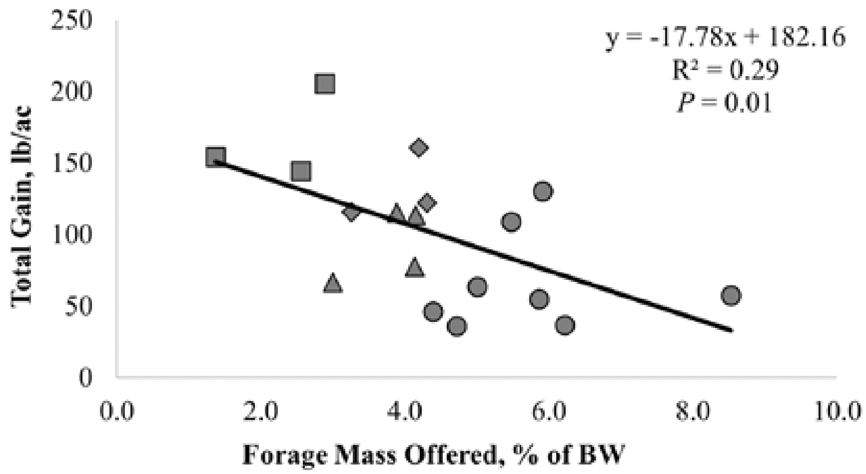

Figure 3: The effect of forage mass offered on total gain standardized to 27 days of grazing. Squares represent year 1, diamonds represent year 2, circles represent year 3, triangles represent year 4, and the solid line represents the relationship between total gain (lb/ac) and forage mass offered (% of BW).

beans years 1 and 2, or sudangrass years 3 and 4). When standardized to a 27-day grazing season, there was a moderate ($R^2 = 0.29$) significant negative linear correlation ($P = 0.01$) between the total gain per acre and the forage mass offered (Figure 3). As forage mass offered increased by 1% of BW, total gain per acre decreased by 18 lbs.

These data suggest, that regardless of forage mass offered consistent individual gain response is observed when rotationally grazing cereal rye for this weight class of stockers. Thus, offering less forage mass as a % of BW (i.e. using higher stocking rates) will result in greater total gain per acre.

Conclusions

Cereal rye can fill an early spring gap in pasture productivity and availability. When rotationally grazing cereal rye, forage nutritive value remained high throughout the grazing season. However, increasing the stocking rate decreased the amount of average forage mass offered. For ~750 lb steers, stocking rates between 630 and 2,300 lbs of BW/ac (0.8 to 3 steers/ac) resulted in similar ADG and there was no correlation observed between available forage mass nor amount of forage offered. Lack of observed differences was likely due to the high forage nutritive value coupled with rotational grazing. Higher stocking rates did increase the total pounds of gain per acre. Therefore, rotationally grazing, at lower forage allowances will increase total gain per acre without sacrificing individual animal performance.

Shelby L. Davies-Jenkins, graduate student

Abigail M. Sartin, graduate student

Daren D. Redfearn, professor, Agronomy, Lincoln

Mary E. Drewnoski, associate professor, Animal Science, Lincoln

Strategies Affecting Performance and Profitability of May-Born Steers

Dempster M. Christenson
Jacki A. Musgrave
Rick N. Funston

Summary with Implications

This study compared the performance and economic outcomes of differing backgrounding and feedlot systems in May-born yearling steers. We hypothesized reduced supplementation with adequate forage availability while backgrounding weaned steers will yield a similar carcass with greater profitability. It was hypothesized yearling steers backgrounded on pasture before finishing in feedlot would have a more valuable carcass that is more profitable than steers that enter the feedlot immediately. Weaned steer calves were backgrounded with ad libitum hay and 4 lb/d supplement in drylot or on pasture with 1 lb/d supplement. As yearlings, half of each backgrounding group immediately entered the feedlot or were allowed to develop on pasture before entering the feedlot. In summary, producers with pasture available for weaned and yearling steers can risk a slow rate of gain for greater body weight at slaughter and a greater return on investment.

Introduction

Two common strategies for finishing a calf after weaning include calf and yearling systems. Calf fed weaned steers utilize a shorter feeding period and greater efficiency to yield finished cattle in the shortest time. Yearling fed steers leverage forage available on pasture at much lower prices to allow calves to develop more frame before finishing, which yields greater body weight (**BW**) and greater average daily gain (**ADG**) from greater inputs while extracting greater profitability. Traditional backgrounding treatments for yearling calves have been focused on weight gain and maturation prior to feedlot entry; however, recovery of weight at a given day of age following a low-quality diet may alter metabolic function and energy utilization. Increased efficiency and profitability were found in a similar study on March-calving yearling steers (*2021 Nebraska Beef Cattle Report*, pp. 24–27). Feedlot operations who have pasture available can choose to finish yearlings immediately or utilize pasture through summer to background yearlings before entering the feedlot, reducing days in the feedlot. The objective of this study was to examine the performance and economic outcomes of differing backgrounding and feedlot systems on May-born steers.

Procedure

Results found in *2019 Nebraska Beef Cattle Report*, pp 32–35 were reanalyzed to improve accuracy and expounded upon to add relevance and economic data. A 6-yr study from 2011 to 2017 utilized 65 ± 8.2 head/year (n = 392) May-born (May 22 ± 13 days) crossbred steers at Gudmundsen Sandhills Laboratory (GSL), Whitman, NE. After weaning in January (Day 0 ± 4), 7.5 month (mo) old steer calves were weighed, blocked by BW and age, and randomly assigned to 1 of 2 backgrounding systems until May (Figure 1; Day 120 ± 5). Steers assigned to a high-input system (**HI**; n = 12, 436 ± 53 lb) were offered ground meadow hay ad libitum and 4 lb/day of a 33% crude protein supplement in a drylot. The remaining steers were assigned to a low-input system (**LO**; n = 12, 434 ± 51 lb) and allowed to graze dormant sub-irrigated meadow with 1 lb/d of the same supplement provided three times weekly. Stocking rate was 0.35 AUM/acre (animal unit months per acre).

Immediately following backgrounding in May, one-half (33 ± 3.8 steers/year) of the 11.5 mo old steers from each backgrounding system were blocked by BW, transported to West Central Research, Extension, and Education Center (WCREEC), and placed in a feedlot (**S-YRL**; n = 12, 570 ± 73 lb; Figure 1). Synovex Choice (Zoetis, Parsippany-Troy Hills, NJ) was administered to S-YRL steers at feedlot entry. The steers remaining at GSL grazed upland range. These steers were transported to the WCREEC in September at 15.5 mo of age (**L-YRL**; n = 12, 789 ± 81 lb; Figure 1). Revalor G and Ralgro (Merck Animal Health, Rahway, NJ) were administered to L-YRL steers in

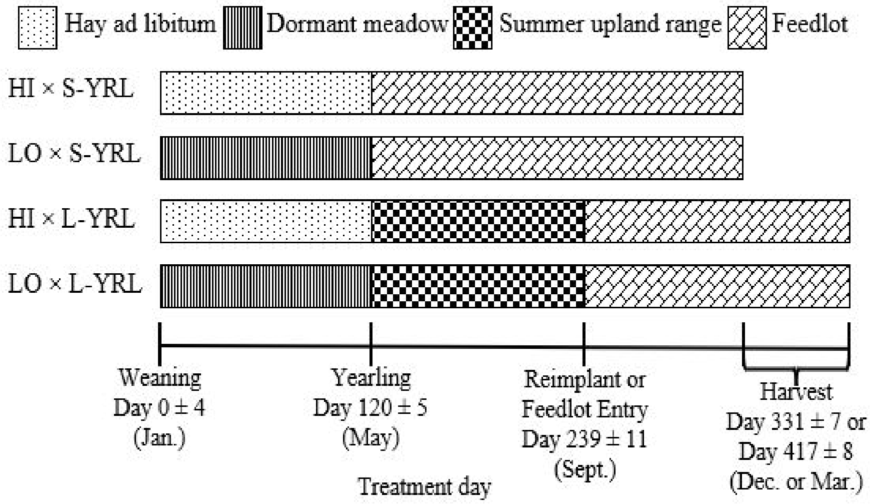

Figure 1: Timeline of steer calf backgrounding treatment (HI[1] or LO[1]) and yearling feedlot system (S-YRL[2] or L-YRL[2])

[1]At weaning in January, 7.5 mo old steers were assigned to 1 of 2 backgrounding treatments until May at 11.5 mo of age: HI = steers offered meadow hay ad libitum plus 4 lb/d 33% CP (DM) cube, LO = steers grazed dormant subirrigated meadow plus 1 lb/d of the same supplement.

[2]Feedlot system: S-YRL = steers entering feedlot at 11.5 mo of age were reimplanted at 15.5 mo of age and slaughtered at 18.5 mo of age in Dec., L-YRL = steers grazed upland pasture at 11.5 mo of age, entered feedlot in Sept. at 15.5 mo of age, were reimplanted at 18.5 mo of age, and slaughtered at 21.5 mo of age in March.

May and at feedlot entry, respectively. The S-YRL and L-YRL steers (Zoetis, Parsippany-Troy Hills, NJ) were administered Synovex Plus 110 ± 8 days or 71 ± 8 days later, respectively. Steers were slaughtered at 18.5 mo of age for S-YRL or 21.5 mo of age for L-YRL in December and March respectively. Final BW was calculated by adjusting hot carcass weight to a common dressing percentage of 63% recorded at slaughter. Carcass data were collected 24 h later for marbling, 12th rib backfat, rib eye area, and yield grade.

Economic Analysis

The net-return of each treatment (i.e.: HI × S-YRL) recorded in 2011–2016 were simulated for every year from 2011 to 2022 (which extended into 2023 for both L-YRL treatments) making 72 simulated years. Partial budget yearly net-return was calculated using the recorded steer body weights, inputs, timeline, and historical costs and revenue of management and production practices in the state of Nebraska. The value of calves and steers were based on BW and a price window or grade at each stage of performance taken from USDA Nebraska weekly reports. Net-return of animals from each year were adjusted to its present value (2022). The net-return for each simulated year was compared by backgrounding treatment (n = 144) and feedlot system (n = 144). The phases of the study considered for economic analysis were weaning to yearling, yearling to slaughter, and weaning to slaughter (retained ownership).

An interest rate of 5% was assessed on 80% of the value of the steers and feed at each phase of the study to calculate the cost of a loan. The cost of hay fed during each phase of the study is based on the average price for hay in the state of Nebraska. Dry matter intake for HI steers was assumed to be 10 lb/day during the backgrounding period. The cost of grazing dormant pasture as a weaned calf was based on half the average rental rate for pasture in the North district of Nebraska each simulated year, the number of acres in the pasture being grazed, and the treatment period. The cost of supplement was based on the yearly purchase price of supplement during and after the study. The yardage in the drylot was $0.45/day per head. The feeding labor costs for each phase of the study were based on ranch wages each year. Diesel costs associated with feeding were based on average prices each year. Health and death related costs during the backgrounding phase were $6 in 2011 increasing by $0.30 annually based on industry estimates.

The cost of grazing steers on pasture after weaning was based on average stocker rental rates for pasture in the North district of Nebraska. The yardage was $0.45/day per head. The cost of feed while in feedlot was calculated using the cost of each feed in the ration and the total fed during that year of the study, which was weighted by intake data collected in the GrowSafe feeding system (GrowSafe Systems Ltd., Calgary, AB, Canada). The cost of implants was based on the cost of those implants each year, and $2/head chute charge. An additional 0.5% annual rate of interest on the value of the steers at feedlot entry was applied for the entire feedlot system period to cover other health and death costs.

Statistical Analysis

All data were analyzed using the PROC GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with quantities expressed as LSM and SEM. Backgrounding treatment × feedlot system × year was considered

Table 1. Effects of calf backgrounding and yearling feedlot system strategies on steer performance from weaning to slaughter

	Treatments[1,2]				Probability values[3]		
	HI	LO	S-YRL	L-YRL	B	FS	B×FS
n	12	12	12	12			
BW, lb[1,2]							≥0.52
7.5 mo	436 ± 3.5	436 ± 3.5	435 ± 3.5	437 ± 3.5	1.00	0.79	
11.5 mo	605 ± 7.5	537 ± 7.5	571 ± 5.6	572 ± 5.6	<0.01	0.89	
15.5 mo	938 ± 11	892 ± 11	1041 ± 13	789 ± 13	0.02	<0.01	
18.5 mo	1278 ± 15	1244 ± 15	1404 ± 14	1119 ± 14	0.09	<0.01	
21.5 mo[4]	1468 ± 18	1424 ± 18	-	1488 ± 14	0.05	-	
Weaning	436 ± 3.5	436 ± 3.5	435 ± 3.5	437 ± 3.5	0.99	0.78	
Yearling	602 ± 5.2	534 ± 5.2	568 ± 6.0	570 ± 6.0	<0.01	1.00	
Feedlot entry	709 ± 10	645 ± 10	568 ± 6.0	786 ± 15	<0.01	<0.01	
Reimplant	1105 ± 14	1050 ± 14	1038 ± 15	1117 ± 15	0.01	<0.01	
Slaughter[4]	1467 ± 15	1421 ± 15	1401 ± 15	1487 ± 15	0.04	<0.01	
ADG, lb/day							
Background[5]	1.4 ± 0.04	0.8 ± 0.04	1.1 ± 0.04	1.1 ± 0.04	<0.01	0.89	0.97
Pasture[6]	1.6 ± 0.02	1.8 ± 0.02	-	1.7 ± 0.01	<0.01	-	-
Entry[7]	4.4 ± 0.08	4.5 ± 0.08	4.2 ± 0.08	4.7 ± 0.08	0.45	<0.01	0.65
Reimplant[8]	3.6 ± 0.09	3.6 ± 0.09	3.5 ± 0.09	3.7 ± 0.09	0.92	0.18	0.12
Feedlot[9]	4.0 ± 0.07	4.0 ± 0.07	3.9 ± 0.07	4.1 ± 0.07	0.81	0.07	0.14
System[10]	3.4 ± 0.05	3.5 ± 0.05	3.9 ± 0.05	3.1 ± 0.05	0.18	<0.01	0.34
F:G[11], lb/lb	7.0 ± 0.09	6.8 ± 0.09	6.6 ± 0.09	7.2 ± 0.09	0.18	<0.01	0.27
Marbling[12]	485 ± 9	496 ± 9	475 ± 9	507 ± 9	0.39	0.02	0.73
Backfat, in	0.6 ± 0.01	0.6 ± 0.01	0.6 ± 0.01	0.6 ± 0.01	0.86	0.15	0.32
Rib Eye, in^2	15 ± 0.1	15 ± 0.1	15 ± 0.1	15 ± 0.1	0.14	0.10	0.53
Yield grade	3.3 ± 0.06	3.2 ± 0.06	3.2 ± 0.06	3.3 ± 0.06	0.79	0.06	0.67

[1]At weaning in January, 7.5 mo old steers were assigned to 1 of 2 backgrounding treatments until May at 11.5 mo of age: HI = steers offered meadow hay ad libitum plus 4 lb/day 33% CP cube, LO = steers grazed meadow plus 1 lb/day of the same supplement.

[2]Feedlot system: S-YRL = steers entering feedlot at 11.5 mo of age were reimplanted at 15.5 mo of age and slaughtered at 18.5 mo of age in Dec., L-YRL = steers grazed upland pasture at 11.5 mo of age, entered feedlot in Sept. at 15.5 mo of age, were reimplanted at 18.5 mo of age, and slaughtered at 21.5 mo of age in March.

[3]B = effect due to backgrounding treatment, FS = effect due to feedlot system, B × FS = interaction of backgrounding system and feedlot system.

[4]Slaughter BW was calculated by adjusting hot carcass weight to a common dressing percentage of 63%.

[5]Background = backgrounding period ADG. Period from January weaning to May (yearling).

[6]Pasture = grazing upland pasture ADG. Period from May to Sept. in L-YRL only.

[7]Entry= period from feedlot entry to reimplant.

[8]Reimplant = period from reimplant to slaughter.

[9]Feedlot = period from feedlot entry to slaughter.

[10]System = period from the end of the backgrounding treatment to slaughter.

[11]F:G = pounds of feed per pound of BW gain while in feedlot.

[12]Marbling score: Choice 400 = Small, 500 = Modest, 600 = Moderate.

Table 2. Average management costs and sale value over twelve years used to simulate net-return of the backgrounding and feedlot treatment systems in dollars per head ($/head)

	Treatments[1,2]			
	HI	LO	S-YRL	L-YRL
n	144	144	144	144
Backgrounding				
Wean price[3]	929.12	920.88	919.65	930.35
Feed[4]	181.31	40.99	111.15	111.15
Interest[5]	14.69	12.73	13.65	13.79
Yardage[6]	54.38	-	27.19	27.19
Labor and gas	12.06	8.19	10.12	10.12
Health	7.65	7.65	7.65	7.65
Total cost	1198.19	990.19	1088.77	1099.61
Sale value[3]	1099.24	1048.45	1074.79	1072.90
Feedlot				
Yearling price[3]	1099.24	1048.45	1074.79	1072.90
Feed[7]	537.31	524.17	489.17	572.32
Interest[5]	41.90	40.23	36.47	45.66
Implanting/health[8]	15.32	15.14	13.50	16.95
Yardage[6]	86.32	86.32	95.78	76.88
Labor and gas	20.48	20.48	21.23	19.73
Total cost	1800.58	1734.80	1730.95	1804.43
Slaughter value[3]	1938.34	1877.03	1817.13	1998.24
Retained[9]				
Interest[5]	51.73	49.30	46.37	54.68
Total cost	1894.67	1672.88	1741.18	1826.37

[1]At weaning in January, 7.5 mo old steers were assigned to 1 of 2 backgrounding treatments until May at 11.5 mo of age: HI = steers offered meadow hay ad libitum plus 4 lb/day 33% CP cube, LO = steers grazed meadow plus 1 lb/day of the same supplement.

[2]Feedlot system: S-YRL = steers entering feedlot at 11.5 mo of age were reimplanted at 15.5 mo of age and slaughtered at 18.5 mo of age in Dec., L-YRL = steers grazed upland pasture at 11.5 mo of age, entered feedlot in Sept. at 15.5 mo of age, were reimplanted at 18.5 mo of age, and slaughtered at 21.5 mo of age in March.

[3]Purchase price or sale price of a weaned calf, yearling steer, or slaughtered steer based on BW and historical prices at that weight.

[4]Cost of supplement (either 4 lb/day or 1 lb/day) and either ad libitum hay or rental of dormant pasture.

[5]Interest on the value of purchasing steers and feed assuming a 5% rate on 80% of the value during the treatment period.

[6]Yardage = $0.45/head per day while in drylot.

[7]Rental cost of stocker range and/or cost of feed in feedlot.

[8]The cost of 2 implants in S-YRL steers and 3 implants in L-YRL steers and additional health costs assessed at 0.5% the value of a yearling steer.

[9]Retaining steers from backgrounding through feedlot to slaughter includes all management costs from each phase except the purchase price of a yearling steer

the experimental unit in a split-plot design. There were no significant interactions between treatments, so only main effects are reported. Response variables were averaged within each experimental unit using the PROC MEANS procedure. Body weight was analyzed using repeated measures based on age and management period. Year was included as a covariate for all analyses. Data were considered significant at P ≤ 0.05 and a tendency if P ≤ 0.10 and P > 0.05.

Results

Analysis of BW, ADG, and carcass characteristics were similar to those reported in *2019 Nebraska Beef Cattle Report*, pp. 32–35 (Table 1). Ground hay and four times more supplementation among HI calves in drylot led to greater ADG and BW than LO calves (P < 0.01) and BW differences were maintained until slaughter (P = 0.05). Immediate feedlot entry as a yearling led to greater ADG (P < 0.01) in S-YRL steers within a shorter time period but L-YRL steers had greater harvest BW (P < 0.01). Average management costs for each treatment can be found in Table 2. Six treatment years simulated over 12 years (72 simulated years) calculates net-return by treatment and the ratio of positive net-return to total simulated treatment years (Table 3).

Simulation of purchasing a weaned steer for backgrounding found the high price of ground hay, additional supplementation, and yardage among HI calves in drylot led to a negative net-return of $131.92 ± $9.06 per head, but LO calves produced a positive net-return of $77.54 ± $9.06 per head for a difference of $209.46 ± $12.82 per head (P < 0.01). Simulations by treatment year found HI steers had positive net-return 7 out of 72 simulated years but LO steers had positive net-return 55 out of 72 simulated years. If a yearling steer was purchased from either backgrounding treatment, there were no significant differences in net-return during the feedlot period (P = 0.87) despite the BW differences at feedlot entry and slaughter. If management retained steer calves from backgrounding through feedlot, both HI and LO steers had positive net return (HI = $44.53 ± $29.70 per head, LO = $259.43 ± $29.70 per head), but LO steers had $214.90 ±

Table 3. Effects of calf backgrounding and yearling feedlot system strategies on simulated net-return (adjusted for present value) during each phase of the study and the number of years each had positive net-return out of twelve simulated years by treatment year

	Treatments[1,2]					Probability values[3]		
	HI	LO	S-YRL	L-YRL	SEM	B	FS	B×FS
n	144	144	144	144				
Backgrounding								
Net-Return, $/head	-131.92	77.54	-18.63	-35.76	9.1	<0.01	0.18	0.79
Year 1, yr/yr	1/12	11/12	6/12	8/12				
Year 2, yr/yr	1/12	8/12	3/12	3/12				
Year 3, yr/yr	1/12	3/12	1/12	1/12				
Year 4, yr/yr	1/12	11/12	6/12	5/12				
Year 5, yr/yr	2/12	11/12	8/12	9/12				
Year 6, yr/yr	1/12	11/12	6/12	5/12				
Total, yr/yr	7/72	55/72	30/72	31/72				
Feedlot								
Net-Return, $/head	186.79	193.00	115.47	264.32	27.4	0.87	<0.01	0.81
Year 1, yr/yr	11/12	10/12	10/12	10/12				
Year 2, yr/yr	11/12	11/12	11/12	10/12				
Year 3, yr/yr	10/12	10/12	8/12	11/12				
Year 4, yr/yr	7/12	7/12	8/12	10/12				
Year 5, yr/yr	9/12	9/12	10/12	10/12				
Year 6, yr/yr	11/12	10/12	10/12	10/12				
Total, yr/yr	59/72	57/72	57/72	61/72				
Retained[4]								
Net-Return, $/head	61.30	275.37	101.78	234.87	29.6	<0.01	<0.01	0.81
Year 1, yr/yr	8/12	11/12	9/12	10/12				
Year 2, yr/yr	7/12	11/12	11/12	9/12				
Year 3, yr/yr	6/12	11/12	5/12	11/12				
Year 4, yr/yr	5/12	11/12	6/12	9/12				
Year 5, yr/yr	8/12	11/12	8/12	10/12				
Year 6, yr/yr	8/12	11/12	8/12	10/12				
Total, yr/yr	42/72	66/72	47/72	59/72				

[1]At weaning in January, 7.5 mo old steers were assigned to 1 of 2 backgrounding treatments until May at 11.5 mo of age: HI = steers offered meadow hay ad libitum plus 4 lb/day 33% CP cube, LO = steers grazed meadow plus 1 lb/day of the same supplement.

[2]Feedlot system: S-YRL = steers entering feedlot at 11.5 mo of age were reimplanted at 15.5 mo of age and slaughtered at 18.5 mo of age in Dec., L-YRL = steers grazed upland pasture at 11.5 mo of age, entered feedlot in Sept. at 15.5 mo of age, were reimplanted at 18.5 mo of age, and slaughtered at 21.5 mo of age in March.

[3]B = effect due to backgrounding treatment, FS = effect due to feedlot system, B × FS = interaction of backgrounding system and feedlot system.

[4]Retaining steers from backgrounding through feedlot to slaughter includes all management costs from each phase except the purchase price of a yearling steer

$42.00 per head greater net-return ($P < 0.01$). It is clear greater supplementation to target high ADG of steers in drylot after weaning averaged a negative net-return with this design, but purchase or retention of these steers can result in a positive net-return. Reduced supplementation to target low ADG of steers on dormant pasture after weaning averaged a positive net-return whether steers were sold, purchased, or retained after the backgrounding period.

If a yearling steer was purchased from either feedlot system, both had positive net-return (S-YRL = $115.47 ± $27.38 per head, L-YRL = $264.32 ± $27.38 per head), but L-YRL steers had $148.86 ± $38.72 per head greater net-return ($P < 0.01$).

Simulations by treatment year found the S-YRL system had positive net-return 57 out of 72 simulated years and the L-YRL system had positive net-return 61 out of 72 simulated years. If management retained steer calves from backgrounding through feedlot, both feedlot systems had positive net-return (S-YRL = $101.78 ± $29.59 per head, L-YRL = $234.87 ± $29.59 per head), but L-YRL steers had $133.08 ± $42.00 per head greater net-return ($P < 0.01$). It is clear both feedlot systems have positive net-return but a longer system of yearling steer development before entering the feedlot can have greater net-return. The added costs, inputs, and risk of keeping cattle longer may not be manageable for some feedlot producers, but the value of the added BW effectively increases net-return.

Conclusions

Producers should consider alternative backgrounding and feedlot strategies to reduce costs and increase profits. Steers backgrounded on the HI system exhibit greater backgrounding ADG and BW compared to the LO system at the conclusion of the backgrounding treatment and maintained these differences until slaughter. Despite greater BW in HI steers, carcass quality was not significantly different and did not offset the high costs of supplementation and drylot feeding during the backgrounding period, which led to greater net-return in the LO backgrounding system. Yearling steers that were allowed to develop before entering the feedlot (L-YRL) had greater slaughter BW, which resulted in many carcass characteristics being greater. Both feedlot systems had positive net-return, but L-YRL steers had greater net-return than S-YRL steers due to increased BW and reduced feeding costs. Feedlot systems that require longer periods of pre-feedlot backgrounding replace the high cost of high energy feed with pasture availability and additional risk.

Dempster M. Christenson, research technician and graduate student

Jacki A. Musgrave, research technician

Rick N. Funston, full professor, animal science, West Central Research and Extension Center, North Platte NE

Interaction of Backgrounding System and Implant Use on Growing Calf Performance

Sydney T. Vanderhoff
Braden C. Troyer
Rebecca L. McDermott
Mitchell M. Norman
Brandon L. Nuttelman
Galen E. Erickson
Mary E. Drewnoski
James C. MacDonald

Summary with Implications

A two-year study utilized 480 weaned steers each year targeted to gain either 1 or 2 lb/d during the winter followed by ad libitum forage intake during the summer to determine the effects of winter rate of gain and implant strategy during the winter backgrounding and summer phases on steer performance, forage intake, and compensatory gain. During the winter, steers received a Revalor-G or no implant. In the summer, steers either received a Revalor-IS or no implant. The use of Revalor-G and increased rate of gain during the winter backgrounding phase had additive effects to increase animal performance during the winter phase. Steers which achieved a lower rate of gain in the winter consumed more DMI as a % of their BW during the summer phase, suggesting increased intake is an important compensation mechanism. On average, steers fed to target 1 lb/d ADG during the winter and only received one implant throughout both the winter and summer phases compensated 22% during the summer while steers receiving 2 implants compensated 9% compared to steers fed to target 2 lb/d during the winter. Use of implants during the backgrounding phase is a viable strategy to improve animal performance and limit subsequent losses in performance due to compensation.

Introduction

Backgrounding systems are known to have a substantial impact on subsequent animal performance. Implants are known to increase average daily gain (ADG) in beef cattle at all stages of production but are utilized in backgrounding programs to a much lesser extent than in finishing programs. Calves backgrounded at a lower rate of gain have a greater ADG during the subsequent summer grazing phase than calves backgrounded at a higher rate of gain during the winter, a phenomenon known as compensatory gain. However, cattle backgrounded at a lower rate of winter gain do not make up all the difference in BW created by the winter phase (*2014 Nebraska Beef Cattle Report*, pp. 36–38). There is recent evidence that suggests a modest implanting program during the winter and summer phases can reduce compensatory gain from 22% to 9% allowing producers to retain most of the additional weight gain cattle achieved through a higher plane of nutrition (*2023 Nebraska Beef Cattle Report*, pp. 22–25). However, the effects on forage intake remain unknown since steers were grazing pasture. The objectives of this study were to assess the effects of winter rate of gain and implant strategy during the winter backgrounding and summer phases on steer performance, forage intake, and compensatory gain.

Procedure

A 2-year backgrounding systems study was conducted at the University of Nebraska-Lincoln Eastern Nebraska Research Extension and Education Center (ENREEC) near Mead, Nebraska that utilized 480 weaned crossbred steer calves (initial BW = 538 lb; SD = 42 lb) each year. Steers were limit-fed a diet consisting of 50% Sweet Bran and 50% alfalfa hay for 5 consecutive days and individually weighed for 2 consecutive days to establish initial BW by averaging the 2-day weights. Within each year, steers were stratified by BW and assigned randomly into one of 48 experimental units and 12 treatments. Treatments were designed to evaluate the interactions between winter rate of gain (targeted ADG of 1 lb/d; LOW or 2 lb/d; HIGH), winter implant strategy (40 mg of TBA and 8 mg of estradiol [Revalor-G; Merck Animal Health] or no implant), winter housing system (backgrounded in pens or backgrounded while grazing corn residue), and summer implant strategy (80 mg of trenbolone acetate and 16 mg estradiol [Revalor-IS; Merck Animal Health] or no implant). The 2 x 2 x 2 x 2 factorial was complete except that steers housed in pens were not implanted with Revalor-G due to labeling restrictions of the implant. This resulted in 12 treatments instead of 16.

Winter Phase

The HIGH and LOW rates of winter gain were achieved by supplementing steers assigned to graze corn residue with 6.4 lb (HIGH) or 2.2 lb (LOW) of dried distillers grains plus solubles (DDGS) per head daily. For steers assigned to pens, the low rate of gain was achieved by feeding 10% modified distillers grains (MDGS), 86% Smooth Bromegrass hay, and 4% supplement which provided 1% dietary urea. The high rate of winter gain was achieved by feeding 30% MDGS, 66% Smooth Bromegrass hay, and 4% supplement, which provided 0.5% dietary urea. Both diets were fed ad libitum with ad libitum access to water. For steers grazing corn residue and assigned to receive the Revalor-G implant, the implants were administered on the last day of limit-feeding before turning out to corn residue. The winter phase lasted 118 days in year 1 and 113 days in year 2.

At the end of the winter period, steers were again limit-fed a diet consisting of 50% Sweet Bran and 50% alfalfa hay for 9 consecutive days in year 1 and 6 consecutive days in year 2. In both years, steers were weighed the last 2 days of limit feeding to establish initial BW of the summer phase. Ending BW of the winter phase was estimated by subtracting 1 lb of ADG per day while steers were consuming the limit-fed diet.

Summer Phase

The summer phase was 103 days both years. Steers were in pens over the summer and were fed a forage-based diet to measure forage intake with the intent that differences in forage intake can be applied to grazing situations. Steers were housed in their assigned experimental units (10 head per pen) equaling 48 pens each year. The summer diet was 40% corn silage, 25% wheat straw, 30% grass hay, and 5% supplement which provided 1% urea and 20 g/ton Rumensin. Book values (from the Nutrient Requirements of Beef Cattle) were used to develop a TDN of 55.2%. The diet was developed to mimic a TDN similar to grass pasture. If steers were assigned to receive a Revalor-IS implant, the implant was administered on the last day of limit feeding.

Statistical Analysis

Data were analyzed using MIXED procedure of SAS as two separate 2 x 2 x 2 factorial designs. Analysis 1 was winter rate of gain by winter implant by summer implant where the model included the effect of winter rate of gain, Revalor-G implant, and Revalor-IS implant including all 2-way and 3-way interactions. Steers housed in pens were removed from Analysis 1 because they were not intended to be part of the factorial analysis of for Analysis 1. Analysis 2 was winter rate of gain by housing during winter by summer implant where the model included rate of winter gain, winter housing, and Revalor-IS. Steers receiving Revalor-G during the winter were removed from analysis 2 because they were not intended to be part of the factorial for Analysis 2. In both Analysis 1 and Analysis 2, there were 8 reps per treatment. Significance was set at $P < 0.05$, while tendencies were declared between $P > 0.05$ and $P < 0.10$. If interactions were not significant ($P > 0.10$), the main effects were presented. Year was considered a random effect in both analyses.

Results

Analysis 1: Rate of winter gain by Revalor-G in the winter by Revalor-IS in the summer.

In Analysis 1, there were no 3-way interactions detected ($P > 0.26$), so data are presented as two 2 x 2 formats. Table 1 shows the interaction of winter rate of gain and the use of Revalor-G in the winter when steers were grazing corn residue. As expected, increasing the daily supplement of DDG from 2.2 lb/steer to 6.4 lb/steer daily increased ADG from 1.17 to 2.09 lb/d in non-implanted steers. This also illustrates that the targeted ADG of 1 and 2 lb/d were met. The use of the Revalor-G implant increased ADG by 0.18 lb/d (15.4%) in steers supplemented with 2.2 lb DDG/steer, and 0.21 lb/d (9.1%) in steers supplemented with 6.4 lb DDG/steer. Given the lack of an interaction in winter ADG ($P = 0.63$), these data suggest the use of a Revalor-G implant in steers grazing corn residue and supplemented with DDG will increase winter ADG by an average of 0.20 lb/d, or a 12% increase in ADG.

The use of a Revalor-G implant in the winter did not impact ADG during the summer ($P = 0.33$) but did produce carryover effects in the summer phase by increasing both initial and ending BW ($P < 0.05$) and increasing DMI during the summer phase ($P = 0.01$). Interestingly, the increase in DMI was not reflected in an increase in DMI expressed as a percentage of BW, suggesting the

Table 1. Effects of winter supplement amount and implant use during the winter on winter and summer performance of steers.

	Treatments[1]					P-Value[2]		
	Low ADG		High ADG		SE	Winter gain	Rev-G	Interaction
Item	None	Rev-G	None	Rev-G				
Winter Performance								
Initial BW, lb	538	539	538	538	8.1	0.98	0.93	1.00
Ending BW, lb	674	693	780	803	9.2	<0.01	0.02	0.83
ADG, lb	1.17	1.35	2.09	2.30	0.06	<0.01	<0.01	0.63
Summer Performance								
Initial BW, lb	682	700	788	810	9.2	<0.01	0.02	0.83
Ending BW, lb	893	904	977	999	13.4	<0.01	0.05	0.48
ADG, lb	2.10	2.02	1.86	1.87	0.11	<0.01	0.33	0.23
DMI, lb	19.0	19.2	18.5	19.4	1.07	0.66	0.01	0.15
DMI, % BW[3]	2.39	2.39	2.10	2.14	0.01	<0.01	0.43	0.41
F:G[4]	9.13	9.51	9.91	10.31	-	<0.01	0.06	0.91

[1]Treatments = 2.2 lb DM of DDG daily (Low = low gain targeted 1.0 lb/d) or 6.4 lb DM of DDG daily (High = high gain targeted 2.0 lb/d), N = no implant, Y = 40 mg of TBA and 8 mg of estradiol (REV- G; Merck Animal Health) during the winter backgrounding period.

[2]*P*-Value: Winter gain = effect of supplementing at LOW vs HIGH during the winter phase, Implant = effect of implant treatment during the winter phase, Supplement*Implant = effect of supplementation rate and implant strategy during the winter phase

[3]Calculated as average DMI/average BW.

[4]Statistically analyzed as G:F and reported as the reciprocal.

increase in DMI during the summer phase for steers implanted with a Revalor-G during the winter phase is due to an increase in BW. Since ADG was not impacted and DMI increased, feed conversion during the summer tended to be poorer (P = 0.06) for steers implanted with Revalor-G during the winter.

As anticipated, the steers that achieved a greater ADG during the winter phase had reduced ADG during the summer phase (P < 0.01) due to compensation. However, the increase in ADG for the low ADG steers was not great enough to overcome the BW difference achieved at the end of the winter phase. Additionally, the use of an implant for steers backgrounded at a lower winter ADG did not make up for the difference in BW created by the increase in winter ADG at the end of the summer. There was no difference in DMI due to winter ADG during the summer phase (P = 0.66). However, when expressed as a percentage of BW, steers which were restricted during the winter consumed a greater amount of DM during the summer (P < 0.01). Additionally, steers that were restricted during the winter had improved feed conversions during the summer phase (P < 0.01). Several mechanisms for compensatory gain have been suggested including an increase in DMI as a percentage of BW and reduced maintenance energy requirements due to a smaller gastrointestinal tract. These observations suggest both may play a role in compensation.

Table 2 shows the interaction of using Revalor-G in the winter and the use of Revalor-IS in the summer. There was no impact of Revalor-IS on winter performance because the implant was given at the end of the winter phase (P > 0.48), so only summer performance is reported. There tended (P < 0.10) to be interactions for ending BW, ADG, and F:G when two implants were used. The use of Revalor-IS during the summer phase resulted in the greatest ADG, followed by the use of Revalor-G in the winter combined with Revalor-IS in the summer. Steers that received no implants during the winter or summer had the least ADG during the summer while steers receiving only a Revalor-G during the winter were intermediate in their summer ADG. The use of implants in the winter and summer were additive in their effects on DMI. The use of Revalor-G followed by Revalor-IS resulted in increased DMI. However, only the use of Revalor-IS in the summer following no implant in the winter resulted in improved feed conversion. Any of the implant strategies utilized increased ending BW compared to steers which did not receive an implant during the winter or summer phases. Interestingly, the use of two implants reduced the percentage of weight that was compensated by

Table 2. Effects of winter and summer implant strategy on steer performance during the summer phase.

	Treatments[1]					*P*-Value[2]		
Winter	REV-G		None		SE	REV-G	REV-IS	Interaction
Summer	REV-IS	None	REV-IS	None				
Initial BW, lb	753	759	736	734	9.2	0.02	0.81	0.63
Ending BW, lb	954[b]	952[b]	952[b]	920[a]	13.4	0.05	0.05	0.08
ADG, lb	1.99[b]	1.90[b,c]	2.12[a]	1.83[c]	0.11	0.40	<0.01	0.01
DMI, lb	19.5	19.1	19.0	18.5	1.08	0.01	0.03	0.94
F:G[3]	9.77[b]	10.04[b]	9.02[a]	10.05[b]	0.002	<0.01	0.002	0.06
Compensation[4], %	9	20	24	21				

[abc]means lacking common letters differ ($P < 0.05$) when the interaction is significant ($P < 0.10$).

[1]Treatments = REV-G = 40 mg of TBA and 8 mg of estradiol (REV- G; Merck Animal Health) during winter phase. REV-IS = 80 mg of trenbolone acetate (TBA) and 16 mg estradiol (REV-IS; Merck Animal Health) during summer phase. None = no implant during that phase.

[2]*P*-Value: REV-G = effect of 40 mg of TBA and 8 mg of estradiol implant (REV- G; Merck Animal Health) during the winter phase, REV-IS = effect of REV-IS implant during the summer phase, Interaction = interaction of winter and summer implant strategy.

[3]Statistically analyzed as G:F and reported as the reciprocal.

[4]Compensation was calculated as the difference in BW between the high and low treatments at the end of the winter phase and the end of the summer phase as a percentage of the difference at the end of the winter phase

Table 3. Effects winter rate of gain and housing on steer performance during the winter and summer phases.

	Treatments[1]					*P*-Value[2]		
	Low ADG		High ADG		SE	Winter gain	Housing	Interaction
	Stalks	Pens	Stalks	Pens				
Winter Performance								
Initial BW, lb	537	537	537	537	8.1	0.98	0.89	1.00
Ending BW, lb	673	685	780	763	17.8	<0.01	0.81	0.16
ADG, lb	1.17[c]	1.28[c]	2.09[a]	1.96[b]	0.13	<0.01	0.74	0.02
Summer Performance								
Initial BW, lb	682	693	788	772	17.8	<0.01	0.81	0.16
Ending BW, lb	895	902	977	965	26.2	<0.01	0.79	0.32
ADG, lb	2.09	2.05	1.86	1.90	0.05	<0.01	0.92	0.23
DMI, lb	18.7	19.2	18.5	19.0	0.97	0.37	0.02	0.78
DMI, % BW[3]	2.37	2.41	2.10	2.19	0.06	<0.01	0.02	0.42
F:G[4]	8.90	9.37	9.91	9.93	-	<0.01	0.17	0.20

[abc]means lacking common letters differ ($P < 0.05$) when the interaction is significant ($P < 0.10$).

[1]Treatments = steers fed a bromegrass hay base diet with 10% DM of DDG daily (Low = low gain 1.0 lb/d) or 30% DM of DDG daily (High = high gain 2.0 lb/d) for steers fed in pens during the winter phase, 2.2 lb DM of DDG daily (Low = low gain 1.0 lb/d) or 6.4 lb DM of DDG daily (High = high gain 2.0 lb/d) for steers grazing corn residue during the winter phase

[2]*P*-Value: Winter gain = effect of low or high rate of gain during the winter, Housing = effect of stalks or pens, Interaction = interaction of winter gain treatment and housing during the winter phase. There were no interactions between gain, housing, and summer implant ($P > 0.53$), so the effects of winter ADG and winter housing are presented.

[3]Calculated as average DMI/average BW.

[4]Statistically analyzed as G:F and reported as the reciprocal.

Table 4. Main effects of Revalor-IS implant on steer performance during the summer phase.

	None[1]	Revalor-IS	SE	*P*-value
Initial BW, lb	732	735	16.4	0.80
Ending BW, lb	920	950	25.3	<0.01
ADG, lb	1.84	2.11	0.04	<0.01
DMI, lb	18.6	19.1	0.96	0.01
DMI, % BW[2]	2.26	2.28	0.06	0.43
F:G[3]	10.05	9.02	-	<0.01

[1]None = no implant during the summer phase. Revalor-IS = 80 mg of trenbolone acetate (TBA) and 16 mg estradiol (REV-IS; Merck Animal Health) during summer phase. There were no interactions between gain, housing, and summer implant ($P > 0.81$), so the main effects of summer implant strategy are presented. No steers in this data set received an implant during the winter phase.

[2]Calculated as average DMI/average BW.

[3]Statistically analyzed as G:F and reported as the reciprocal.

steers backgrounded at a lower winter rate of gain from approximately 20% to 9%. This suggests that a greater percentage of the additional weight that is gained during the winter is retained at the end of the summer if two implants are utilized.

Analysis 2: Rate of winter gain by winter housing by Revalor-IS in the summer.

In Analysis 2, there were no 3-way interactions detected ($P > 0.53$), so data are presented as a 2 x 2 factorial showing the interaction of winter rate of gain and housing (Table 3). Additionally, there were no 2-way interactions with Revalor-IS and other factors (winter rate of gain or housing system; $P > 0.63$), so the main effects of Revalor-IS in the summer are presented in Table 4.

There was an interaction of winter rate of gain and housing ($P < 0.01$) during the winter period. Steers targeted to achieve a higher ADG during the winter and grazed corn residue had greater ADG than those housed in pens, 2.09 and 1.94 lb/d respectively ($P < 0.05$) whereas steers targeted to gain a lower ADG during the winter had similar ADG, regardless of housing system. Steers housed in pens during the winter had greater DMI during the summer, perhaps because they were adapted to eating from bunks and all steers were fed from bunks in the summer. While the intent of feeding steers from bunks during the summer was to accurately measure forage intake, this strategy may have impacted the comparison between steers that were housed in pens in the winter compared to those that grazed corn residue in the winter. Housing system did not impact summer ADG ($P = 0.92$). Consistent with Analysis 1, steers backgrounded at a lower rate of gain during the winter compensated during the summer phase. Steers backgrounded by grazing corn residue at a low rate of winter gain compensated by 23.4% compared to their cohorts backgrounded at a high rate of winter gain. For steers housed in pens, the degree of compensation was 19.25%. There is a perception that steers backgrounded in grazing systems will perform better in a subsequent phase of production. These data suggest that subsequent performance is affected by winter ADG and not by housing system.

The main effects of implanting with Revalor-IS in the summer phase are presented in Table 4. The use of a Revalor-IS during this phase increased ADG, ending BW, DMI, and feed conversion ($P < 0.01$). Consistent with Analysis 1, the increase in DMI was not apparent when expressing DMI as a function of BW, suggesting the increase in DMI is driven by an increase in ADG resulting in a larger animal. Revalor-IS increased ADG by 14.7% during the summer phase.

Conclusions

Increasing the winter rate of gain from approximately 1 lb/d to 2 lb/d increases the amount of salable weight at the end of the summer phase. The pounds of weight sold is maximized using one implant either in the winter or the summer. However, the use of two implants (one in each phase of production) minimizes compensatory gain and allows producers to keep a greater percentage of the additional weight generated from a greater rate of gain in the winter.

Sydney T. Vanderhoff, former graduate student

Braden C. Troyer, research technician

Rebecca L. McDermott, research technician

Mitchell M. Norman, research technician

Brandon L. Nuttelman, Merck Animal Health, Amherst, NE

Galen E. Erickson, professor

Mary E. Drewnoski, associate professor

James C. MacDonald, professor

Quantifying Cereal Rye Pastures Biomass with Image Analysis

Pedro Henrique J. Fernandes
Shelby L. Davies-Jenkins
Biquan Zhao
Wei-Zhen Liang
Mary E. Drewnoski
Yijie Xiong

Summary with Implications

By accurately assessing the amount of forage available, producers can estimate the pasture carrying capacity to make informed decisions on management. To provide producers with a feasible and efficient approach to estimate forage mass, this project evaluated performance of two image analysis tools, Crop Canopy Image Analyzer (CCIA) and Canopeo, in estimating forage mass for cereal rye. Forage mass measured by clipping the forage (areas with 5.625 ft²) was correlated with plant cover analyzed by the two tools using photos of the forage taken 37 in above the ground. Results obtained have supported the feasibility of quantifying cereal rye mass with both tools, which suggests a convenient and efficient way for producers to estimate pasture forage availability by simply taking a picture with their smartphones.

Introduction

Recognizing the importance of accurately and reliably estimating biomass to improve pasture management, various technological tools are being developed to assist producers. Currently, accurately assessing forage mass involves a labor-intensive and time-consuming procedure, including cutting pasture forage, drying the materials, and weighing the dry material. Accurate biomass availability can assist producers in making more informed pasture management decisions. However, due to the labor and resources required, many producers do not gather forage mass estimates. This is where technological tools become valuable resources for producers, as they can be accessed via mobile phones, computers, and other devices. Therefore, this report aims to compare two plant green cover analysis tools, Crop Canopy Image Analyzer (CCIA) and Canopeo, by regressing the percentage of green cover of plants (in relation to the soil) present in the images with biomass.

Methodology

Biomass Collection

This study measured forage biomass by using the clipping method from a cereal rye pasture, along with taking pictures for each biomass collection area prior to clipping the forage, between May 2nd and May 24th, 2023, and a total of 124 samples were collected. Areas (5.625 ft²) for biomass collection were chosen randomly within the pasture. A photograph was taken at a height of 37 in for each area, after which the cereal rye plant within the area was cut to the ground level. This process was repeated four times for each sampling pasture, ranging from 2.1 to 4.95 acres. The rye forage was then placed in a forced-air oven to dry at 140°F until all moisture was removed and the forage reached a constant weight. The weight of the dried materials was recorded. In this project, the dry matter of all samples weighed ranged from 78 to 4,288 lb/ac.

Image Analysis

Photos taken for each area were processed in both tools to calculate the percentage of plant cover in the area (relative to the soil). In CCIA, available through (https://phrec-irrigation.com/) web interface, an algorithm runs immediately after a photo is uploaded. This tool automatically calculates the plant cover without requiring any customized adjustments (Figure 1). In the Canopeo (https://canopeoapp.com/) interface, there is an option to fine-tune the leaf area index after uploading the photo, allowing for inclusivity of the plant's green coloration (Figure 2). It utilizes 3 settings including blue to green ratio, red to green ratio and noise index. This project used a value of 1.1 for the green saturation option (i.e., blue to green ratio), which was considered to capture more variation of rye greenness in the photo, as mature cereal rye has more of a blue hue. The default red to green ratio (= 0.95) was used. The noise setting allows for the exclusion of small unwanted green pixels associated with weeds. Due to the lack of weeds observed in this pasture, the noise was set to 1. Other combinations of

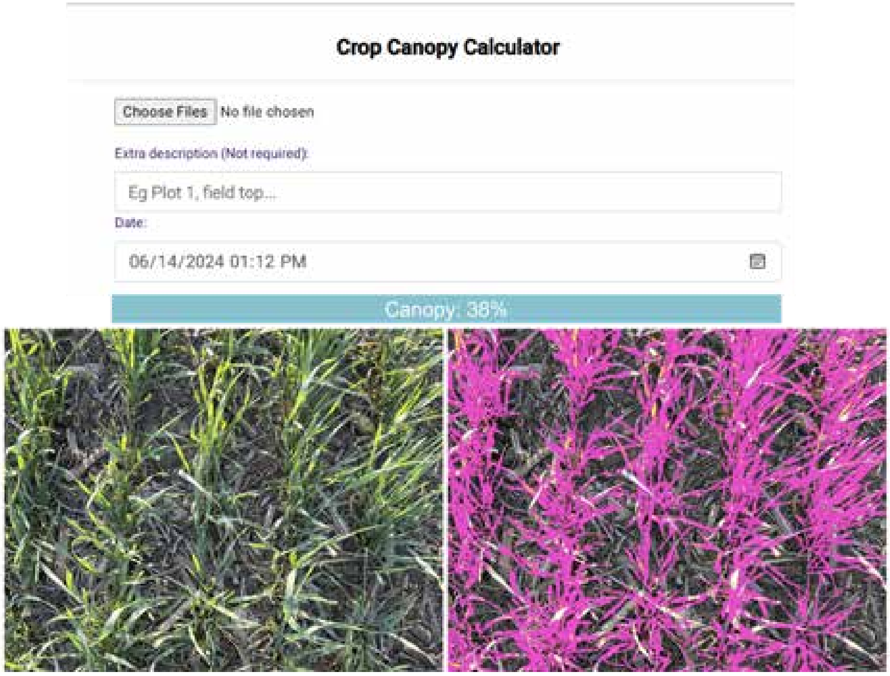

Figure 1. Interface of CCIA available through PHREC-AgLab (https://phrec-irrigation.com). Identified canopy cover was shown as pink color and the background was shown as original color in the output image.

these parameters were evaluated, but only the strongest correlation is presented here.

Data and Statistical Analysis

A regression analysis between the amount of green coverage derived from each tool and biomass (lb/ac) was performed in SAS using the PROC GLM procedure (version 9.4, Institute SAS Inc., Cary, NC). According to the regression equations obtained from the analysis, this project estimated the biomass by using the plant cover as the predictor variable. The dataset was then split into training (80% of the data) and validation (20% of the data) datasets. The estimation performance (predicted biomass versus measured biomass) was performed by applying the quadratic equation obtained from the training dataset to the plant coverage

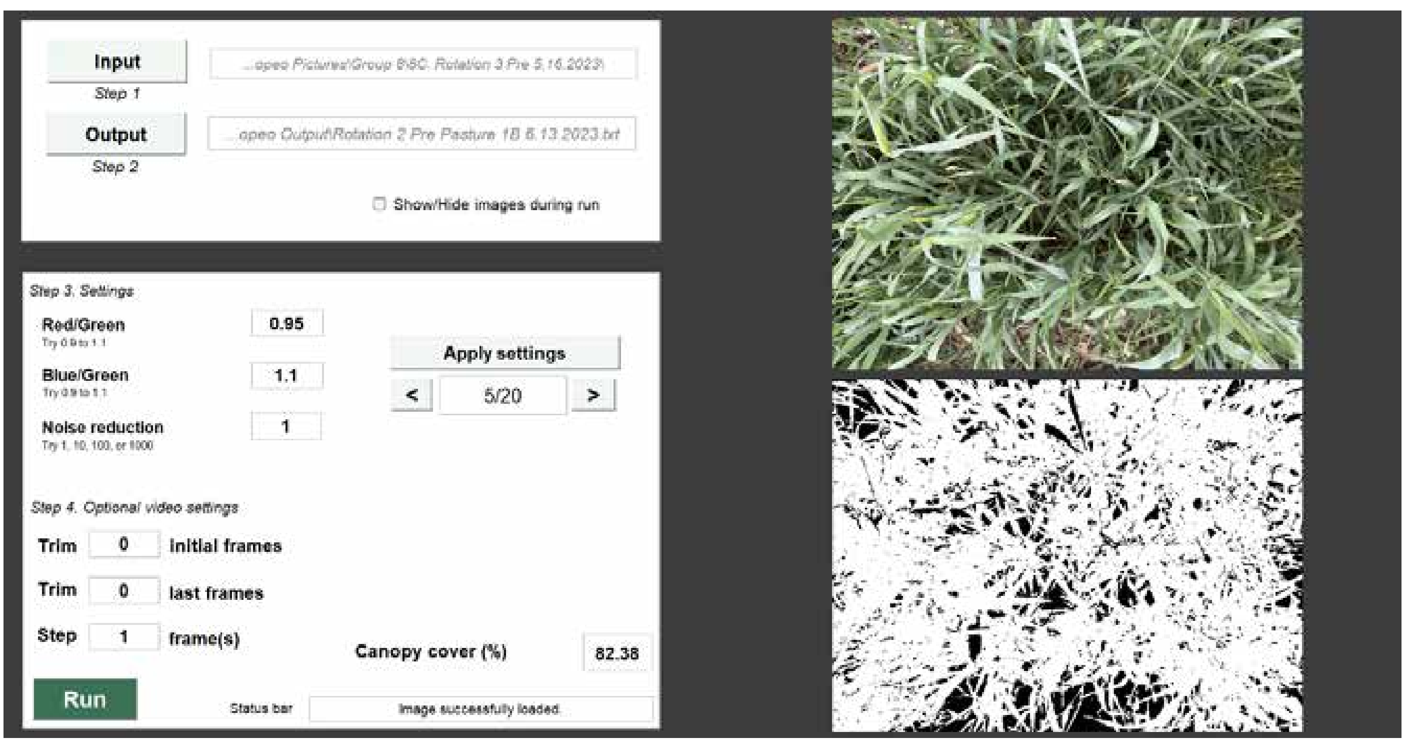

Figure 2. Interface of the Canopeo App. Identified canopy cover was shown as white color and the background was shown as black color in the output image.

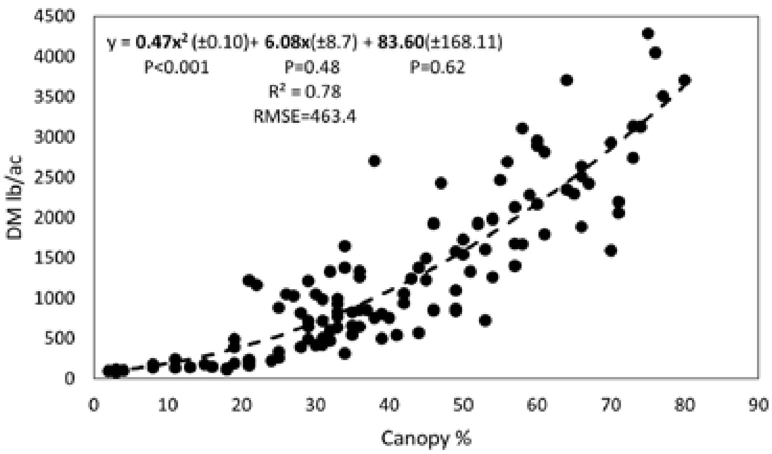

Figure 3. A quadratic regression performed between biomass in dry matter (expressed in lb/ac) and the plant cover in percentage obtained using the CCIA webtool.

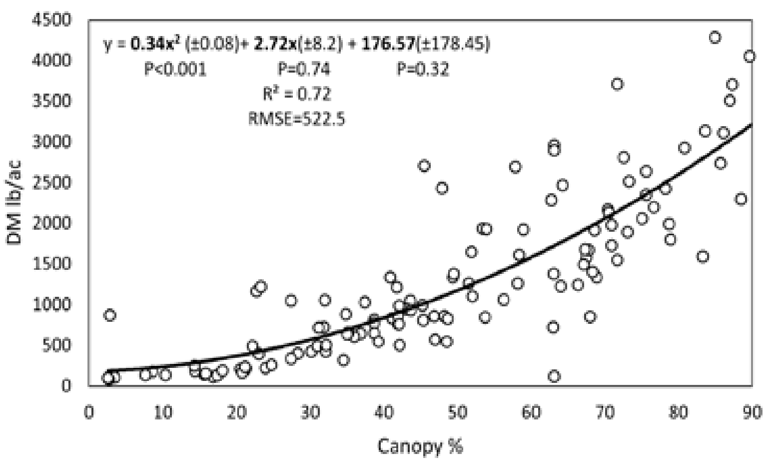

Figure 4. A quadratic regression performed between biomass in dry matter (expressed in lb/ac) and the ground coverage in percentage obtained using the Canopeo tool.

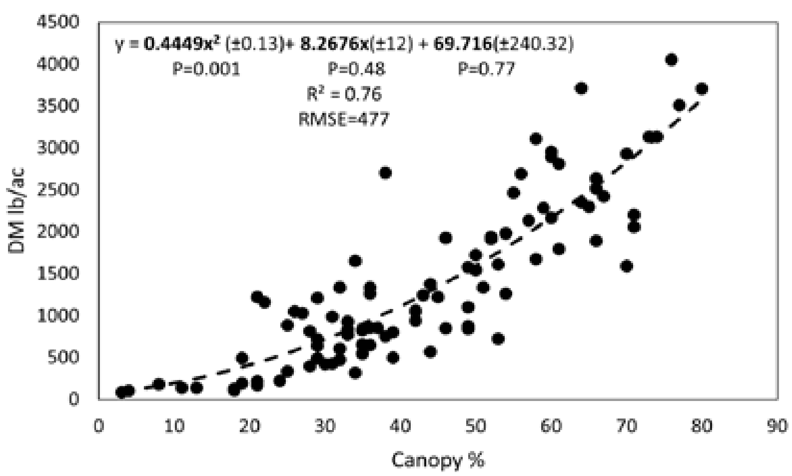

Figure 5. The Training dataset (80% data presented in Figure 3) performed between the predicted biomass (lb DM/ac) obtained using CCIA tool and the measured biomass (lb DM/ac) for cereal rye.

values in the validation dataset, then statistics of the equation estimation performance was assessed using the PROC REG procedure in SAS.

Results

It was found that the quadratic regression fitted the plant cover and cereal rye mass well in our project ($P < 0.0001$), by using plant cover derived from both tools (Figures 3 and 4). The adjusted R^2 of the regression was 0.78 for the CCIA tool (Figure 3), in other words the equation explained 78% of the variation in biomass. Result of using Canopeo showed an adjusted R^2 of 0.72 (Figure 4), or 72% were explained by the equation. These results indicate a strong relationship between the plant cover derived from the two tools and cereal rye mass, suggesting the great potential of using these image analysis tools to facilitate the cereal rye mass estimation by taking field images.

Using the quadratic regression and the plant cover derived from the image analysis tools as the predictor variable, we compared their performance in forage biomass estimation for cereal rye (Figure 7 and 8). By using the CCIA (Figure 7), the R^2 between the predicted vs. measured biomass was 0.82, with a Root Mean Square error (RMSE) of 420 lb/ac, which showed a better estimation performance when compared to that of Canopeo (R^2 of 0.67 and RMSE of 575 lb/ac).

Conclusion

Both plant cover analysis tools proved to be promising for biomass estimation of cereal rye. Using the prediction equation generated from this study, these tools can save time and allow producers to determine

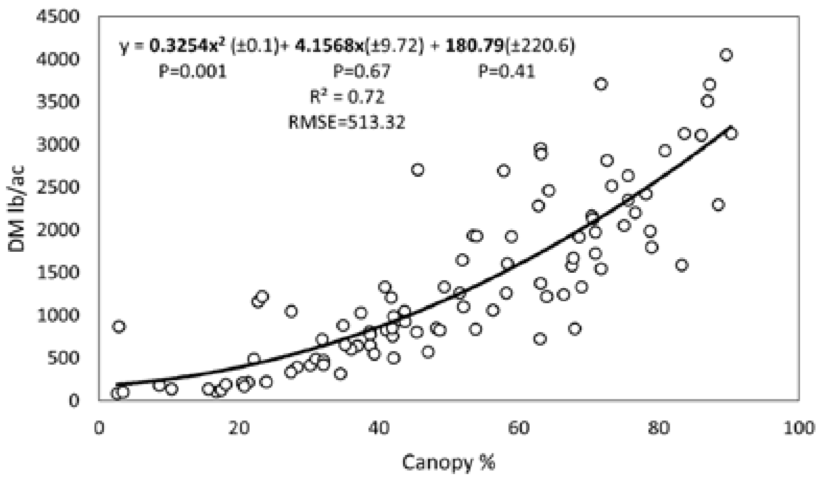

Figure 6. The Training dataset (80% data presented in Figure 4) performed between the predicted biomass (lb DM/ac) obtained using Canopeo tool and the measured biomass (lb DM/ac) for cereal rye.

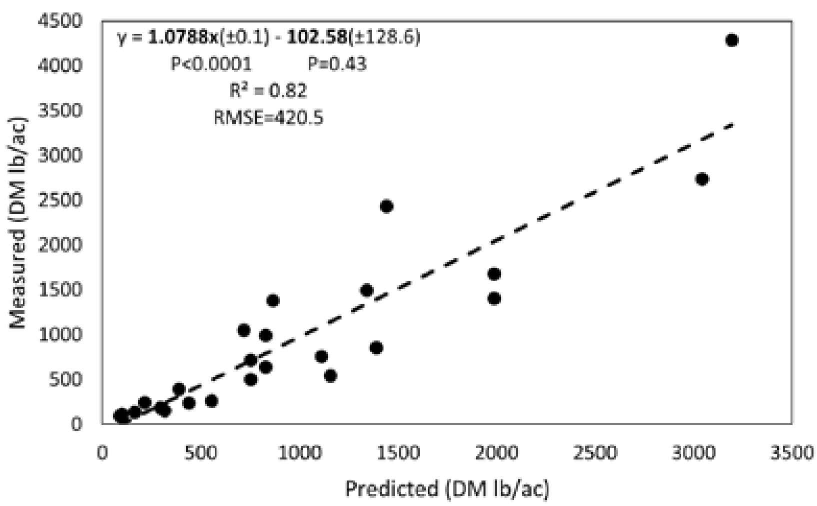

Figure 7. Validating the equation estimation performance between predicted biomass (lb DM/ac) obtained using CCIA tool and the measured biomass (lb DM/ac) for cereal rye.

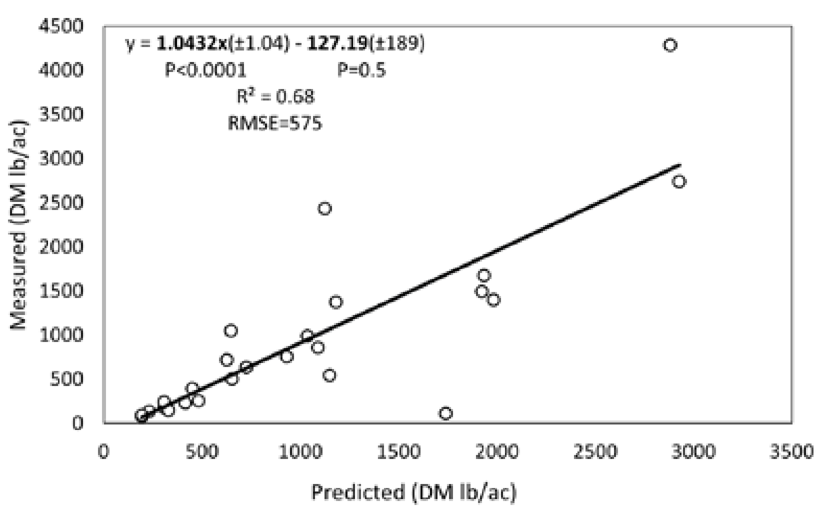

Figure 8. Validating the equation estimation performance between predicted biomass (lb DM/ac) obtained using Canopeo tool and the measured biomass (lb DM/ac) for cereal rye.

appropriate carrying capacity. The imaging analysis approach helps address a significant gap in pasture management by allowing accurate and consistent estimation of biomass with relatively little labor. A detailed comparison based on R^2 and RMSE of the regression analysis demonstrated the CCIA tool outperformed the Canopeo tool for biomass estimation in cereal rye.

Pedro H. J. Fernandes, Graduate student, Animal Science, Lincoln

Shelby L. Davies-Jenkins, Graduate student, Animal Science, Lincoln

Biquan Zhao, Postdoctoral Research Associate, Animal Science and Biological System Engineering, Lincoln

Wei-Zhen Liang, Assistant Professor, Biological Systems Engineering, Scottsbluff

Mary E. Drewnoski, Associate Professor, Animal Science, Lincoln

Yijie Xiong, Assistant Professor, Animal Science and Biological System Engineering, Lincoln

Impact of Constant versus Variable Inclusions of Modified Distillers Grains plus Solubles on Feedlot Cattle Performance and Carcass Characteristics

Paige M. Madison
Rebecca L. McDermott
Isaque F. Vicci
Josh R. Benton
James C. MacDonald
Galen E. Erickson

Summary with Implications

A finishing trial was conducted to evaluate the effects of varying dietary inclusion of modified distillers grains plus solubles compared to a constant inclusion throughout the entire feeding period on finishing cattle performance. Treatments were arranged as a 2 × 2 + 1 factorial with two inclusions of modified distillers grains plus solubles (10% and 25%) that were constant or varying in dietary inclusion, and a corn control (0% modified distillers grains plus solubles). Increasing the inclusion of distillers grains from 0 to 25% increased both DMI and ADG when fed at a constant inclusion of 10 or 25%. When inclusion varied around 10 (0 to 20%) or 25% (15 to 35%) inclusion, only ADG tended to increase and to a lesser degree. Varying the inclusion of distillers grains in the diet due to supply disruptions or incorrect loading may lessen the improvements in animal performance compared to including distillers at a constant rate in the diet every day.

Introduction

Distillers grains in feedlot diets are critically important to Nebraska and surrounding states. Feedlot producers in these areas have shown a willingness to feed 35% or more distillers grains when priced at a discount to corn. However, as the price of distillers grains has increased relative to corn, inclusions have declined. Additionally, inconsistent availability of distillers grains has limited inclusion. A previous study at the University of Nebraska evaluated the effects of varying inclusion of modified distillers grains plus solubles (MDGS) on a weekly basis with two inclusions of grass hay (*2024 Nebraska Beef Cattle Report*, pp. 69–71). This study found that varying inclusion weekly from 15, 20, 25, 30, or 35% (chosen randomly each week) did not negatively impact the performance of finishing cattle when compared to a constant inclusion of 25% of diet DM (both treatments averaged 25% inclusion over the entire feeding period). Variable inclusion was essentially the same as supplying distillers in the diet at the same inclusion every day, and feeding more roughage was unnecessary to help with variable inclusion of distillers as feeding more roughage just increased intake leading to poorer conversions. In that study, distillers grains inclusion never went below 15% inclusion (varied from 15 to 35% inclusion). The impacts of varying the inclusion at lower dietary percentages that may be more typical of many operations today has not been tested. Therefore, the objective of this study was to determine the impact of changing inclusion of modified distillers grains plus solubles throughout the feeding period on animal performance when distillers is fed at an average inclusion of either 10 or 25% of the diet. The hypothesis was that varying inclusion will not be detrimental for these cattle, at least when 25% distillers is included in the diet. With only 10% distillers in the diet, supply disruptions may be more detrimental to animal performance.

Procedure

The experiment was conducted at the Eastern Nebraska Research, Extension and Education Center feedlot near Mead, NE. Four-hundred crossbred beef steers (initial BW= 632 lb; SD = 48 lb) were fed for an average of 191 days. Before the study began, steers were limit-fed a diet of 50% Sweet Bran and 50% alfalfa hay (DM basis) fed at 2% of body weight (BW) for 5 days to equalize gut fill. Cattle were weighted on two consecutive days and averaged to establish an initial BW. The experiment was conducted using a randomized block design, with three body weight (BW) blocks: heavy (2 pens/treatment), medium (4 pens/treatment), and light (2 pens/treatment), based on initial BW.

Table 1. Diet composition (DM-basis) fed to steers containing 0, 10, or 25% modified distillers grains (MDGS) on a constant or variable basis.

	Treatments												
			Variable						Variable				
Ingredient[1]	0% MDGS[2]	10% MDGS Constant	0%	5%	10%	15%	20%	25% MDGS Constant	15%	20%	25%	30%	35%
HMC	40	35	40	37.5	35	32.5	30	27.5	32.5	30	27.5	25	22.5
DRC	40	35	40	37.5	35	32.5	30	27.5	32.5	30	27.5	25	22.5
Corn Silage	15	15	15	15	15	15	15	15	15	15	15	15	15
MDGS	-	10	-	5	10	15	20	25	15	20	25	30	35
Supplement[3]	5	5	5	5	5	5	5	5	5	5	5	5	5
Urea	1.2	1.0	1.2	1.2	1.0	0.67	0.33	0	0.67	0.33	0	0	0

[1] HMC= high-moisture corn, DRC=dry-rolled corn, MDGS=modified distillers grains plus solubles.

[2] 0% MDGS diets contained 2% corn gluten meal (Empyreal, Cargill Wet Milling) for the first 45 days and 1% inclusion the next 45 days to ensure metabolizable protein was not limiting growth. Empyreal replaced the blend of HMC:DRC.

[3] Supplements provided minerals, vitamins, Rumensin (33 g/ton DM), Tylan (8.8 g/ton DM) and different amounts of urea (as noted) due to protein supply.

Table 2. Performance and carcass characteristics of steers fed 0, 10, or 25% modified distillers grains on a constant or variable inclusion basis.

	Treatments[1]						*P*-value			
							Constant		Variable	
Item	0% Control	10% MDGS Constant	10% MDGS Variable	25% MDGS Constant	25% MDGS Variable	SEM	Linear	Quadratic	Linear	Quadratic
Steer Performance										
Initial BW, lb	633	634	633	632	635	0.9	0.20	0.33	0.15	0.53
Final BW[2], lb	1299	1315	1316	1350	1332	12.7	<0.01	0.74	0.08	0.83
DMI, lb/d	22.1	22.3	22.7	23.2	22.7	0.4	0.03	0.61	0.32	0.39
ADG, lb	3.48	3.56	3.57	3.76	3.65	0.066	<0.01	0.69	0.09	0.76
F:G[3]	6.34	6.26	6.34	6.19	6.22	-	0.18	0.87	0.25	0.63
Carcass Characteristics										
HCW, lb	819	828	829	851	840	8.01	<0.01	0.74	0.08	0.84
12th rib fat, in	0.537	0.563	0.584	0.638	0.586	0.024	<0.01	0.62	0.18	0.34
LM area[4], in^2	13.5	13.7	13.7	13.8	13.8	0.134	0.09	0.77	0.23	0.47
Marbling score[5]	531	556	566	552	545	14.4	0.37	0.37	0.61	0.11
Yield grade	3.34	3.40	3.46	3.60	3.46	0.058	<0.01	0.59	0.17	0.34
Abscessed livers, %	38	43	50	37	46	6.09	0.81	0.44	0.42	0.26

[1] The treatments were due to consistency of MDGS inclusion in diet and MDGS inclusion in diet; Control= control diet with no MDGS, 10% MDGS Constant= 10% MDGS inclusion for whole feeding period, 10% MDGS Variable= MDGS inclusion in diet varied from 0–20% and averaged 10% at end of feeding period, 25% MDGS Constant= 25% MDGS inclusion for whole feeding period, 25% MDGS Variable= MDGS inclusion in diet varied from 15–35% and averaged 25% at end of feeding period (DM basis).

[2] Final BW calculated as HCW weight divided by a common dressing percentage of 63%

[3] Analyzed as G:F, the reciprocal of F:G

[4] LM area=longissimus muscle (ribeye) area

[5] Marbling score indicating 400 =small 0 or low choice, and 500=moderate 0 or mid choice quality grade

The treatment design was a 2 × 2 + 1 factorial with one factor being the inclusion of MDGS at either 10% or 25% of the diet, and the other factor is the variability of the MDGS included in the diet (constant or varied weekly). Inclusions included 10% constant or 10% variable, which could vary from 0% to 20% by adjusting inclusions weekly so that at the end of the feeding period, inclusion averaged 10% of diet DM. The other two treatments were 25% constant or 25% variable, which could vary from 15% to 35% adjusting weekly to average 25% of diet DM at the end of the feeding period. For 10% variable inclusion, either 0, 5, 10, 15, or 20% was fed (chosen randomly by week). For the 25% variable inclusion, either 15, 20, 25, 30 or 35% was fed (chosen randomly by week). A negative control that included 0% MDGS was also fed to evaluate response above a corn control. Inclusion variations occurred weekly on Wednesdays and any dietary change was made that morning with no consideration of previous diet. Each week's MDGS inclusion was randomly determined before the start of the experiment. Diet compositions are shown in Table 1. Cattle on the control diet were fed a branded corn gluten meal product (Empyreal, Cargill Wet Milling, Blair, NE) on a phase-out schedule to meet the metabolizable protein requirements for calf-fed steers during the first 90 days, assessed using the NASEM nutrient requirements of beef cattle model. These cattle received an inclusion of 2% for 45 days, then 1% for 45 days, and then 0% Empyreal was included in diet for the rest of the feeding period. On day 1, steers received 200 mg trenbolone acetate and 40 mg estradiol (Revalor-XS; Merck Animal Health).

In this generalized randomized block design, cattle were blocked by initial BW into one of 3 blocks, and assigned randomly to pen within block. Pen was considered the experimental unit, and the five treatments were assigned randomly to pens, with each treatment replicated across 8 pens with ten steers per pen, totaling forty pens. Cattle in the heavy and medium blocks were supplemented with 300 mg ractopamine/steer daily (Optaflexx; Elanco Animal Health) for the last 28 days of the feeding period and the light block was supplemented during the last 42 days (all steers started on Optaflexx on the same day). Heavy and medium block cattle were fed for 184 days, light block cattle were fed for 198 days, and they were harvested at a commercial abattoir in Omaha, NE (Greater Omaha). Hot carcass weight (HCW) and liver score data were collected during the harvest. Other carcass traits were collected using camera data 48 hours after slaughter that included 12th rib fat, longissimus muscle (LM) area, and USDA marbling score. USDA yield grade (YG) data were calculated from measured carcass traits assuming a 2% kidney, pelvic, heart fat.

Data were analyzed using the MIXED procedure of SAS as a 2 × 2 + 1 factorial with pen as the experimental unit. The model included block and treatment as fixed effects, and contrast statements were used to determine the linear and quadratic effects of MDGS inclusion for consistent and variable treatment with both lines fitted through the 0% MDGS control as an intercept. Since the inclusions were not equally spaced, PROC IML was used to determine the correct coefficients to determine the polynomial effects. The proportion of steers with liver abscesses was evaluated using the Glimmix procedure of SAS using a binomial distribution and a logit-link function. Significance was set at $P < 0.05$ with tendencies declared at $P < 0.10$.

Results

During the trial, 10 steers died and 2 were removed from trial. All deads and removals were from complications of respiratory issues or injuries. No deaths or removals from trial were treatment related (Control: 3 head; 10% variable: 2 head; 10% constant: 1 head; 25% variable: 4 head; 25% constant: 2 head).

No interactions were observed between MDGS consistency and MDGS diet inclusion for any performance or carcass characteristics so the linear and quadratic effects of increasing inclusion of distillers grains are presented for the constant and variable approaches. Increasing the inclusion of MDGS from 0 to 25% of the diet and feeding it consistently linearly increased dry matter intake ($P = 0.03$), average daily gain ($P < 0.01$), hot carcass weight ($P < 0.01$), and final body weight ($P < 0.01$). Fat thickness ($P < 0.01$), ribeye area (LM area; $P = 0.09$), and yield grade ($P < 0.01$) were also increased by including MDGS from 0 to 25% of the diet when inclusion was consistent each day. Improvements in intake, weights, and gain have commonly been reported from feeding increasing dietary inclusion of MDGS within this range. In the current study, there was no improvement in feed conversion with increasing concentrations of MDGS, suggesting the improvement in performance and carcass characteristics resulted from greater intakes.

Increasing the average dietary concentration of MDGS from 0 to 25% but allowing the concentrations to vary from 0 to 20% for the 10% inclusion, and 15 to 35% in the 25% inclusion also tended to increase average daily gain ($P = 0.09$) and hot carcass weight ($P = 0.08$) but less significantly and to a lesser degree. No other improvement in animal performance was observed when increasing MDGS from 0 to 25% in a variable manner. When comparing the performance and carcass characteristics of the constant and variable approaches, steers fed 10% MDGS performed similarly. While the performance appeared to drop off for steers fed 25% MDGS in a variable approach compared to feeding 25% consistently, there were no statistical differences between constant and variable inclusion when MDGS was fed at 25%. Therefore, we cannot conclude that performance was worse when distillers grains were fed at variable inclusions. Nevertheless, there was less improvement in animal performance when MDGS was fed using the variable approach compared to feeding constant inclusions. There were no differences in the percentage of abscessed livers across any of the treatments ($P > 0.25$).

Conclusion

Varying inclusion of MDGS on a weekly basis in finishing diets did not affect the performance of feedlot cattle in comparison to constant MDGS inclusion, but may lessen the expected improvement in animal performance from feeding 25% MDGS.

Paige Madison, graduate student

Rebecca McDermott, research technician

Isaque Vicci, graduate student, ENREEC

Josh Benton, postdoc, Beef Feedlot Unit Director, ENREEC

Jim MacDonald, professor, Animal Science, Lincoln

Galen Erickson, professor, Animal Science, Lincoln

Funding provided by Nebraska Corn Board. Products used on cattle were provided by Elanco Animal Health, Zoetis, and Merck Animal Health

Impact of Full-Fat Wet Distillers Grains Inclusion in Steam-Flaked Corn Based Finishing Diets

Gatlin Hissong
Bill Dicke
Doug Smith
Andrea Watson
Galen Erickson

Summary with Implications

Steam- flaked corn and distillers grains are common feed ingredients in finishing rations, but the interaction between the two is not well understood. A finishing trial at a commercial feedlot using 700 calf-fed heifers was conducted to evaluate cattle performance when fed 18 or 30% (dry matter basis) full-fat wet distillers grains plus solubles in steam-flaked corn based diets with 8% roughage (hay + corn silage). No effects on cattle performance were observed due to distillers grains inclusion in the diet. Final body weight, dry matter intake, average daily gain, feed conversion, and hot carcass weight were not statistically different between treatments when expressed on a carcass-adjusted basis. These data suggest flexibility of including 18 to 30% of the diet when using full-fat (13% fat) wet distillers grains plus solubles even in diets based on steam-flaked corn.

Introduction

Steam-flaking corn has become a widespread practice in large feed yards due to its performance and economic benefits. Steam-flaked corn (SFC) has shown positive impacts on feed conversion due to increased total-tract digestibility and reduced feed intake. Fuel, water, equipment, and labor to operate the mill combine to make steam-flaking corn a large investment. However, moisture appreciation and improved feed conversion due to increased starch availability add value that is not possible with dry-rolled corn.

Feeding ethanol by-products is also very common. Distillers grains have a high energy density, protein content, and are often competitively priced in relation to corn. Although SFC and distillers grains are both commonly fed, there are conflicting results on whether adding distillers grains improves performance in diets based on SFC, unlike dry-rolled or high-moisture corn. Response to adding distillers grains resulted in better F:G and ADG in diets based on high-moisture corn or dry-rolled corn, but in diets with SFC, limited improvement was observed when wet distillers grains plus solubles (WDGS) replaced SFC (*2007 Nebraska Beef Cattle Report*, pp. 33–35). Based on these data, distillers inclusion was generally limited to less than 20% of diet dry matter (DM). At low inclusion, distillers grains are primarily included as a protein source. More recently, ADG was improved when 10–30% modified or wet distillers were fed in SFC-based diets compared to not including distillers, and F:G improved linearly up to 30% inclusion of WDGS, but not modified (*2022 Nebraska Beef Cattle Report*, pp. 57–59). As a result, perhaps the previous limits of 20% inclusion of WDGS do not apply in diets based on SFC. At times, price of distillers make it competitive to replace more than 20% corn in feedlot diets. Therefore, the objective of this study was to evaluate 18 or 30% DM inclusions of WDGS in SFC-based finishing diets on feedlot performance in a commercial setting.

Procedure

A feedlot study was conducted at a commercial feedyard (Hi-Gain Feedlot, Farnam, NE) with backgrounded heifers (n=700; initial BW = 801 lb). The study was designed as a completely randomized design using two different diet inclusions of WDGS. Before processing, the heifers were sorted randomly by alternating pens after every 2 heifers. Treatments were replicated 6 times for a total of 12 pens. Pen size and bunk space were equal within each replication in relation to the number of head in the pen.

The heifers were received over a span of three days and limit fed at 2.4% of body weight for 6–9 days depending on date of arrival to equalize gut fill. Group weights were conducted on the day of processing and the heifers were not fed in the morning before being weighed. On day 1, cattle were implanted with a Revalor-IH (Merck Animal Health) implant. On day 59, they were re-implanted with Revalor-200 (Merck Animal

Table 1. Composition of steam-flaked corn based finishing diets with different levels of wet distillers grains plus solubles (WDGS)

Ingredient, % DM	18% WDGS	30% WDGS
Steam-flaked corn	65.3	53.3
WDGS	18.0	30.0
Hay	5.0	5.0
Corn Silage	6.0	6.0
Liquid Supplement[1]	5.7	5.7
Diet Nutrient Analysis, % DM		
CP	17.0	19.7
Fat[2]	4.3	5.5

[1]Supplement was 58.9% CP, 65% DM, and provided 340 mg/animal Rumensin, 70 mg/animal Tylan, and 0.45 mg/animal MGA daily.

[2]The WDGS fed contained 13% fat until the last 6 weeks on feed. Values shown in the table are for this time period. For the last 6 weeks on feed, fat concentration in the diets was 3.4 (18% WDGS treatment) and 4.0% (30% WDGS treatment).

Table 2. Effect of wet distillers grains plus solubles inclusion on performance characteristics, deads-out analysis

Performance	18% WDGS	30% WDGS	SEM	*P* -value
Carcass-adjusted Performance[1]				
Initial BW, lb	801	803	13.4	0.94
Final BW, lb	1327	1338	7.63	0.33
Dry Matter Intake, lb/d	23.5	23.9	0.25	0.27
Average Daily Gain, lb	3.52	3.58	0.06	0.49
Feed:Gain	6.67	6.67	—	0.99
Hot carcass weight, lb	836	843	4.82	0.34
Live performance				
Final Live BW, lb	1314	1301	10.5	0.41
Dressing %	63.6	64.8	0.60	0.08
Live Average Daily Gain, lb	3.43	3.33	0.11	0.52
Live Feed:Gain	6.84	7.16	—	0.22

[1]Carcass adjusted performance calculated using a common 63% dress for all cattle.

Health). Cattle were on feed a total of 144 d and harvested at a commercial plant in Grand Island, NE (JBS). Final weights were yield adjusted by dividing hot carcass weight (HCW) by a 63% dressing percentage.

All cattle were backgrounded on a corn silage diet with no SFC before feedlot entry. Upon arrival at the feedlot, all cattle were fed a diet containing 35% WDGS and no SFC until trial initiation. In addition to WDGS, the starter ration was made up of corn silage, hay, and supplement. Cattle were then adapted to the finisher ration over 19 d and remained on the same treatment finisher ration for the remainder of the feeding period. Four step-up diets were used with the original diet being fed in the morning and the new diet being fed in the afternoon. The first step up diet for both treatments contained 30% SFC. The 18% WDGS treatment cattle started with 24% WDGS in the diet in step 1 with inclusion decreasing over time. The 30% WDGS treatment had constant WDGS inclusion in the diet throughout the step-up period. Roughage DM inclusion was approximately 8.0% for both treatments, from a combination of hay and corn silage. The finishing diet composition is shown in Table 1.

The mixed procedure of SAS was used to analyze the data. Treatment was a fixed effect and data were analyzed 2 ways, all cattle removed from trial were not included in the dataset (deads out analysis) as well as a deads included analysis. In the 18% WDGS treatment, 4 head (1.14%) were removed. In the 30% treatment, 8 head (2.29%) were removed.

Results

For the deads-out analysis, no significant differences were found between treatments for initial body weight (BW), final BW, dry matter intake (DMI), average daily gain (ADG), feed:gain (F:G), or HCW ($P \geq 0.27$; Table 2). Initial BW was similar between treatments, averaging 802 lb ($P = 0.94$). Cattle DMI was also not statistically different with both treatments averaging 23.7 lb/d ($P = 0.27$). The F:G averaged 6.67 ($P = 0.99$), and ADG averaged 3.55 lb/d ($P = 0.49$). Carcass-adjusted final BW and HCW were also statistically similar, averaging 1,332 lbs ($P = 0.33$) and 840 lbs ($P = 0.34$), respectively. Live performance suggested similar results. Live final body weight averaged 1,308 lb ($P = 0.41$). Live ADG averaged 3.38 lb/d ($P = 0.52$) between treatments and F:G averaged 7.00 ($P = 0.22$). Dressing percentage tended to be impacted ($P = 0.08$) with heifers fed 30% WDGS having a greater dressing percentage compared to heifers fed 18%.

Data were also analyzed with deads included (Table 3). All performance measures were not different between treatments ($P \geq 0.27$). Final carcass-adjusted BW averaged 1310 lb ($P = 0.80$) with 3.39 lb ADG ($P = 0.78$) and 6.93 F:G ($P = 0.56$). Dressing percent was greater for the

Table 3. Effect of wet distillers grains plus solubles inclusion on performance characteristics, deads-in analysis

Performance	18% WDGS	30% WDGS	SEM	*P* -value
Carcass-adjusted Performance[1]				
Initial BW, lb	801	803	13.4	0.94
Final BW, lb	1312	1307	11.9	0.80
Dry Matter Intake, lb/d	23.4	23.6	0.28	0.67
Average Daily Gain, lb	3.41	3.37	0.11	0.78
Feed:Gain	6.86	7.00	—	0.56
Hot carcass weight, lb	826	823	7.52	0.79
Live performance				
Final Live BW, lb	1309	1290	13.1	0.33
Dressing %	63.1	63.8	0.19	0.03
Live Average Daily Gain, lb	3.40	3.26	0.12	0.45
Live Feed:Gain	6.91	7.25	—	0.27

[1]Carcass adjusted performance calculated using a common 63% dress for all cattle.

30% WDGS treatment (*P* = 0.03), but HCW was not different between treatments (825 lb; *P* = 0.79).

Conclusion

Including 18 or 30% of diet DM as WDGS in steam-flaked corn diets resulted in no differences in cattle performance. This is beneficial because it increases flexibility when formulating rations. Having fewer restrictions when formulating diets can result in a lower cost, more optimized diet. Also, more adjustments can be made due to the availability of byproducts or flaker capacity without jeopardizing cattle performance. These data apply to WDGS that contained 13% fat which is atypical today so additional data are needed as more and more plants remove more and more corn oil.

Gatlin Hissong, Masters of Applied Science graduate student

Bill Dicke, Dicke Consulting LLC

Doug Smith, Performance Plus

Andrea Watson, former Research Associate Professor

Galen Erickson, Professor, Animal Science, University of Nebraska, Lincoln.

Effect of Feeding Palm Oil on Finishing Cattle Performance, Carcass Characteristics, and Methane Production

Anna M. Kobza
Rebecca L. McDermott
Mitch C. Norman
Josh R. Benton
Long Zou
Jim C. MacDonald
Galen E. Erickson

Summary with Implications

Increased demand for biofuel production has increased demand and price of commonly fed supplemental fat sources in beef operations. This finishing study evaluated the effect of feeding palm oil products on performance, carcass characteristics and methane production of feedlot finishing steers. Dietary treatments were feeding no supplemental fat or feeding one of the following fat sources at 4% of diet dry matter: whole palm oil, palm stearin, palm olein, or corn oil. Feeding supplemental fat, regardless of source, increased final body weight, average daily gain, and hot carcass weight. Feeding supplemental fat had no effect on dry matter intake, but an improvement in average daily gain led to improved feed conversion compared to cattle fed diets without supplemental fat. Marbling score was greater in carcasses of cattle consuming olein and stearin oil; however, no other differences in carcass characteristics were observed. A subset of pens sourced from the no oil or whole palm oil treatments were selected to rotate through chambers that measure enteric methane and carbon dioxide. Feeding whole palm oil reduced enteric methane yield (g/lb of DMI) by 14.8% compared to feeding no oil. These results suggest palm oil products can be used as a fat source for finishing cattle to improve feed efficiency and decrease methane production.

Introduction

Fat plays several dietary roles, but the primary reason for supplemental fat inclusion in feedlot finishing diets is to increase the energy density, without increasing the starch content. In a survey conducted of feedlot consulting nutritionists in 2016, 54.2% of nutritionists' clients were using added fat in feedlot diets. Of the feedlots that used added fat, 29.5% used tallow, 25% used a fat blend, 16.7% used yellow grease, and only 4.17% used corn oil. A combination of the increased demand for biofuel and increased production has caused an increase in the price of fat sources as well as variability of those prices. Because of this, the proportion of feedlots using supplemental fat today is likely lower. Palm oil is the most widely traded vegetable oil globally but does not qualify for biofuel credit. Limited research is available on using palm oil in feedlot finishing diets typical of the U.S. but may be a cost-effective supplemental fat in the future. The objectives of this experiment were 1) to evaluate the effect of feeding palm oil or other palm products on feedlot performance, carcass characteristics, and 2) to determine the effect of palm oil inclusion in finishing diets on methane production.

Procedure

A finishing study was conducted at the Eastern Nebraska Research, Extension and Education Center using 320 crossbred steers (initial BW 836 lb ± 32) in a randomized block design. Steers were limit-fed at 2% of BW for five days to equalize gut fill, then weighed individually for 2 consecutive days to determine initial body weight. Cattle were assigned randomly to pens based on initial BW and blocked into a light and heavy group (4 replicates/block), so that there were 8 steers per pen, across 40 total pens (8 replicates/treatment). An unstructured treatment design was used with 5 dietary treatments (Table 1) evaluating different sources of supplemental fat included at 4% of diet DM. Total dietary fat concentrations were 8.1% of diet DM for diets containing supplemental fat. The four sources of supplemental fat included: whole palm oil, palm stearin, palm olein, and corn oil. Palm oil products used in the study were refined bleached and deodorized. Palm olein and palm stearin are derived through fractionation of whole palm oil. Palm olein has greater unsaturated fatty acid content, whereas palm stearin has greater saturated fatty acid content compared to whole palm oil. A neg-

Table 1. Diets fed to finishing steers to compare different types of palm oil compared to a negative control (no added oil) and a positive control (added corn oil) on finishing performance, carcass characteristics, enteric methane emissions, and meat characteristics.

	Dietary Treatment				
Item	No Oil	Corn Oil	Whole Palm	Olein	Stearin
Ingredient, % of DM					
Dry-rolled corn	32.5	30.5	30.5	30.5	30.5
High-moisture corn	32.5	30.5	30.5	30.5	30.5
MDGS [1]	15	15	15	15	15
Corn silage	15	15	15	15	15
Corn Oil (distillers)	-	4	-	-	-
Whole Palm	-	-	4	-	-
Palm Olein	-	-	-	4	-
Palm Stearin	-	-	-	-	4
Supplement [2]	5	5	5	5	5
Nutrient Composition, DM Basis					
Dry Matter, %	68.2	69.1	69.1	69,1	69.1
NDF, %	16.3	16.0	16.0	16.0	16.0
Crude Protein, %	13.3	13.0	13.0	13.0	13.0
Crude Fat, %	4.2	8.1	8.1	8.1	8.1

[1] MDGS = modified distillers grains plus solubles

[2] Supplement (UNL BN-2304) provides Rumensin (30 g/ton of DM) and Tylan (8.8 g/ton of DM) along with minerals and vitamins to meet or exceed nutrient requirements, along with urea for rumen degradable protein needs.

ative control treatment was included with 0% supplemental fat, where total dietary fat concentration was 4.2% of diet DM. Steers were implanted with a Revalor XS on day 1 of the trial. After 155 days on study, steers were harvested at a commercial abattoir, where hot carcass weight (HCW) and liver abscess scores were recorded. Dietary NEm and NEg values were calculated based on intake and performance by cattle, using nutrient requirement modeling from the NRC (1996) equations. Marbling score, ribeye area (REA) and 12th rib fat thickness were recorded after a 48-hr chill and USDA yield grade calculated.

A sub-set of steers (4 pens of whole palm oil and 4 pens of no oil) rotated through 2 pen-scale methane chambers for methane and carbon dioxide production measurements.

Table 2. Effects of diets containing no oil, corn oil, or fractions of palm oil on finishing cattle performance and carcass characteristics.

	Treatments[1]						
Items	No Oil	Corn Oil	Whole Palm	Olein	Stearin	SEM[2]	P-value[3]
Initial BW, lb	836	836	836	836	836	0.6	0.92
Final BW, lb	1480^{b}	1520^{a}	1495^{ab}	1509^{a}	1519^{a}	10.1	0.04
DMI, lb/d	26.4^{ab}	27.1^{a}	25.7^{b}	26.5^{ab}	26.3^{ab}	0.29	0.03
ADG, lb	4.15^{b}	4.42^{a}	4.25^{ab}	4.35^{a}	4.40^{a}	0.065	0.04
F:G	6.36	6.14	6.05	6.10	5.98		<0.01
F:G Improvement, %[4]	-	3.56	5.21	4.32	6.35		
NEm, Mcal/lb[5]	1.27^{c}	1.30^{b}	1.31^{ab}	1.30^{ab}	1.32^{a}	0.008	<0.01
NEg, Mcal/lb[5]	0.56^{c}	0.57^{b}	0.59^{ab}	0.58^{ab}	0.59^{a}	0.006	<0.01
HCW, lb	932^{b}	959^{a}	942^{ab}	951^{a}	957^{a}	6.4	0.03
Marbling Score[6]	523^{ab}	506^{b}	505^{b}	552^{a}	551^{a}	10.4	0.01
12th-rib fat, in	0.71	0.73	0.73	0.72	0.73	0.023	0.94
Ribeye Area, in^{2}	14.7	14.7	15.0	14.8	14.8	0.16	0.74
Liver Abscesses, %	13.4	12.5	14.3	12.7	12.7	-	0.99

[1] No Oil = negative control, 0.0% added fat; Corn Oil = positive control, 4.0% corn oil; Whole Palm= 4.0% whole palm oil; Olein = 4.0% olein palm oil; Stearin = 4.0% stearin palm oil.

[2] Standard error of the mean.

[3]Means within a row with different superscript letters differ, $P < 0.05$.

[4]Percent improvement in F:G from the negative control.

[5]Dietary NEm and NEg values calculated based on intake and performance by cattle, using the NRC (1996) equations.

[6]Leading digit in marbling number indicates marbling score; 200=trace^{00}, 300=slight^{00}, 400=small^{00}, 500=modest^{00}, 600^{00}=moderate, 700^{00}=slightly abundant, 800^{00}=moderately abundant, 900^{00}=abundant. Following digits indicate degree of marbling within marbling score.

Table 3. Effects of diets containing no oil or whole palm oil on gas emissions.

Items	Treatment[1]		SEM[2]	P-Value
	No Oil	Whole Palm		
Gas Emissions measured in chambers				
DMI, lb/d (in Barn)	25.3	25.2	0.46	0.84
CH_4,g/steer	178.4	147.4	6.28	0.01
CH_4,g/lb of DMI	7.03	5.99	0.279	0.04
CO_2, g/steer	7108	6860	452.6	0.71
CO_2, g/lb of DMI	279.3	277.2	16.05	0.93
CH_4:CO_2	0.026	0.023	0.0083	0.03
Estimated production over feeding period				
DMI, lb/d (in pen)	26.4	25.7	0.29	0.10
ADG, lb	4.15	4.25	0.066	0.26
CH_4,g/steer	185.7	154.0	7.27	0.02
CH_4,g/lb of ADG	44.7	36.2	1.73	0.01

[1] No Oil = negative control, 0.0% added fat; Whole Palm= 4.0% whole palm oil

[2] Standard error of the mean.

Cattle were fed and housed within a sealed barn fitted with an exhaust fan capable of sampling air flow for methane and carbon dioxide concentration while measuring total volume of air flow. Selected pens were rotated through the calorimetry barn on a 7-day schedule with 5 days of continuous monitoring, followed by 1 day of monitoring emissions from manure accumulation, the barns were cleaned, and then emissions were monitored for 1 day from a clean pen. Performance data, carcass data and gas emissions data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit, and block as a fixed effect.

Results

Performance

Performance data are shown in Table 2. Cattle consuming corn oil, olein oil and stearin oil were all heavier ($P = 0.04$) at harvest than cattle consuming no oil but were not different ($P > 0.11$) from each other or from those fed whole palm oil.

Dry matter intake (DMI) of cattle consuming no oil, whole palm oil and stearin oil were not statistically different; however, cattle fed corn oil had greater DMI than those fed whole palm oil ($P = 0.03$). Cattle fed corn oil, olein oil and stearin oil all had greater average daily gain (ADG) than cattle consuming no oil ($P = 0.04$) but were not different ($P > 0.12$) from those fed whole palm oil, which was intermediate and not different than no oil. Adding fat improved feed conversions as all diets including added fat improved F:G compared to cattle fed no supplemental fat. Cattle consuming diets containing stearin had the greatest improvement in F:G followed by those fed whole palm, olein and corn oil compared to no oil with each improving conversion by 6.35, 5.21, 4.32 and 3.56%, respectively. Feeding diets containing additional fat resulted in greater ($P < 0.01$) NEm and NEg concentration (derived from performance) than those containing no supplemental fat.

For carcass characteristics (Table 2), HCW of cattle consuming corn oil, olein oil, and stearin oil were greater ($P = 0.03$) than those consuming no oil, but carcasses of cattle fed no oil and whole palm oil were not different from each other. Marbling scores were greater ($P = 0.01$) for cattle fed olein and stearin oil than those fed corn and whole palm oil, which were no different than those fed no supplemental fat. There were no differences in 12th rib fat, REA or liver abscess incidence among treatments ($P > 0.74$).

Methane

Gas emissions were evaluated in cattle fed no oil and whole palm oil treatments (Table 3). Total grams of carbon dioxide produced per steer was not different ($P = 0.71$) from each other. However, total methane (g/d) and methane yield (g/lb of DMI) were 17.4 and 14.8% less, respectively ($P < 0.04$) for cattle consuming whole palm oil than those fed no oil. These results are similar to those reported previously (*2019 Nebraska Beef Cattle Report*, pp. 60–62) where a 13% reduction in total methane and methane per pound of DMI was observed when cattle were fed corn oil relative to those fed no oil in a similar finishing feedlot diet. Methane produced per pound of ADG for cattle fed whole palm oil was reduced ($P < 0.01$) by 23.5% compared to cattle fed no supplemental oil.

Conclusion

Feeding supplemental fat in finishing diets increased carcass weight gains of finishing cattle compared to feeding no supplemental fat but had minimal impact on intake. As a result, feed conversions were improved for cattle consuming diets containing fat, but no differences were detected between sources. Feeding fat did not impact carcass traits. Adding supplemental fat reduced methane emissions by 17.4% in cattle fed whole palm oil compared to no oil. Feeding palm oil products in feedlot finishing diets may be an economical fat source that improves conversion and reduces methane production.

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Anna M. Kobza, graduate student

Rebecca C. McDermott, research technician
Mitch M. Norman, former research technician

Josh R. Benton, postdoc, beef feedlot unit director, ENREEC

Long Zou, Bunge, St. Charles, MO

James C. MacDonald, professor, Animal Science, Lincoln

Galen E. Erickson, professor, Animal Science, Lincoln

Acknowledgements:
Funding for this study was provided by Bunge. Products used in this study were provided by Elanco Animal Health and Merck Animal Health.

Impact of Feeding Distillers Grains Compared to New Fractionated Distillers Grains (Solbran) on Feedlot Cattle Performance and Enteric Methane

Debora G. Sousa
Rebecca L. McDermott
Mitch M. Norman
James C. MacDonald
Rick Stock
Ryan A. Mass
Galen E. Erickson

Summary with Implications

This study evaluated feeding wet or dry traditional distillers grains with wet and dry fractionated distillers (Solbran) fed at 40% of diet DM compared to a corn control diet on enteric methane emissions and performance. Compared to the control, there was no difference in carbon dioxide production, but there was an increase in methane production in the steers fed fractionated distillers compared to conventional distillers. Feeding steers traditional or fractionated distillers grains increased consumption, increased gain, but improved conversions only for steers fed WDGS, while steers fed the other distillers grains had worse or the same feed conversions as steers fed the control corn diet. The ethanol plant processing methods increased the intake of steers fed fractionated distillers grains but did not affect gain or feed efficiency. In terms of moisture content, steers fed wet distillers grains had lower intake, but similar gain to steers fed dry distillers grains. This resulted in better feed efficiency for the steers fed wet distillers grains.

Introduction

Distillers grains from ethanol production can be dried and marketed as dry, modified, or wet distillers grains, with wet distillers having more energy when fed to cattle (*2011 Nebraska Beef Cattle Report*, pp. 50–52). More recently, ethanol plants are interested in fractionation to produce high-protein distillers grains for aquaculture, poultry, and swine. Another type of distillers feed will be produced that is a combination of distillers solubles (syrup) and the fiber or bran component of the corn kernel (Solbran, ICM, Colwich, KS) that is targeted mainly for cattle. There is not much information on the use of this feed on cattle performance. Increasing the inclusion of dry Sobran in the finishing diet of feedlot cattle reduces performance (weight gain efficiency) but increasing the inclusion of wet Solbran does not (*2024 Nebraska Beef Cattle Report*, pp. 65–68). However, few data are available on impact of distillers grains inclusion in feedlot diets on enteric methane, and no data available feeding fractionated distillers on enteric methane. The objective of this study was to evaluate the energy value of dry and wet fiber plus syrup compared to traditional wet and dry distillers grains plus solubles using cattle finishing performance. The objective of this study was to evaluate the effect of inclusion of distillers grains types on performance, methane, and carbon dioxide production of feedlot cattle, compared to feeding corn to finishing cattle.

Procedure

The experiment was conducted at the Eastern Nebraska Research, Extension, and Education Center near Mead, NE. Steers were assigned randomly to pens within block. The experiment consisted of a total of 32 pens with 8 steers per pen. Treatments were assigned randomly to pens, accounting for the control treatment having 16 pens (128 steers) and each distillers treatment having 4 pens (32 steers) each.

The experiment was conducted in a randomized block design, with three BW blocks: heavy, medium, and light, where initial weight was used as a blocking factor. The initial live weight was determined using the average of two weights from two consecutive days. Before the weights, the animals had feed restricted to 2% of live body weight for 5 days, during which time the diet was composed of 50% alfalfa hay and 50% Sweet Bran (DM basis). This procedure was performed to equalize gut fill. Pen was considered the experimental unit, and the treatments were assigned randomly to pens. The steers received Revalor-IS (80 mg trenbolone acetate and 16 mg of estradiol; Merck Animal Health) the medium and heavy block steers on day -1 and the light block steers on d 13 and were re-implanted on day d 81 with

Table 1 Diets fed to finishing steers to evaluate methane production of new fiber plus syrup distillers fed wet (Wet SOLBRAN) or new fiber plus syrup distillers fed dry (Dry SOLBRAN) compared to dry distillers grains plus solubles (DDGS) or wet distillers grains plus solubles (WDGS). All ingredient inclusions are % of diet DM.

	Treatments[1]				
Item	Control	DDGS	Dry SOLBRAN	WDGS	Wet SOLBRAN
Ingredient[2]					
HMC	39	20	20	20	20
DRC	39	20	20	20	20
Corn silage	15	15	15	15	15
DDGS	-	40	-	-	-
Dry FS	-	-	40	-	-
WDGS	-	-	-	40	-
Wet FS	-	-	-	-	34
Syrup	-	-	-	-	6
Empyreal	2	-	-	-	-
Supplement[3]	5	5	5	5	5
Analyzed composition, %					
CP	13.12	16.73	13.38	17.33	15.44
ADF	6.47	7.39	10.48	11.97	11.59
NDF	14.57	25.22	26.94	28.50	27.39
EE	3.51	5.99	3.93	5.91	5.55
Ca	0.81	0.89	0.90	0.91	0.95
P	0.26	0.62	0.72	0.52	0.83
K	0.47	0.94	1.19	0.81	0.72
S	0.13	0.34	0.35	0.33	0.38

[1] Treatments were due to byproduct type in the diet; Control= control diet with no byproducts inclusion; DDGS = inclusion of 40% dry distillers grain plus solubles; Dry SOLBRAN = inclusion of 40% dry fiber plus syrup; WDGS = inclusion of 40% wet distillers grain solubles; Wet SOLBRAN= inclusion of 40% wet fiber plus syrup; (DM basis).

[2]HMC=high-moisture corn, DRC = dry-rolled corn, DDGS= dry distillers grain plus solubles, Dry FS = dry fiber plus syrup, WDGS= wet distillers grain plus solubles, Wet FS = wet fiber plus syrup, Empyreal is branded corn gluten meal to provide rumen undegradable protein (Cargill milling),

[3] Two supplements were used. The steers of the control treatment were fed with supplement contained 1.2% urea and 1.63% fine ground corn in the diet. Steers of the treatments containing byproducts were fed with supplement containing no urea and 2.83% fine ground corn. Both supplements provided Rumensin (30 g/ton of DM), Tylan (8.8 g/ton of DM), tallow, minerals, vitamins, salt, and limestone.

Revalor-200 (200 mg trenbolone acetate and 20 mg of estradiol; Merck Animal Health). Cattle were supplemented with 300 mg ractopamine/steer daily (Optaflexx; Elanco Animal Health) for the last 28 days of the feeding period with a 2-d withdrawal prior to slaughter.

Five treatments were evaluated, the control with no added distilled grains, and the inclusion of 40% of one of the distillers grains treatments: dry distillers grains plus solubles (DDGS; NDF= 36.8%; CP= 30.22; Ether extract= 9.5%), wet distillers grains plus solubles (WDGS; NDF= 45%; CP= 31.7%; Ether extract= 9.3%), dry fiber plus solubles (Dry SOLBRAN; NDF= 41.1%; CP= 21.84%; Ether extract= 8.4%), and wet fiber plus solubles (Wet SOLBRAN; NDF= 49.7%; CP= 22.67%; Ether extract= 8.5%). All distillers were produced at one plant (ICM, St. Joseph, MO). The fractionated products were produced using the prefractionation process utilized by ICM whereby high protein distillers grains is produced resulting in a feed product labeled Solbran. In that process, distillers grains are produced that are lower in protein and greater in fiber, but also allows for more solubles to be applied to the isolated fiber product. Due to the production process, not all the solubles could be added to Wet SOLBRAN, so those diets included distillers solubles (syrup) added to the diet as an ingredient at the ratio needed to match Dry SOLBRAN. All materials were received from the same plant, twice over the feeding period and stored. Wet products (WDGS and Wet SOLBRAN) were stored in silo bags and dry products stored in a commodity shed under roof. The diet composition is presented in Table 1.

Cattle were harvested at a commercial abattoir located in Omaha, NE (Greater Omaha). On the day of slaughter, sequence of cattle, hot carcass weight (HCW), and liver score data were collected whereas 12th rib fat, LM area, and USDA marbling score were collected 46 hours after slaughter. Data were analyzed using the MIXED procedure of SAS, the pen was considered as the experimental unit and the block was considered as a fixed effect.

To evaluate CO_2 and CH_4 production, four paired replicates (4 control and 4 paired pen distilled grains) were monitored for 16 consecutive weeks using the pen scale emissions barn (*2019 Nebraska Beef Cattle Report*, pp. 60–62). Each pen was measured, with 4 replications per distillers treatment. In each case, a control pen was included for comparison as the control. The barn uses a negative air pressure system equipped with LI-COR 7700 and LI-COR 7500 gas analyzers (LI-COR, Lincoln, NE) that quantify CH_4 and CO_2 levels.

Table 2. Effect of new fiber plus syrup wet (Wet SOLBRAN) or fiber plus syrup wet dry (Dry SOLBRAN) distillers fed compared to dried distillers grains plus soluble (DDGS) or wet distillers grains plus soluble (WDGS) inclusion on performance and carcass characteristics of finishing steers.

	Treatments[1]						*P-values*			
Item	Control	DDGS	Dry SOLBRAN	WDGS	Wet SOLBRAN	SEM	*F*-Test	Method	Moisture	Method × Moisture
Performance										
Initial BW, lb	672	673	671	672	672	1.4	0.95	0.54	0.83	0.54
Final BW, lb[2]	1379[b]	1422[a]	1425[a]	1437[a]	1446[a]	14.6	< 0.01	0.61	0.18	0.79
DMI, lb/d	20.1[b]	22.0[a]	22.6[a]	20.9[b]	22.1[a]	0.36	< 0.01	< 0.01	< 0.01	0.18
ADG, lb	3.94[b]	4.17[a]	4.20[a]	4.25[a]	4.30[a]	0.082	< 0.01	0.52	0.17	0.88
F:G[3]	5.10[b]	5.29[bc]	5.38[c]	4,90[a]	5.13[bc]	-	< 0.01	0.14	0.01	0.51
Carcass characteristics										
HCW, lb	869[b]	896[a]	898[a]	905[a]	911[a]	9.2	< 0.01	0.62	0.18	0.78
12th rib fat, in	0.53	0.54	0.55	0.58	0.63	0.033	0.11	0.38	0.09	0.56
LM area, in[4]	14.3[b]	14.9[a]	14.5[ab]	13.9[b]	14.9[a]	0.24	0.02	0.19	0.22	0.02
Marbling score	453	425	461	426	472	16.5	0.18	0.02	0.70	0.74
Yield Grade	3.31	3.36	3.39	3.46	3.59	0.086	0.08	0.37	0.09	0.54

[a-c] Within a row, means without a common superscript differ ($P < 0.05$) for *F*-Test.

[1] Treatments were due to byproduct type: Control= no byproduct included; DDGS= Dry distillers grain plus solubles; Dry SOLBRAN = Dry fiber plus syrup; Wet SOLBRAN = Wet fiber plus syrup; WDGS 40% = Wet distillers grain plus solubles.

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

[3] Analyzed as G:F, the reciprocal of F:G

[4] LM area = longissimus muscle (ribeye) area

Table 3. Effect of new fiber plus syrup wet (Wet SOLBRAN) or fiber plus syrup wet dry (Dry SOLBRAN) distillers fed compared to dried distillers grains plus soluble (DDGS) or wet distillers grains plus soluble (WDGS) inclusion on CH_4 and CO_2 production for finishing steers.

	Treatments						
	Control	DDGS	Dry Solbran	WDGS	Wet Solbran		*F*-Test
Pen, n	16	4	4	4	4	SEM	
Steers, n	128	32	32	32	32		
CH_4							
g/ steer	123.0^{b}	119.9^{b}	140.1^{a}	110.4^{b}	154.0^{a}	6.50	<0.01
g/lb of DMI*	5.7^{b}	4.8^{c}	6.1^{ab}	5.7^{bc}	7.1^{a}	0.34	0.01
g/lb of ADG**	28.8^{a}	26.4^{a}	33.0^{b}	27.3^{a}	35.9^{b}	1.24	< 0.01
CO_2							
g/ steer	6755	7168	6219	6126	7380	577.4	0.54
g/lb of DMI*	308.2	291.6	276.6	324.3	338.6	24.08	0.48
CH_4:CO_2	0.022	0.021	0.027	0.021	0.025	0.0020	0.16

a—c Within a row, means without a common superscript differ (P < 0.05).

2 Treatments were due to byproduct type: Control= no byproduct included; DDGS= Dry distillers grain plus solubles; Dry Solbran = Dry fiber plus syrup; Wet Solbran = Wet fiber plus syrup; WDGS 40% = Wet distillers grain plus solubles.

*DMI in CH_4 barn across all collection period.

** ADG across all collection period.

Each chamber is closed except for clear air inlets above the garage doors to allow for feeding daily, ensuring that there is no air emission cross-over. In each replicate, a control and a treatment with distilled grains were monitored simultaneously for a period of five days, one day to monitor accumulated manure, then pens scraped and monitored as open pens to establish baseline.

Data were analyzed using the MIXED procedure of SAS, with pen as the experimental unit and the block considered a fixed effect. To evaluate the interaction between processing method and moisture, a separate statistical analysis as a 2×2 factorial was performed using the MIXED procedure. For enteric methane data, the control treatment was used as a covariate, and data were analyzed as a 2×2 factorial, where the factors were processing method (ICM or Traditional), moisture (dry and wet).

Results

Intake was lower for steers fed the control and WDGS treatment ($P = 0.08$) than for steers fed DDGS, Dry and Wet SOLBRAN. Gains were greater for all steers fed byproducts compared to the CON treatment. Because steers in the control group had lower ADG ($P < 0.01$) than those fed WDGS, cattle fed WDGS had lower F:G than control fed steers. Steers fed Dry SOLBRAN had greater F:G than steers in the control group, but this was not different from steers fed DDGS and Wet SOLBRAN. For the 2×2 factorial, no interactions were observed except for LM area. Cattle fed fractionated distillers consumed more feed ($P < 0.01$) but with similar ADG ($P = 0.52$). But, feed conversion only tended ($P = 0.14$) to be better for traditional distillers compared to fractionated distillers grains. Moisture content of the distillers byproducts affected performance as expected. Steers fed wet byproducts had lower DMI ($P < 0.01$), similar ADG ($P = 0.17$), but improved F:G ($P = 0.01$) compared to steers fed dry byproducts. These results are fairly consistent with previous research (*2024 Nebraska Beef Cattle Report*, pp. 65–68) whereby feeding fractionated distillers increased intake with similar gains, but lead to a significant increase in F:G compared to feeding traditional distillers grains. Previous research has shown that feeding wet byproducts improves conversions compared to dry byproducts (*2024 Nebraska Beef Cattle Report*, pp. 65–68; *2013 Nebraska Beef Cattle Report*, pp. 62–63; *2011 Nebraska Beef Cattle Report*, pp. 50–52). Steers fed byproducts had greater HCW than steers in the control group. There was greater LM area for steers fed DDGS and Wet SOLBRAN than for steers fed no byproducts (control treatment) and WDGS. No differences were observed between the other carcass characteristics, only a trend of greater YG in steers fed Wet SOLBRAN than steers in the control group ($P = 0.08$; Table *2*).

There was an increase ($P < 0.01$) in methane production per steer (g/d) for steers fed fractionated distillers grains (Dry and Wet SOLBRAN) compared to steers fed the corn control diet (Table 3). Steers fed conventional DDGS and WDGS produced similar amounts of methane as the corn control and to one another in g/d ($P > 0.26$). Use of the Wet and Dry SOLBRAN also resulted in greater methane production compared to the corn control expressed as g/lb of DMI ($P = 0.01$) illustrating the change was not due to greater intakes. There was no difference in CO_2 production in g/d or g/lb of DMI ($P \geqq 0.48$; Table *3*).

For the 2×2 factorial with the corn control used as a covariate, there tended to be an interaction between the moisture content and ethanol

Table 4. Effect of dry or wet Solbran distillers fed compared to dried distillers grains plus soluble (DDGS) or wet distillers grains plus soluble (WDGS) inclusion on in CH_4 and CO_2 production for finishing steers. Data from using the control treatment as a covariate.

	Treatments[1]					*P*-value		
	DDGS	Dry Solbran	WDGS	Wet Solbran	SEM	Method[2]	Moisture	Method × Moisture
Pen, n	4	4	4	4				
CH_4								
g/ steer	121.7[a]	140.3[b]	111.0[a]	151.4[b]	5.27	<0.01	0.98	0.06
g/lb of DMI*	5.1 [a]	6.1 [b]	5.7 [a]	6.8 [b]	0.31	0.01	0.05	0.80
g/lb of ADG**	26.9 [a]	32.9 [b]	27.5 [a]	35.4 [b]	1.31	<0.01	0.27	0.46
CO_2								
g/ steer	7074	6352	6207	7260	746.9	0.80	0.98	0.34
g/lb of DMI*	295.8	270.6	320.7	344.1	33.08	0.98	0.15	0.52
CH_4:CO_2	0.020	0.027	0.021	0.025	0.0029	0.07	0.93	0.93

[a—c] Within a row, means without a common superscript differ (P < 0.05).

[1] Treatments were due to byproduct type: Control= no byproduct included; DDGS= Dry distillers grain plus solubles; Dry Solbran = Dry fiber plus syrup; Wet Solbran = Wet fiber plus syrup; WDGS 40% = Wet distillers grain plus solubles.

[2] Superscripts for the method factor.

*DMI in CH_4 barn across all collection period.

** ADG across all collection period.

plant production method ($P = 0.06$) for methane in g/d where the magnitude of change from dry to wet was different whether fed as traditional distillers compared to fractionated distillers (Table 4). Lack of interaction ($P = 0.80$) in methane production when expressed as g/lb of DMI suggested these effects are intake related. Steers fed traditional distillers grains had lower CH_4 production per steer in g/d ($P < 0.01$), g/lb of DMI ($P = 0.01$) and g/lb of ADG ($P < 0.01$) compared to fractionated distillers which tended to be a lower CH_4:CO_2 ratio ($P = 0.07$).

Conclusion

Feeding fractionated distillers increased intake and gain but did not improve feed conversion compared to feeding corn. Regardless of production process, distillers byproducts fed wet improve conversion. Feeding traditional distillers grains resulted in equal or less enteric methane production compared to feeding corn in finishing diets. Fractionated distillers byproducts increased methane production compared to feeding corn or traditional distillers, likely due to nutrient composition.

Debora G. Sousa, graduate student

Rebecca L. McDermott, research technician

Mitch M. Norman, research technician

James C. MacDonald, professor, Animal Science, Lincoln

Rick Stock, professor, Animal Science, Lincoln

Ryan A. Mass, ICM Biofuels, Colwich, KS

Galen E. Erickson, professor, Animal Science, Lincoln.

Acknowledgements: Funding provided by Nebraska Corn Board. Thanks to ICM Inc (Kolwich, KS) for supplying the distillers grains products used in this study. Products provided by Elanco Animal Health and Merck Animal Health

Effect of Feeding Two Different Feed Additives (Optipartum C+ and Prime Force) on Finishing Cattle Performance and Carcass Characteristics

Sofia Suarez-Lorences
Rebecca McDermott
Josh Benton
Robert Bondurant
Willard Lemaster
James MacDonald
Galen Erickson

Summary with Implications

A feedlot study was conducted to evaluate the effects of adding two different natural feed additives, Prime Force and Optipartum C+, on finishing cattle performance and carcass characteristics. Treatments were applied as a 2×2 factorial that included a control diet with no additive; a diet containing Prime Force; a diet containing Optipartum C+; and a diet containing both Prime Force and Optipartum C+ combined. Treatment diets were fed the last 67 d prior to slaughter as designed. Cattle fed Prime Force had greater live final body weight, carcass weight, intake, and average daily gain compared to cattle not fed Prime Force but due to increased intake and gain, no impact was observed on feed conversion. Feeding Optipartum C+ resulted in increased hot carcass weight and carcass-adjusted final BW as well as greater ADG which led to a small improvement in feed conversion compared to cattle fed no Optipartum C+. These data suggest that adding Prime Force to finishing diets improved gain and hot carcass weight, while feeding Optipartum C+ improved gain without increasing intake. No interaction suggests combining the two was additive resulting in 24 lb of carcass weight and 42 lb of live weight for the combination treatment compared to no additives.

Introduction

All-natural beef programs aim to provide consumers with beef raised without the use of additives, hormones, and antibiotics. Finding natural alternatives to "conventional" products that can improve performance would be advantageous. Prime Force (Furst McNess Company, Rockford, IL) contains a mix of zinc and amino acid complex, live yeast, yeast extract and yeast culture from *Saccharomyces cerevisae* and *S. boulardii*, lecithin, chromium propionate, natural flavors and saponins that help support and maintain rumen function. Another natural feed additive, Optipartum C+ (AB Vista, Plantation, FL), is a fermentation product of barley, which supplies the rumen with fermentation metabolites and enzymes to maximize rumen function and utilization of starch in the diet. In this context, both Prime Force and Optipartum C+, may be well-suited for all natural feeding programs. No data exist on the effect of feeding either of these two additives on feedlot cattle performance. The objective of this experiment was to evaluate the impact of feeding Prime Force or Optipartum C+ alone or in combination on feedlot performance and carcass characteristics.

Procedure

An experiment was conducted at the Eastern Nebraska Research, Extension and Education Center to evaluate the effect of feeding two natural feed additives (Prime Force; Furst-McNess Company, Rockford, IL; and Optipartum C+; AB Vista, Plantation, FL) on finishing cattle performance and carcass characteristics. A total of 32 pens (10 steers/pen) were assigned randomly to one of the 4 treatments resulting from a 2×2 factorial arrangement. Feed additive treatments were applied to a basal diet containing monensin and tylosin as a 2×2 factorial design that included a control diet (no additional additive, Table 1); the control diet with Prime Force to deliver 68 g/hd/d; the control diet with Optipartum C+ to deliver 20 g/hd/d; or the control diet with both Prime Force and Optipartum C+ to deliver 68 and 20 g/hd/d, respectively. Cattle were implanted with Revalor-XS (Merck Animal Health) on day 1.

Treatments were initiated 67 days before slaughter (about 44% of the feeding period) and fed daily until slaughter. Cattle were fed for 151 days total. Cattle were pen weighed and shipped the afternoon

Table 1. Dietary treatment composition for cattle fed either Prime Force, Optipartum C+, or Prime Force and Optipartum C+ combined.

	Control	Prime Force	Optipartum C+	Prime Force/ Optipartum C+
Dry-rolled corn	55	55	55	55
Modified Distillers Grains	25	25	25	25
Corn Silage	15	15	15	15
Supplement[1]	5	5	5	5
Fine ground corn	2.349	1.814	2.192	1.657
Limestone	1.640	1.640	1.640	1.640
Tallow	0.125	0.125	0.125	0.125
Urea	0.500	0.500	0.500	0.500
Salt	0.300	0.300	0.300	0.300
Beef trace mineral	0.050	0.050	0.050	0.050
Vitamin A-D-E	0.015	0.015	0.015	0.015
Monensin premix	0.0165	0.0165	0.0165	0.0165
Tylosin premix	0.0044	0.0044	0.0044	0.0044
Prime Force, g/hd	-	68	-	68
Optipartum C+, g/hd	-	-	20	20

[1] Supplement provided 30 g/ton of DM for Rumensin (Elanco Animal Health) and 8.8 g/ton of DM for Tylan (Elanco Animal Health).

prior to slaughter. Ending live weight was calculated based on pen weights, shrunk 4%. Cattle were harvested at a commercial abattoir. Hot carcass weight and liver abscesses were recorded at harvest and marbling score, longissimus muscle area and 12th rib fat depth were recorded after a 48-hour chill. Carcass-adjusted final BW was calculated from a common 63% dressing percentage; and was used to determine average daily gain (ADG) and feed conversion (F:G).

Performance data were analyzed using the Mixed procedure of SAS (SAS Institute, Inc., Cary, N.C.), while incidence and severity of liver abscesses were analyzed using the Glimmix procedure of SAS. Pen was the experimental unit and treatment was a fixed effect. Data were analyzed as a completely randomized design with a 2×2 factorial arrangement of treatments. If no significant interaction was found, then effect of feed additive was evaluated. Significance was declared at $P \leq 0.05$ and a tendency was declared at $P \leq 0.10$. Due to an outlier test, one pen assigned to Prime Force was different at allocation for initial BW compared to all other pens on that treatment, and was removed from the data analysis. Removal did not influence any of the conclusions although decreased variation making the BW and gain data slightly more significant.

Results

There were no interactions between feed additives for initial BW, carcass adjusted final BW, DMI, ADG, F:G, HCW, ribeye area, marbling score, fat depth or yield grade ($P \geq 0.41$; Table 2).

For the main effects of feed additive, cattle fed Prime Force had heavier ($P < 0.05$) live final BW and adjusted final BW compared to cattle not fed Prime Force (Table 2). Average daily gain was greater ($P < 0.05$) for cattle fed Prime Force versus cattle with no Prime Force in the diet. Hot carcass weight was significantly greater ($P < 0.05$) for cattle fed Prime Force compared to cattle with no Prime Force added (958 lb and 945 lb, respectively). Even though there was no interaction between feed additives, when combined, HCW was increased by 24 lb versus control cattle with no feed additives in the diet. Cattle fed Prime Force had greater intake ($P = 0.05$) and tended to have greater ADG, therefore feed conversion was similar ($P = 0.59$) for cattle fed Prime Force versus cattle not fed Prime Force. Marbling score was greater ($P = 0.0.5$) for cattle fed Prime Force compared to cattle with no Prime Force in the diet (561 and 535 marbling score, respectively). Dressing percentage, ribeye area, and fat depth were not affected by the addition of Prime Force to the diet ($P \geq 0.20$). Incidence of liver abscesses was not different ($P = 0.40$) for cattle fed Prime Force versus cattle not fed Prime Force (4.38% vs 6.65%, respectively).

Cattle fed Optipartum C+ had greater live final BW and adjusted final BW ($P < 0.05$; Table 2) compared to cattle not fed Optipartum C+. Average daily gain was greater ($P < 0.05$) for cattle fed Optipartum C+ versus cattle with no Optipartum C+ in the diet. Dry matter intake was not affected ($P = 0.31$) by the addition of Optipartum C+ to the diet; cattle fed Optipartum C+ ate 29.0 lb daily, while those not fed Optipartum C+ ate 28.7 lb daily. A small improvement in feed conversion was observed ($P = 0.12$) due to equal intake. Hot carcass weight was greater ($P < 0.05$) for cattle fed Optipartum C+ (957 lb) compared to cattle not fed Optipartum C+ (946 lb). Marbling score was similar ($P = 0.47$) for cattle fed no Optipartum C+ versus cattle with Optipartum C+ in the diet (553 and 544 marbling score, respective-

Table 2. Impact of feeding Prime Force, Optipartum C+ or a combination of both on finishing cattle performance

	Treatments							
	Control	Prime Force	Optipartum	Prime+Opt	SEM	Int.[1]	Prime[2]	Opt[3]
Performance								
Initial BW, lb	858	861	858	860	1.2	0.95	0.03	0.80
Live FBW[4], lb	1502	1528	1524	1544	8.6	0.75	0.01	0.04
Adj FBW[1]	1491	1513	1510	1529	7.9	0.80	0.02	0.04
DMI, lb	28.4	29.1	28.8	29.0	0.30	0.63	0.05	0.31
ADG	4.19	4.32	4.32	4.42	0.051	0.80	0.03	0.03
F:G	6.69	6.92	6.77	6.77	-	0.91	0.59	0.12
Live gain, lb	644	667	666	677	8.7	0.50	0.06	0.09
Adj live gain, lb	633	652	652	661	8.17	0.52	0.09	0.09
Carcass characteristics								
HCW, lb	939	953	952	963	5.07	0.77	0.02	0.04
Dress[5], %	62.5	62.4	62.4	62.3	0.18	0.96	0.61	0.79
LM area, in²	14.6	14.5	14.5	14.6	0.16	0.68	0.79	0.97
Fat[6], in	0.71	0.73	0.72	0.74	0.015	0.75	0.17	0.32
Marbling[3]	546	559	524	563	12.0	0.29	0.05	0.47
Liver abscess, %	11.54	3.75	3.75	5.13	3.617	0.15	0.40	0.40

[1] *P*-value for the interaction between Prime Force and Optipartum C+

[2] *P*-value for the main effect of Prime Force

[3] *P*-value for the main effect of Optipartum C+

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

[5] LM area = longissimus muscle area

[6] marbling score 400 = small00; 500 = modest00; etc

ly). Dressing percentage, ribeye area, and fat depth did not differ ($P \geq 0.35$) between cattle fed Optipartum C+ compared to cattle with no Optipartum C+ added to the diet. Incidence of liver abscesses was not different ($P = 0.40$) for cattle fed Optipartum C+ versus cattle not fed Optipartum C+ (4.38% vs 6.65%, respectively).

No significant interaction was detected. This suggests that effects of feeding these additives on gain and live/carcass weights was additive. The weight increase attributed to feeding Primeforce was 13 lb of carcass or 23 lb of live weight. For Optipartum C+, the increase in carcass weight was 11 lb of carcass and 19 lb of live weight. Combining the two together further increased weight as expected with increases of 24 lb of carcass and 42 lb of live weight compared to the control with no additives, which is very similar to the weight increases associated with each individual product.

Conclusions

The addition of Prime Force to a finishing diet 67 d prior to slaughter resulted in greater final BW and hot carcass weight. Average daily gain was improved by the addition of Prime Force likely due to dry matter intake being greater for cattle fed Prime Force. Adding Optipartum C+ to a finishing diet 67 d prior to slaughter tended to increase ADG and slightly improved feed conversion due to equal DMI when compared with diets with no Optipartum C+ added.

Sofia Suarez-Lorences, graduate student

Rebecca McDermott, research technician

Josh Benton, post-doc, beef feedlot unit director, ENREEC

Robert Bondurant, Furst-McNess Company, Rockford, IL

Willard Lemaster, Furst-McNess Company, Rockford, IL

James MacDonald, professor

Galen Erickson, professor

Acknowledgements: funding provided by Furst-McNess Company; products supplied for use on cattle used in this experiment from Elanco Animal Health, Merck Animal Health, and Zoetis

Effect of Feeding Fenugreek Extract and Encapsulated Lecithin on Finishing Cattle Performance, Carcass Characteristics, and Liver Abscesses

Sofia Suarez-Lorences
Rebecca McDermott
Josh Benton
Robert Bondurant
Willard Lemaster
James MacDonald
Galen Erickson

Summary with Implications

A feedlot study was conducted to evaluate the effects of adding Fenugreek extract and encapsulated Lecithin (Furst-McNess Company, Rockford, IL) on finishing cattle performance, carcass characteristics, and liver abscesses. Treatments were applied as a 2×2 factorial that included a control diet with no additive; a diet containing Fenugreek extract; a diet containing encapsulated Lecithin; and a diet containing both Fenugreek extract and encapsulated Lecithin. Tylosin was not included in any diets to test natural occurrence of liver abscesses. No interactions were observed between Fenugreek extract and encapsulated Lecithin treatments but neither feed additive impacted intakes, gains, feed conversion, or body weights. In addition, no impacts of dietary treatments were observed on carcass characteristics. Incidence and severity of liver abscesses was not different among treatments. Total abscess rate averaged 54% for the trial cattle, with 22.2% A+, 7.3% A, and 23.9% A-. These results indicate that feeding Fenugreek extract or encapsulated Lecithin will not impact performance or incidence of liver abscesses.

Introduction

In feedlots, incidence of liver abscesses varies from 12 to 32% depending on whether tylosin is fed and type of cattle being fed, however, it can be as high as 95%. There are many factors that can influence incidence of liver abscesses, with feeding practices (variation in feeding schedule or variation in amount of feed delivered) being one of the major ones. Furthermore, liver abscesses represent an economic loss for packers and producers. The liver represents about 2% of the carcass weight, so when condemned, it is a significant financial loss for the packer. Additionally, severe liver abscesses can reduce cattle performance due to lower intake and gain, poorer feed conversion, and less carcass weight; causing economic losses for producers. In this context, finding non-antibiotic products that may help mitigate liver abscesses would be beneficial. Fenugreek extract and encapsulated Lecithin (Furst-McNess Company, Rockford, IL) are natural feed additives that aim to reduce incidence of liver abscesses and may be suitable for "all-natural" feeding programs for beef cattle. The objective of this study was to evaluate the impact of feeding Fenugreek extract and encapsulated Lecithin alone or combination on feedlot cattle performance, carcass traits, and liver abscesses.

Procedure

An experiment was conducted at the Eastern Nebraska Research, Extension and Education Center to evaluate the effect of feeding two different feed additives (encapsulated Lecithin and Fenugreek extract; Furst-McNess Company, Rockford, IL) on finishing cattle performance, carcass characteristics, and liver abscesses. Crossbred steers (n = 800; initial BW 626 ± 40 lb) were used in a randomized block design. Steers were blocked and stratified by weight and assigned randomly to pen. Pens were assigned randomly to one of the 4 treatments. Cattle were limit fed at 2% of BW for five days to equalize gut fill and weighed on two consecutive days at the beginning of the experiment to establish initial BW. Cattle were implanted with Revalor-XS (Merck Animal Health) on day 1.

Four treatments were evaluated in a total of 40 pens with 20 steers/pen. Treatments were arranged as a 2×2 factorial included no additives,

Table 1. Dietary treatments for cattle fed either a control diet, a diet containing Fenugreek extract, a diet containing encapsulated Lecithin, or a diet with Fenugreek extract and encapsulated Lecithin combined (FenSorb).

	Treatments			
Ingredient	Control	Fenugreek extract	encapsulated Lecithin	FenSorb
Dry-rolled corn, %	24.8	24.8	24.8	24.8
High moisture corn, %	37.2	37.2	37.2	37.2
MDGS[1], %	20	20	20	20
Corn silage, %	14	14	14	14
Supplement [2] ,%	4	4	4	4
Fine ground corn	1.368	1.368	1.368	1.368
Limestone	1.640	1.640	1.640	1.640
Tallow	0.100	0.100	0.100	0.100
Urea	0.500	0.500	0.500	0.500
Salt	0.300	0.300	0.300	0.300
Beef trace mineral	0.050	0.050	0.050	0.050
Vitamin A-D-E	0.015	0.015	0.015	0.015
Fenugreek extract, g/hd/d	-	1.25	-	-
encapsulated Lecithin, g/hd/d	-	-	5.0	-
FenSorb, g/hd/d	-	-	-	6
Monensin premix	0.017	0.017	0.017	0.017

[1] Supplement provided 30 g/ton of DM for Rumensin (Elanco Animal Health).

[2] Supplement provided 0.5% urea to account for rumen degradable protein.

feeding 1.25 g/steer/d of Fenugreek extract; feeding 5.0 g/steer/d of encapsulated Lecithin; or a combination of both (Table 1). The heavy block cattle were fed for 186 days, and the light block cattle were fed for 190 days total. Cattle were harvested at a commercial abattoir. Hot carcass weight and liver abscesses were recorded at harvest and marbling score, longissimus muscle area and12th rib fat depth were recorded after a 48-hour chill. Carcass-adjusted final BW was calculated by assuming a common 63% dressing percentage; and was used to determine average daily gain (ADG) and feed efficiency.

Performance data were analyzed using the Mixed procedure of SAS (SAS Institute, Inc., Cary, N.C.), while incidence and severity of liver abscesses were analyzed used the Glimmix procedure of SAS. Pen was the experimental unit and treatment was a fixed effect. Data were analyzed as a 2×2 factorial, evaluating an interaction between both feed additives (Fenugreek extract and encapsulated Lecithin). If no significant interaction was observed, then the main effect of feed additive was discussed. Significance was declared at $P \leq 0.05$ and a tendency at $P \leq 0.10$.

Results

There were no interactions between feed additives for initial BW, carcass adjusted final BW, DMI, ADG, F:G, HCW, ribeye area, marbling score, 12th rib fat or yield grade ($P \geq 0.17$; Table 2).

For the main effects of feed additive, there was no difference ($P = 0.99$; Table 2) in adjusted final body weight (FBW) for cattle fed Fenugreek extract versus cattle with no Fenugreek extract added (1310 lb for both groups). Average daily gain (ADG) was not different ($P = 0.97$) between cattle fed Fenugreek extract versus cattle not fed Fenugreek extract. No differences were observed for DMI and F:G ($P \geq 0.80$) for cattle fed Fenugreek extract compared to cattle not fed it. Carcass traits such as HCW, ribeye area, marbling score and 12th rib fat were not different ($P \geq 0.30$) when comparing cattle fed Fenugreek extract versus cattle with no Fenugreek extract added. Incidence of liver abscesses was not different among treatments ($P = 0.28$). Cattle fed Fenugreek extract had 51.02% incidence of liver abscesses while cattle fed no Fenugreek extract had 54.95% incidence of liver abscesses. However, cattle fed Fenugreek extract had a tendency ($P = 0.10$) for lower liver abscess severity compared to cattle not fed it.

Cattle fed encapsulated Lecithin had similar adjusted FBW ($P = 0.75$) compared to cattle fed no encapsulated Lecithin, (1311 lb vs 1309 lb, respectively). Average daily gain was not different ($P = 0.83$) for cattle fed

Table 2. Simple effect means of adding Fenugreek extract, encapsulated Lecithin, or a combination of both (FenSorb) on performance and carcass characteristics of finishing steers.

	Treatments					P-value		
	Control	Fenugreek extract	encapsulated Lecithin	FenSorb	SEM	Int.[1]	Fenugreek extract[2]	encapsulated Lecithin [3]
Performance								
Initial BW, lb	630	630	630	630	0.5	0.58	0.58	0.58
Adj FBW[4]	1313	1309	1307	1311	6.4	0.48	0.99	0.75
DMI, lb	22.6	22.4	22.4	22.6	0.15	0.18	0.94	0.94
ADG	3.63	3.61	3.60	3.62	0.034	0.51	0.97	0.83
F:G	6.23	6.20	6.22	6.24		0.74	0.80	0.74
Carcass characteristics								
HCW, lb	828	826	825	827	4.03	0.50	0.97	0.80
LM area[5], in	12.7	13.2	13.1	13.1	0.25	0.20	0.33	0.51
Fat depth, in.	0.66	0.65	0.63	0.63	0.015	0.81	0.65	0.18
Marbling[6]	466	490	475	480	15.2	0.52	0.32	0.98
Liver abscess, %	53.5	49.7	56.4	52.3	3.65	0.96	0.28	0.45
Abscess severity								
0	46.2	49.2	41.8	46.6		0.99	0.10	0.14
A-	25.8	22.2	24.3	23.0				
A	6.5	11.1	6.9	7.3				
A+	21.5	17.5	27.0	23.0				

[1] *P*-value for the interaction between Fenugreek extract and encapsulated Lecithin

[2] *P*-value for the main effect of Fenugreek extract

[3] *P*- value for the main effect of Lipidol

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

[5] LM area = longissimus muscle (ribeye) area

[6] Marbling score 400 = Small00; 500 = Modest00; 600 = Moderate00, etc

encapsulated Lecithin compared to cattle not fed encapsulated Lecithin. Cattle fed encapsulated Lecithin gained 3.61 lb/d while cattle fed no encapsulated Lecithin gained 3.62 lb/ds. Dry matter intake and feed conversion were equal ($P \geq 0.74$) when comparing cattle fed encapsulated Lecithin versus cattle fed no encapsulated Lecithin. No differences were observed ($P \geq 0.47$) for HCW, ribeye area, marbling score and fat depth between cattle fed encapsulated Lecithin compared with cattle fed no encapsulated Lecithin. Incidence and severity of liver abscesses was not different among treatments ($P > 0.10$). Cattle fed encapsulated Lecithin had 54.4% incidence of liver abscesses versus 51.6% of incidence for cattle with no encapsulated Lecithin in the diet.

Conclusions

The addition of either Fenugreek extract or encapsulated Lecithin to finishing diets resulted in similar intakes, gains, conversions and carcass traits. Feeding either Fenugreek extract or encapsulated Lecithin had no effect on incidence or severity of liver abscesses.

Sofia Suarez-Lorences, graduate student

Rebecca McDermott, research technician

Josh Benton, post-doc research assistant

Robert Bondurant, Furst-McNess Company, Rockford, IL

Willard Lemaster, Furst-McNess Company, Rockford, IL

James MacDonald, professor

Galen Erickson, professor

Acknowledgements: Funding provided by Furst-McNess Company; Products supplied for use on cattle used in this experiment from Elanco Animal Health, Merck Animal Health, and Zoetis.

Effect of Using Whole Soybeans, Roasted Soybeans, or Soybean Meal in Finishing Cattle Diets

Melissa K. Bausch
James C. MacDonald
Galen E. Erickson
Pablo L. Loza

Summary with Implications

A feedlot study compared the effect of using whole or roasted soybeans at two inclusion rates (12% and 16% of diet dry matter), soybean meal, distillers grains, or a dry-rolled corn with urea control in finishing cattle diets. Steers fed the diet with the 16% inclusion of roasted soybeans had better average daily gain, feed conversion, and hot carcass weight. All other diets resulted in similar performance to the dry-rolled corn and distillers grains treatments. Roasted soybeans fed at a 16% inclusion improved F:G over the 12% roasted soybeans as compared to the whole soybeans which were better at the 12% inclusion. These data suggest that soybeans can be fed to finishing cattle to provide fat and protein, but roasting enhances the response in performance.

Introduction

The evolution of the ethanol industry to the production of more processed byproducts has resulted in lower supply of the traditional distillers grains and subsequent increases in price. Additionally, the recent COVID-19 pandemic brought sudden disruptions in ethanol production that exacerbated sourcing and trucking issues of distillers grains. Concurrently, demand for fats and oils to produce renewable diesel is increasing the availability of soybean products. Soybeans have a crude protein content of 40%, which is mostly comprised of rumen degradable protein (RDP). The protein content of soybean meal remaining after oil extraction is approximately 50%, with measured RDP content of about 30% but varies depending on heating. Roasting soybeans can increase the amount of protein that is rumen undegradable which is available for absorption in the small intestine. Soybeans also contain approximately 20% oil which is readily available in the rumen. Feeding whole soybeans is usually limited by the oil content as oil that is available in the rumen can eventually inhibit microbial fermentation if fed at too high of inclusions. Roasting soybeans not only protects protein from rumen degradation, but also partially protects the oil which increases energy to cattle with less concern on inhibition of microbes in the rumen. The objective of this study was to evaluate the use of soybean products as a protein and energy source, and particularly if roasting soybeans improves performance by protecting the protein (and oil) in the rumen compared to whole soybeans.

Procedure

A finishing study was conducted at the Panhandle Research Extension and Education Center (PREEC) near Scottsbluff, NE utilizing crossbred yearling steers (n = 504; initial BW = 929 lb) in a generalized, randomized block design. Before trial initiation in November 2023, steers were limit-fed at approximately 2% of body weight for five consecutive days before the collection of initial body weight (BW) to minimize weight variation due to gut fill. Steers were weighed on two consecutive days to establish initial body weights. Cattle were assigned to pens based on the weight of the first day and sorted into pens from one of three weight blocks on the second day of obtaining weights: light (2 replications), medium (4 replications), and heavy (2 replications). Steers were stratified by weight within block and assigned randomly to pens to ensure equal initial pen weights by block. Pens were assigned randomly to treatment within each block with 8 pens per treatment and 9 steers per pen.

All steers were implanted on the first day of weighing with Revalor-XS (Merck Animal Health) at weighing. Cattle were stepped onto their respective finishing diets together utilizing a 21-day step-up period where forage was replaced with dry-rolled corn in four steps (3, 5, 6, and 7 days). Alfalfa was stepped down at 30%, 20%, 12.5%, 5%, and 0% (DM basis) and silage was stepped down over steps 2–4 at 30%, 25%, 20, and 15% (DM basis) with all test products being fed at their final inclusion beginning day 1. There were seven dietary treatments used in this study and final finishing treatment diets are

Table 1. Dietary treatment composition (DM basis) fed to finishing cattle comparing whole or roasted soybeans to soybean meal, wet distillers grains, or an urea control.

	Treatment[1]						
Ingredient	CON	SBM	WDGS	12% WSB	16% WSB	12% RSB	16% RSB
Dry-Rolled Corn	79	70	63	67	63	67	63
Corn Silage	15	15	15	15	15	15	15
Soybean Meal	-	9	-	-	-	-	-
Wet Distillers Grains	-	-	16	-	-	-	-
Whole Soybeans	-	-	-	12	16	-	-
Roasted Soybeans	-	-	-	-	-	12	16
Supplement[2]	63	6	6	6	6	6	6

[1]Treatments included control (CON with urea), soybean meal (SBM at 9%), wet distillers grains (WDGS at 16%), 12% and 16% inclusions of whole soybeans (WSB), and 12% and 16% inclusions of roasted soybeans (RSB)

[2]Diets included Rumensin (Elanco Animal Health) at 360 mg/hd and Tylan (Elanco Animal Health) at 90 mg/hd

[3]Supplement for the CON treatment included urea at 1% of diet DM with a premix including limestone, vitamins, and minerals

summarized in Table 1. All diets were formulated to meet or exceed the metabolizable protein requirements of the animals using the beef NASEM model (2016). Urea was added to the supplement at 1% of the total diet DM in the diet containing only dry-rolled corn (DRC) as the grain source to meet RDP requirements. Each final diet contained 6% supplement and 15% corn silage on a dry-matter basis. The rest of the treatments contained the ingredient of interest along with DRC making up the remainder. The soybean meal diet (SBM) contained 9% (DM basis) soybean meal and 70% (DM basis) DRC. The 12% soybean treatments contained whole or roasted soybeans at 12% of diet DM and 67% DRC. The wet distillers grains (WDGS) and 16% soybean (whole and roasted) diets contained 16% (diet DM) of their ingredient and 63% (DM basis) DRC. Therefore, treatments included a corn control, 9% SBM, 16% WDGS, and then 12 or 16% whole or roasted soybeans arranged as a 2 × 2 factorial. A beta-agonist was added to all diets (Optaflexx; Elanco Animal Health) for 28 days at the end of the feeding period and removed 2 days before harvest. Steers were fed trial diets for 119 days (heavy block) and 160 days (light and medium blocks) including the step up period and harvested at a commercial abattoir (Cargill, Fort Morgan, Colorado). Liver abscess scores and hot carcass weights (HCW) were collected on the day of harvest. Final BW was calculated from HCW using a common 63% dressing percentage. Average daily gain (ADG) and feed efficiency were calculated based on carcass-adjusted final BW. Feed efficiency (G:F) was analyzed, but data are reported as feed conversion (F:G). Carcass characteristics such as 12th rib fat thickness, USDA marbling score, and longissimus muscle (LM) area were collected after a 48-hour chill. Carcass and performance data were analyzed using the MIXED procedure of SAS and analyzed with pen as the experimental unit and block as a fixed effect. Liver abscess presence data were analyzed as a binomial distribution using the PROC GLIMMIX procedure of SAS.

Results

Treatment significantly impacted carcass-adjusted final BW, DMI, ADG, HCW and feed conversion as well as fat thickness and LM area (Table 2). Cattle fed soybean meal, distillers grains, and both roasted soybean diets had greater DMI ($P < 0.01$) than the 16% whole soybean inclusion, which was not different than the control and 12% whole soybean diets. Cattle fed the 16% roasted soybean diet had the greatest ADG at 4.18 lb/d, which was greater than ($P < 0.01$) the control (3.63 lb/d), soybean meal (3.81 lb/d), distillers (3.62lb/d), and 16% whole soybean (3.72 lb/d) diets. Steers fed the control and distillers grains diets resulting in had greater ($P < 0.01$) F:G compared to the 16% roasted soybean inclusion. There was no difference in feed conversion among cattle fed the control, soybean meal, distillers grains, whole soybeans, and 12% inclusion of roasted soybeans treatments (Table 3).

Table 2. Effect of feeding soybeans or roasted soybeans compared to soybean meal, distillers grains, or urea control on feedlot performance and carcass characteristics.

	Treatment[1]								F-test
Item	CON	SBM	WDGS	12% WSB	16% WSB	12% RSB	16% RSB	SEM	*P*-Value
Pens	8	8	8	8	8	8	8		
Performance									
Initial BW, lb	930	932	929	926	931	930	928	2.8	0.81
Final BW[2], lb	1481[b]	1508[ab]	1481[b]	1515[ab]	1495[b]	1535[ab]	1562[a]	13.1	<0.01
DMI, lb/d	27.7[ab]	28.8[a]	28.6[a]	27.7[ab]	26.[b]	28.5[a]	28.5[a]	0.37	<0.01
ADG[2], lb/d	3.63[b]	3.81[b]	3.62[b]	3.88[ab]	3.72[b]	3.97[ab]	4.18[a]	0.083	<0.01
Feed:Gain [2 3]	7.87[b]	7.74[ab]	8.20[b]	7.34[ab]	7.45[ab]	7.59[ab]	7.12[a]	-	<0.01
Carcass Characteristics									
HCW, lb	933[b]	950[ab]	933[b]	954[ab]	942[b]	967[ab]	984[a]	8.2	<0.01
Marbling[4]	486	507	492	484	497	496	470	9.5	0.21
Fat thickness, in.	0.58[b]	0.60[ab]	0.59[b]	0.59[ab]	0.58[b]	0.63[ab]	0.66[a]	0.017	0.01
LM area, in.	13.6[b]	13.7[ab]	13.9[ab]	14.1[ab]	14.0[ab]	14.2[ab]	14.4[a]	0.17	0.02
Liver abscess[5], %	19.2	29.9	26.2	21.9	15.4	26.2	25.3	5.72	0.54

[ab]Means within a row that lack a common superscript differ ($P \leq 0.05$)

[1]Treatments included control (CON with urea), soybean meal (SBM at 9%), wet distillers grains (WDGS at 16%), 12% and 16% inclusions of whole soybeans (WSB), and 12% and 16% inclusions of roasted soybeans (RSB)

[2]Calculated using hot carcass weight with a 63% dressing percentage adjustment

[3]Analyzed as Gain:Feed, reciprocal of Feed:Gain

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

[5]Liver abscess counts were analyzed in SAS as a binomial distribution, effect of diet was not significant

Table 3. Effects of roasting and soybean inclusion on feedlot performance and carcass characteristics.

	Treatments[1]				*P-Value*[2]		
	Whole Soybeans		Roasted Soybeans		Interaction	Roasting	Inclusion
Item	12%	16%	12%	16%			
Performance							
Initial BW, lb	926	931	930	928	0.19	0.81	0.55
Final BW[3], lb	1515[ab]	1495[b]	1535[ab]	1562[a]	0.07	<0.01	0.75
DMI, lb/d	27.7[ab]	26.8[b]	28.6[a]	28.6[a]	0.03	<0.01	0.77
ADG[3], lb/d	3.88	3.72	3.97	4.18	0.22	<0.01	0.22
Feed:Gain[3 4]	7.34[ab]	7.45[ab]	7.59[ab]	7.12[a]	0.05	0.71	0.26
Carcass Characteristics							
HCW, lb	954[ab]	942[b]	967[ab]	984[a]	0.07	<0.01	0.74
Marbling[5]	484	497	496	470	0.05	0.46	0.48
Fat thickness, in.	0.594	0.576	0.626	0.662	0.11	<0.01	0.59
LM area, in[2]	14.1	14.0	14.2	14.4	0.29	0.14	0.92

[1]Treatments included 12% and 16% inclusions of whole soybeans, and 12% and 16% inclusions of roasted soybeans

[2]*P*-Value: Interaction = interaction of roasting and inclusion rate; Roasting = main effect comparing whole to roasted soybeans; Inclusion = effect of soybean inclusion rate of 12 or 16%

[3]Calculated using hot carcass weight with a 63% dressing percentage adjustment

[4]Analyzed as Gain:Feed, reciprocal of Feed:Gain

[5]Marbling Score 400=Small00, 500=Modest00

Feeding the 16% inclusion of roasted soybeans resulted in a greater HCW ($P < 0.01$) and 12th rib fat thickness ($P = 0.01$) compared to the control, distillers grains, and 16% whole soybean diets. Cattle fed the control diet had a 13.3% smaller LM area ($P = 0.02$) than the 16% roasted soybeans with no other significant LM area differences between treatments. Diet had no impact on marbling score ($P = 0.21$) or occurrence of liver abscesses ($P = 0.54$). There were no differences among the control, distillers grains, soybean meal, whole soybeans, or 12% roasted soybean rations for carcass characteristics. In this study, the cattle fed WDGS did not respond like past experiments (Vander Pol, 2004), which is puzzling why response to feeding WDGS was dramatically different compared to control corn fed cattle in this study.

For the factorial treatment arrangement evaluating inclusion and roasting effects of soybeans, interactions were observed for DMI and F:G ($P < 0.05$) suggesting that roasting impacts the performance of cattle and this response is dependent on dietary inclusion. Steers fed roasted soybeans consumed more than steers fed whole soybeans ($P < 0.01$) but was equal ($P = 1.00$) for cattle fed 12 and 16% roasted soybeans. Steers fed 16% whole soybeans had numerically greater F:G compared to 12% inclusion whereas steers fed roasted soybeans had also a numerically improved F:G ($P = 0.32$) by 6.5% when fed 16% compared to 12%. Cattle fed roasted soybeans had greater HCW, carcass-adjusted final BW, and ADG ($P < 0.01$) compared to steers fed whole soybeans. The interaction for HCW and final BW tended to be significant ($P = 0.07$) as weight tended to increase with inclusion of roasted soybeans but tended to decrease when inclusion of whole soybeans increased from 12 to 16%. Otherwise, inclusion rate of soybeans had no significant impact on performance or carcass characteristics. These data suggest that 'non-protected' soybeans can negatively impact gain, weights, and F:G once the inclusion rises above 12%, whereas roasting protects the oil which in turn allows for more to be fed and further improve weights, gain, and F:G.

Conclusion

In this study, the greatest inclusion of roasted soybeans resulted in the greatest performance. Soybean meal, whole soybeans, and the 12% inclusion of roasted soybeans provided performance and carcass traits that did not significantly differ from the control and distillers grains diets. These data suggest that soybeans may be an option to displace corn or distillers grains in finishing diets where the product is readily available or economical without reducing cattle performance, with a 16% roasted soybean inclusion out performing corn.

Melissa K. Bausch, graduate assistant and clinical veterinarian, office of research and economic development, Lincoln

James C. MacDonald, professor, animal science, Lincoln

Galen E. Erickson, professor, animal science, Lincoln

Pablo L. Loza, assistant professor, animal science, Panhandle Research Extension and Education Center. Scottsbluff.

Acknowledgements: Funding provided by the Nebraska Soybean Board; Products provided by Elanco Animal Health and Merck Animal Health

Effects of Replacing Wet Corn Distillers Grains with a PureField Distillers Grains® at 15% and 30% (DM basis) in Feedlot Diets

Sofia A. Canafoglia
Pablo L. Loza

Summary with Implications

A 2×2 +1 factorial experiment was performed to evaluate the effects of replacing wet corn distillers grain (WCDGS) with PureField distillers grains, a proprietary blend of wet distillers grains plus wheat middlings (Purefield LLC, KS) at 15% or 30% of the diet (DM basis), on finishing performance and carcass characteristics. The inclusion of either byproduct resulted in improved steer performance, and carcass characteristics when compared to the treatment without the byproduct inclusion. No interactions between byproduct and inclusion level were observed for steer performance or carcass characteristics. A tendency for higher average daily gains was observed in cattle fed wet corn distillers grains when compared to PureField distillers grains. Because of a numerically lower DMI in the PureField DG fed cattle, no differences resulted in feed efficiency. PureField DG is a suitable alternative to replace corn distillers grains in feedlot finishing diets without affecting cattle performance.

Introduction

Extensive research has been performed in the past two decades to evaluate the effects of corn distillers grains obtained with the ethanol production. In recent years, the quality of the distillers have changed with oil removal and as new fractionation technologies are added to the post fermentation part of the process. Similarly, blending the distillers grains with byproducts of other industries could result in feed products that could complement or replace a portion of the distillers. PureField distillers grains (PDG) is a blend of ethanol and milling industries byproducts. PureField distillers grains originated in the ethanol production from the fermentation of milo, corn, and wheat in a proprietary blend proportion, with the addition of wheat middling. An experiment was conducted with the objective of evaluating the effects of replacing wet corn distillers grains plus solubles (WCDGS) (Colorado Agr. LLC, Bridgeport, NE) with PDG (Purefield, KS) at 15% and 30% of inclusion in the diet (DM basis), on steers finishing performance and carcass characteristics.

Procedures

Three hundred steers (initial BW=703 ± 1.58 lb.) were used in a 2 × 2 plus one factorial design. Factors were distillers grains type, wet corn distillers grains and PDG, and level of inclusion in the diets, 15 and 30% (DM basis). The experiment was conducted at the UNL, Panhandle Research, Extension and Education Center Research Feedlot, Mitchell (NE), starting on December 1st, 2022. Before starting the experiment, cattle were limit-fed a common diet at 2% of body weight equalizing gut fill for five days. The limit-fed diet was comprised of 50% corn silage, 20% dry rolled corn, 24% WCDGS and 6% liquid supplement (DM basis). At the beginning of the trial, cattle were individually weighed on two consecutive days, to establish initial body weight (IBW) as the average of both individual weights.

The weights taken on day 0 were used to stratify and block cattle by weight, then steers were assigned randomly to pens within 3 weight blocks. Pens within block were assigned randomly to one of the five treatments, 2 replications of treatment per block. Each pen contained 10 steers for a total of 30 pens, with pen was the experimental unit. Cattle were implanted with Revalor-IS (Merck Animal Health) on day 0, and re-implanted with Revalor 200 (Merck Animal Health) and individually weighed at 91 DOF.

The treatment finishing diets consisted of 20% corn silage, 59% or 44% dry rolled corn (DM basis) for treatments with lower or higher inclusion of the byproducts, respectively (Table 1). The control diet contained 20% corn silage and 74% dry rolled corn (DM basis). All diets included 6% supplement liquid (DM basis) which contained Vitamin A, D and E and microminerals. Diets included Rumensin® (Monensin, Elanco Animal Health) at 30 g/ton of diet DM and Tylan® (Tylosin, Elanco Animal Health) at 7.0 g/ton.

Table 1. Diets composition on a DM basis fed to finishing steers1

	Control	WCDGS		PureField DG	
Inclusion levels	0	15	30	15	30
Corn Silage, %	20	20	20	20	20
DRC, %	74	59	44	59	44
WDGS, %	0	15	30	15	30
PDG, %	6	6	6	6	6
Supplement,%	6	6	6	6	6

[1] Diets were formulated to include Rumensin (Elanco Animal Health) at 30 g/ton of DM and Tylan (Elanco Animal Health) at 7 g/ton of DM.

[2] Supplement included urea at 1% of diet DM, trace minerals and vitamins.

Due to a respiratory disease outbreak all cattle were fed Aureomycin® (chlortetracycline, Zoetis) at 28 DOF for 5 days at 45.0 g/ton of ration (DM basis—350.0 mg/head/d).

Cattle were transitioned to the final diet, in three step ups lasting 7 days each, over the course of 21 days. (Table 1). On the control treatment, the transition over the three steps consisted in decreasing the inclusion of corn silage from 45% to 20% (DM basis) and WCDGS from 16% to 0% (DM basis), and increasing the dry rolled corn from 33% to 74% (DM basis). The transition for the treatment diets with distillers grains consisted in decreasing the inclusion of corn silage from 45 % to 20% (DM basis). In the treatment diets with 15% byproduct, dry rolled corn was increased from 34% to 59% and the concentration of WCDGS or PDG were held constant at 15% in the diet (DM Basis). In treatment diets at 30% of distillers, dry rolled corn was increased from 28% to 44% and of WDGS or the Purefield blend were held constant at 26% to 30%. For the final diet, all cattle achieved the 90% concentrate diet, starting the finishing ration on the day after the end of the third step. All diets contained 6% liquid supplement.

Cattle were fed once daily, and bunks were managed for ad libitum access to feed. After 225 days on feed, cattle were harvested at a commercial abattoir (Cargill, Fort Morgan).Hot carcass weights and liver scores were

Table 2. Effects of PureField Distillers Grains in comparison to wet corn distillers grains fed at 15 and 30% DM inclusion levels in steers fed feedlot finishing diets.

	Control	WCDGS		PureField DG					
Inclusion levels	0	15	30	15	30	Control. vs Byprod	Byprod*level	Byproduct	Level
Pen #	6	6	6	6	6	P Val	P Val	P Val	
Performance									
Initial BW, lb.	702	703	701	703	705	0.79	0.48	0.45	0.84
Final BW, lb[1]	1444	1521	1529	1504	1497	<0.05	0.66	0.16	0.96
DMI, lb./d.	23.29	25.46	25.19	25.08	24.74	<0.05	0.88	0.30	0.45
ADG, lb./d	3.31	3.65	3.69	3.57	353	<0.05	0.56	0.11	0.98
Feed: Gain	7.04	6.96	6.81	7.02	7.00	0.41	0.58	0.25	0.51
Carcass Characteristics									
HCW	910	958	964	948	943	<0.05	0.65	0.16	0.96
Fat, in [2]	0.57[a]	0.65[ab]	0.70[b]	0.65[a]	0.57[a]	<0.05	<0.05	<0.05	0.56
LM area, in[2]	14.59	14.57	14.45	14.58	14.57	0.83	0.78	0.75	0.74
Calculated YG[3]	3.10	3.51	3.70	3.46	3.25	<0.05	0.08	0.03	0.87
Marbling Score[3]	528	538	540	534	519	0.09	0.34	0.41	0.68
% of abscessed Livers	26.35	35.15	30.18	22.72	23.32		0.68	0.14	0.68

[1] Final BW calculated from HCW, adjusted to a common 63% dressing percentage

[2] Means within a row with different superscripts are different (P<0.05)

[3] Calculated yield grade = 2.5 + (2.5*fat thickness)-(0.32*LM area) + (0.2*2.5) = (0.0038*HCW)

[4] Fat Marbling is scored as 400+ = slight, 500+ = modest, 600+= moderate, etc.

recorded at harvest, and marbling score, longissimus muscle area, yield grade, and 12th rib fat depth were recorded after a 48-hour chill.

Data were analyzed using the MIXED procedure of SAS, with pen as the experimental unit. Levels of significance were determined with P values less than 0.05 and tendencies for P values less than 0.15. Liver data was evaluated as a binomial distribution using the GLIMMIX procedures of SAS. Interactions between byproduct type and inclusion level were analyzed as a 2×2 factorial. Orthogonal contrasts were utilized to evaluate the interaction between byproduct type and level, the inclusion of any byproduct compared with the control diet, the main effects of byproduct type, and level of inclusion.

Results

Including either type of byproducts in the diets significantly improved (*P*<0.05) hot carcass weights, consequently improving carcass adjusted final body weights (*P*<0.05). Including any type of byproducts in the diets resulted in an increase (*P*<0.05) in DMI or ADG (*P*<0.05) but resulted in no differences (*P*=0.42) in feed conversion. Fat thickness was significantly (*P*<0.05) improved by the diet inclusion of byproducts of any type; however, longissimus muscle area was not affected (*P*=0.83) by the inclusion of byproducts. Calculated yield grades were significantly different in animals fed diets that included byproducts (*P*<0.05) , and marbling score tended (P=0.09) to increase with the inclusion of any of the two byproducts type.

No significant interactions (*P>0.05*) between byproduct type and inclusion level were observed in any of the live performance measurements or any of the carcass characteristics (Table 2).

An interaction (*P*<0.05) between byproduct type and inclusion level was observed in fat thickness, where the inclusion level of 30% WDGS in the diets resulted in an increase of fat thickness, while no differences were observed in any of the other treatments. A tendency (*P=0.08*) for an interaction between byproduct type and inclusion level was observed in Calculated Yield Grade. Although numerically greater intakes were observed in cattle fed corn distillers, no significant (*P*=0.30) differences was observed when the two byproducts were compared. The average daily gains tended (*P*=0.11) to be higher in diets that included corn distillers grains when compared to the diets with PureField blend. Feed efficiency was not different (*P*=0.25) when compared among treatments.

No interaction (*P*=0.68) between byproduct type and level were observed for the number of abscessed livers by treatment. Cattle fed the Purefield blend at both inclusion levels tended (P=0.14) to result in less abscessed livers.

Conclusion

The blend of wheat middling and wet distillers grains produced by PureField is a suitable alternative to corn distillers grains, and including either byproduct in the diet increases ADG, and feed conversion should be used when compared to diets without byproducts. The inclusion of the PDG in finishing diets seems to reduce back fat thickness and ribeye area, affecting yield grade, however more specific research should be conducted to further elucidate these effects. Using the PureField Distillers Grains in finishing diets seems to moderate the effect of these high energy diets on liver health.

Sofia Canafoglia, visitor scholar, animal science, Panhandle Research Extension and Education Center. Scottsbluff.

Pablo L. Loza, assistant professor, animal science, Panhandle Research Extension and Education Center. Scottsbluff.

Acknowledgements: Funding provided by Purefield LLC, Kansas.

Statistics Used in the Nebraska Beef Report and Their Purpose

The purpose of beef cattle and beef product research at UNL is to provide reference information that represents the various populations (cows, calves, heifers, feeders, carcasses, retail products, etc) of beef production. Obviously, the researcher cannot apply treatments to every member of a population; therefore he/she must sample the population. The use of statistics allows the researcher and readers of the Nebraska Beef report the opportunity to evaluate separation of random (chance) occurrences and real biological effects of a treatment. Following is a brief description of the major statistics used in the beef report. For a more detailed description of the expectations of authors and parameters used in animal science see Journal of Animal Science Style and Form at: http://jas.fass.org/misc/ifora.shtml.

— **Mean** Data for individual experimental units (cows, steers, steaks) exposed to the same treatment are generally averaged and reported in the text, tables and figures. The statistical term representing the average of a group of data points is mean.

—**Variability** The inconsistency among the individual experimental units used to calculate a mean for the item measured is the variance. For example, if the ADG for all the steers used to calculate the mean for a treatment is 3.5 lb then the variance is zero. But, this situation never happens! However, if ADG for individual steers used to calculate the mean for a treatment range from 1.0 lb to 5.0 lb, then the variance is large. The variance may be reported as standard deviation (square root of the variance) or as standard error of the mean. The standard error is the standard deviation of the mean as if we had done repeated samplings of data to calculate multiple means for a given treatment. In most cases treatment means and their measure of variability will be expressed as follows: 3.5 0.15. This would be a mean of 3.5 followed by the standard error of the mean of 0.15. A helpful step combining both the mean and the variability from an experiment to conclude whether the treatment results in a real biological effect is to calculate a 95% confidence interval. This interval would be twice the standard error added to and subtracted from the mean. In the example above, this interval is 3.2–3.8 lb. If in an experiment, these intervals calculated for treatments of interest overlap, the experiment does not provide satisfactory evidence to conclude that treatments effects are different.

—*P* **Value** Probability (P Value) refers to the likelihood the observed differences among treatment means are due to chance. For example, if the author reports P 0.05 as the significance level for a test of the differences between treatments as they affect ADG, the reader may conclude there is less than a 5% chance the differences observed between the means are a random occurrence and the treatments do not affect ADG. Hence we conclude that, because this probability of chance occurrence is small, there must be difference between the treatments in their effect on ADG. It is generally accepted among researchers when P values are less than or equal to 0.05, observed differences are deemed due to important treatment effects. Authors occasionally conclude that an effect is significant, hence real, if P values are between 0.05 and 0.10. Further, some authors may include a statement indicating there was a tendency or trend in the data. Authors often use these statements when P values are between 0.10 and 0.15, because they are not confident the differences among treatment means are real treatment effects. With P values of 0.10 and 0.15 the chance random sampling caused the observed differences is 1 in 10 and 1 in 6.7, respectively.

—**Linear & Quadratic Contrasts** Some articles contain linear (L) and quadratic (Q) responses to treatments. These parameters are used when the research involves increasing amounts of a factor as treatments. Examples are increasing amounts of a ration ingredient (corn, by-product, or feed additive) or increasing amounts of a nutrient (protein, calcium, or vitamin E). The L and Q contrasts provide information regarding the shape of the response. Linear indicates a straight line response and quadratic indicates a curved response. P-values for these contrasts have the same interpretation as described above.

—**Correlation (r)** Correlation indicates amount of linear relationship of two measurements. The correlation coefficient can range from 1 to 1. Values near zero indicate a weak relationship, values near 1 indicate a strong positive relationship, and a value of 1 indicates a strong negative relationship.

ACKNOWLEDGEMENTS

Appreciation is expressed to the following research technicians, unit managers, and valuable employees involved in the research programs at our various locations.

Eastern Nebraska Research, Education and Extension Center, Ithaca

Bill Bat Erdene
Josh Benton
Autumn Berger
Lindsey Celesky
Sophia Collett
Dale Foster
Gavin Guldner
Tanner Harris
Austin Holliday
Cayden Jackson
Jeff Kadansky
Paul Kumke
Justin Moore
Gwen Olberding
Jazmin Phares
TJ Sabatka
Mark Schroeder
Matt Sillivan
Barb Smith
Sawyer Starrett
Isaque Vicci

Department of Animal Science, Lincoln

Kevin Bahr
Bethany Blackburn
Clay Boyles
Brent Johnson
Anna Kobza
Scott Kurz
Sofia Suarez Lorences
Eileen Marks-Nelson
Erin Marotz
Rebecca McDermott
Jessica Miller
Samantha Powell
Calvin Schrock
Erin Stevens
Darren Strizek

Gudmundsen Sandhills Laboratory, Whitman

Andy Applegarth
Jacki Musgrave
John Nollette
Roger Carpenter

Panhandle Research, Education & Extension Center, Scottsbluff

Alejandro Casella
Nabor Guzman

West Central Research, Education & Extension Center, North Platte

Mike Kirby
Jess Milby
Jim Teichert

High Plains Ag Laboratory

Jacob Hansen
David Blanke

Animal Science
http://animalscience.unl.edu

Curriculum: The curriculum of the Animal Science Department at the University of Nebraska–Lincoln is designed so that each student can select from a variety of options oriented to specific career goals in professions ranging from animal production to veterinary medicine. With unique opportunities to double major in ***Grazing Livestock Systems*** (http://gls.unl.edu) or complete the ***Feedlot Management Internship Program*** (http://feedlot.unl.edu/intern)

Careers

Animal Health
Banking and Finance
Animal Management
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Meat Safety
Quality Assurance
Research and Development
Veterinary Medicine

Scholarships: The Animal Science Department also offers scholarships to incoming freshmen and upperclassmen. The department awards over $30,000 each year to Animal Science students.

ABS Global Scholarship
Baltzell-Agri-Products, Inc. Scholarship
Maurice E. Boeckenhauer Memorial Scholarship
Mike Cull Judging and Activities Scholarship
Don Geweke Memorial Award
Parr Young Senior Merit Award
Nebraska Pork Producers Association Scholarship
Waldo Family Farms Scholarship
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Lincoln Coca-Cola Bottling Company Scholarship.
William J. and Hazel J. Loeffel Scholarship
Nutrition Service Associates Scholarship
Parr Family Student Support Fund
Chris and Sarah Raun Memorial Scholarship
Walter A. and Alice V. Rockwell Scholarship
Standard Manufacturing Co. Scholarship
Max and Ora Mae Stark Scholarship
D. V. and Ernestine Stephens Memorial Scholarship
Dwight F. Stephens Scholarship
Arthur W. and Viola Thompson Scholarship
Thomas H. Wake, III Scholarship
Frank E. Card Scholarship
Derrick Family Scholarship
G. H. Francke Livestock Judging Scholarship
Eric Peterson Memorial Award
Winkler Memorial Livestock Judging Scholarship

Electronic copies of Nebraska Beef Reports and Summaries available at:
http://beef.unl.edu > Research > UNL Beef Cattle Research Reports