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1000 Effects of anabolic implants on growth and carcass traits of feedlot steers and heifers: A meta-analysis. C. D. Reinhardt*[1] and L. R. Corah[2], [1]*Kansas State University*, *Manhattan,* [2]*Certified Angus Beef*, *Manhattan, KS*.

Data from 82 studies (60 steer and 22 heifer studies) were compiled and analyzed to evaluate the effects of anabolic implants on feedlot performance and carcass traits. Dependent variables in the model included ADG, G:F, DMI, dressing percentage, HCW, and marbling score. Categories created for type and dosage of active compound were: low dose primarily estrogenic hormone (E2; LOW), moderate dose E2 (MOD), intermediate dosage combination E2 + trenbolone acetate (TBA; INT), and full-strength TBA or E2 + TBA (HIGH). Treatment categories were: no implant, single MOD, single HIGH, delayed HIGH, initial and terminal MOD, initial and terminal INT, initial LOW and terminal HIGH, initial MOD and terminal HIGH, initial INT and terminal HIGH, and initial and terminal HIGH. Implant treatment was the fixed effect in the model, and trial was a random effect. Increasing the implant dosage (potency of individual implants or reimplant vs. single implant) increased ADG, G:F, and HCW in both steers and heifers ($P < 0.01$). Increasing implant dosage in steers decreased marbling score ($P < 0.01$) but did not affect yield grade ($P = 0.11$). Increasing implant dosage in heifers decreased yield grade and marbling score ($P < 0.01$) so that when marbling score was adjusted to a common yield grade, there was no effect of implant on marbling score ($P = 0.52$). The percentage of Prime and Choice carcasses increased at a decreasing rate with increased marbling score, fitting the equation: Percent Prime + Choice = (sin[-2.2144 + 0.00548 * Marbling score]) * 100; (R2 = 0.86). Implants reduce marbling content of steers, but high-potency implant programs will have a decreasing impact on quality grade in cattle with high average marbling score compared with cattle with low average marbling score.

Key Words: carcass, feedlot, implant

1001 Factors affecting *Certified Angus Beef* acceptance in spring-born, black-hided beef calves. G. D. Fike*[1], M. E. King[1], L. R. Corah[1], and W. D. Busby[2], [1]*Certified Angus Beef LLC*, *Wooster, OH*, [2]*Iowa Tri-County Steer Carcass Futurity*, *Lewis*.

Logistic regression was used to determine factors affecting *Certified Angus Beef* (CAB) acceptance in black-hided beef calves (n = 966) born during the springs of 2002 to 2007 at a central Missouri ranch. After weaning, all calves were fed, implanted and managed similarly each year in a southwest Iowa feedlot and were harvested when visually determined to have one cm of fat cover. Calves born in 2006 were excluded from the analysis because percent Angus of the calf could not be determined. For categorical variables, the odds ratio (OR) for each variable category was the odds of calves in that category qualifying for the CAB program compared with calves in the reference category (OR = 1). The OR for continuous variables was the odds of calves qualifying as CAB for each unit increase in the continuous variable. Gender and percent Angus of the calf significantly affected CAB acceptance. Steers were 0.59 times as likely to qualify as CAB as heifers. Calves that were 0–25% or 26–50% Angus were 0.45 and 0.38, respectively, times as likely to meet CAB requirements as were calves that were 51–100% Angus. CAB acceptance tended ($P = 0.06$) to be influenced by time of birth within the calving season. The oldest calves (born during the first 21 d) tended to be twice as likely to be CAB than the youngest calves (born >63 d into the calving season). As adjusted final weight (OR = 1.014) and back fat thickness (OR = 2.93) increased, the odds of CAB acceptance were higher. The odds of CAB acceptance were lower in calves with higher feedlot ADG (OR = 0.35) and heavier delivery weight/d of age (OR = 0.003). These data indicate that CAB acceptance is affected by gender, percent Angus, delivery weight/d of age, ADG, back fat thickness and adjusted final weight and tends to be influenced by time of birth in spring-born, black-hided beef calves.

Key Words: CAB acceptance, spring-born beef calves, percent Angus

1002 Effect of time of birth within the spring calving season on performance and carcass traits of beef calves fed in the Iowa Tri-County Steer Carcass Futurity. G. D. Fike*[1], M. E. King[1], L. R. Corah[1], and W. D. Busby[2], [1]*Certified Angus Beef LLC*, *Wooster, OH*, [2]*Iowa Tri-County Steer Carcass Futurity*, *Lewis*.

Calves (n = 1,369) from a central Missouri ranch born from 2002 to 2007 were used to determine the effect of birth sequence within a spring calving herd on feedlot performance and carcass traits. After weaning, all calves were fed, implanted and managed similarly each year in a southwest Iowa feedlot in the Iowa Tri-County Steer Carcass Futurity program and were harvested when visually determined to have 1 cm of fat cover. Calving sequence periods were defined as: d 1–21 (early = E); d 22–42 (mid-early = ME); d 43–63 (mid-late = ML); d > 63 (late = L). The effect of birth sequence on continuous outcomes was quantified using one-way ANOVA. Chi-squared analysis was used to determine the effect of birth sequence on rates. E calves were heavier at feedlot delivery than ME, ML and L calves (328.2, 321.7, 310.8 and 291.4 kg, respectively; $P < 0.05$). Adjusted final and hot carcass weights were greater for E than for L calves (554.2 vs. 538.6 kg and 341.1 vs. 332.5 kg, respectively; $P < 0.05$), but were similar to ME and ML calves. The percentage of Angus in the E calves was greater than ME, ML and L calves (49.3, 44.9, 39.4 and 43.3%, respectively; $P < 0.05$). Disposition scores were lower for E and ME calves than for L calves ($P < 0.05$). ADG for E calves was less than ML calves (1.46 vs. 1.53 kg/d; $P < 0.05$), but not different from ME or L calves. L calves had better feed efficiency than E and ME calves (6.72, 7.14 and 7.03 kg/kg, respectively; $P < 0.05$). Marbling scores were greater for E and ME calves than ML and L calves ($P < 0.05$). The percentage of calves grading USDA Choice decreased as calves were born later in the calving season ($P = 0.009$), and *Certified Angus Beef* (CAB) acceptance rate followed a similar pattern in black-hided calves ($P < 0.0001$). Calves born during the first 21 d of the spring calving season had heavier delivery, adjusted final and carcass weights; greater marbling scores and a higher percentage grading Choice and CAB than their latest born counterparts.

Key Words: beef calves, carcass and performance, CAB acceptance

1003 Effects of roughage source and dried corn distiller's grains concentration on feedlot performance and carcass characteristics. C. L. Maxwell*[1], M. S. Brown[1], N. A. Cole[2], B. Coufal[1], J. O. Wallace[1], J. Simroth-Rodriguez[1], and S. Pratt[1], [1]*West Texas A&M University*, *Canyon,* [2]*USDA ARS Conservation and Production Research Laboratory*, *Bushland, TX*.

Physical attributes of roughages used in finishing diets may impact the extent of ruminal digestion of dried distillers grains (DDG) and growth performance. Crossbred steers (n = 380) were adapted to a common finishing diet, blocked by BW, implanted with Revalor-S (120 mg of

trenbolone acetate and 24 mg of estradiol), and assigned to treatments of roughage source (sorghum-sudan hay [SH] or sorghum-sudan silage [SS]) and DDG concentration (0 or 20% of diet DM). Cattle were housed in 40 soil-surfaced pens with at least 16.7 m^2 of pen space and 30.5 cm of bunk space/animal. Roughages were included on an equal NDF basis. All diets contained 3.4% non-protein N from urea (1.2% urea) and cottonseed meal was utilized as a protein source in 0% DDG diets. Cattle were fed twice/d for 108 d (initial BW = 410 ± 13 kg). Steers fed 20% DDG ate 4.1% more DM than steers fed 0% DDG (10.42 vs. 10.85 kg, $P = 0.007$), but SS or SH did not influence DMI ($P = 0.55$). Overall shrunk ADG on a live basis was not altered by treatment ($P > 0.57$). Gain efficiency on a live basis was not altered by SS or SH ($P = 0.77$), but steers fed 0% DDG were 2.8% more efficient than steers fed 20% DDG ($P = 0.008$). There was a roughage source × DDG interaction for carcass-adjusted ADG and gain efficiency, dressing percentage, hot carcass weight, and LM area ($P < 0.08$). Adjusted ADG was increased 7% by 20% DDG with SS ($P = 0.05$), but not with SH ($P = 0.39$). Gain efficiency was reduced ($P = 0.03$) 4.8% by 20% DDG with SH, but was not altered ($P = 0.71$) with SS. Dressing percentage was reduced by 20% DDG with SH (63.0 vs. 62.4, $P = 0.02$) and increased by 20% DDG with SS (62.4 vs. 63.3, $P < 0.001$). Hot carcass weight was not altered by DDG with SH, but was increased 8 kg by 20% DDG with SS. The LM area was increased by 20% DDG with SS ($P = 0.02$), but not with SH ($P = 0.29$). Marbling score was higher when DDG was fed with SS or SH (380 vs. 390, $P = 0.06$). Results suggest that rate of gain on a carcass basis can be improved by feeding DDG with SS, but performance can be reduced when DDG is fed with SH.

Key Words: feedlot cattle, growth performance, dried distiller's grains

1004 The relative importance of weaning management and vaccination history on finishing performance and carcass characteristics of beef calves. M. J. Macek*[1], K. C. Olson[1], J. R. Jaeger[2], T. B. Schmidt[3], D. U. Thomson[1], J. W. Iliff[1], and L. A. Pacheco[1], [1]*Kansas State University*, *Manhattan,* [2]*Western Kansas Agricultural Research Center*, *Hays,* [3]*Mississippi State University*, *Starkville*.

Angus × Hereford calves (n = 437; average initial BW = 208 ± 25 kg) were stratified by BW, sex, and age and assigned randomly to 1 of 3 weaning treatments that corresponded to length of time between maternal separation and shipping to a feedlot: 45, 15 or 0 d. Within each weaning treatment, calves were assigned randomly to 1 of 2 BRD-vaccination treatments: vaccinated 14 d before maternal separation and again at weaning (PRE) or vaccinated on the d of arrival at the feedlot and again 14 d later (POST). On a common shipping date, calves were transported 3 h to an auction market and held for 12 h. Calves were then transported 1 h to a feedlot. All calves were fed the same diets ad libitum during the weaning (PRESHIP), receiving, and finishing phases of the experiment. Steers were fed to a harvest endpoint of 11.5 mm subcutaneous fat over the 12th rib and harvested in 3 groups. Calves weaned 45 d PRSHIP required fewer ($P = 0.02$) days on feed than calves weaned 15 or 0 d PRESHIP. Calf ADG during finishing was greater ($P < 0.01$) for 45- and 15d calves than for 0-d calves, whereas ADG was similar ($P = 0.26$) between PRE and POST. Consequently, 45-d calves had greater ($P < 0.01$) harvest BW than 15- or 0-d calves. Carcass weight tended to increase ($P < 0.02$) as the length of the weaning period increased. Marbling score, USDA yield grade, 12th-rib fat thickness, REA, and KPH were similar ($P \geq 0.22$) between weaning and vaccination treatments. Likewise, incidence of liver abscesses was similar ($P < 0.47$) between weaning and vaccination treatments. Incidence of lung lesions was not affected ($P > 0.81$) by weaning treatment; however, POST tended ($P < 0.09$) to have greater incidence of lung lesions than PRE. Ranch-of-origin weaning for 45 d was associated with increased carcass weight but similar growth performance during finishing and carcass merit compared with weaning for 15 d. PRESHIP BRD vaccination did not improve growth performance or carcass merit of ranch-direct cattle relative to BRD vaccination deferred until feedlot arrival.

Key Words: carcass merit, preconditioning, weaning

1005 Effects of degree of respiratory disease vaccination on health and growth performance of ranch-direct beef calves during weaning and receiving. M. J. Macek*[1], J. R. Jaeger[2], T. B. Schmidt[3], D. U. Thomson[1], J. W. Bolte[2], L. A. Pacheco[1], N. A. Sproul[1], L. R. Hibbard[1], G. J. Eckerle[1], and K. C. Olson[1], [1]*Kansas State University*, *Manhattan,* [2]*Western Kansas Agricultural Research Center*, *Hays,* [3]*Mississippi State University*, *Starkville, MS*.

Angus × Hereford calves (n = 430; initial BW = 230 ± 31.8 kg) were stratified by sex, age, and BW and assigned randomly to 1 of 4 treatments: 0, 1, 2, or 3 BRD vaccinations before feedlot placement (NOVACC, VACC1, VACC2, or VACC3, respectively). Calves were removed from their dams 29 d before feedlot placement; they were weighed, vaccinated for clostridial diseases, treated for internal and external parasites, and placed in a ranch-of-origin weaning facility. Calves on VACC1, VACC2, and VACC3 treatments were given an initial BRD-vaccination at that time. Calves were revaccinated according to their respective treatments at 14-d intervals during the ranch-of-origin weaning phase of the experiment (PRESHIP). On a common shipping date, calves were transported 3 h to an auction market and held for 12 h. Calves were then transported 1 h to a feedlot. During the PRESHIP period, NOVACC calves tended ($P = 0.06$) to have greater incidence of undifferentiated fever than VACC1, VACC2, or VACC3 calves. Consequently, NOVACC calves had greater ($P < 0.01$) drug-therapy costs PRESHIP than other treatments. Calf ADG, DMI, and G:F during the PRESHIP period were similar ($P \geq 0.61$) between treatments. Upon arrival at the feedlot, calves were weighed and assigned to a receiving pen based on treatment. Calf BW was similar ($P \geq 0.48$) between treatments at feedlot placement, 27 d post-receiving, and 55 d post-receiving; moreover, calf ADG during receiving was similar ($P < 0.92$) between treatments. Degree of BRD vaccination had no affect ($P \geq 0.71$) on DMI or G:F during the receiving period. Incidence of undifferentiated fever among VACC2 calves was greater ($P < 0.01$) than that among NOVACC, VACC1, or VACC3 calves during the receiving period; therefore, drug-therapy costs of VACC2 cattle were greater ($P < 0.01$) than that of NOVACC, VACC1, and VACC3 cattle. Vaccination for BRD, regardless of degree, improved health of calves during the PRESHIP period but not DMI, ADG, or G:F. Degree of BRD vaccination influenced calf health during receiving but not DMI ADG, or G:F.

Key Words: beef calves, health, preconditioning

1006 Influencing steer performance through maternal nutrition. A. F. Summers*[1], K. H. Ramsay[2], and R. N. Funston[1], [1]*University of Nebraska West Central Research and Extension Center*, *North Platte*, [2]*Rex Ranch*, *Ashby, NE*.

A 2-yr study was conducted to determine the effects of maternal nutrition on male progeny. Two locations of a commercial ranch in the Nebraska Sandhills were used with crossbred spring-calving multiparous cows at one location (yr1 = 754; yr2 = 700) receiving higher levels of supplement (HN) and cows at the second location (yr1 = 673; yr2 = 766) being fed lower levels of supplement (LN). Cows were managed in a year-round grazing system with HN cows receiving the equivalent of

1.1 kg/d supplement (28% CP) and LN cows receiving 0.4 kg/d supplement delivered 3 times weekly from December through February and then meadow hay through calving in March and April. After weaning, a random group (yr 1 = 100, yr 2 = 100) of male progeny from each management regimen were placed in a feedlot and slaughtered 218 d later. There were significant ($P < 0.05$) interactions between yr x treatment for performance and carcass characteristics. There was no difference ($P = 0.17$) in initial BW between HN and LN calves. Re-implant and final BW were greater ($P = 0.09$; 0.07) for HN calves compared with LN calves (437 vs. 428 ± 3 kg; 625 vs. 614 ± 4.4 kg). Calf ADG tended ($P = 0.12$) to be greater for HN calves. Calves from yr1 had greater ($P < 0.01$) ADG from initiation to re-implant, whereas yr2 calves had greater ($P = 0.02$) ADG from re-implant to slaughter. Steer HCW and marbling score were greater ($P = 0.07$; 0.05) for HN calves. Steer 12-th rib fat, LM area, final yield grade, and percent USDA Choice were similar ($P > 0.10$) among treatments. Final yield grade and percent grading USDA Choice were greater ($P < 0.01$) for yr2 calves compared with yr1. The proportion of HN calves and yr2 calves grading USDA quality grade of modest or greater was greater ($P = 0.07$; < 0.01) compared with LN calves (21 vs. 11%) and yr1 calves (24 vs. 8%), respectively. Level of dam nutrition during the last trimester of gestation influenced subsequent steer progeny final BW, HCW, and percent USDA average Choice or greater in this study.

Key Words: maternal nutrition, carcass quality, beef cattle

1008 Incidence of quality defects in market beef and dairy cows and bulls sold through livestock auction markets in the Western United States. J. K. Ahola*[1], H. A. Foster[3], D. L. VanOverbeke[4], K. S. Jensen[2], R. L. Wilson[2], J. B. Glaze[2], T. E. Fife[2], C. W. Gray[2], S. A. Nash[2], R. R. Panting[2], and N. R. Rimbey[2], [1]*Colorado State University*, *Fort Collins,* [2]*University of Idaho*, *Moscow,* [3]*Independent Contractor, California Beef Council*, *Sacramento,* [4]*Oklahoma State University*, *Stillwater*.

The incidence of Beef Quality Assurance-related defects in market beef and dairy cows and bulls selling at auction was determined during 2 seasons in 2008. Traits were evaluated by 9 trained personnel during sales at 10 livestock auction markets in Idaho (n = 5; beef and dairy), California, (n = 4; dairy only), and Utah (n = 1; beef and dairy). Overall, 18,949 unique lots (8,213 beef cows, 1,036 beef bulls, 9,177 dairy cows, and 523 dairy bulls,) consisting of 23,479 head (9,299 beef cows, 1,091 beef bulls, 12,429 dairy cows, and 660 dairy bulls,) were evaluated. Market cattle weighed 548 ± 103.6 kg (beef cows), 751 ± 176.1 kg (beef bulls), 658 ± 129.7 kg (dairy cows), and 731 ± 150.8 kg (dairy bulls). Mean BCS for beef cattle (9-point scale) was 4.7 ± 1.24 (cows) and 5.3 ± 0.94 (bulls), and for dairy cattle (5-point scale) was 2.6 ± 0.76 (cows) and 2.9 ± 0.56 (bulls). Some 16.5% of beef cows and 4.1% of beef bulls were thin (beef BCS 1 to 3) while 34.8% of dairy cows and 10.4% of dairy bulls had a dairy BCS of 2.0 or less. Among beef cattle, 85% of cows and bulls were considered to not be lame. However, 45% of dairy cows and 26% of dairy bulls were considered lame. Hot-iron brands were observed in 60.6% of beef cows and 57.3% of beef bulls, but only in 27.9 and 29.1% of dairy cows and bulls, respectively. Some stage of ocular neoplasia was observed in 0.6% and 0.3% of beef cows and bulls (respectively) and 0.25% of dairy cows and 0.0% of dairy bulls. Cattle classified as visibly sick included 0.84% of beef cows, 2.95% of dairy cows, 0.10% of beef bulls, and 1.15% of dairy bulls. Lots that were no-saled included 0.15% of beef cow lots, 1.5% of dairy cow lots, and no bull lots. Results suggest that incidence rates of quality defects among both market beef and dairy cattle selling at auction in the Western United States are substantial.

Key Words: auction market, Beef Quality Assurance, market cows

1009 Effects of quality defects in market beef and dairy cows and bulls on selling price at auction in the Western United States. J. K. Ahola*[1], H. A. Foster[3], D. L. VanOverbeke[4], K. S. Jensen[2], R. L. Wilson[2], J. B. Glaze[2], T. E. Fife[2], C. W. Gray[2], S. A. Nash[2], R. R. Panting[2], and N. R. Rimbey[2], [1]*Colorado State University*, *Fort Collins,* [2]*University of Idaho*, *Moscow,* [3]*Independent Contractor, California Beef Council*, *Sacramento,* [4]*Oklahoma State University*, *Stillwate*.

The relative effect of Beef Quality Assurance-related defects observed in market beef and dairy cows and bulls on selling price at auction was determined during 2 seasons in 2008. The BQA-related traits were evaluated by 9 trained personnel among 18,949 lots (23,479 head) offered for sale at 10 livestock auction markets in Idaho, California, and Utah. The mean sale price ± SD (per 45.45 kg) for market beef cows, beef bulls, dairy cows, and dairy bulls was $45.15 ± 9.42, $56.30 ± 9.21, $42.23 ± 12.26, $55.10 ± 9.07, respectively. Linear regression models were developed based on type and(or) sex to evaluate the effect of each quality-related trait on selling price. Dummy variables were used to test for observer bias, regional differences, and selected traits. Premiums and discounts were determined in comparison to a par animal. Compared with a BCS of 5 (9-point scale), beef cows with less condition were discounted ($P < 0.0001$), while slight premiums ($P < 0.05$) were estimated for BCS 6, 7 and 8 cows. Compared with BCS 3.0 dairy cows (5-point scale), more body condition resulted in premiums ($P < 0.001$), while dairy cows with a less-than-desirable BCS of 2.0 or 2.5 were discounted ($P < 0.0001$). Beef cows weighing less than 455 kg were discounted ($P < 0.0001$) compared to cows weighing 545 to 635 kg, and heavier beef cows received ($P < 0.05$) a premium. Compared to dairy cows weighing 636 to 727 kg, cows less than 636 kg were discounted ($P < 0.0001$) while heavier cows (727 to 909 kg) received premiums ($P < 0.01$). Both beef and dairy cows with any amount of visible lameness were discounted ($P < 0.0001$). Cancer eye in the precancerous stage tended (P = 0.05) to discount beef cows and heavily discount ($P = 0.002$) market dairy cows; while the cancerous stage extremely discounted ($P < 0.0001$) all cows. Animals that were visibly sick were discounted ($P < 0.0001$) substantially. Results suggest that improving BCS and BW increases sale price on a per kg basis. However, visibly sick animals, or those with severe quality defects, were discounted considerably.

Key Words: auction market price, Beef Quality Assurance, market cows

1010 Performance of medium and small frame steers under pasture and pasture-feedlot finishing. G. K. Mantz* and P. Nyren, *North Dakota State University Central Grasslands Research Extension Center*, *Streeter*.

This study evaluated the performance of Medium Frame (MF) and Small Frame (SF) steers under 2 finishing systems: 1) Full-season pasture finishing; and 2) Early-season grazing followed by feedlot finishing. Forty yearling steers were frame-scored. Frame scores 4, 5, and 6 were classified as MF and frame scores 2 and 3 classified as SF. Day 1 (14 May 2009) the steers were placed in 6 native range pastures, 3 supplied with a salt-limited, sunflower screening-oat supplement and 3 non-supplemented. Each pasture contained approximately equal numbers of MF and SF steers (average BW 373 and 297 kg, respectively). Frame within pasture was the unit of replication. On d 48 all steers were weighed and half of the MF and SF in each pasture (chosen at random within frame and pasture) were removed for feedlot finishing and divided into 2 pens of MF and 2 pens of SF steers with pens as unit of replication. Pasture-

finish steers were removed from pasture on d 152, weighed and scanned by ultrasound for percent intramuscular fat (IMF). Feedlot steers were harvested when ultrasound indicated 4.00% IMF or 12.8 mm of back fat. The first 48 d on pasture, supplementation did not affect ADG (P = 0.40) and ADG for MF and SF steers was 1.0 and 0.8 kg, respectively (P = 0.17). For pasture-finish steers in the d 48 to d 152 period, ADG was greater in supplemented than control pastures (0.9 vs. 0.7 kg; P = 0.002) and ADG was greater for MF than SF steers (0.9 vs. 0.7 kg; P = 0.001), but no frame by supplement interaction was found (P = 0.81). Pasture-finish steers average IMF of 3.7% was not impacted by frame (P = 0.70) or supplement (P = 0.78). In the feedlot, MF steers tended to have greater final BW (614 vs. 511 kg; P = 0.14) and hot carcass weight (372 vs. 310 kg; P = 0.14) than SF steers. However, MF and SF steers did not differ in ADG (1.5 vs. 1.4 kg; P = 0.27), days on feed (123 vs. 131 d; P = 0.66) DM G:F (0.116 vs. 0.119; P = 0.94) or yield grade (2.8 vs. 2.6; P = 0.40). All feedlot steers produced USDA choice carcasses. Results show MF and SF steers can both perform well under pasture and pasture-feedlot finishing systems.

Key Words: feedlot, frame size, pasture finishing

1011 Comparing the environmental impact of the US beef industry in 1977 to 2007. J. L. Capper*, *Department of Animal Sciences, Washington State University*, *Pullman*.

Historical livestock production is commonly perceived to be inherently more environmentally sustainable than modern agricultural practices. This study modeled the environmental impact of the 1977 US beef industry, which produced 10.6 billion kg beef from 38.7 million head slaughtered, compared with that of 2007 (11.9 billion kg beef produced from 33.7 million head). The deterministic environmental impact model integrated resource inputs and waste outputs from animal nutrition and metabolism, herd population dynamics and cropping parameters using a life cycle assessment approach. Rations were formulated according to NRC for growing animals (steers, heifers) at breed-appropriate bodyweights and growth rates; and for the supporting population (cows, bulls, herd replacements). System boundaries extended from the cow-calf operation to arrival at the slaughter plant, thus all operations and transport within these limits were included. Resource inputs included feedstuffs, water, land, fertilizers and fossil fuels. Waste outputs included manure and greenhouse gas emissions. The total animal population required to produce one billion kg of beef in 2007 was reduced by 27% compared with 1977. The decrease in population size conferred reductions in total feed energy, feedstuffs and land use of 10%, 17% and 27% respectively. Water use per billion kg beef was reduced by 15% between 1977 and 2007. Compared with the 1977 beef industry, fossil fuel energy for beef production was reduced by 11% per unit in 2007. Methane and nitrous oxide emissions per billion kg beef produced in 2007 were reduced by 17% and 13% respectively. The total carbon footprint (expressed as CO_2-equivalents per billion kg beef) was therefore reduced by 14% in 2007 compared with 1977. This analysis clearly demonstrates that improvements in US beef industry productivity conferred by advances in slaughter weight, growth rate, nutrition and management have considerably reduced the environmental impact of modern beef production, thus improving the sustainability of livestock production.

Key Words: beef production, environmental impact, carbon footprint