2022
Plains Nutrition Council Spring Conference

APRIL 13-15, 2022
SAN ANTONIO, TX

PLAINS NUTRITION COUNCIL
AMARILLO, TX

THE PLAINS NUTRITION COUNCIL

2022 SPRING CONFERENCE

2021-22 OFFICERS AND EXECUTIVE COMMITTEE

THE PLAINS NUTRITION COUNCIL
3340 BELL ST 320 #305
AMARILLO, TX 79109

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The 2022 Plains Nutrition Council Spring Conference

Detailed Agenda *(with location in parentheses)*

<u>Wednesday, April 13th</u>

12:00 PM Check-in table open *(Texas Prefunction)*

Graduate student poster setup *(Texas Corridor)*

2:00 PM Professional member only closed-door session *(Texas ABC)*

- 2:00 PM Issues and opportunities in feeding beef x dairy composites – Dr. Pete Anderson, Midwest PMS
- 2:50 PM Beef processing observations and considerations for beef x dairy calves – Dr. Ty Lawrence, West Texas A&M University
- 3:40 PM Break and open bar sponsored by Huvepharma
- 4:00 PM Closed door discussion on feeding beef x dairy composites

5:00 PM View graduate student posters *(Texas Corridor)*

6:00 PM Pre-conference reception hosted by Lallemand Animal Nutrition *(Texas Prefunction)*

<u>Thursday, April 14th</u>

7:00 AM Check-in and registration table open *(Texas Prefunction)*

View graduate student poster presentations *(Texas Corridor)*

8:00 AM Pre-conference symposium hosted by Lallemand Animal Nutrition – The microbiota: connections and interactions within the body *(Texas ABC)*

11:30 AM Boxed lunch provided by Lallemand Animal Nutrition *(Texas ABC)*

Graduate Student and Legends of Feedlot Nutrition Luncheon *(Texas D)*

Speaker luncheon *(Republic C)*

1:00 PM Plains Nutrition Council Spring Conference opening session *(Texas ABC)*

- 1:10 PM Revisiting nutrition and health of newly received cattle: What have we learned the last 15 years? – Dr. Mike Galyean, Texas Tech University
- 2:00 PM 2022 Legends of Feedlot Nutrition induction ceremony
- 3:00 PM Break and view graduate student poster presentations
- 3:30 PM ARPAS overview presentation – Dr. Paul Beck, Oklahoma State University
- 3:45 PM The effect of three implant programs on performance, carcass outcomes, and activity of finishing steers fed different days on feed Socorro Martinez – Midwest PMS
- 4:15 PM Something about fat – Dr. Richard Zinn, University of California – Davis

5:00 PM View graduate student poster presentations *(Texas Corridor)*

5:30 PM RAMP and Sweet Bran reception hosted by Cargill *(Terrace Patio)*

Friday, April 15th

7:00 AM Check-in and registration table open *(Texas Prefunction)*

8:00 AM Plains Nutrition Council Spring Conference closing session *(Texas ABC)*

- 8:00 AM Plains Nutrition Council annual business meeting
- 8:15 AM Academic research update – Dr. Zachary Smith, South Dakota State University
- 8:45 AM Sustainability: opportunities and challenges for the food supply chain – Dr. Kim Stackhouse-Lawson, Colorado State University AgNext
- 9:35 AM Break and view graduate student poster presentations
- 10:00 AM Presentation of graduate student poster awards, sponsored by Cargill Animal Nutrition – Dr. Kristin Hales, Plains Nutrition Council 2nd Vice President
- 10:20 AM Climate neutrality for U.S. cattle production: what does it mean? – Dr. Sara Place, Elanco Animal Health
- 11:10 AM Potential practices to decrease the carbon footprint of cattle feeding – Dr. N. Andy Cole, retired USDA-ARS

12:00 PM Closing remarks and adjourn *(Texas ABC)*

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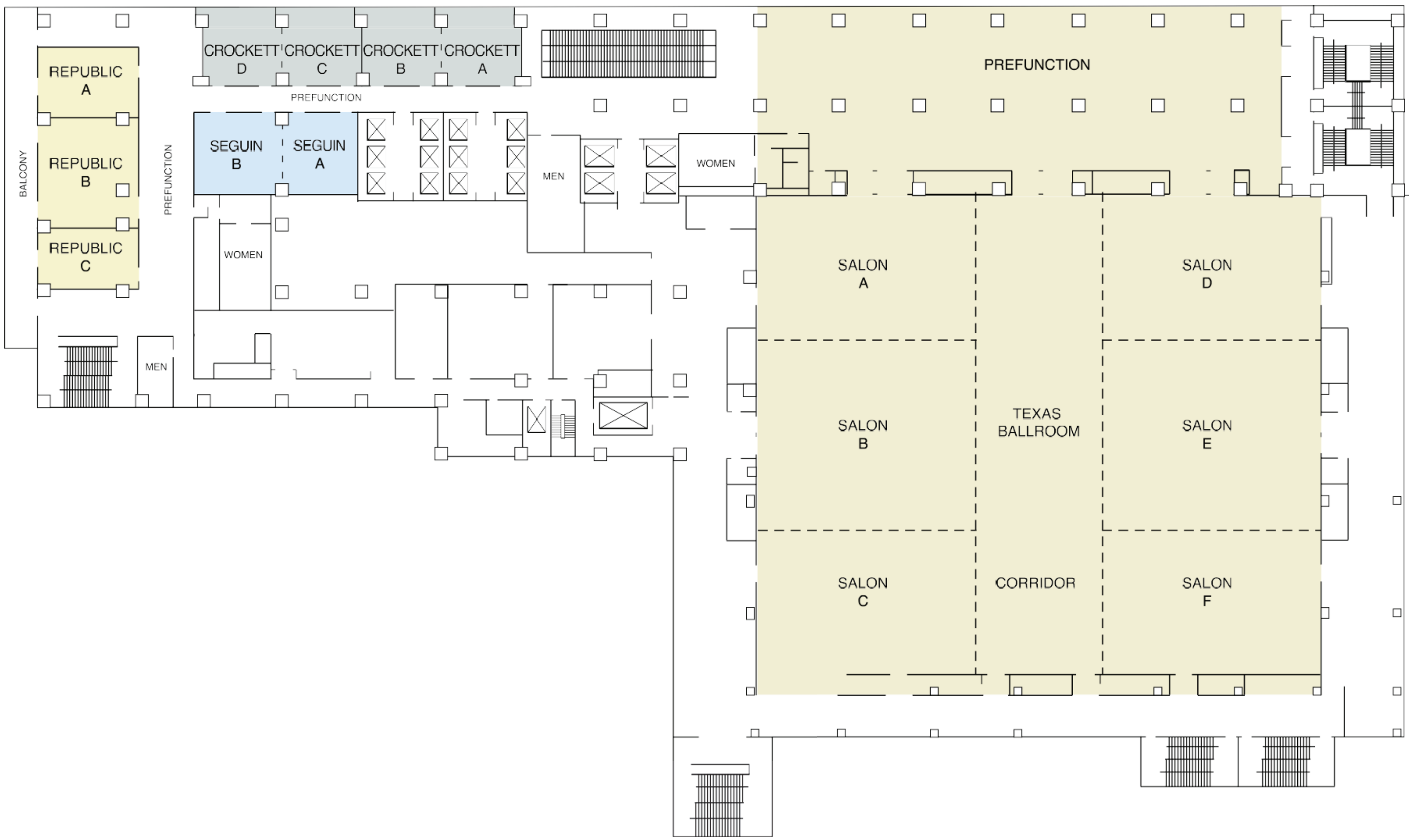
Layout of meeting space



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Revisiting nutrition and health of newly received cattle – What have we learned in the last 15 years?

M. L. Galyean*, *G. C. Duff, and J. D. Rivera*

***Department of Veterinary Sciences, Davis College of Agricultural Sciences and Natural Resources, Texas Tech University, Lubbock**

Galyean Appreciation Club Review: Revisiting nutrition and health of newly received cattle – What have we learned in the last 15 years?

M. L Galyean, G. C. Duff, and J. D. Rivera

Open Access Article in the *Journal of Animal Science*:
https://academic.oup.com/jas/advance-article/doi/10.1093/jas/skac067/6542850?guestAccessKey=9f62c633-b12a-4ee1-8703-c02b8b3565f0

Lay Summary:

Bovine respiratory disease (BRD) is a significant economic and animal welfare problem for the beef industry. Experiments related to health and management of newly received cattle published in the last 15 years were reviewed. Limited progress is being made in developing accurate, real-time methods for diagnosis of BRD, and overall, diagnosis is less effective than desired. Measurement of lung and heart sounds combined with rectal temperature have been studied as diagnostic tools, as well as measurement of blood metabolites and remote monitoring of behavior. Vaccination for viral and bacterial BRD agents and mass-treatment of cattle with antibiotics continue to be important tools for prevention and control of BRD, but development of antimicrobial resistance is a concern. Energy and roughage concentration as well as roughage source continue to be important dietary considerations, as does mineral supplementation, with mineral source and injectable minerals receiving significant research attention. Probiotics and prebiotics fed to newly received cattle have shown variable results in terms of effects on the incidence of BRD and animal performance. Additional research is needed to define optimal diagnostic, management, and nutritional practices for newly received cattle.

Journal of Animal Science Manuscript

Topics Reviewed

- BRD Diagnosis
  - Techniques and tools
- Management Factors
  - Preconditioning
  - Transportation
  - Vaccination
  - Metaphylaxis programs
  - Anti-inflammatories

- Nutritional Factors
  - Energy
  - Protein
  - Roughage
  - Silages
  - Water
  - Minerals
  - Vitamins
  - Probiotics/Prebiotics

- Other Additives and Approaches
- Research Needs

BRD Diagnosis

Health: The overall condition of an organism at a given time. Soundness, especially of body or mind; freedom from disease or abnormality. - *The American Heritage Dictionary of the English Language* (3rd ed.).

In practice:

- *Health is a subjective measurement*
- *Assessing health is more husbandry than science*
- *Visual appraisal + rectal temperature is common*
- *Newer methods are being evaluated, but there is no "gold standard" for diagnosis*

BRD Diagnosis

How do we know whether our diagnostic methods are working?

• Generally, diagnostic tests are evaluated in terms of sensitivity and specificity

- Sensitivity = the ability of the test to correctly classify the disease condition (i.e., true positive rate)

- Specificity = the ability of the test to correctly classify the absence of the disease condition (i.e., true negative rate)

How Accurately Do We Assess Health in Practice?

Blakebrough-Hall et al. (2020); *J. Anim. Sci.* 98(2):1-11

• 898 crossbred steers

*** Overall, 18% morbidity and 2.1% mortality from BRD**

*** Evaluated pleural and lung lesions at slaughter**

- Clinical BRD (visual signs, treated, and severe lung lesions at slaughter) = 6.7% (58 animals)

- Subclinical BRD (no clinical signs or treatment, but severe lung lesions) = 8.4% (73 animals)

- Treated (treated because of visual signs of BRD, but no lung lesions) = 10.2% (89 animals)

- Visually Healthy but Treated (treated based on rectal temperature or lung auscultation) = 7.2% (63 animals)

- Healthy (not treated and no lung lesions) = 67.5% (587 animals)

How Accurately Do We Assess Health in Practice?

Blakebrough-Hall et al. (2020); *J. Anim. Sci.* 98(2):1-11

- Subclinical BRD cattle had greater ADG, HCW, and net return ($P < 0.05$) than Clinical BRD cattle – both lower ($P < 0.05$) than Healthy and Visually Healthy cattle
- Treated cattle that did not have lung lesions had ADG, HCW, and net return that did not differ from Subclinical cattle

Bottom Line: Sensitivity and Specificity of BRD Diagnosis Need to be Improved

Research on BRD Diagnosis

- Whisper On Arrival technology – Nickell et al. (2021); *Transl. Anim. Sci.* 5:1-13 – potential decrease in antibiotic use?
- Blood ^{1}H NMR metabolomics – Blakebrough-Hall et al. (2020); Sci. Rep. 10:115 (12 pp.). doi.org/10.1038/s41598-019-56809-w – blood metabolites could potentially serve to identify cattle with BRD
- Feeding/Watering Behavior, Accelerometers, and Global Positioning Systems – Richeson et al. (2018); *Transl. Anim. Sci.* 2:223-229 – potential for remote monitoring and identification of morbid cattle

Preconditioning

Weaning Management and PI-BVD Exposure in Newly Received Calves

	Auction market		Preconditioned			Contrasts, *P* =		
Item	Control	PI-exposed	Control	PI-exposed	SEM	Management	Exposure	Interaction
No. pens	14	14	12	11	-	-	-	-
Initial BW, kg	249	248	250	249	9.3	0.36	0.43	0.58
42-d BW, kg	286	283	301	299	7.5	<0.001	0.19	0.71
42-d ADG, kg	0.86	0.84	1.21	1.18	0.10	<0.001	0.29	0.99
BRD, %	67.2	73.7	7.7	5.7	4.3	<0.001	0.40	0.96
Antibiotic cost, $/calf	18.49	22.55	2.31	2.65	2.01	<0.001	0.10	0.16

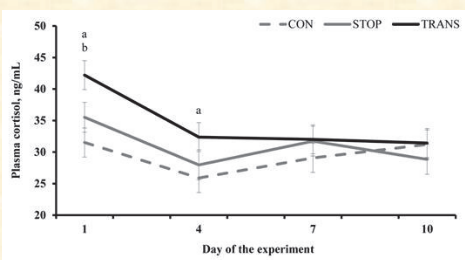
Source: Richeson et al. (2012); *J. Anim. Sci*. 90:1972-1985

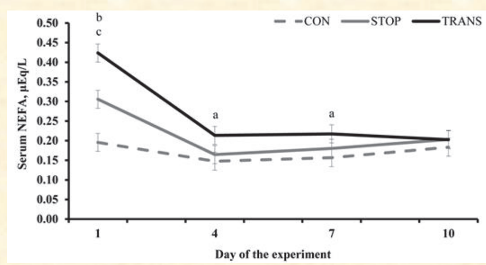
"Despite its value, implementation of preconditioning programs has been slow to be widely adopted by the beef cattle industry."

Transportation

Cooke et al. (2013); *J. Anim. Sci.* 91:5448-5454

No transport vs. 1,290-km transport with or without 2-h rest stop





Item	CON	STOP	TRANS	SEM	*P*-value
BW, kg					
Initial	230	229	229	4	0.96
Final	268	261	262	5	0.56

Also see review by Schwartzkopf-Genswein et al. (2016); *Prof. Anim. Sci.* 32:707-716

Vaccination

- Vaccination against viral pathogens involved in BRD continues to be a vital tool for producers
- Work in the last decade has focused on timing of vaccination

Lippolils et al. (2016); *J. Anim. Sci.* 94:3987-3995 and Schumaher et al. (2019); J. Anim. Sci. 97:620-630

- Vaccination twice before feedlot arrival increased antibody response to viral antigens

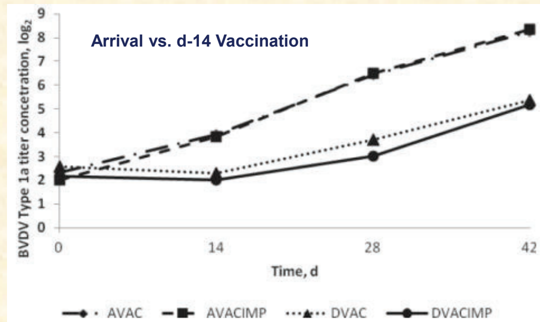


Figure 1. Effect of respiratory vaccination timing and growth-promoting implant on bovine viral diarrhea virus (BVDV) type 1a antibody concentrations of newly received stocker cattle. Vaccination × day interaction (cubic, $P = 0.08$). Effect of vaccine treatment × day ($P = 0.01$). No effect of implant treatment ($P = 0.52$; SE = ± 0.63). AVACIMP = arrival (d 0) bovine respiratory disease (BRD) vaccination with implant; AVAC = arrival BRD vaccination without implant; DVACIMP = delayed BRD disease vaccination with implant; DVAC = delayed BRD vaccination without implant.

Source: Poe et al. (2013); *Prof. Anim. Sci.* 29:413-419

Metaphylaxis

Injectable antibiotic therapy given under veterinary guidance continues to be the primary means of treating cattle with BRD and a vital management tool

NAHMS (2013); Feedlot 2011. Part IV. USDA-APHIS-VS-CEAH-NAHMS:

- Virtually all cattle diagnosed with BRD were given an injectable antibiotic
- 59.3% of feedlots used metaphylaxis for some cattle – focus on cattle < 317 kg

Dennis et al. (2018); J*. Agric. Res. Econ.* 43(2):233-250:

- Cattle feeding industry receives a net return value of $532 to $680 million/year from use of metaphylaxis programs

Effects of metaphylaxis on production responses and total antimicrobial use in high-risk beef calves

A. B. Word,[1] T. A. Wickersham,[1] L. A. Trubenbach,[1] G. B. Mays,[2] and J. E. Sawyer[1,3]*
[1]Department of Animal Science, Texas A&M University, College Station 77840; [2]Department of Large Animal Clinical Sciences, Texas A&M University, College Station 77840; and [3]McGregor Research Center, Texas A&M AgriLife Research, McGregor 76657

Table 2. Morbidity and average number of days (after arrival) until first pull

	Treatment[1]				Contrast *P*-value[2]	
Item	CON	EXC	MIC	SEM	CON vs. TRT	EXC vs. MIC
Morbidity, %	76.7	56.5	46.4	4.3	0.01	0.14
Calves treated						
Twice,[3] %	36.3	29.7	17.9	5.8	0.12	0.19
Thrice,[3] %	15.3	12.7	1.4	4.4	0.16	0.11
Success rate,[4] %	53.2	47.1	61.4	8.2	0.92	0.25
Days to first pull[5]	5	12	8	1.1	0.01	0.02

[1]CON = no metaphylaxis at arrival; EXC = 6.6 mg/kg ceftiofur crystalline free acid at arrival; MIC = 13.2 mg/kg tilmicosin phosphate at arrival.
[2]Contrast *P*-values: CON vs. TRT = control vs. EXC plus MIC.
[3]Calves treated twice or thrice. Includes calves treated for bovine respiratory disease (BRD) symptoms only.
[4]Success rate = number of morbid animals in a pen (animals treated once for BRD), minus the number treated greater than one time for BRD, divided by the number morbid in a pen.
[5]Days to first pull = average number of days until an animal required BRD treatment. EXC and MIC groups underwent a 3-d moratorium following metaphylactic treatment on study d 0.

Source: *Appl. Anim. Sci.* 36:265-270 (2020)

Effects of antimicrobial metaphylaxis using no antimicrobial, tilmicosin, or tildipirosin and 2 different days on feed on the health and growth performance of lightweight beef steer calves originating from Mexico

A. B. Word,[1]* G. B. Ellis,[2]† B. P. Holland,[1] PAS, M. N. Streeter,[2] and J. P. Hutcheson[2]
[1]Cactus Research, Amarillo, TX 79101; and [2]Merck Animal Health, De Soto, KS 66018

Table 3. Morbidity and mortality in lightweight steers originating in Mexico and administered no metaphylaxis, tildipirosin, or tilmicosin on arrival

	Treatment[1]				
Item	CON	MIC	ZUP	SEM	*P*-value
Pens, no.	10	10	10	—	—
Steers, no.	1,361	1,362	1,363	—	—
Morbidity due to BRD[2] and all-cause mortality during the first 60 d on feed					
BRD treated once, %	10.98[a]	4.24[b]	2.06[c]	0.837	<0.001
BRD treated twice, %	1.60[a]	0.59[b]	0.44[b]	0.339	0.003
Mortality, %	2.12[a]	0.51[b]	0.59[b]	0.390	0.001
Removals, %	0.37[a]	0.14[ab]	0.00[b]	0.165	0.546
Morbidity due to BRD across the entire feeding period					
Days to first treatment	23	48	51	10.26	0.111
Treated once, %	12.08[a]	5.56[b]	3.58[c]	0.873	<0.001
Treated twice, %	1.67[a]	0.95[ab]	0.65[b]	0.345	0.035

Source: *Appl. Anim. Sci.* 37:207-216 (2021)

Metaphylaxis

- A significant challenge with antibiotic use in general and metaphylaxis in particular is antibiotic resistance

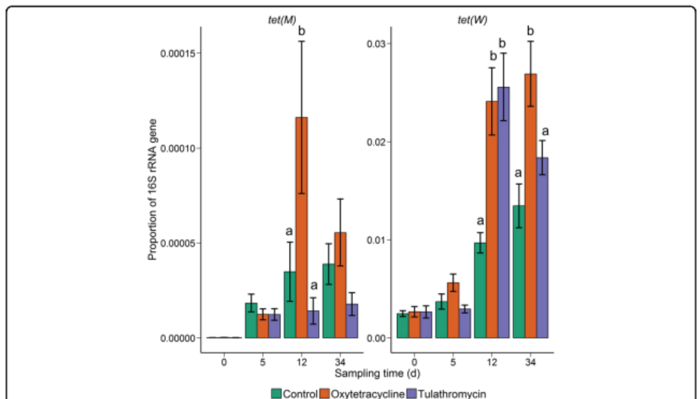


Fig. 7 The proportion of the resistance determinants tet(M) and tet(W) to 16S rRNA gene copies in fecal samples within each treatment group at days 0, 5, 12, and 34. Different lowercase letters within each sampling time represent significantly different means ($P < 0.05$). Error bars indicate ± standard error of the mean ($n = 12$)

- Only 2 of 10 resistance genes were above detection limits in fecal and nasopharyngeal samples – in feces, only 2 differed by antibiotic treatment – Holman et al. (2019); *Microbiome* 7:86 (14 pp)

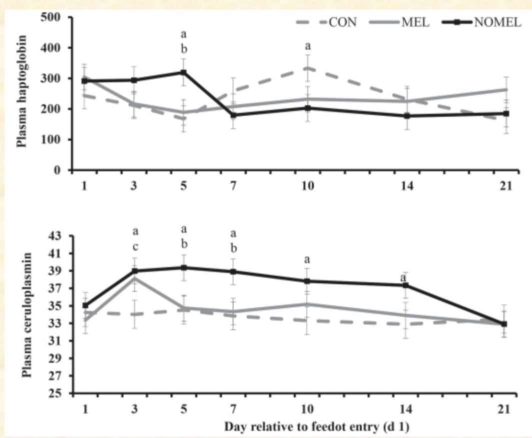
Anti-Inflammatory Agents

See review by Cooke (2017); *Prof. Anim. Sci.* 33:1-11

- Stresses associated with weaning, transport, commingling, etc. increase proinflammatory cytokines (PiC) and acute-phase proteins (ACP) in newly received cattle

Can anti-inflammatory agents decrease these effects and improve performance?

- Cooke (2017) – addressed the effects of essential fatty acids (EFA), flunixin meglumine, and meloxicam in newly received cattle
- Anti-inflammatory treatments affected serum PiC and ACP; EFA and meloxicam increased receiving period ADG



Energy and Protein

- **Limited additional research on energy for newly received cattle in the last 15 years**
  - **Interest remains in whether high-starch diets might induce subacute acidosis, which could be conflated with symptoms of BRD**
  - **See Spore et al. (2019); *Appl. Anim. Sci.* 35:397-407, but more research needed**
- **Protein – as with energy, limited additional research has been conducted**
  - **Stress and inflammation should increase amino acid requirements**
  - **Higher-protein receiving diets have had variable effects on performance and BRD**

Effects of a high-energy programmed feeding protocol on nutrient digestibility, health, and performance of newly received growing beef cattle

Tyler J. Spore,[1] PAS, Sean P. Montgomery,[2] PAS, Evan C. Titgemeyer,[1] Gregg A. Hanzlicek,[3] Chris I. Vahl,[4] Tiruvoor G. Nagaraja,[5] Kevin T. Cavalli,[1] William R. Hollenbeck,[1] Ross A. Wahl,[1] and Dale A. Blasi[1,5]*
[1]Department of Animal Sciences and Industry, Kansas State University, Manhattan 66506; [2]Corn Belt Livestock Services, Papillion, NE 68046; [3]Veterinary Diagnostic Laboratory, Kansas State University, Manhattan 66506; [4]Department of Statistics, Kansas State University, Manhattan 66506; and [5]Department of Diagnostic Medicine and Pathobiology, Kansas State University, Manhattan 66506

Diets based on dry rolled corn and Sweet Bran

Table 5. Effects of dietary energy level on performance

	Diet[1]				
Item	**0.99**	**1.10**	**1.21**	**1.32**	**SEM**
No. of pens	8	8	8	8	
No. of animals	90	87	91	86	
BW, kg					
d 0	214	215	214	214	0.60
d 55	268	269	269	272	2.3
ADG, kg/d	0.98	0.98	1.0	1.1	0.05
DMI,[2] kg/d *	7.0	6.5	6.2	6.0	0.15
G:F, kg/kg *	0.142	0.150	0.162	0.174	0.006
NE_m,[3] Mcal/kg of DM	1.47	1.53	1.62	1.70	0.03
NE_g,[3] Mcal/kg of DM	0.88	0.94	1.01	1.07	0.03

[1]Diets were formulated to provide 0.99, 1.10, 1.21, and 1.32 Mcal of NE_g/kg.
[2]DMI controlled for treatments other than 0.99; includes the 14-d gut-fill equalization period.
[3]Net energy calculations based on equations from NASEM (2016).

Table 3. Effects of dietary energy on health

	Diet[1]					
Item	**0.99**	**1.10**	**1.21**	**1.32**	**SEM[2]**	***P*-value**
Morbidity, %						
Treated once	11.2	12.6	12.3	12.6	4.6	0.99
Treated twice	3.6	4.8	2.8	4.8	2.9	0.86
Treated thrice	2.6	3.7	1.8	2.7	2.5	0.86
Mortality, %	4.8	4.4	2.1	4.3	2.1	0.83

[1]Diets were formulated to supply 0.99, 1.10, 1.21, or 1.32 Mcal of NE_g/kg of DM.
[2]The largest SEM among treatments is reported.

***Linear effect, $P < 0.01$**

Source: *Appl. Anim. Sci.* 35:397-407 (2019)

Roughage and Silages

Areas of research related to roughage:

- **Alternative roughage sources**
  - **Use of Sweet Bran in receiving diets (RAMP) – seems to be an effective and widely used program**
  - **Soybean and cottonseed hulls; corn residue**
- **Silage – traditionally not considered and optimal roughage source for newly received calves**
  - **See Smerchek et al. (2020); *Transl. Anim. Sci.* 4:848-853**
- **Roughage processing**
  - **See Loya-Olguin et al. (2008); *J. Anim. Sci.* 86:2749-2755**

Increasing hay inclusion in silage-based receiving diets and its effects on performance and energy utilization in newly weaned beef steers

Smerchek et al. (2020); *Transl. Anim. Sci.* 4:848-853

	Grass Hay Level, %					
Item	0	10	20	SEM	Linear	Quad
No. pens	6	6	6	-	-	-
Initial BW, kg	278	278	277	0.3	0.12	0.30
56-d BW, kg	352	353	357	2.7	0.21	0.62
ADG, 0-56, kg	1.33	1.35	1.43	0.048	0.16	0.54
DMI, 0-56, kg/d	6.46	6.74	7.04	0.105	0.01	0.93
G:F	0.206	0.200	0.204	0.0045	0.72	0.37

Base diet: 73.64% corn silage, 20.36% DDGS, and 6% supplement – Grass hay replaced corn silage

Influence of slice baling on feeding value of alfalfa hay in receiving and finishing diets for feedlot cattle[1]

F. Loya-Olguin,* L. Avendaño-Reyes,† A. M. Encinias,* D. A. Walker,* N. A. Elam,* and S. A. Soto-Navarro‡[2]

*Clayton Livestock Research Center, New Mexico State University, Clayton 88415; †Universidad Autónoma de Baja California, México; and ‡Department of Animal and Range Sciences, New Mexico State University, Las Cruces 88003

Item	Ground	Sliced	SEM	P-value
No. pens	6	6	-	-
Initial BW, kg	183.1	183.2	1.72	0.95
28-d BW, kg	208.6	217.6	2.11	0.01
ADG, 0-28, kg	0.91	1.23	0.04	0.001
DMI, 0-28, kg	3.96	4.05	0.11	0.57
BRD, %	44.3	33.7	3.94	0.20
Retreatment, %	39.2	22.2	7.5	0.14

No major effects of hay processing in a subsequent finishing study

Source: *J. Anim. Sci.* 86:2749-2755 (2008)

Water

- **Dehydration (shrink) is common (basically expected) in newly received cattle**
- **Tomczak et al. (2019); *Appl. Anim. Sci.* 35:30-38 evaluated oral hydration therapy (0.57 L of water/45.4 kg BW) for newly received calves in two experiments**

Exp. 1 – SF Corn/Alfalfa Diet

Item	Con	H_2O	SEM	*P*-value
No. pens	6	6	-	-
Initial BW, kg	197.4	196.7	2.48	0.63
56-d BW, kg	261.8	262.1	5.87	0.91
ADG, 0-56, kg	1.15	1.17	0.08	0.64
DMI, 0-56, kg	5.09	5.29	0.29	0.12
BRD, %	21.5	29.0	4.6	0.07
Mortality, %	3.4	4.3	2.2	0.54

Exp. 2 – Sweet Bran/Corn Stalks Diet

Item	Con	H_2O	SEM	*P*-value
No. pens	5	5	-	-
Initial BW, kg	188.7	189.5	0.73	0.42
56-d BW, kg	248.7	256.8	3.09	0.08
ADG, 0-56, kg	1.07	1.19	0.05	0.08
DMI, 0-56, kg	5.03	5.27	0.13	0.19
BRD, %	33.6	36.4	0.08	0.64
Mortality, %	3.4	8.8	3.33	0.06

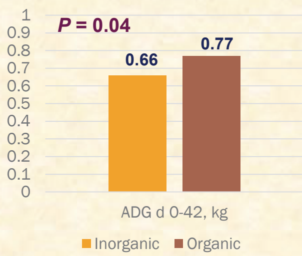
Minerals

Major areas of research in the last 15 years:

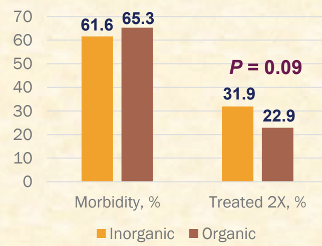
- **Organic vs. inorganic sources in "packages"**
- **Injectable trace minerals**
  - **Interaction with vaccination**
- **"Fetal programming" effects of mineral sources**
- **Supplemental chromium for newly received cattle**

Kegley et al. (2012); ***Prof. Anim. Sci.*** **28:313-318**

288 bull and steer calves – 8 paddocks/treatment



360 mg Zn
125 mg Cu
200 mg Mn
12 mg Co



Injectable Trace Minerals

Effect of supplemental trace minerals from injection on health and performance of highly stressed, newly received beef heifers

J. T. Richeson and E. B. Kegley

Prof. Anim. Sci. **27:461-466 (2011)**

Table 4. Effect of supplemental trace minerals from injection on health and antibiotic treatment cost of newly received beef heifers

Item	Treatment[1] CON	TM1	TM2	SEM	*P*-value
Morbidity, %	87.1[a]	54.8[b]	67.9[ab]	—	0.02[2]
Treated with 2nd antibiotic, %	51.6[a]	19.4[b]	17.9[b]	—	0.01[2]
Treated with 3rd antibiotic, %	32.3[a]	9.7[b]	10.7[b]	—	0.02[2]
Antibiotic cost, $/calf	13.66[a]	8.07[b]	9.47[b]	1.22	0.03[3]

[a,b]Least squares means within a row without a common superscript differ ($P \leq 0.05$) according to *t*-test.

[1]CON = negative control, TM1 = Inject-A-Min injectable trace mineral solution (Mineral Technology, Porterville, CA), TM2 = Mineral Max II injectable trace mineral solution (RXVeterinary Products, Westlake, TX).

[2]Analyzed using the GENMOD procedure of SAS (SAS Institute Inc., Cary, NC), *P* > chi-square.

[3]Analyzed using the MIXED procedure of SAS, *P* > *F*.

90 heifers (199 kg initial BW); 5 pens per treatment

TM1 (mg/mL) = Zn (20), Mn (20), Cu (10), Se (5) - 1 mL/45.5 kg

TM2 (mg/mL) = Zn (48), Mn (10), Cu (16), Se 5); 1 mL/45.5 kg

Injectable Trace Minerals and Vaccine Response

Effect of injectable trace mineral administration on health, performance, and vaccine response of newly received feedlot cattle

S. L. Roberts, N. D. May, C. L. Brauer, W. W. Gentry, C. P. Weiss, J. S. Jennings and J. T. Richeson

Prof. Anim. Sci. 32:842-848 (2016)

128 bull and steer calves (275 kg initial BW) – 42-d receiving period

ITM (mg/mL) = Zn (60), Mn (10), Cu, (15), and Se (5) given at 2.2 mL/100 kg

No effects of treatments on ADG, DMI, or BRD morbidity (15.6 vs. 12.5% for Con vs. ITM)

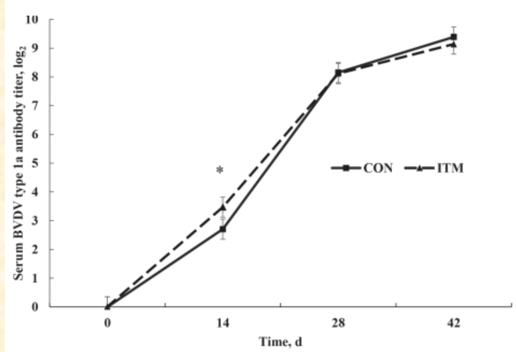
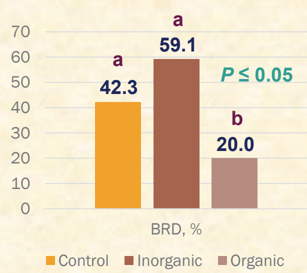


Figure 2. Effect of injectable trace mineral administration on serum bovine viral diarrhea virus (BVDV) type 1a antibody titer in newly received feedlot cattle. Treatment × d interaction, $P = 0.09$; asterisk indicates treatment difference within d, $P = 0.03$. CON = negative control cattle that did not receive an injectable trace mineral solution, ITM = injectable trace mineral solution (Multimin 90, Multimin USA, Fort Collins, CO) containing 60 mg of Zn/mL (as Zn disodium EDTA), 10 mg of Mn/mL (as Mn disodium EDTA), 5 mg of Se/mL (as sodium selenite), and 15 mg of Cu/mL (as Cu disodium EDTA) administered s.c. at 2.2 mL/100 kg of BW on d 0. Error bars indicate the SEM.

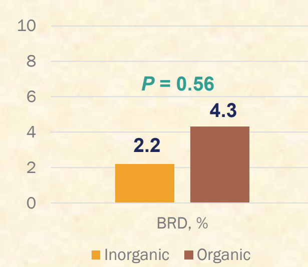
Fetal Programming and Trace Minerals

Marques et al. (2016); J. Anim. Sci. 94:1215-1226



Steers and heifers: Cows fed inorganic or organic sources of Zn, Cu, Mn, and Co during 3rd trimester vs. negative control

Harvey et al. (2021); J. Anim. Sci. 99(6):1-11



Steers only: Cows fed inorganic or organic sources of Zn, Cu, Mn, and Co during 2nd and 3rd trimester – no negative control

Supplemental Chromium

Effects of *Bacillus subtilis* PB6 and/or chromium propionate supplementation on clinical health, growth performance, and carcass traits of high-risk cattle during the feedlot receiving and finishing periods[1]

Taylor M. Smock,[†] Kendall L. Samuelson,[†] Jerilyn E. Hergenreder,[‡] P. Whitney Rounds,[‡] and John T. Richeson[†,2]

[†]Department of Agricultural Sciences, West Texas A&M University, Canyon, TX 79016; and [‡]Animal Nutrition and Health, Kemin Industries, Inc., Des Moines, IA 50317

	Treatment					*P*-value		
Item	Control	*B. sub*	CrPro	*B. sub* + CrPro	SEM	B. sub	CrPro	*B. sub* x CrPro
No. pens	12	12	12	12	-	-	-	
Initial BW, kg	219	220	220	220	0.39	0.13	0.86	0.04
56-d BW, kg	287	298	291	293	2.67	0.02	0.95	0.16
ADG, 0-56, kg	1.21	1.37	1.27	1.31	0.05	0.04	0.95	0.26
DMI, 0-56, kg/d	5.46	5.88	5.58	5.86	0.13	0.01	0.70	0.60
BRD, %*	43.9	34.6	35.8	21.3	-	0.02	0.03	0.59

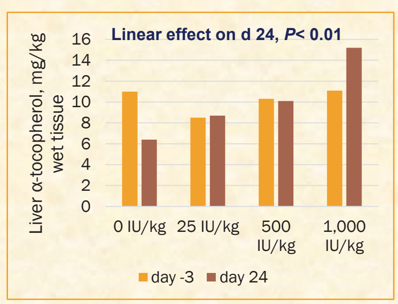
*Includes treatments during both receiving and finishing periods.

Vitamins

Not a major research are in the last 15 years
- **Mainly vitamin E and vitamin C**
- **Injectable vitamins**

Vitamin E supplementation strategies during feedlot receiving: Effects on beef steer performance, antibody response to vaccination, and antioxidant defense
E. L. Deters and S. L. Hansen – *J. Anim. Sci.* 97:4362-4369 (2019)

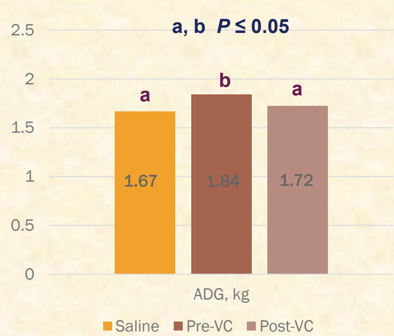
- **204 Angus-based steers (249 kg) fed 0, 25, 500, or 1,000 IU/kg of supplemental vitamin E**
- **No effects on performance or morbidity**

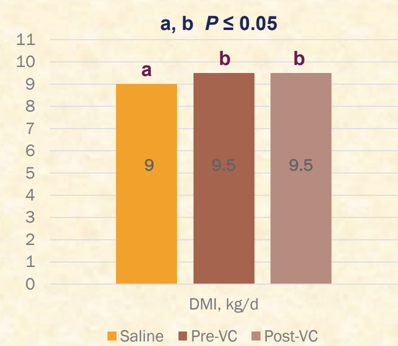


Vitamins

Pre-transit vitamin C injection improves post-transit performance of beef steers
E. L. Deters and S. L. Hansen – *Animal* 14:10, 2083-2090 (2020)

72 Angus-based steers – 356 kg initial BW
18-h transit (1,675 km)
Saline vs. 5 g vitamin C either Pre or Post transit





Probiotics/Prebiotics

- **A variety of products have been tested – yeast and yeast culture products and yeast cell wall probably most common**
- **Batista et al. (2022); *Anim. Feed Sci. Technol.* 283:115182 (12 pp) - meta-analysis of studies with stressed cattle:**
  - **27 studies – weaning, receiving, and heat stress**
  - **Increased ($P < 0.01$) DMI, ADG, and G:F**
  - **No effect on morbidity and mortality (risk ratio 0.94 and 0.77, respectively, $P > 0.49$)**
- **More research needed on BRD morbidity in large-scale studies**

Other Additives and Approaches

- Limited data on several non-antimicrobial approaches
  - Essential oils and plant extracts – some work in low-risk cattle
  - Saponins – increased ADG; fewer antibiotic treatments in one study
  - Bovine appeasing pheromone – increased ADG and fewer antibiotic treatments in one study
  - Exercise – decreased gains; no improvement in health measures
- More research needed on BRD morbidity and potential mechanisms of action

Research Needs

- Improve BRD diagnosis
  - Must be chute-side, rapid, high specificity and sensitivity
- Better define issues related to antimicrobial resistance
- Methods for rapid assessment of nutritional status
  - Targeted supplementation programs
- Improved understanding of fetal programming effects on BRD
  - Need data on individual nutrients when possible
- Better define the role of inflammation in BRD

Research Needs

- Understand the role of energy, starch and roughage in BRD morbidity
- Targeted use of metaphylaxis
  - Apply to arrival groups based on risk algorithms
  - Diagnostic basis for arrival antibiotic treatment
    - Temperature or other diagnostic tools
    - Effectiveness of "random" treatment?
- Optimize antibiotic use
  - Recognize antibiotics as an important tool from an animal welfare standpoint

Industry Goals

- Better understand the value of pre- and probiotics, nutraceuticals, and other non-antimicrobial approaches
- Increase adoption of preconditioning programs
  - More research on optimal type, length, facilities
  - Value of pre-weaning vaccination alone?

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The effect of three implant programs on performance, carcass outcomes, and activity of finishing steers fed different days on feed

S.L. Martinez[1], A.B. Word[2], B.P. Holland[2], K. J. Karr[2], J.P. Hutcheson[3], L. J. Walter[3], J.T. Richeson[1], T.E. Lawrence[1], and K.L. Samuelson[1]

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Slow-release growth implants promote growth, feed efficiency, and carcass quality as a single implant strategy or as a component of a more aggressive multiple-implant program. Extending days on feed (DOF) is a management strategy used to increase hot carcass weight (HCW) and improve quality grade. Managing an implant program with respect to total dose and re-implant timing can aid in retaining efficiencies at longer DOF, but additional research is needed to understand how timing of re-implantation and marketing impacts cattle performance. This study evaluated the effects of a single slow-release implant compared to 2 re-implant programs administered at either 120 DOF or 80 days from harvest on performance, carcass characteristics, and activity of serially harvested feedlot cattle. Using a randomized complete block design, steers (n = 4,680; initial BW = 797 ± 7.36 lb) were randomly assigned to 72 pens (12 pens per block, 60 to 70 animals per pen) and 1 of 12 treatments in a 3 × 4 factorial arrangement. Treatments were Revalor®-XS only (**REVXS**), Revalor®-XS followed by Revalor®-200 at 120 DOF (**REVXS+REV200-120**), or Revalor®-XS followed by Revalor®-200 80 days from harvest (**REVXS+REV200-80**) in cattle serially harvested at 166, 180, 194, or 208 DOF. In blocks 1, 2, and 3 a random subset of steers (n = 1,080; 30 animals per pen) received a 3-axis accelerometer ear-tag to quantify rumination and activity. No implant × DOF interactions ($P \geq 0.09$) were observed. Implant did not affect ($P \geq 0.25$) final BW, ADG, or DMI, but re-implanted steers had a lower ($P = 0.01$) F:G ratio than REVXS. Final BW and F:G increased ($P < 0.01$) and ADG decreased ($P < 0.01$) with additional DOF. Re-implanted steers had greater ($P \leq 0.03$) HCW, dressed yield, and ribeye area, but less ($P < 0.01$) backfat, marbling, and empty body fat (EBF) compared to REVXS. The percentage of Prime carcasses did not differ ($P = 0.33$). However, percentage of Choice carcasses was less ($P < 0.01$) and Select carcasses were greater ($P < 0.01$) for re-implanted cattle than REVXS. Re-implanted steers also had a greater ($P < 0.01$) percentage of yield grade 1 and 2 carcasses and fewer ($P < 0.01$) yield grade 4 and 5 carcasses. As DOF increased, HCW, carcasses > 1,050 lb, dressed yield, backfat, and EBF increased linearly ($P < 0.01$), marbling increased quadratically ($P < 0.01$), and ribeye area did not differ ($P = 0.33$). Percentage of Prime and Choice carcasses linearly increased ($P < 0.01$) with additional DOF and the percentage of Select carcasses was greater ($P < 0.01$) for cattle fed 166 than 188, 194, and 208 DOF. Yield grade 1 and 2 carcasses linearly decreased ($P < 0.01$), and yield grade 4 and 5 increased ($P < 0.01$) with additional DOF. Liver abscess rate and rumination minutes did not differ ($P \geq 0.71$). However, an implant × day interaction ($P < 0.01$) for weekly activity minutes indicated that steers receiving a second implant had greater activity than REVXS after re-implant. Re-implanting within the payout

period of a slow-release implant improved feed efficiency, HCW, and dressed yield, but decreased carcass fatness and reduced quality grade regardless of the timing of secondary implant administration.

Effect of three implant programs on performance, carcass outcomes, and activity of finishing steers fed different days on feed

S.L. Martinez[1], A.B. Word[2], B.P. Holland[2], K.J. Karr[2], J.P. Hutcheson[3], L.J. Walter[3], J.T. Richeson[1], T.E. Lawrence[1], and K.L. Samuelson[1]

[1]Department of Agricultural Sciences, West Texas A&M University, Canyon, TX
[2]Cactus Feeders, Amarillo, TX [3]Merck Animal Health, Madison, NJ

Introduction

- **Since the 1950's, anabolic implants have been widely used to improve cattle ADG and G:F (Preston, 1999) and modify carcass composition in favor of lean muscle accretion (Bryant et al., 2010)**
- **Implant strategy decisions are influenced by genetics, sex, market conditions, feedlot logistics, and economic expectations**

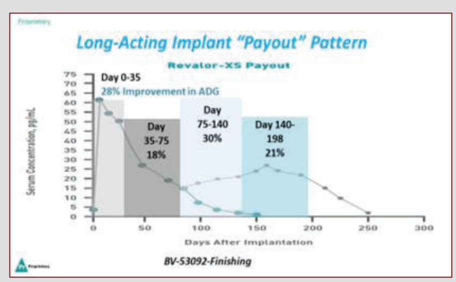
Introduction

- Combination TBA + E_2 implants
  - First approved in 1991 (120 mg TBA and 24 mg E_2)
  - TBA + E_2 increased ADG 22% when compared to control (Hunt et al., 1991)
  - Payout period of 120 d on feed (DOF)
  - Often used with other combination implants to develop more aggressive implant strategies

DOF			
120	1st Implant		
200+	1st Implant	90-120 DOF	2nd Implant

Introduction

- Slow release/coated implants
  - First approved in 2007
  - Coated pellets slowly release hormone extending payout period up to 200 d
  - May eliminate re-implant
    - Labor cost
    - Injury opportunity
    - Stress
    - Decreased intake after re-implant



Introduction

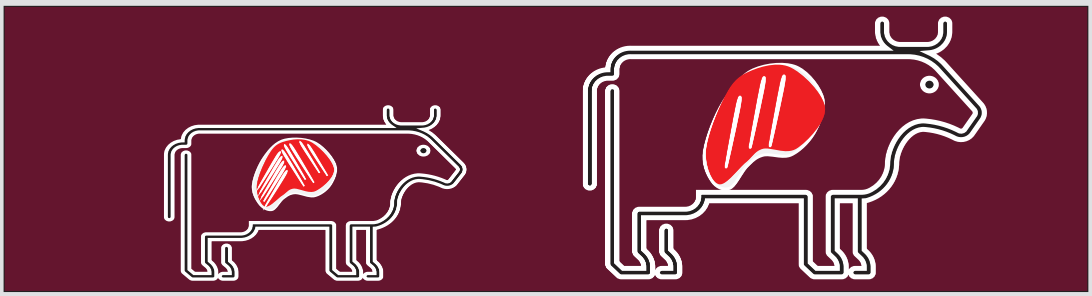
- Average DOF for feedlot cattle was 201 d (Samuelson et al., 2016)
- Placement of lighter cattle on feed increases DOF required to over 200 d (Smith et al., 2018)

Introduction

- In today's feedlot industry, many cattle are also fed to heavier final BW, which further extends DOF
  - Extending DOF increases final BW and HCW (Ohnoutka et al., 2021)
  - Extending DOF increases marbling and 12th rib fat deposition and improves quality grade (Pillmore et al., 2020)

Introduction

- Implanted cattle need to be fed additional DOF to reach similar EBF percentage as non-implanted cattle (Smith et al., 2018)
- Using more aggressive implant strategies may provide a way to increase carcass leaneness without negatively impacting final BW

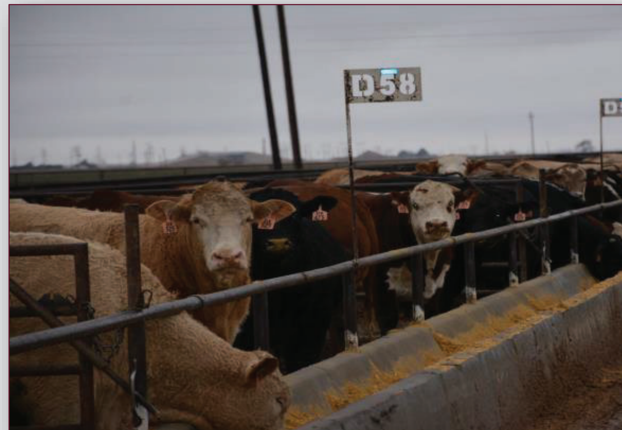


Introduction

- When using technologies that modify carcass composition, developing further understanding of how these influence cattle performance and carcass composition will improve decision making at the feedlot
- Harvesting cattle at different DOF allows observation in changes of carcass value, live performance, and efficiency which could be used to identify ideal marketing end points (Streeter et al., 2012).

Objective

- To compare Revalor-XS as a single implant compared to 2 reimplant programs of Revalor-XS followed by Revalor-200 at either 120 DOF or 80 d from harvest on feedlot cattle performance, carcass characteristics, and pen activity when steers are fed different DOF



WT

Materials and Methods

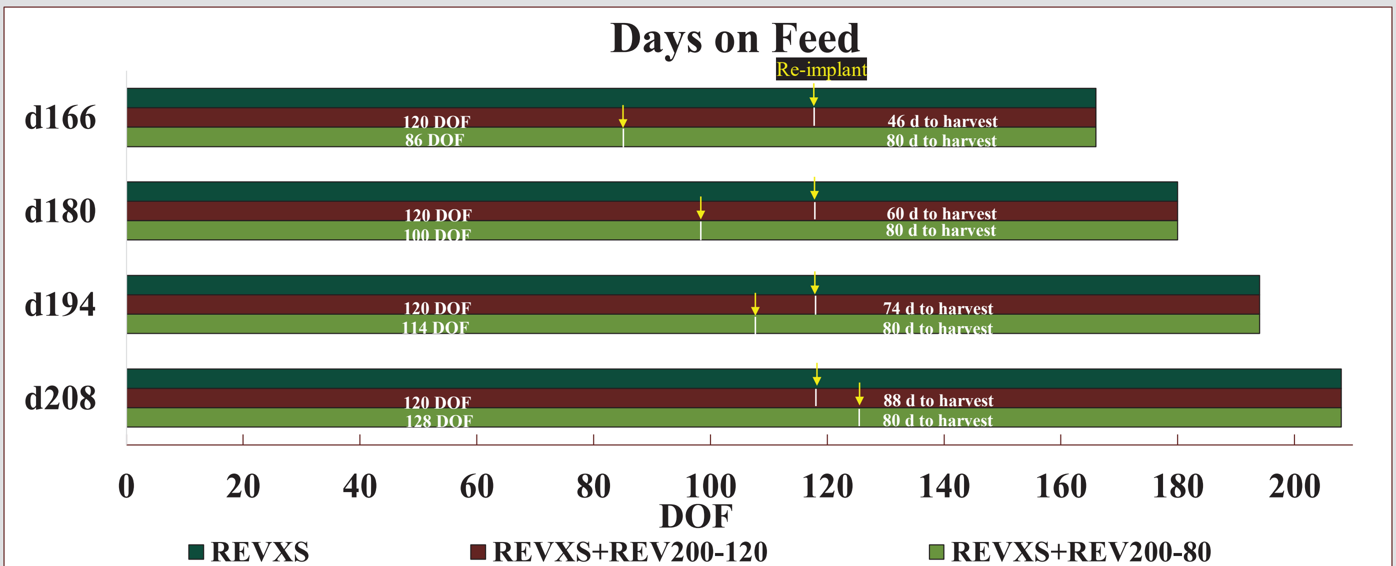
- Study conducted at a commercial feedlot in the Texas panhandle
- Randomized complete block design
- 3 × 4 factorial arrangement of treatments
  - Factor A: Implant regimen
  - Factor B: DOF

WT

Materials and Methods

- **Implant treatments:**
  - Single slow-release implant
    - Revalor-XS, Merck Animal Health, 40mg E_2 17β and 200 mg TBA
  - Slow-release implant followed by terminal implant at 120 DOF
    - Revalor-XS
    - Revalor-200, Merck Animal Health, 20mg E_2 17β and 200 mg TBA
  - Slow-release implant followed by terminal implant 80 d before harvest
    - Revalor-XS
    - Revalor-200
- **Days on feed treatments:**
  - 166, 180, 194, and 208

Materials and Methods



Materials and Methods

- Steers (n = 4,680; Initial BW = 797 ± 7.36 lbs) were allocated over 2 seasons:
  - 72 pens
    - 6 blocks
    - 60 to 70 steers per pen
    - 6 pen replicates per treatment

Materials and Methods

- On d -1 steers were processed according to the feedlot's SOP's and randomly assigned to treatment
- 3-axis accelerometer ear-tag (Allflex Livestock Intelligence; n = 1,080) applied in first 3 blocks
  – 30 accelerometer tags per pen
- On d 0 each pen was weighed to obtain initial BW
- Pen was the experimental unit

Materials and Methods

- Statistical Analysis
  - Continuous data were analyzed using the MIXED procedure of SAS (SAS Inc.; Carey, NC)
  - Categorical data were analyzed using the GLIMMIX procedure of SAS
  - Model included effects of implant, DOF, and implant × DOF
  - Block and season were used as random effects
  - Activity and rumination data were analyzed using the MIXED procedure of SAS with repeated measures
    - Only implant treatments analyzed

Results

Implant × Days on Feed

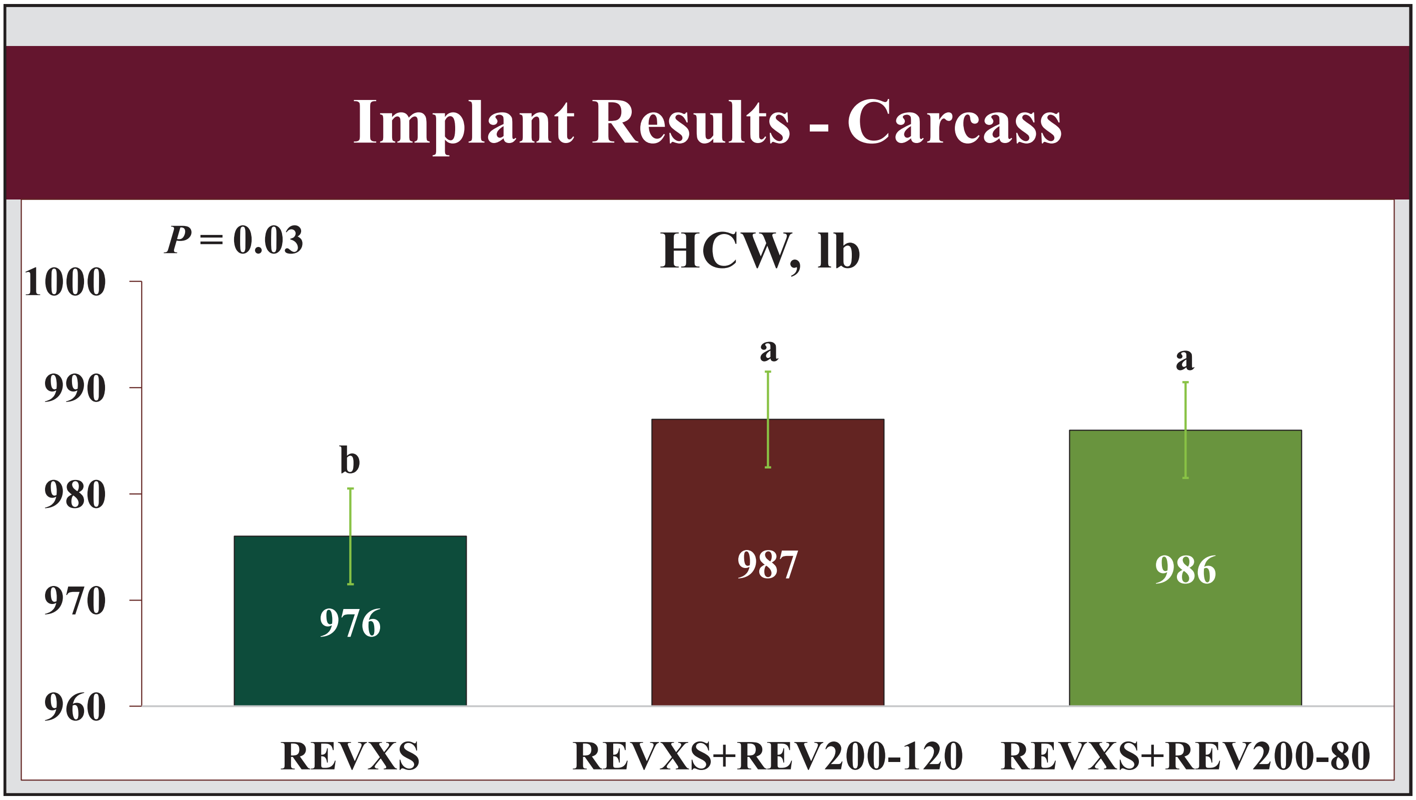
Results

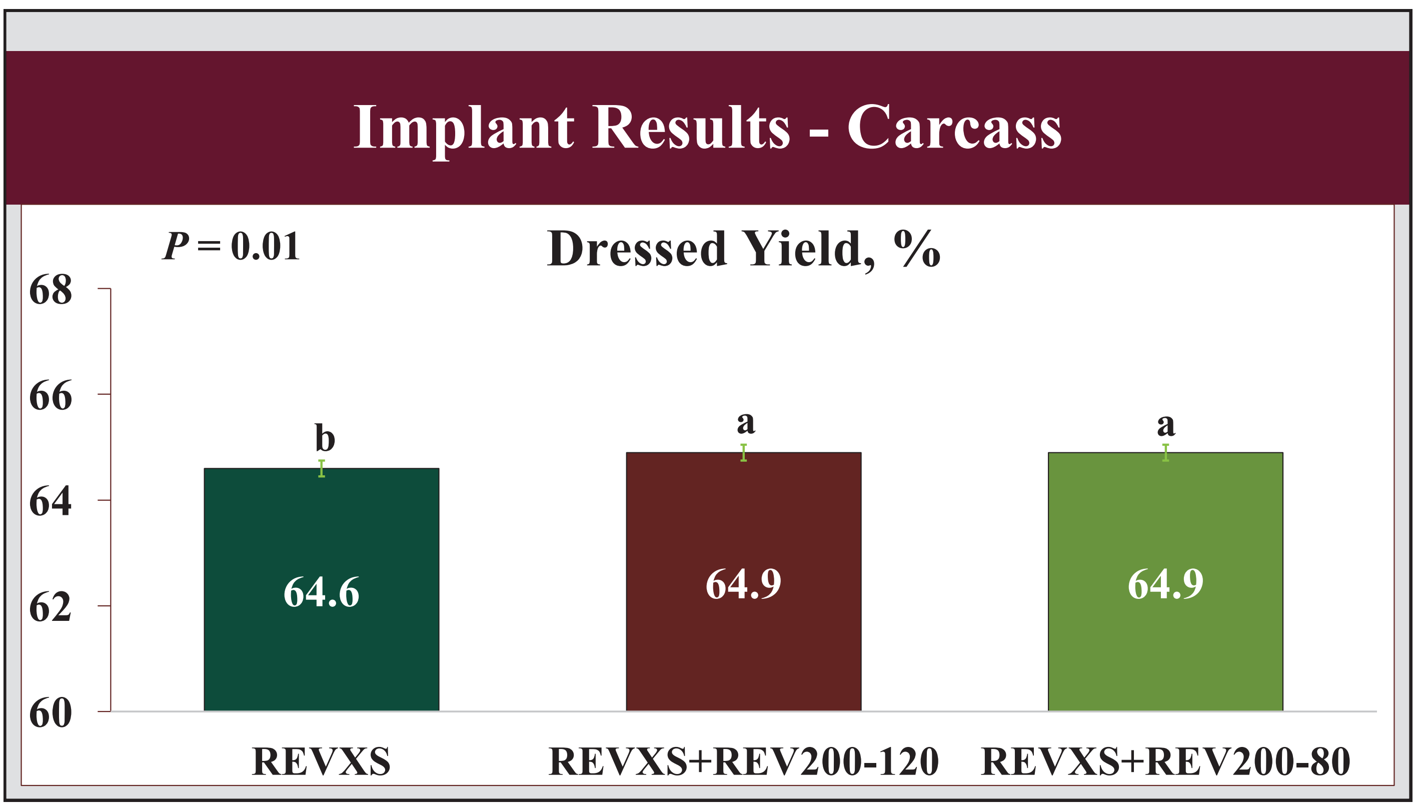
Effect of Implant

Results - Performance

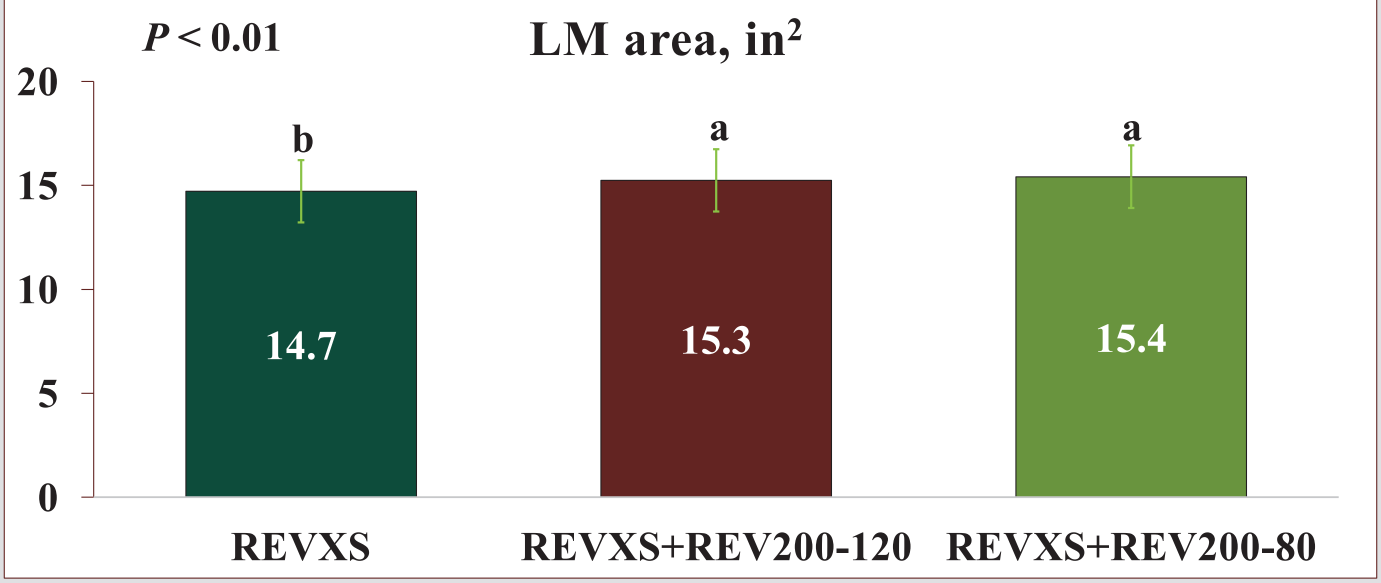
Table 1. Performance of serially harvested feedlot steers receiving Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

	Implant				*P*-value
	REVXS	REVX+REV 200-120	REVXS+ REV 200-80	SEM	Implant
Item					
Steers	1560	1560	1560	-	-
Pens	24	24	24	-	-
Performance					
Initial BW, lb	795	799	796	7.27	0.50
Final BW, lb	1512	1521	1520	17.88	0.36
ADG, lb/d	3.84	3.87	3.88	0.07	0.56
DMI, lb/d	22.4	22.2	22.3	0.32	0.25
F:G	5.85^{x}	5.73^{y}	5.77^{y}	0.11	0.01

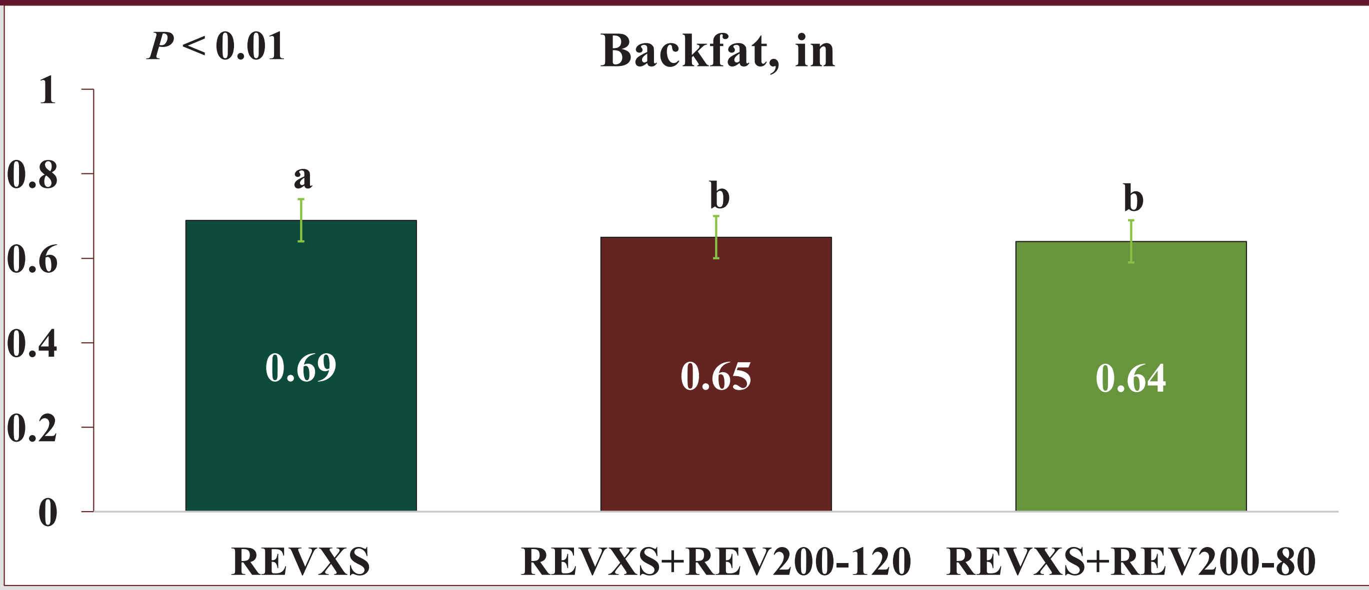

Implant Results - Carcass
P = 0.03
HCW, lb
1000
990
980
970
960
b
a
a
976
987
986
REVXS
REVXS+REV200-120
REVXS+REV200-80

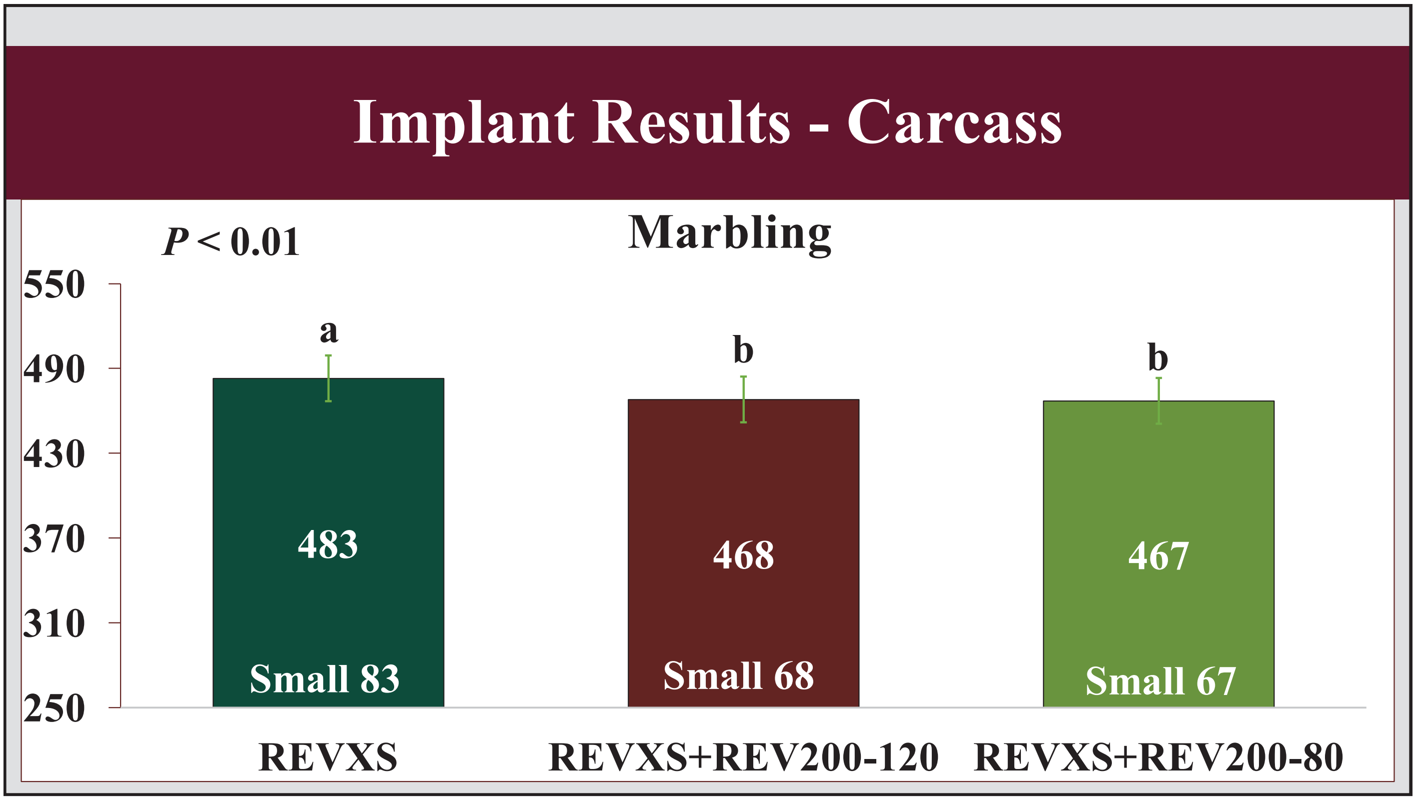

Implant Results - Carcass
P = 0.01
Dressed Yield, %
68
66
64
62
60
b
a
a
64.6
64.9
64.9
REVXS
REVXS+REV200-120
REVXS+REV200-80

Implant Results - Carcass

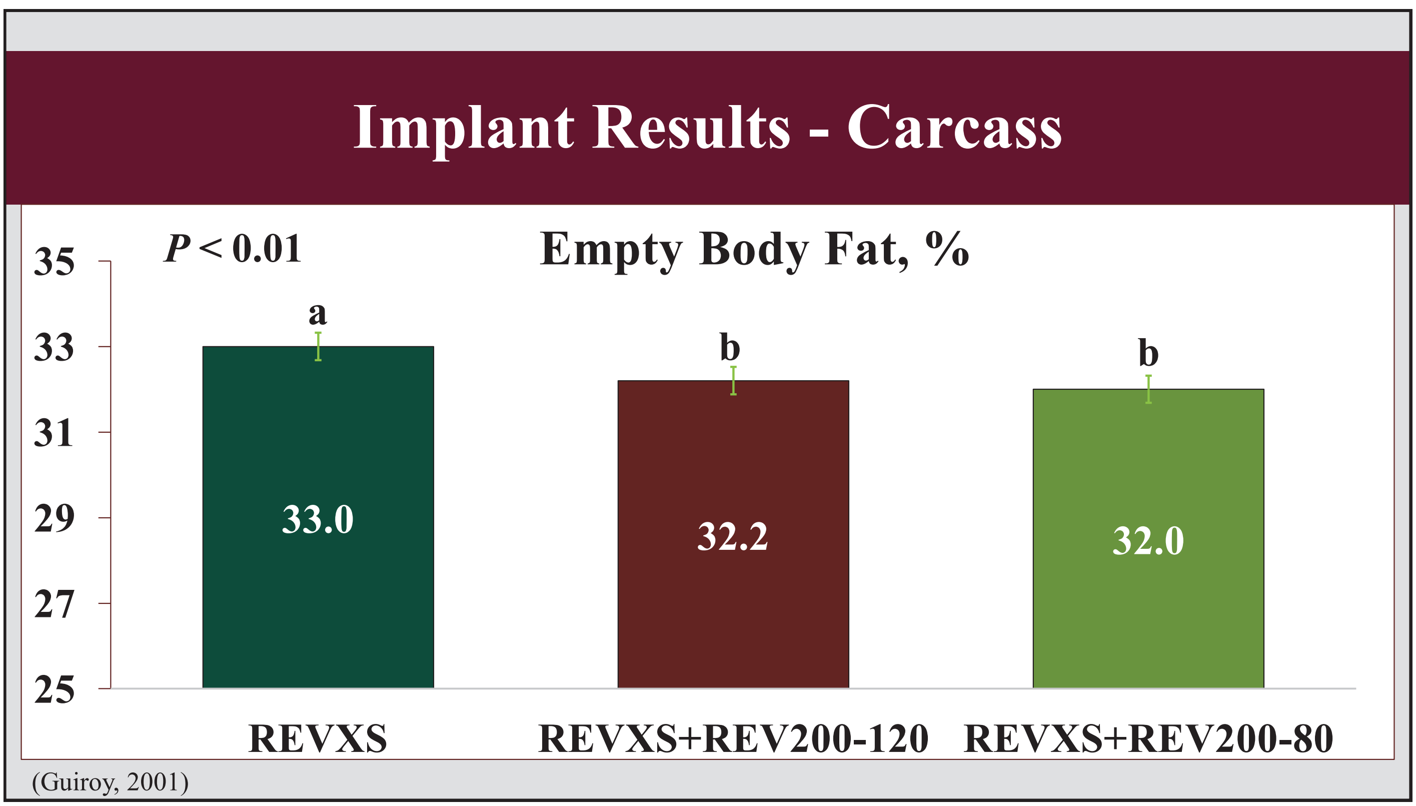


Implant Results - Carcass



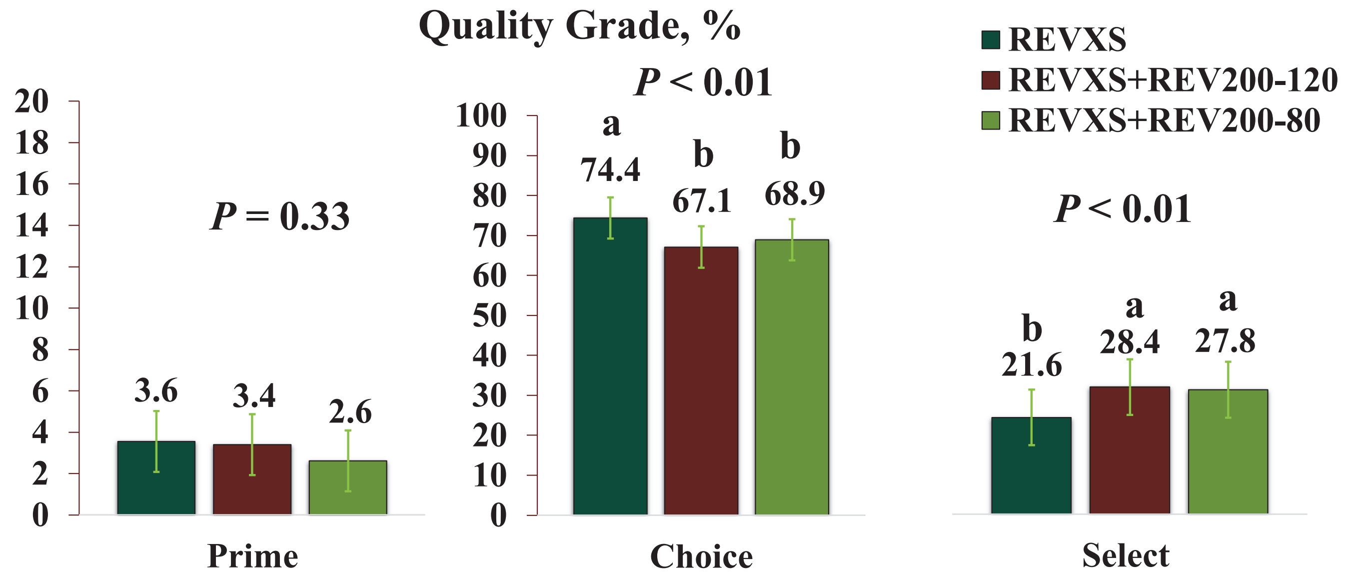


Implant Results - Carcass
Marbling
P < 0.01
550
490
430
370
310
250
a
b
b
483
468
467
Small 83
Small 68
Small 67
REVXS
REVXS+REV200-120
REVXS+REV200-80



Implant Results - Carcass
Empty Body Fat, %
P < 0.01
35
33
31
29
27
25
a
b
b
33.0
32.2
32.0
REVXS
REVXS+REV200-120
REVXS+REV200-80
(Guiroy, 2001)

Implant Results - Carcass



Implant Results - Carcass

Table 2. Yield grade outcomes of serially harvested feedlot steers implanted with Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

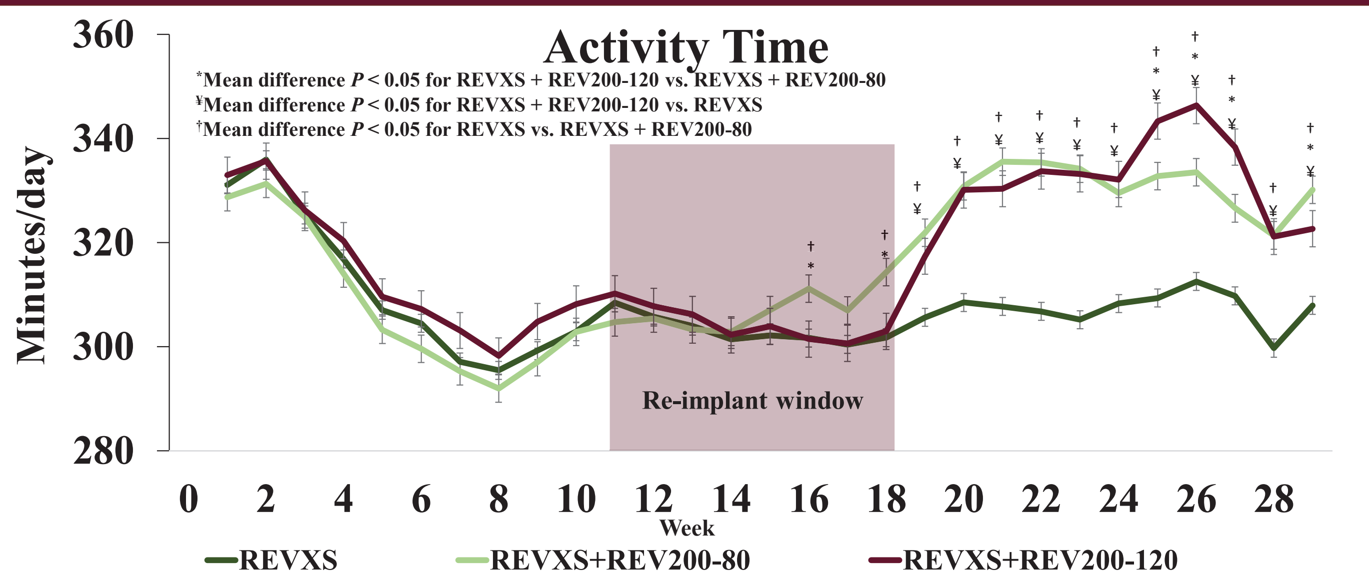
	Implant			*P* - Value
Item	REVXS	REVXS+REV 200-120	REVXS+REV 200-80	Implant
Steers	1511	1508	1523	-
Pens	24	24	24	-
Yield Grade, %				
Yield Grade 1	4.2[y]	6.9[x]	8.9[x]	< 0.01
Yield Grade 2	22.9[y]	28.5[x]	31.4[x]	< 0.01
Yield Grade 3	40.7	41.6	39.2	0.44
Yield Grade 4	24.3[x]	19.0[y]	16.7[y]	< 0.01
Yield Grade 5	8.0[x]	4.0[y]	3.9[y]	< 0.01

Implant Results - Health

Table 3. Health outcomes of serially harvested feedlot steers implanted with Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

	Implant			*P* - Value
Item	REVXS	REVXS+REV 200-120	REVXS+REV 200-80	Implant
BRD 1 Morbidity, %	4.07	3.61	4.16	0.82
BRD 2 Morbidity, %	0.40	0.70	0.40	0.35
BRD 3 Morbidity, %	0.06	0.32	0.26	0.28
BRD Mortality, %	0.13	0.58	0.45	0.12
Digestive, %	0.19	0.13	0.32	0.54
AIP, %	0.13	0.19	0.13	0.88
Lame, %	0.38	0.58	0.58	0.72
Bullers, %	0.12	0.57	0.50	0.34

Implant Results - Activity



Implant Results - Rumination

Table 5. Daily and hourly rumination and activity of steers implanted with Revalor-XS alone or Revalor-XS followed by Revalor-200 120 days on feed (DOF) or 80 d from harvest.

	Treatments				*P*-value		
Item	REVXS	REVXS+REV 200-120	REVXS+REV 200-80	SEM	Implant	Time	Implant × Time
Rumination Time							
Min/d	306	300	301	14.45	0.71	< 0.01	0.99
Min/2 h	25.23	24.51	24.51	1.09	0.51	< 0.01	0.41

Results

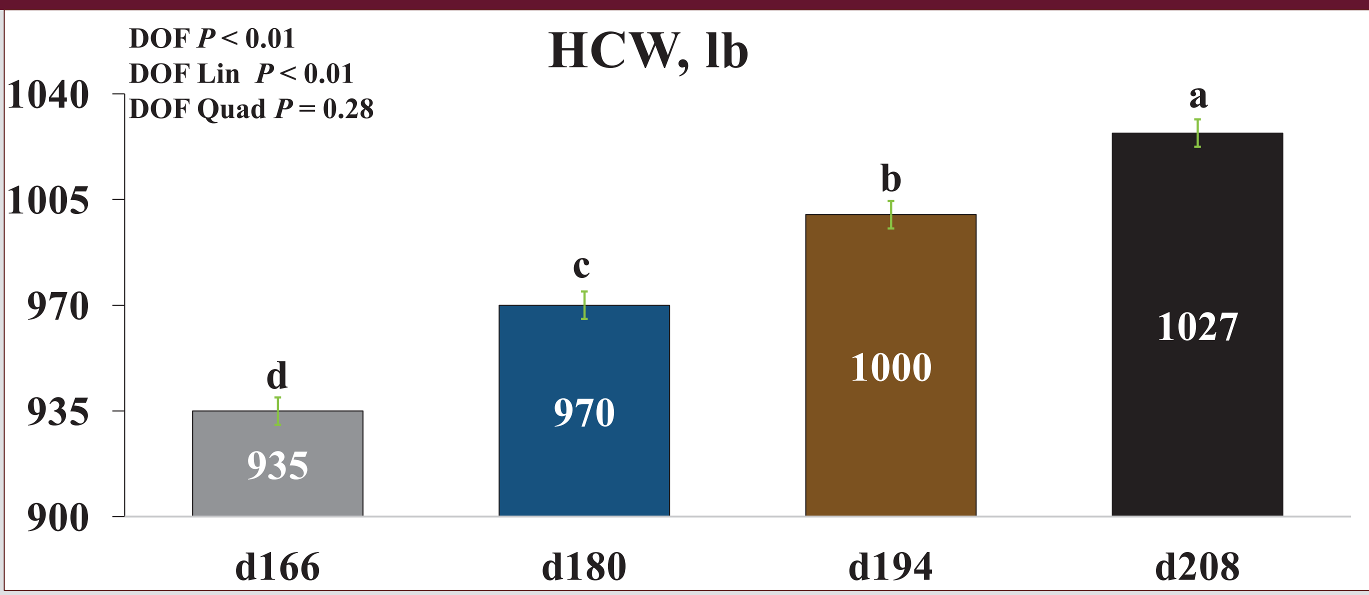
Effect of DOF

DOF Results - Performance

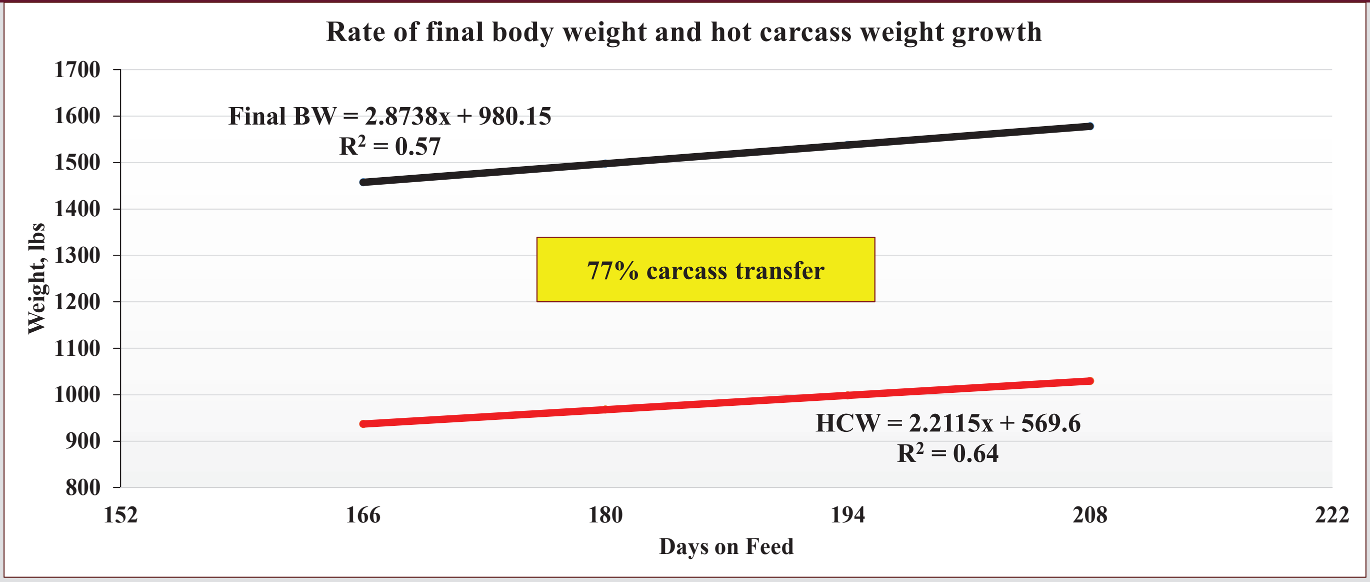
Table 4. Performance of serially harvested feedlot steers receiving Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

	DOF					*P* - value		
	166	180	194	208	SEM	DOF	DOF Lin.	DOF Quad.
Item								
Steers	1170	1170	1170	1170	-	-	-	-
Pens	18	18	18	18	-	-	-	-
Performance								
Initial BW, lb	794	796	799	798	7.36	0.47	0.19	0.42
Final BW, lb	1456[d]	1501[c]	1535[b]	1578[a]	18.08	< 0.01	< 0.01	0.85
ADG, lb/d	3.99[a]	3.91[a]	3.80[b]	3.75[b]	0.07	< 0.01	< 0.01	0.61
DMI, lb/d	22.0	22.4	22.4	22.3	0.32	0.11	0.13	0.06
F:G	5.53[a]	5.73[b]	5.91[c]	5.95[c]	0.11	< 0.01	< 0.01	0.01

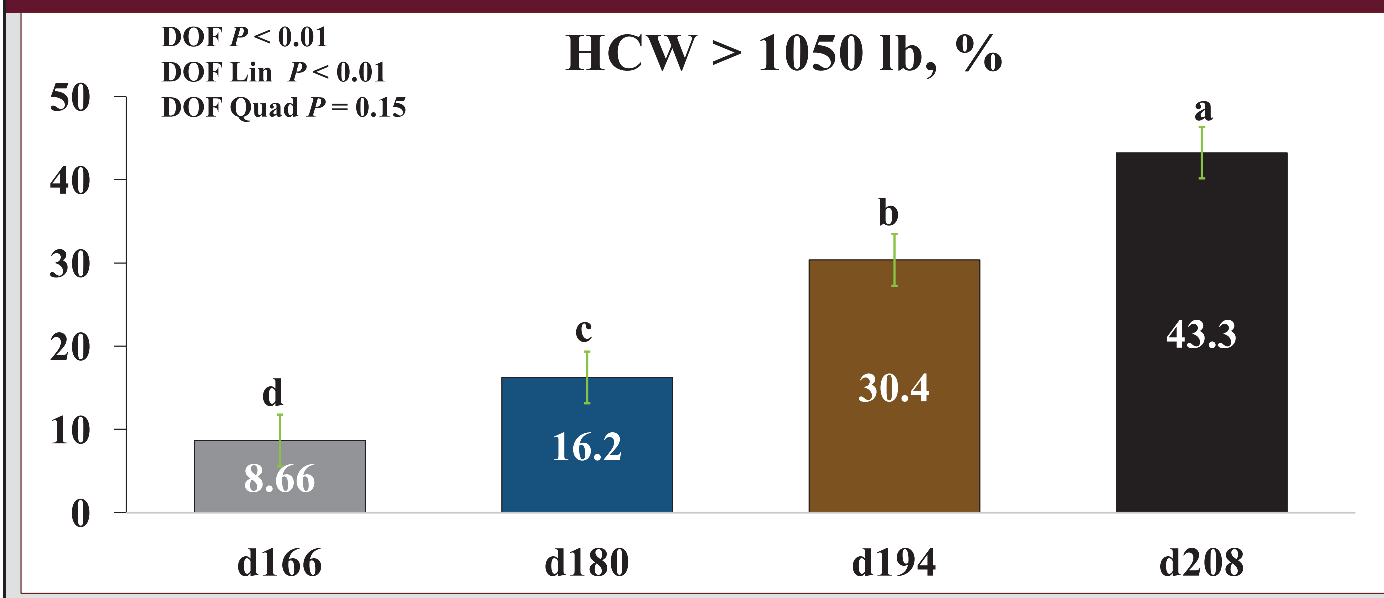
DOF Results - Carcass

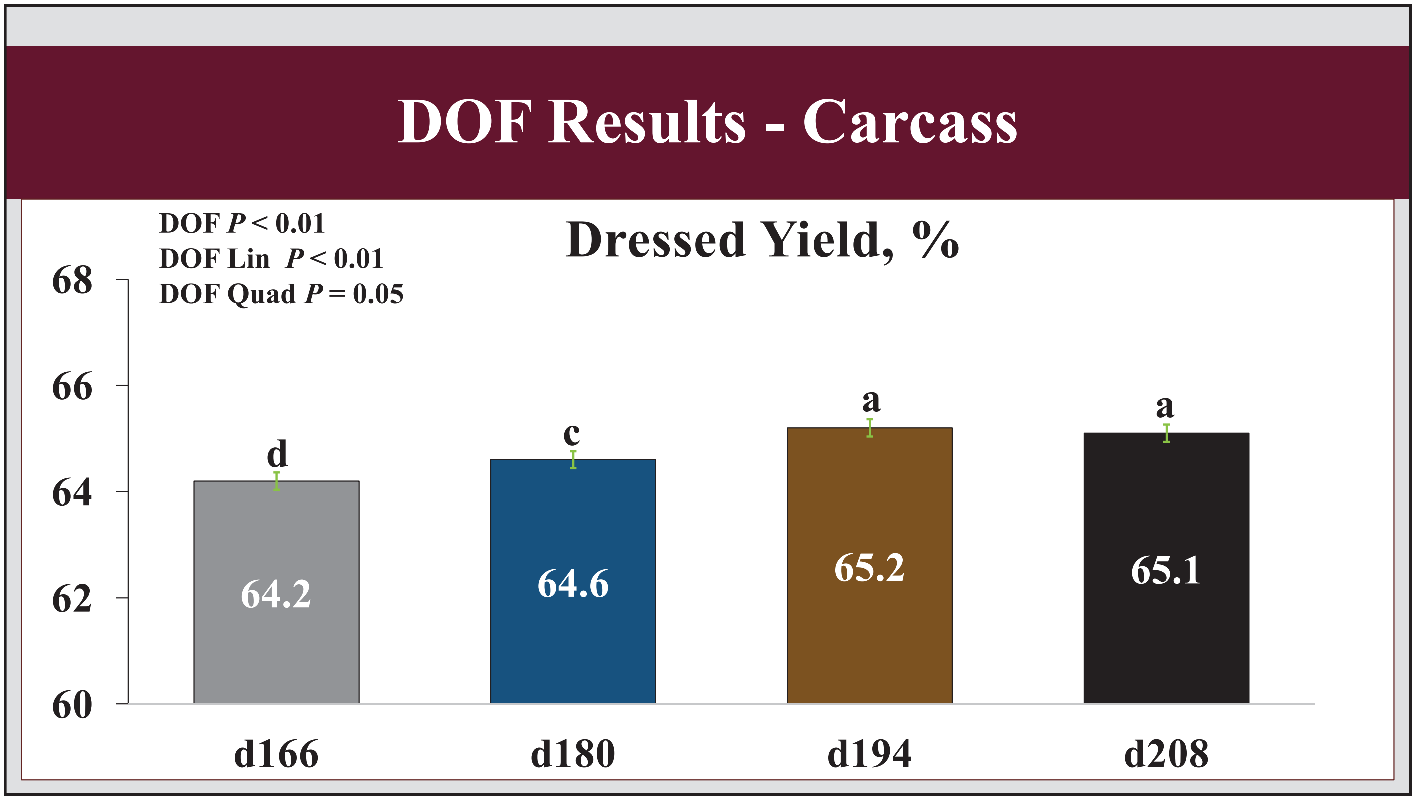


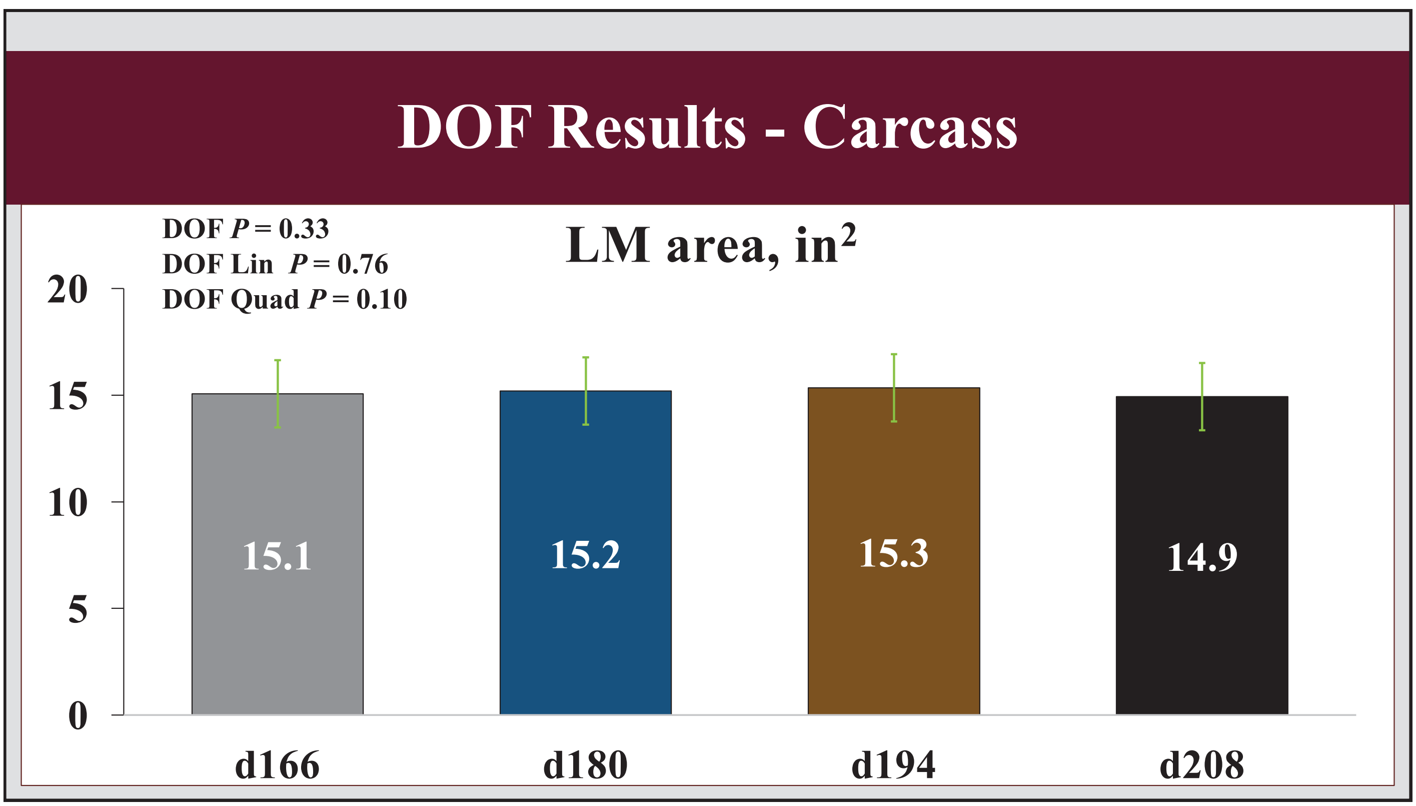
DOF Results

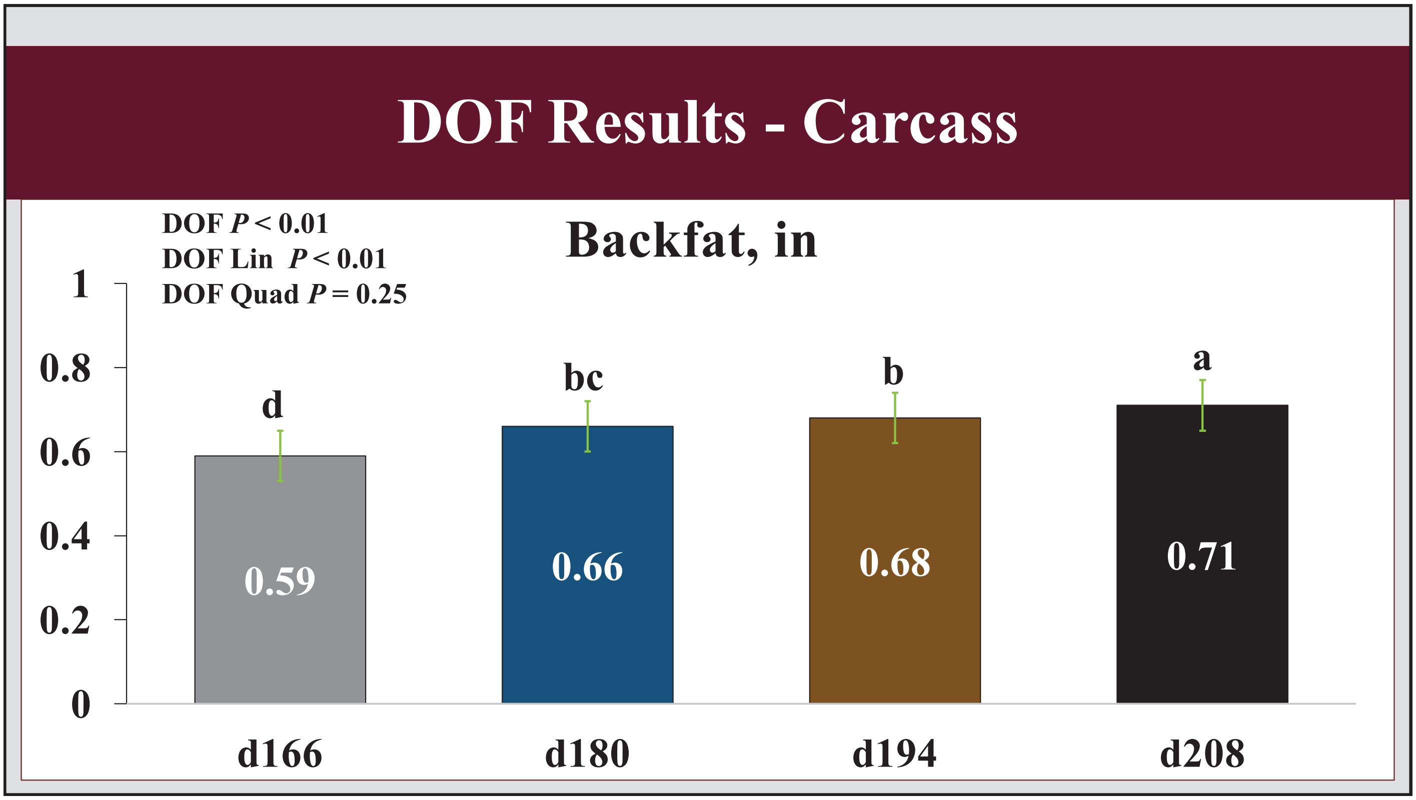


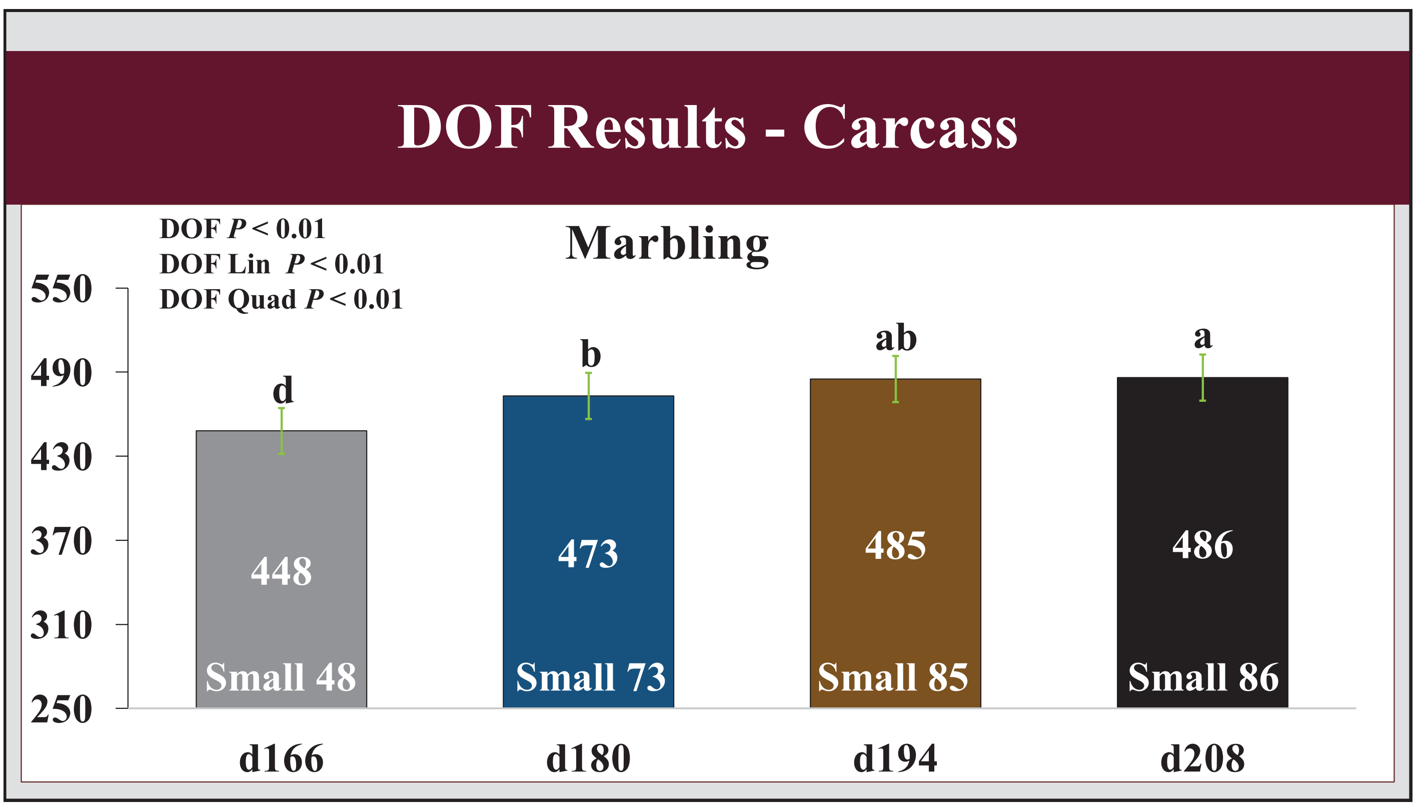
DOF Results - Carcass



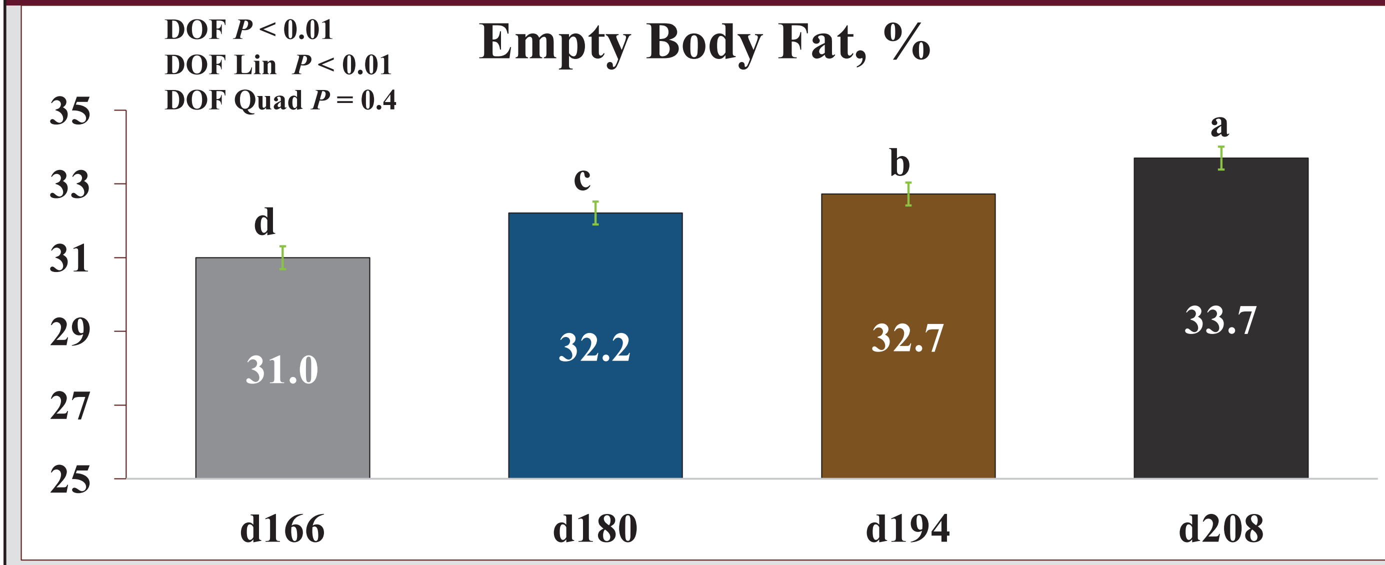

DOF Results - Carcass
Dressed Yield, %
DOF P < 0.01
DOF Lin P < 0.01
DOF Quad P = 0.05
68
66
64
62
60
d
c
a
a
64.2
64.6
65.2
65.1
d166
d180
d194
d208


DOF Results - Carcass
LM area, in²
DOF P = 0.33
DOF Lin P = 0.76
DOF Quad P = 0.10
20
15
10
5
0
15.1
15.2
15.3
14.9
d166
d180
d194
d208


DOF Results - Carcass
Backfat, in
DOF P < 0.01
DOF Lin P < 0.01
DOF Quad P = 0.25
1
0.8
0.6
0.4
0.2
0
d
bc
b
a
0.59
0.66
0.68
0.71
d166
d180
d194
d208

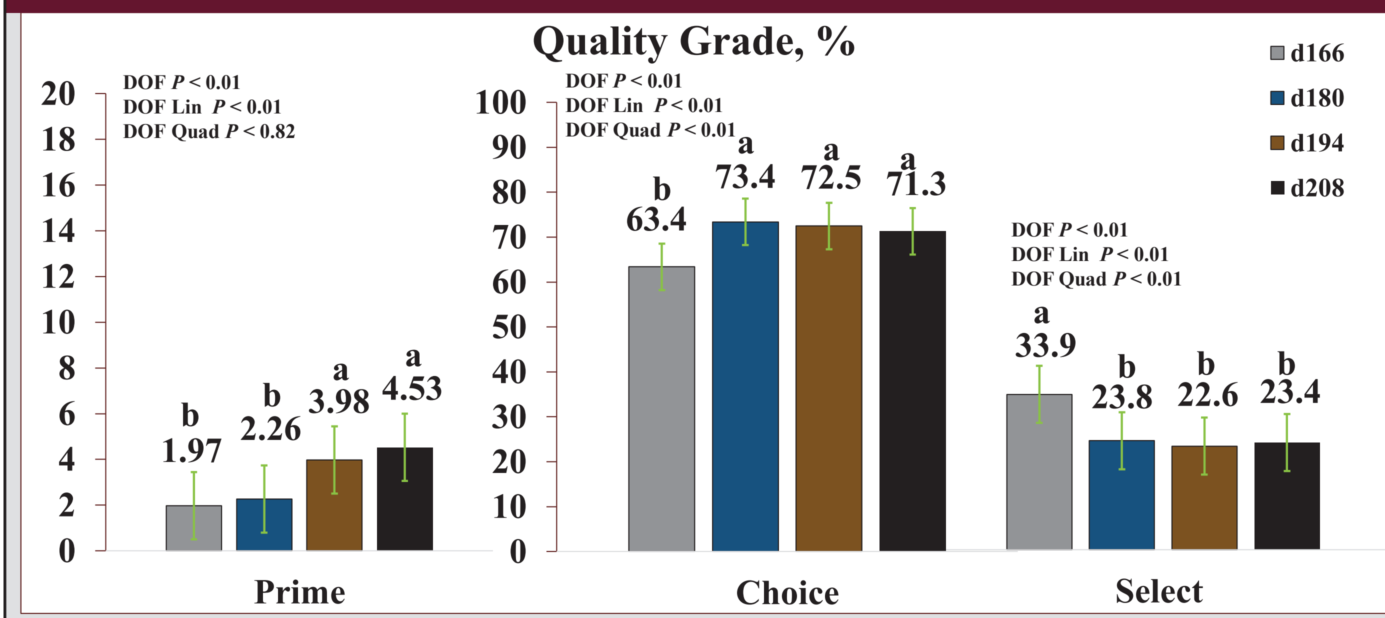

DOF Results - Carcass
Marbling
DOF P < 0.01
DOF Lin P < 0.01
DOF Quad P < 0.01
550
490
430
370
310
250
d
b
ab
a
448
473
485
486
Small 48
Small 73
Small 85
Small 86
d166
d180
d194
d208

DOF Results - Carcass



(Guiroy, 2001)

DOF Results - Carcass



DOF Results - Carcass

Table 5. Yield grade outcomes of serially harvested feedlot steers implanted with Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

	DOF				*P* - Value		
Item	166	180	194	208	DOF	DOF Lin	DOF Quad
Steers	1138	1140	1132	1132		-	-
Pens	18	18	18	18		-	-
Yield Grade, %							
Yield Grade 1	10.1[a]	6.2[b]	6.1[b]	4.3[b]	< 0.01	< 0.01	0.25
Yield Grade 2	36.1[a]	28.8[b]	26.5[b]	18.9[c]	< 0.01	< 0.01	0.94
Yield Grade 3	39.5[ab]	43.7[a]	41.2[ab]	37.6[b]	0.05	0.25	0.02
Yield Grade 4	13.2[c]	17.7[bc]	21.2[b]	27.9[a]	< 0.01	< 0.01	0.54
Yield Grade 5	1.1[c]	3.6[bc]	5.1[b]	11.3[a]	< 0.01	< 0.01	0.09

DOF Results - Health

Table 6. Health outcomes of serially harvested feedlot steers implanted with Revalor-XS followed by no re-implant or Revalor-200 at 120 days on feed (DOF) or 80 days before harvest.

	DOF				*P* - Value
Item	166	180	194	208	DOF
BRD 1 Morbidity, %	3.70	2.86	4.77	44.6	0.31
BRD 2 Morbidity, %	0.26	0.60	0.51	0.60	0.61
BRD 3 Morbidity, %	0.26	0.08	0.26	0.26	0.75
BRD Mortality, %	0.43	0.34	0.68	0.08	0.15
Digestive, %	0.26	0.17	0.35	0.08	0.62
AIP, %	0.08	0.17	0.08	0.26	0.67
Lame, %	0.51	0.43	0.60	0.51	0.96
Bullers, %	0.66	0.16	0.34	0.44	0.62

Conclusions

- Administration of a terminal implant during the payout period of a slow-release implant increased HCW, feed efficiency, and dressed yield
- Re-implanting decreases carcass fat and quality compared to a single slow-release implant
- No difference in re-implant treatments suggests that a terminal implant can be administered at either 120 DOF or 80 d from harvest with similar effects

Conclusions

- Extending DOF increased final BW, HCW, carcasses > 1050 lb, and overall carcass quality at the cost of decreased ADG and increase F:G
- When cattle are fed greater DOF use of terminal sorting programs may allow producers to optimize marketing decisions and offer flexibility in use of various implant strategies
- Selecting the optimum implant strategy is dependent upon balancing the relationship between carcass yield and fatness and dependent on marketing date and the Choice-Select spread

Acknowledgments

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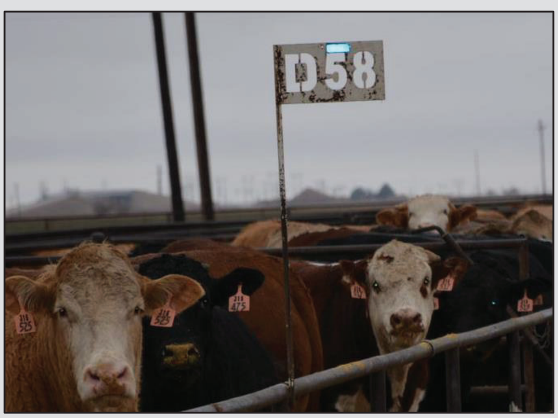
Questions??



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Something about fat

R.A. Zinn, P.H.V. Carvalho, and B.C. Latack

Historically, in the United States market, inedible fats and oils typically had a least cost advantage (cost/Mcal NE) over cereal grains. Supplemental fats have nearly three times the NE value of corn (NRC, 1996). The net energy of conventional supplemental fat (tallow, yellow grease) for feedlot cattle are 6.00 and 4.85 Mcal/kg for maintenance and gain, respectively (NRC, 1996).Over the past 40 years, fat supplementation of feedlot growing finishing diets has been extensively evaluated. Important considerations include type or source of fat (Zinn, 1989a; Brandt and Anderson, 1990; Khrebiel et al., 1995), free fatty acid concentration (Zinn, 1992; Zinn et al., 2000), degree of saturation or titre (Johnson and McClure, 1972; Elliott et al., 1997; Plascencia et al., 2001), method of supplementation (Zinn et al., 1998; Zinn and Plascencia, 2004) and level of supplementation (Haaland et al., 1981; Moore et al., 1986; Zinn 1989b, 1994; Pylot et al., 2000; Plascencia et al., 2002). As previously stated, the great interest in fat supplementation in feedlot cattle diets during this time was driven by its lower comparative cost as an energy source. However, the fat price has dramatically increased over the past 2 years. Yellow grease, for example, increased from $24.75/cwt in 2020 to $62.00/cwt in 2022, similar to white grease (Fig.1), which jumped from an average of $25.00/cwt in the past 5 years to $62.50 in 2022 (USDA, 2020; USDA, 2022). Therefore, one of the most common questions that feedlot nutritionists have recently faced is: *What are the impacts of removing fat from the feedlot cattle diet?*

One of the benefits of supplementing fat is that it reduces the dust generated during the processing and handling of feed. Chiba et al. (1985) demonstrated that supplementation with 2.5% animal fat reduced airborne dust by 82% while feed delivery augers operated. Added fat also functions as a lubricant to reduce wear on feed mixing equipment and reduce particle separation to improve the uniformity of feed mixes (Zinn, 2000).

Although adapted cattle can tolerate high levels of supplemental fat (6%) without depressing ADG (Haaland et al., 1981; Zinn, 1989b; Ngidi et al., 1990; Zinn, 1994; Zinn and Plascencia, 2004), allowing for initial adaptation is important. Previous research has demonstrated that as little as 3% supplemental fat can detrimentally affect the growth performance of non-adapted cattle (Hatch et al., 1972; Krehbiel et al., 1995). This effect is not related to the energy value of the fat, per se, but rather to the effect of fat supplementation on diet acceptability (palatability). Consequently, receiving diets should not contain greater than 2% supplemental fat. And inconsideration of “adaptation”, even a sudden diet change in the source of supplemental fat may result in disruption of feed intake and increased incidence of bloat.

Feedlot cattle growth performance response to supplemental fat has been quite variable. Consequently, considerable attention has focused on better understanding supplementation constraints. Because supplemental fats are comprised largely (90%) of fatty acids (AFOA, 1999), and fatty acids are not digested within the rumen, the energy value of supplemental fats for feedlot cattle will depend on fatty acid digestibility within the small intestine (Zinn, 1989b). Intestinal fatty acid digestion averages 77% in feedlot cattle but varies greatly depending on the level of supplementation. Indeed, the level of supplementation is the single most important factor affecting the energy value of fat: fatty acid digestion, % = 87.560 – 8.591*fatty acid intake, g/kg BW (R^2=0.89, n=25). Given that one kg of digestible fat has an ME value of 9 Mcal (100% of its physiological fuel value); and the partial efficiency of utilization of ME from dietary fat for BW gain is 67% (Czerkawsky et al., 1966; Garrett, 1980; Zinn, 1994), the expected NEg value of dietary fat is 6.03 Mcal/kg digested fat. Thus, the actual NE value of a given fat is dynamic, largely dependent on the level of supplementation. For example, suppose total fatty acid intake was 0.75 g/kg BW (i.e., 4% total dietary fat). In that case, the expected intestinal fatty acid digestion is 81.1%, [87.56 – (8.59*0.75)], and the corresponding NEg value would be 4.89 Mcal/kg (6.03*0.811; Table 1). Increasing the level of total fatty acid intake to 1.50 g/kg BW (i.e., 8% total dietary fat), the expected intestinal digestion of dietary fat decreases to 74.5% and the corresponding NEg value of fat decreases to 4.49 Mcal/kg. Corresponding NEm values for fat at the two intake levels are 6.04 and 5.59 Mcal/kg, respectively, where NEm = (NEg + 0.41)/0.877. An example of how ME and NE values for supplemental fat are expected to vary accordingly to total fat intake in a 400 kg steer with a dry matter intake of 7.6 kg/d is shown in Table 1.

Holstein steers are expected to have greater dry matter intake and, hence, greater fatty acid intake at comparable initial weight and days on feed than conventional beef steers. Provided that the level of fatty acid intake is taken into consideration, there is very little evidence to suggest that the feeding value of fat is different for Holsteins than has been observed for beef breeds. In a series of comparative slaughter trials (carcass specific gravity), Zinn (1988) compared the feeding value of supplemental fat in a finishing diet fed to crossbred steers and calf-fed Holstein steers. The 88% concentrate (steam-flaked barley-based) finishing diet was supplemented with or without 4% yellow grease. Fat supplementation increased empty body weight gain in both crossbred and Holstein steers (12.5 and 4.4%, respectively). However, fat supplementation did not affect carcass component gain on crossbred steers. Whereas with Holstein steers, fat supplementation increased empty body fat and energy gain. For crossbred steers, fat supplementation increased ribeye area (the expected result of increased weight gain). In both crossbred and Holstein steers, fat supplementation increased the percentage of KPH (a consistent effect of fat supplementation). Fat supplementation did not affect dressing percentage, marbling score, or retail yield. Using the replacement technique, the NEm and NEg value of supplemental fat was 6.40 and 5.20 Mcal/kg, respectively, for crossbred steers, and

6.00 and 4.85 Mcal/kg, respectively for Holstein steers. Based on fatty acid intake (0.85 g/kg BW), observed NE values for supplemental fat fed to Holsteins were consistent with expected (5.99 and 4.84 Mcal/kg, respectively). However, the basis for the greater NE value for supplemental fat when fed to crossbred steers is not certain. Adjusting for the lower fatty acid intake (0.74 g/kg BW), the NE value of supplemental fat should have been only slightly (1%) greater than tabular values.

Zinn et al. (1998) observed that the addition of 5% yellow grease did not affect ADG but decreased dry matter intake (6.3%) and increased feed efficiency (4.7%) and dietary NE (6%) of calf-fed Holstein steers. The replacement estimated NEm and NEg values of supplemented fat were 5.00 and 3.97 Mcal/kg, respectively (83% of the tabular values). These low NE values were in close agreement with expected (4.95 and 3.93 Mcal/kg, respectively) due to low intestinal fat digestion (65.2%). However, Plascencia et al. (1999) evaluated the influence of supplementing an 88% concentrate finishing diet with 0 or 5% of yellow grease with different free fatty acid content and reported that fat supplementation increased ADG (11%), feed efficiency (9%), and dietary NE (6.4%). The replacement NEm and NEg values for supplemental fat averaged 5.39 and 4.37 Mcal/kg, respectively. Again, observed NE values were in good agreement with expected values (5.49 and 4.40 Mcal/kg, respectively), based on the level of fatty acid intake and intestinal fatty acid digestion (73%). Fat supplementation increased dressing percentage (1.2%) and KPH (20.4%) but did not affect ribeye area or fat thickness (Plascencia et al., 1999). Due to their very heavy mature weights, Holstein steers have the genetic potential of achieving and maintaining high rates of gain throughout the growing and finishing phases. Zinn et al. (2000) observed that in well-managed calf-fed Holstein steers (initial weight of 122 kg), ADG of greater than 1.6 kg/d may be achieved during 112 d on feed. With conventional steam-flaked corn-based fat supplemented diets (characteristic of most southwestern feedlots) containing an energy density of 2.21 Mcal/kg NEm (dry matter basis), the dry matter intake required to achieve 1.6 kg ADG is 4.64 kg/d or 2.78% of BW. Removing supplemental fat (4%) from the diet will lower the NEm to 2.06 Mcal/kg and increase the required dry matter intake to 5.04 kg/d, or 3.02% of body weight! A sustained DMI of 3% of BW may be untenable. A recent study conducted by Plascencia et al. (2022) concluded that the inclusion of 3.5% supplemental yellow grease in a steam flaked corn-based feedlot diet for Holstein calves increased both gain efficiency and estimated dietary NE and tended to increase daily gain weight with no negative effects on DMI; however, the authors warned that due to greater relative dry matter intake of Holstein calves (2.8% BW), during the early growing phase, it is recommended that supplementation level does not exceed of 3.5% of DM in the diet.

In conclusion, when feeding fat, it is important to consider the type and source of fat, free fatty acid concentration, degree of saturation, adaptation, method of supplementation, and level of supplementation. Maximal efficiency of energy utilization of supplemental fat in finishing diet for feedlot cattle is achieved when the total dietary fat does not exceed 7.5% of diet dry matter or ≈1% of live weight. Due to marked increases in current relative pricing of supplemental fat, it is no longer attractive as a least-cost energy source ($/NEg). However, supplemental fats have important extra caloric benefits that may also lead to enhanced growth performance.

Table 1. Metabolizable and net energy values, and cost variance based on total fat intake.

% Fat in the diet	[1]G of fat Intake	F.A. Digestion	F.A. Intake (g/kg BW)	[2]ME Mcal/Kg	[3]NEg Mcal/Kg	[4]NEm Mcal/Kg	[5]2020 Cost of fat NEg	[6]2022 Cost of fat NEg
0.5	38	86.7	0.10	7.81	5.23	6.43	0.10	0.26
1.0	76	85.9	0.19	7.73	5.18	6.38	0.10	0.26
1.5	114	85.1	0.29	7.66	5.13	6.32	0.11	0.27
2.0	152	84.3	0.38	7.59	5.08	6.26	0.11	0.27
2.5	190	83.5	0.48	7.51	5.03	6.21	0.11	0.27
3.0	228	82.7	0.57	7.44	4.98	6.15	0.11	0.27
3.5	266	81.8	0.67	7.37	4.94	6.10	0.11	0.28
4.0	304	81.0	0.76	7.29	4.89	6.04	0.11	0.28
4.5	342	80.2	0.86	7.22	4.84	5.98	0.11	0.28
5.0	380	79.4	0.95	7.15	4.79	5.93	0.11	0.29
5.5	418	78.6	1.05	7.07	4.74	5.87	0.11	0.29
6.0	456	77.8	1.14	7.00	4.69	5.81	0.12	0.29
6.5	494	77.0	1.24	6.93	4.64	5.76	0.12	0.30
7.0	532	76.1	1.33	6.85	4.59	5.70	0.12	0.30
7.5	570	75.3	1.43	6.78	4.54	5.65	0.12	0.30
8.0	608	74.5	1.52	6.71	4.49	5.59	0.12	0.30
8.5	646	73.7	1.62	6.63	4.44	5.53	0.12	0.31
9.0	684	72.9	1.71	6.56	4.39	5.48	0.12	0.31
9.5	722	72.1	1.81	6.48	4.34	5.42	0.12	0.32

[1]Intake estimated base on 400 kg steer consuming 1.9% of body weight on DM Basis
[2]ME = 9 Mcal/kg
[3]NEg = 6.03 Mcal/k of Digested fat
[4]NEm = (NEg+0.41)/0.877
[5]2020 Cost of fat NEg = $24.50 cwt ($0.54/kg) of yellow grease
[6]2022 Cost of fat NEg = $62.00 cwt ($1.37/kg) of yellow grease

Figure 1. Cost of white grease in ($/cwt) in 2021 and 2022 (USDA, 2022).

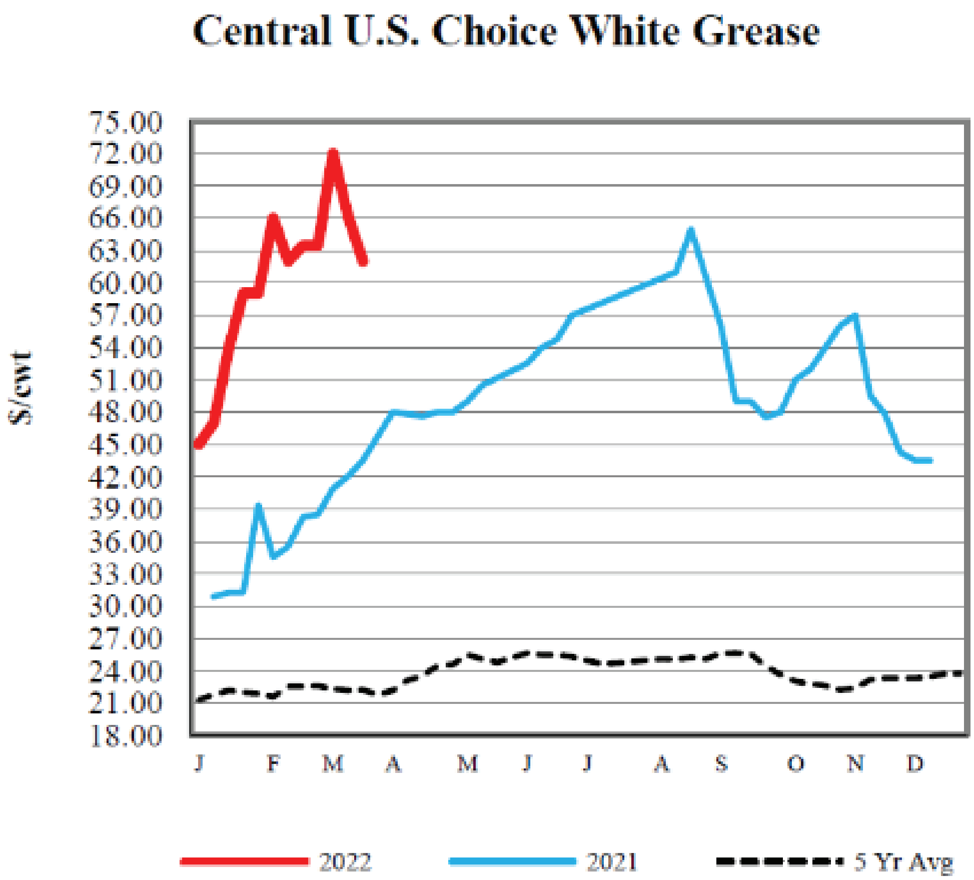
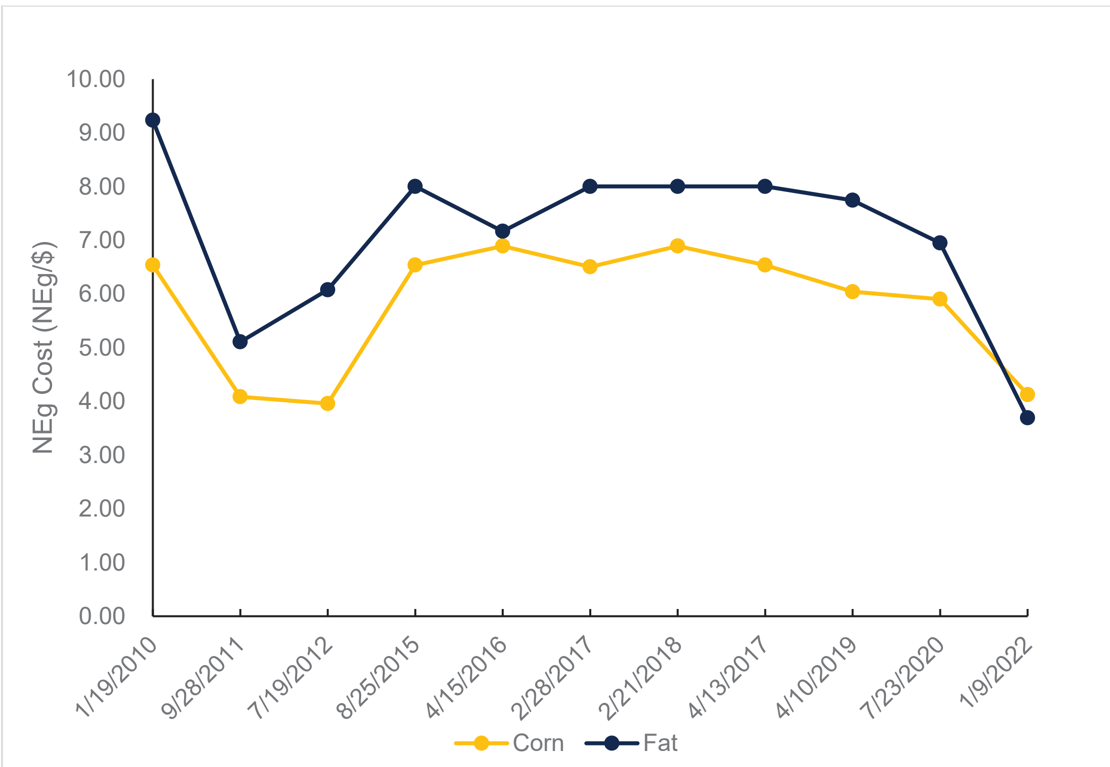


Figure 2. Historical cost of fat and corn NEg (NEg/$) from 2010 to 2022.



LITERATURE CITED

AFOA. 1999. Trading and Arbitration Rules. American Fats and Oils Association, Inc. New York.

Brandt, R.T. Jr., and S.J. Anderson.1990. Supplemental fat source affects feedlot performance and carcass traits of finishing yearling steers and estimated diet net energy value. J. Anim. Sci. 68:2208-2216.

Chiba, L.I., E.R. Peo, A.J. Lewis, M.C. Bruma, R.D. Fritschen, and J.D. Grenshaw.1985. Effect of dietary fat on pig performance and dust level in modified-open-front and environmentally regulated confinement buildings. J. Anim. Sci. 61-763-781.

Cerkawsky, J.W., L. Blaxter, and F.W. Wainman.1966. The metabolism or oleic, linoleic and linolenic acids by sheep with reference to their effects on methane production. Br. J. Nutr. 20:349-361.

Elliott, J.P., J.K. Drakley, C.G. Aldrich, and N.R, Merchen .1997. Effect of saturation and esterification of fat sources on site and digestion of organic matter, fiber, and nitrogen. J. Anim. Sci.75:2803-2812.

Garret, W.N. 1980. Energy utilization of growing cattle as determined in seventy-two comparative slaughter experiments. Page 3 in Energy Metabolism. Butterworths, London.

Haaland, G.L., J.K. Matsushima, D.E. Jhonson and G.M. Ward.1981. Effect of replacement of corn by protected tallow in a cattle finishing diet on animal performance and composition. J. Anim. Sci. 52:696-702.

Hatch, C.F., T.W. Perry, M.T. Mohler, and W.M. Beeson. 1972. Effect of added fat with graded levels of calcium and urea-containing rations for beef cattle. J. Anim. Sci. 34:483-487.

Johnson, R.R., and K.E. McClure.1972. High fat rations for ruminants. I. The addition of saturated and unsaturated fats to high roughage and high concentrate rations. J.Anim. Sci.34:501-509.

Krehbiel, C.R., R.A. McCoy, R.A Stock, T.J. Klopfenstein, D.H. Shain, and R.P. Huffman.1995. Influence of grain type, tallow level, and tallow feeding system on feedlot cattle performance. J.Anim. Sci.73:2916-2921.

Moore, J.A., R.S. Swingle, and W.H. Hale.1986. Effects of whole cottonseed, cottonseed oil or animal fat on digestibility of wheat straw diets by steers. J.Anim.Sci. 63:1267-1273.

Ngidi, M.E., S.C. Loerch, F.L. Fluharty, and D.L. Palmquist.1990. Effect of calcium soaps of long-chain fatty acids on feedlot performance carcass characteristics and ruminal metabolism in steers. J.Anim. Sci. 68:2555-2565.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th ed. National Academy of Sciences Press. Washington, DC.

Plascencia, A., M. Cervantes, and R.A. Zinn. 2001. Influence of fat titer and method of addition on characteristics of ruminal and total tract digestion. Proc. West. Sect. Am. Soc.Anim. Sci.52:548-550.

Plascencia, A., M. Estrada, and R.A. Zinn. 1999. Influence of free fatty acid content on the feeding value of yellow grease in finishing diets for feedlot cattle. J.Anim Sci.77:2603-2609.

Plascencia, A., G.D. Mendoza, C. Vazquez, and R.A. Zinn. 2004. Influence of levels of fat supplementation on bile flow and fatty acid digestion in cattle. J. of Anim. and Vet. Adv. 3:763-768.

Plascencia, A., and R.A. Zinn. 2002. Evaluation of a forage-fat blend as an isocaloric substitute for steam-flaked wheat in finishing diets for feedlot cattle: Growth-performance and digestive function. Prof. Anim.Sci.18:247-253

Plascencia, A., B. C. Latack., P. H. V. Carvalho, and R.A. Zinn. 2022. Feeding Value of Supplemental Fat as a Partial Replacement for Steam-Flaked Corn in Diets for Holstein Calves during the Early Growing Phase. *Trans. Anim. Sci. Under review.*

Pylot, S.J., J.J. McKinnon, A.F. Mustafa, V.J. Racz, and D.A.Christensen. 2000. Effects of processing and fat content of coarse canola screenings on voluntary intake and total tract nutrient digestibility of beef steers. Can. J. Anim. Sci.80:153-159.

USDA. 2020. National Weekly Ag Energy Round-Up. Accessed online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fmymarketnews.ams.usda.gov%2Ffilerepo%2Fsites%2Fdefault%2Ffiles%2F2805%2F2020-03-13%2F46924%2Fams_2805_00003.pdf&clen=70681&chunk=true

USDA. 2022. National Weekly Ag Energy Round-Up. Accessed online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.ams.usda.gov%2Fmnreports%2Flswagenergy.pdf&clen=74451&chunk=true

Zinn, R.A. 1988. Comparative feeding value of supplemental fat in finishing diets for feedlot steers supplemented with and without monensin. J. Anim.Sci. 66:213-227.

Zinn, R.A.1989a. Influence of level and source of dietary fat on its comparative feeding value in finishing diets for steers: Metabolism. J. Anim. Sci. 67:1038-1049.

Zinn, R.A. 1989b Influence of level and source of dietary fat on its comparative feeding value in finishing diets for steers: Feedlot cattle growth performance J. Anim. Sci. 67:1029-1037.

Zinn, R.A. 1992. Comparative feeding value of supplemental fat in steam-flaked corn- and steam-flaked wheat- based finishing diets for feedlot cattle. J. Anim. Sci. 70:2959-2969.

Zinn, R.A.1994. Effects of excessive supplemental fat on feedlot cattle growth performance and digestive function. Prof. Anim. Sci. 10:66-72.

Zinn, R.A., E.G. Alvarez, A. Plascencia, and Y. Shen. 1998. Influence of method of supplementation on the utilization of supplemental fat by feedlot steers. Proc. West. Sect. Am. Soc. Anim. Sci. 49:291-296.

Zinn, R.A., S.K. Gulati, A. Plascencia, and J. Salinas.2000. Influence of ruminal biohydrogenation on the feeding value of fat in finishing diets for feedlot cattle. J. Anim. Sci. 78:1738-1746.

Zinn, R.A., and A. Plascencia.1992. Comparative digestion of yellow grease and calcium Soaps of long-chain fatty acids in cattle. Proc. West. Sect. Am. Soc.Anim. Sci. 43:454-457.

Zinn, R.A., and A. Plascencia. 2004. Influence of level and method of supplementation on the utilization of supplemental fat by feedlot steers. J. of Anim. and Vet. Adv. 3:473-477.

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Research Update from South Dakota State University

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Kernel Processing Corn Silage for Growing and Finishing Cattle

Kernel processing of corn silage has gained wide acceptance in the last 20 years, especially on dairy operations. Kernel processing effects on diet digestibility and growth performance have yielded inconsistent results in beef cattle and this is likely a function of differing DM content of corn silage at harvest, inclusion levels in the diet, theoretical length of cut, and a variety of other factors. Two experiments were conducted between October of 2020 and March of 2022 to determine if kernel processing has an effect on production responses in growing (Exp. 1) and finishing beef steers (Exp. 2).

In Exp. 1, Charolais × Red Angus steers (n = 184 steers; initial shrunk BW = 855 ± 49.2 lbs) were used in a 46-d experiment to evaluate the influence that kernel processing of corn silage has on growth performance responses in growing beef steers. Corn silage harvest occurred over a 2-day period in late August of 2021 [estimated yield (as is) = 18.0 tons/acre; actual DM = 38.3%; actual CP, NDF, and starch = 7.7, 40.3, and 34.0%, respectively (DM basis)]. Diets consisted of (DM basis) corn silage (65%), dried distillers grains plus solubles (20%), high-moisture corn (10%), and a liquid supplement (5%). The liquid supplement provided monensin sodium at 25 g/ton and vitamins and trace minerals to meet nutrient requirements for growing and finishing beef cattle (NASEM, 2016). Steers were assigned to 1 of 24 pens (7 to 9 steers/pen) in a randomized complete block design (blocked by location) and pen was randomly assigned to 1 of 2 treatments (12 pens/treatment). Steers were not administered a steroidal implant during this study as they had received an implant containing 200 mg of progesterone and 20 mg estradiol benzoate approximately 56-d prior to the initiation of the present experiment. Treatments were based upon corn silage fed to steers that was either kernel processed (KP) or not (Con). Corn silage processing scores (starch proportion of native sample retained below a 0.18 in. sieve) were 71.0 and 58.3 for KP and Con, respectively. Each corn silage fed was stored in a separate concrete bunker silo (bunker face 12’ × 10’) that was covered with an oxygen exclusion barrier.

There was no morbidity or mortality attributable to treatment noted in the present study. Growth performance data are presented in Table 1. Initial BW was not different between treatments ($P = 0.48$). Final BW tended ($P = 0.07$) to be increased by 0.8% in KP. Daily gain and dry-matter intake were increased ($P \leq 0.04$) in KP steers by 5.9% and 2.2%, respectively; however, gain efficiency was not appreciably influenced by treatment ($P = 0.15$). Observed dietary net energy (NE) for maintenance (NEm) and gain (NEg) calculated from growth performance did not differ ($P \geq 0.29$) and were in close agreement with tabular estimates for dietary NE values (observed-to-expected NE ratio = 0.98). Steers from KP had numerically greater dietary NEm based upon growth performance of 1.2 Mcal/cwt (81.6 vs 80.4 ± 1.08 Mcal/cwt). The replacement NEm (Mcal/cwt) for corn silage that is not kernel processed can be calculated as: ((Con NEm – KP NEm)/0.65)+75.0, where 0.65 is the inclusion of the corn silage on a DM basis and 75.0 is the tabular NEm estimate for corn silage. The replacement NEm value for Con is 73.1 Mcal/cwt, which is approximately 97.4% the feeding value of KP corn silage.

In Exp. 2, Red Angus steers (n = 192; initial shrunk BW = 983 ± 62.3 lbs) were used in a 112-d finishing experiment at the Southeast Research Farm (SERF) of the South Dakota Agricultural Experiment Station in Beresford. Steers were from a single source and obtained from a local SD auction facility. Steers were received 2 weeks prior to trial initiation. Steers were offered a common diet containing 60% concentrate upon arrival. Steers were transitioned to a 90% concentrate diet over the course of 14-d. The diets were based upon (DM basis) dry-rolled corn (56%), modified distillers grains plus solubles (20%), corn silage (20%), and a liquid supplement (4%). Diets were fortified to provide vitamins and minerals to meet or exceed nutrient requirements and provided monensin sodium (DM basis) at 30 g/ton (NASEM, 2016). All steers were administered a steroidal implant containing 200 mg of trenbolone acetate and 28 mg of estradiol benzoate 84-d before harvest. Steers were fed ractopamine hydrochloride (Optaflexx 45, Elanco, Indianapolis, IN) at a rate of 300 mg/steer·d^{-1} for the final 28-d prior to harvest. The study used 6 replicate pens of 8 steers assigned to each of the 4 dietary treatments. Treatments were arranged in a 2 × 2 factorial arrangement. Factors included silage moisture level at harvest: 1/2 to 2/3 milk line (ML) or black line (BL) and KP: no KP (KP-) or KP (KP+). All silage was obtained from a single cornfield that was planted on April 27, 2020. ML harvest occurred on August 28, 2020 [yield (as is) = 17.4 tons/acre; DM = 43.1%; CP, NDF, and starch = 6.5, 46.0, and 32.9%, respectively (DM basis)]. BL harvest occurred on September 9, 2020 [yield = 16.83 ton/acre (as is); DM = 49.2%; CP, NDF, and starch = 6.6, 49.8, and 37.5%, respectively (DM basis)]. The same equipment was used for both harvest maturity endpoints with KP achieved by narrowing the processing rollers. All corn silage fed in this experiment was stored in a silage bag (8’ Ag-Bag).

There was no morbidity or mortality attributable to treatment noted in the present study. Growth performance response are located in Table 2. No harvest maturity × KP interaction was detected ($P \geq 0.16$) for any growth performance parameters. Initial BW was not influenced by harvest maturity ($P = 0.53$) or KP ($P = 0.95$). Final BW was not affected by harvest maturity ($P = 0.66$) or KP ($P = 0.14$). Cumulative ADG was not influenced by harvest maturity ($P = 0.60$) or KP ($P = 0.12$). Daily DMI was not influenced by harvest maturity ($P = 0.23$) or KP ($P = 0.12$). Additionally, growth efficiency was not impacted by harvest maturity ($P = 0.23$) or KP ($P = 0.22$). Observed dietary NE values were in close agreement tabular NE values and were not influenced by the maturity of corn silage at harvest ($P \geq 0.43$) or by KP ($P \geq 0.21$).

Carcass trait responses for Exp. 2 are located in Table 3. There was no interaction between harvest maturity and KP ($P \geq 0.18$) for any carcass traits. Harvest maturity did not influence ($P \geq 0.17$) any carcass trait responses, but delayed harvest tended ($P = 0.07$) to reduce final BW at 28% EBF by 1.6%. Kernel processing did not influence ($P \geq 0.14$) any carcass trait responses but KP tended ($P = 0.08$) to reduce calculated yield grade by 4.5%. Since corn silage was the sole roughage source in the finishing diet, there is potential that inadequate effective fiber was supplied from the corn silage. Inadequate effective fiber supplied from the corn silage would be masking any potential influences of enhanced ruminal starch digestibility associated with kernel processing to be detected caused in part by decreased ruminal pH and potential impacts on digestive function.

Data from Exp.1 when corn silage was included in the diet at 65% (DM basis) indicate that kernel processing of corn silage enhances DMI and daily gain of beef steers with no appreciable influence on DM conversion efficiency. Data from Exp. 2 indicate that harvest maturity and kernel processing of corn silage have minimal effects on animal growth performance and carcass traits in finishing steers when corn silage is fed at 20% inclusion DM basis. Alternatively, it can be concluded that not processing wet corn that is included in the diet at 10% DM inclusion (corn silage is on average 50% grain on a DM basis) such as in Exp. 2, does not appreciably influence growth performance, but when wet corn is processed and included in the diet at 32.5% DM inclusion, such as in Exp. 1, growth performance and intake are enhanced. Variable responses could be related to differences in inclusion level, differences in effective roughage level fed, and a variety of other factors. The recommendation from the South Dakota Station is that corn silage fed to growing calves should be kernel processed as a means to enhance intake and subsequently daily gain, while kernel processing corn silage fed to finishing steers does not appreciably influence daily gain, efficiency of gain, or enhance carcass parameters.

Receiving Calf Management Work

Weaning and transportation are significant stressors to beef cattle. Supplementation of trace minerals to support maintenance of immune function under these conditions can enhance health and growth performance. *Saccharomyces cerevisiae* fermentation products have under certain circumstances improved health outcomes and performance measures during the feedlot-receiving period. Many supplemental trace mineral and yeast products are available to cattle feeders and these products can be delivered through a variety of methods. A series of experiments were undertaken to determine if use (Exp. 3) and method of delivery (Exp. 4) of a "Stress-Pack" containing added organic trace minerals (7 g/steer daily; Availa 4, ZINPRO, Eden Prairie, MN) and a *Saccharomyces cerevisiae* yeast culture product (14 g/steer daily; Diamond V XPC, Diamond V, Cedar Rapids, IA) have an influence on receiving period growth performance and hepatic Cu status in newly weaned beef steer calves from a single ranch in Western South Dakota.

In Exp. 3, bawling Charolais × Red Angus steer calves (n = 46 steers; initial BW = 529 ± 84.0 lbs) in a 42-d receiving experiment. Steers were blocked by initial BW grouping and allocated to pens (n = 5 pens/treatment; 4 to 5 steers/pen) of no stress-tub (Con) or stress-tub (Tub). Bedding was applied as needed to provide a dry, bedded area for all the steers within a pen to lay down. Steers were transported 318 mi (6-h transit) from a ranch in Western South Dakota to the Ruminant Nutrition Center (RNC) in Brookings, SD on October 19, 2020. Upon arrival, all steers were group housed and provided unlimited access to long-stem grass hay and water. The following morning, all steers were individually weighed, applied a unique identification tag, vaccinated for viral respiratory pathogens/clostridia species, and administered pour-on wormer. Steers were not implanted during the initial processing procedure as steers had been administered a steroidal implant at the ranch ~45-d prior to the initiation of the present experiment (36 mg zeranol; Ralgro; Merck Animal Health, DeSoto, KS). The afternoon following initial processing, steers were allotted to their treatment pens and the "stress" tub was introduced (~24-h after arrival). All steers were fed twice daily in a 50/50 split a diet that was fortified to meet mineral and vitamin requirements (NASEM, 2016) and provided monensin sodium at 25 g/ton. The diet was based upon (DM basis) corn silage (65%), dried distillers grains plus solubles (19%), oat hay (10%) and a soybean meal based pelleted supplement (6%). During the initial 14-d on feed, intake was closely managed by feed calls to accommodate adaptation to the receiving diet. For the remainder of the experiment (d 15 to 42) bunks were managed using a slick bunk management approach such that bunks were managed to be devoid of feed by 0800h most mornings. Using this intake management approach, steers were allowed to express differences in *ad libitum* intake from d 15 to 42. Tub consumption was monitored daily through d 21. Average daily disappearance from the tubs was 0.31 ± 0.15 lb/steer daily or approximately 93% of the lower recommended voluntary dose. There was no morbidity or mortality attributable to treatment noted in the present study.

Liver biopsies were collected on d 7, 21, and 42, during the interim weighing process, using the method described previously (Engle and Spears, 2000). Steers selected for liver biopsies (n = 2 steers/pen) were selected based upon being the closest to the initial pen mean BW for each pen. Liver samples were shipped to Michigan State University Diagnostic Center for Population and Animal Health (Lansing, MI) for analysis of liver mineral content. Concentration of Cu, was measured using an Agilent 7500ce Inductively Coupled Plasma Mass Spectrometer (Agilent Technologies Inc., Santa Clara, CA) via procedures reported by (Wahlen et al., 2005).

Growth performance and observed dietary NE are presented in Table 4. Initial BW differed ($P = 0.04$) between treatments, thus, initial BW was used as a covariate for all growth performance analyses. No difference ($P \geq 0.30$) was detected between treatments for d 42 BW. No appreciable ($P \geq 0.30$) responses were detected for cumulative growth performance (ADG, DMI, or G:F). Additionally, the observed dietary NE and the ratio of observed-to-expected dietary NE did not differ ($P \geq 0.33$) between treatments during the course of the 42-d experiment. Liver Cu content (DM basis) is presented in Table 5. A treatment × day interaction was noted for Cu ($P = 0.01$). On d 7, 21, and 42 (21-d following stress tub removal) steers from Stress Tub had greater ($P \leq 0.01$) liver Cu compared to control.

In Exp. 4, bawling Charolais × Red Angus steer calves (n = 192 steers; initial BW = 565 ± 31 lbs). Steers were blocked by location and allocated to 1 of 24 pens (n = 8 pens/treatment; 8 steers/pen). Treatments included: conventional receiving diet (Con), conventional receiving diet with added "Stress-Pack" (Force), conventional receiving diet and offered a low-moisture, cooked molasses-based block fortified with a "Stress-Pack" (Tub). Calves were weaned on the truck and hauled (6.0 h transit) to the RNC in Brookings, SD on October 18, 2021. Upon arrival, all steers were group housed and provided unlimited access to long-stem grass hay and water. The following morning, all steers were individually weighed, applied a unique identification tag, and vaccinated for viral respiratory pathogens and clostridia species. Steers were not administered a steroidal implant during the receiving phase experiment. The afternoon following initial processing, steers were allotted to their treatment pens (~24-h after arrival). All steers were fed twice daily in a 50/50 split a diet that was fortified to meet mineral and vitamin requirements (NASEM, 2016) and provided monensin sodium at 25 g/ton. The diet was based upon (DM basis) wheat silage (40%), pelleted soybean hulls (36%), oat hay (10%), dried distillers grains plus solubles (9%), and a liquid-based supplement (5%). During the initial 14-d on feed, intakes were managed similar to Exp. 3. For the remainder of the experiment (d 15 to 49) bunks were managed using a slick bunk management approach such that bunks were managed to be devoid of feed by 0800h on most mornings. Using this intake management approach, steers were allowed to express differences in *ad libitum* intake from d 15 to 49. Tub consumption was monitored daily through d 28. Average daily disappearance from the tubs was 0.26 ± 0.06 lb/steer daily or approximately 79% of the lower recommended voluntary dose. There was no morbidity or mortality attributable to treatment noted in the present study.

Liver biopsies were collected from a subsample of steers (n = 14 steers) the day of initial processing (day after weaning). Subsequent hepatic tissue biopsies (d 14, 28, and 49) were collected from a sentinel steer that was selected based upon being closest to the initial average BW (n = 1 steer/pen) on d 14, 28, and 49 using the same procedures outlined in Exp. 3. Treatment effects were tested using the following contrasts: Con vs. Force and Tub (effect of stress-pack) and Force vs. Tub (effect of supplementation method).

Growth performance responses for Exp. 4 are located in Table 6. Final BW was not influenced by Stress-pack use ($P = 0.17$) but tended to be influenced by supplementation method ($P = 0.07$; 690 vs. 681 ± 4.7 lbs) for Force vs. Tub. Cumulative ADG revealed that Stress-pack use did not influence ADG ($P = 0.18$), but method of supplementation did influence ADG ($P = 0.05$) where steers from Force had enhanced gain by 9.4% compared to Tub. Finally, efficiency of feed conversion, observed dietary NE values, nor dietary net energy utilization were influenced by stress-pack use ($P \geq 0.23$) or method of supplementation ($P \geq 0.23$). Hepatic Cu content from steers in Exp. 4 are located in Table 7. A treatment × day interaction was noted for hepatic concentrations of Cu ($P = 0.01$). Steers from Stress-pack had greater hepatic Cu compared to Con on d 14, 28, and 49 ($P \leq 0.01$); steers from Force had greater hepatic Cu compared to Tub on d 14 and 28 ($P \leq 0.01$), and tended to have greater hepatic Cu on d 49 ($P = 0.06$) compared to Tub.

Evaluation of daily tub consumption revealed that cattle markedly reduced voluntary consumption of the tub on around d 10 in both experiments. This is likely a function of increased DM delivered during the initial week on feed or potentially due to the fact that the tub lost its “novelty”. Future research related to free-choice mineral supplementation to cattle fed in confinement should consider palatability of the basal diet and how this might alter voluntary consumption of the product used to supply the additional feed additives and what doses should be fed to ensure adequate “nutrient spiking”. Collectively, these data indicate that application of a stress-pack containing supplemental organic trace minerals and a *Saccharomyces cerevisiae* fermentation product enhances hepatic Cu stores of newly weaned calves and might alter growth performance responses during the 7 weeks following weaning, but method of delivery is likely the most important aspect to consider.

Current and Ongoing Activities

- Use of differing direct-fed microbial products and their influences on production traits
- Timing of vaccination in bawling calves administered pre-conditioning vaccinations prior to arrival at the feedlot
- Manger space allocation in cattle limit-fed a concentrate based diet
- Rumen protected B-vitamins on production trait responses in yearling finishing steers
- Dose effects of encapsulated butyric acid and zinc (BZ) on growth performance measures in yearling steers of GIT tissue integrity in feedlot lambs
- Feeding a single diet throughout the growing and finishing phase as a method to simplify feeding
- Evaluation of source of origin and feeding location (Northern Plains vs. Southern Plains) on *Salmonella* prevalence in feces and lymph nodes
- Optimization of rye processing methods for growing and finishing cattle
- Influence of ingredient inclusion accuracy on production responses
- Characterization of corn grain harvested at high moisture in cattle feeding yards in the Upper Midwest

Literature Cited

Engle, T. E., and J. W. Spears. 2000. Effects of dietary copper concentration and source on performance and copper status of growing and finishing steers. J Anim Sci 78(9):2446-2451. doi: 10.2527/2000.7892446x

NASEM. 2016. Nutrient Requirements of Beef Cattle. 8 ed.

Wahlen, R., L. Evans, J. Turner, and R. Hearn. 2005. The use of collision/reaction cell ICP-MS for the determination of elements in blood and serum samples. Spectrosc. (Santa Monica)

Table 1. Growth performance responses from Exp. 1.[1]

Item	Kernel Processing Yes	Kernel Processing No	SEM	*P* – value
Pens, n	12	12	-	-
Steers, n	92	92	-	-
Initial BW, lbs	855	855	1.0	0.48
Final BW, lbs	1013	1005	3.9	0.07
ADG, lbs	3.39	3.20	0.079	0.04
DMI, lbs	21.71	21.24	0.196	0.04
G:F	0.156	0.151	0.0035	0.15
F:G[2]	6.41	6.62	-	-
Observed dietary net energy (NE), Mcal/cwt				
Maintenance	81.6	80.4	1.08	0.29
Gain	53.0	52.0	0.95	0.29
Observed-to-expected NE				
Maintenance	0.99	0.97	0.013	0.35
Gain	0.97	0.95	0.017	0.35

[1] All BW measures were shrunk 4% to account for digestive tract fill.

[2] F:G = 1/G:F

Table 2. Growth performance responses from Exp. 2.[1]

Item	ML/KP-	ML/KP+	BL/KP-	BL/KP+	SEM	*P* - value		
						Harvest time	Kernel processing	Interaction
Pens, n	6	6	6	6	-	-	-	-
Steers, n	48	48	48	48	-	-	-	-
Initial BW[2], lbs	982	983	984	983	1.7	0.53	0.95	0.35
Final BW[3], lbs	1586	1560	1574	1561	18.4	0.66	0.14	0.63
ADG, lbs	5.40	5.15	5.27	5.16	0.159	0.60	0.12	0.55
DMI, lbs	31.63	31.58	31.58	30.83	0.447	0.23	0.22	0.28
G:F	0.171	0.163	0.167	0.168	0.0039	0.93	0.21	0.16
F:G[4]	5.85	6.13	5.99	5.95	-	-	-	-
Observed dietary net energy (NE), Mcal/cwt								
Maintenance	95.7	93.0	95.3	95.3	1.61	0.43	0.21	0.26
Gain	65.3	62.6	64.9	64.9	1.41	0.43	0.21	0.26
Observed-to-expected NE								
Maintenance	1.02	0.99	1.02	1.02	0.017	0.55	0.29	0.35
Gain	1.03	0.99	1.02	1.02	0.022	0.57	0.30	0.37

[1] ML = silage harvested at ½ to 2/3 milk line, BL = silage harvested at black line, KP- = No kernel processing, and KP+ = kernel processing.
[2] Initial BW was pencil shrunk 4% to account for digestive tract fill.
[3]Final BW = HCW/0.625.
[4] F:G = 1/G:F

Table 3. Carcass trait responses from Exp. 2.[1]

Item	ML/KP-	ML/KP+	BL/KP-	BL/KP+	SEM	*P* - value		
						Harvest time	Kernel processing	Interaction
Pens, n	6	6	6	6	-	-	-	-
Steers, n	48	48	48	48	-	-	-	-
HCW, lbs	992	975	984	975	11.5	0.66	0.14	0.63
DP, %	62.27	62.06	62.03	62.44	0.497	0.84	0.78	0.40
RF, in	0.62	0.61	0.66	0.62	0.031	0.22	0.25	0.43
REA, in^2	14.82	14.77	14.61	14.99	0.220	0.99	0.30	0.18
Marbling[2]	543	540	566	563	23.0	0.17	0.84	0.98
Calculated YG	3.56	3.50	3.71	3.45	0.125	0.55	0.08	0.28
Estimated EBF, %	32.62	32.38	33.38	32.59	0.530	0.21	0.18	0.48
Final BW at 28% EBF, lbs	1381	1365	1343	1358	16.7	0.07	0.99	0.20

[1]ML = silage harvested at ½ to 2/3 milk line, BL = silage harvested at black line, KP- = No kernel processing, and KP+ = kernel processing.
[2] 400 = small00 = USDA Low Choice.
[a, b] Means within a row lacking a common superscript differ ($P \leq 0.05$).

Table 4. Growth performance responses from Exp. 3.[a]

Item	Treatment[1] Control	Stress Tub	SEM	*P* - value
Pens, *n*	5	5	-	-
Steers, *n*	23	23	-	-
Initial BW[2], lbs	525	532	2.2	0.04
d 42 BW[3], lbs	626	631	4.0	0.30
ADG, lbs	2.33	2.45	0.095	0.30
DMI, lbs	12.38	12.41	0.280	0.94
G:F	0.190	0.199	0.0065	0.26
F:G[4]	5.26	5.03	-	-
Observed dietary net energy (NE), Mcal/cwt				
Maintenance	79.7	81.8	1.73	0.33
Gain	51.3	53.1	1.51	0.33
Observed-to-expected NE				
Maintenance	1.01	1.04	0.022	0.33
Gain	1.02	1.05	0.030	0.33

[a] Initial BW was used as a covariate for all analyses.
[1] No cooked molasses stress tub (Control) or cooked molasses stress tub (Purina; Stress Tub).
[2] No shrink was applied to initial BW.
[3] 4% shrink applied to account for digestive tract fill.
[4] F:G = 1/G:F

Table 5. Hepatic Cu concentration (DM basis) on d 7, 21, or 42 in Exp. 3.

	Treatment[1, 2]			
Item	Control	Stress Tub	SEM	*P* - value
Pens, *n*	5	5	-	-
Steers, *n*	10	10	-	-
d 7				
Cu, µg/g	6.09	25.35	3.723	0.01
d 21				
Cu, µg/g	10.95	71.82	11.462	0.01
d 42				
Cu, µg/g	39.67	99.80	9.343	0.01

[1] No cooked molasses stress tub (Control) or cooked molasses stress tub (Purina; Stress Tub).
[2] Treatment × Day interaction: (P = 0.01).

Table 6. Growth performance responses for Exp. 4.

	Treatments				*P* - value	
	Control (1)	Force (2)	Stress-Tub (3)	SEM	1 vs. 2 and 3 (Stress-Pack)	2 vs. 3 (Force vs. Tub)
Pens, n	8	8	8	-		
Steers, n	64	64	64	-		
Initial BW[1], lbs	566	565	567	1.0	0.94	0.06
d 49 BW[2], lbs	679	690	681	4.7	0.17	0.09
ADG, lbs	2.07	2.33	2.19	0.114	0.07	0.23
DMI, lbs	11.77	12.27	11.81	0.132	0.02	0.01
G:F	0.175	0.190	0.185	0.0085	0.11	0.57
F:G[3]	5.71	5.26	5.41	-	-	-
Observed dietary net energy (NE), Mcal/cwt						
Maintenance	79.6	80.6	80.4	1.11	0.35	0.92
Gain	51.2	52.1	52.0	0.97	0.35	0.92
Observed-to-Expected NE						
Maintenance	1.02	1.03	1.03	0.0137	0.23	0.86
Gain	1.03	1.04	1.04	0.0194	0.39	0.90

[1] No shrink was applied to initial BW.
[2] 4% shrink applied to account for digestive tract fill.
[3] F:G = 1/G:F

Table 7. Hepatic Cu concentration (DM basis) on d 7, 14, 28, or 49 in Exp. 4.

	Treatment[1, 2]				*P* - value	
Item	Control (1)	Force (2)	Stress-Tub (3)	SEM	1 vs. 2 and 3 (Stress-Pack)	2 vs. 3 (Force vs. Tub)
Pens, *n*	8	8	8	-	-	
Steers, *n*	8	8	8	-	-	
d 1						
Cu, µg/g	12.41[3]	-	-	-	-	
d 14						
Cu, µg/g	39.5[c]	147.5[a]	94.8[b]	17.34	0.01	0.01
d 28						
Cu, µg/g	76.0	261.4	162.5	24.20	0.01	0.01
d 49						
Cu, µg/g	125.4	257.6	187.4	31.97	0.01	0.06

[1] No cooked molasses stress tub (Control) or cooked molasses stress tub (Purina; Stress Tub).
[2] Treatment × Day interaction: ($P = 0.01$).
[3] Collected from a random sub-sample of steers (n = 14 steers) on the day of initial processing (~24 h after gathering for weaning and 12 h after arrival to the research feed yard).

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Sustainability: Opportunities and Challenges for the Food Supply Chain

Kim Stackhouse-Lawson, PhD
2022 Plains Nutrition Conference
April 15, 2022

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Identify and scale innovation that fosters the health of animals and ecosystems to promote profitable industries that support vibrant communities.

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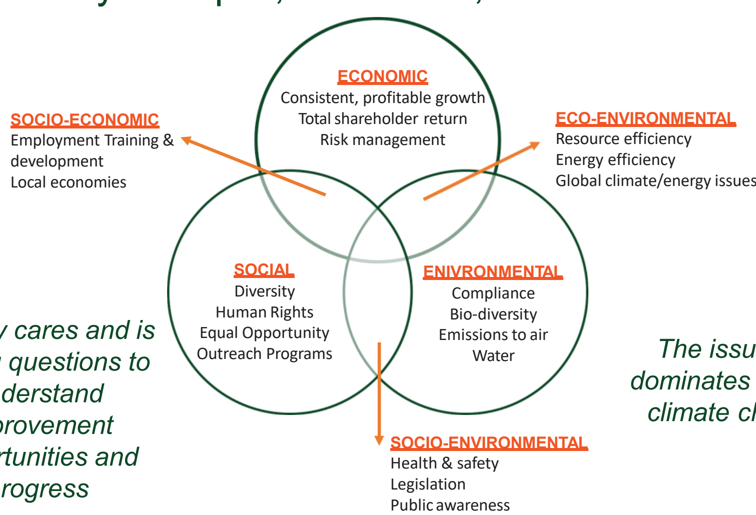
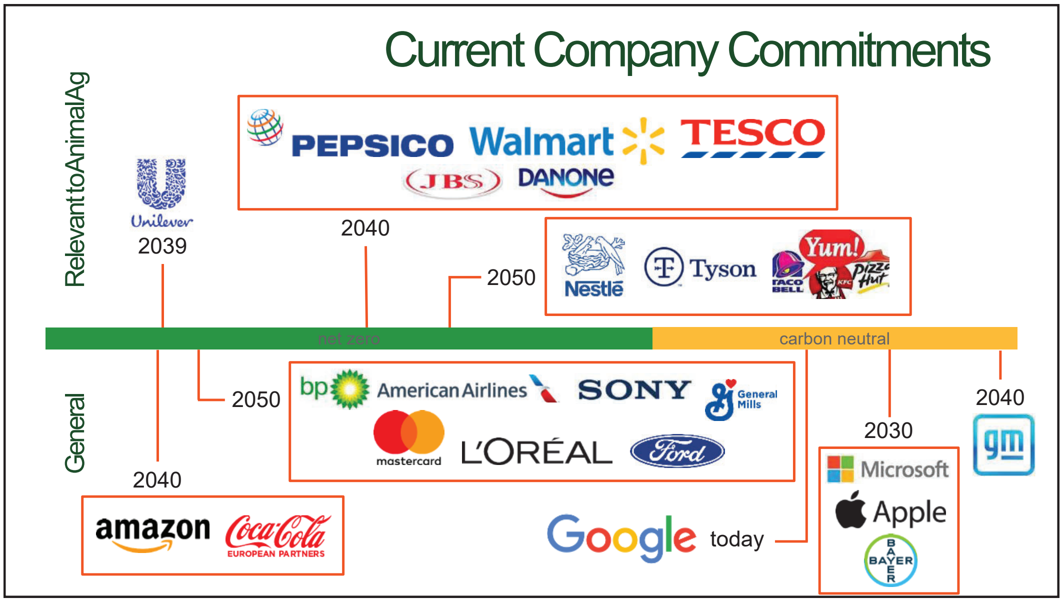
Sustainability is complex, multi-faceted, and often emotionally driven



Society cares and is asking questions to understand improvement opportunities and progress

The issue that dominates today is climate change.



Scope 1
Emissions from owned operation

Scope 2
Emissions from electricity used

Scope 3
Emissions from growing products, from transportation to supermarket, packaging and waste

When a company commits to Net Zero, it often includes its entire value chain and they rarely know how or have plans to achieve scope 3 emission reduction.

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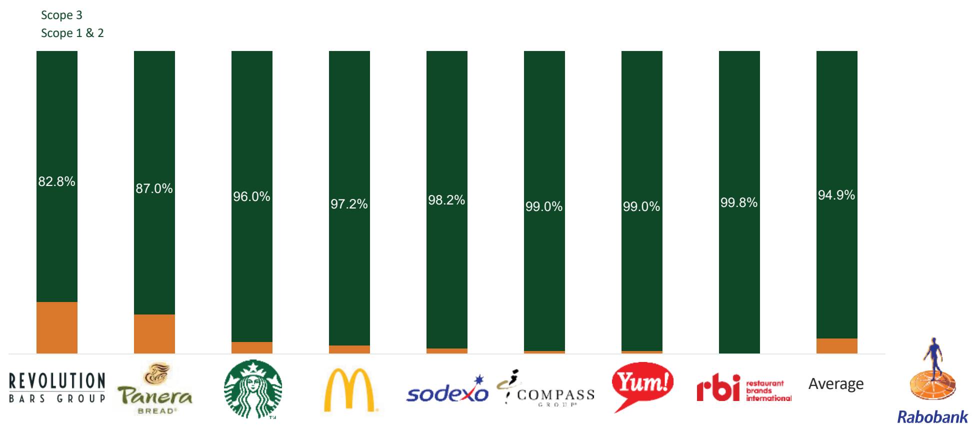
Scope 3

…accounts for more than 90% of emissions for consumer food companies



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The New IPCC AR6 Report

- Near term 1.5 to 2 °C warming unavoidable
- Many climate impacts also now irreversible
- "Net zero" goals cited by many misinterpret the IPCC

> "…limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions. Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality."

- Methane reductions are seen more as a way of offsetting reduced cooling by sulfate aerosols (fossil fuel reductions coincide with reductions in sulfate aerosols)

Biden's Executive Action: Biden-Harris Administration Commits on Climate Change – Creating Jobs, Building Infrastructure, and Delivering Environmental Justice

- Issue of National Security
- NetZero economy by 2050
  - Carbon pollution-free power sector by 2035
  - 30 by 30 program, conserving 30% of lands and oceans by 2030
- At least 30% reduction of CH_4 by 2030 compared to 2020

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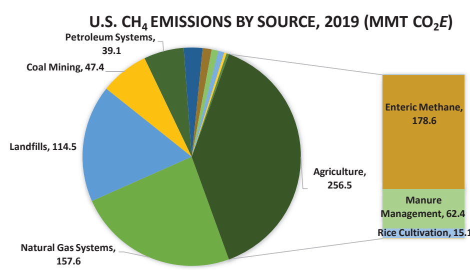
Global Methane Pledge Announced at COP26.

- U.S. and EU Leadership announce a commitment to reduce CH_4 emissions below 2020 levels by 2030.
- USDA is prioritizing the following to achieve this:
  - The adoption of alternative manure strategies and other methane reducing strategies
  - Expansion of on-farm generation and use of renewable energy
  - Development of climate-smart agricultural commodities partnership
  - Increased investments in agriculture methane quantifications and related innovations



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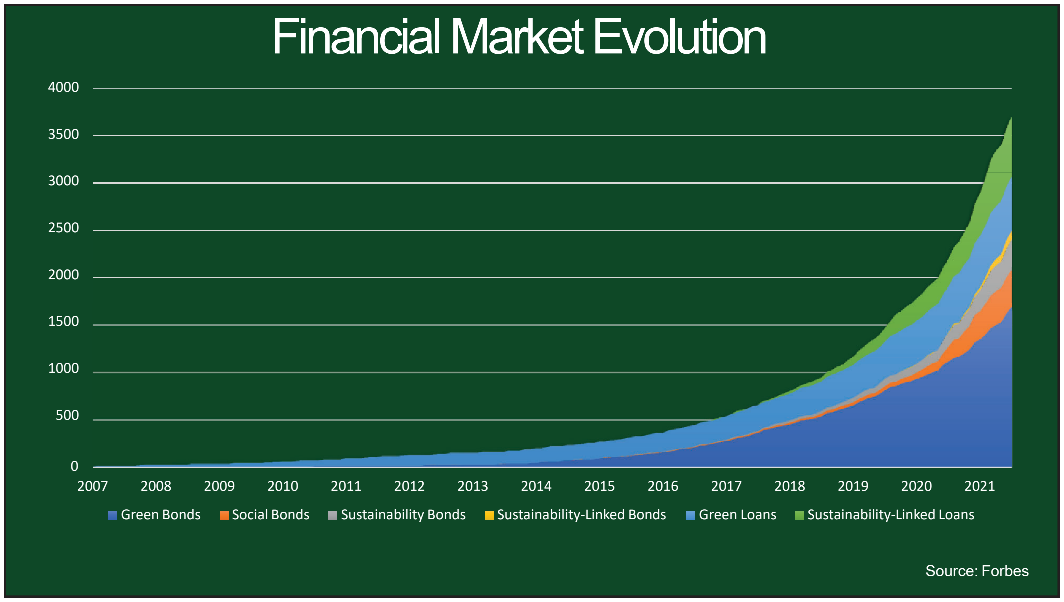
Financial Market Evolution
4000
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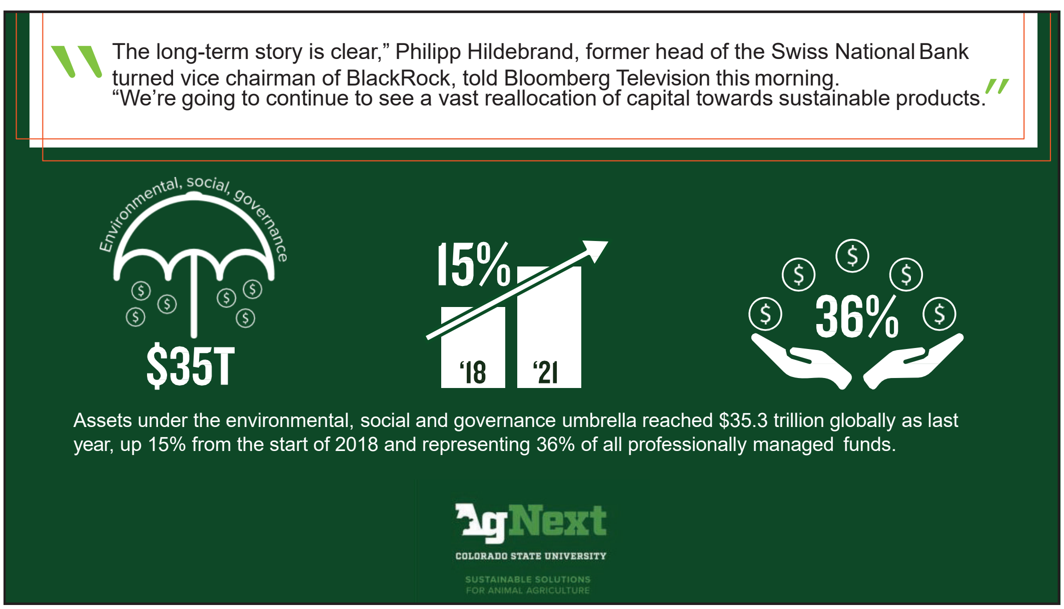
Sustainability-Linked Loans
Source: Forbes


The long-term story is clear," Philipp Hildebrand, former head of the Swiss National Bank turned vice chairman of BlackRock, told Bloomberg Television this morning. "We're going to continue to see a vast reallocation of capital towards sustainable products."
Environmental, social, governance
$35T
15%
'18
'21
36%
Assets under the environmental, social and governance umbrella reached $35.3 trillion globally as last year, up 15% from the start of 2018 and representing 36% of all professionally managed funds.
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SEC's Milestone Proposed Climate-Related Disclosure Framework

- The U.S. Securities and Exchange Commission (SEC) proposed a new rule March 21st that would require U.S.-listed companies to disclose their physical and transition climate-related risks, actions to mitigate those risks, and greenhouse gas (GHG) emissions
- This proposal seeks to standardize climate impact reporting, in answer to what a variable alphabet soup of existing frameworks (SASB, GRI, TCFD, CDP, WEF IBC, etc.)
- It would also require companies to provide annual progress updates on their climate commitments
- Reporting Scope 1 and Scope 2 are considered reporting table stakes.
- Disclosure of Scope 3 emissions are mandatory only if output of those greenhouse gasses is material, or significant to investors, or if companies outline specific targets for them
  - If a company announces plans to reach 'net-zero' emissions by a certain date, it would have to specify whether that goal includes all scopes of greenhouse-gas output.
- The proposed rule was approved by the SEC in a 3-to-1 vote; the public will now have up to 60 days to comment on the plan

75%

Of millennials believe their investments can influence climate change

84%

Of millennials believe their investments can help lift people out of poverty

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Source: Credit Suisse, Making an Impact: Earing Returns on Sustainable Terms

Industry approaches

NCBA Targets Carbon Neutrality

- Demonstrating Climate Neutrality of U.S. Cattle Production by 2040
- Increasing Producer Profitability and Economic Sustainability by 2025
- Enhance Trust Through Improved Animal Welfare, Handling & Training
- Continuously Improving Industry's Workforce Safety and Well-Being

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2022

INDUSTRY GOALS & SECTOR TARGETS

Establish industry goals & sector targets. Promote adoption of U.S. Beef Industry Sustainability Framework & sustainability modules

2023

IMPLEMENTATION & ADOPTION

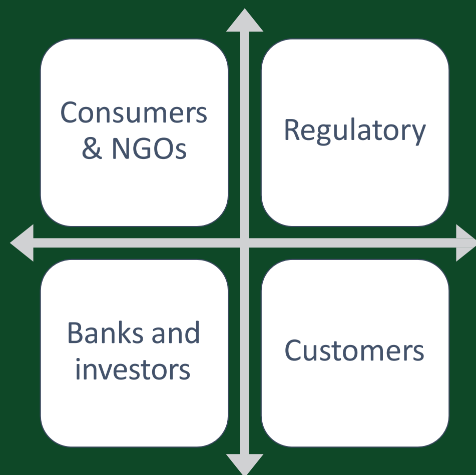
Implementing goals and promoting adoption of U.S. Beef Industry Sustainability Framework & track progress towards goals and sector targets

2024

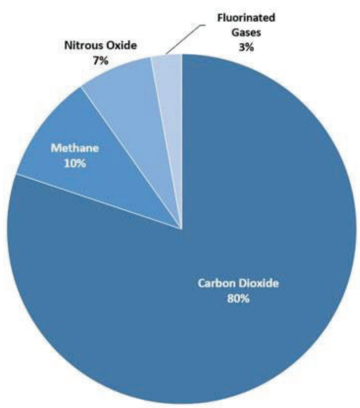
PROMOTE ADOPTION & DEMONSTRATING PROGRESS

Promote adoption of U.S. Beef Industry Sustainability Framework & track progress towards goals and sector targets

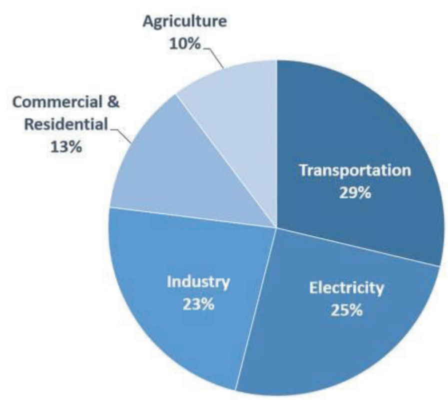
Pressure to Take Action is Coming from Every Angle



Overview of U.S. Greenhouse Gas Emissions in 2019

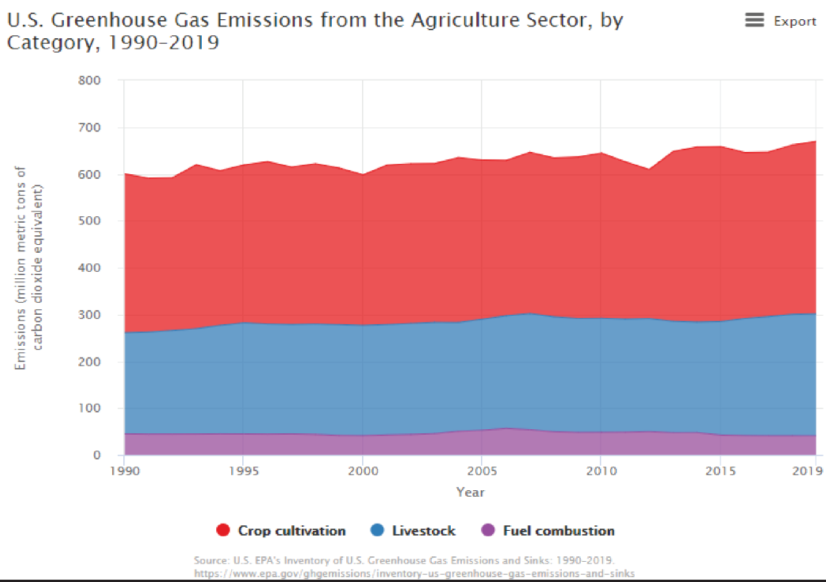


Sources of U.S. Greenhouse Gas Emissions in 2019



Source: US EPA (2021). Inventory of U.S. GHG emissions and sinks: 1990-2019

Colorado State University



Percent change:

1990–2019

Crop cultivation:
▲ 8.4%

Livestock:
▲ 20.7%

Fuel combustion:
▼ 8.9%

Total: ▲ 11.5%

CO_2 increased 9.9%
CH_4 increased 17.5%
N_2O increased 10.4%

Livestock is responsible for 3.8% of U.S. GHG emissions

Environmental footprints of beef cattle production in the U.S.

150 representative production systems across 7 regions

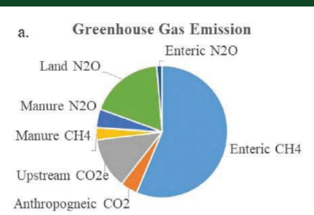


Fig 3 (abrev). Distribution of each environmental footprint among sources

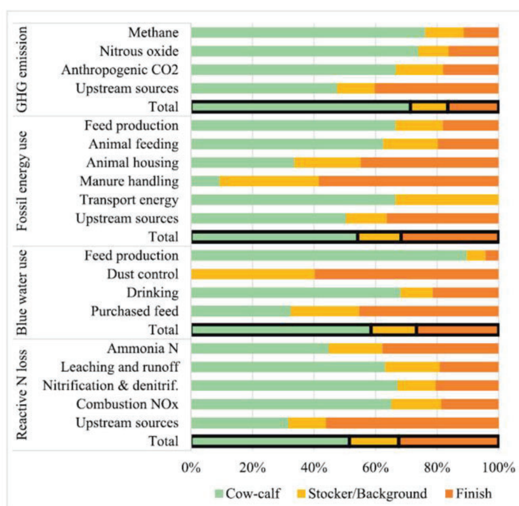


Fig. 2. Distribution of the sources of each environmental impact across the three major phases in the life cycle of beef cattle production.

Source: Rotz et.al, 2019. Agricultural Systems 1369:1-13.

Enteric Methane Mitigations Strategies

	Seaweed	3-NOP	Nitrate	Essential Oils	Lipids	Genetic Selection	Vaccine	Management Strategies
Animal production	↓	Little change	Little change	↓	Little change	??	??	↑
Methane, g/day	↓	↓	↓	↓	↓	Unlikely, not directly	Unknown	↓
Methane, g/kg HCW	↓	↓	↓	↓	↓	??	??	↓
Long term monitoring	147 days	115 days	90 days	70 days	250 days	Early stages	??	Life cycle analyses ongoing
Status	Lack of largescale cultivation of seaweed	Not FDA approved in U.S.	Experimental, acclimation is critical	Lack of largescale cultivation	DMI declines at high levels	Research ongoing	Research ongoing	Research ongoing
Scalability	Unlikely to be successful, decreases in HCW (20 lb)	Unknown	Unlikely to be successful, may increase N_2O	Unlikely to be successful due to palatability and cost	Unlikely to be successful due to cost and intake	Unknown	Unknown	Ongoing for 30+ years

Source: Kristin Hales, TTU (amended)

GHG Challenges & Opportunities

- Enteric Methane:
  - Nothing has been tested in grazing cattle
  - Long-term trials to test efficacy
  - Win-wins
  - Scalability
- Nitrous oxide
  - Primarily produced by nitrification and denitrification processes in soil:
    - following urine deposition
    - fertilizer application
    - stored manure
- Emission measurement in the natural environment is limited
- Anthropogenic CO_2
  - Natural gas/electricity in feed mills
  - Water delivery
  - Fuel in equipment and vehicles
- Upstream sources

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Livestock allow us to produce food on land unsuitable for cultivation, while enhancing ecosystems

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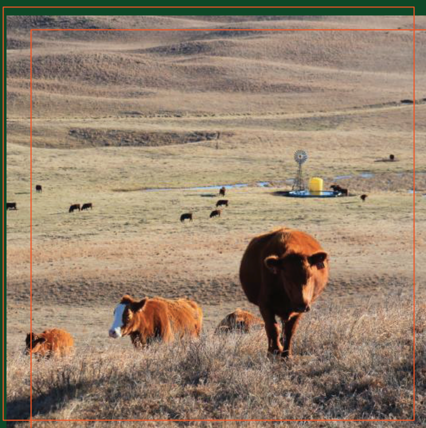

Source: Sanderson et. al, 2020. Cattle, conservation and carbon in the western Great Plains. Journal of Soil and Water Conservation

The most important thing we can do for soil organic carbon in rangelands is to:

1. Preserve rangelands (avoid conversion)
2. Restore cultivated and degraded lands
3. Practice adaptive livestock management

This does not consider benefits of other ecosystems services (wildlife habitat, water storage capacity, etc.), rural community well-being and rural economies

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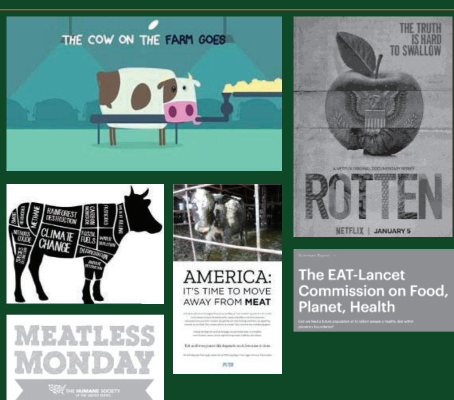
Feed in Animal Agriculture Systems

- Feed is an important impact, practices to reduce N_2O and CO_2 in cropping systems are necessary to reduce emissions in animal agriculture systems
  - No-till
  - Appropriate fertilizer application
  - Cover cropping in certain regions
  - Appropriate crop for the region (includes water resources)
- Livestock integration into cropping systems has potential for increase carbon sequestration

PERCEPTION



REALITY

With **2.2 billion** more mouths to feed by **2050**, experts estimate food production must grow by **70%**

In Summary

- Climate will be a focus in sustainability for the foreseeable future (social equity for corporations will be comparable)
  - Total methane emissions are increasing
- The impact of animal agriculture on climate is measured and reported differently
- Behind in research, we don't have a good "start here" for the supply chain
- Corporate programs (including retail and food service) have matured beyond the industry approach
  - Significant supply-chain expectations
- Sustainability (social, economic, environmental) will be an expectation moving into the future

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Thank you

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April 15, 2022

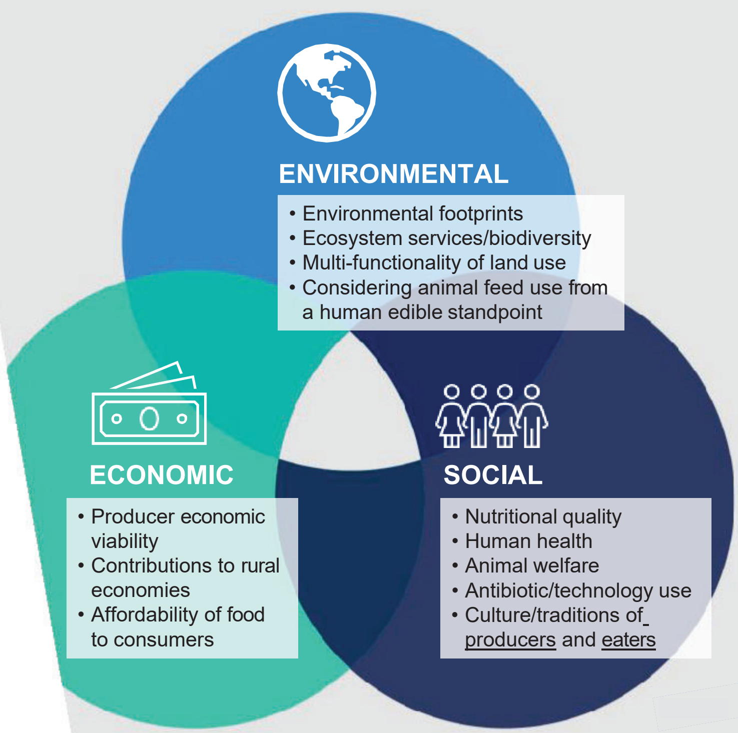
Climate neutrality for U.S. cattle production: What does it mean?

Sara Place, PhD
Chief Sustainability Officer

Sustainability is complex & full of value judgments, yet the issue that dominates today is climate change

Questions that society is asking:

- What should we be eating?
- How should food be grown/produced?
- Can beef/dairy be a part of a sustainable diet?



Consumers are asking questions, but so are investors – ESG expectations are shaping the landscape

"Our question to these companies is: what are you doing to disrupt your business? How are you preparing for and participating in the net zero transition? As your industry gets transformed by the energy transition, will you go the way of the dodo, or will you be a phoenix?"
-Larry Fink, CEO of Blackrock

$9.5 trillion assets under management

> We focus on sustainability not because we're environmentalists, but because we are capitalists and fiduciaries to our clients.

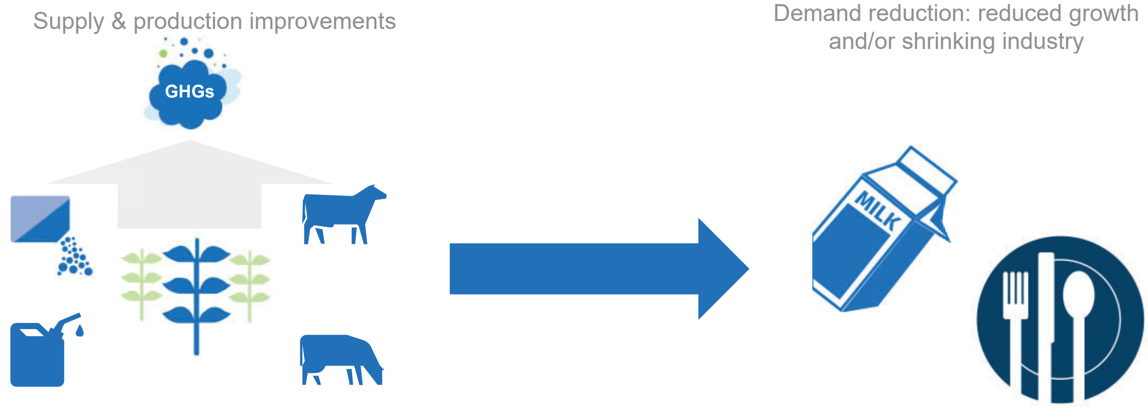
https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter

Simple reality: We can achieve progress on the supply side or the demand side

It's up to the cattle industry to determine if supply side alone can achieve societal expectations. We have knowledge gaps, economic barriers, and implementation challenges ahead

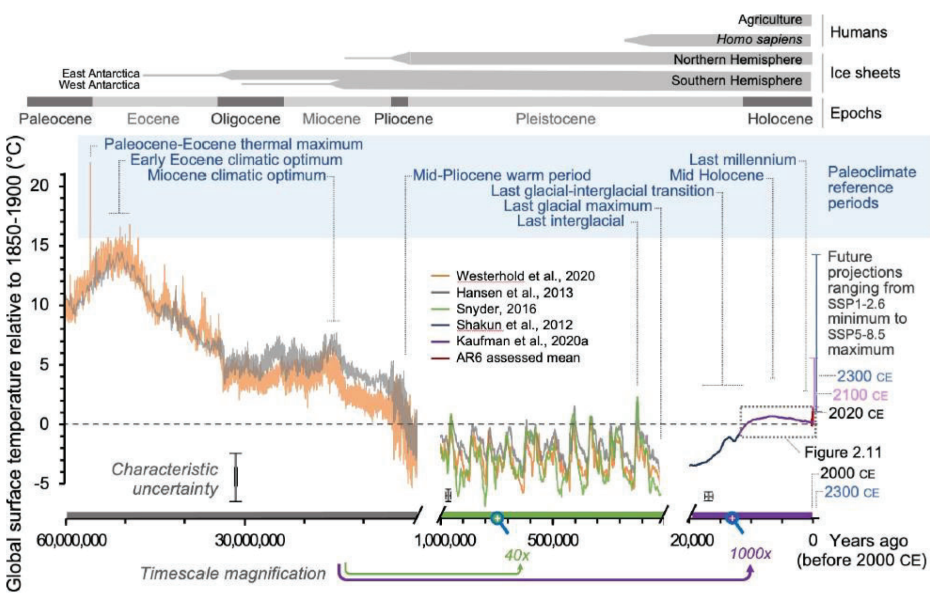
Supply & production improvements

Demand reduction: reduced growth and/or shrinking industry



Climate in Context

Earth's Recent Surface Temperature History



Cross-Chapter Box 2.1, Figure 1: Global mean surface temperature (GMST) over the past 60 million years relative to 1850-1900 shown on three time scales.

Gulev, S. K., P. W. Thorne, J. Ahn, F. J. Dentener, C. M. Domingues, S. Gerland, D. Gong, D. S. Kaufman, H. C. Nnamchi, J. Quaas, J. A. Rivera, S. Sathyendranath, S. L. Smith, B. Trewin, K. von Shuckmann, R. S. Vose, 2021, Changing State of the Climate System. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

Greenhouse effect keeps global average temperature at ~57 °F.

Without the greenhouse effect, global average temperature would be less than 0°F.

Available at: https://climate.nasa.gov/climate_resources/188/graphic-the-greenhouse-effect/

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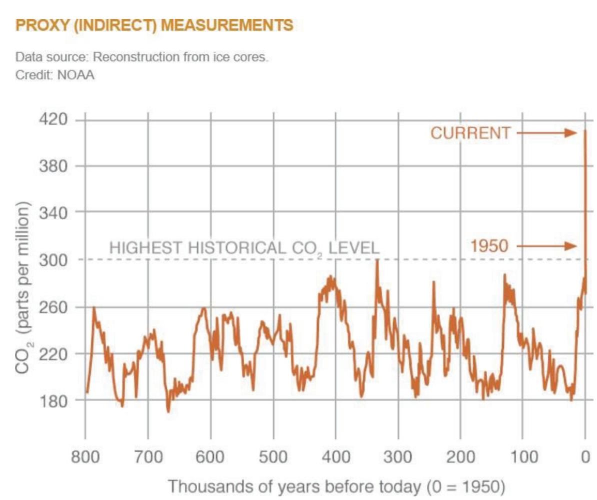
Carbon dioxide (CO_2) concentrations within the atmosphere have increased rapidly in the past few decades

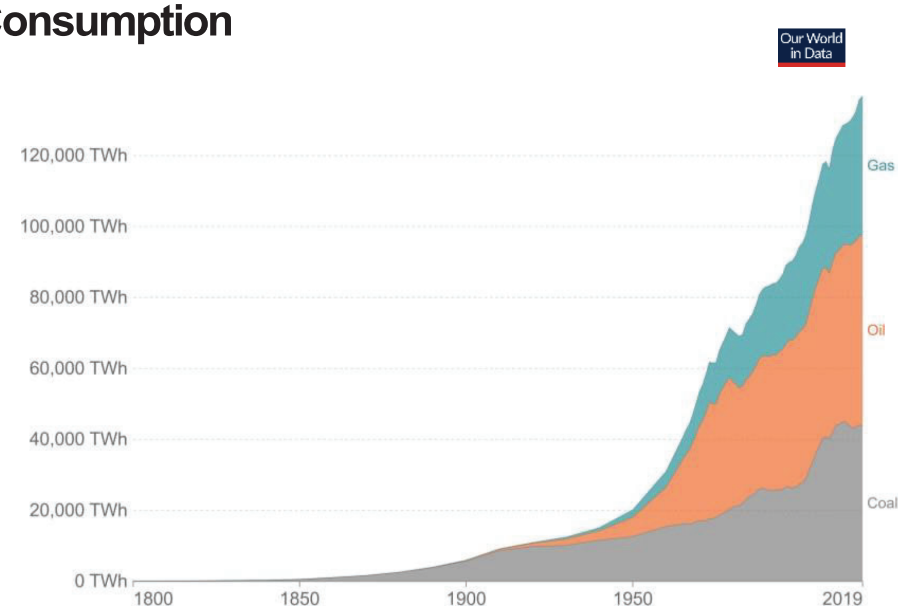
"Over the past 171 years, **human activities have raised atmospheric CO2 concentrations by 48%** above pre-industrial levels found in 1850. This is **more than what had happened naturally over a 20,000 year period** (from the Last Glacial Maximum to 1850, from 185 ppm to 280 ppm)."



Available at: https://climate.nasa.gov/vital-signs/carbon-dioxide/

Global Fossil Fuel Consumption

Global primary energy consumption by fossil fuel source, measured in terawatt-hours (TWh)



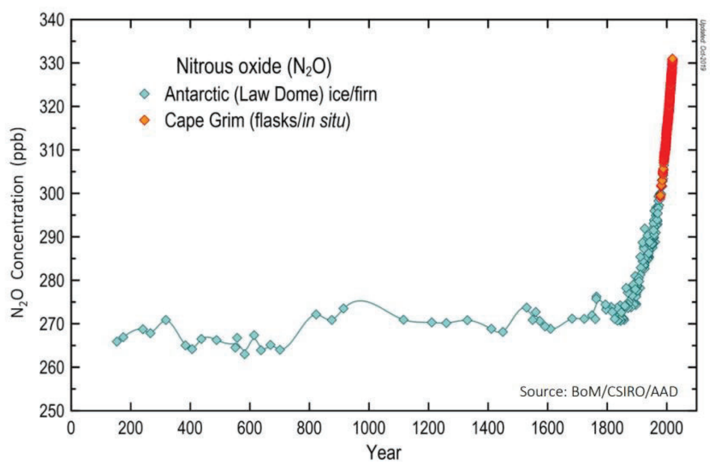
Source: Vaclav Smil (2017), Energy Transitions: Global and National Perspective & BP Statistical Review of World Energy
OurWorldInData.org/fossil-fuels/ • CCBY

Available at: https://ourworldindata.org/fossil-fuels

9

The global N_2O concentration has increased by about 22%, from 270 parts per billion (ppb) in 1750 to 331 ppb in 2018.

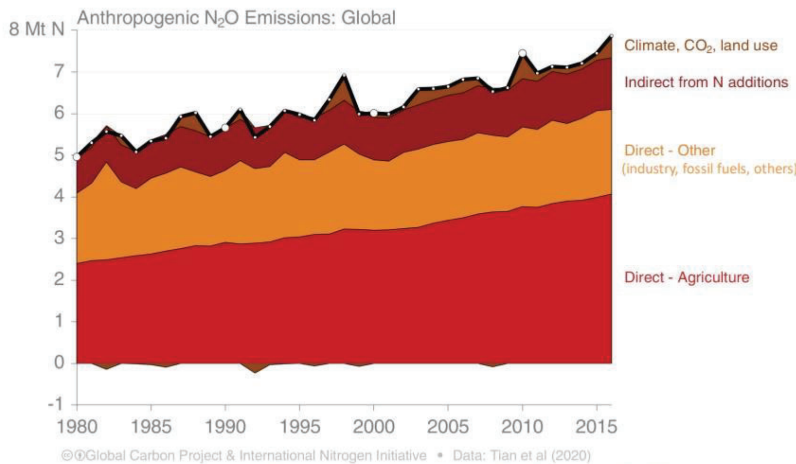
The global N_2O *concentration* has increased by about 22%, from 270 parts per billion (ppb) in 1750 to 331 ppb in 2018.



Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/20/files/GCP_NitrousOxideBudget_2020.pdf

Agriculture is the main disrupter of the global N cycle and is a major contributor to N_2O emissions

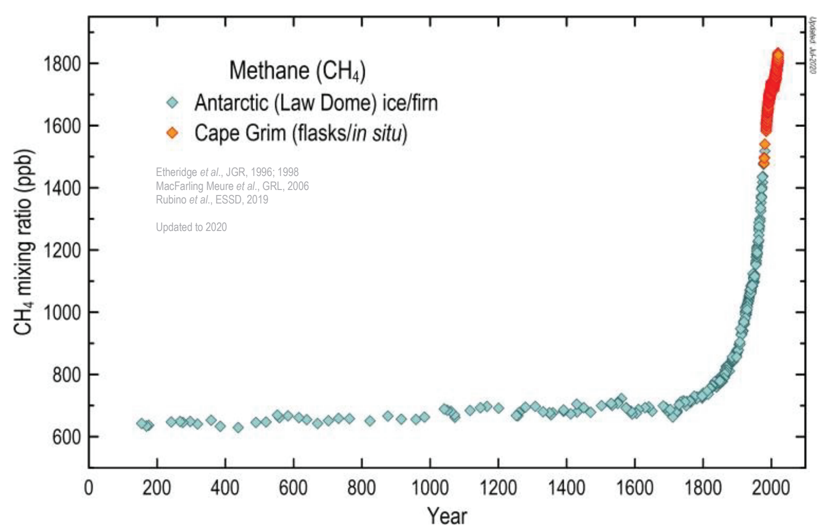
Global anthropogenic N_2O emissions are growing at over 1% pear year.
Agriculture is the single largest anthropogenic source of N_2O emissions.



Direct sources are those occurring where nitrogen additions are made, while indirect sources are those occurring down-stream or downwind

Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/20/files/GCP_NitrousOxideBudget_2020.pdf

Methane (CH_4) is the second most important anthropogenic GHG and has also increased atmospheric concentrations since the Industrial Revolution (up 150% since 1750)



Available at: https://www.globalcarbonproject.org/methanebudget/20/presentation.htm

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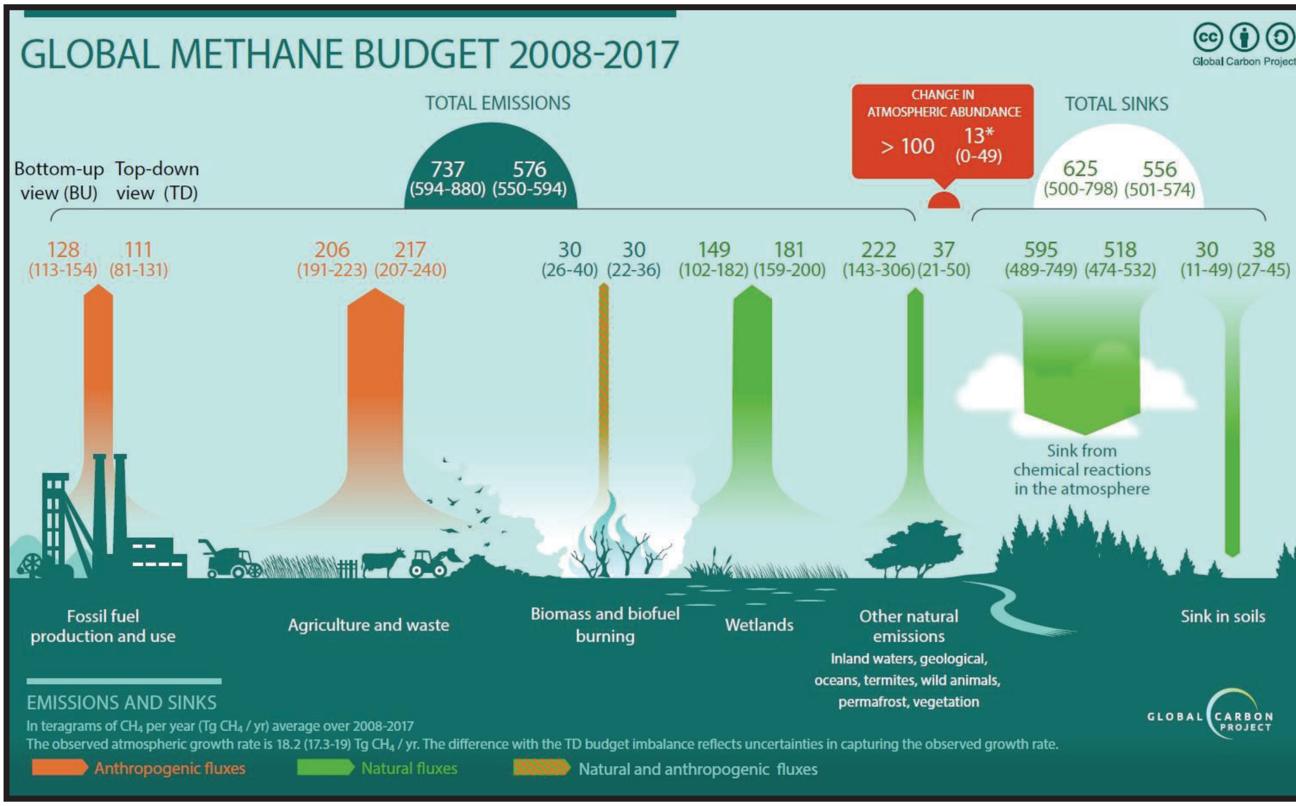
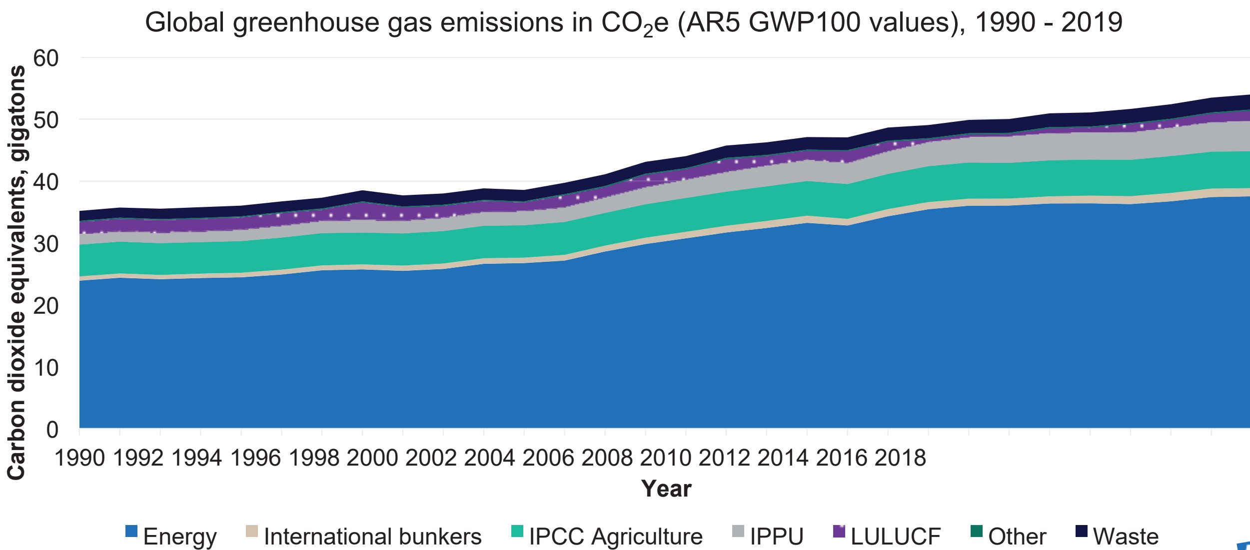


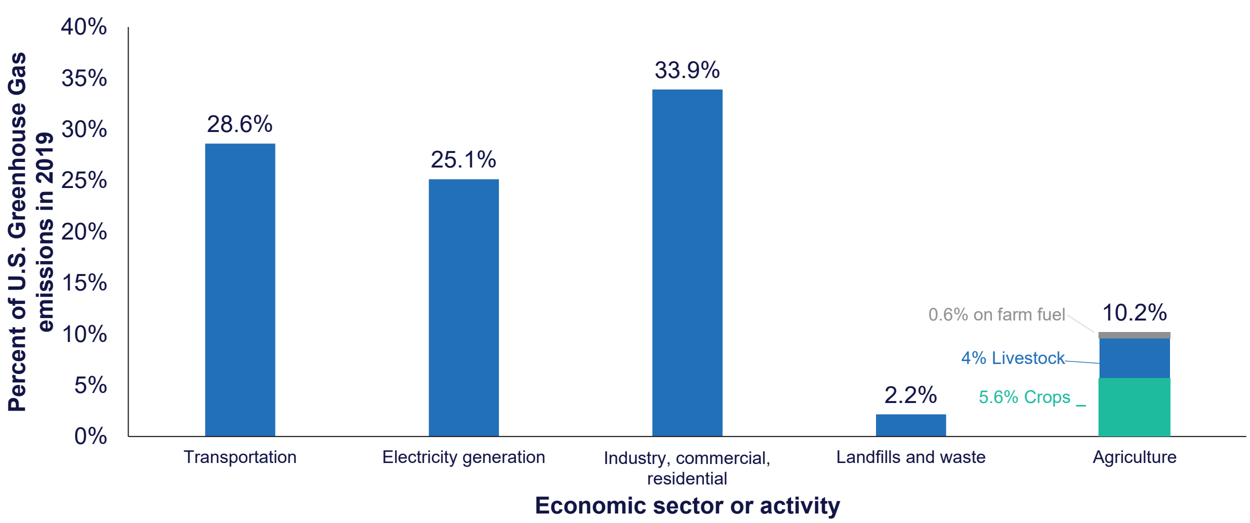
Greenhouse Gas Emissions in Context

Since 1990, global GHG emissions have grown 53%, while agriculture + ag land use emissions are down 3% (population is up 45%)



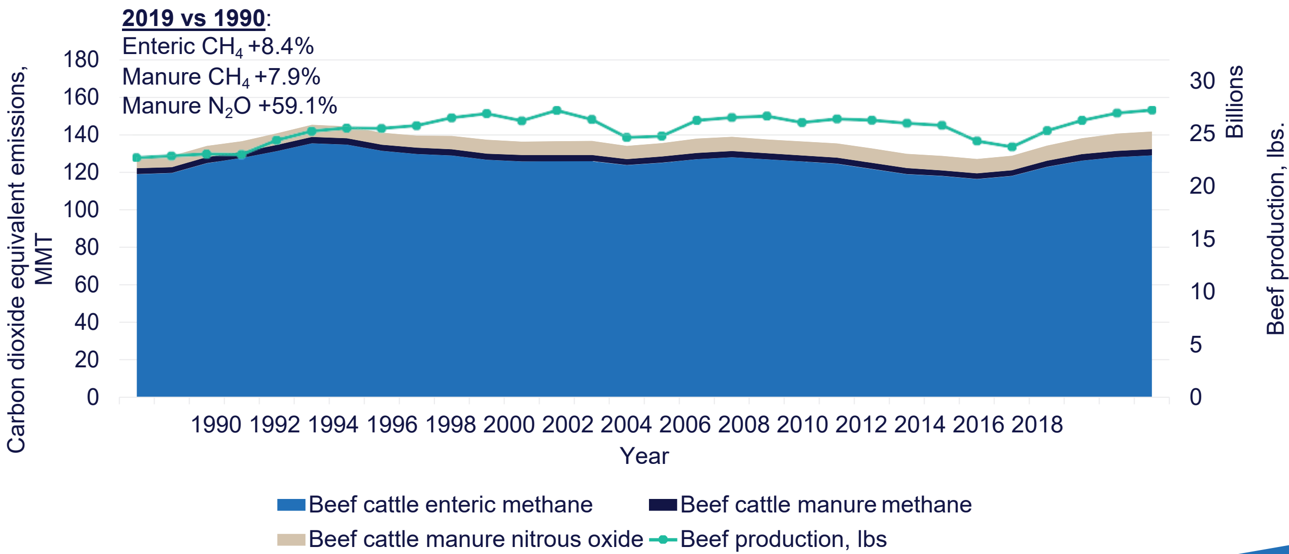
Source: UN FAOSTAT database, available at: https://www.fao.org/faostat/en/#data

U.S. Greenhouse Gas Emissions in 2019



United States Department of Agriculture. National Agriculture Statistics Service. Available at: https://quickstats.nass.usda.gov/
US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2019. 2021. available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019

Emissions intensity of US beef is down 7.5%, beef production is up 19.7%, & absolute emissions are up 10.7% since 1990



United States Department of Agriculture. National Agriculture Statistics Service. Available at: https://quickstats.nass.usda.gov/
US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2019. 2021. available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019

The Climate Balance Sheet for US Beef Cattle Production

EMISSIONS SOURCES (% OF TOTAL[1]):

Enteric methane emissions (56%)
- Cow-calf production = 77% of enteric methane emissions
- Opportunities: improved production efficiency, reduced mortality, increased digestibility of feedstuffs, new innovations to inhibit methane

Feed/soil emissions (24%)
- Mostly soil nitrous oxide
- Opportunities: improvements in crop yields, optimized fertilizer use, integration of cattle & crops

Fossil fuel & input emissions (17%)
- Equipment, fertilizer, electricity, lime
- Opportunities: energy efficiency, optimized fertilizer use

Manure emissions (3%)
- Manure nitrous oxide & methane
- Opportunities: Manure management strategies and innovations customized to operations (e.g., composting, anaerobic digestion where relevant)

[1]Rotz, CA, Asem-Hiablie, S, Place, S, Thoma, G. Environmental Footprints of Beef Cattle Production in the United States. Agricultural Systems [Internet]. 2019 Feb [cited 2020 Aug 13]. 169:1-13. https://www.sciencedirect.com/science/article/pii/S0308521X18305675

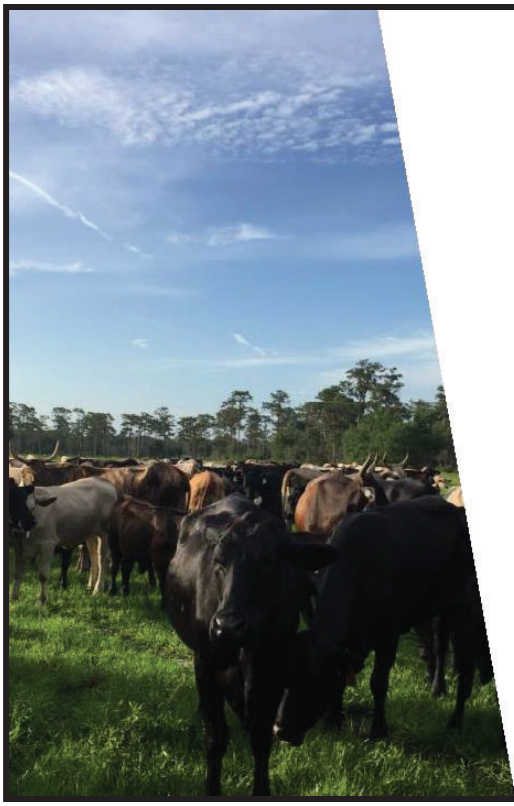
CARBON SEQUESTRATION:

Pasture and rangelands
- Opportunities: Maintain soil C stores, increase soil where possible via management & re-establishment on degraded/highly erodible croplands

Row crops fed to cattle
- Opportunities: increase no-till/reduced tillage, cover crops, integration with cattle & other livestock

REDUCE EMISSIONS
+
MAINTAIN & ENHANCE SINKS
=
NET ZERO CLIMATE IMPACT

US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2018. 2020. available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018



US Cattle Emissions

- Both beef and dairy are dominated by methane (enteric + manure)
- Critically important to understand the implications of different climate metrics & how different metrics relate to climate goals

Accounting for Short-lived GHG Emissions Separately to Better Link Emissions to Warming

OXFORD MARTIN SCHOOL

UNIVERSITY OF OXFORD

Net zero for agriculture

Oxford Martin Programme on Climate Pollutants

August 2019

To design effective policies to stop global warming, we need to know the impact of different measures on temperature. This has long been a challenge for action involving short-lived climate pollutants such as methane. CO_2-warming-equivalent (CO_2-we) emissions provide a simple but accurate way of assessing the glob temperature outcomes of different mitigation options, avoiding well-known problems arising from the use of conventional CO_2-equivalent (CO_2-e) emissions.

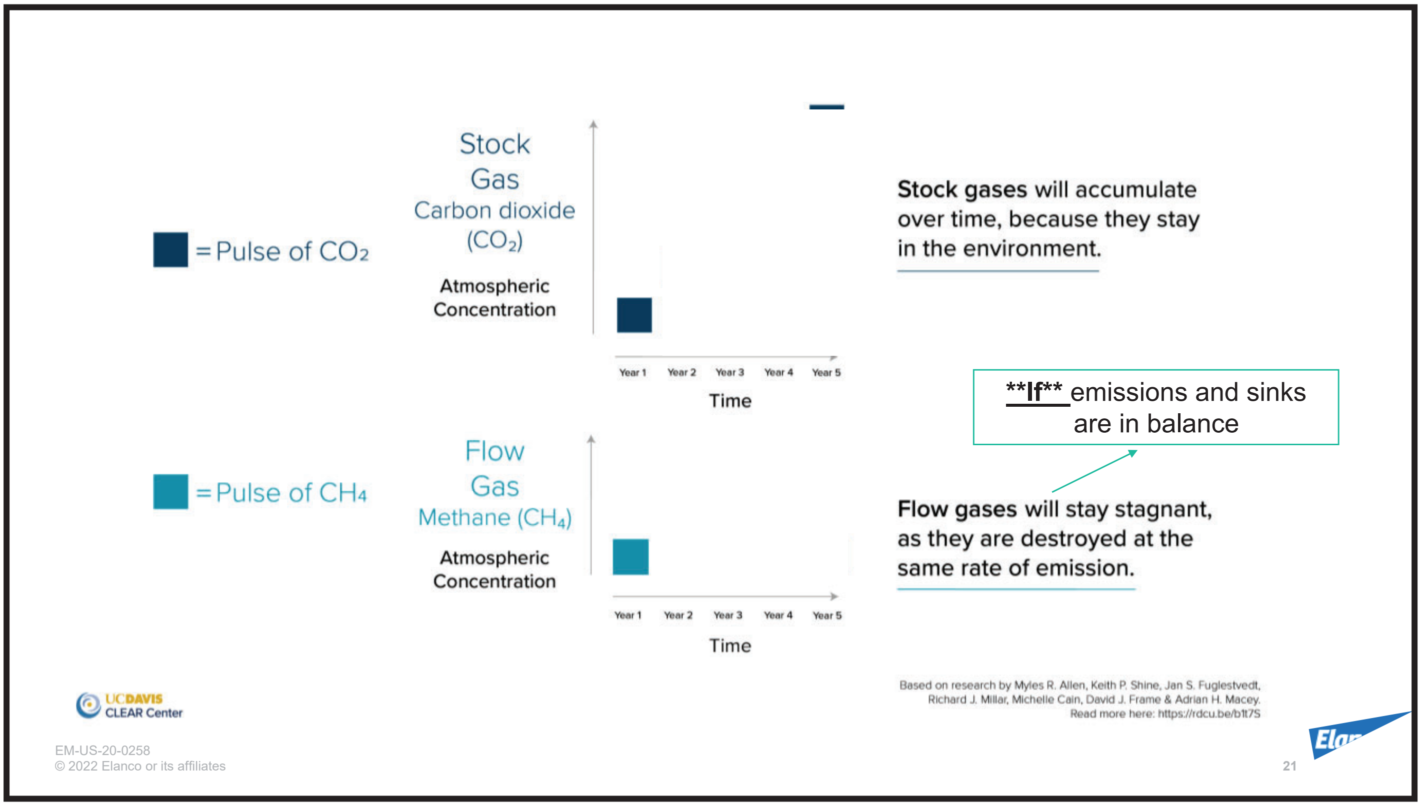
Article | Open Access | Published: 04 September 2019

Improved calculation of warming-equivalent emissions for short-lived climate pollutants

Michelle Cain, John Lynch, Myles R. Allen, Jan S. Fuglestvedt, David J. Frame & Adrian H Macey

npj Climate and Atmospheric Science **2**, Article number: 29 (2019) | Cite this article

2813 Accesses | **64** Altmetric | Metrics



The "So-what" of New Climate Metrics for Short-lived Gases

Better reflects reality of how emissions impact temperature

– This is what we actually care about

Highlights that methane emissions do not have to be zero to reach "climate neutrality"

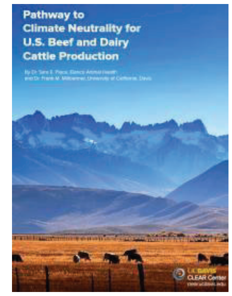
– Climate neutrality defined here as not contributing to additional warming or achieving net zero warming

Important for beef/cattle as methane is the largest GHG in profile

– But, it's not the only GHG associated with cattle production!

If the Goal is Climate Neutrality for US Cattle

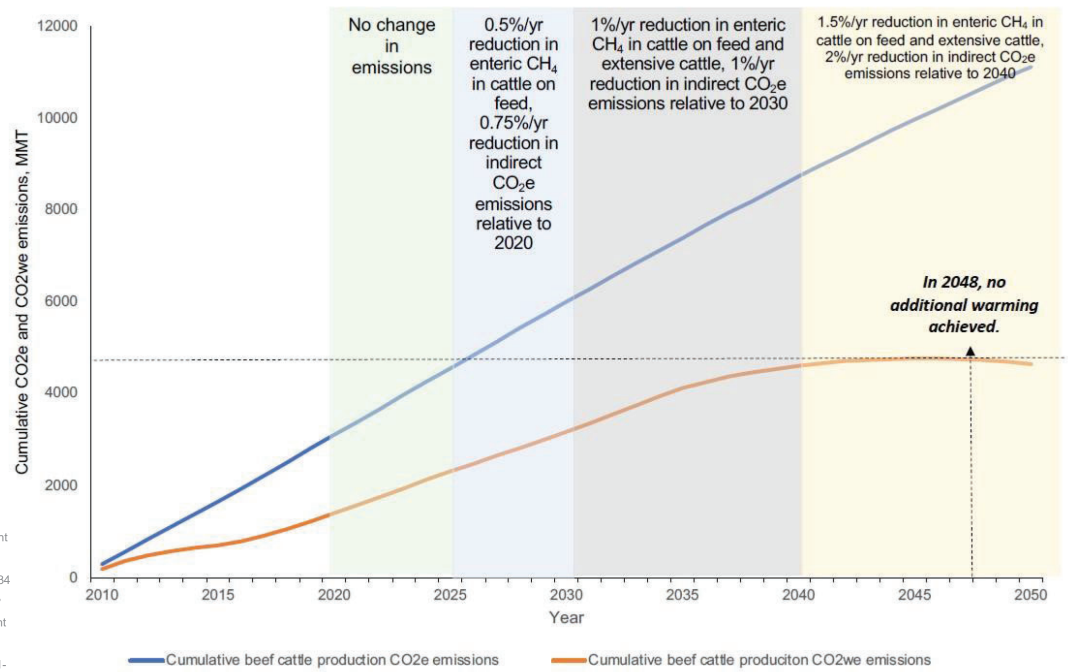
What Could that Look Like?



Assumptions in Scenario to Reach Climate Neutrality for Beef

Item	2020	2050	% change from 2020
Total non-dairy cattle, Jan. 1	**79,766,700**	**79,549,600**	**-0.3%**
Beef production, billion lbs.	**27.1**	**31.2**	**+15%**
Beef cattle enteric CH_4, Tg CO_2e[1]	175.5	136.0	-23%
Feedlot cattle enteric CH_4/d, g/hd	127	96	-24%
Beef cow enteric CH_4/d, g/d	262	204	-22%
Indirect GHG emissions, Tg CO_2e[1]	101.4	72.3	-28%
Carbon footprint, kg CO_2e/kg beef carcass[1,2]	23.72	15.70	-34%
Total GHG emissions, Tg CO_2e[1]	291.3	222.4	-24%

[1]Carbon dioxide equivalents (CO_2e) using GWP100 values of 34 and 298 for methane and nitrous oxide, respectively
[2]The carbon footprint here does not allocate emissions to or from dairy cattle, but rather only accounts for enteric and manure emissions directly attributed to non-dairy cattle within the U.S. EPA GHG inventory. For comparison, Rotz et al. (2019) found a U.S.-wide carbon footprint for beef cattle production of 21.3 kg CO2e/kg carcass weight using GWP100 values of 28 and 265 for CH4 and N2O, respectively. The 2020 footprint reported here would be 21.04 kg CO2e/kg carcass weight using those GWP100 values



[1]Carbon dioxide warming equivalent (CO_2we) emissions are calculated using 20-year time horizon & AR5 GWP100 values for CH_4 & N_2O of 34 and 298, respectively. Smith, M.A., Cain, M. & Allen, M.R. Further improvement of warming-equivalent emissions calculation. npj Clim Atmos Sci 4, 19 (2021). https://doi.org/10.1038/s41612-021-00169-8

Figure 6. *Cumulative carbon dioxide equivalent (CO_2e) or carbon dioxide warming equivalent (CO_2we) for US beef cattle production from 2010 to 2050 for the case study scenario. Assumed changes in emissions by time period are indicated on the graph. The point at which annual CO_2we emissions do not add to further warming is indicated on the graph.*

5

What Would Be Needed To Reach Climate Neutrality While Maintaining Herd and Production Growth

Need to reduce absolute emissions, not just per lb. of beef & milk

Enteric methane is a major "lever" to pull for beef:

- Genetics (feed intake, methane directly)
- Feed additives, feeding strategies
  - Challenge how to deliver to grazing cattle where ~82% of the methane emissions come from?
- Other innovations (e.g., vaccine?)

26

What Would Be Needed To Reach Climate Neutrality While Maintaining Herd and Production Growth

Unlikely reducing enteric methane will get cattle production to climate neutrality alone, so need other reductions and/or increase C sinks

Other reduction examples:

- Reducing feed emissions (e.g., soil N_2O emissions)
- Reducing energy/fuel emissions

Carbon sequestration

- Potential to increase is likely highly dependent upon climate & land's prior use
- **Consideration: if carbon sold as an offset to buyers outside supply chain, can beef or dairy claim as well??**

Carbon value of beef – will it be a cost or a revenue opportunity?

$9.3 billion carbon value in beef cattle production @ $40 per metric ton CO_2e

		Beef cattle production GHG emissions, MMT CO_2e	Total carbon value @**$40**/t CO_2e, USD	@ 25% reduction & 50% market share, MMT CO_2e	Carbon offset value @**$40**/t CO_2e, USD
Enteric	CH_4	129.1	$5,162 mil	-16.1	$645.3 mil
Manure	CH_4	3.40	$136 mil	-0.4	$17.0 mil
Manure	N_2O	9.39	$375 mil	-1.2	$46.9 mil
Feed, fuel, other indirect[1]	CO_2e	90.0	$3,600 mil	-11.3	$450 mil
			$0.34/lb. of beef[2]		**$1,159 mil** **$0.04/lb. beef[2]**

[1]Using GWP100 value for methane of 25, for nitrous oxide 298, & estimate of feed, fuel, & other indirect based on Rotz et al., 2019 & source: US EPA GHG Inventory for year 2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf
[2] Using 2019 beef production as base production from USDA-NASS Quick Stats database

Bottom Line

Climate neutrality for beef cattle production in the USA is likely possible and technically feasible

- But, it requires new innovations

We cannot lose focus of other aspects of sustainability

- First and foremost, need **economic viability**
- Cattle production is critical source of nutrition & ruminant benefits to sustainability are substantial (optimum land use, upcycling, wildfire suppression, etc.)

Societal perceptions are driving conversation & expectations are high

- Future pathways to tangibly achieve action are needed
- Gaps to fill in knowledge, implementation, economic feasibility, and people!

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Thank You

Potential Practices to Decrease the Carbon - Footprint of Cattle Feeding

N. Andy Cole, PhD, PAS, ACAN
Retired USDA-ARS, Bushland, TX.

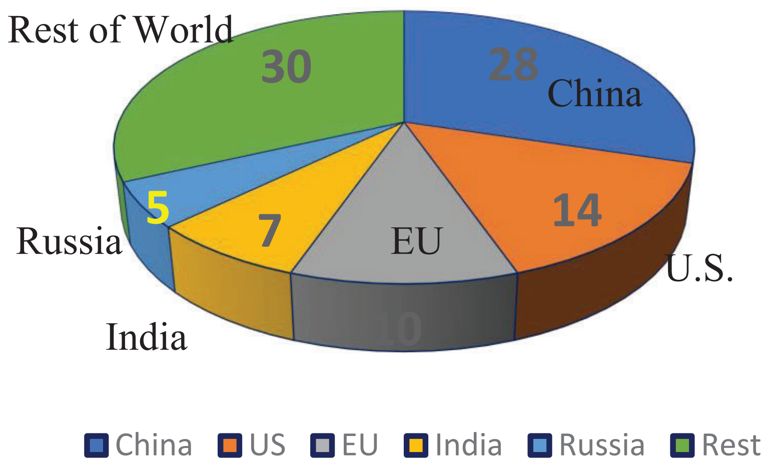
PNC: San Antonio, TX. April 15, 2022

Outline:

- Introduction / Background
- Dietary Factors
  - Grain processing
  - Roughage
  - Fat
  - Distillers grains
- Technology
- Conclusions

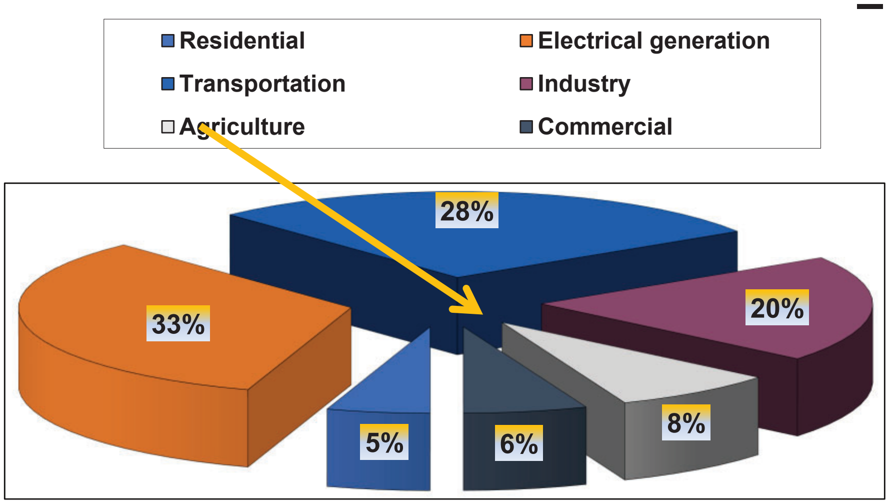
World GHG Emissions: CO2e (%)

32.8 billion tons CO_{2e}



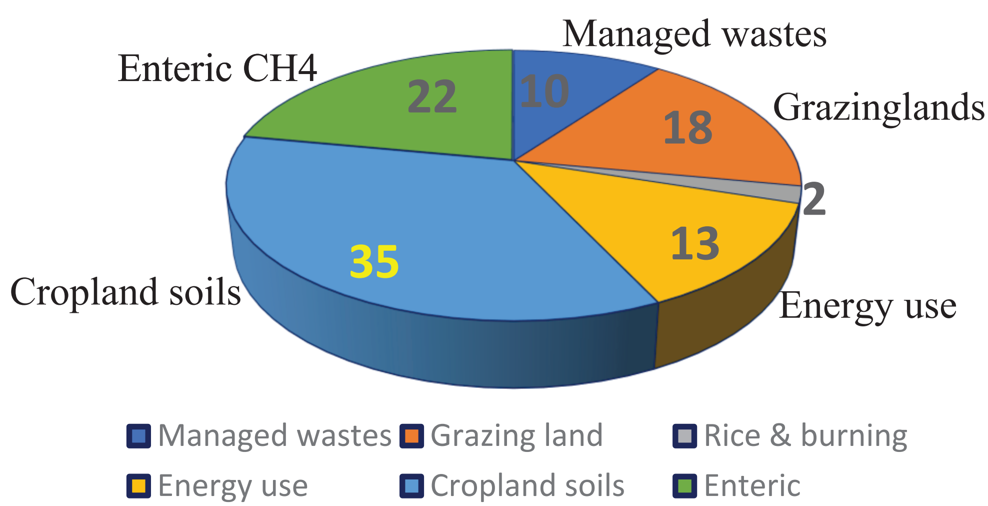
NOTE: U.S. decreased CO2e from 6.5 to 4.8 between 2005 and 2017

U.S. GHG Emissions: CO_2e

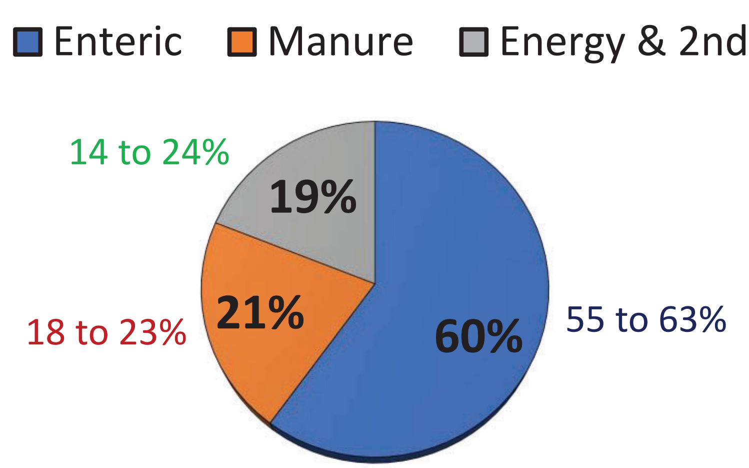


Manure → 0.127% of total CO_2e; Beef Cattle ~= 2% of total emissions

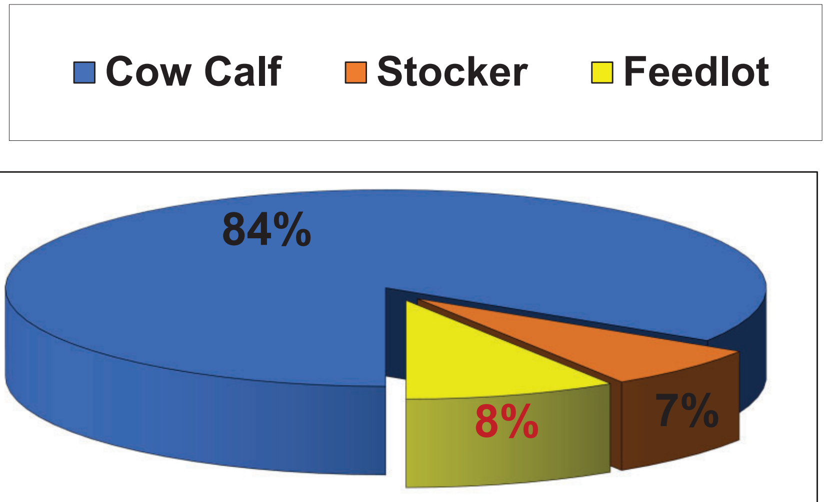
Agricultural Greenhouse Gases %



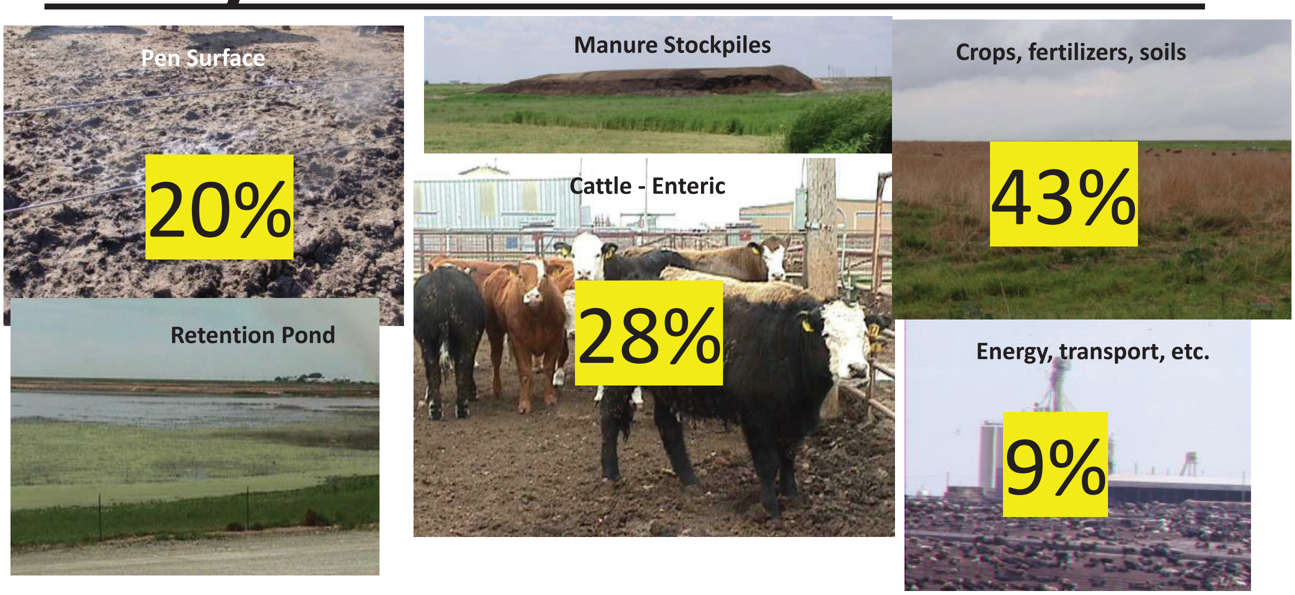
Sources of U.S. GHG From Beef: %CO_{2e}



U.S. Beef Cattle Enteric CH4: %



Feedyard GHG Sources and Sinks



Outline

- Introduction / Background
- Dietary Factors
    - Grain processing
    - Roughage
    - Fat
    - Distillers grains
- Technology
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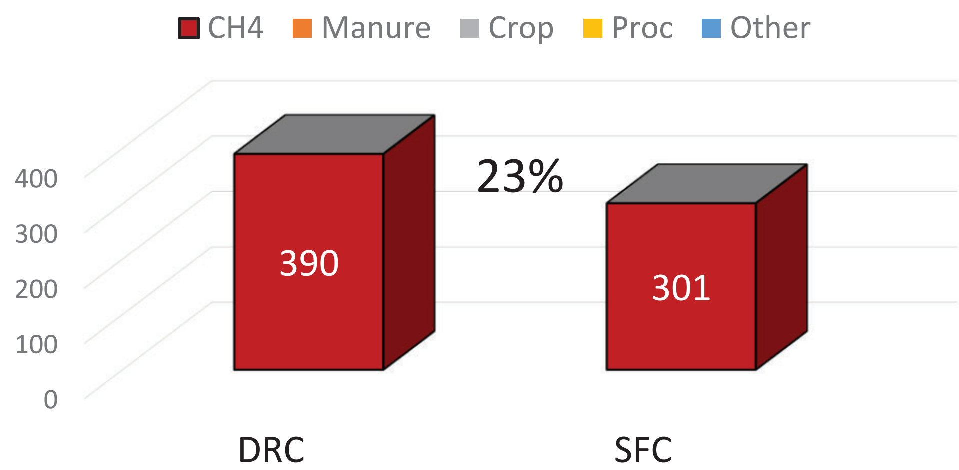
Grain Processing & C-Footprint

Dry Rolled (Cracked) Corn	Steam Flaked Corn
1.54Mcal NEg /kg	1.68 Mcal NEg /kg

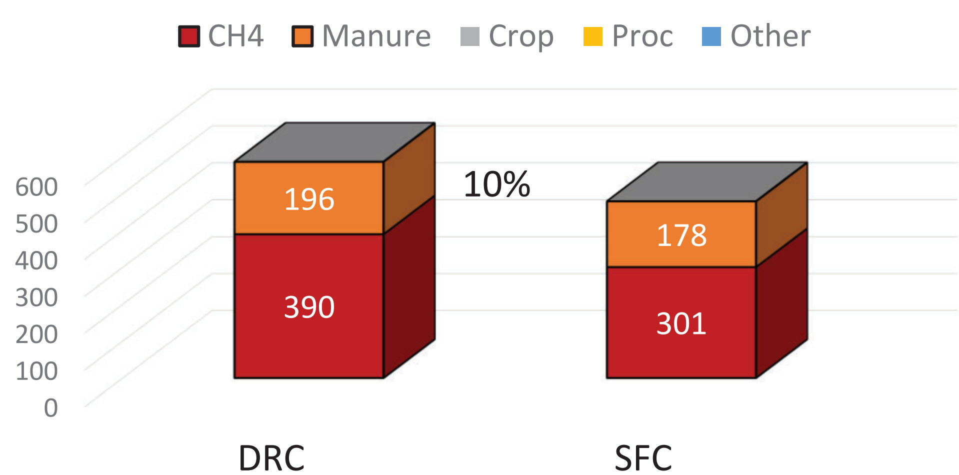
5 Factors in Carbon-Footprint

1) Animal performance
2) Greenhouse gas emissions
3) Grain processing energy use
4) Growing crops
5) Transportation, energy use

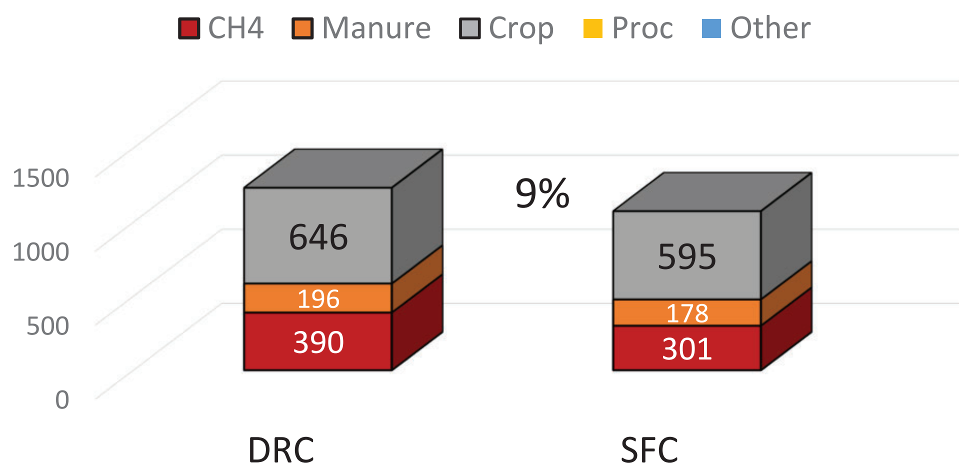
Grain Processing & C-Footprint, kg CO2e/hd



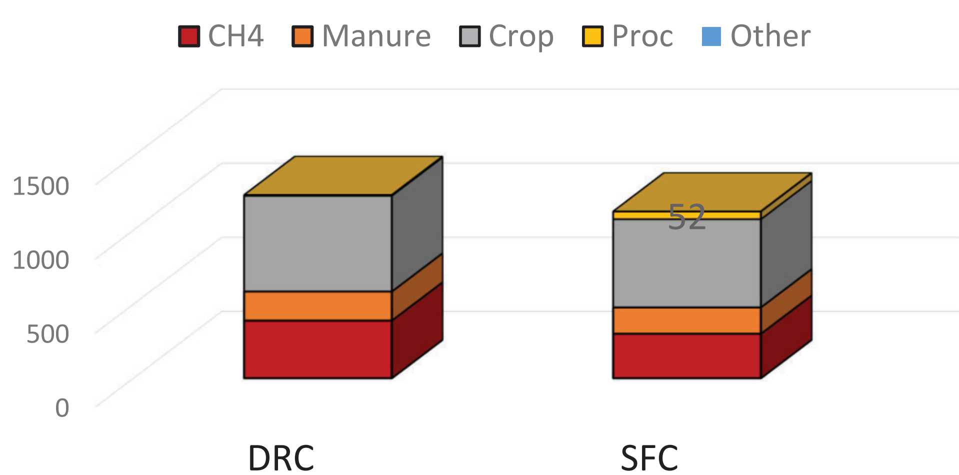
Grain Processing & C-Footprint, kg CO2e/hd



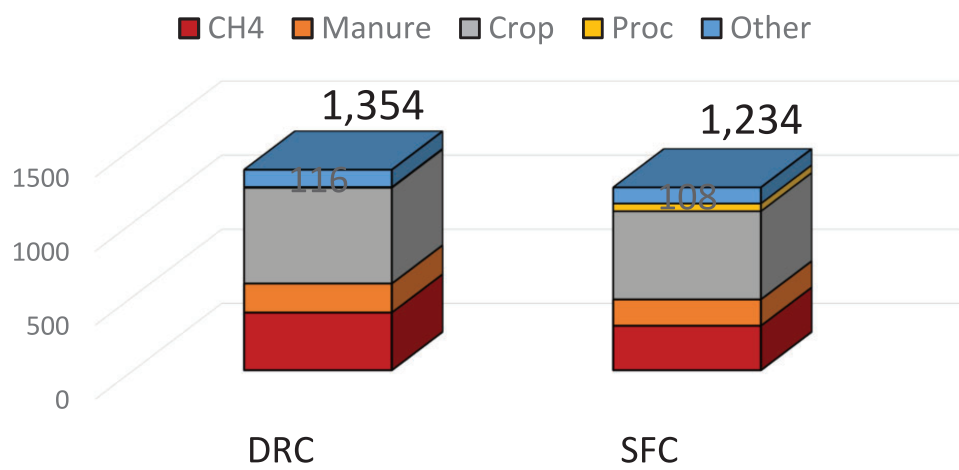
Grain Processing and C-Footprint, kg CO2e



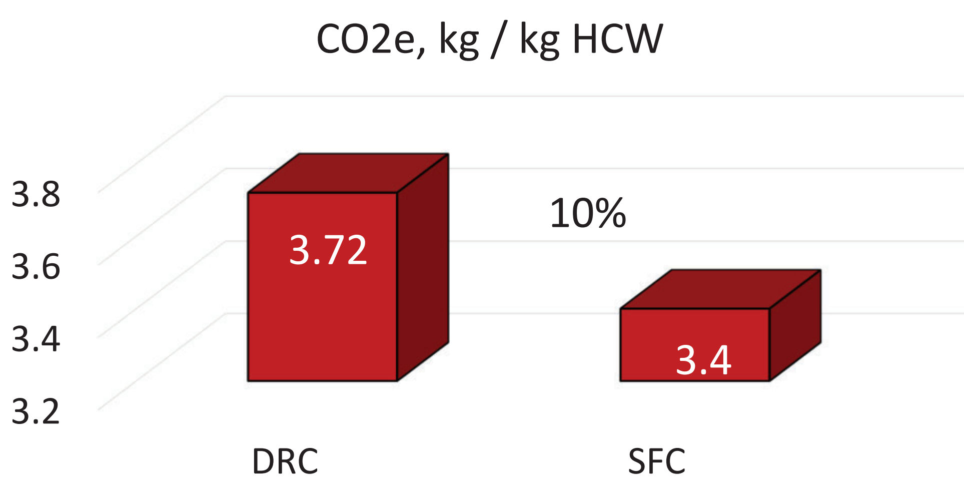
Grain Processing and C-Footprint, kg CO2e



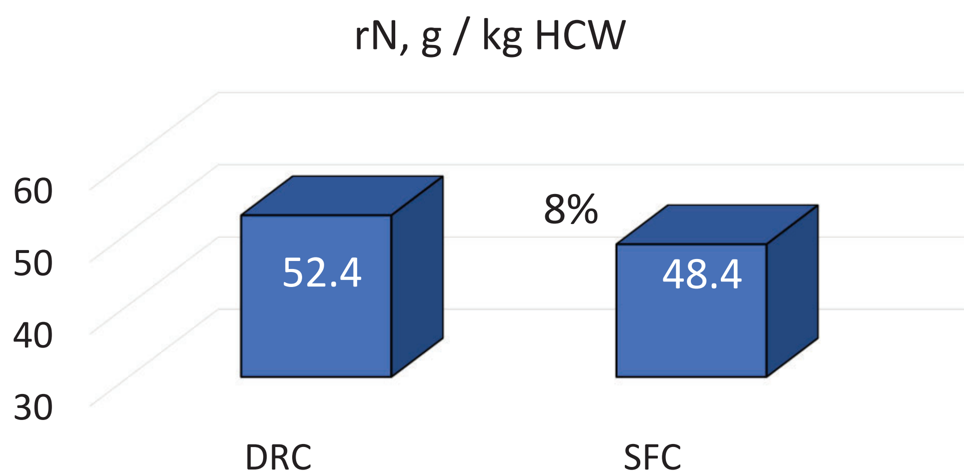
Grain Processing & C-Footprint, kg CO2e/hd



Grain Processing and C-Footprint



Grain Processing and Reactive N Losses



Steam Flaked vs. Dry Rolled Corn

- Uses additional fossil fuel (32 ft^3 / ton corn DM)
- Increases gain:feed (10-15%)
- Decreases feed DM and grain intake (10-15%)
- Decreases daily enteric CH_4 (20-25%)
- Increases digestibility of OM & starch (5-25%)
    - Decreases manure volatile solids (35-50%)

•Decreases C-footprint by 8 to 12%

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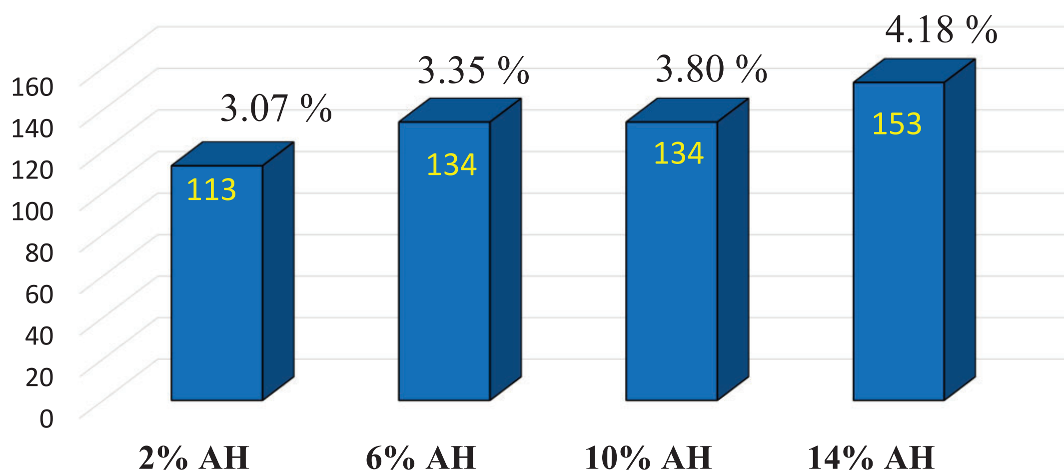
Dietary Roughage & CH4, (L/d)

Hales et al., 2014



Linear effect P < 0.01

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Effects of Fat Intake on Enteric CH_4

- Lovett, et al. (2003)
  - CH4 (g/day) decreased about **6.92%** for each 1% added coconut oil
- Beauchemin et al. (2008)
  - CH4 (g/kg DMI) decreased **5.6%** for each 1% added fat
- Martin et al. (2010)
  - CH4 (g/kg DMI) decreased **3.8%** for each 1% added fat
- Hunerberg et al. (2013)
  - CH4 (g/kg DMI) decreased **4.9 to 6.8 %** for each 1% added fat (oil or DGS)

- **Supplemental Fat – decreases enteric CH4 3.8 to 6.9% / added %**

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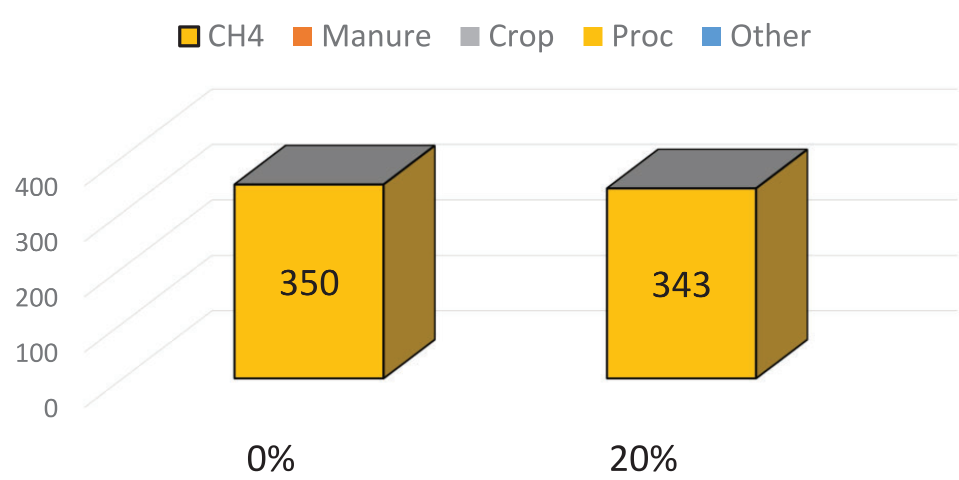
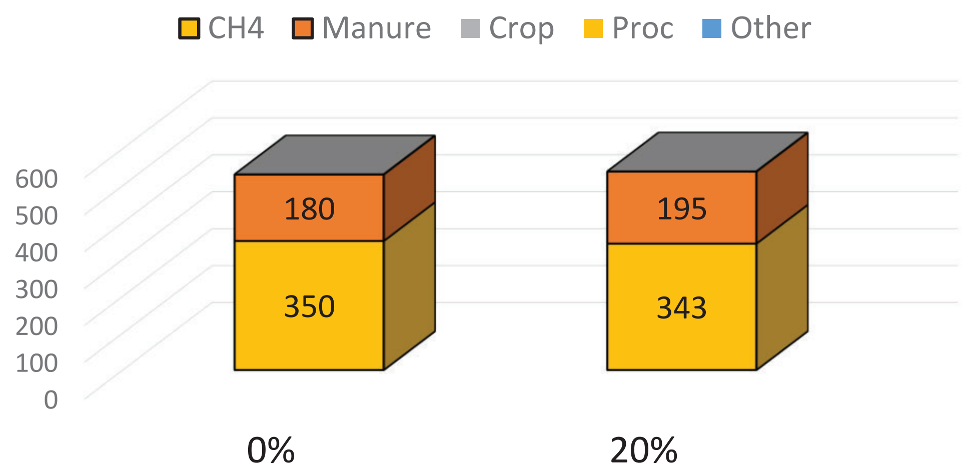
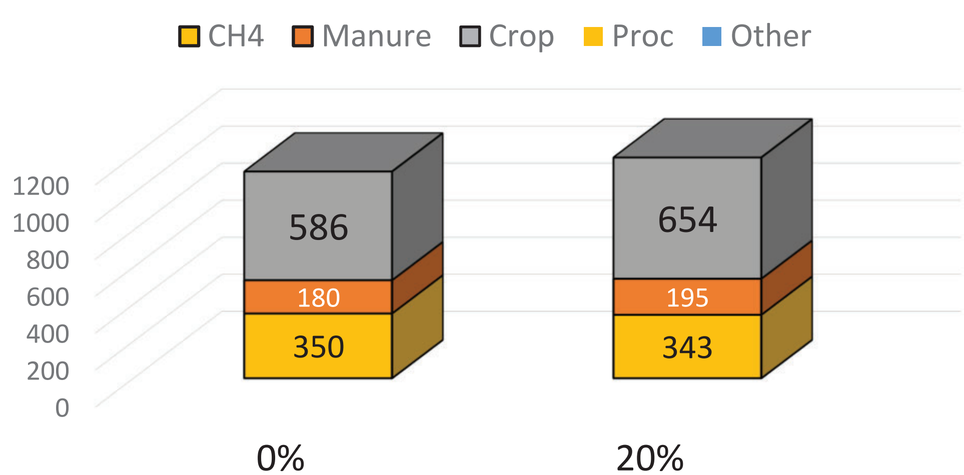
WDGS and C-Footprint, kg CO2e



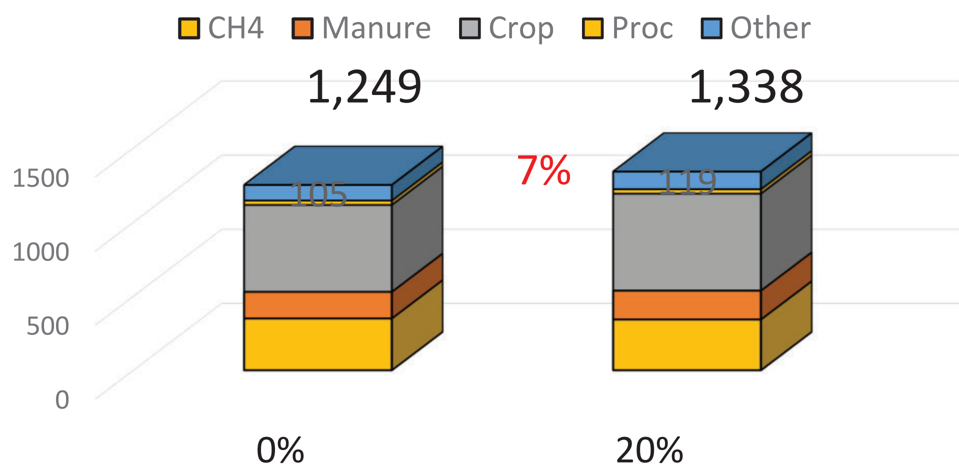
WDGS and C-Footprint, kg CO2e



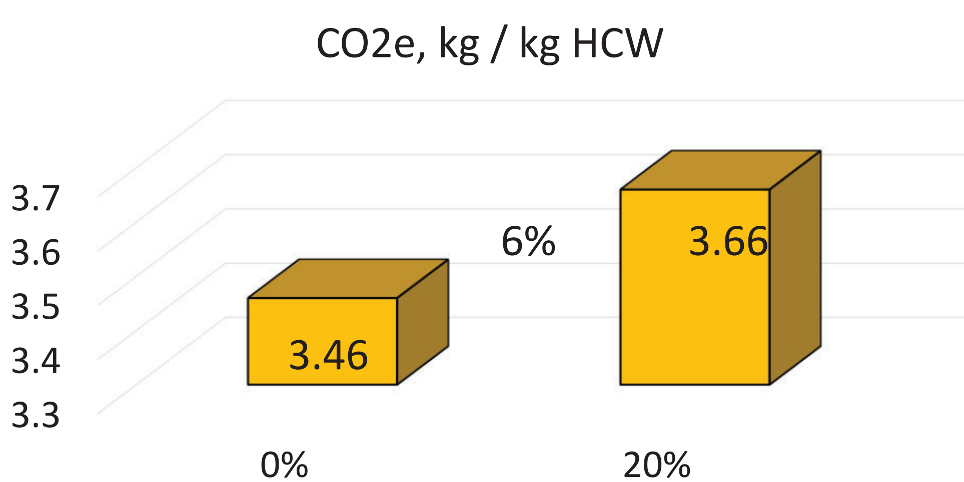
WDGS and C-Footprint, kg CO2e



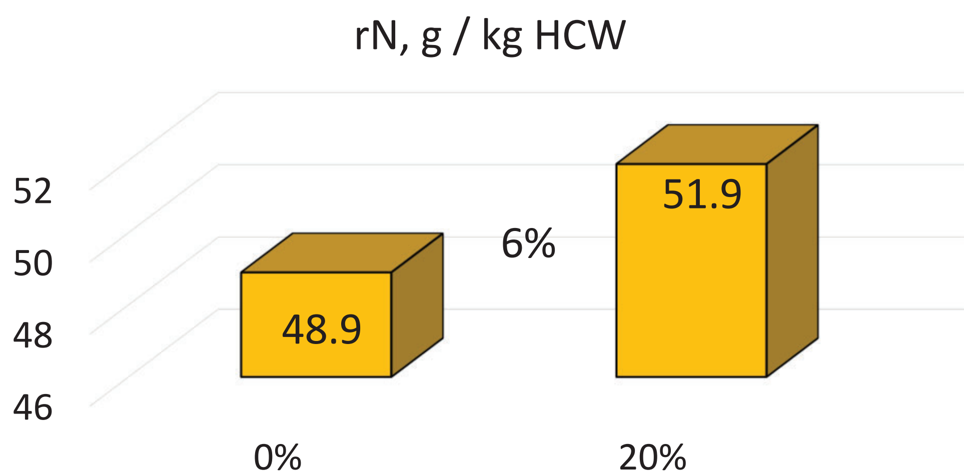
WDGS and C-Footprint, kg CO2e/head



WDGS and C-Footprint



WDGS and Reactive N Losses



C-Footprint of Feeding Distillers Grains?

- Affected by
  - Grain processing
  - Roughage, protein, fat source & concentration
  - Dry > Wet DGS
  - Length of haul
  - DGS dietary concentration
  - **% of WDGS footprint assigned to ethanol vs DGS**
  - C- credit?

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  - Distiller's grains
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Technology & Beefs C-Footprint (1a)

- Stackhouse et al (2012)
- 5 Treatments
  - Angus – natural
  - Angus – ionophore + implant
  - Angus – ionophore + implant + Beta-agonist
  - Holstein – ionophore + implant
  - Holstein – ionophore + implant + bAA
- = DOF
- Not = Final BW or HCW

Technology & Beefs C-Footprint (1b)

- Stackhouse et al (2012)
- Results Summary
  - I+M+bAA decreased NH3 loss / kg HCW by 13%
  - I+M+bAA decreased C-footprint /kg HCW by 10% in Angus
  - bAA decreased NH3 loss / kg HCW by 7%
  - bAA decreased C-footprint / kg HCW by 5% in Holstein

Technology & Beefs C-Footprint (2a)

- Stackhouse-Lawson et al (2013)
- 4 Treatments
  - Angus – natural
  - Angus – ionophore + Tylan
  - Angus – ionophore + Tylan + implant
  - Angus – ionophore + Tylan + implant + zilpaterol
- = DOF
- Not = BW or HCW

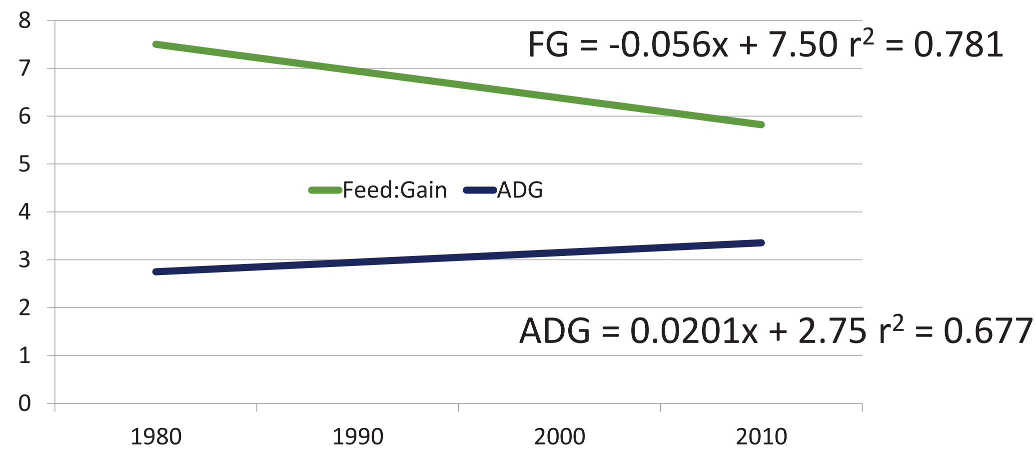
Technology & Beefs C-Footprint (2b)

- Stackhouse-Lawson et al (2013)
- Results Summary
  - IMP + bAA increased ADG 35% & HCW by 11%
  - I+M+bAA decreased NH3 loss /Kg HCW by 42%
  - I+M+bAA decreased CH4 loss/kg HCW by 20%
  - bAA increased daily N2O emissions by 14% (why??)

Technology & Beefs C-Footprint (3)

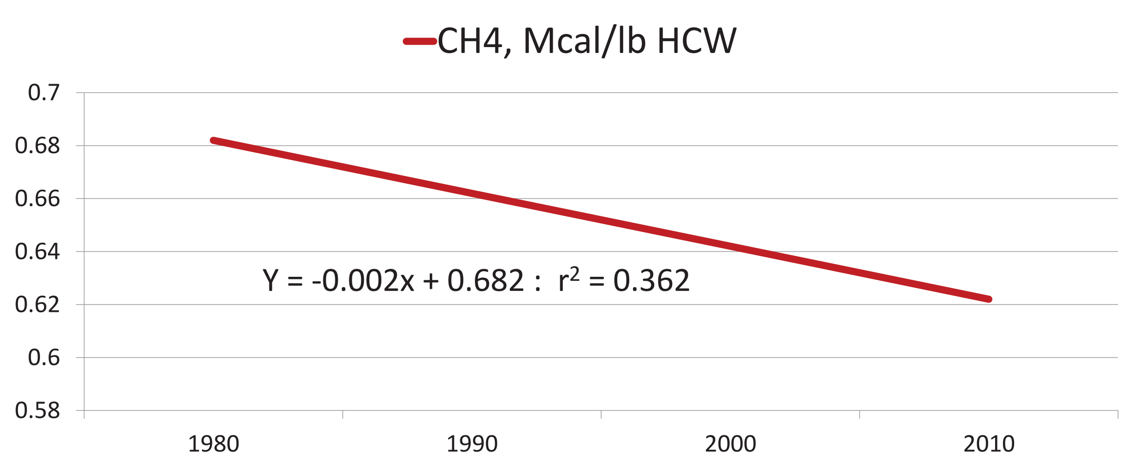
- Rotz et al., 2013
- MARC – 2010 vs 1970
  - Changes - Genetics and increased use of WDGS
  - C-footprint decreased 6%
  - Energy footprint – no change
  - rN loss – increased 10% but rN footprint decreased 3%
  - Water footprint – increased 42% (irrigation)
  - Cost of production decreased 6%

Changes in performance since 1980



Data from KSU Focus on Feedlots dataset (1990-2007) and memory of NA Cole (1980 performance).
MacDonald and Cole., 2009

Changes in environmental characteristics



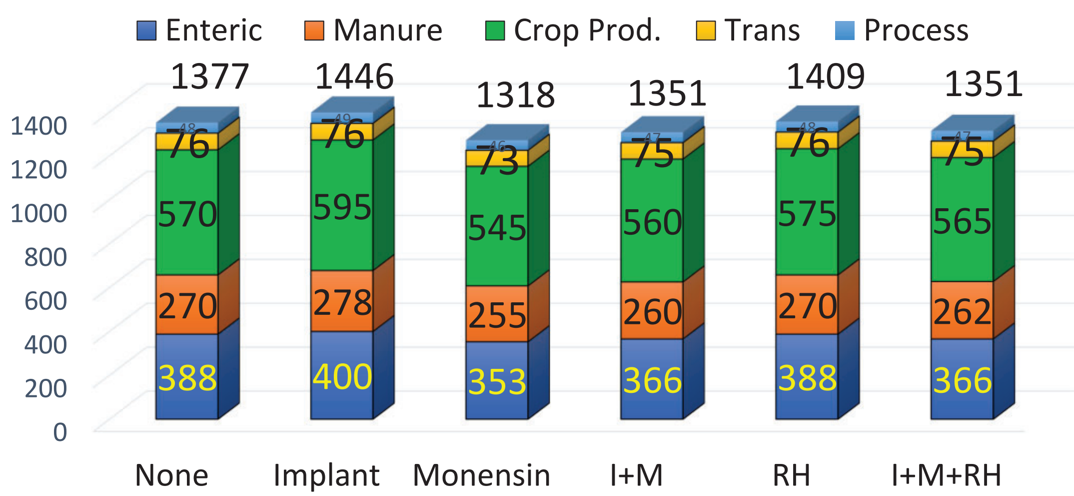
Data from KSU Focus on Feedlots dataset (1990-2007) and memory of NA Cole (1980 performance).
MacDonald and Cole, 2009

Typical Diets in U.S. Feedyards, %

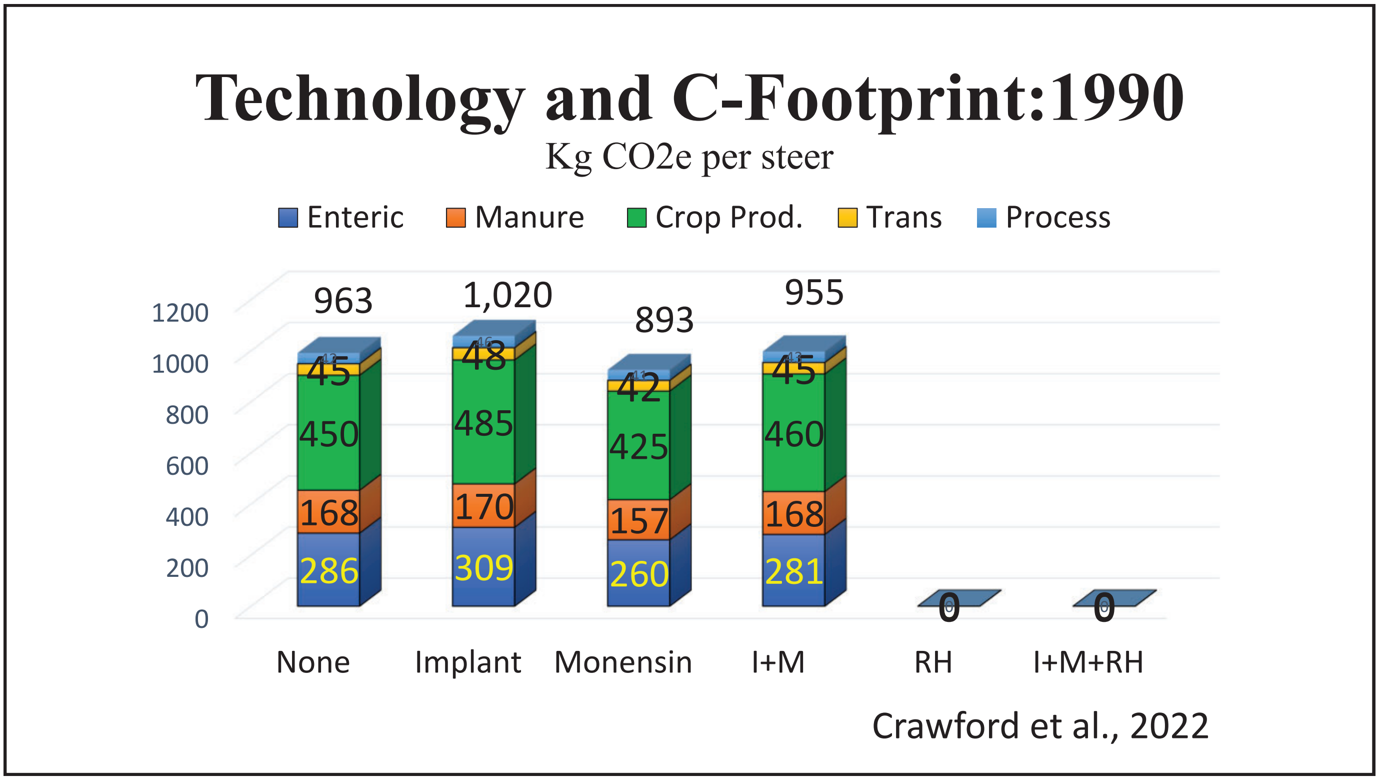
Ingredient	1980	Today
Corn (DR, HM or SF)	75	48
Hay or silage	7	7
Wet distiller's grains	0	20
Wet corn gluten feed	0	20
Fat	3	0
Solubles, protein, mineral	15	5
CP	12-13	15++
Starch	40-50	25-35

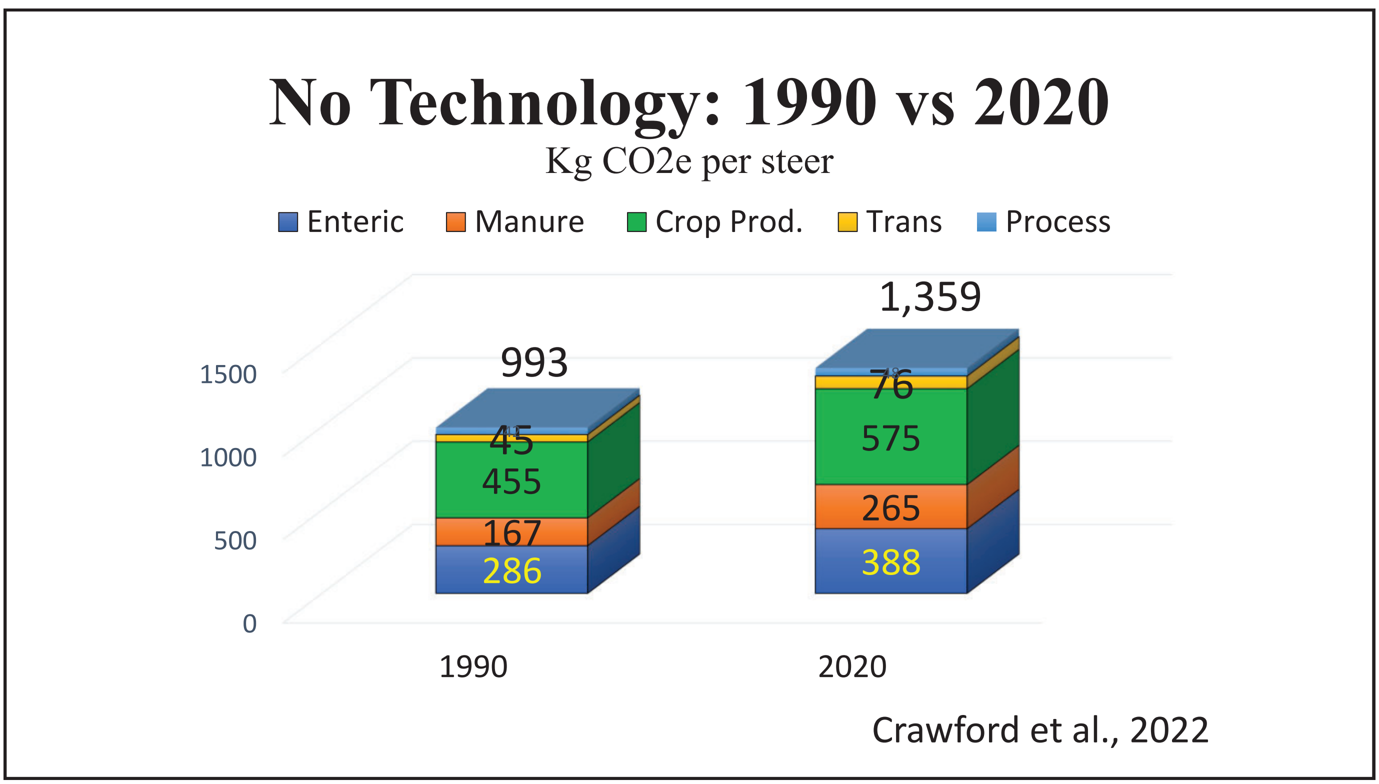
Technology and C-Footprint:2020

Kg CO2e per steer

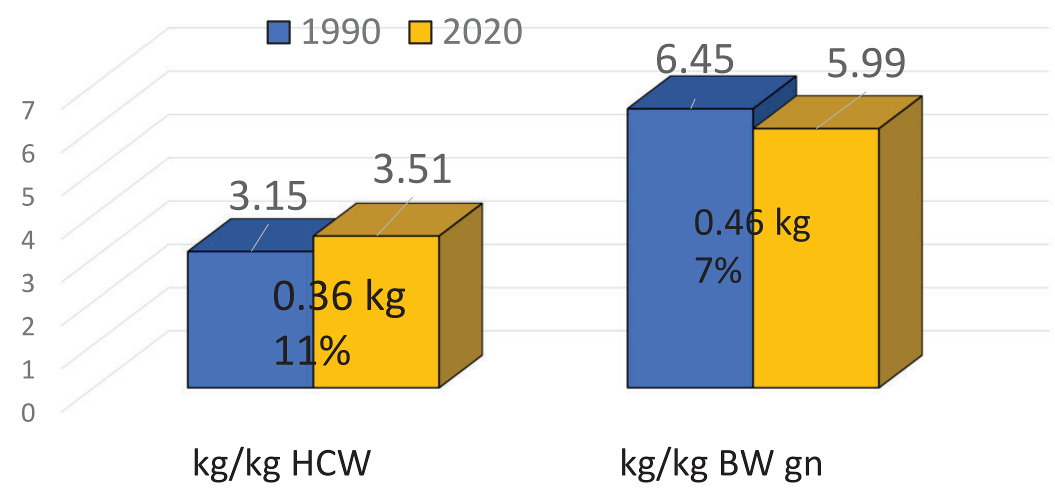


Crawford et al., 2022


Technology and C-Footprint:1990
Kg CO2e per steer
Enteric
Manure
Crop Prod.
Trans
Process
1200
1000
800
600
400
200
0
963
1,020
893
955
45
48
42
45
450
485
425
460
168
170
157
168
286
309
260
281
0
0
None
Implant
Monensin
I+M
RH
I+M+RH
Crawford et al., 2022

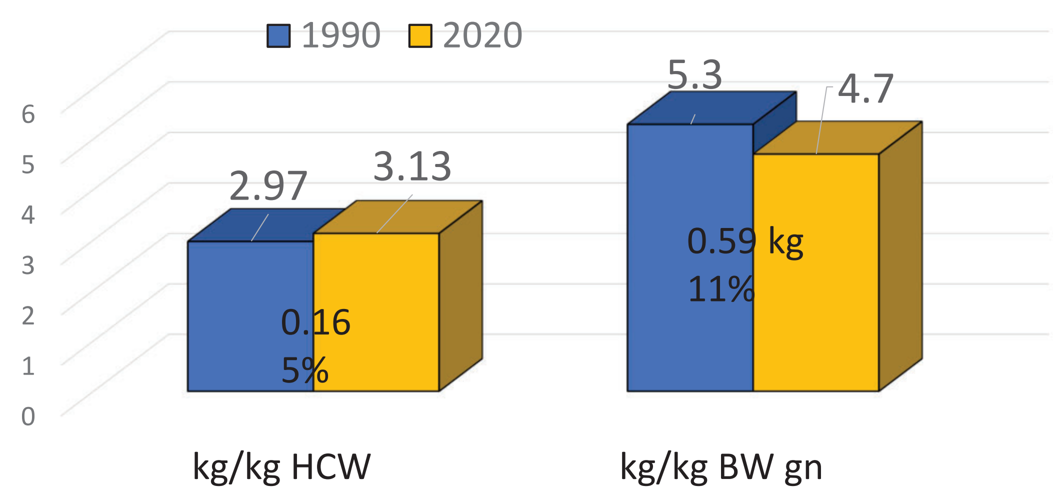

No Technology: 1990 vs 2020
Kg CO2e per steer
Enteric
Manure
Crop Prod.
Trans
Process
1500
1000
500
0
993
1,359
45
76
455
575
167
265
286
388
1990
2020
Crawford et al., 2022

CO_{2e} - 1990 vs 2020: No Technology



Crawford et al., 2022

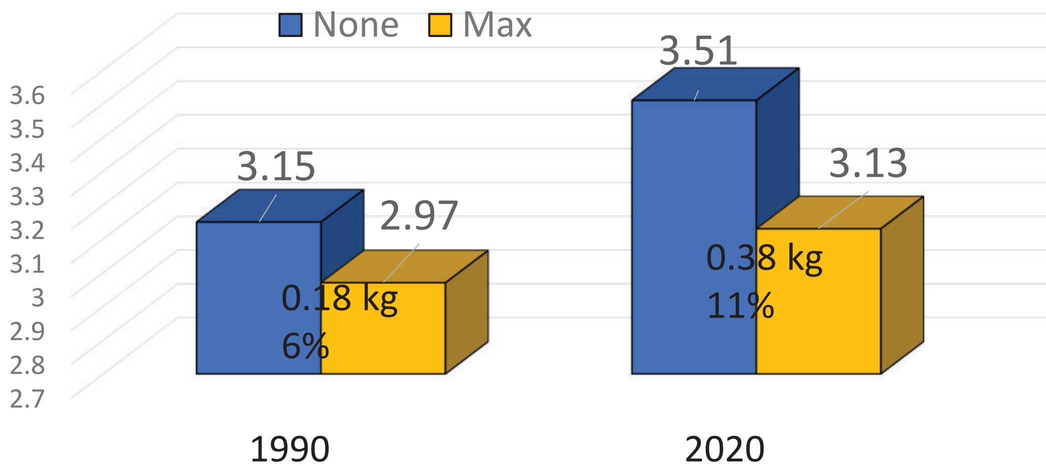
CO_{2e} - 1990 vs 2020: Max Technology



Crawford et al., 2022

1990 vs 2020: No vs Max Technology

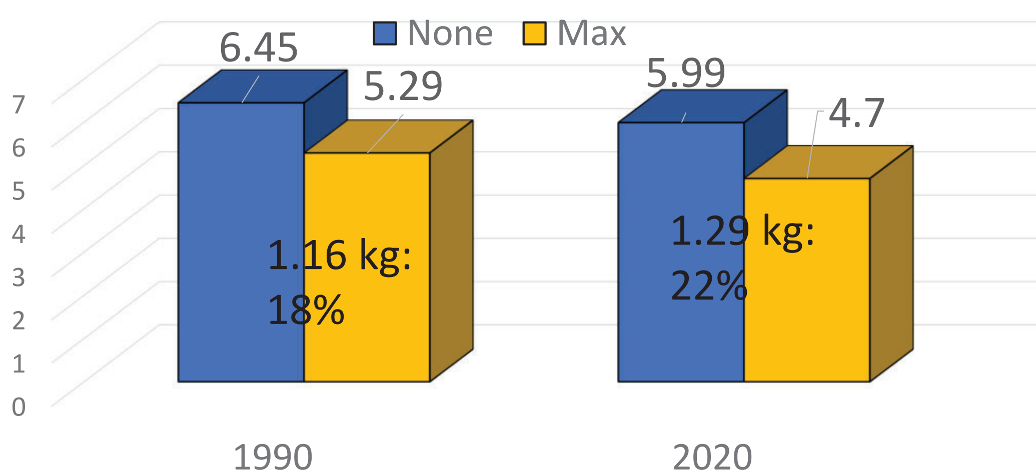
kg CO2e/ kg HCW



Crawford et al., 2022

1990 vs 2020: No vs Max Technology

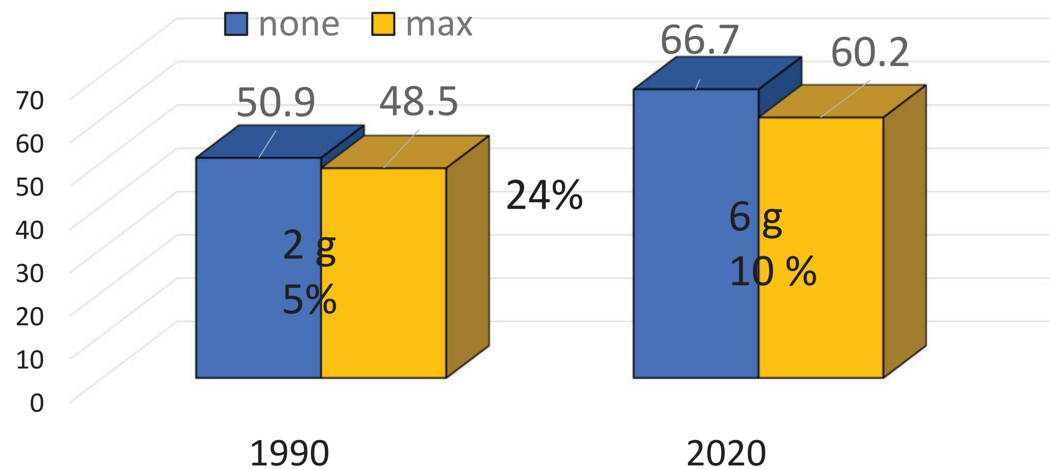
kg CO2e/ kg BW Gain



Crawford et al., 2022

rN - 1990 & 2020: No vs Max

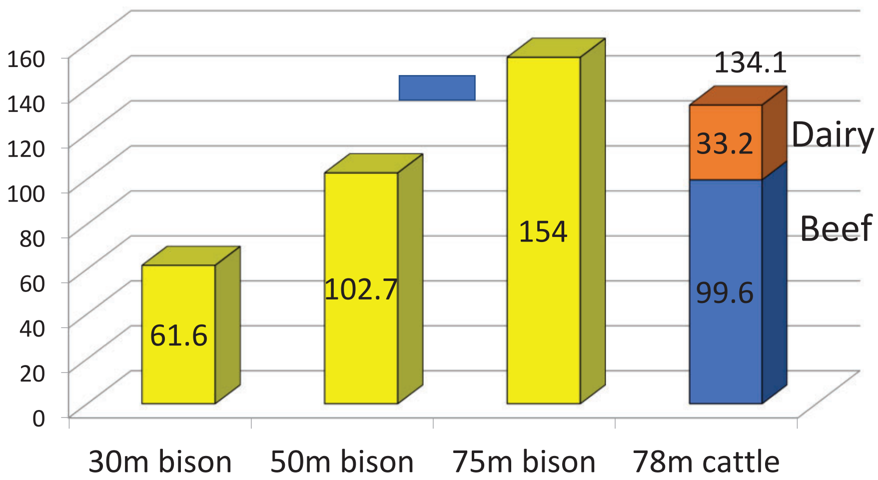
g/kg HCW



Crawford et al., 2022

Some Miscellaneous "Stuff"

N.A. Enteric CH_4: 1860 vs. 2013



Hristov et al, 2010

C-Footprint of Beef Cattle Industry

Some "Typical" Results

Grass - Fed

- ADG = 1.0 – 2.0 lb
- Age at slaughter = 450
- CO_{2e}/ lb BW = 19.2
- CO_{2e}/ lb HCW = 32.5
- lb CO_{2e} = 9500 lb/hd

Grain - Fed

- ADG = 3.2 lb
- Age at slaughter = 303
- CO_{2e}/ lb BW = 14.8
- CO_{2e}/ lb HCW = 23.9
- lb CO_{2e} = 9970 (yearling-fed)
- lb CO_{2e} = 7685 (calf-fed)

C-Footprint of Beef Cattle Industry

- Stackhouse et al 2012
  - Calf-fed = 21.1 kg CO2e/ kg HCW
  - Stocker/Yearling fed – 22.6 kg CO2e/ kg HCW
    - ***7% less***
- Pelletier et al., 2010
  - Calf-fed = 23.0 kg CO2e/kg HCW
  - Yearling fed = 26.1 kg CO2e/ kg HCW
    - ***13% less***

Challenges with C-Footprints

- C-footprint of manure: C-credit for fertilizer replaced?
- Feeding of by-products:
  - % to product / coproduct?
  - Should there be a C-credit?
- Land use change?
  - Assume forest is converted to farmland – often not true.
  - Many overestimate C-sequestration by grasslands, etc.
- Units – HCW? BW Gain? Protein? Human Edible? Lysine?

Conclusions - When it comes to GHG

- The cow-calf herd is the 800 lb. gorilla
  - 60 to 80% of C-footprint of N.A. beef cattle.
- The C-footprint per unit of production is lower for grain-fed cattle than for pasture-finished cattle.
- U.S. beef cattle CH4 emissions are about the same as the 1860 bison herd

Conclusions- When it Comes to GHG

- Steam flaking corn may lower the C-footprint because of its effects on enteric CH4 production and feed efficiency (i.e. less corn required).
- Effects of WDGS - - depends on the control diet & assumptions made.
- We have made progress in lowering the C-footprint of cattle feeding.

To Minimize the C-Footprint

- Start um early – Calf-fed < Yearling-fed
  - But Water-footprint will be increased
- Optimize starch availability (SF or HM grain)
- Minimize roughage fed
- Maximize fat fed (within tolerance)
- Limit WDGS to < 20% of diet
- Optimize/maximize use of available technologies
- Watch for new technologies / Carbon markets

For Additional Details/Information

- Adom et al., 2012. Int J. Life Cycle Assess. 17:52—534
- Cole et al., 2020. Trans. Anim. Sci. 4:S84-S89
- Crawford et al., 2022. Appl. Anim. Sci. 38: 47-61
- Hales et al., 2014. JAS 92:264-271
- IPCC. 2019. www.ipcc.ch/report/2019-refinement-to-the-...
- Stackhouse et al., 2012. JAS 90:4656-4665.
- Stackhouse-Lawson et al., 2013. JAS 91:5438-5447
- Rotz et al., 2013. JAS 91:5427-5437

2022 Legend of Feedlot Nutrition

Robert C. (Bob) Albin

Growing up on a family livestock operation near Follett, TX, Bob Albin developed an early love for animal production. He enrolled at Texas Technological College in the fall of 1957, earning a BS in Agricultural Sciences (1961). He remained in Lubbock, completing his MS in Animal Science (1962). He entered the doctoral program at the University of Nebraska, receiving his PhD in Nutrition (1965).

Dr. Albin returned to the Animal Science Department in Lubbock, leading to a distinguished 42-year career at Texas Tech University as teacher, researcher, administrator and internationally recognized feedlot management specialist. He was named Outstanding Teacher in the Davis College of Agricultural Sciences & Natural Resources in 1973 and fall semester 1974 and received several Teacher of the Month Awards. He was named Outstanding Educator in America in 1972 and received an Outstanding Young Men of America Awards in 1973. He was the recipient of an AMOCO Distinguished Teaching Award in 1974.

Dr. Albin's illustrious administrative career included serving as Department Chair (1977-1979) and culminated as Associate Dean and Director, College of Agricultural Sciences and Natural Resources (1997-2002). For his contributions, he was honored as Fellow (Administrative Category) in 2012 by the American Society of Animal Science. Retiring from the Dean's office in 2002, he returned to the Department of Animal and Food Sciences to teach and assist farm operations.

He co-authored the book published in 1990, "Cattle Feeding: A Guide to Management", a key cross-reference used worldwide. Dr. Albin travelled the globe providing expertise in a variety of programs, including evaluating the U.S. Peace Corps' beef cattle program in Peru; serving as a feedlot management consultant to private industry in Monterrey, Mexico; conducting a feasibility study on ranching/mixed agriculture programs in Niger, Africa; and evaluating small-ruminant collaborative research support programs in Peru and Kenya.

Even though he spent the majority of his career as an administrator, Dr. Albin had a passion for teaching. His legacy is reflected in the Bob Albin Graduate Student

Research Award, bestowed annually in his honor for exemplary research presentation. Further, he and wife Donna established the Robert C. and Donna J. Albin Scholarship Endowment to provide scholarships for majors in the Department. His relationship with former students continues to this day.

Dr. Albin played a pivotal role in the formation and early leadership of the Plains Nutrition Council. He is a Certified Animal Scientist in the American Registry of Professional Animal Scientists, and a Charter Diplomat with the American College of Animal Nutrition.

Dr. Albin retired from the Department in 2008. Reflecting on 40+ years of experience, his advice for a solid career is to work hard, tell the truth, and stand by your word. In 2009 he was honored by CASNR with the Distinguished Alumni Award.
Bob and Donna, his wife of 61 years, reside in Lubbock, enjoying retirement at Raider Ranch and spending time with their children, Sydney Dean and husband Sonny of Crawford, TX, Craig Albin and wife Jeannette of Clovis, NM. They treasure special times with their grandchildren.

2022 Legend of Feedlot Nutrition

Dr. Michael Hubbert

Dr. Michael (Mike) Hubbert has been involved in ruminant nutrition his entire life having been born on the Squaw Butte Experiment Station in Eastern Oregon where his father, Farris Hubbert, Jr., was for many years a Livestock Research Scientist. Farris Hubbert later served on the Animal Sciences faculty at the University of Arizona. Mike followed in his father's footsteps and during his 35-year (and counting) career has made numerous innovative contributions, which have found application in the commercial cattle feeding industry.

Mike earned his BS in Agriculture from the University of Arizona, then spent time on the professional rodeo circuit before starting graduate school at New Mexico State University, where he was Dr. Michael Galyean's first graduate student. Upon completion of his master's degree Mike went to the University of Wyoming to manage a federally funded project evaluating grazing interactions between cattle and feral horses. He then continued his graduate studies at the University of Alaska where he earned his PhD in ruminant biology studying energetics and nutritional physiology of moose and other wild ungulates. Dr. Hubbert returned to New Mexico State for a post-doctorate with Dr. Glen Lofgreen, where he was instrumental in the conceptual development and initial conduct of research to evaluate the efficacy and implementation of ionophore rotation programs.

Throughout his career as a feedlot consultant and technical services nutritionist, Dr. Hubbert has touched nearly every facet of the cattle feeding industry. As founder of Hubbert Biological Systems Mike consulted for a diverse cliental ranging both in feedlot size and geographic location. He used his observations and knowledge of feeding behavior in wild ruminants in refining innovations in feeding management of cattle, helping to facilitate development of "clean bunk" and "two-ration" systems for feeding cattle.

Later in his career Dr. Hubbert was Professor, and Superintendent of the New Mexico State University Clayton Livestock Research Center, where he brought his extensive knowledge and experience of cattle nutrition, feedlot management and operations to provide a unique educational and training experience to many graduate students.

Reflecting his commitment to both students and the industry, Dr. Hubbert was a driver in establishing the Feedlot Nutritionist Boot Camp, an event for select graduate students, that has been held every other year since 2012. Dr. Hubbert has over 60 published professional papers, abstracts, and conference proceedings, has co-written several invited papers, been an invited speaker at national and international conferences, and is the co-inventor and holder of 12 US Patents related to cattle feeding. He is Board Certified in Animal Nutrition (ACAS/ARPAS) and received the WSASAS Distinguished Service Award in 2015. Dr. Hubbert's accomplishments throughout his career reflect his commitment to advancing knowledge through sound research and applying that knowledge for the benefit of cattle and the people who care for them.

Dr. Hubbert currently resides in Ft, Collins, CO with his wife, Zeno, and their daughter, HannahRose and is a nutritionist with Cargill Animal Nutrition. A person of many outside interests and talents, Mike has at various times become interested in and become proficient at golf, fly fishing, 3-gun competition and cycling.

2022 Legend of Feedlot Nutrition

David Hutcheson

Dr. David Paul Hutcheson grew up on a dairy farm in Hill County TX. He received a B.S. degree in Animal Science from Texas A&M University in 1963 and his MS in Animal Husbandry (1967) and PhD in Nutrition (1970) from the University of Missouri under the leadership of Dr. Rodney Preston. His graduate research included early studies with growth promoting implants (diethylstilbesterol) and body composition of beef cattle.

Hutch began his career as an Assistant/Associate Professor of Biostatistics and Nutrition at the Sinclair Comparative Medicine Research Farm at the Univ. of Mo. from 1969 to 1977 where he worked with a variety of mammalian species and even collaborated on studies of the nutrient requirements of astronauts with NASA. Much of his work at Sinclair revolved around developing animal models for human disease. He helped develop an alcoholism model to better study rehab of alcohol withdrawal during delirium tremors (DT) and helped develop a model using heavy metal markers to determine the digestibility of nutrients by astronauts during the Apollo Space Program.

In 1977, Hutch moved to Amarillo, TX to take an appointment as an Associate Professor for the Texas A&M Agricultural Experiment Station as a Research Beef Cattle Nutritionist. In 1980 he was promoted to Full Professor. At Amarillo, Hutch's team research focused on the nutrient requirements of beef calves stressed through the marketing system and on strategies to decrease the incidence and severity of bovine respiratory disease. This research played a major role in establishing the effects of stress on nutrient requirements and the adding of a new chapter (which Hutch wrote as a member of the committee) on stress in the 1996 NRC Nutrient Requirements of Beef Cattle. The research was recognized as one of the top-10 contributions to beef cattle production in the 1980's by Feedstuffs Magazine. Today much of the cattle feeding industry relies on the research results produced by that team.

While at Univ. of Missouri and Texas A&M AgriLife, Hutch was instrumental in the training of numerous graduate students that themselves have become leaders in the industry.

In 1992, Dr. Hutcheson founded Animal-Agricultural Consulting International He has consulted on ruminant nutritional management of beef and dairy cattle, sheep, and goats in the US and 17 foreign countries. His specialty has been developing sustainable and competitive integrated production systems for dairy-beef value chains. Hutch has shared his expertise in both academia and as a nutritional consultant for over 50 years (although he still claims he is only 39 years old). Hutch currently serves on the Research Committees of both the Texas Cattle Feeders Association and National Cattlemen's Beef Association. In honor of his contributions, many of Hutch's friends and colleagues established the Hutcheson Endowed Scholarship in the Dept of Animal Science at Texas A&M University, providing scholarships to deserving students.

Hutch currently lives in Van, Texas where he enjoys fishing and continues consulting in the USA with limited international projects. He is the proud father of two grown children, John and Sherry, and 3 grandchildren.

2022 Legend of Feedlot Nutrition

Lowell M. Schake

Lowell Schake was born on his family farm near Marthasville, MO, attended one-room Cedar Grove School (he and one other in the first two grades) followed by Marthasville Grade School. After graduating from nearby Washington High School, he enrolled at the University of Missouri-Columbia, where he earned a BS Degree in Agriculture (1960) and an MS Degree in Animal Husbandry (1962). He then attended Texas A&M University-College Station, earning a PhD in Animal Nutrition (1967). In 1959 Lowell married Wendy Walkinshaw, a Michigan native and member of TAMU's first class of women.

Dr. Schake had a long and prolific career in extension, research, teaching and administration. While serving the cattle feeding industry as TAMU Area Livestock Specialist in Lubbock (1967-69), he also held Graduate Faculty and Experiment Station Research appointments, the first position of its kind in the U.S. In this role he taught graduate Beef Cattle Production courses and published research conducted at two commercial feedlots to evaluate grain-sorghum processing methods.

After returning to TAMU campus in College Station, Dr. Schake advanced from Assistant to Full Professor in Animal Science (1969-84). He established the Master of Agriculture Degree program (professional MBA concept) emphasizing internships in feedlots, on ranches or other allied industries. Instead of a thesis, Degree candidates were required to author problem-solving professional papers addressing current industry issues. The MAg degree soon became a model for similar endeavors at other universities. Dr. Schake chaired over 80 MAg, MS and PhD students from across the U.S. and abroad.

He also developed today's Domestic Animal Behavior curriculum for undergraduate and graduate students while continuing his primary research focus on feed-energy utilization as affected by harvesting, processing and storage techniques.

Later, while Chair of the Animal Science Department at the University of Connecticut (1984-1992), Dr. Schake established the New England Biotechnology Conference with allied industry co-sponsors and served as President of the NE Section of ASAS Department Heads and Chairs. He concluded his administrative leadership serving as

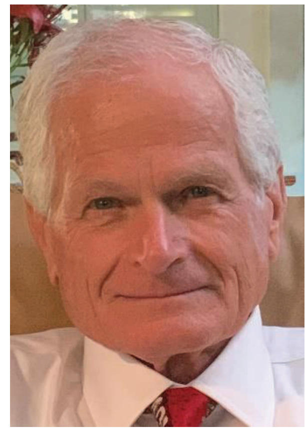
Chairman of the Animal Science Department at Texas Tech University (1992-1995). In addition to his exemplary career in roles at several universities, Dr. Schake consulted with the U.S. government and with commercial entities in the U.S. and internationally.

Schake is among those credited as instrumental in the formation and early growth of the Plains Nutrition Council, acknowledged as a leader of the endeavor. He documented that evolution in the proceedings of the 2004 PNC Spring Conference. He authored or co-authored more than 350 publications in an academic career spanning 30+ years. His innovative leadership contributions were further recognized as the recipient of the Texas A&M Innovative Teaching Award (1978),

In 1995 Lowell and Wendy retired to the Texas coast, residing first on North Padre, now at Port Aransas on Mustang Island. There they enjoy the amenities of beach living, chronicling the history of their Schake and Walkinshaw ancestors, and most importantly being with the families of daughter Dr. Sheryl Schake-Meskin and son Dr. Scott Schake, a Plains Nutrition Council member.

2022 Legend of Feedlot Nutrition

Richard Avery Zinn



Dr. Zinn a native of El Centro, California, received his B.S. (1974) and M.S. (1975) degrees in Animal Science from Brigham Young University. His Ph.D. in Nutrition from University of Kentucky (1978) with postdoctoral studies at Oklahoma State University. In 1981, Dr. Zinn joined the Animal Science Department U.C. Davis. Dr. Zinn is stationed at the university's Desert Research and Extension Center, in the Imperial Valley of California.

Dr. Zinn's research in beef cattle energetics yielded more accurate equations predicting mature weight and growth performance of feedlot cattle. His widely cited approach for determining the net energy value of feeds based on growth performance has yielded valuable, practical information on a wide variety of feedstuffs.

His research has established metabolizable amino acid requirements during the early growing phase (first 56 to 112 d on feed) of feedlot cattle. This work resulted in a stand-alone empirical assessment of requirements.

His work with grain processing and starch utilization is recognized world-wide, leading to important changes in feeding standards. His research has led to a greater understanding of feeding value of dietary fat. The greater fat NE values have also resulted in the establishment of constraints on the upper levels of supplementation. Dr Zinn's research also focuses on optimizing growth performance of calf-fed Holsteins. In addition to requirements for macro minerals, his studies characterize the growth curve, energetics, and carcass characteristics as affected by growth implants, forage NDF, and environmental stressors during periods of high ambient temperatures.

World-wide, Dr Zinn has compiled and analyzed large datasets at the commercial feedlot level to help optimize growth performance, health and profitability, to better understand the intricacies of how certain technologies may respond in various feedlot nutritional programs and to access research outcomes.

Dr. Zinn recognized early in his career, diverse demographic of feedlot personnel. To maximize his ability to effectively communicate with all, Dr. Zinn became proficient in the Spanish language. He is a visiting professor in Mexico and his class presentations are presented in Spanish.

Dr Zinn has been active throughout his career in PNC. He or his graduate student(s) have presented research findings and given University Updates at our meetings. A few of his honors and awards include;

- Merito Academico 1996, Research. Given by Universidad Autonoma de Baja California
- Catedratico Patrimonial. 1999 (National Endowment Scholar. Given by CONACYT, Mexico City, Mexico
- AFIA Ruminant Nutrition Research Award. 2000. Given by ASAS, July, 2000. Baltimore, MD

He has been a reviewer, and editor in chief of science-based journals. He has been on the committees of 30 plus graduate students to date. Dr. Zinn is respected as a friend and mentor to many consulting Nutritionists.

Dr. Zinn is devoted to his faith and serves his church and its mission with the same drive, integrity and service that have helped his great success in agriculture.

Guiding philosophy: When we think we know, learning stops dead in its tracks.

Effects of supplementing extruded dried distillers' grains cubes to stocker cattle grazing introduced pastures on subsequent feedlot performance and carcass characteristics. J. M. Adams[1,2], L. O. Tedeschi[1], and P. A. Beck[2]. [1]*Texas A&M University, College Station, TX;* [2]*Oklahoma State University, Stillwater, OK*

Our objective was to evaluate the effects of supplementing extruded dried distillers' grains (DDG) cubes to stocker steers on subsequent feedlot performance and carcass characteristics. Steers (n = 140) grazed tall fescue (*Festuca arundinacea*)/ bermudagrass (*Cynodon dactylon*) pastures from 14 April to 17 September 2020 to investigate the effects of supplementation rate of DDG cubes on animal performance. Supplemental treatments (n = 3 pastures/treatment) included: 1) Fertilized Control (FC), no supplementation on N fertilized pastures (112 kg N/ha); 2) Fertilized Supplement (FS), supplemented DDG cubes at 2.9 kg/d prorated for 3-d/wk feeding on N fertilized pastures; and 3) Supplement (S), supplemented DDG cubes at 0.75% of BW/d prorated for 5-d/wk feeding on unfertilized pastures. Following grazing, animals were followed through the finishing phase in a commercial feedyard to investigate carryover effects on feedlot performance in 2 pens comingled across supplement treatment. Carcass characteristics were evaluated via ultrasound on d0 and d84 of finishing, and measurements obtained at harvest. Feed DMI were segregated to individual animals by equations according to Guiroy et al. (2001) and Tedeschi and Fox (2020b). Supplemented animals were heavier ($P < 0.01$) at feedlot entry than FC, but harvest BW did not differ ($P = 0.23$). However, S and FS required 37 fewer days on feed ($P = 0.01$) than FC. Supplementation on pasture reduced total feed required ($P = 0.02$) and feed costs ($P = 0.01$) relative to FC. Gains were greater ($P = 0.02$) for FC and FS than S from d0 to d84, but did not differ thereafter ($P \geq 0.15$). At harvest, FC had lower yielding carcasses than FS ($P = 0.01$), but did not differ ($P = 0.11$) from S. Dressing percent was greatest ($P < 0.01$) for FC, but there were no differences in any other carcass characteristics ($P \geq 0.15$). Overall, extruded DDG cube supplementation during grazing did not negatively affect subsequent feedlot performance or carcass characteristics.

Effects of parenteral or intranasal respiratory vaccination and revaccination in auction-derived feedlot heifers. E. D. Auchard[1], D. V. Hardee[2], W. C. Koers[3], M. S. Davis[3], T. R. Parks[2], and J. T. Richeson[1]. [1]*West Texas A&M University, Canyon, TX;* [2]*Merck Animal Health, Madison, NJ;* [3]*Bos Technica Research Services, Inc., Salina, KS*

The effects of modified-live virus (MLV) vaccination may be influenced by the route of administration and the impact of revaccination is unclear. Intranasal MLV vaccination may influence the nasal carriage of *Histophilus somni* due to the immunomodulatory effects of bovine respiratory syncytial virus (BRSV) replication in the upper respiratory tract. The study objectives were to determine the effects of route of modified-live virus (MLV) vaccine administration, revaccination on day 14, and BRSV and *Histophilus somni* frequency of carriage in auction-derived feedlot heifers. Twelve blocks of beef heifers (n=3,517; BW= 607 ± 2 lb) were sourced from regional auction markets and assigned randomly to treatment pens based on arrival day and purchase location. The experimental unit was pen in this randomized complete block design with a total of 48 pens (n=12/treatment). Treatments were: 1) parenteral MLV vaccination (Bovilis Vista Once SQ; Merck Animal Health, Summit, NJ) on d 0 (INJ); 2) intranasal MLV vaccination (Bovilis Nasalgen 3-PMH and Bovilis Vista BVD CFP; Merck Animal Health) on d 0 (INT); 3) parenteral MLV vaccination on d 0 and revaccinated (Bovilis Nasalgen 3; Merck Animal Health) on d 14 (INJ-R); and 4) intranasal MLV vaccination on d 0 and revaccinated (Bovilis Nasalgen 3; Merck Animal Health) on d 14 (INT-R). Deep nasal pharyngeal swabs were collected on d 0, 14, and 60 in the revaccinated treatments to determine BRSV and *Histophilus somni* frequency of carriage using rtPCR. Data were analyzed using PROC MIXED and PROC GLIMMIX in SAS. There was a difference observed for INT and INT-R to have increased F:G ($P = 0.02$), reduced HCW ($P = 0.02$), smaller REA ($P < 0.01$), and these treatments tended ($P = 0.08$) to have less final BW. A decrease in edible livers ($P < 0.01$) and an increase in severe liver abscesses ($P < 0.01$) was observed for the INT treatment. There were no treatment differences ($P \geq 0.19$) observed in ADG, DMI, BRSV or *Histophilus somni* frequency of carriage, respiratory morbidity, or overall mortality. However, there was a day effect ($P < 0.01$) for *Histophilus somni* frequency of carriage with a marked increase observed on d 60 (46.6% overall). No differences ($P > 0.05$) were observed between the revaccinated and arrival only vaccinated treatments for any of the variables measured in this study. In conclusion, the parenterally vaccinated groups had greater HCW, REA, and less liver abscesses; whereas, revaccination on d 14 did not affect health, performance or carcass traits.

Effectiveness of Virginiamycin administration on animal health and its impact on growth, developments, intake, and ruminal pH dynamics in growing and finishing calves. L. F. D. Batista, M. E. Rivera, L. O. Tedeschi. *Texas A&M University, College Station, TX*

Virginiamycin (VM) is an antibiotic that displays inhibitory effects on etiologic agents like *Fusobacterium necrophorum* and *Actinomyces pyogenes,* major liver abscess causing bacteria. In feedlot animals, dietary VM has been shown to actively reduce subacute rumen acidosis (SARA) and improve feed conversion by increasing the ruminal concentration of propionate. This study evaluated the continuous or intermittent provision of VM during the growing and finishing phases of a 150-d feeding period in 120 Angus- crossbred steers (291 ± 28 kg) housed in a Calan gate feed system with 20 pens. Steers received VM (240 mg/d) as follows: no VM (T000); VM in the last 50 d (T001); VM in the last 100 d (T011); VM in the first 50 d (T100); VM in the first 100 d (T110); and VM for 150 d (T111). Animals were fed a grower-type diet (metabolizable energy [ME]: 2.45 Mcal/kg; crude protein [CP]: 12.2 % dry matter basis [DM]) for 50 d prior to the adaptation of a finisher- type diet over a 17 d period. The transition scheme was 67% grower + 33% finisher (DM) for 7 d followed by 10 d of a mixed diet containing 67% finisher and 33% grower (DM). The finisher-type diet (ME: 2.60 Mcal/kg; CP: 10.6% DM) was fed for the remaining 84 d of the experimental period. On d -1 and d 82 each animal received an indwelling pH bolus (smaXtec) to record ruminal pH at 10-min intervals. Data were analyzed using a random coefficients model with the pen as a random effect and animals within treatment as the subject. DM intake (DMI) was less for T111 compared to T000, and greater for T011 compared to T110 ($P \leq 0.028$), which resulted in greater average daily gain (ADG) with no difference in feed efficiency ($P = 0.015$ and 0.225, respectively). The T011 tended ($0.052 \leq P \leq 0.075$) to have a greater carcass, final shrunk body weight compared to T110. Empty body fat (EBF; %) tended ($0.050 \leq P \leq 0.080$) to be lower for animals that consumed VM regardless of the period or length of feeding. ADG-adjusted metabolizable energy (paME) content increased by 3.08% for T111 compared to T000. Ruminal pH decreased as DMI increased for all treatments ($P < 0.001$). However, T000 declined 0.0453 pH units per kg of DMI, whereas T111 only declined 0.0163 pH units per kg of DMI, which indicates a 36% reduction in ruminal pH per kg of DMI when VM was provided during the entire 150 d feeding period. The T111 treatment tended to have less time under pH 5.8 (2.50 h/d) when compared to T001, T100, and T000 (5.27; 4.94; and 4.23 h/d, respectively; P = 0.107). Overall, this study indicates that VM fed during the transition period had the most impact on regulating the risk of ruminal sub-acute acidosis. The 50 d on feed pre-harvest, directly carries the effects of diet management, where the addition or removal of VM during this period may or may not stifle rumen acidosis management and finishing performance. Only animals that received VM for at least 2/3 of the feeding period had ruminal pH below 5.8 for less than 4 h/d. Daily supplementation of 240 mg VM during the entire feeding period reduces the incidence of SARA with positive results in animal growth and development.

Pre-transit feeding management and road transportation effects on plasma and salivary cortisol, inflammatory markers, and the rumen environment. B. Birkenstock[1], J. J. Figueroa-Zamudio[1], S. A. Soto-Navarro[1], G. C. Duff[2], V. N. Gouvêa[3], A. Akter[1], D. T. Yates[4], E. Marks-Nelson[4], K. E. Smith[1], B. G. Smythe[1], and C. A. Löest[1]. *[1]New Mexico State University, Las Cruces, NM; [2]Clayton Livestock Research Center, New Mexico State University, Clayton, NM; [3]Texas A&M AgriLife Research and Extension Center, Amarillo, TX; [4]University of Nebraska-Lincoln, Lincoln, NE*

Transit stress in cattle elevates circulating cortisol, which can enter the rumen via saliva. Literature shows that stress hormones suppress the immune system and directly influence bacterial proliferation, altering rumen microbial fermentation. This study evaluated effects of pre-transit feeding management and road transportation on plasma and salivary cortisol, immune parameters, rumen fermentation, and rumen bacteria utilizing 20 ruminal-cannulated heifers (764 ± 35 lb BW). Heifers were fed (ad libitum) a diet (64% TDN, 12.4% CP, DM basis) consisting of 40% sorghum Sudan grass hay and 60% commercial pellet (DM-basis) for 13 days before initiation of study. Experimental groups were arranged in a 2 × 2 factorial with 2 dietary treatments fed (ad libitum) for 3 days before cattle were exposed to 2 transportation treatments for 8 hours. Dietary treatments were 100% sorghum Sudan grass hay (HAY) vs. 30% hay and 70% pellets (H+P), and transportation groups were no transportation (NT) vs. road transportation (TR). During the 8-hour transportation period, all cattle (including NT group) received no feed or water. Upon feedlot arrival at hour 8, all cattle were sampled, placed in a communal pen, and held off feed and water for 4 hours. At hour 12, all cattle were fed a diet (69% TDN, 16.6% CP, DM basis) of 30% wheat hay and 70% commercial feed. Samples were collected at hours 0, 8, 12, 24, 72, and 168. Interactions between diet and transport were not observed. Blood neutrophil concentrations were less ($P < 0.05$) at hour 72 in cattle fed HAY compared to H+P, and neutrophil-to-lymphocyte ratios were less ($P < 0.05$) at hours 12 and 72 in cattle receiving HAY compared to H+P. Salivary cortisol was not different among dietary or transport treatments. Cattle consuming HAY had less ($P < 0.05$) plasma cortisol concentrations at hour 72 compared to cattle receiving H+P. The TR cattle had decreased ($P < 0.05$) plasma TNF-α concentrations compared with NT cattle. Rectal temperature, rumen pH, and total volatile fatty acid concentrations were not different among dietary or transport treatments. Cattle consuming HAY had increased ($P < 0.05$) molar percentages of acetate and decreased ($P < 0.05$) molar percentages of propionate, resulting in decreased ($P < 0.05$) acetate to propionate ratios at hours 0 and 12 compared to cattle receiving H+P. Molar percentages of butyrate were less at hour 0 for cattle consuming HAY compared to H+P ($P < 0.05$). Bacterial phyla richness tended to be less in NT cattle receiving HAY compared to NT cattle receiving H+P and greater in TR cattle receiving HAY compared to TR cattle receiving H+P ($P = 0.08$). *Proteobacteria* relative abundances were less ($P < 0.05$) at hour 0 in cattle receiving HAY compared to those receiving H+P. Effects of salivary cortisol on bacterial populations were presumably minimal due to the negligible cortisol responses to transportation. This study implies that pre-transit feeding management had minimal impact on rumen bacterial populations of cattle after being transported for 8 hours.

Timing of implants use in the backgrounding system. K. M. Butterfield, K. C. Adair, Z. C. Carlson, B. C. Troyer, J. Xiong, M. M. Norman, B. L. Nuttelman, G. E. Erickson, M. E. Drewnoski, and J. C. MacDonald. *University of Nebraska – Lincoln, Lincoln, NE*

A 2-year study was conducted at the Eastern Nebraska Research and Extension Center near Mead, Nebraska utilizing 240 (initial BW= 544 lb, SD= 13 lb YR 1; BW= 562 lb, SD= 24 lb YR 2) weaned steers each year. Cattle were placed in feedlot pens upon arrival (winter phase) and fed one of two backgrounding diets consisting of bromegrass hay and 10% MDGS (low gain supplementation; LG) or 30% MDGS (high gain supplementation; HG). This study was designed as 2 x 3 factorial with the first factor as supplementation targeting 1lb average daily gain (ADG) or 2 lb ADG (HG) and the second factor as implant strategy. The three implant strategies included a Ralgro (36 mg zeranol; Merck Animal Health, De Soto, KS) implant during the winter phase and a Revalor-G (40 mg trenbolone acetate and 8mg estradiol; Merck Animal Health, De Soto, KS) implant during the summer phase (STRNG), no implant during the winter phase and a Rev-G during the summer phase (MED), and no implant during the winter and summer phases (NONE). Steers were backgrounded in the feedlot for a 148-day winter phase followed by a 56-day summer phase where they grazed smooth bromegrass paddocks. Upon arrival in the feedlot for the finishing phase, steers received a Revalor-XS (200mg TBA and 40 mg estradiol; Merck Animal Health, De Soto, KS) and fed a common diet for the entire finishing phase. The finishing phase varied in length from 119 to 129 days depending on the estimated back fat of each treatment group. In the winter phase, steers fed the HG diet had a greater ADG, ending body weight (EBW), dry matter intake (DMI), and improved gain:feed (G:F) over steers fed LG (P<0.01). Steers that received a Ralgro implant during the winter phase (STRNG) were observed to have an 11% improved ADG (P <0.01), a 7% increase in G:F (P < 0.01), and an additional 26 lb of EBW for the winter backgrounding phase. There were no interactions between the rate of gain and implant strategy ($P \geq 0.15$) during the winter period. In the summer, HG steers had greater initial body weight (IBW) and maintained heavier EBW than LG. Steers winter backgrounded at LG had a greater ADG than HG (1.54 and 1.17 lb, respectively; P < 0.01) while grazing pasture due to compensatory gain. Compensatory gain was greatest for LG steers assigned MED implant strategy. Steers assigned to the MED and STRNG implant strategies gained more than NONE (1.20, 1.43, and 1.42 lb/d for NONE, MED, and STRNG respectively; P = 0.02) suggesting the REV-G improved gain by 17% during the grazing period. Differences in initial BW and ADG during the summer period resulted in a tendency for an interaction between supplement and implant in EBW (P = 0.10). Steers assigned to HG during the winter phase had a greater IBW for the finishing phase. Steers fed HG during the winter and administered an implant at both backgrounding phases (STRNG) had the greatest HCW with no differences in ADG or G:F during the finishing phase. There was an interaction between winter rate of gain and implant strategy for IBW and HCW. Implant strategy and rate of gain during the winter growing period had additive effects to increase animal performance through all phases. When cattle were winter backgrounded at a low rate of gain, the additional 32 lb of HCW from the implant was attributed to REV-G. When cattle were winter backgrounded at a high rate of gain, the additional 28 lb of HCW from the implant was attributed to Ralgro. Combining a strong implant program and high rate of gain during winter backgrounding resulted in 75 lb of additional HCW at marketing.

Replacement of barley-based diet components with high-moisture corn products in western Canadian beef finishing diets: effects on ruminal fermentation and diet digestibility. R. E. Carey[1], M. G. Evans[1], G. O. Ribeiro[1], D. Moya[1], H. A. Lardner[1], Z. D. Paddock[2], T. A. McAllister[3], and G. B. Penner[1]. *[1]University of Saskatchewan, Saskatoon, SK; [2]Feedlot Health Management Services, Okotoks, AB; [3]AAFC, Lethbridge Research and Development Centre, Lethbridge, AB.*

Short-season corn production for silage and grazing has increased in the past 10 years in western Canada, but early harvest due to frost is a concern. Although short-season corn could be harvested for high-moisture shelled corn or snaplage, there are no studies available. This study investigated the impact of partially replacing barley grain and silage with high-moisture corn grain or snaplage on ruminal fermentation and the site and extent of nutrient digestion. Six ruminally and duodenally cannulated heifers (420 ± 21 kg BW) were used in a replicated 3 × 3 Latin square with 25-d periods. Treatments included a finishing diet containing 9.7% barley silage and 85.7% barley grain with mineral, vitamin and urea at 4.6% (DM basis; BG), a diet where the silage and 10.5% of the barley grain were replaced with snaplage (SN), or where 50% of the barley grain was replaced with high-moisture corn (HC). Ruminal and total tract digestibility were determined (d 21 to 25) using acid detergent lignin as an internal marker. Ruminal pH was measured every 5 minutes from d 21 to 25 using an indwelling pH meter, and ruminal digesta was sampled 0, 2, 4, 8, 12, and 24 h after feeding on d 21 for VFA and ammonia concentrations. Dry matter (6.9 ± 0.4 kg) and starch (3.9 ± 0.2 kg) intake did not differ among treatments, but NDF intake was 0.3 ± 0.1 kg greater for SN than HC ($P = 0.02$). Ruminal starch degradation was greater for SN than BG (87.17% vs. 81.95%; $P = 0.05$) but did not differ from HC. Intestinal and total tract starch digestibility were not affected. Ruminal pH and VFA concentrations did not differ among treatments, but ammonia concentration was greater for BG and SN than HC ($P = 0.01$). High-moisture corn can partially replace barley grain in a finishing diet. Snaplage can also partially replace barley grain and silage in finishing cattle diets, while increasing ruminal starch digestion without impacting total tract starch digestibility.

Effects of limit-feeding high-energy diets in conjunction with shade may improve stocker calf performance: year 1 of 2. Z. L. DeBord, Z. M. Duncan, M. G. Pflughoeft, K. J. Suhr, W. R. Hollenbeck, T. J. Spore, D. A. Blasi, and A. J. Tarpoff. *Kansas State University, Manhattan, KS*

Limit-fed high-energy diets have improved feed efficiency in growing cattle. Access to shade has improved animal comfort, increased feed efficiency and reduced water usage in feedlot cattle. Our objective of this study was to compare growth performance, animal comfort, and water usage of growing calves limit-fed a high-energy diet with or without access to shade. A group of 413 black-hided heifers (563 ± 59 lb initial BW) were purchased from Missouri and Kansas then transported to Kansas State University Beef Stocker Unit in May and June 2021. Pens were assigned to 1 of 4 factorial treatments consisting of traditional high roughage based diet fed *ad libitum* or high-energy diet limit-fed 2.2% body weight (DM basis) in shaded or non-shaded pens; within block (n=5) calves were stratified by arrival body weight and assigned to 1 of 8 pens. Panting scores were collected at 0930, 1330, and 1730 during periods of heat stress to evaluate animal comfort. Water usage was recorded using iPERL systems (SENSUS, Morrisville, NC). All data were analyzed as a randomized complete block design using the MIXED procedure in SAS (SAS Institute Inc. Cary, NC). Final body weights were greater (P<0.01) for limit-fed calves compared with *ad libitum* fed calves. Average daily gains were greater (P<0.01) for calves with access to shade compared with calves without access to shade. In addition, average daily gains tended (P=0.10) to be greater for calves fed *ad libitum* compared with limit-fed calves. Feed-to-gain ratio was lesser (P<0.01) for limit-fed calves and calves provided shade compared with calves fed *ad libitum* or calves without access to shade. Water usage decreased (P <0.01) for limit-fed calves and calves provided shade when compared with calves fed *ad libitum* or calves without access to shade, respectively. Panting score was lower (P<0.01) for shaded calves compared with non-shaded calves. Stocker calf producers can potentially utilize shade in combination with limit-fed high-energy diets to increase feed efficiency, reduce water consumption and improve animal comfort.

Association of liver abscess presence and epithelial integrity of the hindgut in feedlot cattle to *Salmonella* carriage in the peripheral lymph nodes. C. A. Dockray[1], B. B. Grimes[1], T.J. Tilton[1], W. N. Smith[1], K. L. Belt[1], T. R. Brown[2], T. S. Edrington[3], L. W. Lucherk[1], T. C. Tennant[1], and T. E. Lawrence[1]. [1]*West Texas A&M University, Canyon, TX;* [2]*Cargill Protein, Wichita, KS;* [3]*Diamond V Mills, Cedar Rapids, IA*

Salmonellosis is a foodborne disease that burdens the United States with 1 million illnesses annually (Scallan et al., 2015). *Salmonella* colonizes in the intestines and stress can cause disruptions of the tight junctions (Boyle et al., 2006) allowing for infection of other tissues such as the lymph nodes and liver (Ring, 1985). The objective of this study was to quantify the prevalence and concertation of *Salmonella* in liver, colon, and subiliac lymph nodes (SNL). Feedlots (n=6) were surveyed, from the Texas Panhandle, quarterly across one year for differences in management. Liver (n=8), colon (n=8), and SLN (n=16) were sampled from cattle from each feedlot, quarterly. Liver samples were organized into abscessed (n=4) and edible (n=4). Colon samples were organized into #1 (n=4) and #2 (n=4) colons; categorization was based on the integrity of the epithelial cell layer, #1 colon layers resembled a very ridged surface and #2 colon surface were free of ridges and smooth (Figure 10). Weather data was collected from the Texas Tech University Mesonet. *Salmonella* was uncommon in the winter months of quarter 1 (1.70% prevalence) and quarter 2 (0% prevalence). In the warmer months, *Salmonella* prevalence increased dramatically with quarter 3 having 90.63% prevalence and quarter 4 having 20.45% prevalence. Overall, the greatest prevalence of *Salmonella* was in SLN from carcasses with a #2 colon (27.59%); the lowest prevalence of *Salmonella* was in the tissue from an edible liver (18.75%). The greatest concentration of *Salmonella* was detected in #2 colons (2.16 LogCFU/g); the lowest prevalence of *Salmonella* was detected in liver tissue (0.1 LogCFU/g). Feedlot B had the highest average prevalence of *Salmonella* (29.35%) whereas Feedlot A had the lowest average prevalence (17.19%). Nineteen percent of liver and colon samples were positive for *Salmonella* whereas 25% of the SLN samples were positive for *Salmonella.* The relative risk of a SLN being positive for Salmonella when associated with a #1 colon or #2 colon was 0.77 (P = 0.37) and 0.71 (P = 0.22), respectively*.* The relative risk of a SLN being positive for Salmonella when associated with an edible or abscessed liver was 0.75 (P = 0.30) and 0.83 (P = 0.49), respectively*.* Samples taken during quarter 3 demonstrated the greatest prevalence of *Salmonella* due to an increase in precipitation and temperature. These data suggest that *Salmonella* proliferation is strongly associated to local climatic conditions. This would suggest that as temperature and precipitation increase during warmer months strategies need to be developed to minimize *Salmonella.* Though *Salmonella* is of notable risk in lymph nodes, these data exhibit that other edible products such as liver is also of concern.

Effects of injectable vitamin E before or after transit on receiving phase growth performance, health, and blood metabolites of beef steers. C. W. Dornbach[1], A. M. Beenken[2], D. W. Shike[1], S. L. Hansen[2], and J. C. McCann[1]. *[1]University of Illinois at Urbana-Champaign, Urbana, IL; [2]Iowa State University, Ames, IA*

The objective was to determine the effects of injectable vitamin E (VE) before or after transit on feedlot cattle receiving performance, health, and blood metabolites. Angus × Simmental steers (n = 196; body weight [BW] = 361 ± 64 lb) were utilized in a randomized complete block design. Steers were blocked by BW and randomly assigned to 1 of 3 treatments: intramuscular injections of saline pre- and post-transit (CON), intramuscular injections of VE (2000 mg d-α-tocopherol) pre-transit and saline post-transit (PRE), or intramuscular injections of saline pre-transit and VE (2000 mg d-α-tocopherol) post-transit (POST). Pre-transit injections and vaccination boosters were administered on d 0. Steers were transported on d 7 for ~4 h (216 mi). After arrival, steers were fed a common corn silage-based diet in GrowSafe bunks. A treatment effect tended ($P = 0.08$) to increase final BW for CON steers when compared with POST steers with PRE steers being intermediate. From d 7 to 63, there was a treatment effect of VE on average daily gain (ADG) with PRE and CON steers exhibiting ($P = 0.04$) greater ADG compared with POST steers. Dry matter intake and gain:feed from d 7 to 63 were not affected ($P \geq 0.29$) by treatment. Day 0 serum α-tocopherol concentrations were considered marginal (2.4 ± 0.2 mg/L). A treatment × day interaction ($P < 0.01$) was observed for serum α-tocopherol concentrations. Serum α-tocopherol concentrations were greatest for PRE steers on d 7 (prior to and post-transit), but greater for POST steers on d 10 and 14. A treatment effect elevated ($P = 0.04$) plasma ferric-reducing antioxidant potential (FRAP) concentrations for POST steers when compared with CON steers and PRE steers being intermediate. Non-esterified fatty acids (NEFA) concentrations had a treatment × day interaction ($P = 0.04$) with POST steers being greater than PRE steers on d 14 and CON steers being intermediate. Plasma glucose exhibited a treatment × day interaction ($P = 0.03$) with PRE steers tending to be greater than POST steers on d 14 and CON steers being intermediate. Serum Bovine Herpesvirus, Bovine Viral Diarrhea Virus type 1 and 2 antibody titers on d 21 were not affected ($P > 0.33$) by treatment. There was no main effect ($P \geq 0.14$) of treatment on the number of bovine respiratory disease (BRD) morbidity treatments. However, hair cortisol concentrations were affected ($P < 0.01$) by treatment with CON steers being greatest compared with PRE and POST steers. Overall, injectable VE administered before or after transit can be beneficial for stress mitigation and antioxidant support, but did not improve growth performance of beef steers during the receiving phase.

Bunk space requirements for growing beef cattle limit-fed a high-energy corn and corn co-product diet. Z. M. Duncan, Z. L. DeBord, M. G. Pflughoeft, K. J. Suhr, W. R. Hollenbeck, K.C. Olson, and D. A. Blasi. *Kansas State University, Manhattan, KS*

Bunk space recommendations for growing beef calves fed *ad libitum* (i.e., 500-700 lb) are 18 inches of bunk per head; however, bunk requirements for limit-fed diets have not been systematically evaluated. Our objective was to determine the effects of bunk allotment during the receiving period on growth performance of limit-fed beef calves and subsequent growth performance during a 90-d grazing season. Three-hundred eighty-five crossbred steers (initial body weight 473 ± 56 lb) were blocked by arrival date and assigned to one of four bunk space treatments (i.e., 10, 15, 20, or 25 inches of bunk per head) for a 58-d receiving period. Following the receiving period, calves were blocked by treatment, assigned to 1 of 18 pastures, and grazed for 90-d from May to August. Data were analyzed as a randomized incomplete block design using PROC MIXED of SAS. The model for receiving performance included a fixed effect of treatment and random effect of block. Pasture was added as a random effect for grazing and overall performance data. No differences ($P \geq 0.34$) in body weight, dry matter intake, or gain-to-feed ratio were observed between treatments during the receiving period. During the first 29-days, average daily gains (ADG) increased linearly as bunk space increased ($P = 0.03$); however, no treatment effects were observed thereafter. In addition, the standard deviation among ADG d 0 to 29 tended to be greater for 15 in and was greater for 20 in compared with 10 in ($P = 0.07$ and $P = 0.04$, respectively). During the grazing season, ADG increased linearly ($P \leq 0.01$) as bunk space decreased; however, final bodyweights did not differ ($P = 0.53$) between treatments at the completion of the grazing season. Overall body weight gains and ADG from the receiving and grazing periods did not differ ($P = 0.57$) between treatments. We interpreted our data to suggest that bunk-space allotments of 10, 15, 20, or 25 inches per calf had minimal impact on growth performance during a 58-d receiving period and did not affect final body weights at the completion of a 90-d grazing season.

Dose effects of encapsulated butyric acid and zinc on beef feedlot steer growth performance, dietary net energy utilization, and carcass attributes. F. L. Francis[1], E. R. Gubbels[1], T. G. Hamilton[1], W. C. Rusche[1], D. Lafleur[2], J. E. Hergenreder[2], and Z. K. Smith[1]. *[1]South Dakota State University, Brookings, SD; [2]Kemin Industries, Inc., Des Moines, IA*

The objective of this study was to determine the effects that increasing doses of encapsulated butyric acid and zinc (BZ) have on finishing phase growth performance, efficiency of dietary net energy (NE) utilization, and carcass characteristics in beef steers. Steers from two sources (Source 1: n = 136; initial shrunk BW = 771 lbs, SD = 55 | Source 2: n = 136; initial shrunk BW 816 lbs, SD = 56) in the Northern Plains region were assigned to one of four dietary treatments: 0 (CON), 2, 4, or 6 lbs BZ/ton of diet dry matter. All diets contained monensin sodium at 29.1 g/ton of diet dry matter; no tylosin phosphate was fed during the experiment. Cattle were harvested at a commercial abattoir when visually appraised to have 0.5 in. of rib-fat (Source 1= 126 d; Source 2= 161 d) where individual carcass traits and liver health outcomes were recorded. Receiving period growth performance was calculated on a shrunk live basis (BW × 0.96). Cumulative growth performance and observed diet NE was calculated on a carcass-adjusted (initial BW shrunk 4%; final BW= HCW/0.625) and deads excluded basis. Daily maintenance requirement (Mcal/d) was calculated as: 0.077 ($BW^{0.75}$), where BW is the average BW (kg) from the feeding period. Daily energy gain (EG, Mcal/d = ADG, $kg^{1.097}$ × $0.0557W^{0.75}$; W = equivalent shrunk BW, kg) was used to calculate performance based dietary NE. The equation: DMI= EG/(0.877NEm-0.41), was resolved to determine estimated dietary NEm (Mcal/kg) via the quadratic equation and estimated NEg was calculated with the formula: NEg, Mcal/kg = 0.887NEm-0.41. Continuous and frequency data were analyzed as a randomized complete block design with pen as experimental unit, fixed effect of BZ inclusion level and random effect of block. Treatment effects for the following contrasts were tested: CON vs. BZ, linear, and quadratic effect. No differences ($P \geq 0.14$) were observed for receiving period DMI, final BW, cumulative DMI, cumulative ADG, cumulative G:F, observed NEm or NEg, observed-to-expected diet NEm or NEg, HCW, REA, rib-fat thickness, marbling score, estimated EBF percentage, frequency of USDA Yield Grades 1,3,4,5, and USDA quality grade. Receiving period shrunk BW, ADG, and G:F were increased ($P \leq 0.05$) for BZ vs. CON. Calculated YG tended to differ ($P = 0.10$) for CON vs. BZ. Tendencies were detected for USDA YG 2 frequency (linear; $P = 0.07$) and for liver abscess prevalence (quadratic; $P = 0.08$). Dressed yield tended to be greater ($P = 0.08$) for BZ vs. CON and increased with dose (linear; $P = 0.05$). Supplementation of BZ in finishing cattle diets did not influence cumulative growth performance but increased receiving period growth performance, dressed yield, and decreased liver abscess prevalence at the 2 and 4 lbs/ton diet dry matter level. The addition of BZ to receiving, growing, and finishing cattle diets for the improvement of rumen and intestinal health and for decreasing the prevalence of liver abscesses should be further investigated.

Beef genetics in the dairy management system: management system and maternal genetic effects on calf growth and body measurements. L. K. Fuerniss, J. D. Young, J. R. Hall, K. R. Wesley, O. J. Benitez, R. J. Rathmann, and B. J. Johnson. *Texas Tech University, Lubbock, TX*

Improved reproductive management has allowed dairy cow pregnancies to be optimized for beef production. However, effects of the dairy management system on growth performance of progeny with beef genetics are unknown. The objective of this sire-controlled study was to characterize the influence of maternal genetics and the dairy management system on calf growth. Maternal genetics were evaluated by creating pregnancies in a 2 × 2 factorial arrangement of dam breed (Holstein or Jersey) and mating type (artificial insemination or implantation of an in vitro produced embryo from a commercial beef cow oocyte). Resulting progeny were separated from their dams at birth and reared in a calf ranch. To evaluate effects of the dairy management system, commercial beef cows were inseminated and resulting progeny were reared on range alongside their dams. The resulting five treatments were Angus × Holstein (A×H; n = 19), Angus × Jersey (A×J; n = 22), Angus × Beef gestated by Holstein (H ET; n = 18), Angus × Beef gestated by Jersey (J ET; n = 8), and Angus × Beef raised by beef (A×B; n = 20). Approximately every 28 days beginning at birth, calf body weight and measurements of cannon circumference, forearm circumference, top width, hip width, body length, and hip height were collected. Hip height was not measured at birth. At birth, A×J calves weighed the least ($P < 0.01$) compared to calves of all other treatments (71 vs. 83 to 87 lbs; SEM ≤ 4.4 lbs). At 150 days of age, treatment affected body weight ($P < 0.01$); A×B calves were the heaviest (447 ± 12.21 lbs), H ET and A×H calves were intermediate (337 ± 10.0 and 354 ± 10.0 lbs), and J ET and A×J calves were the lightest (275 ± 12.6 and 267 ± 7.0 lbs). When individual calf body measurements were adjusted to a common weight of 300 lbs, multivariate morphometric differences were detected ($P < 0.01$). Discriminant function analysis indicated the primary axis was positively associated with hip height, and negatively associated with cannon circumference and top width. Testing of primary axis scores identified A×B cattle having lesser values than A×J or A×H calves ($P < 0.01$). The secondary axis was positively associated with forearm circumference; J ET and H ET calves had greater scores on the secondary axis than A×J or A×H calves ($P < 0.01$). Since hip width was not a driver of morphometric differences between groups, an allometric model relating hip width to body weight was fit on a log-log scale for calves raised in the dairy management system [Body weight, lbs = 1.082 × (Hip width, $\text{in}^{2.390}$)]. On the log-log scale, the model had an r^2 value of 0.97. On the back transformed scale, the model had mean bias of -1.08 lbs and CV of 10.16%. These data indicated the dairy management system limited growth rate of beef genetics compared to the beef management system. In addition, Holstein dams transmitted greater growth potential than Jersey dams. Replacing maternal dairy genetics with beef genetics added top width and muscularity of forearm while decreasing hip height.

Effect of supplementing an extruded 100% DDGS cube on pasture and subsequent feed yard performance and carcass characteristics. Z. Grigsby[1], P. Beck[1], C. Worthington[2], M. New[3], T. Fanning[4], and D. Turner[5]. *[1]Oklahoma State University, Stillwater, OK; [2]Marvin Klemme Range Research Station, Bessie, OK; [3]Oklahoma State University Extension, Chickasha, OK; [4]Buffalo Feeders, Buffalo, OK; [5]Masterhand Milling, Lexington, NE*

The objectives of this experiment were to determine the effect of plane of nutrition pre-finishing on performance of steers during the finishing period. In the summer of 2020, a grazing trial was conducted at the Marvin Klemme Range Research Station (Klemme) near Bessie, Oklahoma to test the effects of supplementing stocker steers with an extruded 100% DDGS cube on native range. Treatments were 1) Positive Control (PC) supplemented at a daily rate of 2.5 lbs/steer prorated for feeding 3 days per week in the late summer, with a stocking rate of 6 acres/steer and 2) High Supplement (HS), supplemented at 0.75% of BW throughout the entire grazing season with a 33% increase in stocking rate (4 acres/steer). The steers (n = 140) were shipped to Buffalo Feeders, near Buffalo, to be fed out. Weights and ultrasound carcass data were collected on days 0, 84, and carcass data was collected at harvest. Feed efficiency, days on feed, and DMI are calculated according to Guiroy et al. (2001) and Tedeschi et al. (2004). On pasture, final BW was 42 ± 12.67 lbs greater ($P \leq 0.03$) for HS than PC. Overall ADG of HS steers supplemented the entire grazing season were 0.32 ± 0.07 lbs greater ($P \leq 0.01$) than PC. Upon arrival at Buffalo Feeders, initial BW were 54 ± 12 lbs greater for HS than PC ($P \leq 0.01$). At reimplant (d 84), BW were 56 ± 19 lbs greater ($P \leq 0.04$) for HS than PC, but BW at harvest did not differ ($P \geq 0.38$). Average daily gains did not differ from day 0-84 ($P \geq 0.91$) or day 84-harvest ($P \geq 0.38$). Individual DMI for HS and PC did not differ ($P \geq 0.84$). However, calculated total feed intake required for finishing was 718 ± 114 lbs greater ($P < 0.01$) for PC than HS because days on feed were 22 ± 6 days greater for PC than HS. There was no difference in feed efficiency in the feed yard from different treatments on pasture ($P \geq 0.64$). At processing and harvest rib eye area (REA) did not differ ($P \geq$0. 06), however, at reimplant (day 84) REA was 0.7 ± 0.21 inches greater ($P \leq 0.03$) for HS than PC. Back fat was 0.02 ± 0.006 inches greater ($P \leq 0.02$) at processing for HS than PC. However, back fat did not differ at reimplant ($P \geq 0.06$) or at harvest ($P \geq 0.70$). At harvest, quality grades of carcasses did not differ ($P \geq 0.83$) between HS and PC. HS steers had a 0.73 ± 0 % greater ($P < 0.01$) dressing percentage than PC. Season long supplementation did not have an effect on yield grade ($P \geq 0.55$), nor did it have an effect on the total hot carcass weight ($P \geq 0.73$). Economically, the increased number of days on feed led to a $109.61 ± 17.44 greater ($P < 0.01$) total feed cost per steer for PC than HS. However, the cost per pound of gain in the feed yard did not differ ($P \geq 0.07$). These data suggests that the use of an extruded 100% DDGS cube on pasture during summer grazing is a viable management option to increase gains on pasture without negatively impacting finishing performance, efficiency, or carcass quality, even with increased body weights and back fat levels entering the feed yard. However, season long supplementation's decreased days on feed had a positive effect for the producer by decreasing total feed inputs required to get these steers to harvest.

Association of liver abnormalities with carcass performance. B. B. Grimes, T. C. Tennant, T. J. McEvers, and T. E. Lawrence. *West Texas A&M University, Canyon, TX*

The association of liver abnormalities with carcass performance was evaluated on data from 371,476 carcasses housed in the West Texas A&M University Beef Carcass Research Center database collected between 2010 and 2021. Liver abnormalities were scored as: edible liver; A- = 1 to 2 small abscesses or inactive scars; A = 1 to 2 large abscesses or multiple small abscesses; A+ = multiple large abscesses; A+AD = liver adhered to diaphragm; A+OP = open liver abscess; A+AD/OP = adhered to diaphragm with an open liver abscess; cirrhosis, flukes, and telangiectasis. Liver abnormality rates were A- = 7.4%, A = 2.7%, A+ = 2.4%, A+AD = 3.9%, A+OP = 1.4%, A+AD/OP = 0.8%, cirrhosis = 0.2%, flukes = 3.6%, telangiectasis = 0.7%, with 77.0% of livers being edible. For carcasses with severe abscesses (A+, A+AD, A+OP, A+AD/OP) and cirrhotic livers, HCW was 31.7 lbs and 93.7 lbs less ($P < 0.01$) compared to carcasses with edible livers. Carcasses with A-, A, A+, A+AD, A+OP, A+AD/OP, flukes, and cirrhosis had reduced ($P < 0.05$) HCW and reduced ($P < 0.05$) LM area compared to carcasses with edible livers. Less ($P < 0.05$) 12th-rib subcutaneous fat was observed for carcasses with A-, A, A+, A+AD, and cirrhosis abnormalities compared to carcasses with edible livers. Estimated KPH was less ($P < 0.05$) for carcasses with livers identified with flukes or cirrhosis abnormalities. Calculated yield grade was less ($P < 0.03$) for carcasses with A+AD liver scores and cirrhosis than those with edible livers. The ratio of LM area to HCW, an indicator of muscling, was less ($P < 0.05$) for carcasses exhibiting A+ and A- liver scores and flukes compared to edible livers. These data indicate liver abnormalities, especially severely abscessed, adhered, open and cirrhotic livers outcomes, greatly effect HCW, an important economic factor effecting carcass merchandising, and other carcass outcomes. Liver abscess rate had no detrimental effect on marbling score, which may indicate the timing to which liver abscesses are developed during the feeding period compared to deposition of intramuscular fat. These results indicate control of liver abscesses is important in order to prevent losses in carcass value.

Evaluation of Celmanax and Certillus used alone or in combination on feedlot phase growth performance, efficiency of dietary net energy utilization, *Salmonella* and *E.coli* O157:H7 prevalence, heat stress measures, and carcass characteristics in beef steers fed in confinement for 258 d in the Northern Plains. E. R. Gubbels[1], F. L. Francis[1], T. G. Hamilton[1], J. E. Griffin[1], W. C. Rusche[1], T. Rehberger[2], E. Block[2], and Z. K. Smith[1]. [1]*South Dakota State University, Brookings, SD;* [2]*Arm & Hammer Animal Nutrition, Princeton, NJ*

The objective of this research determined the influence a direct fed microbial (DFM) and/or enzymatically hydrolyzed yeast cell culture (YCW) product (both from Arm & Hammer Animal Nutrition, Princeton, NJ) have on growth performance, heat stress measures (during ractopamine hydrochloride (RH) supplementation at 300 mg/steer·d-1), Salmonella and E. coli O157:H7 prevalence, and carcass traits in beef steers fed in the Northern Plains (NP). This study used 256 single-sourced, newly-weaned steers (initial BW = 542 ± 3.7 lb; n=8 pens/treatment with 8 steers/pen). Steers were blocked by location in a 2×2 factorial arrangement of DFM (Certillus CP B1801 Dry; 28 g/steer·d-1) and YCW (Celmanax; 18 g/steer·d-1). Steers were vaccinated and poured at processing and individually weighed on d 1, 14, 42, 77, 105, 133, 161, 182, 230 and 258. Fecal samples were collected on d 1, 14, 77, 133, 182, and 258. The final diet provided 64.8 Mcal/cwt of NEg and 30 g/ton of monensin sodium. Temperature-humidity index (THI) was calculated during RH supplementation. On d 1 and 2 and d 21 and 22 on RH, respiration rate (RR) and panting scores (PS) were determined before and after the AM and PM feedings (0700h, 1100h, 1400h, 1700h). RR (n=3 steers/pen) was calculated from: 600/seconds required for 10 flank movements. PS utilized this scoring system: 0 (not distressed) to 4.5 (severely distressed). Steers were harvested after 258-d on feed at a commercial harvest facility. Data were analyzed as a randomized complete block design with pen as the experimental unit; an α level of 0.05 determined significance. Little Salmonella prevalence (1.5%) was observed throughout the study. No DFM×YCW interactions or DFM main effects (P≥0.05) were observed for cumulative growth performance measures. However, YCW steers had 2% lower (P=0.04) dry matter intake compared to DFM steers. There were 12-d where the THI was greater than 72 during the RH supplementation period. Treatment interactions and main effects for PS and RR are as follows. A DFM×YCW interaction was noted for the proportion of steers categorized as PS 2.0 at 1100h on d 21 (P = 0.03) and RR on d 21 at 1400h (P=0.02). Control steers had a greater proportion of PS 2.0 at 1100h on d 21 compared to DFM or YCW steers (P≤0.05), while DFM×YCW steers did not differ from others (P≥0.05); DFM×YCW steers had greater (P<0.05) RR compared to DFM steers, control and YCW steers did not differ from others (P≥0.05). No DFM×YCW interactions or main effects (P≥0.05) were observed for carcass traits or liver abscess severity. However, a DFM×YCW interaction (P=0.02) was noted for the distribution of USDA yield grade (YG) 1 carcasses. Control steers had a greater proportion (P<0.05) of YG 1 carcasses compared to other treatments. A DFM×YCW interaction (P=0.04) was noted for the distribution of USDA Prime carcasses. DFM×YCW steers had a greater proportion (P<0.05) of USDA Prime carcasses compared to DFM or YCW, but were similar to the control steers, which were also similar to DFM or YCW. The use of DFM and YCW alone or in combination had minimal effects on growth performance, carcass traits, and heat stress measures in NP steers. Overall, the effects of DFM and YCW used alone or in combination cannot be expected to show productive benefits when animals are relatively unstressed with low pathogen loads.

Evaluation of dietary roughage inclusion in a single or two-diet system for backgrounding and finishing steers. T. G. Hamilton, W. C. Rusche, and Z. K. Smith. *South Dakota State University, Brookings, SD*

The objective of this experiment was to determine the influence that equal cumulative roughage inclusion in a single diet or two-diet system during a 210-d growing-finishing period has on growth performance responses, efficiency of dietary net energy (NE) utilization, and carcass traits in beef steers. Pre-conditioned crossbred beef steers (n = 46; initial shrunk [4%] BW = 621 ± 89.1 lbs) were used in a 210-d grow-finish experiment at the Ruminant Nutrition Center (RNC) in Brookings, SD. Steers were fed once daily, and bunks were managed according to a slick bunk management system. Cattle were fed in 25 × 25 ft concrete surface pens (n = 10 pens; 5 pens/treatment) with 25 linear ft of bunk space. Treatments included: 1) A single-diet program (targeted a 59 Mcal/cwt NEg diet fed for 210-d; 1D) or 2) two-diet program (targeted a 55 Mcal/cwt NEg diet fed for 98-d, a 59 Mcal/cwt NEg diet fed for 14-d, and a 63 Mcal/cwt NEg diet fed for 98-d; 2D). All steers were implanted initially (d 1) with a 100 mg trenbolone acetate (TBA) and 14 mg estradiol benzoate (EB) implant (Synovex Choice, Zoetis, Parsippany, NJ) and re-implanted with a 200 mg TBA and 28 mg EB implant on d 112 (Synovex Plus, Zoetis). All steers were weighed individually approximately every 28-d. Ingredients were analyzed weekly for dry matter (DM) content and composited monthly for nutrient analysis. Growth performance, carcass traits, and efficiency of dietary NE utilization were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. The model included the fixed effect of dietary treatment; block (weight grouping) was included as a random variable. USDA Yield and Quality grade data as well as liver abscess prevalence and severity were analyzed as binomial proportions. Feed efficiency improved by 9.4% ($P = 0.05$) and ADG tended ($P = 0.06$) to be 9.5% greater for 1D compared to 2D during the backgrounding phase. Conversely, F:G and ADG were improved ($P = 0.01$) for 2D compared to 1D during the finishing phase of the experiment (11.3 and 11.4%, respectively). Cumulative ADG did not differ ($P = 0.86$) between treatments (3.55 vs. 3.57 ± 0.101 lbs) for 1D and 2D, respectively; nor were any treatment effects observed for F:G ($P = 0.76$). Cumulative observed dietary NEm and NEg did not differ ($P = 0.96$) between treatments. There were no differences ($P \geq 0.18$) detected between treatments for HCW, dressing percentage, rib eye area, rib fat, USDA marbling score, KPH, yield grade, retail yield, empty body fat or body weight at 28% estimated EBF. No differences ($P \geq 0.14$) were noted between dietary treatments for liver abscess prevalence or severity. In conclusion, Northern Plains feedlot producers can feed a single growing-finishing diet to preconditioned beef steers with minimal effects on overall growth performance or carcass traits. Observed responses for growth performance were as anticipated for varying levels of roughage fed during growing vs. finishing production phases. Feeding a single diet during both the growing and finishing phases could be used as a strategy to simplify management by reducing number of diets fed, or as a way to utilize ensiled roughage more rapidly to reduce feedout losses during summer months.

Evaluation of precision feeding on production efficiency responses in finishing beef cattle. S. R. Hanson, W. C. Rusche, and Z. K. Smith. *South Dakota State University, Brookings, SD*

Angus heifers (n = 60; initial shrunk [4%] BW = 1013 ± 57.7 lbs; n = 10 pens; 5 replicate pens/treatment) were used in a 112-d feedlot finishing experiment to evaluate animal growth performance outcomes, efficiency measures, and carcass characteristics when varying degrees of ingredient inclusion tolerances were imposed. Treatments included: 1) Normal feeding with 1 lb tolerance for all ingredients (Constant) or 2) Variable inclusion strategy where each ingredient was randomly increased or decreased but the targeted as-fed quantity for the daily delivery was met (Variable). Initial processing of the heifers included vaccination against viral respiratory diseases (Bovishield Gold 5; Zoetis, Parsippany, NJ) and clostridial species (Ultrabac 7/Somubac, Zoetis), and administration of pour on moxidectin (Cydectin, Bayer, Shawnee Mission, KS). Heifers were also administered a terminal implant on d1 (200 mg trenbolone acetate and 28 mg estradiol benzoate; Synovex Plus, Zoetis). All heifers were fed once daily with all bunks managed using a slick bunk approach. Monensin sodium was fed at 30 g/ton and ractopamine HCl was fed (300 mg per head daily) the final 28 d. Individual BW measures were captured at processing and on d 1, 21, 42, 63, 84, and 112. Diets consisted of earlage (HMEC), dried distiller's grains (DDGS), and a liquid supplement (LS). Ingredient inclusions were randomized by assigning independently a random integer to DDGS and LS with each integer corresponding to the deviation from targeted inclusions. As-fed inclusion rates for DDGS and LS varied from formulated targets by -20, -15, -10, -5, 0, +5, +10, +15 or +20%. The HMEC inclusion was adjusted so that the targeted as-fed amount of the diet was delivered daily. Actual DM inclusion was within 5% of expectations 72% of the time in Constant (13 periods/18 periods) and only 27% of the time in Variable (5 periods/18 periods). Data was analyzed using the GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. Ingredient inclusion accuracy did not affect ADG, DMI, or feed conversion efficiency in this experiment ($P \geq 0.15$). However, DMI and liquid inclusion rates showed an inverse relationship. There were no differences ($P \geq 0.35$) detected between treatments for HCW, dressing percentage, rib eye area, rib fat, USDA marbling score, KPH, yield grade, retail yield, empty body fat, or body weight at 28% estimated EBF. No differences ($P \geq 0.84$) were noted between dietary treatments for liver abscess prevalence or severity. Under the conditions of this experiment, randomly altering ingredient proportions did not affect live animal performance, efficiency measures, or carcass characteristics.

Individual animal feed intake estimation using bunk cameras and feeding algorithms. M. A. Harrison[1], P. Demochkina[2], and J. W. Oltjen[1]. [1]*University of California – Davis, Davis, CA;* [2]*HSE University, Novgorood, Russia*

Feed efficiency and dry matter intake (DMI) have major economic impacts on feedlot cattle production systems. Individual monitoring of DMI can provide data for evaluating animal health and making informed management and marketing decisions. Currently, there are no commercial technologies available to accurately measure individual animal DMI. To evaluate the feasibility of using bunk cameras to identify cattle for DMI prediction, forty-eight Angus-cross steers were housed in four pens with concrete bunks. Pens were equipped with solar-powered camera modules placed 4.6 m above the ground. Steers were uniquely identified using colored adhesive patches that were placed at varying locations along the spine. Images were taken at one-minute intervals, and initial machine vison algorithms were developed to test identifying patch combinations and recording frequency of daily bunk visits (BV) and mealtime (MT). Individual MT were summed to daily eating duration (ED). Trained observers reviewed camera images and reported daily BV and ED for each steer. Algorithm BV and ED predictions were compared to those reported by the reviewers. The effect of camera image interval on MT was evaluated using reviewers that observed steers pen-side. Based on 166 records, average ED was reported as 132 ± 31 by image reviewers. Algorithm ED predictions averaged 13 min less than reviewer ED, based on 137 individual records. On average, MT measured pen-side was two minutes less compared to MT predicted by the algorithm. These results suggest that bunk cameras can identify ED and may be useful for individual steer DMI prediction in group pens.

Utilization of Biochar as an emissions management strategy in beef cattle. H. A. Heil, B. Troyer, L. J. McPhillips, J. L. Sperber, A. K. Watson, and G. E. Erickson. *University of Nebraska – Lincoln, Lincoln, NE*

Two experiments were conducted to evaluate impacts of biochar on methane (CH_4) and carbon dioxide (CO_2) emissions, performance, and carcass characteristics of finishing beef cattle. A food use authorization (FDA) was granted as biochar is not approved for feeding to beef cattle. Experiment 1 (initial BW = 725 lb ± 42 lb) utilized biochar sourced from pistachio shells (VGrid Energy Systems) in a 70% corn, 20% distillers grains, and 5% corn residue diet. Experiment 2 (initial BW = 851 ± 42 lb) utilized biochar sourced from ponderosa pine wood waste (Vital Ag) in a 40% corn, 40% Sweet Bran, and 15% corn silage diet. Each experiment evaluated 128 crossbred angus steers with 2 treatments: control (CON) diet containing no biochar and biochar (BIO) replacing 1% of dietary corn. Pen was the experimental unit with 8 steers per pen and 8 replicates. Four CON and BIO replicates (paired and monitored simultaneously) rotated through a two-chamber emissions barn in 5-day cycles to measure CH_4 and CO_2 emissions. Cattle performance data were analyzed using the MIXED procedure of SAS with treatment and body weight block as fixed effects and emissions data analyzed as a repeated measure. Feeding biochar in experiment 1 did not impact CH_4, in g/day ($P = 0.76$) or g/kg of dry matter intake (DMI; $P = 0.81$) or CO_2 as g/day ($P = 0.94$) and g/kg DMI ($P = 0.88$). Cattle performance and carcass characteristics did not differ between cattle fed biochar or not for DMI, average daily gain (ADG), and hot carcass weight (HCW; $P>0.31$). In experiment 2, there were no statistical differences between treatments for CH_4, g/day ($P = 0.78$) and g/kg DMI ($P = 0.84$) or CO_2, g/day ($P = 0.50$) and g/kg DMI ($P = 0.52$). Results from this study found no performance differences in DMI or GF ($P > 0.23$) or carcass parameters of HCW, longissimus muscle (LM) area and marbling score ($P > 0.47$). Overall, supplementing biochar at 1% of diet DM did not impact eructed CH_4 or respired CO_2 emissions, performance, and carcass traits in finishing beef cattle so is not an effective methane mitigation strategy.

Infrared thermography as an alternative technique for measuring body temperature in cattle. A. A. Hoffman[1], N. S. Long[1], T. M. Smock[1], J. A. Carroll[2], N. C. Burdick-Sanchez[2], P.R. Broadway[2], J. T. Richeson[3], T. C. Jackson[3], and K. E. Hales[1]. *[1]Texas Tech University, Lubbock, TX; [2]USDA-ARS Livestock Issues Research Unit, Lubbock, TX; [3]West Texas A&M University, Canyon, TX*

Rectal temperature (RT) is used as a proxy for body temperature, a key indicator of health, but measuring RT can yield inaccurate results by creating additional stress, and it is time consuming and invasive (Reuter et al., 2010). The use of infrared thermography (IRT) might be a viable, non-invasive alternative to RT in cattle. Therefore, our objective was to evaluate the use of IRT as an alternative to RT in 31 steers (652.1 ± 102.5 lbs) within a temperature-controlled environment prior to, during, and after an induced febrile response. Each steer was fitted with an indwelling rectal thermometer to monitor changes in RT every 5-min (averaged by hour), and *Escherichia coli* lipopolysaccharide (LPS) was administered intravenously to each steer to produce a febrile response. Infrared temperatures, measured at the lacrimal region of the eye, were collected in 60-min increments beginning at -1.5 to -0.5 and 6.5 to 12.5 h relative to LPS injection. Additionally, IRT temperatures were collected in 30-min increments beginning at 0.5 to 1.5, 2.5 to 3.5, and 4.5 to 5.5 h relative to LPS injection. The IRT temperatures were subsequently recorded at 18.5, 24.5, 36.5, and 47.5 h after injection. Steer was the experimental unit for all dependent variables. Correlation analyses were conducted using PROC CORR of SAS, where Pearson and Spearman correlation coefficients were evaluated between the RT and IRT. Data for RT and IRT also were analyzed using PROC MIXED with a model that included measurement method (RT or IRT), sampling hour, and method × sampling hour. Steer nested within temperature measurement method was included as a random effect and was the subject of the repeated measures analysis. Increases in RT and IRT were observed at 1 h, confirming that both methods could detect a febrile response. The two methods differed at -0.5, 0.5, 1.5, 5.5, 9.5, 10.5, 11.5, 18.5, 24.5, 36.5, and 47.5 h ($P < 0.01$), but otherwise did not differ ($P \geq 0.1838$). Infrared thermography measurements were greater than RT measurements at -0.5, 0.5, 1.5, and 5.5 h relative to LPS injection. Conversely, RT measurements were greater than IRT measurements at 9.5, 10.5, 11.5, 18.5, 24.5, 36.5, and 47.5 h relative to LPS injection. Across sampling times, a Pearson correlation of 0.71 ($P < 0.01$) was noted between the RT and IRT measurements with a Spearman correlation of 0.66 ($P < 0.01$) between measurements. These data indicate that IRT could be a viable alternative to RT, but further research under a variety of experimental conditions is needed to assess the utility of IRT more fully in practical settings.

The effect of days on feed for feedyard performance, health, carcass, and organ characteristics of Angus x Holstein heifers. T. C. Husz[1], A. B. Word[2], K. J. Karr[2], B. P. Holland[2], T. E. Lawrence[1], L. J. Walter[3], and J. P. Hutcheson[3]. [1]*West Texas A&M University, Canyon, TX;* [2]*Cactus Research, Amarillo, TX;* [3]*Merck Animal Health, Summit, NJ*

The objective of this study was to evaluate the effect of days on feed (DOF) on performance, health, carcass, and organ characteristics of composite Angus by Holstein heifers (n = 3,676). At time of arrival (d 0), heifers from a single source were placed into large (~300 animal) pens at two commercial feedlot locations in the Texas Panhandle. At administration of final implant (Revalor® 200; d 240), heifers, within lot, were randomly assigned to one of four smaller pens, creating a block (location A block n = 6, location B block n = 7). Pens within blocks were randomly assigned to treatment (323, 344, 365, or 386 DOF). Data were analyzed using DOF as the fixed effect; block was nested within location as a random effect. Linear and quadratic effects were also tested; pen was experimental unit (n = 52). Heifer DMI did not differ across DOF (P = 0.72). Heifer ADG decreased linearly (3.36, 3.01, 2.88, and 2.80 lb/d; 0.07 lb lost every 10 d; P ≤ 0.01) concomitant with linearly increasing F:G (6.30, 6.91, 7.30, and 7.51; 0.18 lb of additional feed every 10 d; P ≤ 0.01) as DOF increased. Final BW increased linearly with DOF (1,304, 1,345, 1,391, and 1,442 lb; 22 additional lb every 10 d; P ≤ 0.01). Heifer HCW (820, 854, 884, and 914 lb; 14.9 additional lb every 10 d), longissimus dorsi muscle area (13.74, 13.88, 14.07, and 14.25 in2; 0.08 additional in2 every 10 d), marbling score (modest35, modest53, modest63, and modest94; 9 additional marbling points every 10 d) and percentage of Prime QG (6.6, 11.2, 12.8, and 19.0 %; 1.9% increase every 10 d) linearly increased (P ≤ 0.01) as DOF increased. Frequency of liver scores (edible, minor, or major abscess) did not change across this range of DOF (P ≥ 0.82). Frequency of ideal heart score (a subjective assessment of congestive heart failure) linearly decreased with increasing DOF (53.0, 44.3, 25.7, and 15.0 %; P ≤ 0.01). Frequency of lung score (normal vs. consolidation and fibrin tags) did not change across DOF (P ≥ 0.41). Frequency of YG 3 heifers did not change (P = 0.68), however frequency of YG 4 heifers linearly increased with DOF (6.2, 12.0, 14.0, and 22.5 %; 2.5% increase every 10 d; P ≤ 0.01). Data collected in this trial indicate that increasing DOF in the range of 323 to 386 d led to increased HCW, LM area, marbling, YG, and QG with minimal changes to DMI or liver scores for Angus x Holstein heifers.

Effect of targeted metaphylaxis using blood leukocyte status on health, performance and economic outcomes of auction-derived heifers. C. P. Johnson[1], N. Bate[2], S. Sweiger[2], and J. T. Richeson[1]. [1]*West Texas A&M University, Canyon, TX;* [2]*Advanced Animal Diagnostics, Morrisville, NC*

High-risk beef cattle typically receive antimicrobial metaphylaxis upon feedlot arrival, but there is individual variation in the risk level and health outcomes within groups. Metaphylactic treatment has been effective to control bovine respiratory disease (BRD,) but is relatively expensive and there is pressure to use antimicrobials more judiciously. The study objective was to evaluate health, performance, and antimicrobial costs of heifers where targeted metaphylaxis was guided by a commercial blood analyzer (QScout BLD, Advanced Animal Diagnostics, Morrisville, NC; SWV 1.0.6.30078) compared to a traditional metaphylaxis regimen. Using a randomized complete block design, heifers (n = 1,271) [average initial body weight (BW) = 513.2 ± 2.38 lb] were randomly allocated to treatment pens (n = 20; 10 blocks). Treatments were: 1) all cattle administered metaphylactic treatment with gamithromycin at arrival (**META)**, and 2) cattle administered metaphylaxis with gamithromycin according to the QScout BLD blood analyzer outcome (**TARGETED**). The blood analyzer indicated immune status of individual animals according to the number and proportion of leukocytes in the blood; red signified "abnormal" and green signified "normal" status. Only cattle with a red outcome were administered antimicrobial in the TARGETED treatment group. Of all cattle that were enrolled in the study, 73% were deemed normal and 27% were deemed abnormal by the chute side blood analyzer. Treatment groups had an equal distribution of normal (META = 73% and TARGETED = 74%) and abnormal (META = 28% and TARGETED = 26%) cattle enrolled in the study. Cattle were fed a common starter ration for the duration of the 62-d study. Pen riders were blinded to treatment pen status. Cattle observed by the pen riders that expressed signs of BRD were pulled and treated with an antimicrobial up to 3 times if eligible. Data was analyzed using PROC MIXED and GLIMMIX in SAS. Final BW, ADG, and feed conversion were less for TARGETED ($P \leq 0.02$). However, the arrival processing antibiotic cost (META = 11.77 and TARGETED = $3.27/heifer) at arrival and total antibiotic cost (META = 17.77 and TARGETED = $9.12/heifer) was reduced ($P < 0.01$) for TARGETED cattle. TARGETED cattle had an arrival processing antibiotic cost savings of $8.50/heifer and an overall drug input cost savings of $8.65/heifer. The hospital BRD morbidity rate for normal status heifers was 18.85% and less than those determined to be abnormal (26.49%; $P < 0.01$). Normal status heifers had a mortality rate of 3.17 vs. 5.80% for abnormal ($P = 0.03$). In conclusion, drug costs were reduced but performance of TARGETED in this study was also less, probably because some cattle that were considered normal would have benefited from gamithromycin on arrival. This method of targeted metaphylaxis may be increasingly effective with further research and advancement of the Qscout BLD algorithm.

Varying levels of trace mineral supplementation on performance, carcass characteristics, and mineral balance in feedlot cattle. B. A. Lippy, C. A. Robison, and B. K. Wilson. *Oklahoma State University, Stillwater, OK*

The objective of this experiment was to determine the effects of supplementing varying concentrations of trace minerals (TM) on performance, carcass characteristics, and mineral balance in feedlot cattle. Angus crossbred steers (n = 240; body weight, BW = 291 kg ± 27.4) were stratified by arrival BW and source and randomly assigned to 1 of 4 experimental treatments in a randomized complete block design (12 pens/treatment; 5 steers/pen). Treatments included a negative control (CON) in which cattle received no additional TM supplementation, a requirement treatment (1X) in which cattle received added Co (cobalt carbonate), Cu (copper sulfate), Fe (ferrous sulfate), I (ethylenediamine dihydriodide), Mn (manganese oxide), Se (sodium selenite), or Zn (zinc oxide) at 2016 Nutrient Requirements of Beef Cattle (NASEM) requirement levels, a 2 times NASEM requirement (2X) treatment, and a 4 times (NASEM) requirement (4X) treatment. Selenium was included at 0.1, 0.2, and 0.3 mg/kg for 1X, 2X, and 4X respectively, based on federal regulations. There was no difference in overall BW, average daily gain (ADG), dry matter intake (DMI), or gain to feed (G:F) due to supplementation (CON vs SUPP $P \geq 0.47$). There was a tendency for an effect of TM supplementation on DMI ($P = 0.08$) and an effect of TM supplementation on G:F ($P = 0.03$) in the when feeding a beta-agonist. There were no differences in hot carcass weight, rib eye area, fat thickness, dressing percentage, marbling score, or USDA Yield Grade due to supplementation (CON vs SUPP $P \geq 0.30$). One steer was chosen at random from each pen to be evaluated for serum and liver TM status. There was a treatment × day interaction for serum Co, and liver Cu and Se ($P < 0.0001$). Serum Co was greatest for the 4X treatment from d 28 through harvest. Liver Cu was greatest for the 2X and 4X treatments from d 56 through harvest. Liver Se was greatest for 2X and 4X from d 28 through harvest. There was an effect of treatment ($P = 0.02$) on serum Zn, where 4X was greatest at harvest ($P = 0.02$). There was an effect of day on liver Co, Fe, Mn, Mo, and Zn ($P \leq 0.0001$) and serum Cu, Mn, Mo, Se, and Zn ($P \leq 0.002$). Concentrations for individual TM had different trends over time, however, all reported values were within normal ranges. Overall, trace mineral supplementation above NASEM requirements had no effect on overall cattle performance or carcass characteristics, but does affect the storage and circulation of certain TM. However, the results of this experiment do indicate that increased supplementation of TM with the addition of a beta-agonist may result in synergistic effects immediately prior to harvest.

Metaphylactic antimicrobial effects on occurrences of antimicrobial resistance in *Salmonella*, *Escherichia coli*, and *Enterococcus* spp. measured longitudinally from feedlot arrival to harvest in high-risk beef steers. N. S. Long[1], J. E. Wells[2], E. D. Berry[2], D. R. Woerner[1], P. R. Broadway[3], J. A. Carroll[3], N. C. Sanchez[3], J. F. Legako[1], C. M. Coppin[1], C. L. Helmuth[1], T. M. Smock[1], J. L. Manahan[1], A. A. Hoffman[1], and K. E. Hales[1]. *[1]Texas Tech University, Lubbock, TX; [2]USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE; 3USDA-ARS, Livestock Issues Research Unit, Lubbock, TX*

The potential for contamination of the food supply by bacterial pathogens resistant to antimicrobials is a major concern for the food production industry and human medicine. Our objective was to determine whether metaphylactic use of injectable antimicrobials for the prevention of bovine respiratory disease affected populations of *Salmonella*, *Escherichia coli*, and *Enterococcus* spp. in feedlot cattle. High-risk crossbred beef steers (n = 240; average initial BW = 248 kg) were sorted into 2 blocks by arrival date and assigned randomly to 1 of 4 antimicrobial treatments: a sterile saline control (CON); tulathromycin (TUL); ceftiofur (CEF); and florfenicol (FLR). Fecal samples were collected on d 0, 28, 56, 112, 182, and 238 of the feeding period. Hide swabs and *subiliac* lymph nodes were collected on d 238 and at harvest the following d, respectively. Samples were cultured using selective agar media for total, tetracycline-resistant (TET^R), trimethoprim-sulfamethoxazole-resistant (COT^R), and cefotaxime-resistant (CTX^R) *E. coli*; total, erythromycin-resistant ($8ERY^R$), and highly-erythromycin-resistant ($128ERY^R$) *Enterococcus* and *Salmonella*. Individual animal was the experimental unit with fixed effects of metaphylactic treatment, sampling day, and metaphylactic treatment × sampling day for fecal data and a fixed effect of metaphylactic treatment for hide swab and lymph node data. There was a treatment × sampling day interaction for all targeted bacterial populations except total *E. coli* ($P \leq 0.01$). Log_{10} CFU counts of total *E. coli* were greater ($P \leq 0.01$) on d 112, 182, and 238 compared to earlier timepoints. Use of TUL resulted in greater ($P \leq 0.01$) counts and prevalence of *Salmonella* compared with CON on d 238. Administration of TUL or CEF resulted in greater ($P \leq 0.01$) prevalence of *Salmonella* in hide swabs and greater log_{10} CFU counts of $128ERY^R$ *E. coli* on d 238 compared with CON. Fecal samples were tested for *Salmonella* resistant to tetracyclines or 3rd generation cephalosporins, but none were detected. Use of CEF caused greater ($P \leq 0.03$) counts of $8ERY^R$ *Enterococcus* spp. on d 238. By d 238, antimicrobial use did not increase prevalence or counts ($P \geq 0.13$) for all other targeted bacterial populations compared with CON. Our results indicate metaphylactic use of antimicrobials affected antimicrobial resistance throughout the receiving and finishing phase in feedlot cattle, but effects varied across sampling days.

Effects of exogenous melatonin on the post-weaning immune response and growth performance of crossbred beef calves. A. E. Martin, V. S. Machado, R. J. Rathmann, and W. L. Crossland. *Texas Tech University, Lubbock, TX*

Although 96.6% of large capacity feedlots vaccinate against BVD and 93.7% against IBR, bovine respiratory disease continues to be the leading cause of morbidity and mortality in feedlots (USDA NAHMS, 2013). Melatonin has demonstrated an immunomodulatory role in humans and mice and has been a successful adjuvant during vaccination of sheep to a common foot rot bacterium. The effect of melatonin on the immune response of calves remains unknown. The objective of this study was to evaluate the effects of exogenous melatonin on the immune response and growth performance of crossbred beef calves during a vaccination series at weaning. Crossbred beef calves (n = 48, initial body weight = 355 ± 48 lb) were enrolled in a completely randomized design with a 2 ×2 factorial arrangement of treatments. Calves were vaccinated with 0.5 mg ovalbumin (d 0 and 21) or not; calves received a 24 mg injection of melatonin (d 0 and 21) or not. This resulted in four treatment groups: placebo injections only (CON), vaccination only (VAC), melatonin only (MEL), and both melatonin and vaccination (MVAC). Calves were weaned on d 0, sorted into 8 pens (n = 6 calves per pen, 2 pens per treatment), and fed for 63 days. Calf body weights and blood samples were collected on d 0, 8, 21, 42, and 63 to evaluate growth performance, polymorphonuclear leukocyte (PMN) function via oxidative burst and phagocytosis, and anti-ovalbumin IgG optical density. The MEL treated calves tended to have greater oxidative burst capacity on d 8 ($P = 0.09$) and had greater intensity on d 21 ($P = 0.003$). On d 8, phagocytosis activity was greater ($P = 0.01$) for MEL treated calves and tended to have greater intensity ($P = 0.09$) than all other treatment groups. Contrasts revealed that all calves who received melatonin had a greater percentage of PMN leukocytes performing oxidative burst (d 8) and phagocytosis (d 21) and with greater intensity, regardless of vaccination ($P \leq 0.05$). All calves who received a vaccination responded similarly, except on d 63 where calves who received the MVAC treatment had greater circulating anti-ovalbumin IgG ($P = 0.02$) compared to VAC. Calves administered melatonin had a 36.7% greater (P = 0.003) ADG in the first eight days of weaning compared to calves not receiving melatonin and tended to remain greater through d 21 (3.19 vs 2.71 lb, respectively; $P = 0.09$). Overall (d 0 to 63), VAC treated calves had greater DMI than MVAC ($P = 0.02$), while MVAC treated calves tended to have a greater G:F than VAC (0.26 vs. 0.23 lb, respectively; $P = 0.08$). Final body weight among treatments did not differ ($P = 0.58$). These data indicated that exogenous melatonin applied to crossbred beef calves during weaning may increase the innate and humoral immune response to vaccination, and, perhaps, longer lasting circulating IgG, which warrants further investigation. In addition, these effects may translate into improved growth performance. Strategic use of melatonin may offer value to cattle health and performance as a management strategy during critical times of stress.

A conceptual hybrid intelligent mechanistic model for bovine respiratory disease prediction. E. D. M. Mendes[1], K. Kaniyamattam[1], V. N. Gouvêa[1,2], and L. O. Tedeschi[1]. *[1]Texas A&M University, College Station, TX; [2]Texas A&M AgriLife Research, Amarillo, TX*

Bovine respiratory disease (**BRD**) is the most common cause of morbidity and mortality in feedlot cattle, with a prevalence of 16.2%, costing the US beef industry more than $1 billion, annually. Typical management practice on feedlots to identify BRD candidates ("pulls") is the human-based, subjective visual identification of clinical signs expressed by sick animals, i.e., depression, loss of appetite, change in respiratory patterns, and increased rectal temperature (**DART** score). The inefficiencies associated with the DART system includes the lack of interrater concordance, non-availability of labor required for the 24×7 surveillance of pens, and less than desirable accuracy of BRD detection. Predictive modeling is required to identify a current or future event of BRD and other BRD-related outcomes, including mortality, treatment response, and relapse. Predictive modeling requires the three-way integration of a) sensor-based precision livestock farming (**PLF**) technologies, b) artificial intelligence-based learning applied to the data streams from PLF sensors, and c) domain-based concept-driven modeling, resulting in real-time, on-farm decision-making with respect to BRD pulls. Through literature review we identified four different PLF technologies which when integrated can predict the DART scores for BRD pulls with high precision and accuracy, namely 1) activity and rumination sensors via smart collar can be used for identifying depression, 2) feed intake monitoring with red-green-blue and depth camera for loss of appetite identification, 3) lung ultrasonography and computer-aided scoring system for detecting respiratory rhythm deviation, 4) facial infrared thermography based imaging for high-temperature detection. Highly sophisticated, data-driven artificial intelligence techniques like machine learning (for example, activity and rumination sensors uses random forest decision tree, feed intake monitoring uses support vector regressor) and deep learning (lung ultrasonography and facial infrared thermography uses convoluted neural nets) is being used to classify outcomes based on streams of big data available from PLF sensors, for BRD prediction. Quite often a combination of techniques is used by each of these PLF technologies. The classification outcomes from these different PLF technologies should be collated (as shown in Figure 1) and should be used as an input to a concept-driven mechanistic programming model (in which the DART scoring logic must be hardcoded) which can predict the DART scores of individual animals in the arrival lots. A probable choice to predict DART scores (out of many possibilities) could be a multivariable logistic regression model. More accurate and earlier prediction of BRD will lead to the faster implementation and better targeted preventive interventions, such as vaccination, meta phylaxis, management of processing and transport time, and preconditioning programs. More accurate and precise identification of BRD candidates will also prevent a significant fraction of economic losses currently incurred from BRD, thereby justifying the investment in the described PLF technology infrastructure.

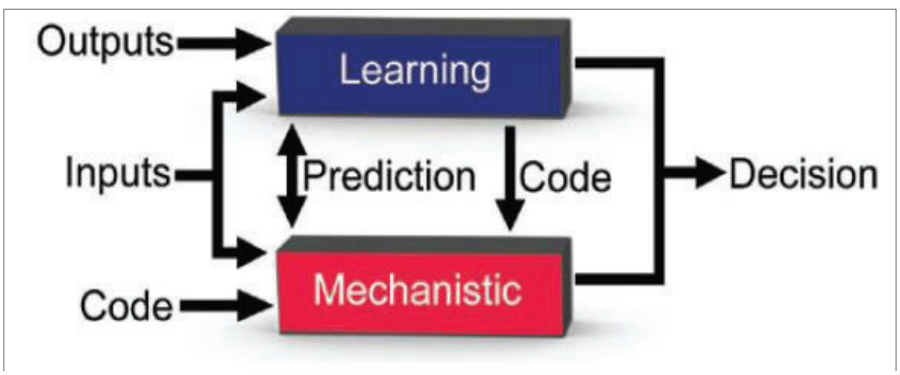


Figure 1. A theoretical representation of a parallel hybridization of data (learning) and concept-driven paradigms (mechanistic) in which *decision (BRD Pull candidate identification)* represents a combined prediction that met the minimum acceptability threshold. Adapted from Tedeschi et al., (2021).

Effect of weaning strategy and backgrounding length on growth performance and carcass characteristics of beef steers. A. M. Pittaluga and A. E. Relling. *The Ohio State University, Wooster, OH*

Chronological differences in adipocyte formation between depots that seem to arise in the neonatal stage and close to weaning. Therefore, an opportunity window arises to increase intramuscular fat deposition without concomitantly increasing 12th rib fat thickness and yield grade (YG). This study aimed to investigate the effect of weaning strategy (WS; early weaning at 130 ± 21 d vs normal weaning at 187 ± 20 d) and backgrounding length (BGL; short vs long backgrounding) on growth performance and carcass characteristics of beef steers. One hundred and twenty Angus × SimAngus-crossbred steers (IBW = 130 ± 11.2 kg) were used in randomized complete block design with a 2 × 2 factorial arrangement of treatments. Steer claves were blocked by age, stratified by body weight (BW), and randomly assigned to 1 of 4 treatments (n = 2 pens/treatment). Early weaned calves were offered an average of 4.5 kg/d (dry matter [DM] basis) of a whole shelled corn-based diet for 57 d until nursing calves were normal weaned. Subsequently, all steer calves were offered in average either 7.5 kg/d of a hay-based diet for 196 d or 8 kg/d (DM basis) of a concentrates-based diet for 84 d for the long or short backgrounding, respectively. Upon finalization of the backgrounding periods, steers were finished on a ground corn (GC)-based diet until harvested at a common 12th rib fat thickness, determined by ultrasound. During the finishing period, individual feed intake data was recorded through the GrowSafe (GrowSafe®, GrowSafe Systems Ltd., Airdrie, AB, Canada) feeding systems bunks. Data were analyzed as a randomized complete block design using PROC MIXED in SAS. Early weaned steers had greater BW ($P < 0.01$) at the beginning of the backgrounding and finishing period due to a greater average daily gain (ADG) since weaning. At the beginning of the finishing phase, steers with a long BGL were heavier ($P < 0.01$) than steers with a short BGL. There was a WS × BGL interaction for FBW ($P = 0.01$), where normal weaned steers with a long BGL were the heaviest among treatments. In the finishing phase, steers that were previously backgrounded for a longer period had greater DMI and ADG but lower G:F ($P < 0.01$). For days on feed (DOF), there was WS × BGL interaction ($P = 0.03$) where early weaned steers backgrounded for a longer period required less DOF to reach the finishing target than the remaining treatments. A treatment interaction occurred ($P \leq 0.03$) for hot carcass weight (HCW) and rib eye area (REA). Normal weaned steers with a longer BGL had the greatest HCW, and together with early weaned steers with a short BGL had the greatest REA among treatments. No effect of WS or BGL was observed for marbling score (MS), 12th rib fat thickness, YG, and quality grade ($P \leq 0.20$). Results from this study indicate that early weaning followed by a 196-d backgrounding period in a forage-based diet did not improve marbling score of beef steers when harvested at a common 12th rib fat thickness but required fewer DOF during the finishing phase to reach harvesting target.

Supplemental organic trace minerals and a yeast culture product "stress pack" in newly weaned steer calves: effects of use and delivery method on growth performance, efficiency, and hepatic trace mineral content. T. L. M. Ribeiro, E. R. Gubbels, F. L. Francis, S. R. Hanson, T. G. Hamilton, T. C. Norman, W. C. Rusche, and Z. K. Smith. *South Dakota State University, Brookings, SD*

The objective of the study was to determine if use and method of delivery of added organic trace minerals (Availa 4, ZINPRO, Eden Prairie, MN) and a *Saccharomyces cerevisiae* yeast culture product (Diamond V XPC, Diamond V, Cedar Rapids, IA) have an influence on growth performance, growth efficiency, and hepatic trace mineral measures upon introduction to the feedlot in newly weaned beef steer calves. Crossbred steer calves (n = 192; 565 ± 31.0 lbs) from a single source, were used in a 49-d randomized complete block design experiment at the Ruminant Nutrition Center in Brookings, SD after being transported for 6.5 h. Within 36 h of weaning, steers were individually weighed and allotted to one of 24 pens (n = 8 steers per pen; 8 pens/treatment) and randomly assigned to 1 of 3 treatments: 1) traditional receiving diet fed (Con); 2) traditional receiving diet fed and fed the "stress-pack" directly in the diet (Force); 3) traditional receiving diet fed and offered a low-moisture, cooked molasses block fortified with the "stress-pack" (Tub). The "stress-pack" was offered for the first 28 d of the 49-d receiving period. Hepatic biopsy samples were collected from a sub-sample of steers (n = 14 steers) on the day of weaning and subsequent samples were collected from the same sentinel steer (n = 1 steer/pen) on d 14, 28 and 49 for the determination of hepatic Co, Cu, Mn, and Zn. Data were analyzed as a randomized complete block design with pen as an experimental unit. Treatment was included as a fixed effect and block (batch fraction) was considered a random effect in the statistical model. Hepatic trace mineral content was analyzed via repeated measures and included the fixed effects of treatment, day, and their interaction. Treatment effects were tested by means of the following orthogonal contrasts: 1) Con vs. Force and Tub and 2) Force vs. Tub. A treatment × day interaction ($P \leq 0.01$) for hepatic concentrations of Co and Cu was noted. Force had greater hepatic Co ($P \leq 0.05$) compared to Tub and Con on d 14, 28, and 49. Steers from Tub had greater hepatic Co compared to Con on d 14 ($P < 0.05$), but hepatic Co content was similar to Con on d 28 and 49 ($P > 0.10$). Force had greater hepatic Cu ($P \leq 0.05$) compared to Tub and Con on d 14, 28, and 49. Steers from Tub had greater hepatic Cu compared to Con on d 14 and 28 ($P < 0.05$), but hepatic Cu content was similar to Con on d 49 ($P > 0.10$). Force steers tended ($P = 0.08$) to have greater DMI compared to Tub from d 1 to 14. From d 15 to 28, steers offered the "stress-pack" had greater DMI ($P = 0.01$) and tended ($P = 0.07$) to have greater ADG compared to Con by 12.5%. From d 29 to 49, steers offered the "stress-pack" had greater DMI ($P = 0.01$) and steers from Force consumed 6.9% more DM compared to Tub ($P = 0.01$). Cumulative DMI ($P = 0.01$) and ADG ($P = 0.05$) was greater for steers from Force compared to Tub by 5.4% and 9.4%, respectively. Application of a "stress-pack" in diets offered to newly weaned cattle enhanced production responses, but method of delivery influences DMI and daily gain.

Effects of NaturSafe and ractopamine HCl on the performance, antioxidant capacity, immune system, and muscle gene expression of finishing steers.

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Saccharomyces cerevisiae fermentation products (SCFP) has been shown to improve immune function and antioxidant capacity, and growth in rapidly growing cattle. The beta-agonist, ractopamine hydrocholoride (RAC) is commonly fed to feedlot cattle and has previously been shown to alter cytokine concentration and muscle cytokine (myokine) gene expression. The objective was to determine the effects of feeding NaturSafe (Diamond V, Cedar Rapids, IA) on the immune system, antioxidant capacity, and growth of finishing steers receiving ractopamine hydrochloride. Angus-cross steers (288; 960 ± 81 lb) from two sources were housed at the Iowa State Beef Nutrition Farm (Ames, IA) for this 90-day finishing study. At study initiation, steers were blocked by source into groups, stratified by weight, and randomly assigned to pens. Steers were also implanted with a component TE-200 (Elanco Animal Health, Greenfield, IN) at study initiation. Pens were randomly assigned to treatments (16 pens/treatment), including NS57 receiving NaturSafe beginning 57 days before harvest; NS29 receiving NaturSafe beginning 29 days before harvest, and control (CON) receiving no SCFP. NaturSafe supplementation was targeted at 12 $g \cdot steer^{-1} \cdot day^{-1}$, and all steers were fed RAC (Optaflexx, Elanco Animal Health) at 300 $mg \cdot steer^{-1} \cdot day^{-1}$for 29 days before harvest. Blood samples from three steers per pen and individual animal BW were collected 57, 29, 13, and 1 (BW only) day before steers were harvested at a commercial facility (National Beef, Tama, IA). Longissimus thoracis muscle samples were also collected 29 and 13 days before harvest from one steer per pen for analysis of relative gene expression of muscle cytokines (myokines), antioxidant and growth signaling. Blood was analyzed for interleukin 8 expression, antioxidant capacity and immune cell population (d -13 only). Data were analyzed using the Mixed procedure of SAS 9.4 (Cary, NC) with pen as the experimental unit. The model included fixed effects of treatment and group. Increased BW compared to CON was observed 29, 13, and 1 day before harvest in NS57 steers ($P \leq 0.05$), with NS29 being intermediate 13 and 1 day before harvest. Overall G:F was improved in NaturSafe-fed steers ($P = 0.01$). Antioxidant capacity (plasma FRAP) was greater in NS57 compared to CON before RAC (d -29; $P = 0.02$). The percent of gamma delta T cells and natural killer cells in both NaturSafe supplemented groups was greater than CON 13 days before harvest ($P = 0.02$). There were no treatment × day effects for muscle gene expression measured in this study ($P \geq 0.25$). Interleukin 6 tended to be decreased in NaturSafe steers 13 days before harvest ($P = 0.098$). No other treatment effects were observed for muscle gene expression. Muscle gene expression of interleukin 8 was decreased ($P = 0.03$) and expression of NF-E2- related-factor 2 (NRF2) tended to be increased ($P = 0.098$) due to RAC feeding. Increased growth in NaturSafe-fed cattle may be related to changes in antioxidant capacity, and the immune system.

Effects of a nutritional packet on calf-fed system growth performance, carcass traits, nutrient digestibility, and ruminal characteristics. C. J. Rush, J. O. Sarturi, D. D. Henry, N. O. Huerta-Leidenz, F. M. Ciriaco, D. R. Woerner, A. M. Lopez, K. S. Silva, B. M. Rodrigues, K. T. Nardi, S. D. Peters, M. R. DiManna, A. M. Osorio-Doblado, K. D. Coello, A. A. R. Quijada, J. K. Hinds, Y. F. M. Saes, and K. D. Wilkes. *Texas Tech University, Lubbock, TX*

The effects of a nutritional packet containing a direct-fed microbial combined with vitamins/electrolytes offered to a calf-fed system on growth performance, carcass characteristics, apparent total tract digestibility, ruminal papillae morphology, and volatile fatty acid (VFA) profile were evaluated. Angus crossbred steer-calves (n = 60; BW = 234 ± 4 kg) were assigned to a randomized complete block design (block = body weight; steer = experimental unit) and stratified into 2 treatments: a) control (no packet, finely-ground corn carrier only); and b) 30 g of DM/animal-daily of a nutritional packet [live-yeast (*Saccharomyces cerevisiae*; 8.7 Log CFU/g), Vitamin C (5.4 g/kg of Ascorbic acid), Vitamin B1 (13.33 g/kg of Thiamine hydrochloride), NaCl (80 g/kg), and KCl (80 g/kg)]. Animals were individually offered [electronic feed-bunks (Smart-Feed/C-Lock Inc.)] a steam-flaked corn-based finishing diet ad libitum, once daily for 233 d. Treatments were offered during the first (phase-1) and last (phase-2) 60 d on feed. Body weight measurements were taken every 30 d before feeding. During the digestibility assessments (phases 1 and 2), feed samples were collected once daily, while fecal samples twice daily (0700 and 1700 h) from each steer during 4 consecutive days. Fecal and feed sample composites were dehydrated (55^{o}C) and ground (1 mm) for further analyses. The 288-h indigestible NDF was used as dietary internal marker to estimate fecal output and used to calculate nutrient digestibility. Upon harvest (federally inspected facility), samples of rumen tissue and content were collected. Ruminal epithelial tissue was dissected for morphology assessment, while ruminal content was used for volatile fatty acid analysis. Data were analyzed using the GLIMMIX procedure of SAS. Steers offered the nutritional packet had 14% less ($P < 0.01$) intake and 18% greater ($P = 0.01$) gain efficiency during the initial 30-d on feed. Overall intake (d0 to d233) was 6% greater ($P = 0.02$) for steers consuming the nutritional packet, while ADG (1.56 vs. 1.61), and gain efficiency (0.204 vs. 0.198) for control and packet, respectively, were unaffected ($P \geq 0.44$). Dressing percent of steers offered the packet was 1 percentage-unit greater ($P = 0.02$), while other carcass variables were unaffected ($P \geq 0.33$). Digestibility of DM, NDF, and ADF were increased ($P < 0.01$) by 2.5%, 8.3%, and 10%, respectively. Average papillae area was increased ($P = 0.02$) by 30% and the total VFA tended ($P = 0.09$) to increase by 8% for animals consuming the packet. Calf-fed steers improved gain efficiency during the initial 30 d after feedlot arrival, while superior intake, dressing percentage, nutrient digestibility, total VFA, and ruminal papillae area appear to last until cattle harvest.

Using whole cottonseed to replace dried distiller's grains plus soluble and prairie hay in finishing rations balanced for physically effective neutral detergent fiber.

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Recent increased demand for dried distillers grains plus solubles (DDGS) and fluctuations in DDGS availability have created a need to find alternative commodities to provide protein and fat within feedlot diets. The objective of this experiment was to determine if replacing hay and DDGS with whole cottonseed (WCS) affected the performance, carcass characteristics, and plasma metabolites of feedlot cattle when diets were balanced for physically effective neutral detergent fiber (peNDF). Crossbred heifers (n = 103) and steers (n = 104) were allocated to 12 pens in a randomized complete block design (6 pens per treatment; 3 pens of heifers and 3 pens of steers per treatment) with sex and body weight (BW) serving as blocking factors. Pens were previously randomly allocated to 1 of 2 experimental treatments. Treatments consisted of the control diet (CON; prairie hay, DDGS, dry-rolled corn, and liquid supplement), and the WCS diet (CTN; WCS, dry-rolled corn, and molasses). Both treatment diets contained a dry vitamin and mineral supplement and urea at the same inclusion rate. Body weights were collected every 14 d until d 56. After d 56, BW were collected every 28 d. Cattle were shipped to harvest in 3 different harvest groups based on BW block. Body weights tended to be greater for cattle receiving the CTN diet by d 56 ($P = 0.06$) and were greater from d 84 to d 140 ($P \le 0.03$). The CTN treatment also tended to have a heavier final BW ($P = 0.10$). Average daily gain (ADG) was greater for the CTN treatment from d 15 to 28 and again from d 43 to 56 ($P \le 0.02$). Overall, the CTN treatment had a greater ADG across the entire experiment ($P = 0.03$). Dry matter intake (DMI) was greater for the CON treatment from d 0 to 14, but not different between treatments for any other interval across the experiment ($P \ge 0.35$). Gain to feed ratio (G:F) was greater for the CTN treatment from d 15 to 28, 43 to 56, and for the overall experiment ($P \le 0.05$). There were no differences between treatments for fecal consistency score (FCS) until d 42 ($P = 0.03$), at the beginning of beta-agonist feeding and prior to harvest ($P < 0.01$) when the CON treatment had a greater FCS. The CON treatment also tended to have a greater FCS change over the course of the experiment ($P = 0.06$). The CON treatment tended to have a more neutral fecal pH (6.77) on d 14 ($P = 0.08$), but the CTN treatment fecal pH tended to be more neutral on d 56, 84, and prior to beta- agonist feeding ($P \le 0.09$). On d 140 and final d of the experiment, the CTN treatment had a more neutral fecal pH ($P < 0.01$). The CTN treatment had greater hot carcass weights ($P = 0.02$), fat thicknesses ($P = 0.05$), and final calculated USDA Yield Grades ($P = 0.001$). There was no difference in rib eye area or marbling score ($P \ge 0.67$) between treatments. No treatment × day interactions were detected for plasma glucose, lactate, or plasma urea nitrogen (PUN) concentrations. A day effect was observed for plasma glucose, lactate, and PUN concentrations ($P < 0.01$). Treatment effects were observed for plasma lactate and PUN concentrations with the CON treatment having greater concentrations ($P < 0.01$). This research demonstrated that WCS could effectively replace the roughage and byproduct protein and fat source within a feedlot finishing diet while simultaneously resulting in increased animal performance.

Interaction of corn processing method and Sweet Bran inclusion in finishing diets.

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Two studies were conducted to evaluate the effect of corn processing method and inclusion of Sweet Bran (SB; Cargill, Blair, NE) on feedlot performance and nutrient digestion. Treatments were arranged as a 2 × 3 factorial, consisting of two corn processing methods [steam-flaked corn (SFC) or a 2/3 high-moisture corn (HMC) 1/3 dry-rolled corn (DRC) blend] and three inclusions of SB (0, 20, or 40% of diet dry matter). In Exp. 1, yearling steers (n = 480; initial body weight = 799 ± 33.3 lb) were utilized in a generalized randomized block design. A linear interaction was observed ($P < 0.01$) for average daily gain (ADG), feed efficiency (G: F), and hot carcass weight (HCW). At 0% SB, cattle fed SFC had greater ($P < 0.01$) ADG and HCW than cattle fed HMC/DRC. As SB increased, ADG and HCW increased at a greater rate for HMC/DRC fed cattle than SFC fed cattle resulting in similar ADG and HCW at 40% SB. At 0% SB, cattle fed SFC were 12.4% more efficient ($P < 0.01$) than cattle fed HMC/DRC, but as SB inclusion increased, the improvement declined to 5.3% at 40% SB. In Exp. 2, six fistulated steers were utilized in a 6 × 6 Latin square design. In Exp. 1 and Exp. 2, cattle fed SFC or HMC/DRC had greater dry matter intakes (DMI; $P < 0.01$) as SB inclusion increased. In Exp. 2, digestible energy (DE) intakes were also greater ($P < 0.01$) as SB inclusion increased. The improvements in ADG and G: F when feeding Sweet Bran in Exp. 1 can be explained by greater DMI and increased DE intake. Feeding up to 40% SB in SFC diets did not affect G:F whereas feeding SB in HMC/DRC based finishing diets linearly improved G:F at inclusions up to 40%.

Effects of supplemental Zn concentration and source on performance and biomarkers of immune Status in receiving steers. D. T. Smerchek, J. L. McGill, and S. L. Hansen. *Iowa State University, Ames, IA*

Newly received, low-risk weaned Angus crossbred steers (n = 72; initial BW = 626 ± 54 lbs) were enrolled in a 42-d feedlot receiving study to determine the effects of dietary supplemental Zn concentration and source on biomarkers of immune status, trace mineral (TM) status, and growth performance. Steers were housed in 12 pens equipped with GrowSafe feed bunks (n = 1 GrowSafe feed bunk/pen of 6 steers; GrowSafe Systems Ltd., Airdire, AB, Canada) for measurement of individual animal feed disappearance. Cattle received a diet of corn silage, Sweet Bran, DDGS, and a premix delivering dietary TM treatments. The three dietary treatments (n = 24 steers/treatment) included: 1) TM supplemented from an organic source (Availa4; Zn amino acid complex, Mn amino acid complex, Cu amino acid complex, and Co glucoheptonate; Availa4, Zinpro Corp., Eden Prairie, MN) at 7 $g \cdot hd^{-1} \cdot d^{-1}$; for the entirety of the 42 d receiving trial (ORG); 2) ORG plus AvailaZn to provide 1,000 mg $Zn \cdot hd^{-1} \cdot d^{-1}$for first 14 d (ORG+Z); 3) inorganic TM sources (Zn sulfate, Cu sulfate, Mn sulfate, and Co carbonate) to match TM concentration in ORG treatment (ING). Data were analyzed in the Mixed procedure in SAS 9.4 (SAS Inst. Inc., Cary, NC) with fixed effect of treatment and steer as experimental unit. Initial body weight was a covariate for growth performance analysis. Bodyweights were collected on d -1, 0, 14, 41, and 42. At the conclusion of the 42-d receiving study no difference in final BW was detected ($P = 0.19$; ING = 792, ORG = 807; ORG+Z = 807 ± 7.0 lbs) and there was no difference in overall ADG ($P = 0.19$; ING = 3.92, ORG = 4.29; ORG+Z = 4.28 ± 0.161 lbs). However, overall DMI tended to differ ($P = 0.06$; ING = 19.4, ORG = 19.7; ORG+Z = 18.1 ± 0.56 lbs) and G:F was greater in ORG+Z than ING, with ORG intermediate ($P = 0.04$; ING = 0.201, ORG = 0.218; ORG+Z = 0.237 ± 0.0102 lbs). Blood samples for plasma TM analysis were collected on d 0, 14, and 42 and analyzed as repeated measures. A treatment effect was noted ($P = 0.06$) in which plasma Cu concentration was greater in ING than ORG+Z, while ORG was intermediate. Plasma Cu concentrations decreased over time (Day; $P = 0.01$). Plasma Fe was unaffected by treatment or day ($P \geq 0.15$). Plasma Zn increased from d 0 to d 14, while d 14 and d 42 did not differ (Day; $P = 0.02$). Frequency and activation status of circulating CD8 T cells and Natural Killer (NK) cells in whole blood collected from all steers on d 0, 14, and 42 were evaluated as single timepoints. Frequency of total circulating NK and CD8 T cells did not differ ($P \geq 0.07$), however TM supplementation differentially affected markers of immune activation. Specifically, changes were noted in the expression of CD16, CD44 and CD8 on NK cells. These data indicate organic TM supplementation positively impacts feed efficiency in newly received weaned beef steers and that TM supplementation, regardless of source, influences markers of immune function but an exact relationship between TM and immune status has not been fully elucidated.

Rumination and ruminal characteristics of beef steers receiving steam-flaked corn-based finishing diet with increasing concentrations of dried distiller's grains with solubles.

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Although a considerable amount of research has been conducted to evaluate the impact of grain by-products, especially distillers' grains with solubles on feedlot performance. Research is limited on the evaluation of the physically effective fiber fraction of distillers' grains with solubles and their impact on rumination time and ruminal pH of finishing beef cattle. We hypothesized that dietary dried distillers' grains with solubles (DDGS) concentration would not impact total daily rumination of finishing steers, however, increasing level of steam-flaked corn replacement with DDGS would increase ruminal pH. The objective of the study was to evaluate rumination behavior and ruminal characteristics of beef steers fed steam-flaked corn-based finishing diets with 15, 20, or 25% DDGS on a dry matter basis. To keep diets isonitrogenous and isoenergetic, steam-flake corn (SFC), soybean meal and corn oil was replaced with DDGS. Ruminally cannulated steers (*n* = 6; average BW = 871 ± 37 lb.) were used in a 3 × 3 replicated Latin square experimental design that consisted of three dietary treatments and three 21 d periods. Each 21 d period consisted of 20 d of dietary adaptation followed by 1 d of sampling. Steers were fitted with sensory collars to record daily rumination (Allflex Livestock Intelligence; Natanya, Israel). Ingredient samples were collected weekly for dry matter analysis. Subsamples were composited monthly and analyzed by a commercial laboratory (ServiTech; Amarillo, TX) to determine nutrient composition. Weekly dietary samples were evaluated to determine estimated physically effective neutral detergent fiber NDF (epeNDF) using the Penn State Particle Separator (PSPS) equation. Actual physically effective NDF (apeNDF) was calculated by daily rumination time. Ruminal pH was measured using a handheld pH probe on d 21 at 0, 3, 6, 12, and 24 h post feeding. Proc Mixed was used for all analysis with steer as the experimental unit. One steer was removed from the entire study for reasons unrelated to the experiment. For particle separation, peNDF, rumination and digestibility variables fixed effects included diet and period and random effects included square and steer nested within square. For ruminal characteristics fixed effects included period, diet, time, and treatment×time interactions. Pre-planned linear and quadratic orthogonal contrast were calculated when $P < 0.10$. Total daily rumination and rumination per lb. of nutrient intake along with epeNDF, apeNDF, and ruminal pH did not differ across dietary inclusion of DDGS ($P \geq 0.14$). Total ruminal VFA concentration (m*M*) tended to be greater ($P = 0.07$) for steers consuming 15 or 20% DDGS than steers consuming 25% DDGS. Fecal NDF output tended to differ ($P = 0.07$) between diets, as dietary DDGS inclusion increased, fecal NDF increased. Apparent total tract organic matter digestibility (OMD) tended to differ ($P < 0.07$) across diets, where OMD decreased in a linear ($P = 0.03$) fashion as DDG inclusion increased. This data suggests that DDGS may influence acidosis risk through means other than increasing peNDF, such as starch dilution.

Effects of a supplemental water source and trace-mineral based electrolyte drinking solution on the performance and health of newly received feedlot calves. M. M. Smithyman[1], V. N. Gouvêa[1,2], D. L. Campbell[1], G. C. Duff[1], C. A. Loest[1], and M. E. Branine[3]. *[1]Clayton Livestock Research Center, New Mexico State University, Clayton, NM; [2]Texas A&M AgriLife Research and Extension Center, Amarillo, TX; [3]Zinpro Corporation, Eden Prairie, MN*

Newly received feedlot cattle are frequently subjected to prolonged periods of restricted access to feed and water due to marketing and transportation. The significant loss of water and key nutrients from the body can put the animal at increased risk for bovine respiratory disease (BRD). It is hypothesized that rapidly rehydrating calves upon arrival can aid these animals in making a healthy and easier transition to the feedlot while also minimizing a loss in value due to illness and decreased performance. The objective of this study was to rapidly replenish water and key nutrients in newly received feedlot calves by assessing water intake (WI) and providing a supplemental water source or a nutritional rehydration solution during the first three days after arrival. A total of 270 crossbred heifers (initial BW = 512 ± 36 lb) were blocked by truckload, ranked by initial BW, and allocated to one of 6 pens within block. Three experimental treatments were randomly assigned to pens of cattle (pen was the experimental unit). Therefore, there were 18 pens, 15 heifers per pen, with 6 pens per treatment. Treatments were: 1) Control (CON): water provided through standard in-pen automatic waterer only (Richie CM480; one waterer/pen); 2) Supplemental water source (SWS): CON + water provided with one additional 110-gallon stock tank/pen; 3) Nutritional rehydration solution (NRS): trace-mineral based drinking solution provided with one stock tank/pen as the only water source. Treatments were provided from days 1 to 4, after which supplemental tanks were removed. From days 5 to 56, cattle had access to CON, the automatic waterer only. The WI was measured daily, and BW was recorded on days 1, 4, 14, 28, and 56. The DART scoring system was employed during the 56-day experiment to monitor health for diagnosis of BRD. Performance data were analyzed using the MIXED procedure of SAS. Morbidity and mortality data were analyzed using the GLIMMIX procedure. Treatment × experimental period interactions were observed for dry matter intake (DMI; P=0.03), average daily gain (ADG; P=0.017), WI (P<0.001), and BW (P=0.06). An experimental period effect was observed for gain:feed (**G:F**; P<0.001). The DMI was greater for both SWS (12.4 ± 1.16 lb/day) and NRS (12.6 ± 1.16 lb/day) than CON (9.84 ± 1.16 lb/day) from days 5 to 15 (P≤0.01), and SWS (18.3 ± 1.14 lb/day) had greater DMI than CON (15.33 ± 1.14 lb/day) from days 16 to 29 (P=0.01). The ADG was lower for NRS than CON from days 1 to 4 (P=0.01); however, treatments did not affect ADG from days 5 to 56 (P≥0.12). There was an effect of experimental period on BW and G:F (P<0.001). The BW increased after day 4 in all sampling days. The G:F was greatest from days 5 to 15 (0.362 ± 0.02; P<0.001), but not from days 1 to 4 (0.046 ± 0.02) and 16 to 56 (0.208 ± 0.02; P>0.05). Both SWS (3.11 ± 0.50 gal/day) and NRS (4.66 ± 0.50 gal/day) had greater WI than CON (1.10 ± 0.50 gal/day) from days 1 to 4 (P≤0.001), but not from days 5 to 56 (P>0.36). Treatments did not affect morbidity and mortality (P≥0.20). The results from this experiment suggest that providing SWS or NRD to newly received calves during the initial three days following feedlot arrival increases WI and DMI; however, it has no effect on ADG or morbidity and mortality.

The effects of administering different metaphylactic antimicrobials on growth performance and health outcomes of high-risk, newly received feedlot steers. T. M. Smock[1], C. M. Coppin[1], C. L. Helmuth[1], J. L. Manahan[1], N. S. Long[1], A. A. Hoffman[1], J. A. Carroll[2], P. R. Broadway[2], N. C. Burdick-Sanchez[2], J. E. Wells[3], S. C. Fernando[4], and K. E. Hales[1]. *[1]Texas Tech University, Lubbock, TX; [2]USDA-ARS, Livestock Issues Research Unit, Lubbock, TX; [3]USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE; [4]University of Nebraska – Lincoln, Lincoln, NE*

The objective of this experiment was to compare methods of antimicrobial metaphylaxis on clinical health and growth performance outcomes during feedlot receiving and finishing periods. Multiple-sourced steers (n = 238) were used in a generalized complete block design consisting of 2 arrival date blocks, 6 treatment replications during the receiving period, and 15 treatment replications during the finishing period. Pen was the experimental unit for all dependent variables. Experimental treatments were: 1) negative control, 5 mL subcutaneous sterile saline; 2) subcutaneous administration of florfenicol, 40 mg/kg BW (NUF); 3) administration of ceftiofur in the posterior aspect of the ear, 6.6 mg/kg BW (EXC); or 4) subcutaneous administration of tulathromycin, 2.5 mg/kg BW (DRA). Both DRA and EXC decreased first BRD morbidity compared to NUF and CON ($P < 0.01$). Likewise, ADG, DMI, and G:F were greatest in DRA during the receiving period ($P \leq 0.02$), however, these observations were not substantiated throughout the finishing period on both a live and carcass-adjusted basis ($P \geq 0.12$). Additionally, no differences in carcass characteristics or liver abscess score were observed ($P \geq 0.18$). All CBC variables were affected by day ($P \leq 0.01$) except mean corpuscular hemoglobin concentration ($P = 0.29$). Treatment × time interactions observed for platelet count, WBC count, monocyte count and percentage, and lymphocyte percentage ($P \leq 0.03$). Nonetheless, all observed hematological values fell within normal ranges for cattle. The results of this work indicate that metaphylaxis with tulathromycin or ceftiofur effectively improved clinical health outcomes of high-risk calves, and that feedlot production metrics are similar overall among differing drugs evaluated.

Effects of replacing corn silage with alfalfa haylage in growing beef cattle diets.

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Corn silage is the predominant forage source for feedlot cattle production in the United States because of high yield. Alternatively, because of multiple cuttings per year and lower annual cost, use of alfalfa, or other forages, may increase opportunities for manure spreading, perennial soil cover, pollinator habitat and greater carbon fixation. The objective of this trial was to determine the feeding value of alfalfa haylage when replacing corn silage at the same dietary NDF concentration in growing cattle diets. One-hundred-sixty-eight Angus crossbred steers [719 ± 112 lbs of body weight (BW)] were blocked by arrival BW and randomly assigned to one of 28 pens at the University of Minnesota feedlot. Pens were randomly assigned to dietary treatments, comprised of (DM basis) 50% corn silage, 19.25% rolled corn grain, 19.25% high moisture corn, 7% dried distillers grains with solubles, and 4.5% liquid supplement (corn silage control, CS Control). Alfalfa haylage (AH) diets substituted corn silage at 33% (AH 33), 66% (AH 66) or 100% (AH 100) to provide 20.5% forage NDF. Growth performance measurements [dry matter intake (DMI), average daily gain (ADG) and gain to feed (GTF) ratio] were assessed for 56 to 70 days. Afterwards, steers received a common finishing diet until harvested. No effect of treatment (P = 0.18) was observed on DMI. There was a linear effect ($P \leq 0.05$) of replacing corn silage with alfalfa haylage on ADG and GTF. Cattle fed CS or AH33 had similar ADG, which was greater than that of steers fed AH100 ($P < 0.05$). Similarly, no differences were observed for GTF between steers fed CS and AH33 (P = 0.18); GTF in these treatments was greater than that in AH66 and AH100. No differences ($P \geq 0.10$) were observed in carcass traits. Alfalfa could potentially replace CS at 33% without impacting growth performance or carcass quality. Thus, there is opportunity to increase alfalfa acreage to enhance beef systems through ecosystem management while increasing revenues per acre through reduced costs of crop maintenance and greater opportunities to spread manure from beef cattle operations.

The effect of supplementing CLOSTAT® 500 (*Bacillus subtilis* PB6) to yearling steers in a commercial feedyard on health, *Salmonella* spp. prevalence, feedlot performance and carcass characteristics. T. Tilton[1], S. J. Trojan[2], P. R. Broadway[3], N. C. Burdick-Sanchez[3], J. A. Carroll[3], K. E. Hales[4], A. B. Word[5], K. J. Karr[5], B. P. Holland[5], G.B. Ellis[5], C.L. Maxwell[5], L. G. Canterbury[6], J. T. Leonhard[6], D. LaFleur[6], and J. E. Hergenreder[6]. [1]*West Texas A&M University, Canyon, TX;* [2]*Peak Beef Nutrition and Management Consulting, LLC, Casper, WY;* [3]*Livestock Issues Research Unit, Lubbock, TX;* [4]*Texas Tech University, Lubbock, TX;* [5]*Cactus Research, Amarillo, TX;* [6]*Kemin Industries, Inc., Des Moines, IA*

Crossbred beef steers, *n* = 2,100; 689.5 ± 83.69 lbs. initial body weight (BW) were used to evaluate *Bacillus Subtilis PB6* supplementation to yearling steers. Cattle were blocked by arrival date and assigned randomly to pen within block; pens were randomly assigned to treatment within block. Treatments, replicated in 15 pens/treatment with 70 steers/pen, included: 1) control (CON), diets containing no supplemental direct fed microbials; 2) CLOSTAT (CLO), diets supplemented with 0.5 g/hd/d *Bacillus subtilis* PB6 (CLOSTAT® 500, Kemin Industries, Des Moines, IA). Supplementing CLO reduced morbidity (*P* = 0.03), 10.38% (CLO) vs. 13.43% (CON), decreased the percentage of cattle treated once for bovine respiratory disease (BRD; *P* < 0.01), 9.14% (CST) vs. 12.76% (CON), and decreased BRD re-treatment rate (*P* = 0.03). Mortality did not differ among treatments (*P* = 0.23). Cattle removed from the study tended to be less for CLO than CON (53 vs. 73 head respectively, *P* = 0.06). The prevalence of fecal *Salmonella* was not different among treatments, (*P* ≥ 0.35). Overall fecal *Salmonella* counts tended to be less for CLO (1.59 log CFU/g) than for CON (2.04 log CFU/g; *P* = 0.07). Concentration of *Salmonella* in subiliac lymph nodes did not differ by treatment (*P* = 0.62); however, mean prevalence of lymph node *Salmonella* decreased 46% by CLO (28.66% vs. 15.48%, CON vs. CLO, respectively, *P* = 0.46). With deads and removals included, final BW was heavier for CLO steers than CON, (*P* = 0.05), and average daily gain (ADG; *P* = 0.08), and gain efficiency (G:F, *P* = 0.06) tended to be greater for CLO than CON. With deads and removals excluded, final BW, ADG, and G:F did not differ among treatments (*P* ≥ 0.30). Carcass traits were similar between treatments (*P* ≥ 0.15). Supplementing CLO improved health outcomes of yearling steers.

Corn processing, flake density, and starch retrogradation influence ruminal solubility of dry matter, starch, protein, and fiber. R. J. Trotta[1], K. K. Kreikemeier[2], R. F. Royle[3], T. Milton[4], and D. L. Harmon[1]. [1]*University of Kentucky, Lexington, KY;* [2]*Foote Cattle Co., Hoxie, KS;* [3]*Servi-Tech Inc., Dodge City, KS;* [4]*Midwest PMS, Firestone, CO*

Five ruminally-cannulated steers (body weight = 390 ± 8 kg) were used in three experiments to evaluate the effects of corn processing, flake density, and starch retrogradation on *in situ* ruminal solubility. In Exp. 1, corn was left whole or processed with no screen (coarsely cracked corn), ground through a 6-mm screen (coarsely ground corn), or ground through a 1-mm screen (finely ground corn). In Exp. 2, we produced steam-flaked corn at four densities: 24, 26, 28, and 30 lb/bu. These four flake densities were sifted for 20 s through a 4-mm screen to produce two particle sizes within each flake density: sifted flakes (> 4-mm) and sifted fines (< 4-mm). In Exp. 3, sifted flakes (26 lb/bu) were stored in heat-sealed foil bags for 3-d at either 23°C (starch availability = 55%) or 55°C to induce starch retrogradation (starch availability = 41%). All samples were weighed into nylon bags, swirled in the rumen for 10 s, and rinsed 5 times in a washing machine to estimate the soluble fraction of several nutrients. In Exp. 1, whole shelled corn had lesser ($P < 0.01$) ruminal solubility of all nutrients measured compared with ground corn. Corn ground with a screen (6-mm and 1-mm) had greater ($P < 0.01$) ruminal solubility of all nutrients measured compared with corn ground with no screen. Corn ground through a 1-mm screen had greater ($P < 0.03$) ruminal solubility of DM, total starch, crude protein (CP), acid detergent fiber (ADF), acid hydrolyzed fat (AHF), and minerals compared with corn ground through a 6-mm screen. In Exp. 2, increasing flake density linearly decreased ($P < 0.02$) the soluble fraction of DM, total starch, CP, ADF, AHF, P, K, S, and Zn of sifted flakes. The soluble DM fraction of sifted fines tended to decrease ($P = 0.06$) linearly with increasing flake density. Total starch, CP, neutral detergent fiber (NDF), and Zn soluble fractions of sifted fines were not influenced by flake density. In Exp. 3, storage of sifted flakes in heat-sealed foil bags at 55°C for 3-d decreased ($P < 0.04$) the soluble fractions of DM, total starch, CP, NDF, P, Mg, K, S, and Fe. With each increase in the degree of corn processing, there was an increase in the solubility of nutrients. Comparing corn ground to pass a 1-mm screen in Exp. 1 and 26 lb/bu steam-flaked corn from Exp. 2, the soluble DM fractions were numerically similar (38.1% and 44.4%, respectively), suggesting that fine-grinding corn may increase nutrient utilization similar to steam-flaked corn (26 lb/bu). Increasing flake density can decrease ruminal solubility of flakes; however, the soluble fraction of sifted fines is not influenced as much by changes in flake density. These findings show that it is critical to sample the proportion of flakes and fines consistently to avoid incorrect interpretations relative to steam-flaker quality control and/or laboratory analytical error. Inducing starch retrogradation decreases ruminal solubility of starch, non-starch organic matter, and minerals; however, it remains unclear if feeding retrograded flakes would influence growth performance.

Evaluating performance of calf-fed steers fed steam-flaked corn-based finishing diets with varying inclusions of distiller's grains. B. C. Troyer, M. M. Norman, L. J. McPhillips, A. K. Watson, J. C. MacDonald, and G. E. Erickson. *University of Nebraska – Lincoln, Lincoln, NE*

Steam-flaked corn (SFC) is gaining some popularity in Northern Plains and Midwest feeding areas. While performance benefits of feeding wet (WDGS) or modified (MDGS) distillers grains are well documented in diets with dry-rolled or high-moisture corn, fewer data are available evaluating distillers grains in SFC-based diets. Therefore, the objective of this study was to evaluate performance when feeding WDGS or MDGS at increasing inclusions in SFC-based finishing diets. Crossbred steers (n=560; initial BW =658 lb; SD = 33.3 lb) were utilized in a $2 \times 3 + 1$ factorial design with factors consisting of two distillers types (MDGS or WDGS) fed at one of 3 inclusions (10%, 20%, or 30%) replacing SFC on a dry matter (DM) basis. A 0% distillers treatment was used for determining type by inclusion interactions. An interaction between type and inclusion of distillers was observed for dry matter intake (DMI; P=0.06) and feed efficiency (G:F; P =0.02). Intake for steers fed WDGS tended to quadratically increase (P=0.08), while steers fed MDGS had a more dramatic linear increase ($P < 0.01$) in DMI. Increasing WDGS inclusion resulted in a linear increase in G:F ($P = 0.01$), whereas increasing MDGS inclusion had no effect on G:F ($P = 0.16$). No interaction between type and inclusion of distillers grains for other variables (P>0.20). Feeding distillers grains, regardless of type, resulted in linear increases in daily gain (ADG), hot carcass weight, and backfat ($P \leq 0.03$). Control cattle gained 3.80 lb/d while cattle fed 30% MDGS and WDGS had ADG of 4.15 lb/d and 4.19 lb/d, respectively. Overall, gain of calf-fed steers was improved when distillers grains was increased in steam-flaked corn based finishing diets regardless of type, but G:F was increased with WDGS and not MDGS suggesting feeding WDGS provides more energy than MDGS in SFC-based diets.

Impact of steam-flaked rye fed in combination with steam-flaked corn on performance and carcass characteristics of yearling steers.

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The objective of this study was to evaluate the effects of increasing inclusions of steam-flaked hybrid rye (SF rye) replacing steam-flaked corn (SFC) in finishing diets on cattle performance and carcass quality. Rye was grown as one hybrid and processed at a single feedyard in eastern Nebraska ((31.9 lb/bu for SF rye and 26.9 lb/bu for SFC). Crossbred yearling steers (n = 400, initial BW = 880 ± 52 lb) were used in a randomized block design (blocked by BW and source), stratified, and assigned randomly to pen (n = 40), and pen assigned randomly to treatment. Four treatments were evaluated, a control with no SF rye (0%), and 3 inclusions of SF rye where the rye replaced 25%, 50%, or 100% of the SFC in the diet (0%, 15.4%, 30.8%, and 58.4% SF rye respectively). A linear decrease in carcass weight, dry matter intake, average daily gain (ADG), and gain:feed (G:F) was observed as SF rye inclusion increased in the diet ($P \leq 0.01$). Intake decreased by 2.7 lb per day as SF rye increased from 0 to 100% of the grain inclusion. A 14.5% reduction in ADG and 6.2% decrease in G:F was observed as SF rye replaced SFC, which lead to decreases in calculated NEm and NEg dietary energy values based on performance. Longissimus muscle area ($P \leq 0.01$), 12th rib fat ($P \leq 0.03$), and marbling score ($P \leq 0.01$) decreased linearly with increasing rye inclusion due to performance. Calculated yield grade did not differ among treatments ($P = 0.16$). These data suggest no evidence of an associative effect for blending SF rye with SFC. Based on dietary energy calculated using performance, SF rye has approximately 92% the energy value of steam-flaked corn. Feeding steam-flaked rye grain decreased intake, gain and feed efficiency suggesting SF rye contains less energy than steam-flaked corn.

Effect of three different initial implant programs on beef × dairy steer feedlot performance and carcass characteristics. K. R. Wesley[1], A. B. Word[2], B. P. Holland[2], K. J. Karr[2], J. P. Hutcheson[3], L. A. Walter[3], and B. J. Johnson[1]. *[1]Texas Tech University, Lubbock, TX; [2]Cactus Feeders, Amarillo, TX; ‡Merck Animal Health, Madison, NJ*

Historically, bull calves have been viewed as a low-value byproduct of milk production; however, prevalence of beef × dairy steers in feedlots during the last several years has increased dramatically. Producers are searching for ways to optimize performance of these cattle during finishing though growth-promoting technologies. The objective of this study was to evaluate dosage and timing of trenbolone acetate (TBA) administration on live performance and carcass characteristics of beef × dairy steers. A total of 6,895 beef × dairy steers (initial body weight = 345 ± 11.5 lbs) were allotted into 30 pens with pen as the experimental unit. Each pen was randomly assigned one of three implant treatments: 1) Revalor-IS (IS) at d0, IS at d80, and Revalor-XS (XS) at d160 (IS/IS/XS); 2) Ralgro at d0, IS at d80 and XS at d160 (Ral/IS/XS); or 3) Encore at d0 and XS at d160 (Enc/XS). Steers were blocked by arrival date, each pen was terminally sorted three ways at approximately 250 d, and shipped at 329 ± 25 days on feed. For live outcomes, fixed effects of implant treatment and block were evaluated. For carcass outcomes, fixed effects of implant treatment, terminal sort group, interaction of treatment × sort group, and block were evaluated. Only effects of implant treatment and interaction of implant treatment × sort group are presented. Data are reported on a deads-and-removals-out basis. Overall removals, morbidity, and mortality were similar across treatments ($P \geq 0.42$). Initial body weight (BW) was similar ($P = 0.51$) across treatments. Steers administered TBA prior to d 160 were on average 12.8 lbs heavier ($P < 0.001$) than Enc/XS steers at d 160. Final BW was not different ($P = 0.15$) statistically, but numerically IS/IS/XS increased BW an average 15.5 lbs compared to other treatments. Administration of a TBA-containing implant earlier in the feeding period resulted in a greater prevalence of bullers from IS/IS/XS to Ral/IS/XS to Enc/XS (6.89, 5.15, 2.38%, respectively; $P < 0.001$). Overall, dry matter consumption increased ($P < 0.01$) 2.3% from Enc/XS to IS/IS/XS; however, intake was similar as a percentage of body weight. Average daily gain and feed efficiency were similar ($P \geq 0.11$). Hot carcass weight increased 7.6 lbs for IS/IS/XS compared to Enc/XS steers, but was not statistically different ($P = 0.30$). Similarly, ribeye area was 0.2 in^2 larger for IS/IS/XS compared to Enc/XS, but not statistically different ($P = 0.56$). Dressed yield, heavy carcass occurrence, and 12^{th} rib fat thickness were similar ($P \geq 0.16$). Marbling score differed ($P = 0.04$), and Enc/XS graded a greater proportion of USDA Prime and fewer USDA Select carcasses than IS/IS/XS ($P < 0.05$). Additionally, fewer Enc/XS and Ral/IS/XS carcasses tended ($P = 0.07$) to be yield grade (YG) 3, and exhibited numerically more ($P \geq 0.39$) YG 1 and 2 carcasses than IS/IS/XS. Liver abscesses were most prevalent ($P = 0.04$) in Ral/IS/XS and IS/IS/XS steers, however no differences ($P = 0.38$) in abscess severity were observed. Live performance was similar across implant treatments and delayed administration of TBA-containing implants decreased prevalence of buller pulls ($P < 0.001$). While delaying administration or decreasing total dosage of aggressive implants may impact quality grade, few differences in performance in the study were observed as a result of initial implant.

Evaluation of the effects of hempseed cake on ruminal fermentation parameters, nutrient digestibility, nutrient flow, and nitrogen balance in finishing steers. T. M. Winders[1], B. W. Neville[2], and K. C. Swanson[1]. *[1]North Dakota State University, Fargo, ND; [2]Carrington Research and Extension Center, Carrington, ND*

There is interest in feeding industrial hemp production byproducts to livestock as demand for hemp oil for human use increases. While hempseed cake has recently been evaluated in finishing diets fed to growing heifers, little is known about the digestibility and ruminal fermentation parameters associated with this feedstuff. A nutrient balance experiment utilizing crossbred steers (n = 5; initial BW = 542 kg, SD = 40 kg) in a Youden square design was conducted to evaluate the effects of feeding hempseed cake (HEMP) or dried corn distillers grains plus solubles [DDGS; each included at 20% of diet dry matter (DM) in respective treatments] in comparison to a dry-rolled corn-based negative control treatment (CON) on organic matter (OM) intake, ruminal fermentation parameters, nutrient digestibility, nutrient flow and nitrogen balance. Organic matter tended ($P = 0.07$) to increase and OM total tract digestibility decreased ($P = 0.02$) in steers fed the HEMP diet compared to steers fed the DDGS and CON diets. Total tract nitrogen digestibility was greatest ($P < 0.01$) in steers fed the HEMP diet, while total tract digestibility in all other nutrients was not influenced ($P \geq 0.13$) by treatment. Furthermore, apparent ruminal digestibility for OM was greater ($P < 0.01$) in steers fed the HEMP or CON diets than in steers fed the DDGS diet, and neutral detergent fiber, acid detergent fiber (ADF), and true ruminal digestibility for nitrogen was greatest ($P \leq 0.04$) in steers fed the HEMP diet than in the other treatments. Ruminal essential amino acid degradation was greater ($P < 0.01$) in steers fed the HEMP diet than in steers fed the DDGS and CON diets. Total ruminal VFA concentration was greater ($P < 0.01$) in steers fed the HEMP diet than in steers fed the DDGS and CON diets, while ruminal pH was not influenced ($P = 0.93$) by treatment. A treatment by hour interaction ($P = 0.01$) was observed for ruminal ammonia concentration, with steers fed the HEMP diet being greater than steers fed the CON diet at all hours, and greater than in steers fed the DDGS diet at all hours besides 1, 7, 15, and 21. Nitrogen retention was greatest ($P < 0.01$) in steers fed the HEMP diet, intermediate in steers fed the DDGS diet, and lowest in steers fed the CON diet, suggesting that feeding hempseed cake improved utilization of N compared to the other treatments when fed to finishing steers. Taken together, these results suggest that although ruminal digestibility of all nutrients is improved in steers fed the HEMP diet, the greater ADF concentration in hempseed cake negatively influences OM digestibility when fed to finishing steers.

Factors affecting growth, efficiency, and carcass quality of finishing dairy × beef hybrids.

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Our objectives were to determine the factors affecting growth performance, efficiency, and carcass attributes of dairy-beef hybrid calves. Factors considered in this analysis were pre-finishing plane of nutrition, season, and breed of beef sire. Dairy × beef crossbred steer calves (3 to 7 d of age) with known parentage and genetic merit were acquired by Land O' Lakes Calf Milk Research Facility at Grey Summit, Missouri and maintained on either a moderate plane of nutrition or high plane of nutrition from 0 to 12 wk of age. This experimented was conducted in 4 blocks with 35 to 72 steers per block. Calves (*n* = 211, BW = 270 ± 35.2 lbs) were then transported 426 miles at an average age of 92 ± 1.6 d. Calves were from predominantly Holstein dairies in the Midwest and were predominantly bred to Angus (*n* = 147), Simmental (*n* = 34), Limousin (*n* = 26), or Charolais (*n* = 4) sires. Upon arrival at the WSBRC, steers were placed on hay overnight and initial BW taken the following morning (d 0). Steers were dewormed and vaccinated for clostridial diseases and BRD and implanted with Ralgro on d 0. Steers were sorted by BW within previous treatment into 4 to 5 head pens and fed the same standard receiving diet containing Sweet Bran (51%), dry-rolled corn (15%) and prairie hay (28%) on a DM basis for 2 wk, supplying 17.5% crude protein and 0.48 Mcal NEg/lb. Steers were transitioned to a grower diet consisting of Sweet Bran (40%), dry-rolled corn (23%), prairie hay (20%), and cottonseed meal (5%) on a DM basis to supply 18.4% crude protein and 0.50 Mcal NEg/lb until calves weighed approximately 650 lbs from d 28 to 112. On d 112, steers were transitioned to a finishing diet consisting of consisting of 12% prairie hay, 28% Sweet Bran, and 55% dry-rolled corn supplying on a DM basis 12% crude protein and 0.61 Mcal NEg/lb. A final finishing diet (8% prairie hay, 20% Sweet Bran and 62% dry-rolled corn) was fed at the end of the finishing phase (d 224 to slaughter). Steers were reimplanted on d 56 with Ralgro, d 112 with Component TE-IS, and on d 224 with Component TE-S. The final 28 d of finishing steers diets included ractopamine hydrochloride at a rate of 300 $mg \cdot steer^{-1} \cdot d^{-1}$. High plane of nutrition during the feeding of milk replacer and starter period increased ($P \leq 0.03$) initial BW at arrival and through d 84 on feed. From d 112 through harvest BW was not affected ($P \geq 0.08$) by pre-finishing plane of nutrition. Calves received during the winter and spring were heavier ($P < 0.01$) on arrival through d 168 and at harvest and gained BW more rapidly during the growing phase and final finishing phase than steers received during the summer months. Steers sired by Angus sires were heavier throughout finishing ($P < 0.01$) and gained BW more rapidly ($P < 0.01$) than steers sired by Continental breeds. Breed of sire and season have a large impact on performance of finishing dairy x beef hybrids.