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Roundup 2014

Kansas State University. Agricultural Research Southeast Agricultural Research Center Center--Hays

Roundup 2014

Abstract

Roundup is the major beef cattle education and outreach event sponsored by the Agricultural Research Center-Hays. The purpose is to communicate timely, applicable research information to producers and extension personnel. The research program of the Agricultural Research Southeast Agricultural Research Center Center-Hays is dedicated to serving the people of Kansas by developing new knowledge and technology to stabilize and sustain long-term production of food and fiber in a manner consistent with conservation of natural resources, protection of the environment, and assurance of food safety. Primary emphasis is on production efficiency through optimization of inputs in order to increase profit margins for producers in the long term. Roundup 2014 was held at the Agricultural Research Southeast Agricultural Research Center Center--Hays, KS, April 2014

Keywords

Kansas Agricultural Experiment Station contribution; no. 14-333-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1104 Kansas; Beef cattle production

ARC-Hays Roundup

Agricultural Research Center – Hays

Roundup 2014

Report of Progress 1104

K·STATE Research and Extension

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Round - Up on the Fort Hays Reservation

THE Kansas Experiment Station at Hays and Manhattan invite you and your neighboring stockmen to be present at the Fort Hays Branch Experiment Station, Hays, Kansas,

Friday, May 1, 1914,

when the stockmen and cattle breeders of Kansas, Colorado, and the Panhandle will be entertained.

Cover photos
Top left: Participants at the first Roundup in 1914.
Top right: Experiment stockyards, lots 1-8, looking north in 1921.
Center: Cattle with George Huitt, Barnman (left, with cap) and R.R. Hinde, Field Foreman (right, with hat) on horses in 1923.

Roundup 2014

Statement of Purpose

Roundup is the major beef cattle education and outreach event sponsored by the Agricultural Research Center–Hays. The 2014 program is the 100th staging of Roundup. The purpose is to communicate timely, applicable research information to producers and extension personnel.

The research program of the Agricultural Research Center–Hays is dedicated to serving the people of Kansas by developing new knowledge and technology to stabilize and sustain long-term production of food and fiber in a manner consistent with conservation of natural resources, protection of the environment, and assurance of food safety. Primary emphasis is on production efficiency through optimization of inputs to increase profit margins for producers in the long term.

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Matt Kaus		

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Bradley Bennett	Eric Bailey	Scott Hill
Kari Otterman	Jessica Casey	Carson McMullen
Garrett Preedy		

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An Annotated Chronology of Beef Cattle Research Highlights at the Kansas State University Agricultural Research Center–Hays

Originally written by John R. Brethour, Beef Cattle Scientist
Edited and updated by John R. Jaeger, Keith R. Harmoney, and Justin W. Waggoner

Compiling this chronology revealed several common threads through the years.

- An emphasis on topics that benefit producers in the region served by the station.
- A focus on addressing the problem and getting practical answers to the topic or question at hand.
- A concern for quality research with sound experimental design and execution and appropriate analysis and synthesis.
- Conducting truly novel research; virtually all of the effort at Hays has been original and independent.

*** Denotes that original report appears in this bulletin. Note: Historical reports are printed as they originally appeared, so readers may notice variation in presentation or typographical conventions.**

1914 The first Roundup program was held. Tests reported were a comparison of cottonseed cake and linseed meal for cows and use of rations with wheat straw for growing out calves.

1915 Earliest known existing printed report of research results: "Comparison of Breeds Feeding Test – Baby Beef." In this study, value of feed consumed and animal performance of Galloway, Hereford, Shorthorn, and Holsteins were compared. The total cost of gain (feed and labor) was $9.28/100 lb gain. These cattle weighed an average of 915 lb at the close of the study and were sold in Kansas City for $7.04/cwt.

1917* Early work to examine rate of gain and optimum age at breeding for replacement heifers.

1920 C.W. McCampbell from the Animal Sciences Department in Manhattan took charge of beef cattle research at Hays. This added discipline to the tests. He continued in this capacity for 25 years until 1945.

1920s Emphasis was on roughages grown in western Kansas, especially fodders and stovers of sorghums (kafir, cane, and sudan). Extensive research on chopping and grinding roughages showed no advantage to chopping but a response to grinding when forages contained seed such as kafir fodder. Research also showed that protein needs could be met with alfalfa hay instead of purchased supplements.

1930s Intensive research showed little difference among protein supplements. That was an important finding, because present knowledge of rumen function explains why no difference would have been expected.

1931 The first wheat feeding trial was conducted. Wheat feeding became a major topic and continued to be so through the 1960s.

1932* The first comparisons were made of different sorghums: milo vs. kafir grains and sorgo vs. kafir silages. (Before the advent of hybrids, sorghums were identified by species, and old feed analysis tables contain separate entries for kafir and milo.)

1933 A trial showed no response to a phosphorus supplement, indicating that feeds grown in the Hays area have adequate levels. (Based on that study, we have never added phosphorus to the feedlot rations. Retrospectively, we realize that this has been an immense contribution to the environment.)

1935 During 1934, 6 of 10 studies involved Russian thistle, because that was the only plant that grew well during the drought.

1938 The first beef cattle study using a replicated design was conducted. Good science requires replication. Most cattle research facilities have large numbers of small pens to allow such replication, but the procedure at Hays usually has been to replicate over time with different cattle and environments. That approach provides a more critical assessment of treatment effects.

1944* The first "systems" study was conducted in which the carryover effects of different levels of wintering were followed through summer grazing and growth in the second winter. Because the cattle project includes all stages of the production cycle, this approach can be executed easily here, unlike many other locations.

1945 A.D. Webber briefly took charge of the beef cattle research but was replaced by Frank Kessler in 1947.

1945* The first cattle finishing trial was conducted in western Kansas. Previously, this side of the state had been regarded as suitable only for growing stocker cattle and shipping feeders east. This trial heralded the cattle feeding industry of western Kansas. This trial also involved the first attempt to document the feeding value of the combine grain sorghums (e.g., Midland milo).

1946 Not long after the Great Depression and the blowing Dust Bowl, Kansas State University established a range scientist position at the Branch Experiment Station in Hays. Frank Kessler was hired to fill that position and also to conduct research on animal feeding. The early emphasis of this position was to develop recommended stocking rates for native rangelands on the mixed and short-grass prairies. Years of drought and heavy use of cattle on grazing lands had deteriorated native pastures. The condition of native range following these events prompted the need for research on their effects in western Kansas.

1946* The first long-term grazing study on western Kansas rangelands was initiated. The first summary of this 20-year study appeared in the 1950 Roundup Report, and two other significant reports were developed in 1957 and 1967. This study investigated three different stocking rates and demonstrated the moderate stocking concept of "take half, leave half." This study also showed that individual animal gains and changes in grass species composition can be directly related to stocking rates. Both individual animal gain and pasture yield decline as stocking rates are increased.

1949* The first breeding study to determine the effect of sire on feed efficiency was conducted. Up to this time, the Station had focused on improving the genetics of the cowherd to demonstrate the importance of careful selection in building up the quality of commercial herds in the region, but the cowherd had not been directly involved in research.

1950s More research was conducted at Hays on feeding wheat to cattle than at any other location. The major topics included relative value of wheat to other grains, differences among wheat types, and management of wheat in finishing rations.

1951 The first study to compare the value of dried corn distillers grain, dried sorghum distillers grain, and cottonseed cake as protein supplements in ground sorghum grain and silage finishing diets.

1953* The first trial with feed additives considered the antibiotics bacitracin and aureomycin. Many trials with additives were conducted until the 1980s, but then diminished because private facilities had been developed to take on the role of product testing.

1953 An intensive study of creep feeding started. This was a popular topic at that time but did not withstand critical research. It was not an efficient or economical practice, and many of the contentions of its advocates were proven untrue.

1955 The first trial with feeding of diethylstilbestrol (DES) was conducted. This was the first of the growth-promoting hormones so pervasively used in cattle production. DES eventually was removed from use because of human health concerns.

1955* A project was initiated to measure the heritability of feedlot gain by comparing the performance of half-sib bulls with that of their progeny. This study validated performance testing of sire candidates that is used widely to this day. The research report appeared in the 1960 Roundup Bulletin.

1955 John Launchbaugh was hired to lead the range management program and remained for 30 years. He continued to focus on stocking density and stocking rate research on short-grass rangelands.

1956* A long-term supplementation study was initiated with steers on native shortgrass rangelands. This study investigated whether protein supplementation or energy supplementation was most beneficial to steer gains during summer grazing. The basic conclusion was that years of high precipitation allowed grass to mature quickly and reduced forage quality; thus, protein supplement was most beneficial to enhance forage digestibility. Growth was limited and grass quality remained high during dry years, so greater gains were experienced with energy supplementation from grain.

1957 John Brethour took over the beef cattle research program and conducted the first of many silage studies. The station had four experimental silos, and two more were added in that year. Many of the details of silage management as well as selection of best sorghum cultivars for silage were established by the studies conducted at this location. John Brethour served as the beef cattle scientist for 46 years, taking a leave of absence in 1966 and 1967 and retiring in 2005.

1958 Studies began to follow cattle to the packing plant and collect individual carcass data. Because treatment effects on carcass quality may be as important as performance responses, this practice has been used consistently through the ensuing years.

1959 Ultrasound was used for the first time at this location to evaluate cattle. Dr. Jim Stouffer from Cornell University brought his prototype instrument to measure cattle that were committed to an extensive cutout study. The same cattle (Hereford steers) were evaluated by Charles Murphy of the USDA, and the data were used to construct the yield grade equation that is still in use.

1959 A toxic reaction was observed after systemic insecticide treatment for cattle grubs. This led to a revision in labeling of those pesticides warning against use of the product after the grub has matured because its destruction resulted in production of toxins that were released into the animal's system.

1959* The first experiment using wheat in a finishing ration was conducted. Results indicated the advantage of using 50% wheat and 50% rolled milo, which later was identified as the associative effect of combining rapidly and slowly digested grains.

1959 The first of many studies was conducted with growth-promoting implants (diethylstilbestrol).

1960s Research showed that feeding cattle *Bacillus thuringensis* spore powder prevented development of house fly larvae in manure. We also discovered that short-nosed cattle louse infestations were more severe on cattle that were fed urea compared with cottonseed meal.

1961* A truly high-concentrate finishing ration was studied for the first time. Until then, rations that were more concentrated than one part silage to one part grain were suspect. Results showed substantial advantages for the high-grain rations, and this response later was explained by the negative associative effect that depresses roughage digestibility when grain exceeds about 20% of the ration.

1961 Studies began on the use of ensiled high-moisture grain in feed.

1962 Studies showed that a simple finishing ration of rolled milo, sorghum silage, and alfalfa hay resulted in very satisfactory performance.

1963 All-concentrate finishing rations were investigated. These worked very well in small experimental groups but proved disastrous when attempted in a commercial feedlot environment with large numbers of cattle per pen. This result emphasized the importance of considering evaluations of new ideas in field situations.

1963 We had our first access to a mainframe computer (an IBM 1401 on the Fort Hays State University campus). We developed a general linear model (GLM) statistical program that preceded the one now provided by the SAS Institute by 13 years. The program allowed improved statistical precision in cattle research and enhanced the scientific quality of the experiments. That computer had only 16K memory, but could invert a 50 × 50 matrix if intermediate calculations were exported onto punch cards and reloaded for the next phase. That task took about 50 minutes.

1965 Research showed an advantage to feeding waxy endosperm sorghum grain. This was an important indication that endosperm might affect feeding value of different types of sorghum.

1966 Don Ely took over the research program for two years; John Brethour resumed in 1968. Investigations started on the use of high levels of urea to replace natural protein in cattle rations. Use of ammonium chloride to suppress urinary calculi and provide non-protein nitrogen also was investigated.

1970s Tom Harvey, entomologist at the Agricultural Research Center, originated the idea for insecticide ear tags to control horn flies and face flies and published the first results. The adverse effect of horn flies on weight gains of yearling steers was recorded, and we identified their effect on cattle behavior that accounted for reduced productivity. We also discovered that whole-herd control of horn flies could be obtained by partial-herd treatment with insecticides.

1970* The first study was done with ultrasound on live cattle to predict future carcass merit.

1971 Intensive evaluation of different wheat types showed that hard red winter wheat was equal or superior in cattle rations and thwarted interest in developing a specific "feed wheat."

1971 One of the Holy Grails in cattle production was a method to induce marbling and artificially increase carcass grade. Preliminary investigations suggested that dexamethasone might result in such a response.

1972* We published the first report (from any location) that implants depress carcass grade. This observation was largely ignored until producers started selling on a grade and yield basis.

1972 Additions of thiamin and sodium bicarbonate enabled use of 100% wheat in a finishing ration. Those additives appeared to circumvent the acidosis commonly encountered with high wheat levels. (Later studies showed that ionophores were equally effective in addressing this problem). Several trials were conducted with added thiamin in stress situations and provoked much interest.

1974* We reported the first observation of a response to reimplanting cattle during the finishing phase. It took another 10 years before this became a common feedlot practice.

1974 A preliminary trial was conducted comparing different breeds crossed on Hereford cows, including Simmental, Limousin, Charolais, and Holstein. The Continental breeds from Europe had just arrived in the country. This effort was not continued because the USDA Meat Animal Research Center opened in Nebraska with more appropriate resources to conduct breed evaluations, but in later years, the Hays project evaluated breeds not included in the MARC protocols, including Longhorn, White Park, Braford, and Wagyu.

1975 Intensive work began on feeding out young bulls. One item driving this research was the possibility that growth-promoting implants might be banned, so exploiting the natural hormones in intact males would have merit.

1976 A study showed that an implanting protocol over the lifetime of an animal could increase total gain by more than 100 lb per animal.

1976* Research showed the advantage of finely rolled milo over coarsely rolled milo. Citing this work and arguing that earlier values had been obtained with improper processing, i.e., coarse rolling, convinced the National Research Council to substantially increase the energy value of milo in feed analysis tables.

1977 We discovered that a novel combination of a methane inhibitor and an ionophore had a synergistic effect in improving performance and feed efficiency. Repeated trials with two different methane inhibitors confirmed this response, but we were unable to persuade the companies to get the methane inhibitors cleared for use.

1977 We built an interactive program for a minicomputer that calculated balanced rations for cattle and then proceeded to select the least-cost formulation. This was farmed out for use by several feed companies and probably was the first of its kind.

1979 We attempted to develop a ration to study the effect of ionophores plus a methane inhibitor to combat nitrate toxicity. The strange result was that rations with 5,000 to 20,000 ppm nitrate performed better, apparently because rumen microorganisms were using nitrate as a non-protein nitrogen source.

1980s Horn flies were effectively controlled with back-rubbers made from insecticide ear tags attached to tire chains or sand-filled dust bags. We found that insecticide ear tags applied to nursing calves controlled horn flies on the both cows and calves. Horn flies also were controlled by insecticide in marking fluid applied to cows by bulls equipped with chin-balls or bull point-markers. They also could be controlled with pellets containing insecticide fired from a CO_2-operated pellet pistol. Brahman × Hereford heifers had 70% fewer horn flies than Angus × Hereford heifers, so using insecticide ear tags on 50% Brahman-cross yearlings provided no economic advantage. Livestock insect research was discontinued in 1989.

1981* The first study of intensive early stocking (IES) was started on western Kansas rangelands. Until now, this method of stocking had been implemented only in Eastern Kansas Flint Hills. This study investigated stocking rangelands at 2X and 3X the normal spring stocking density, and followed animal gain and vegetation trends for nine years. The 2X IES system was found to have total animal production and vegetation characteristics equal to continuous season long stocking at a moderate rate, whereas the 3X IES system produced more total animal gain but was unsustainable because it occurred at the expense of much reduced pasture yield and the loss of desirable grass species.

1982* A summary of eight trials indicated that finely rolled milo had 94% the energy value of rolled corn.

1982 We reported what may be the only trials ever conducted on feeding pearl millet to cattle.

1983 The first trials in the Western Hemisphere with Revalor and the first in the United States with Finaplix (growth implants containing trenbolone) were conducted. These are among the most widely used implants today.

1984 At this time, interest in treating wheat straw with ammonia to increase digestibility and crude protein was considerable. Sorghum hay was treated with ammonia, and concrete evidence of toxicity was obtained. Putatively, ammonia reacted with plant sugars to form an imidazole compound that was absorbed by the cow and passed directly to the milk, which was especially lethal to calves. These results were circulated widely and resulted in recommendations against ammoniating roughages that might still contain sugar (e.g., sorghums, grass, and immature cereals).

1984* The first cattle trials in the country with zinc methionine (Zinpro) were conducted. This caused nutritionists to suspect that organic sources of minerals might be more available than inorganic sources.

1985* Developed the one-calf heifer system, in which a female is bred and allowed to have one calf, which is weaned early, while the 2-year-old cow is fed for harvest. This may be the most efficient of all beef cattle programs, but is labor- and management-intensive. This research was conducted during one of the "farm crises" and was promoted as a program to enable maximum profitability for operations with limited resources.

1986 Kenneth Olson, the newly appointed range scientist following Launchbaugh's retirement, continued the research on IES programs for western Kansas.

1987 Research began on applying ultrasound technology to beef cattle production. The first effort was to exploit serial insonation and develop a model for the increase in backfat thickness during the finishing phase.

1988 We discovered that an artifact called ultrasonic speckle is an indicator of marbling (intramuscular fat).

1989 Research showed that cattle management in a growing-grazing system needs to be attuned to cattle type.

1989* The first studies were conducted that indicated improved feedlot profit from sorting cattle into outcome groups appropriate to the carcass and performance potential of each animal.

1990 Research showed that light test weight milo (48 lb/bu) had 96% of the feed value of normal milo. We seem to receive more producer inquiries about the feed value of discounted grains than any other topic.

1991 Several experiments during this period with the breeding herd addressed improved methods of synchronization and timed breeding (artificial insemination).

1992 We perfected computer measurement of ultrasound images to estimate backfat thickness and marbling score. That involved pattern recognition techniques and neural network technology. Three comparisons sponsored by the Beef Improvement Federation showed that the Kansas State University system for estimating marbling was more accurate than other systems.

1993 A project studied feeding cull cows. They represent an important component in the cash flow of a cow-calf operation. This effort showed that income could be enhanced if marketing systems could be devised to reward producers for their extra effort.

1993 Eric Vanzant, who replaced Olson as the station range scientist, continued his work on modifying intensive-early grazing systems. The modified systems entailed double-stocking early in the season then removing only half of the animals during the latter half of the season. Vanzant found no improvement in beef production with this modified system. Double-stocking early actually caused a reduction in weight gains of animals that stayed on pasture season-long.

1994 We developed a profitability model that represented an expert system to synthesize ultrasound estimates with other parameters to predict days-on-feed for maximum feedlot profitability.

1995 We established the model for the rate of marbling increase in feedlot steers.

1997 Research showed adverse effects of supplementing low-quality roughages with high-starch feed ingredients (rolled milo).

1998 The first research was completed showing success in estimating potential carcass quality grade from ultrasound estimates made on calves at weaning.

1999 Six steer carcasses managed and selected with ultrasound technology placed first in the Denver Stock Show carcass contest. All six graded USDA Prime and were acclaimed to be the best carcasses ever observed. They were from a set of Wagyu × Charolais steers that were fed to validate models of marbling increase. U.S. Patent 5,960,105 was granted for an ultrasound procedure to measure intramuscular fat in cattle.

1999 Keith Harmoney replaced Vanzant as the station range scientist. Refinement of stocking rates on modified intensive-early stocking systems continued.

2002* Another seven-year study of intensive early stocking was implemented. In this study, pastures were intensively stocked early in the season at 1.6X the normal stocking density, and then at midseason the heaviest animals were removed and the lightest animals remained on pasture. This stocking strategy resulted in a 26% increase in beef production on a per-acre basis compared with continuous stocking at the normal rate. Continuous season-long stocking, intensive-early double-stocking, and modified 1.6X + 1 intensive-early stocking are all acceptable methods for stocker gains on shortgrass rangeland.

2002 Using ultrasound technology from research that was supported by the Kansas Beef Council, John Brethour selected a pen of 80 steers that won the first-ever Best of Breed contest. The steers were fed a diet of grain sorghum with boosted protein levels from soybean meal. No growth implants were used. The contest was open to Angus producers and feeders in the United States and recognized winners based on the average beef value per hundredweight (cwt) of the 80 steers. Brethour's winning entry was worth an average of $132.05/cwt of carcass. The steers graded 100% Choice or better, 91% Premium Choice (which qualifies at Certified Angus Beef or CAB), and 32% Prime. The winner of the $100,000 prize was announced at the 2003 National Beef Association's annual convention and trade show.

2006 John Jaeger replaced Brethour as the station beef cattle scientist. Emphasis shifted from perfecting ultrasound predictions of carcass quality and optimum time on feed to management at the cow-calf level and how those management decisions may affect feedlot performance of offspring, deposition of marbling, and ultimately carcass quality.

2006–present* A series of experiments were conducted to evaluate the effect of preconditioning management techniques and length of the ranch-of-origin preconditioning period on the health and performance of spring-born beef calves originating from, finished in, and harvested in the Great Plains. This research would question the validity of beef industry assumptions that ranch-of-origin preconditioning periods lasting 45 to 60 days are needed for optimal health and growth of beef calves of all types and origins. During this period, management of early-weaning calves was also examined in response to short summer forage supplies due to drought. This research also indicated that earlier weaning of the calf resulted in better body condition of the cow going into winter, which can result in lower supplementation requirements and feed costs during winter feeding.

2008 Justin Waggoner was hired as the beef systems specialist for Southwest Area Extension Center in Garden City. He also has a research appointment and added his nutrition expertise to research being conducted in Hays.

2007–present Several experiments during this period with heifers and cows again addressed modifications of ovulation synchronization systems to improve conception to fixed-time breeding (artificial insemination).

2009 Wet distillers grains as a protein supplement on late-summer pasture was compared to a soybean meal/milo mixture in a five-year grazing study. A byproduct of the ethanol industry, wet distillers grains fed in a bunk on pasture produced late-season pasture gains greater than the soybean meal/milo mixture and greater than feeding the distillers grains on the ground.

2011 We provided the first report of successful long-term storage (200 days), without significant spoilage, shrink, or change in nutrient content, of wet distillers grain without the addition of low-quality roughages to increase dry matter content to enable packing. This was achieved by covering with 6-mil black plastic and increased the economic potential of small livestock operations in Kansas to use wet distillers grains.

2011 We provided the first report of potential for reduced performance of replacement heifers fed wet distillers grain if provided at a level only to meet their crude protein requirement. The lower level of rumen degradable protein in wet distillers grain compared to oilseed supplements can result in the observed reduction in average daily gain when fed only to meet minimum protein requirements.

2012 We reported that third-trimester cows grazing dormant native range and provided dried distillers grain as a protein supplement once every 6 days performed as well as those receiving the supplement every 3 days or daily.

2013* Due to continued drought and renewed interest in ammoniated wheat straw, research was initiated to examine ammoniation levels of low-quality forage. We found that performance of weaned, pregnant beef cows limit-fed in confinement may be improved by applying anhydrous ammonia to low-quality forages, such as wheat straw, at a rate as low as 1.5% (wt/wt) of the dry matter content. Treating wheat straw with the recommended 3.0% anhydrous ammonia resulted in the greatest body weight gain and average daily gain; however, the improvement in response to the 1.5% rate suggested application of 1.5% anhydrous ammonia may be optimal when anhydrous ammonia prices are relatively high.

This research originally appeared in the 1917 Roundup report.

Development of Breeding Heifers, 1916–17

Forty Hereford heifers coming 2 years old in each lot.

The object is to learn the effect of this feeding and time of breeding upon the development of the heifers and the calves they produce.

	LOT 1. OPTIMUM TREATMENT.		LOT 2. NORMAL TREATMENT.	
	Bred to calve 1917 2 yrs. old	To be bred to calve 1918 3 yrs. old	Bred to calve 1917 2 yrs. old	To be bred to calve 1918 3 yrs. old
Av. initial wt. Dec. 2	827	780	742	706
Av. final weight Mar. 31	1005	964	831	806
Av. gain per head, 120 days	178	184	89	100
Av. gain per head per day	1.48	1.53	.74	.83
Average daily ration, pounds				
Alfalfa hay	9.27		9.13	
Silage	13.4		13.4	
Wheat straw	4.47		4.77	
Corn	3		...	
Cottonseed cake	1		...	
Average cost of feed per head for 120 day period				
Alfalfa hay	$4.45		$4.38	
Silage	2.42		2.42	
Wheat straw	.13		.14	
Corn	6.43		...	
Cottonseed cake	2.40		...	
Average feed cost per head per day	.132		.058	
Cost per pound gain	.0875		.0734	
Value allowed for feed used				
Alfalfa			$8 per ton	
Silage			$3 per ton	
Cane hay			$3 per ton	
Ground corn			$1 per bushel	
Cotton seed cake			$40 per ton	

We have more trouble with cows calving in lot 2 than in lot 1.

Below we give the results of the same experiment last winter. All lots were handled the same during the summer. Study these cattle and draw your own conclusions.

Development of Same Breeding Heifers, 1915–16

120 days, December , 1915 to March 29, 1916

Forty Hereford heifers were fed silage, alfalfa and straw; another forty head were fed the same with an addition of 4.54 lbs. of corn and cob meal and 1 pound of linseed meal per day.

	Lot 1	Lot 2
Average initial weight, December 1	446.25 lbs.	445.72 lbs.
Average final weight, March 29th	671.5	556.1
Average gain per head	225.3	110.4
Average gain per head per day	1.88	.92
Average daily ration per head in lbs.		
Alfalfa hay	7.96	9.12
Silage	8.72	9.53
Wheat straw	.56	.55
Corn and cob meal	4.54	...
Linseed meal	1.00	...
Average feed cost per head, 120 days	$11.43	$4.73
Average feed cost per head per day	.095	.039

This research originally appeared in the 1933 Roundup report.

Cottonseed Cake vs. Grain as Supplemental Feeds

L.E. Call, L.C. Aicher, and C.W. McCampbell

The many inquiries received by the experiment stations of the Kansas State College relative to the possibility and advisability of substituting grain for cottonseed cake as supplements to such feeds as silage, fodder and sorghum hay when these feeds are used as the basis of stock cattle rations, prompted a study of this problem at the Hays Branch Experiment Station. During the winter of 1931-32 two pounds of ground kafir, two pounds of ground milo, two pounds of ground barley and two pounds of ground wheat were each compared with one pound of cottonseed cake in winter rations for stock calves.

The highly satisfactory results secured from the use of these grains as substitutes for cottonseed cake in winter rations for stock calves, prompted another question: "What will happen if the same animals are fed these grains instead of cottonseed cake a second winter?"

The experiments of the winter of 1932-33 were planned to help answer this second question and the animals in this winter's experiment received the same feeds they received during the winter of 1931-32. The results should show any possible detrimental cumulative effect of substituting grains for cottonseed cake as supplemental feeds in winter rations for stock cattle, at least until they are two years of age.

Each of the five lots in this experiment received Atlas sorgo silage as the basal ration. In addition lot 1, the check group, received 1 pound of cottonseed cake per head per day. Each of the other lots received 2 pounds of grain per head per day; lot 2, ground kafir; lot 3, ground milo; lot 4, ground barley; and lot 5, ground wheat.

During the winter of 1931-32 the experiment extended over a period of 150 days; during the winter of 1932-33 a period of 155 days. During the summer of 1932 the cattle in this test were grazed together at the Hays Branch Experiment Station. The results of these two experiments conducted during the winters of 1931-32 and 1932-33 are given in detail in Table I.

Table 1. Cottonseed cake vs. grain as supplement to Atlas sorgo silage

Lot number	1	2	3	4	5
Number of animals per lot	10	10	10	10	10
Ration fed	Atlas sorgo silage Cottonseed cake	Atlas sorgo silage Ground kafir	Atlas sorgo silage Ground milo	Atlas sorgo silage Ground barley	Atlas sorgo silage Ground wheat
	Pounds	Pounds	Pounds	Pounds	Pounds
Average weight per head Nov. 21, 1931	430.80	429.70	430.20	430.40	429.80
Average weight per head April 19, 1932	559.50	549.70	547.80	563.30	568.00
Average gain per head winter 1931-32	128.70	120.00	117.60	132.90	138.20
Average weight per head Nov. 18, 1932	691.70	700.33	699.70	698.80	707.10
Average gain per head summer 1932	132.20	150.63	152.00	135.50	139.10
Average weight per head April 20, 1933	911.80	867.20	851.50	897.70	926.70
Average gain per head winter 1932-33	220.10	166.87	151.80	198.90	219.60
Average gain per head November 21, 1931 to April 20, 1933	481.00	437.50	421.40	467.30	496.90

Observations

An analysis of the gains in Table I shows:

1. That during the first winter (1931-32) calves wintered on a ration consisting of Atlas sorgo and 2 pounds of kafir, milo, barley or wheat or 1 pound of cottonseed cake per head per day, made satisfactory gains for stock cattle.

2. That the grains fed as supplements the first winter (1931-32), based upon gains produced, should be ranked in the following order: ground wheat, ground barley, ground kafir, and ground milo.

3. That during the first winter (1931-32), 1 pound of cottonseed cake proved to be worth slightly less than 2 pounds of ground wheat or ground barley and slightly more than 2 pounds of ground kafir or ground milo as a supplement to silage.

4. That during the second winter (1932-33), the same cattle (now yearlings), wintered on a ration consisting of Atlas sorgo and 2 pounds of kafir, milo, barley or wheat; or 1 pound of cottonseed cake, again made satisfactory gains for stock cattle.

5. That the grains fed as supplements the second winter (1932-33), based upon gains produced, should be ranked in the following order: ground wheat, ground barley, ground kafir, and ground milo. This is the same order in which they ranked the first winter (1931-32).

6. That during the second winter (1932-33), 1 pound of cottonseed cake proved to be worth as much as 2 pounds of ground wheat, slightly more than 2 pounds of ground barley, and appreciably more than 2 pounds of ground kafir or ground milo as a supplement to silage.

7. That no ill effects resulted from the use of wheat, barley, kafir, or milo as supplements to Atlas sorgo when 2 pounds of grain was substituted for 1 pound of cottonseed cake.

8. THAT WHEN PRICE LEVELS JUSTIFY, 2 POUNDS OF GROUND WHEAT, GROUND BARLEY, GROUND KAFIR, OR GROUND MILO MAY BE SUBSTITUTED FOR 1 POUND OF COTTONSEED CAKE AS A SUPPLEMENT TO SILAGE IN WINTER RATIONS FOR STOCK CATTLE.

The feed consumption and gains per unit of feed consumed for each of the two winters are summarized in Table II.

Table 2. Feed consumption and gains per unit of feed

Lot	1	2	3	4	5
Number of animals per lot	10	10	10	10	10
Ration fed	Atlas sorgo silage Cottonseed cake	Atlas sorgo silage Ground kafir	Atlas sorgo silage Ground milo	Atlas sorgo silage Ground barley	Atlas sorgo silage Ground wheat
Average daily ration fed:	Pounds	Pounds	Pounds	Pounds	Pounds
Atlas sorgo silage					
1931-32 as calves	31.00	31.00	31.00	31.00	31.00
1932-33 as yearlings	53.05	52.89	52.90	53.05	53.05
Supplement—same each year					
Cottonseed cake	1.00	...	...	...	...
Ground kafir	...	2.00	...	...	...
Ground milo	...	...	2.00	...	...
Ground barley	...	...	...	2.00	...
Ground wheat	...	...	...	...	2.00
Gain per ton of Atlas sorgo silage fed:	...	...	...	...	...
1931-32 as calves	55.18	51.45	50.42	56.98	59.25
1932-33 as yearlings	53.50	40.80	37.10	48.30	53.50
Gain per acre of Atlas sorgo silage fed:					
1931-32 as calves	465.17	433.72	425.04	480.34	499.48
1932-33 as yearlings	444.05	338.64	307.93	400.89	444.05

Observations

It will be noted that the silage consumption was 31 pounds per head per day the first winter when the cattle were calves, and approximately 53 pounds per head per day the second winter when they were yearlings. In other words, these cattle consumed 70 percent more silage per head per day during the winter they were yearlings than during the winter they were calves. It will also be noted that the average gain per TON of silage consumed by these cattle as calves varied from 50.42 to 59.25 pounds; by the same cattle as yearlings from 37.1 to 53.5 pounds, and that the average gain per ACRE of silage consumed by these cattle as calves varied from 425.04 to 499.48 pounds; as yearlings from 307.93 to 444.05 pounds.

This research originally appeared in the 1946 Roundup report.

The Influence of Winter Gains on Ultimate Returns from Wintering and Grazing Good Quality Calves

L.C. Aicher, C.W. McCampbell, and A.D. Weber

The Hays Station inaugurated a study of the influence of winter gains on the ultimate returns from wintering and grazing good quality calves in the fall of 1942. This study divided itself into two phases—wintering and grazing. During the wintering phase four lots of steer calves were wintered on four different levels of nutrition by feeding the following rations:

Lot 1—A full feed of Atlas silage plus 4 pounds of ground kafir grain and 1 pound of cottonseed cake per head daily.

Lot 2—A full feed of Atlas silage plus 2 pounds of ground kafir grain and 1 pound of cottonseed cake per head daily.

Lot 3—A full feed of Atlas silage plus 1 pound of cottonseed cake per head daily.

Lot 4—A full feed of Atlas silage but no grain or cottonseed cake.

All lots were fed the same amount of Atlas silage. Four lots of heifer calves fed identically the same rations the steer calves were fed were also included in this study. The wintering phase of this study was conducted three successive years with three separate groups of calves. The average of the results secured from these three tests is given in Table 4.

Table 4. The Influence of Winter Gains upon Ultimate Returns from Wintering and Grazing Good Quality Calves
Wintering Phase—An Average of Three Experiments 1942-43; 1943-44; 1944-45

Lot	1A	2A	3A	4A	5A	6A	7A	8A
Ration Fed	Atlas Silage Cotton-seed Cake Ground Kafir	Atlas Silage Cotton-seed Cake Ground Kafir	Atlas Silage Cotton-seed Cake	Atlas Silage	Atlas Silage Cotton-seed Cake Ground Kafir	Atlas Silage Cotton-seed Cake Ground Kafir	Atlas Silage Cotton-seed Cake	Atlas Silage
Age of Cattle	Calves	Calves	Calves	Calves	Calves	Calves	Calves	Calves
Sex of Cattle	Steers	Steers	Steers	Steers	Heifers	Heifers	Heifers	Heifers
Number Days in Test	150	150	150	150	150	150	150	150
Number Cattle per Lot	10	10	10	10	10	10	10	10
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Average Weight per Head into Test	516.63	522.13	522.03	522.17	478.80	478.73	478.80	478.77
Average Weight per Head out of Test	755.47	714.03	659.47	581.40	729.07	686.77	635.23	562.77
Average Total Gain per Head	238.84	191.90	137.44	59.23	250.27	208.04	156.43	84.00
Average Daily Gain per Head	1.59	1.28	.92	.39	1.67	1.39	1.04	.56
Average Daily Ration per Head								
Atlas Silage	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89
Cottonseed Cake	1.00	1.00	1.00	...	1.00	1.00	1.00	...
Ground Kafir	4.00	2.00	...	...	4.00	2.00	...	...
Average Feed Consumption per Head During the Wintering Period								
Atlas Silage (tons)	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77
Cottonseed Cake (pounds)	150.00	150.00	150.00	...	150.00	150.00	150.00	...
Ground Kafir (bushels)	10.75	5.38	...	...	10.75	5.38	...	...
Average Winter Feed Cost per Head	$24.44	$19.33	$14.22	$10.16	$24.44	$19.33	$14.22	$10.16
Average Feed Cost per 100 Pounds of Gain	10.24	10.26	11.18	23.38	9.79	9.42	9.25	12.86

Average Feed Prices: Silage $3.67 per ton; Cottonseed Cake $54.53 per ton; Ground Kafir Grain $1.70 per cwt.

Observations

1. Wintering gains increased in direct proportion to the increase in the level of the planes of nutrition.

2. In the case of the steer calves, there was an increase in gains of 78 pounds per head when one pound of cottonseed cake per head daily was added to a full feed of silage; a further increase of 55 pounds per head when two pounds of ground kafir grain per head daily were added to a full feed of silage plus one pound of cottonseed cake per head daily; and a still further gain of 47 pounds per head when an additional two pounds of ground kafir grain per head daily were added to a full feed of silage plus two pounds of ground kafir grain and one pound of cottonseed cake per head daily.

3. In the case of heifer calves the increases in gain were similar to those of the steer calves being 72 pounds, 52 pounds and 42 pounds.

4. The average of the wintering gains of the heifer calves for the three tests was not only greater than the average of the wintering gains of the steer calves but in eleven out of the twelve direct comparisons possible in the three tests the gains of the heifer calves were also greater than the gains of the steer calves.

5. The difference in gain in favor of the heifer calves increased as the level of the plane of nutrition was lowered. The heifer calves wintered on an average of 36.89 pounds of Atlas silage plus 4 pounds of ground kafir grain plus 1 pound of cottonseed cake gained 4.8 percent more than the steer calves wintered on the same ration. The heifer calves wintered on 36.89 pounds of Atlas silage plus 2 pounds of ground kafir grain and 1 pound of cottonseed cake, gained 8.4 percent more than the steer calves wintered on the same ration. The heifer calves wintered on 36.89 pounds of Atlas silage plus 1 pound of cottonseed cake gained 13.8 percent more than the steer calves wintered on this ration. The heifer calves wintered on 36.89 pounds of Atlas silage alone gained 47.9 percent more than the steer calves wintered on the same ration.

6. It is well known that steer calves make greater gains than heifer calves when full fed identical fattening rations, but the results of this series of tests indicate that heifer calves make greater gains than steer calves when fed identical wintering rations. However, these results also indicate that greater gain made by heifer calves is gradually lessened as the level of nutrition of wintering rations approaches the level of nutrition of fattening rations.

7. Wintering costs increased but the cost of gains **decreased** as the level of the plane of nutrition rose. Cost of gain was much the highest in the lots in which the wintering ration consisted of Atlas silage alone.

8. Each year the calves wintered on Atlas silage alone came through the winter in a decidedly less thrifty and vigorous condition than those in the other lots.

After the wintering phase had been completed each year, the eight lots of calves were grazed together on native pastures, mostly buffalo grass, owned by the Fort Hays Experiment Station. The influence of winter gains on grazing gains in this experiment is shown in Table 5.

Table 5. The influence of winter gains upon ultimate returns from wintering and grazing choice calves
Wintering gains, grazing gains, combined wintering and grazing gains
An average of Three Successive Tests
Wintering 1942-43; 1943-44; 1944-45
Grazing 1943, 1944 and 1945

	Steers					
	Average daily winter ration per head					
Lot	Silage full fed	Grain per head daily	Cottonseed cake per head daily	Average winter gains as calves	Average summer gains as yearlings	Average combined winter and summer gains
1A	37	4	1	239	156	395
2A	37	2	1	192	169	361
3A	37	0	1	137	199	336
4A	37	0	0	59	237	296
	Heifers					
5A	37	4	1	250	114	364
6A	37	2	1	208	138	346
7A	37	0	1	156	167	323
8A	37	0	0	84	209	293

Observations

1. Whereas wintering gains **increased** in direct proportion to the increase in the level of the plane of nutrition of the different lots during the wintering phase, grazing gains **decreased** in direct proportion to the increase in the level of the plane of nutrition during the previous wintering phase.

2. The grazing gains of the steer calves that were fed a full feed of Atlas silage and 1 pound of cottonseed cake per head daily the previous winter were 38 pounds less than for the steer calves that had been fed Atlas silage alone; the grazing gains of the steer calves that had been fed 2 pounds of ground kafir grain per head daily in addition to a full feed of silage and 1 pound of cottonseed cake per head daily were 30 pounds less than those of the steer calves that had been fed a full feed of Atlas silage and 1 pound of cottonseed cake per head daily; the grazing gains of the steer calves that had been fed 4 pounds of ground kafir grain per head daily in addition to a full feed of Atlas silage and 1 pound of cottonseed cake were 13 pounds less than those that had 2 pounds of ground kafir grain per head daily in addition to feed of Atlas silage and 1 pound of cottonseed cake per head daily.

3. Heifer calves fed and grazed in exactly the same manner as the steer calves showed similar decreases in gains during the grazing period—42 pounds, 29 pounds and 24 pounds.

The results of this series of tests indicate conclusively that wintering gains increase as the level of the wintering plane of nutrition rises, but that subsequent grazing gains decrease. The question that now arises is do the wintering gains and the grazing gains equalize each other and leave the combined wintering and grazing gains the same regardless of the level of the plane of nutrition during the wintering phase. The answer to this question may also be found in Table 5.

Observations

1. Grazing tended to equalize differences in wintering gains due to different levels in the plane of nutrition during the winter, but it did not do so completely.

2. Grazing failed to equalize combined wintering and grazing gains of the steer calves by 34 pounds per head in the case of Lots 1A and 2A; 59 pounds for Lots 1A and 3A; and 99 pounds for Lots 1A and 4A.

3. Grazing failed to equalize combined wintering and grazing gains of the heifer calves by 18 pounds in the case of Lots 5A and 6A; 41 pounds for Lots 5A and 7A; and 71 pounds for 5A and 8A.

The results of the third of a series of three tests in which four lots of steer calves were wintered at different levels of nutrition, and four lots of heifers wintered on identical rations after which all four lots were grazed together, are summarized in Table 6.

Observations

1. The gains for both the wintering and the grazing phases followed the same general pattern observed in the two previous tests—wintering gains increased in proportion to the quantity of feed consumed; grazing gains decreased in proportion to the quantity of feed consumed during the wintering phase; and the combined wintering and grazing gains increased in proportion to the quantity of feed consumed during the wintering phase but not by as wide a margin as in the wintering gains.

The four lots of heifer calves that were wintered at different levels of nutrition during the winter of 1944-45 and grazed together during the summer of 1945 were wintered on identical rations during the winter of 1945-46. The results of the 1945-46 wintering test are summarized in Table 7.

Table 6. The influence of winter gains upon ultimate returns from wintering and grazing choice calves

Gains—Wintering phase 1944-45 as calves; grazing phase 1945 as yearlings; and combined wintering and grazing gains—third test

	Steers					
	Ration Winter 1944-45 as calves			Gains		
Lot	Silage full fed	Grain per head daily	Cottonseed cake per head daily	As calves Winter 1944-45	As yearlings Summer 1944	Combined winter and summer
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
9	35.99	4	1	257.20	144.20	401.40
10	35.99	2	1	220.40	142.10	362.50
11	35.99	0	1	174.20	166.20	340.40
12	35.99	0	0	94.50	200.50	295.00
	Heifers					
13	35.99	4	1	272.30	96.60	368.90
14	35.99	2	1	241.50	108.80	350.30
15	35.99	0	1	191.50	137.20	328.70
16	35.99	0	0	118.30	184.10	302.40

Table 7. The influence of winter gains upon ultimate returns from wintering and grazing choice calves

Heifers wintered at different levels of nutrition as calves, grazed together as yearlings, and wintered at the same level of nutrition as yearlings.

Wintering phase 1945-46; 150 days; yearlings

Lot number	5	6	7	8
Ration fed	Silage Cottonseed cake	Silage Cottonseed cake	Silage Cottonseed cake	Silage Cottonseed cake
Number heifers in lot	10	10	10	10
	Pounds	Pounds	Pounds	Pounds
Initial wt. per heifer	843	824	803	776
Final weight per heifer	1018	979	954	940
Total gain per heifer	175	155	151	164
Daily gain per heifer	1.17	1.03	1.01	1.09
Average daily ration:				
Silage	60	60	60	60
Cottonseed cake	1	1	1	1
Feed required for 100 pounds of gain:				
Silage	5154	5819	5974	5500
Cottonseed cake	---	---	---	---

Observations

1. The wintering gains of these four lots of heifers fed and handled in exactly the same manner did not vary greatly but the variation that did exist was greater than the variation in a previous test of the same nature. However, the difference in the final weights of the heaviest and lightest lots in the test was not significantly different from the difference in the previous test.

The average of the two successive tests in which four lots of heifers were wintered at four different levels of nutrition as calves; grazed together as yearlings and wintered on the same level of nutrition as yearlings, is summarized in Table 8.

Table 8. The influence of winter gains upon ultimate returns from wintering and grazing choice calves

Heifers wintered at different levels of nutrition as calves, grazed together as yearlings, and wintered at the same **level of nutrition** as yearlings. An average of two successive experiments.

Lot	5A	6A	7A	8A
Daily wintering ration as calves:	Pounds	Pounds	Pounds	Pounds
Atlas silage	37	37	37	37
Ground kafir grain	4	2	...	...
Cottonseed cake	1	1	1	...
Daily wintering ration as yearlings:				
Atlas silage	61	61	61	61
Cottonseed cake	1	1	1	1
Initial Weight	481	481	481	481
Wintering gains as calves	258	213	163	95
Grazing gains as yearlings	86	110	143	182
Wintering gains as yearlings	221	206	207	216
Total gains from weaning to two years of age 504 days	565	529	513	493
Final weight at two years of age	1045	1010	994	974

Observations

Grazing as yearlings reduced the difference in wintering gains due to differences in the levels of nutrition in the different lots but failed to do so completely and wintering at the same level of nutrition as yearlings made little change in the differences in the final weights as compared to the weights at the end of the grazing season.

This research originally appeared in the 1947 Roundup report.

Comparative Values of Midland Milo, Westland Milo, Pink Kafir, and Corn as Cattle-Fattening Feeds

A.D. Weber[1], L.C. Aicher[2], and F.B. Kessler[3]

This is the third feeding trial conducted at the Fort Hays Branch Experiment Station in which the combine types of grain sorghums have been used as cattle fattening feeds. These trials show conclusively that Midland milo, Westland milo, and Pink kafir are equal to corn when used as the entire grain portion of cattle-fattening rations.

Each lot of cattle in each year's test was sold separately to determine differences in finish, dressing percentage, and carcass grades. There were no significant differences among the lots, in dressing percentage and carcass grades.

Strictly choice yearling steers produced in the grade Hereford herd at the Fort Hays experiment station were used in this test.

Most of the silage used in the experiment was a new sweet sorghum which is an Atlas x Leoti cross, a distinctly sweet selection. It yielded 10 tons of silage and 10 bushels of grain per acre in 1946.

Midland (Selection No. 617), a new combine grain sorghum recently released from the Hays station, is a selection taken from a Pink kafir-Dwarf yellow milo cross made at the station in 1920. Another good selection taken from this cross was Early kalo, which is a high yielding variety, taller than Midland but not a combine type.

Westland milo is a combine type also. Pink kafir, a standard variety of grain sorghum, is not suited for harvesting with a combine. It is adapted to a wide area in Kansas but in eastern Kansas does not yield as well as Blackhull kafir. All three grain sorghums used in this feeding trial are susceptible to chinch bug injury. Shelled yellow corn was fed also.

The Pink kafir fed in 1946-47 was produced in 1945, whereas the other grains, Midland milo, Westland milo, and yello corn, were grown in 1946. More favorable growing conditions prevailed in 1945 than in 1946, and, as a consequence, the Pink kafir was of noticeably better quality than the other two grain sorghums.

A summary of the results of the 1946-47 feeding trial is presented in Table 1 and the average for the three years is presented in Table 2.

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Table 1. Comparative values of midland milo, westland milo, pink kafir, and corn as cattle-fattening feeds

November 15, 1946, to April 13, 1947; 150 days

Lot number	1	2	3	4
Number of steers in lot	10	10	10	10
Grain fed in pounds	Midland milo	Westland milo	Pink kafir	Corn
Average daily ration:				
Ground grain	12.45	12.45	12.45	12.45
Cottonseed meal	1.50	1.50	1.50	1.50
Silage	42.70	42.70	42.70	42.70
Ground limestone	.10	.10	.10	.10
Average initial weight	776	775	775	774
Average final weight	1122	1123	1144	1119
Average gain	346	348	369	345
Average daily gain	2.31	2.32	2.46	2.30
Feed required for 100 pounds gain:				
Ground grain	540	537	506	541
Cottonseed meal	65	65	61	65
Silage	1851	1840	1736	1857
Ground limestone	4	4	4	4
Selling price per cwt. Kansas City	$24.00	$24.00	$24.00	$24.00
Cost of feed for 100 pounds gain	$19.89	$19.77	$18.40	$20.15
Dressing percentage	62.2	61.3	61.8	60.6
Carcass Grades				
Choice (AA)	5	5	7	4
Good to choice (A-AA)	4	5	3	6
Good (A)	1	...	...	...

Feed Prices: Midland milo and Westland milo, $2.55 per cwt.; Pink kafir, $2.50 per cwt.; yellow shelled corn, $1.45 per bu.; silage, $4.50 per ton; cottonseed cake, $59 per ton; ground limestone, $16 per ton.

Observations

3-Year Average

1. There were no significant differences in the gains made by any of the four lots of steers.

2. The dressing percentages were very nearly the same, with the corn-fed steers being slightly lower. There were no appreciable differences in the carcass grades.

3. In conclusion it can be stated definitely that the two combine-type grain sorghums (Midland milo and Westland milo) are fully equal to corn when used to fatten yearling steers. Pink kafir also proved equal to corn in producing gains on yearling steers.

Table 2. Comparative values of midland milo, westland milo, pink kafir, and corn as cattle-fattening feeds
3-Year Average—1944-45, 1945-46, 1946-47

Lot number	1	2	3	4
Number of steers in lot	10	10	10	10
Grain fed in pounds	Midland milo	Westland milo	Pink kafir	Corn
Average daily ration:				
Ground grain	13.28	13.28	13.28	13.28
Cottonseed meal	1.50	1.50	1.50	1.50
Silage	39.87	39.87	39.87	39.87
Ground limestone	.10	.10	.10	.10
Average initial weight	826	826	826	825
Average final weight	1190	1195	1190	1190
Average gain	364	369	360	365
Average daily gain	2.43	2.46	2.43	2.43
Feed required for 100 pounds gain:				
Ground grain	547	539	548	546
Cottonseed meal	62	61	62	62
Silage	1648	1625	1644	1645
Ground limestone	4	4	4	4
Selling price per cwt. Kansas City	$16.34	$16.10	$15.96	$17.66
Cost of feed for 100 pounds gain	$19.42	$19.42	$19.32*	$19.42
Dressing percentage	61.7	61.9	61.3	60.9
Carcass Grades**				
Choice (AA)	25	25	22	24
Good to choice (A-AA)	4	5	3	6
Good (A)	1	0	2	0

Feed Prices: 1944-45—Midland milo, Westland milo, and Pink kafir $1.50 per cwt.; shelled yellow corn $1.08 per bu.; cottonseed meal, $60.00 per ton; silage $4.00 per ton; ground limestone, $20.00 per ton.
1945-46—Midland milo and Westland milo $2.10 per cwt.; Pink kafir, $2.00 per cwt.; shelled yellow corn $1.30 per bu.; cottonseed meal $59.00 per ton; Norkan silage $3.00 per ton; ground limestone $16.00 per ton.
1946-47—Midland milo and Westland milo $2.55 per cwt.; Pink kafir, $2.50 per cwt.; shelled yellow corn, 1.45 per bu.; silage $4.50 per ton; cottonseed cake, $59.00 per ton; ground limestone $16.00 per ton.
* Seven head from Lot 3 sold at $17.00 per cwt. and three head sold at $16.00 per cwt. in 1944-45.
** Dressed yields and carcass grades were not obtained for three steers in Lot 3 in 1944-45.

This research originally appeared in the 1950 Roundup report.

Grass Utilization and Pasture Management

F.B. Kessler, L.C. Aicher, and F.E. Meenan

The investigations started at the Fort Hays branch of the Kansas Agricultural Experiment Station in the spring of 1946 to determine the effects of different intensities of grazing on beef production and on the density, growth, and botanical composition of the vegetation present in the pastures used, have been completed for the fourth season. A fourth pasture has been added this year in the summary (Table 6). This pasture was grazed moderately and cottonseed cake fed the last half of the grazing season. The previous three years' data for the three pastures are averaged in Table 6a. Again, the cattle used were choice quality Hereford yearling steers and heifers produced by this station's cowherd. They were weighed at the beginning and at the end of the season, and monthly during the grazing season. They were sprayed for flies on each weigh day.

Yearling steers and two-year-old heifers also were grazed on planted buffalo grass and planted intermediate wheatgrass. Rain was ample until July 1. There was very little rain after that, which benefited the grass, until October 9. This was too late to be of much benefit from a grazing standpoint.

Table 6. The effects of different intensities of grazing on beef production
May 2, 1949 to October 28, 1949; inclusive,180 days

Pasture number	1	2	3	4 1½ lbs. CSC per head daily Aug. 1–Oct. 28
Grazing intensity	Heavy	Moderate	Light	Moderate
Total acreage	62.93	64.64	113.24	70
Average number of head for season	31	19	22	21
Average number of acres per head for season	2.03	3.40	5.15	3.33
Average initial weight	613	613	613	613
Gain per head for season:				
All cattle	105	165	194	220
Steers	97	171	192	233
Heifers	113	160	117	203
Gain per acre for season	52	49	38	66
Estimated sale price per cwt. (Kansas City):				
Spring: Steers	$24.75	$24.75	$24.75	$24.75
Heifers	23.00	23.00	23.00	23.00
Fall: Steers	22.50	23.25	23.50	23.75
Heifers	21.50	22.25	22.50	22.75

Table 6a. The effects of different intensities of grazing on beef production
Av. for 4 years-1946, 1947, 1948, and 1949-summer grazing seasons

Pasture number	1	2	3
Grazing intensity	Heavy	Moderate	Light
Total acreage	62.93	64.64	113.24
Average number of head for season	31.7	21.8	21.66
Average number of acres per head for season	1.99	3.35	5.22
Average initial weight	624	625	624
Gains per head for season	126	172	192
Gain per acre for season	63	52	37

General Observations

1. In 1949 the cattle in the lightly-grazed pasture gained 89 lbs. per head more than those in the heavily-grazed pasture and were valued $1.00[1] per cwt. higher in the fall. All cattle were of the same value in the spring. The moderately-grazed cattle gained 60 lbs. more and were valued $0.75 per cwt. higher than those in the heavily grazed pasture.

2. In Pasture No. 1 the heifers outgained the steers. When the feed supply became limited the heifers outgained the steers.
3. The cattle in Pasture No. 4, moderately grazed, with protein supplement added the last half of the grazing season, gained 55 lbs. per head more than those in the moderately-grazed pasture with no protein supplement and were valued $0.50 per cwt. higher. They gained 26 lbs. per head more than the cattle in the lightly-grazed pasture and were valued $0.25 per cwt. higher. This was the most profitable of the four systems of pasture management this year.

4. The cattle in Pasture No. 1 started losing weight after September 1 and those in Pastures Nos. 2 and 3 started losing after October 1, while those in Pasture No.4 kept gaining steadily until the end of the season.

5. The rate of gain in each pasture during June was materially lower than in the months of May and July. The same condition occurred in 1948 but to a lesser degree. The month of June was extremely wet both years. The mosquitoes and flies bothered the cattle more than usual and they stood bunched more of the time, thus spending less time grazing. These facts probably account, in part at least, for the low rate of gain during June of the past two years.

6. The heavily-grazed pasture had no excess grass at the end of the grazing season. The grass was uniformly very short over the entire pasture. The lightly-grazed pasture had a large amount of unused western wheatgrass and considerable blue grama and buffalograss left at the end of the season. The amount of unused grass in the moderately-grazed pasture was midway between those in the other two pastures. The condition of the three pastures in the fall compared closely with their condition at the close of the first two grazing seasons. A little more grass was left in all three pastures at the end of the 1948 grazing season.

7. The intermediate wheatgrass planted in the spring of 1948 was grazed with 26 head of yearling steers and six two-year-old heifers and a two-year-old bull for 49 days starting May 13. It

[1] The spring appraisals were made by A. G. Pickett. associate professor of animal husbandry, Kansas State College, and Lot F. Taylor, extension specialist, animal husbandry, Kansas State College. The fall appraisals were made by Lot F. Taylor and Ray M. Ross, extension economists in marketing, Kansas State College.

was approximately 20 inches high at this time and had attained a height of 52 inches by July 1. It produced 82 lbs. gain per acre in the 49 days and in addition produced a seed crop of 3700 lbs. on the 45 acres. This 45-acre field was grazed by 126 cows November 19-22 and would have furnished feed for a total of six days had not the lack of water forced their removal.

8. Twenty-six head of steers were grazed on the 34 acres of buffalograss for 111 days, in which time it produced 95 lbs. gain per acre. There was a surplus of buffalograss left at the end of the grazing season.

9. Table 7 shows the protein content of the grasses and how the protein content declines as the season advances. Note the extreme high protein content of the intermediate wheatgrass in the fall. New growth started about August 20.

Table 7. The percentage of protein in samples of grass taken from the different pastures on certain dates

Dates	July 5						August 5					
Pasture No.	1	2	3	4	6	8	1	2	3	4	6	8
Buffalo	8.11	8.04	8.00	8.20	...	...	6.19	5.61	5.40	5.65	...	...
Western wheat	9.30	9.64	9.64	10.90	...	...	4.57	5.61	6.15	5.66	...	...
Planted buffalo	...	...	...	...	6.29	...	...	...	...	...	5.79	...
	September 2						October 4					
Buffalo	6.48	5.38	5.08	5.43	...	...	4.32	4.46	4.21	4.18	...	...
Planted Buffalo	...	...	...	...	6.66	...	...	...	...	...	4.41	...
Intermediate wheat	...	...	...	...	...	22.40	...	...	...	...	...	...

Pastures 1, 2, 3, and 4 are native pastures. Pastures 6 and 8 are planted buffalograss and planted intermediate wheatgrass, respectively. These percentages are all on a dry basis.

Table 8. Ground cover data for 1946 and 1949 showing the trends in native pastures under different grazing intensities

Pasture No.	Type of Cover	Percent Cover 1946	Percent Cover 1949	Change
1 (Heavily grazed)	Blue grama	5.81	18.20	+12.39
	Buffalograss	70.85	50.99	-19.86
	Western wheatgrass	2.65	1.62	-1.03
	Side-oats grama	...	0.08	+0.01
	Sand dropseed	0.17	0.018	+0.01
	Total grass	79.48	70.91	-8.57
2 (Moderately grazed)	Blue grama	5.96	18.12	+12.16
	Buffalograss	74.11	42.56	-31.55
	Western wheatgrass	1.00	3.88	+2.88
	Side-oats grama	0.16	...	-0.16
	Sand dropseed	0.04	...	-0.04
	Total grass	81.28	64.56	-16.72
3 (Lightly grazed)	Blue grama	2.75	13.12	+10.37
	Buffalograss	66.77	29.21	-37.56
	Western wheatgrass	3.34	6.18	+2.84
	Side-oats grama	...	0.12	+0.12
	Sand dropseed	0.91	0.10	-0.81
	Total grass	73.78	48.73	-25.05

Observations

1. The three pastures were very nearly alike in vegetative cover at the beginning of the experiment.
    a. All contained a high percent of buffalograss.

2. Blue grama increased in all three pastures from 1946 to 1949.

3. Buffalograss decreased in all three pastures. The decrease was least under heavy grazing.

4. Western wheatgrass decreased under heavy grazing and increased under moderate and light grazing.

5. Side-oats grama and sand dropseed do not occupy an important place in these pastures.

6. The total grass cover decreased in all three pastures. The decrease was least under heavy grazing, next under moderate grazing, and greatest under light grazing.

This research originally appeared in the 1952 Roundup report.

The Influence of the Sire on Efficiency of Feed Utilization[1]

L. C. Archer[2] and F.B. Kessler[3]

1. Yearling steers

The yearling steers were sorted and lotted according to their sires and full fed for 150 days. The ration fed consisted of Ellis sorgo silage, ground Midland milo, cottonseed cake, and ground limestone for the first 100 days. At the end of the first 100 days of the feeding period, the supply of cottonseed cake was exhausted. A supply of cottonseed screenings was secured and cottonseed screenings were fed in the place of cottonseed cake for the last 50 days of the feeding period.

They received all the silage they would consume all through the feeding period. Two months were used to get the grain ration up to 16 pounds per head daily. The grain ration was continued at this rate for the remaining portion of the feeding period.

The Midland milo was grown in western Kansas. The Ellis silage was put up in 1950 and yielded 12 tons per acre. The grain yield on the Ellis silage was 50 bushels per acre. The composition of the feeds used is contained in Table 8.

The data concerning the steers appear in Tables 1 and 2 and are discussed in the Observations following those tables.

[1] Contribution No. 78, Fort Hays Branch, Kansas Agricultural Experiment Station, Manhattan, Kansas.
[2] Superintendent, Fort Hays branch station.
[3] Animal husbandman, Fort Hays branch station.

Table 1. Comparison of gains made by yearling steers sired by different bulls
November 14, 1951, to April 11, 1952; inclusive, 150 days

Lot number	1	2	3	4	5	5A
Number of steers in lot	14	12	11	10	10	2
Sires of steers in each lot	Rollo Mischeif 8th	Real Pioneer 23rd	Royal Tredway 68th	Perfect Tredway 2nd	Prince Tredway 12th	Regality
Average daily ration:						
Silage	42.89	42.89	42.89	42.89	42.89	42.89
Ground grain sorghum	12.70	12.70	12.70	12.70	12.70	12.70
Cottonseed cake	1.89	1.89	1.89	1.89	1.89	1.89
Ground limestone	.10	.10	.10	.10	.10	.10
Average weight at birth (Jan. 5, 1950, to April 1, 1950)	79	72	75	76	82	79
Average weaning weight (11-1-50)	588	543	551	515	565	500
Average weight into lots (11-15-50)	581	539	535	518	556	503
Average weight out of lots (4-13-51)	761	733	705	712	731	675
Average gain as calves	180	194	170	194	175	172
Average weight into pasture (4-30-51)	752	733	705	711	731	665
Average weight out of pasture (10-26-51)	928	895	890	870	915	842
Average pasture gain (Summer 1951)	176	162	185	159	184	177
Average weight into lots (11-14-51)	901	860	856	833	867	825
Average weight (final) (4-11-52)	1304	1254	1225	1215	1222	1158
Average gain as yearlings	403	394	369	382	355	333
Average daily gain as yearlings	2.69	2.63	2.46	2.55	2.37	2.22
Average age (days) (4-11-52)	795	801	794	793	804	784
Average gain, birth to (4-11-52)	1225	1182	1150	1139	1140	1079
Average daily gain, birth to (4-11-52)	1.54	1.48	1.45	1.44	1.42	1.38
Feed required for 100 pounds gain as yearlings:						
Silage	1596.53	1632.99	1743.63	1684.29	1812.39	1932.13
Ground grain sorghum	472.70	483.50	516.26	498.69	536.62	572.07
Cottonseed cake	70.47	72.08	76.96	74.35	80.00	85.29
Ground limestone	3.72	3.81	4.07	3.93	4.23	4.50
Cost of feed for 100 pound gain as yearlings	$21.57	$23.06	$23.55	$22.75	$24.48	$26.11
Dressing percentage	61.19	62.13	61.08	60.43	*61.18 for 11 head	
Carcass grades	3 prime 11 choice	5 prime 7 choice	3 prime 8 choice	10 choice	3 prime 8 choice	1 steer not graded
Selling price	$34.00	$34.00	$34.00	$34.00	11 hd. @ $34.00 1 hd. @ $30.00	

Feed Prices: Silage $8 per ton; ground grain sorghum $2.55 per cwt.; cottonseed cake $88.65 per ton; ground limestone $16 per ton.
* Lots 5 and 5A sold together.

Table 2. Comparison of gains made by yearling steers sired by different bulls
Average results from full feeding trials of steers sired by five bulls for three and two years, respectively

Number of years of feeding trials	3-year average			2-year average	
Lot number	1	2	3	4	5
Number of steers in lot	36 hd.	29 hd.	33 hd.	20 hd.	19 hd.
Sires of steers in each lot	Rollo Mischeif 8th	Real Pioneer 23rd	Red Battle No. 1	Perfect Tredway 2nd	Prince Tredway 12th
Average daily ration:					
Silage	41.09	41.12	40.33	42.41	42.57
Ground grain sorghum	13.90	13.90	14.50	13.55	13.55
Cottonseed cake	1.96	1.96	2.00	1.95	1.95
Ground limestone	.10	.10	.10	.10	.10
Average weight at birth	79	76	77	78	82
Average weaning weight	552	524	515	456	504
Average weight into lots (In fall)	566	538	538	480	527
Average weight out of lots (In spring)	714	694	682	654	685
Average gain as calves	148	156	144	174	158
Average weight into pasture as yearlings	711	699	686	667	705
Average weight out of pasture	893	878	868	857	888
Average pasture gain (Summer)	182	179	182	190	183
Average weight into lots	866	848	836	832	858
Average weight (final) spring as 2 yr. olds	1295	1285	1253	1226	1223
Average gain as yearlings	429	437	417	394	365
Average daily gain as yearlings	2.86	2.91	2.78	2.63	2.43
Average age (days) spring as 2 yr. olds	807	807	816	785	792
Average gain, birth to 2 yr. olds	1216	1209	1176	1148	1141
Average daily gain, birth to 2 years	1.51	1.50	1.44	1.46	1.44
Feed required for 100 pounds gain as yearlings:					
Silage	1450.17	1424.04	1472.29	1623.92	1753.26
Ground grain sorghum	487.51	477.86	526.60	515.36	557.08
Cottonseed cake	69.02	67.71	72.69	74.12	80.11
Ground limestone	3.52	3.46	3.64	3.81	4.12
Average selling price	$33.75	$33.75	$33.43	$36.00	$35.68
Average dressing percentage	61.67	61.90	61.77	61.03	61.62
Carcass grades	5 prime 27 choice 4 top good	13 choice 4 top good 5 prime 20 choice	3 prime 20 choice 7 top good 3 good	20 choice	(*)3 prime 15 choice 1 steer not graded

(*) Two other steers weighted with the lot and graded together. This is an estimate of how they probably graded, based on knowledge of the live cattle in feed lot.

Observations

1. The steers in Lot 1 made the greatest gain on full feed and had the highest rate of gain from birth to 2 years of age. These steers as calves also were heaviest when weaned. However, they ranked third in gains as calves on winter maintenance rations and fourth in gains on grass. Three crops of calves from this sire, carried through the same maintenance, grazing, and full feeding program, followed the same pattern of gains.

2. Lot 5 tied with Lot 3 in having the lowest average daily rate of gain from birth to 2 years of age, and ranked lowest in average daily gain as yearlings. However, these steers ranked second in feed lot gains as calves and in summer gains on grass as yearlings. Also, they were heaviest at birth and third heaviest when weaned. The average rank of two crops of calves from this sire tends to follow the same pattern (Table 2).

3. The steers from Lot 2 weighed the least when calved, but when weaned ranked second. They had third highest gains for the winter feeding season. They then dropped to fifth rank at the close of the summer grazing season, but came back to make the top average daily gain in the feed lot as two year olds. These steers ranked second in total average daily gain from birth to 2 years of age.

4. The steers in Lot 4 ranked third in weight at birth, fourth in average weaning weight, and first out of the winter maintenance feed lot in the spring. They also ranked first in average summer pasture gains. These steers ranked fourth in average daily gains as yearlings and third in average daily gain from birth to 2 years of age.

5. The average of figures to date seems to indicate that bulls siring calves with the heaviest weaning weight at the same time provide calves more able to achieve greater gains when full fed on grain, whereas bulls with capability of siring calves with the lowest weaning weight tend to produce calves able to make greater gains on roughage and grass and less gain on grain when full fed.

6. The differences noted are not great and in some instances are within the range of experimental error. On the whole, the investigations to date indicate that either the first five bulls in use have been well selected for good breeding qualities, or the influence of the quality of the cowherd is overcoming deficiencies which the bulls might possess but which are not too apparent in looking over the bulls.

2. Yearling heifers

Yearling heifers produced the same year and by the same sires as the yearling steers were also lotted according to sires and fed a good maintenance ration for a period of 140 days. The ration fed these heifers consisted of 1950 Ellis silage and ground alfalfa hay produced in 1951.

The silage was the same as that fed the yearling steers. Much of the alfalfa hay fed these heifers was low quality, stemmy hay which had been flooded in the spring before cutting. About half the alfalfa fed was medium quality, second cutting, which had been rained on between cutting and baling. The quantity of silage and alfalfa hay was limited to an amount considered sufficient to keep the heifers in good thrifty growing condition to develop them properly for breeding heifers.

Thirty top heifers were selected from this group and added to the breeding herd on April 1, the date the bulls were turned with the cows.

Table 3 gives the data for this past feeding season and Table 4 gives the average for all the calf crops that have been wintered to date from the five sires used. The data in each table are discussed under Observations.

Table 3. Comparison of gains made by yearling heifers sired by different bulls
November 14, 1951, to April 1, 1952; inclusive, 140 days

Lot number	1	2	3	4	5
Number of heifers in lot	12	12	12	11	12
Sires of heifers in each lot	Rollo Mischeif 8th	Real Pioneer 23rd	Royal Tredway 68th	Perfect Tredway 2nd	Prince Tredway 12th
Average daily ration:					
Silage	43.68	43.68	43.68	43.68	43.68
Ground alfalfa	4	4	4	4	4
Average weight at birth (Jan. 5, 1950 to April 1, 1950)	68	69	69	76	73
Average weaning weight (11-1-50)	500	533	504	530	525
Average weight into lots (11-15-50)	488	528	495	534	520
Average weight out of lots (4-13-51)	642	705	647	720	679
Average gain as calves	154	177	152	186	159
Average weight into pasture (4-30-51)	633	705	648	719	685
Average weight out of pasture (10-26-51)	803	837	815	855	845
Average pasture gain (Summer 1951)	170	132	167	136	160
Average weight into lots (11-14-51)	758	800	792	814	809
Average weight (final) (4-1-52)	915	946	920	953	954
Average gain as yearlings	157	146	128	139	145
Average daily gain as yearlings	1.12	1.04	0.91	0.99	1.04
Average age (days) (4-1-52)	789	788	795	787	790
Average gain, birth to (4-1-52)	847	877	851	877	881
Average daily gain, birth to (4-1-52)	1.07	1.11	1.07	1.11	1.12
Feed required for 100 pounds gain as yearlings:					
Silage	3894.90	4188.36	4777.34	4399.28	4217.24
Ground alfalfa	356.69	383.56	437.50	402.88	386.21

Table 4. Comparison of gains made by yearling heifers sired by different bulls

Average results from winter feeding trials of heifers sired by five bulls for three and two years, respectively

Number of years of feeding trials	3-Year average			2-Year average	
Lot number	6	7	8	9	10
Number of heifers fed during the period	35 hd.	36 hd.	18 hd.	18 hd.	19 hd.
Sires of heifers in each lot	Rollo Mischeif 8th	Real Pioneer 23rd	Red Battle No. 1	Perfect Tredway 2nd	Prince Tredway 12th
Average daily ration:					
Silage	42.94	42.94	42.57	43.80	43.80
Ground alfalfa	5.33	5.33	5.00	4.00	4.00
Average weight at birth	71	71	68	73	73
Average weaning weight	496	493	483	448	452
Average weight into lots (In fall)	503	501	498	482	475
Average weight out of lots (In spring)	642	645	637	643	620
Average gain as calves	139	144	139	161	145
Average weight into pasture as yearlings	639	649	644	655	640
Average weight out of pasture	809	808	806	822	827
Average pasture gain (Summer)	170	159	162	167	187
Average weight into lots	780	779	781	794	800
Average weight (final) spring as 2 yr. olds	955	949	992	958	959
Average gain as yearlings	175	170	211	164	159
Average daily gain as yearlings	1.27	1.23	1.36	1.18	1.15
Average age (days) spring as 2 yr. olds	799	791	803	755	779
Average gain, birth to 2 yr. olds	728	878	924	885	886
Average daily gain, birth to 2 years	1.10	1.11	1.15	1.14	1.14
Feed required for 100 pounds gain as yearlings:					
Silage	3521.54	3803.30	2778.52	2802.82	2850.00
Ground alfalfa	362.72	390.18	324.26	347.47	351. 73

Observations

1. The results thus far show that all the heifers fed the same uniform ration made satisfactory growth and development for breeding heifers, regardless of the bull by which they were sired. There was 43 pounds difference in average weight between the heaviest and lightest heifer groups. The heaviest group, averaging 992 pounds, were the lightest as calves at birth. When yearling heifers can make an average gain up to 176 pounds in 140 days on silage and 4 pounds of alfalfa hay to have an average final weight of 962 pounds as 2-year olds, it must be said that their development has been satisfactory.

2. The group of heifers in Lot 8 made an outstanding average gain of 211 pounds, whereas the group in Lot 10 made the lowest gain of 159 pounds. The groups in between averaged 175-170 and 164 pounds, respectively.

3. The average daily gain from birth to 2 years of age varied from 1.10 to 1.15 pounds among the five groups, with an average daily gain for the five groups of 1.128 pounds.

4. There seems to be a reverse correlation between the abilities of sires to transmit gaining ability to steers on a concentrated full feeding ration as compared to heifers from the same sire on a maintenance ration. For three years in succession the sires that produced the steers having the highest average daily gain from birth to two years of age on a concentrated ration, produced heifers that made the lowest average daily gain from birth to 2 years of age on a maintenance ration. The sires that produced the steers making the lowest average daily gains on concentrated rations produced the heifers which made the highest average daily gain on the maintenance ration.

This research originally appeared in the 1954 Roundup report.

Value of Antibiotics in the Wintering Ration of Steer Calves

W.W. Duitsman and F.B. Kessler

This work was a continuation from last year, when Aureomycin and Bacitracin were used to determine the value of antibiotics in steer calf wintering rations.

The calves used were good and choice quality Texas and station raised Herefords. Each lot contained 6 Texas calves and 4 station raised calves.

The wintering period started November 17 and continued 122 days, ending March 18. Results are summarized in Table 2.

Observations

This year the calves receiving Bacitracin (Lot 13) gained less than those in the check lot or those receiving Aureomycin. They consumed less silage, and at a higher cost of gain than either the check or Aureomycin lots. However, the two-year average gain is nearly the same for the check lot (10) and the lot receiving the Bacitracin. The Aureomycin fed calves produced .07 pound per head greater daily gain than the check lot and consumed 1.79 pounds less silage per head daily. This is not considered significant. All calves did well and appeared in good health at the end of experiment. The differential between the check lot and the calves receiving Aureomycin occurred during the last 16 days of the feeding period.

Table 2. Value of aureomycin and bacitracin in the wintering ration of steer calves
November 17, 1953, to March 18, 1954, inclusive,122 days

Lot number	10	12	13
Number in lot	10	10	10
Average daily ration:			
Ellis silage	34.27	32.48	31.00
Midland milo	1.75	1.75	1.75
Cottonseed meal	1.25	1.25	1.25
Aureomycin, 45 mg. per head daily	no	yes	no
Bacitracin, 45 mg. per head daily	no	no	yes
Average initial weight	466	466	466
Average final weight	643	652	630
Average gain	177	186	164
Average daily gain	1.45	1.52	1.34
Daily gain, 2-year average	1.50	1.62	1.49
Feed required for 100 lbs. gain:			
Ellis silage	2362.15	2130.65	2306.71
Midland milo	120.62	114.78	130.18
Cottonseed meal	86.16	81.99	92.99
Aureomycin cost for 100 lbs. gain	...	$0.41	...
Bacitracin cost for 100 lbs. gain	...	...	$0.30
Cost of feed and antibiotic for 100 lbs. gain	$13.95	$13.29	$14.50
Wintering cost per head	$24.69	$24.72	$23.78

Feed prices: Ellis silage $7.00 per ton; Midland milo $2.00 per cwt.; Cottonseed meal $76.00 per ton; Aureofac 2A $0.50 per pound (daily cost per head $0.00625); Baciferm 5 $0.55 per pound (daily cost per head $0.00396).

This research originally appeared in the 1959 Roundup report.

Use of Wheat in a Fattening Ration for Yearling Steers

J.R. Brethour and W. W. Duitsman

One and three-fourths pounds wheat substituted for 1.75 pounds sorghum grain as a supplement for Ellis sorgo silage in a wintering ration consistently increased gains of steer calves, as reported in this circular. Previous investigations have shown that wheat fed as the only grain in a ration with dry roughages becomes unpalatable, lowers intake, and results in reduced rate of gain, although efficiency of gain remains high. When wheat was mixed with another grain, satisfactory results have been achieved.

This trial was conducted to determine if a large quantity of silage included in a ration containing wheat would tend to improve the palatability of the feed. Wheat was fed alone or mixed with an equal quantity of sorghum grain; the ration in each case included 2 parts Ellis sorgo silage to 1 part wheat or the wheat-sorghum grain mixture.

Experimental Procedure

This trial was conducted in the same manner as the study of different ratios of grain to silage reported earlier in this circular.

Two pounds of grain was fed the first day and increased 1 pound every second day until a rolled grain to Ellis sorgo silage ratio of 1:2 was reached. The eight steers in lot 14 were fattened on sorghum grain while the 10 in lot 17 received a mixture of equal parts wheat and sorghum grain. Wheat was the only grain fed the 10 animals in lot 18. In each lot the daily ration included 3 pounds chopped alfalfa hay and 1 1/2 pounds cottonseed meal during the 136-day trial. Each steer was implanted with 36 mgs. stilbestrol at the beginning of the test and received a daily average of 72 mgs. Aureomycin mixed with the cottonseed meal.

Observations

A ration of one part rolled wheat to two parts Ellis sorgo silage fed steers in lot 18 was not so palatable as a similar ration of sorghum grain and silage. It was difficult to keep cattle on feed when wheat was the only grain offered and scouring was frequent. The reduced feed consumed likely explains the slower rate of gain of animals in lot 18 (Table 6).

The average grade of steers in lot 18 was somewhat lower than averages from other lots; however, insufficient marbling in carcasses from any of the three groups prevented their averaging choice grade. An average of 8.64 pounds dry matter was required for each pound gain by steers in this lot compared with 10.07 pounds for the steers in lot 14, which were fed sorghum grain rather than wheat. In lot 17 where each steer received equal portions of wheat and sorghum grain, an average of 8. 77 pounds of dry matter was consumed for each pound gained. Steers in this lot gained faster and more efficiently than those fed only sorghum grain and silage. Wheat at $1.64 per bushel would have made cost of gain in the two lots equal. This test will be repeated to establish more precisely the relative values of the two grains in a fattening ration with sorgo silage.

Table 6. The use of wheat in the fattening ration for yearling steers
November 1, 1958, to March 16, 1959; inclusive, 136 days

Lot	14	17	18
Ration	1 : 2 Rolled sorghum grain : Ellis sorgo silage	1 : 1 : 4 Rolled wheat : Rolled sorghum grain : Ellis sorgo storage	1 : 2 Rolled wheat : Ellis sorgo silage
Number in lot	8	10	10
Average daily ration, lbs.:[1]			
Ellis sorgo silage	47.0	41.5	36.5
Rolled sorghum grain	18.1	8.3	...
Rolled wheat	...	8.3	14.3
Chopped alfalfa hay	3.0	3.0	3.0
Cottonseed meal[2]	1.5	1.5	1.5
Days required to reach full feed	48	36	35
Average daily ration after reaching full feed, lbs.:			
Ellis sorgo silage	42.1	38.0	31.9
Rolled sorghum grain	21.0	9.5	...
Rolled wheat	...	9.5	16.0
Chopped alfalfa hay	3.0	3.0	3.0
Cottonseed meal	1.5	1.5	1.5
Average initial weight, lbs.	834	831	833
Average final weight, lbs.	1287	1309	1265
Average gain, lbs.	453	478	432
Average daily gain, lbs.	3.33	3.52	3.17
Average lbs. feed required for 100 lbs. gain:			
Ellis sorgo silage	1411	1181	1149
Rolled sorghum grain	542	236	...
Rolled wheat		236	450
Chopped alfalfa hay	90	85	95
Cottonseed meal	45	43	47
Average feed cost for 100 lbs. gain:	...	...	...
Ellis sorgo silage, $7.00/ton	$4.94	4.13	4.02
Rolled sorghum grain, $1.80/cwt.	$9.76	4.25	...
Rolled wheat, $1.85/bu. ($3.08/cwt.)	...	$7.28	13.87
Chopped alfalfa hay, $16.00/ton	$0.72	.68	.76
Cottonseed meal, $83.50/ton[3]	$1.88	1.80	1.96
	$17.30	18.14	20.61
Average hot carcass weight as % of final feedlot weight:[4]	59.98	59.68	59.73
Average grade[5]	11.50	11.80	11.50
Average marbling score[6]	6.88	7.20	7.10

[1] Each steer also was implanted with 36 mgs. stilbestrol November 6, 1958. This cost, $0.27, not included in cost of 100 lbs. gain.
[2] Aureomycin mixed with cottonseed meal to provide 72 mgs. per head per day.
[3] Cottonseed meal, $70; Aureomycin, $9.50; mixing, $4.
[4] Final feedlot weight taken at Hays in morning before feeding; hot carcass weight taken in Kansas City 24 hours later.
[5] Average grade was based on: low choice, 13; high good, 12; average good, 11; low good, 10.
[6] Marbling score was based on: modest, 6; small amount, 7; slight amount, 8.

This research originally appeared in the 1961 Roundup report.

High and Low Levels of Silage Compared in Steer Fattening Rations

J.R. Brethour and W. W. Duitsman

A number of experiments have been conducted at this station comparing different ratios of sorghum grain with sorgo silage. These ratios have varied from 1 part grain and 4.5 parts silage to 3 parts grain and 2 parts silage. Gains have tended to be greater with the more concentrated rations. However, there has been little difference among grain to silage ratios of 1:3, 1:2, 1:1, and 3:2 in final grade and yield after a 150-day feeding period. In this year's test a ration of 1 part grain to 2 parts silage (by weight) was compared with a more concentrated ration of 3 parts grain to 1 part silage.

Experimental Procedure

Cattle used and management practices followed were similar to those in the comparison of protein supplements described previously. The first day of the trial steers were fed 2 pounds grain per head plus all the silage they would consume. Thereafter, grain was increased 1 pound every second day until grain and silage were consumed in a 1 to 2 ratio in lot 20 (3 weeks) and until silage intake had dropped to 10 pounds per day in lot 17 (7 weeks). In lot 17 silage was reduced to 5 pounds per day the last 60 days of the trial. Both rations were supplemented with 3 pounds chopped alfalfa hay and 2 pounds cottonseed meal.

Table 8. Comparison of high and low levels of silage in a steer fattening ration
October 3, 1960, to March 16, 1961; 165 days

Lot	17	20
Treatment	Low silage	High silage
Number per lot	10	24
Average daily ration, lbs.:		
Ellis sorgo silage	14.6	35.0
Rolled sorghum grain	19.0	15.8
Chopped alfalfa hay	3.0	3.0
Cottonseed meal	1.5	1.5
Average daily silage intake after steers reach full feed, lbs.	7.2	34.2
Average daily grain intake after steers reach full feed, lbs.	21.5	17.4
Average initial weight, lbs.	832	842
Average final weight, lbs.	1367	1349
Average total gain, lbs.[1]	535	507
Average daily gain, lbs.	3.24	3.07
Average feed cost for 100 lbs. gain	$12.35	$13.80
Average yield [2]		
Carcass grades[3]	62.7	62.7
Choice	5	7
Good	5	5
Average marbling score[4]	6.4	6.3

[1] LSD: p<.05, 38 lbs.
[2] Yield equals hot carcass weight as percentage of final feedlot weight.
[3] Carcass data acquired for 12 head in lot 20
[4] Marbling score based on modest, 6: small amount, 7.

Observations

Animal performance followed the same pattern observed in previous years. Steers fed the more concentrated ration made slightly greater gains (though the difference was not significant) than those in lot 20 (Table 8). No difference was observed in carcass grade and yield. With silage priced at $7 per ton and sorghum grain at $1.40 per cwt., the high grain ration resulted in the most economical gains.

This research originally appeared in the 1965 Roundup report.

Relationship of Feed Lot Performances of a Sire and His Progeny

J.R. Brethour and W.W. Duitsman

Because heritability of feed lot gain is thought to be relatively high, this project was initiated in the fall of 1955 to study feasibility of feeding a fattening ration to a group of bulls for 180 days after weaning, measuring their ability to gain when on full feed and then investigating the importance of gaining ability in selecting a herd sire. The investigation also yields information about the heritability of certain carcass characteristics and other performance traits. The following report summarizes the results of the seventh replication; data from previous trials are given in earlier reports.

Experimental Procedure

In October, 1961, nine bull calves, all sired by the same bull, were obtained from the Thad Douthit herd of St. Francis, Kansas. The bulls were weaned October 27, scored as to conformation, and transported to Hays. They were weighed off the truck and started on a 177-day performance test. At the end of the feeding period the bulls were weighed and rescored. The 9 head were then divided into 3 groups according to daily gain. A bull of the most desirable conformation was chosen from each group (high-gaining, medium-gaining, and low-gaining) to be mated to one of 3 groups of station cows that averaged nearly equal in age, type score, and weight. The breeding season was from May 21 to July 23, 1962.

In the spring of 1963 the progeny of these sires were dropped and were handled alike until weaned October 23, 1963. During the next 242 days they were fed a fattening ration of forage sorghum silage, rolled sorghum grain, chopped alfalfa hay and cottonseed meal. Weaning weights were taken after driving the calves a mile to a scale. Final weights were made in the morning before feeding.

Observations

A summary of the gains and carcass data are presented in Table 26. Differences in average feed lot gain among the three sire groups were significantly related to the daily gains of the sire. When the seven calf crops in this project are considered together, sire gain and progeny gain are significantly related. A summary is presented below:

Average daily gains of sires and respective progeny, lbs.

	Low-gaining sire		Medium-gaining sire		High-gaining sire	
Year	Sire	Progeny	Sire	Progeny	Sire	Progeny
1957	2.00	1.81	2.31	1.94	2.69	2.07
1958	2.11	1.97	2.50	2.02	2.86	2.03
1959	2.56	1.84	2.85	1.84	3.11	1.88
1960	2.54	1.94	2.88	2.13	3.13	2.04
1961	2.24	1.75	2.50	1.81	2.81	1.87
1962	2.49	2.01	2.67	2.08	2.91	2.02
1963	1.99	1.88	2.30	2.08	2.72	2.19

Table 26. The relationship of feed lot performances of a sire and his progeny (Douthit—4A Zato 517, 1963-64)

Group	Progeny of low-gaining sire	Progeny of medium-gaining sire	Progeny of high-gaining sire	LSD p<.1	LSD p<.05
Sire's daily gain in feed lot performance test, lbs.	1.99	2.30	2.72	...	...
Number per lot:					
Steers	9	7	7	...	...
Heifers	7	7	4	...	...
Average birth weight, lbs. [1]	67	68	67	3	4
Average age at weaning (October 23, 1963) days	213	218	221	...	...
Average weaning weight, lbs.	406	430	410	27	32
Average yearling weight, lbs.	653	720	707	40	48
Average final weight, lbs.	797	863	865	...	...
Average feed lot gain (October 23, 1963, to May 17, 1964, 208 days), lbs.	391	433	455	32	44
Average daily gain during feeding test, lbs.	1.88	2.08	2.19	.13	.16
Carcass data:					
Average marbling score	7.7	7.4	7.4	.4	.5
Carcass grades:					
Choice	0	2	1	...	...
Good	12	8	7	...	...
Average backfat thickness, in.	.61	.66	.77	.10	.12
Average loin-eye area, sq. in.	8.09	8.81	9.00	.73	.88
Summary of 7 replications:					
Sire's daily gain in feed lot performance test, lbs.	2.28	2.57	2.89	...	...
Average daily gain of progeny in feed lot, lbs.	1.89	1.99	2.01	...	...

[1] Averages are adjusted for age of calf, age of dam, and sex.

Performance relationships between sires and progeny have been small but consistent. The correlation of sire's gain on test with the average daily gain of his progeny has been .77 ($p<.005$); regression of progeny daily gains on sire daily gains is .22. This means that if two potential sires, selected and fed under the conditions used here, differed by .5 pound per day in gain, gains of their respective progeny groups would be expected to differ by about .11 pound per day (half the regression coefficient). This sire and progeny performance relationship is lower than that usually quoted; however, one needs to keep in mind the relationship of the bulls used in each test. A cross section of the breed would be expected to vary more in genetic makeup than a set of half brothers. Also both steer and heifer calves are used in this test; in the seven tests, average gains of heifer calves have varied less from one progeny group to another than those of steer calves.

This research originally appeared in the 1966 Roundup report.

Sorghum Grain Compared with Cottonseed Meal as a Supplement for Yearling Steers on Native Pasture

J.R. Brethour and W.W. Duitsman

Previous tests at this station (Bulletin 394) have indicated the value of supplementing short-grass range during the last half of the grazing season. In six of the past nine years, 1.5 pounds of rolled sorghum grain per head per day compared favorably with 1.5 pounds of cottonseed meal as a supplement for yearling steers on native pasture. However, in 1958, 1961, and 1962 cattle receiving cottonseed meal gained appreciably faster than those supplemented with sorghum grain. During those three years July-August rainfall was much above the 6.15 inch average. The experiment is being continued to determine conditions that favor a high-protein or a high-energy supplement.

Experimental Procedure

Two adjoining, upland, native pastures, each containing 36 acres, were moderately stocked with 10 steers May 5, 1965. They had been wintered on grass supplemented with 5 pounds alfalfa and 3 pounds grain per head per day.

August 3 through September 29, 1.5 pounds rolled sorghum grain was fed per head daily to one group of steers, 1.5 pounds cottonseed meal each to the other group. All weights were taken in the morning after cattle had been kept from feed and water over night.

Observations

In the 1965 replication there was little difference between either sorghum grain or cottonseed meal in average pasture gain after August 1, (Table 22). In past years response to cottonseed meal has occurred in years of high rainfall. In years of average or below average precipitation, gains were as large when an equal amount of sorghum grain was substituted for cottonseed meal.

Table 22. Sorghum grain compared with cottonseed meal as a supplement for yearling steers on native pasture
May 5, 1965 to September 29, 1965

Supplement on pasture	1½ lb cotton seed meal per head daily after August 2	1½ lb rolled sorghum grain per head daily after August 2
Number per pasture	10	10
Acres per head	3.6	3.6
Average initial weight, May 5, lb	554	554
Average weight, Aug. 3, lb	717	730
Average final weight, Sept. 30, lb	815	833
Average total gain, lb	261	279
Average gain, 8/3 to 9/29, lb	98	103
Average supplemental feed, lb:		
Cottonseed meal	87	...
Rolled sorghum grain	...	87
Average subsequent feedlot gain, lb	392	377
Average yield, %	62.5	62.7
Average marbling score	7.1	7.1
Average backfat thickness, in	.37	.46
LSD: $p < .10$, 13 lb		

Response has very closely matched July-August rainfall (Table 23). The 1965 data tend to fit the established trend. Since rainfall for the July-August period was slightly above average, a slight response to cottonseed meal might have been expected. However, the same situation was experienced in 1957. Both in 1957 and 1965 subsoil moisture was not abundant; although forage production was ample, it was never lush. The correlation coefficient of July-August precipitation with response of cottonseed meal over sorghum grain is .89 ($p < .005$). An explanation for this phenomenon is that in years of high rainfall and high forage production, forage quality is adversely affected so additional protein toward the end of the grazing season is beneficial. When forage production is limited by lack of moisture, quality remains high but additional energy is needed. Then the energy requirement can be more economically met with a grain supplement.

Table 23. Response by steers on native pasture to cottonseed meal or sorghum grain as affected by July-August precipitation, 1956-65

		Average gain after August 1, lbs		
Year	July-August precipitation	1½ lbs cottonseed meal per daily after August 1	1½ lbs sorghum grain per head daily after August 1	Difference cottonseed meal minus sorghum grain, lbs
1956	3.86	75	89	-14
1957	7.03	130	134	- 4
1958	12.17	70	40	30
1959	5.87	64	68	- 4
1960	3.85	41	41	0
1961	9.25	102	81	21
1962	10.44	87	62	25
1963	5.90	101	104	- 3
1964	3.24	88	93	- 5
1965	7.08	98	103	- 5
98-year average precipitation	6.16			

This research originally appeared in the 1970 Roundup report.

Predicting Feed-lot Performance and Resultant Carcass Quality from Sonoray Backfat Estimates at Start of Finishing Phase

J.R. Brethour and W.W. Duitsman

A Sonoray instrument was used to predict fat cover over the 12th rib about 6 inches laterally from the mid-line. All 229 cattle used in the summer fattening trials were measured shortly after being put on full feed. Estimated fat thickness ranged from .18 to .37 inch. Those values did not correlate with feed-lot gain, carcass backfat, carcass ribeye area, carcass cutability grade, or dressing percentage. They correlated slightly but significantly (r=.12) with marbling score. Backfat thickness of feeder cattle may not be a good estimate of total body fat.

This research originally appeared in the 1972 Roundup report.

Ralgro Implants Compared with Diethylstilbestrol Implants for Steers

J.R. Brethour and W.W. Duitsman

Ralgro [RAL] is a trademark for an implant made from resorcylic acid lactone (zeranol or zearalanol). The active ingredient is isolated from a corn fungus. It is not an estrogen and has not been proved carcinogenic. In some tests it has increased gain as much as diethylstilbestrol [DES] has. We compared RAL and DES with pastured steers and steers fed high-silage, backgrounding rations.

Experimental Procedure

Trial 1 was conducted with 625-pound steers summered on native pasture. One group received no implants. April 29 when grazing started, 27 steers were implanted with 24 mg DES and 26 steers with 36 mg RAL. After 160 days on pasture, steers were fed finishing rations (with 10 mg stilbestrol, phd) for 144 days. Half were supplemented with 2 pounds wheat or ~1 pounds cottonseed the last 43 days of the grazing period. Effects of pasture, supplementation, and finishing ration experiments (conducted concurrently with these cattle) were statistically removed.

Trial 2 involved 93, 460-pound steer calves. It evaluated reimplanting with 24 mg RAL after 60 days and compared RAL with DES (Table 21). All steers were fed a ration of sorghum silage, 2 pounds rolled milo, and 5 pounds alfalfa hay.

Table 20. Ralgro implants compared with DES implants for pastured steers (Trial 1)

Treatment	Control	24 mg DES	36 mg Ralgro
Number of head	26	27	26
Average initial weight, 4/29/71, lb	625	625	625
Average total pasture gain (4/29-10/5, 160 days), lb (15[1])	184	201	190
Average gain (10/6-2/26, 144 days), lb (32)	382	393	386
Average total gain, pasture and feedlot, lb	566	594	576
Carcass data:			
Average dressing % (.64)	62.27	63.02	62.81
Average rib eye area, sq in (.56)	12.36	12.32	12.20
Average backfat thickness, in (.07)	.60	.64	.57
Average % kidney fat (.12)	2.50	2.40	2.42
Average cutability grade (.31)	3.38	3.53	3.37
Average marbling score	4.71	4.17	4.77
Carcass grades based on marbling score:			
Choice+	1	...	...
Choice	1	...	2
Choice-	12	3	14
Good+	8	7	2
Good	5	10	4
Good-	2	4	2
Standard	...	1	...
Percent choice	48	12	67

[1] Least significant differences in parentheses (p<.05)

Observations

Trial 1. During the summer grazing season DES and RAL increased average gains 17 (p<.05) and 6 (NS) pounds, respectively (Table 20). Average feedlot gain differed little; and total gain for both pasture and finishing phases were 28 and 10 pounds, respectively, for DES and RAL. Average carcass grade of steers that received DES implants was significantly (p<.05) less than either control or RAL groups.

Trial 2. Both DES and RAL significant (p<.05) increased average gains. Difference between gains of DES and RAL groups was little, and by March 21 no response to reimplanting had occurred.

Table 21. Ralgro implants (RAL) compared with DES implants for steers fed a high-silage ration (Trial 2)

December 2, 1971, to March 20, 1972; 110 days

Treatment	Control	24 mg DES 12/7/71	36 mg RAL 12/7/71	36 mg RAL 12/7/71 plus 24 mg RAL 2/8/72
Number of head	29	32	18	14
Average initial weight, lb	459	457	459	457
Average weight, 3/21/72, lb	609	628	625	627
Average total gain, lb[1]	150	171	166	170

[1] Least significant differences: p<.10, 13 lb; p<.05, 16 lb; p<.01, 21 lb.

This research originally appeared in the 1974 Roundup report.

Three Implants Compared for Finishing Yearling Steers

J.R. Brethour and W.W. Duitsman

During most of 1973, DES was prohibited. In early 1974 its use again was permitted but there is no assurance it will not be withdrawn again. We need to know if other growth stimulants can be substituted. Leading replacement candidates are Ralgro, a trade name for an implant made from resorcylic acid lactone (zeranol), and Synovex-S, trade name for an implant containing 200 mg progesterone and 20 mg estradiol.

Our earlier studies (KAES Bulletin 369) suggested that Ralgro implants stimulate growth for about 75 days, then reimplantation may be necessary. The tests reported here were conducted to more thoroughly evaluate the value of reimplanting and to compare Ralgro, Synovex, and DES implants.

Experimental Procedure

Test 1

We used heavy calves (averaging 620 pounds initially) for 186 days in this study. Implants were superimposed on Test 1 of the ensiled-milo study.

These five treatments were compared:

1. Control—no implant
2. 30 mg DES at start of trial
3. 36 mg RAL at start of trial
4. 30 mg DES at start of trial and 24 mg RAL 76 days later
5. 36 mg RAL at start of trial and 24 mg RAL 76 days later

Test 2

Fifty-three thin yearling steers fed mostly high-silage rations were used in this 249-day test. One group was not implanted, one group received 36 mg RAL near the start of the trial, and one group was implanted both at the start and midway through the trial.

Table 12, Test 1. Results from indicated combinations of DES[1] and Ralgro[1] implants in steer finishing rations

December 7, 1972, to June 10, 1973; 186 days

		December 7, 1972			
		30 mg DES	36 mg RAL	30 mg DES	36 mg RAL
				February 20, 1973	
Treatment	Control			24 mg RAL	24 mg RAL
Number of head	12	12	12	11	12
Average initial weight, lb	619.5	613.1	615.3	615.5	621.1
Average final weight, lb	1084.6	1126.5	1108.0	1124.0	1139.2
Average daily gain, lb (.22)[2]	2.50	2.76	2.65	2.73	2.79
Average energy gain, Mcal/day (.52)	5.04	5.07	5.12	5.24	5.12
Carcass data:					
Average dressing % (1.27)	65.04	64.57	64.75	64.65	63.97
Average backfat thickness, in. (.13)	.63	.59	.59	.65	.58
Average rib eye area, sq in. (.81)	11.40	11.93	11.76	12.20	11.73
Average % kidney fat (.17)	2.78	2.71	2.86	2.80	2.70
Average cutability grade (.53)	3.53	3.35	3.40	3.43	3.41
Carcass energy, Cal/gm (.28)	4.75	4.56	4.68	4.70	4.57
Average marbling score (.97)	4.59	4.05	4.74	4.30	4.16
Carcass grades:					
Choice	1	3	2	2	...
Choice -	4	1	3	3	2
Good +	2	3	4	...	3
Good	2	2	...	2	2
Good -	3	3	3	4	4

[1] DES = diethylstilbestrol; RAL = zeranol (Ralgro)

[2] Least significant difference ($p<.05$).

Test 3

This study, superimposed on Test 2 of the ensiled grain study, used older, heavier steers 146 days. Five treatments were compared:

1. Control no implant
2. 36 mg RAL at the start of the trial
3. Synovex-S at the start of the trial
4. 36 mg RAL both at the start and midway in the trial
5. Synovex-S at the start and midway in the trial.

Table 13, Test 2. Effects of reimplanting with Ralgro[1] and a long-term finishing trial
July 5, 1973, to March 10, 1974; 249 days

		August 8, 1973	
		36 mg RAL	36 mg RAL
			Oct. 19, 1973
Treatment	Control		36 mg RAL
Number of head	15	21	17
Average initial weight, lb	653.4	635.9	643.8
Average final weight, lb	1155.2	1189.8	1238.8
Average daily gain, lb (.14)[2]	2.02	2.22	2.39
Average energy gain, Mcal/day (.36)	3.81	3.93	4.24
Carcass data:			
Average dressing % (1.12)	63.63	63.33	64.01
Average backfat thickness, in. (.10)	.55	.51	.59
Average rib eye area, sq in. (.63)	11.43	12.06	12.02
Average % kidney fat (.21)	2.87	2.84	2.84
Average cutability grade (.42)	3.48	3.32	3.64
Carcass energy, Cal/gm (.23)	4.65	4.51	4.62
Average marbling score (.72)	5.00	4.88	4.64
Carcass grades:			
Prime -	...	1	1
Choice +	...	1	...
Choice	1	1	3
Choice -	9	6	7
Good +	2	5	2
Good	2	6	...
Good -	1	1	4

[1] RAL = zeranol (Ralgro)
[2] Least significant differences in parentheses ($p<.05$).

Observations

Test 1

In this 186-day test (Table 12), steers reimplanted with RAL gained as much as those receiving a single DES implant. There was no advantage to reimplanting with RAL steers that initially received DES. A single RAL implant increased gain less than other implant combinations. Carcasses of implanted cattle were slightly leaner than those of the control. Carcass grades were depressed by treatments that gave greatest gains.

Test 2

In this test (Table 13) rate of gain was increased 10% ($p<.01$) by a single 36 mg RAL implant. Gain was increased 8% more ($p<.05$) by reimplanting. Carcasses did not differ statistically, but implanted cattle tended to have larger rib eyes and to grade lower.

Table 14, Test 3. Ralgro[1] and Synovex[1] implants compared for finishing yearling steers
October 16, 1973, to March 10, 1974; 146 days

		October 20, 1973			
		RAL	Synovex	RAL	Synovex
Treatment	Control			January 16, 1974	
Number of head	16	16	16	16	17
Average initial weight, lb	900.6	867.2	883.4	907.5	912.4
Average final weight, lb	1169.4	1215.3	1243.9	1218.9	1250.5
Average daily gain, lb (.29)[2]	1.84	2.38	2.47	2.13	2.32
Average energy gain, Mcal/day (.47)	5.09	6.02	6.25	5.71	5.76
Carcass data:					
Average dressing % (1.00)	63.77	64.57	64.37	64.09	63.39
Average backfat thickness, in. (.09)	.47	.59	.63	.60	.61
Average rib eye area, sq in. (.72)	11.51	11.93	12.67	12.19	12.46
Average % kidney fat (.21)	2.78	2.91	2.65	2.65	2.49
Average cutability grade (.34)	3.53	3.32	3.52	3.48	3.44
Average carcass energy, Cal/gm (.17)	4.75	3.96	4.23	4.13	4.07
Average marbling score (.46)	4.59	4.17	5.09	4.27	4.09
Carcass grades:					
Choice	1	...	4	...	...
Choice -	4	3	8	4	...
Good +	2	1	4	4	8
Good	2	11	...	6	5
Good -	3	1	...	2	4

[1] RAL = zeranol (Ralgro); Synovex = 200 mg progesterone + 20 mg estradiol
[2] Least significant differences in parentheses ($p<.05$).

Test 3

There was no advantage to reimplanting (Table 14). Single implants increased average gains 32%. The single Synovex implant improved carcass grades significantly. It would be difficult to expect any more response by reimplanting. Some of the steers in this test had been implanted with RAL and/or DES the previous year as calves. This test (146 days) was the shortest of the three.

In summary these studies show that reimplanting with RAL after 75 days may be beneficial when feeding periods exceed 150 days and if the cattle were not implanted earlier in life. A primary concern with reimplanting is the likelihood of depressing carcass grade. However, Ralgro has not affected carcass grade as much as DES did in early studies at this station. The single Synovex-S treatment significantly increased carcass grade, and increased gain as much as we have seen (34%) in an implanting study. These three experiments indicate feasible alternatives to DES; but they cost more, must be managed more carefully, and are more work to use.

This research originally appeared in the 1976 Roundup report.

Finely and Coarsely Rolled Milos Compared

J.R. Brethour

Studies here in 1965 and 1966 showed no advantage to finely rolled milo. Reduced gain accompanied reduced feed intake and feed efficiency remained unchanged. Recent experiments indicated that adding minerals to wheat rations improved performance (page 9). This experiment evaluated finely rolled milo fed with .2 lb ground limestone, a combination of .2 lb ground limestone, .4 lb sodium bicarbonate and .08 lb magnesium oxide, or .4 lb dolomite limestone[1] per head per day.

Grain was dry rolled. Coarsely rolled grain was prepared by separating the rollers[2] as much as possible and still breaking every kernel. Finely rolled grain was obtained by setting the rollers as close together as possible. Variations in particle size were measured with screens:

Range in particle % of total weight diameter, microns	% of total weight	
	Coarsely rolled	Finely rolled
2000 to 4000	36.3	15.8
1000 to 2000	51.8	62.5
500 to 1000	5.5	12.0
Less than 500	6.4	9.6

The combination of magnesium oxide, ground limestone, and soda significantly ($p<.05$) depressed average weight and energy gain (Table 6), but not feed intake.

Finely rolled milo with either regular limestone or Ruminaid produced much more efficient gains than coarsely rolled milo. Weight and energy gains were slightly, but not significantly, higher with dolomite than with ground limestone.

Results (Table 7) indicate that finely-rolled milo may be more efficiently used than coarsely cracked milo. Feeding high levels of calcium carbonate or dolomite seemed to prevent the depressed performance observed in earlier experiments when milo was finely rolled.

[1] Ruminaid (21 percent calcium and 13 percent magnesium)
[2] Peerless roller mill

Table 7. Finely rolled milo with or without mineral additives compared with coarsely rolled milo in finishing rations

October 6, 1975, to February 22, 1976; 140 days

Grain treatment	Coarsely rolled milo	Finely rolled milo		
Mineral treatment[1]	Ground limestone	Ground limestone	Ground limestone, magnesium oxide and $NaHCO_3$	Dolomite
Number of head	36	12	12	12
Average initial weight, lb	769.7	777.6	776.8	769.2
Average final weight, lb	1222.3	1236.2	1192.6	1246.2
Average total gain, lb	452.6	458.6	415.9	477.0
Average daily gain, lb	3.23	3.28	2.97*	3.41
Average feed intake, lb				
Sorghum silage $18[2]	21.29	18.58	19.05	16.07
Rolled milo $85	21.70	20.08	20.50	20.66
Urea $200	.20	.20	.20	.20
Premix $112	.68	.68	.68	.48[3]
Mineral			.48	.40
Dry matter total	27.24	24.60	25.13	24.05
Feed per cwt gain				
Lb dry matter	843	742	844	718
Cost, $	$36.05	$31.95	$36.35	$31.74
Average carcass characteristics				
Dressing %	63.38	63.72	63.14	62.76
Backfat thickness, in	.55	.55	.53*	.72
Rib eye area, sq in	12.47	12.68	12.04	12.16
Yield grade	3.39	3.30	3.40	3.98
Marbling score	4.65	5.03	4.86	4.56
Average energy gain				
Mcal/day	7.66	7.89	7.38	8.24
Estimated net energy value of milo:				
NEm (Mcal/kg DM)	1.85	2.17	1.99	2.25
NEg (Mcal/kg DM)	1.23	1.43	1.32	1.46

1 .2 lb ground limestone, .08 lb magnesium oxide, .4 lb sodium bicarbonate or .4 lb dolomite per head daily.
2 Feed costs, $ per ton. No cost assigned to minerals.
3 Ground limestone omitted—.2 lb ground limestone added to the other 3 rations.
* Significantly less than dolomite treatment.

This research originally appeared in the 1982 Roundup report.

Finely Rolled Milo Compared With Rolled Corn for Finishing Cattle

J.R. Brethour

Many feed analyses tables, based on experiments conducted many years ago, show milo to be only 82 percent the value of corn for cattle. Important changes in feedlot nutrition and management since those milo-corn comparisons were conducted have changed their comparative values. Also, we have shown that finely rolled milo is used more efficiently than coarsely rolled milo (which was used in the old corn-milo comparisons). For those reasons and because milo is an important Kansas feed grain, we have conducted studies to revaluate milo and corn.

Milo and corn were compared at three roughage-concentrate ratios (Table 26). Two pens were fed silage for only 3 weeks, then continued on all-concentrate rations. Steers fed the standard ration were limited to 10 pounds silage per day after they reached full feed. Two more pens were fed high-silage rations with grain limited to 4 pounds per day for 80 days followed by high-grain rations for only 69 days.

There was more feed consumed when milo was fed but gains were the same as when corn was fed. Cattle fed all-concentrate rations containing either corn or milo ate and gained significantly less than those fed the standard rations with 15 percent roughage. However, no acidosis nor bloat was observed with either all-concentrate ration (Rumensin was added to all rations). Steers fed high-silage rations gained slower and were less efficient than those fed the standard ration, but averaged as high in USDA quality grade and had more desirable cutability (leaner carcasses).

Table 27 summarizes a trial comparing milo and corn fed to heavy yearling steers for 102 days. Cattle fed milo ate more feed, gained the same, and were slightly fatter at the end of the test.

We have finished eight comparisons of finely rolled milo with corn. Those are summarized in Table 28. Total feed intake averaged 5.8 percent higher when milo was fed, gains were 1 percent less, and 6.8 percent more feed was required per unit gain. There was very little difference in average dressing percent, quality grade, and carcass cutability.

Calculations from relative animal performance in those trials indicated net energy (for gain) content of milo was 1.39 Mcal/kg dry matter (55 Mcal/lb air dry). Value of grain for feeding cattle is closely associated with net energy content, so in those tests finely rolled milo was worth 94% as much as corn. As there was some variability in the net energy calculations from trial to trial, we estimate the true net energy of finely rolled milo is between 92 and 95 percent that of corn.

Table 26. Milo compared to corn at three roughage levels
March 24, 1981, to August 19, 1981; 149 days

Treatment	All concentrate		Standard		High silage	
	Corn	Milo	Corn	Milo	Corn	Milo
Number of head	12	12	12	11	13	13
Average initial weight	726.4	727.2	728.4	730.0	732.6	730.0
Average final weight	1104.4	1122.9	1213.4	1195.9	1110.1	1121.2
Average gain	378.0	395.7	485.0	465.9	377.5	391.2
Average daily gain	2.54	2.66	3.26	3.13	2.53	2.63
Average daily ration, lb:						
Sorghum silage	2.74	3.52	11.77	12.23	33.71	34.19
Rolled corn	15.23	...	17.47	...	10.48	...
Rolled milo	...	16.67	...	18.46	...	11.32
Supplement[1]	1.39	1.39	1.39	1.39	1.39	1.39
Airy dry total	18.21	19.86	23.47	24.56	23.78	24.74
Lb feed/100 lb gain	705.0	732.1	725.1	784.8	920.6	961.5
Energy gain Mcal/day	8.15	8.26	8.83	8.83	8.03	7.90
Net energy of milo[2]						
NEg (Mcal/kg DM)	...	1.38	...	1.40	...	1.37
NEm (Mcal/kg DM)	...	2.08	...	2.12	...	2.07
Carcass data:						
Dressing percent[3]	65.51	65.39	66.09	66.69	63.60	64.62
Backfat, in	.49	.51	.57	.58	.44	.44
Marbling score	5.19	4.55	5.26	5.12	5.39	5.30
Percent choice	83	58	75	82	85	77

[1] Supplement includes .75 lb soybean meal, .11 lb urea, .08 lb ammonium sulfate, .22 lb limestone, 300 mg Rumensin, 90 mg Tylan, trace minerals and vitamin A.
[2] Assumes net energy of corn= 1.48 Mcal/kg DM (NE gain).
[3] Gains and final weights adjusted to constant dressing percent of 64.

Table 27. Milo compared to corn for yearling steers
June 4 to September 13, 1981; 102 days

Treatment	Milo	Corn
Number of head	21	21
Average initial wt, lb	881.8	879.9
Average final wt, lb	1209.7	1210.8
Average gain, lb	327.9	330.9
Average daily gain, lb	3.22	3.24
Average feed intake, lb		
Sorghum silage	11.80	11.17
Grain	18.90	16.86
Soybean meal	.61	.61
Urea	.11	.11
Premix	.53	.53
Air dry total	23.97	21.68
Lb feed/100 lb gain	745.7	683.1
Carcass data:		
Dressing percent	66.84	66.42
Backfat, in	.55	.52
Marbling score	5.30	5.06
Percent choice	86	71
Energy gain/Mcal/day	9.25	8.87
Grain net energy:		
NEg Mcal/kg	1.36	1.48
NEm Mcal/kg	2.64	2.28

Table 28. Finely rolled milo compared to corn for finishing steers. ***Pooled results of eight trials.***

	Corn	Milo
Number of head	120	117
Average daily gain, lb	3.10	3.07
Average feed intake, lb	23.15	24.48
Lb feed/ 100 lb gain	756.6	808.4
Carcass data:		
Dressing percent[1]	65.13	65.34
Backfat, in	.54	.54
Marbling score	5.06	4.96
Percent choice	76	72
Energy gain, Mcal/day	8.89	8.95
Net energy value for grain:		
NEg (Mcal/kg DM)	1.48	1.39
NEm (Mcal/kg DM)	2.28	2.10

[1] Gain data corrected to dressing percent of 64.

This research originally appeared in the 1984 Roundup report.

Zinc Methionine in Steer Finishing Rations

J.R. Brethour

Zinc methionine (Zinpro)[1] is an organic form of zinc that may be more readily absorbed than the inorganic zinc that is usually included in mineral supplements. We conducted five trials with that product in milo-based finishing rations from September, 1982, to October, 1983. Zinpro rate was 9 grams per head per day and supplied 360 mg zinc in addition to 272 mg inorganic zinc provided by a standard trace mineral premix.

Cattle fed Zinpro averaged 3.5 percent faster gains ($p < .10$) and 3.1 percent better feed conversion (Table 14); relative responses in the individual trials were +6, + 7, + 1, -13, and +6 percent, respectively. The trial with the negative performance seemed anomalous and, as it contained fewer cattle, did not substantially affect the weighted average[2]. Zinpro is also effective against footrot, but that was not observed in our tests.

Rumensin and Tylan were fed in two trials and there were no liver abscesses; in the other three trials Bovatec was used and liver abscess incidence was 46 and 38 percent in the control and Zinpro groups, respectively. This is probably not a significant reduction. Zinpro consistently and significantly improved marbling score and USDA grade (Table 15).

[1] Zinpro Corporation, Chaska, Minnesota

[2] The trial with the negative results presented difficulty in combining data from the five experiments because we considered that trial unrepresentative. Consequently, we used a statistical technique we call the Hodges-Lehman estimator which derived a median of paired weighted values called Walsh averages. That procedure minimized the effect of those outlying values that we judged abnormal.

Table 14. Zinc methionine (Zinpro) in finishing rations
5 trial summary (108 day average)

	Treatment	
Item	Control	Zinc methionine
Number of head	113	114
Average initial weight	832.2	833.2
Average final weight	1153.8	1166.2
Average gain	321.6	333.0
Average daily gain	2.99	3.09
Average daily ration:		
Sorghum silage	12.82	12.81
Rolled milo	20.96	20.83
Supplement	1.06	1.16
Dry matter total	22.80	22.82
Lb feed/100 lb gain	769.2	746.1
Carcass data:		
Dressing percent	63.08	63.59
Marbling score	4.59	4.85
Percent choice	50%	68%
Backfat, in	.50	.49
Meats calories	4.07	4.07
Energy gain	8.13	8.19
Liver abscess incidence (3 trials)	46%	38%

Table 15. Effect of Zinpro on carcass grade

	Marbling Score		Percent Choice	
Trial	Control	Zinpro	Control	Zinpro
1	4.68	4.91	64%	76%
2	4.84	5.11	62%	76%
3	4.34	4.60	33%	52%
4	4.99	5.20	71%	89%
5	4.28	4.67	31%	59%

This research originally appeared in the 1989 Roundup report.

Steer Growth and Nutritional Response to Intensive-Early Stocking of Western Kansas Shortgrass Rangeland

K.C. Olson, Range Scientist

Introduction

Intensive-early stocking (IES) is a stocker grazing program that has gained popularity over the last ten years in the Flint Hills region of eastern Kansas. The concept is based on the fact that range forage is most nutritious when it is most rapidly growing, which occurs during the first half of the typical 5 month summer grazing season. Sixty to seventy percent of the total summer gain is put on during that time. After that, gains gradually decline, until steers are only maintaining their weight at the end of the summer. Therefore, IES is designed to take advantage of seasonal differences in forage quality by only grazing during the first half of the season. This allows the producer to at least double the number of animals per acre. This decreases total gain per head, but because there are more animals, gain per acre substantially increases. Studies done at Manhattan indicate that this does not lengthen the feeding period needed to finish these steers to market weight. The vegetation is allowed to recover from the intensive grazing by being rested during the latter half of its growing season. Because of this late season rest, it is feasible to expect that IES is capable of supporting more than twice as many animals as would be recommended for season-long grazing without damaging the plant community. In addition, IES allows animals to be marketed before the typical late season slump in feeder cattle prices. Both research at Manhattan and extensive rancher experience throughout the Flint Hills indicate that IES is a very successful grazing program for that part of Kansas. However, it has not gained popularity on shortgrass ranges in western Kansas. Research done in the 1940's in eastern Colorado that compared steer gains from early season versus late season grazing indicated that IES might be a feasible grazing management plan for shortgrass range, as well. Therefore, a study was conducted at FHBES to compare IES to season-long grazing (SLG).

Procedures

The study area was a clay upland site with typical shortgrass vegetation. Dominant plant species included western wheatgrass, buffalograss, and blue grama. Other important components were annual bromes and western ragweed.

Three stocking densities of IES, all grazed from May 1 to July 15, were compared to SLG (grazed from May 1 to October 1) at the recommended stocking rate (X) of 3.5 acres per steer. The three stocking densities were twice as many animals (2X), 2.5 times as many (2.5X), and three times as many (3X). The study was conducted from 1981 to 1988. However, the 2.5X treatment was not started until 1984. The intent of the higher stocking density treatments (2.5X and 3X) was to determine if late season rest would allow an increase in stocking rate above that recommended for SLG. Each treatment was replicated twice. However, the cattle in some of the pastures were supplemented. The data from these supplemented groups will not be reported here.

Livestock performance was monitored by measuring weight gains. Initial weight of the steers involved was 550 to 600 lb. in all years, except in 1985-86 when a mixture of different sized animals, ranging from 600 to 800 lb., was superimposed to study the response of steers of different frame scores to grazing management.

During 1987-88, animal nutritional responses to the grazing treatments were evaluated. Diet quality was determined by use of esophageally fistulated steers. These steers had surgically created passages through their neck into their esophagus, so that samples of what they grazed could be collected to analyze for its quality. This material, called masticate (meaning chewed food), was analyzed in the laboratory for its nutritional value. Analyses included crude protein content, digestibility, and composition of fiber components, including neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, hemicellulose, and lignin. NDF is a measure of the percentage of the plant material that is cell wall, as opposed to the soluble cell constituents, such as crude protein and sugars. The cell wall is what gives the plant its structure, i.e., it serves as the skeleton of the plant. Therefore, it is composed of fiber components, including cellulose, hemicellulose, and lignin, all of which serve to provide structural rigidity. Hemicellulose and cellulose are complexes of simple sugar molecules that are strongly bonded together, but are still available to ruminant animals and, therefore, of nutritive value, although they are slow to digest. ADF is an intermediate product in the extraction of each of these components, and includes both cellulose and lignin, but the cell solubles and hemicellulose have been removed. Lignin is a group of complex molecules that are essentially indigestible and of no nutritive value in themselves, and they also encapsulate the fiber and cell constituents, making them less available to digestion.

Forage intake was determined by total fecal collection. Because the amount of feed eaten cannot be directly measured in grazing animals, this indirect method has to be used. Forage intake was calculated from the ratio of fecal output to digestibility.

The nutritional data were collected at the beginning, middle, and end of the IES grazing season (May 1 to July 15). Only the data for 1988 are reported here.

Results and Discussion

Livestock Gains

Livestock gains are shown in Fig. 1. Averaged over the eight years of the study, SLG yielded 185 lb. of gain per steer. On the average, 109 lb., or 59%, of this was gained by July 15. However, the percent of gain achieved under SLG by July 15 fluctuated among years, from 38 to 71 percent. Interestingly, steer gains in 2X IES averaged 105 lb., almost identical to that gained under SLG up to July 15. Thus, the fact that there were twice as many animals competing for forage during the lush growth period appeared to have little effect on their ability to gain. Average animal gains in 2.5X IES and 3X IES were less, at 95 lb. and 89 lb., respectively.

One somewhat alarming response is that gains seemed to slowly decline under the IES treatments during the first six years of the study, followed by a partial rebound in the last two years, while they appeared to be maintained under SLG. It appears that gains declined in all treatments during drier than average years, but they did not rebound under IES treatments in ensuing wet years, while they did rebound under SLG. For example, 1983 was a dry year, and all treatments suffered. However, 1984 was near average, and SLG posted the highest gains recorded during this study, whereas all IES treatment gains were only slightly better than those in 1983. The rebound in gains in 1987 were probably due to a combination of very wet conditions, particularly early in the growing season, and, more importantly, use of better quality stocker cattle for the study than had been used in 1985-86. The effects of the drought conditions of 1988 were reflected in the gain of the steers.

Livestock production per acre (Fig. 2) was a direct reflection of the stocking density during the early years of the study, with 2X and 3X being proportionately higher in productivity than SLG. However, because of the decline in gain per head under the IES treatments, the productivity per acre from each treatment gradually converged as the study progressed. After the first four years, the productivity of all treatments appeared to have been similar, with weather determining which treatment was the most productive in any given year. Above-average precipitation favored IES, whereas below-average precipitation favored SLG. The effect of dry years may have been related to two reasons: (1) reduced grazing pressure under SLG reduced competition for forage of limited availability when growing conditions were poor and (2) presence of steers on the pasture to utilize small spurts of grass growth caused by rain showers during the extended grazing season.

Nutritional Response

Crude Protein (Fig. 3). The crude protein content of the diet declined as the season progressed, as would be expected. The quality of forage declines as it matures, because plants become more stemmy (stems are lower in soluble nutrients such as protein and sugars than leaves) and because plants translocate soluble nutrients from the aboveground parts to the roots and stem bases. Additionally, the preference of livestock for the more nutrient-rich portion of the forage (green vs. dead and leaves vs. stems) causes a downward shift in the nutritional value of remaining forage as grazing progresses. Crude protein content of the diet was higher under SLG and 2.5X IES than under 2X and 3X IES at the beginning and middle of the season, but all treatments were essentially the same at the end of the grazing season.

Digestibility. There were no significant differences detected in digestibility of the esophageal masticate samples. Digestibility ranged from 49 to 55 percent, which is somewhat low, but is probably a reflection of poor forage conditions because of the drought.

Fiber Components. Significant differences were not detected among grazing treatments in neutral detergent fiber (NDF), hemicellulose, or cellulose. Minor changes occurred among sampling periods as the grazing season progressed. NDF and cellulose increased slightly, while hemicellulose decreased slightly, from the beginning to the middle, and then all three components remained unchanged to the end. Once again, as the plants matured and became more stemmy, increased cell wall components were expected. However, these increases were slight in comparison to what would be expected. This was probably a reflection of the drought conditions. Other researchers have also reported that drought decreased the magnitude of normal seasonal trends in forage nutrition. Drought probably forced the plants into early dormancy. This did not allow the plants to complete the normal annual processes of producing stems and seedheads and of translocating nutrients to roots and stem bases.

At the beginning of the grazing season, acid detergent fiber (ADF) was least under SLG, second least under 2.5X, most under 3X, and intermediate to 2.5 and 3X under 2X (Fig. 4). Because this component is a measure of the combination of cellulose, a slowly digestible fiber, and lignin, the essentially indigestible fraction, lesser amounts are desired. Therefore, SLG and 2.5X IES were nutritionally superior at the beginning of the season. As the season progressed, this difference disappeared, and all treatments were the same at the end of the grazing season.

Lignin content of the esophageal masticate was least under SLG throughout the grazing season (Fig. 5). It was the same under the 2X and 2.5X IES treatments at the beginning and the middle of the season. However, it decreased dramatically under 2.5X at the end of the season. This response was surprising. Lignin increased significantly between the beginning and the end of the study, but the overall means for the entire season were not different among the three IES treatments.

Forage Intake. Daily forage intake (Fig. 6) did not change as the season progressed under 2X and 3X IES, but increased significantly under SLG and 2.5X IES. Therefore, although intake was slightly less under 2.5X IES at the beginning of the study than under the other treatments, it was much greater under SLG and 2.5X by the end of the grazing season. These results indicate that forage intake increased as the animals grew under SLG and 2.5X IES, but did not do so under 2X and 3X IES.

Conclusions

The SLG and 2.5X treatments were nutritionally superior to the 2X and 3X treatments. The quality of the diet was higher under these treatments, particularly at the beginning of the grazing season. This was reflected in higher crude protein content and lower acid detergent fiber and lignin. In fact, the lignin content was lower throughout the grazing season under these two treatments. Additionally, forage intake was greater under these two treatments, particularly late in the grazing season when animals were larger. This was reflected in the livestock gain data, with SLG and 2.5X posting the highest gain in 1988 (101 and 74 lb. were gained by July 15, respectively, versus 70 and 56 lb. under 2X and 3X, respectively).

It was interesting that the responses under 2X and 2.5X were reversed. It may have been a reflection of the response of the vegetation to the grazing treatments, which we reported in the 1987 Field Day Report. In short, a drastic shift occurred under the 2.5X and 3X treatments, with the cool-season grasses (western wheatgrass and annual bromes) and standing dead grass being greatly reduced. However, the SLG and 2X treatments were in much better condition, with a good mix of both cool-season and warm-season grasses. The result was that SLG and 2X provided more forage, but it contained more dead and/or low nutrition material, whereas 2.5X and 3X were much less productive, but the available material was all new, green leafy material that was highly nutritious. Thus, there were two sets of pasture conditions with two densities of stocking on each. The lower density stocking in each pair (SLG for the good condition pair and 2.5X for the low condition pair) allowed more forage to select from per animal, and through reduced competition for forage, allowed the animals to select a higher quality diet and to eat more (higher forage intake).

In conclusion, we recommend IES at 2X as a sound grazing management practice that can be used as an alternative to SLG on shortgrass ranges. However, we do not believe that shortgrass range is capable of supporting an increase in the IES stocking density from 2.5X and 3X. Although 2.5X provided a nutritionally superior diet to 2X, we doubt that it can be sustained because of shifts in the vegetation. The 3X treatment was definitely inferior because changes in the vegetation and dramatic decreases in nutrition resulted in drastically reduced livestock productivity. The choice between SLG or 2X IES is dependent on the weather. SLG was superior in drier than average years, and IES was superior in wetter than average years. Unfortunately, the weather cannot be predicted in time to make this decision. We recommend that some cattle be stocked season-long and some be stocked IES (in separate pastures) as a hedge against possible weather conditions and against fluctuations of the market (i.e., marketing more often decreases the likelihood of catching a bad market with all the cattle).

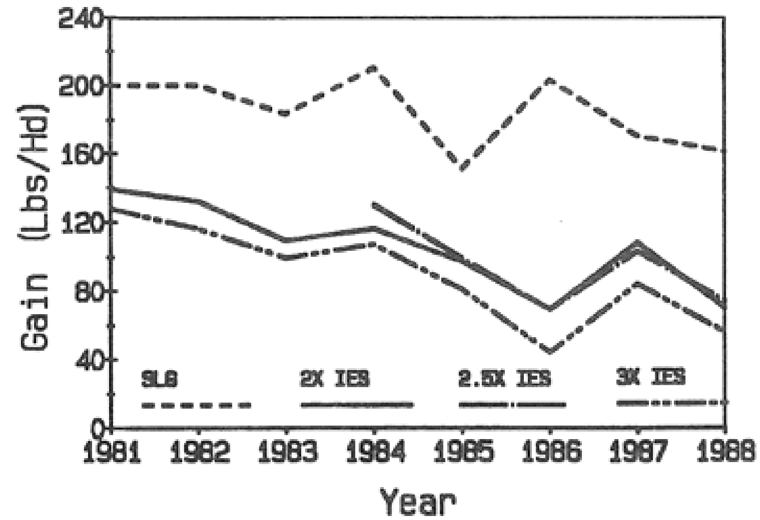

Figure 1. Steer Gain

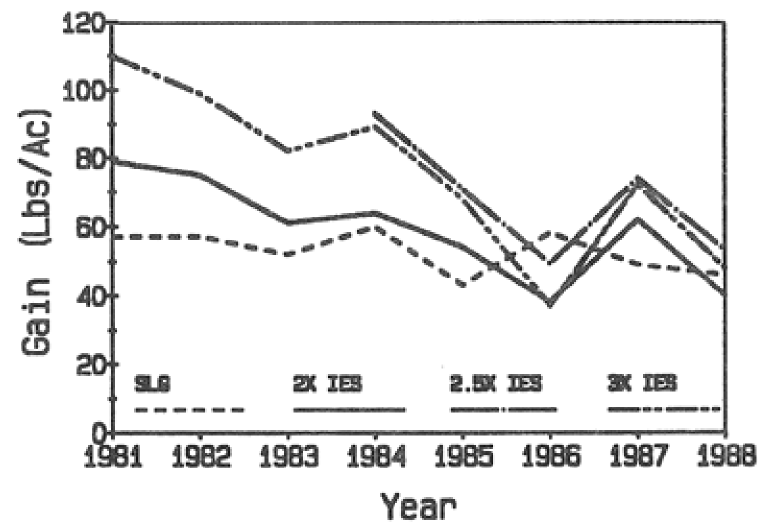

Figure 2. Livestock Production

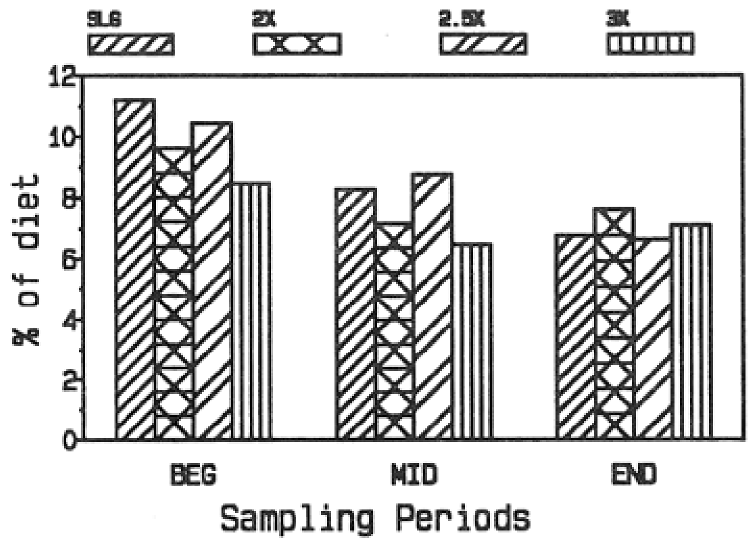

Figure 3. Dietary Crude Protein.

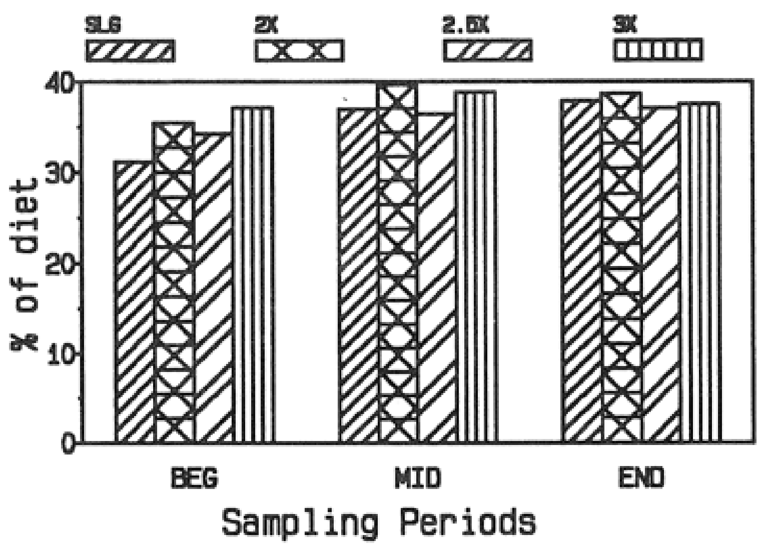

Figure 4. Dietary Acid Detergent Fiber.

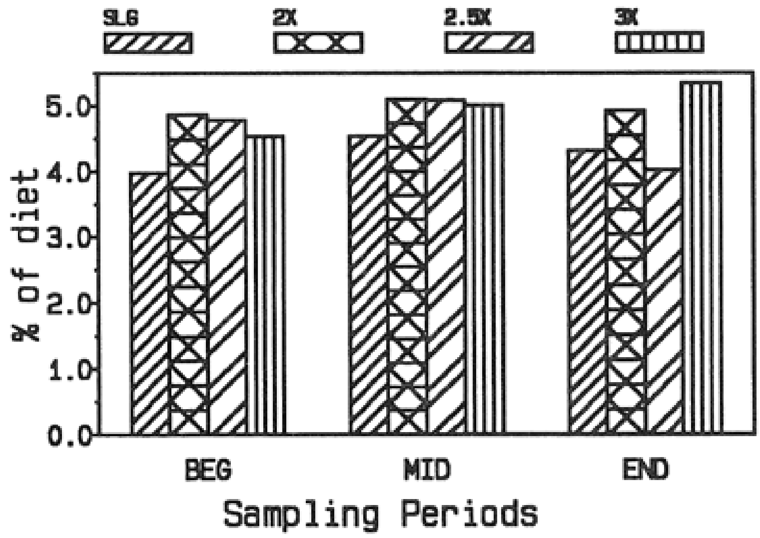

Figure 5. Dietary Lignin.

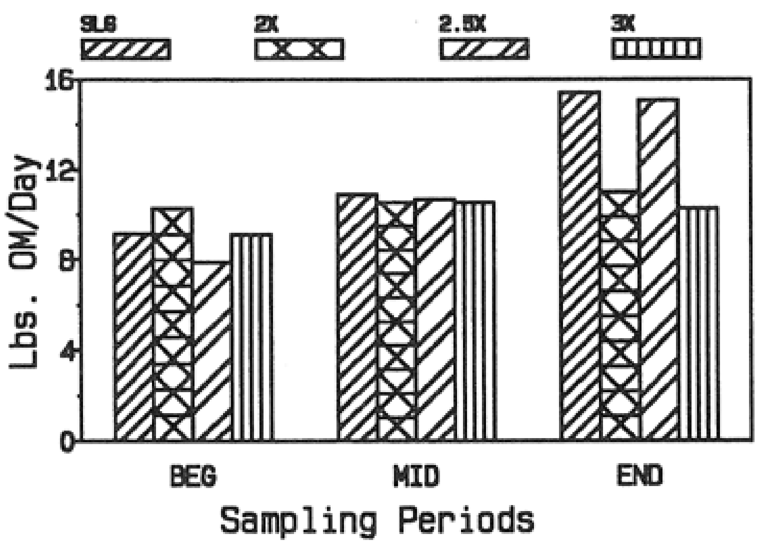

Figure 6. Daily Forage Intake.

This research originally appeared in the 1989 Roundup report.

The Single-Calf Heifer System

J.R. Brethour and J.R. Jaeger, Beef Cattle Scientists

Introduction

A new beef cattle production system that appears to improve efficiency and profit is the Single-Calf Heifer (SCH) system. Fundamentally, the system involves breeding a heifer to have one calf, then feeding her for slaughter. That contrasts with traditional cowherd strategy, which tries to maximize the number of calves per cow and to strive for cow longevity (in order to amortize the costs of developing replacements). But, economic analyses of cow/calf operations often fail to account fully for the value of cull cows sold from the herd and the amount of meat that results from their slaughter. If the combined meat potential of both cow and calf is considered, greater efficiency (carcass weight produced per unit feed) results from reducing, rather than increasing, the number of calves per cow. That efficiency is achieved from pooling reproduction and growth for meat production into one animal and eliminating the maintenance costs of holding a cow over from year to year. Also, in the United States, there is tremendous price disparity among different carcass qualities. If a calved 2-year-old can be fed to grade USDA choice, she is worth as much as 30% more per pound than a cull cow.

The Fort Hays Branch Experiment Station has conducted a project since 1982 to develop the Single-Calf Heifer system. Experiences during that period have enabled us to identify potential pitfalls and also to suggest refinements that enhance the feasibility of the program. This report should guide those producers who are interested in installing the system. Our results with several hundred head continue to impress us with the potential profitability of this program for those who are willing to invest the extra labor and management that are essential.

The Single-Calf Heifer system, which is outlined in Fig. 1, is conceptually quite simple but probably entails much more rigorous management than any other beef production system. An essential component is that the heifer should reach slaughter weight and condition before she is 30 months old in order to qualify for top carcass price. Older animals may be graded into advanced maturity categories and be discounted by the packing plant. In order to have full control of the program it is probably best to start with heifer calves when they are weaned.

Choice of Heifers

The SCH program may be more feasible now because improved breeding and management have resulted in opportunities to purchase breedable heifers from the feeder cattle market. Today's "culls," after cowherd replacements are selected, might have been considered superior prospects 30 years ago. Most of those heifers are crossbreds, which enhances reproductive ability. In addition, there is a tendency to cull the very large-framed heifers, probably best suited for the SCH program, because of concern for their extra maintenance needs. Those large-framed heifers should result in faster growth during the feedout period and larger, more profitable carcasses. This system is less concerned with the additional maintenance requirements of larger breeds because the ratio of feed for maintenance to feed for production is much smaller than in a traditional cow/calf scheme. One should avoid small-framed and late, young-age heifers because they may not reach puberty soon enough to synchronize with the system and are probably more likely to have calving difficulty if they do conceive.

Management the First Year

Nutrition of the heifer calves during the first winter is critical. The goal is to reach 65 percent of mature body weight by spring breeding season. It is important to encourage skeletal growth during this phase because that will reduce dystocia the following year. Also, proper nutrition will hasten the onset of puberty and increase conception rates.

It is important to breed the heifer to calve as early as possible to allow time to feed her out before she is 30 months old. (There may be additional efficiency from calving at 20 months instead of 24 months, but we have not tried that.) Two-year-old heifers often require assistance at calving, so the most important criterion for selecting bulls is calving ease. Yet, the calf represents the profit from the enterprise, so it is important to also maximize calf value. Because small birth weights that reduce calving difficulty often result in smaller, slower growing calves, each operator may have to optimize the two traits according to his own abilities. We have used semen from progeny-tested Angus bulls that transmitted both calving ease and growth rate. Synchronization may not have an inherent advantage in the system, but we feel that the MGA and prostaglandin synchronization method may hasten puberty. It also enabled us to incorporate artificial insemination and utilize semen from tested sires.

The herd should be checked for pregnancy as soon as possible after the end of the breeding period. All open heifers should be culled and moved to the feedlot. If pregnancy is checked early enough, there may be additional culling to remove and also feed out pregnant heifers that could cause problems later. For example, if an abnormally small pelvic opening is discovered during palpation, the heifer probably will require calving assistance and should not be retained. On the other hand, we found that measurement of pelvic area was an imperfect way to predict most cases of calving difficulty. An additional benefit of pregnancy determination in mid-summer is the opportunity to reduce grazing pressure during months when pasture carrying capacity is declining.

Management at Calving Time

From the end of the breeding season until the start of calving, it is important to keep heifers growing but to avoid fattening them. Compared to the older cow, the heifer must be nourished for both growth and fetal development. Therefore, it is essential to emphasize pasture and roughage management to ensure adequate ration quality. On the other hand, we found that feeding 5 pounds extra grain during the 73-day prepartum period increased heifer gains only 37 pounds but added 3.6 pounds to calf birth weight. However, dystocia incidence was increased from 18 percent to 27 percent when grain was fed. Winter pasture was poor that year, and heifers that did not receive extra grain only maintained weight.

Calving

We have had to assist about 20 percent of the heifers at calving. There is probably no substitute for experience, skill, facilities, and dedication during this critical phase. That combination also reduces death loss among both heifers and calves. Our heifers could be mated with sire breeds, such as Longhorn or Jersey, that reputedly convey calving ease, but we are reluctant to sacrifice calf value.

The Feedlot Phase

After calving, the pairs are moved from the calving pasture to the feedlot. There they are placed on a high-silage ration until a pen is filled (about 25 pairs) and then brought to full feed. We tried holding them on a high-silage ration for about 30 days before starting them up to full-feed but that was not beneficial and did not reduce the number of days on a high-grain ration to reach slaughter status. The nutritional demands are heavy during this feeding phase, especially until the calf is weaned, and pairs may eat as much as 35 pounds per day. The fact that nutrients must be provided for growth, compensatory gain, and lactation dictates that a high-energy ration be fed, so we use the same feeding program as in a finishing operation.

If there is any likelihood of muddy conditions, then a creep area must be provided for the calves so they can escape trampling. Calves quickly learn to eat from the bunk, along with the heifers, so feedbunk design should enable calves to reach feed. We have observed an immense amount of cross-suckling in confinement, so calf gain in this program would not measure a dam's milking ability. Most operations will want to wait and wean calves when they are 10-12 weeks old. There is a tradeoff between calf gain and heifer gain. In one study, we found that each day's delay in weaning increased calf gain 1.7 pounds and reduced heifer gain 1.2 pounds, but the advantage in calf gain was not retained after the calves became older. We have left calves with heifers until slaughter but the heavy udders drastically reduced dressing percentage. When we used continental, crossbred heifers with good milking ability, about 50 days were required to shrink the udder back to normal weight.

Managing Calves

We have found that calves become accustomed to bunk feeding and wean easily; weaning probably stresses the heifers more than the calves. In our program, bull calves are left intact and are fed a high-grain ration until they are slaughtered at 15 months. (A steer calf would become fat too early with this procedure.) Heifer calves are turned onto Sudan grass pasture when it becomes available about July 1. However, they need grain supplement on pasture to achieve adequate growth. Attempts to cycle early-weaned heifer calves back into the system have been only partially successful, probably because they have not obtained growth and development fully equivalent to those of calves that are allowed to nurse until normal weaning age. The early weaned calves seem very susceptible to sickness during the summer, especially if kept in a hot and dusty environment, and health care must not be neglected.

Marketing

It is difficult to prescribe the exact length of the full-feeding period and to specify rate of gain and feed efficiency during that period. We have not concluded when to establish an initial weight for the feeding phase. If that weight is based on the shrunk condition immediately after parturition, rate of gain may be overestimated. Because they were older than most feeder cattle, our heifers have tended to deposit intramuscular fat quickly, and the percentage of USDA choice carcasses has been high (as much as 80 percent). Those carcass had exceptional cutability and also were about 80 percent yield grade #1 and #2. We have usually fed a high-grain ration for about 100-120 days, and heifers have averaged about 1150 pounds at slaughter. However, there may be additional growth potential in the crossbred heifers that should be exploited by feeding for a longer time. Performance has been uneven, and a strategy to market heifers in clusters after different time periods may be more profitable than trying to specify a constant feeding period for all animals. Length of feeding also will depend on premiums and discounts for carcass yield and quality grades, growth potential, and feed costs.

Meat Quality

An intensive meat evaluation was performed one year with heifers from the system. The calved-out heifers were compared with their non-pregnant contemporaries, which were held over and fed out concurrently. USDA yield and quality grades from both groups were very comparable and acceptable. The calved-out heifers showed more carcass bone maturity and also slightly higher shear force values (indicating less tender beef). Comparable one-year-old heifers, also used in the study, had significantly more kidney, pelvic, and heart fat but did not otherwise differ from the two-year-old open heifers.

System Flexibility

A feature of the system is the opportunity to bail out at virtually any point. For example, in a year when drought curtailed pasture and escalated roughage costs, we diverted the yearling heifers to the feedlot and successfully fed them to slaughter. After calving, there may be interest in retaining the better pairs for cowherd replacements or selling them as breeding stock. Selection is enhanced because there has been an opportunity to observe calving ease, milking ability, and maternal instinct. These very important traits are concealed when herd replacements are chosen at weaning. If an exceptional heifer were held over and sold as bred two-year old, she should be especially valuable.

Many farms and ranches do not have facilities for feeding out cattle. A possible option involves breeding heifers to calve at 20 months, so that the pairs can run together for about 3 months until the calf is old enough to wean. At that time, the heifers could be consigned or sold to a commercial feedlot. It may not be necessary to advance calving date to enact that program. We expected that a potential carcass maturity problem would appear at about 30 months. However, we have had virtually no discounts for "heiferettes" or "hardbones" among our cattle, even though some have been slaughtered when they were 31 months old. (There is a need for research that enables us to project carcass maturity development and determine if our present haste to put heifers on full feed is necessary.)

Financial Considerations

The financial feasibility of the program will vary with each farm. We have prepared a spread sheet template (Lotus 1-2-3) that includes many of the factors affecting returns to the system. The default values are scaled to a system that might replace an 100-head, traditional cowherd operation and utilizes the same pasture resources. The accounting is intensive, and other enterprises such as a traditional cow/calf system should be subjected to comparable scrutiny.

The system is forage-intensive and probably will be more appropriate on a farm where there is a need to convert raised forage to cash than for an operation that must purchase all feed. Consequently, an alternative cash flow projection might set forage price at zero and examine return to the total farm enterprise rather than the cattle program by itself. Obviously, grazing on stalk fields and wheat pastures could be substituted for budgeted feed. If a similar budget is applied to a traditional cow/calf system, the SCH program will probably appear to be 3 or 4 times more profitable. Much of that difference is caused by the inherent biological efficiency of the system, because a much larger proportion of feed input is directed into marketable meat production. But, if both systems are sized to the same pasture resources, the SCH system contains substantially more animals and greater investment. Management and labor inputs are increased, although peak labor requirements are outside the cropping season. In such a complex system there are more opportunities for pitfalls (drought, blizzards, sickness, death loss) that can cause results to deviate from the optimal situation. Price and performance projections in the feed-out phase can be an especially treacherous risk.

System Potential

The system requires vigilant management, but that may make it an exciting candidate for incorporation of new and sophisticated technology in cattle reproduction. Future developments in semen sexing, twinning (through embryo transfer), controlled parturition, and puberty induction should especially enhance productivity.

Unfortunately, because the concept is so new, there have not been pilot projects on farms to determine the system's feasibility and success. Undoubtedly, there are still pitfalls that need resolving. On the other hand, there appear to be several opportunities for fine-tuning which should more than overcome the unknown obstacles. We believe that the inherent efficiency of combining meat production and reproduction into the same animal unit will place the Single-Calf Heifer system into our catalogue of management strategies.

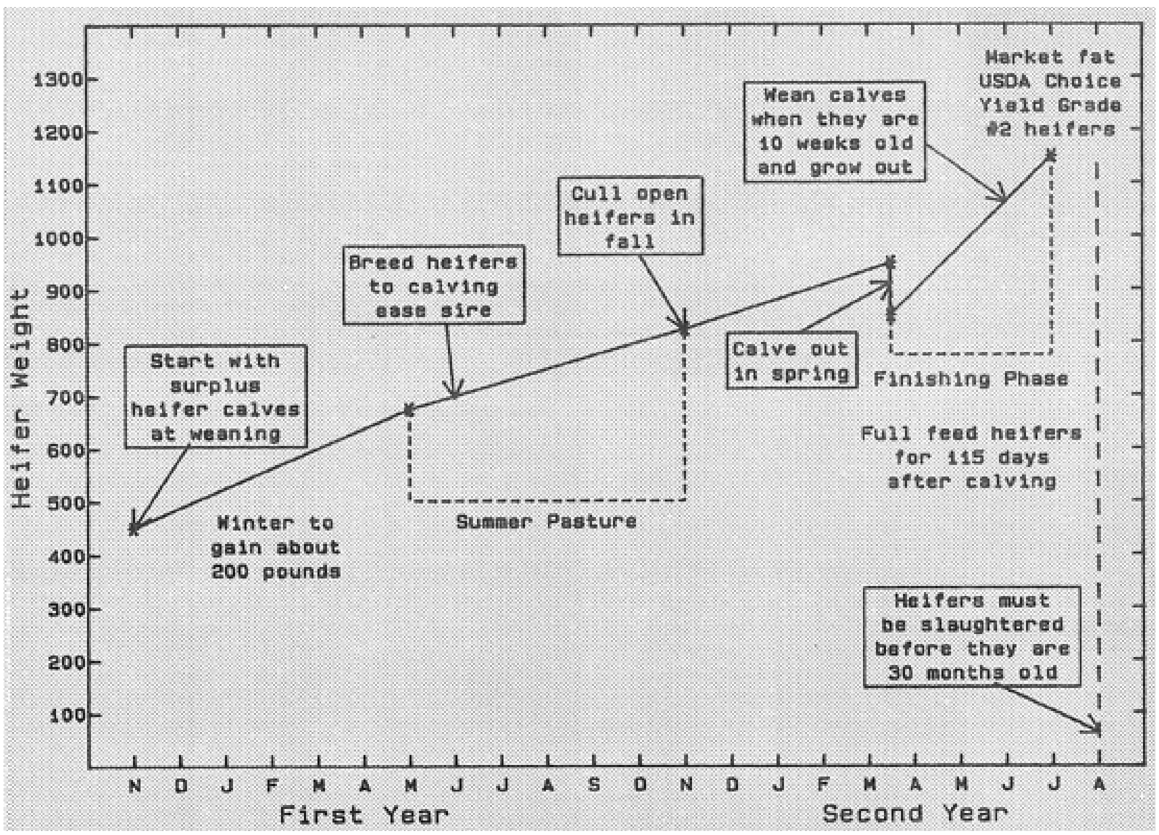

Figure 1. Outline of single-calf heifer system for 20-month cycle.

This research originally appeared in the 1990 Roundup report.

Using Ultrasound to Identify Qualitative Traits Such as Marbling

J.R. Brethour, Beef Cattle Scientist

Importance of Beef Quality

Factors that affect beef carcass prices include leanness (USDA yield grade), quality (USDA quality grade), maturity, sex, and weight. Beef leanness has captivated most research attention; however, USDA quality grade remains important in establishing carcass price. In 1988 and 1989, there were times when the premium for USDA Choice over USDA Select carcasses reached $120 per carcass. Maximizing the proportion of Choice-grade cattle in a pen without incurring too many Yield Grade #4 carcasses remains the objective of most cattle feeders. Quality grade is determined almost entirely by marbling score, which is estimated visually from the amount and distribution of intramuscular fat. Marbling is considered an indicator of favorable organoleptic properties (juiciness, flavor, and — to a lesser extent — tenderness) of beef.

It is difficult to visually estimate marbling in a live animal. Experienced judges and cattle buyers probably rely on cues such as breed, sex, age, overall fatness, time on feed, season, and experience to estimate the percent Choice in a pen of cattle. A method to estimate marbling with ultrasound in the live animal would facilitate clustering procedures for targeting carcasses to more exact packer (and consumer) specifications. It might also enable cattle breeders to select for this economically important trait. Companion technology could facilitate mechanical carcass evaluation in the packing plant.

Tissue Characterization with Ultrasound

Up to now, the primary application of ultrasound has been picturing organ structures with pulse-echo techniques. In doing that, we discard about 95% of the information that is carried back to the transducer by the sound wave. There is an emerging science in ultrasonic bioengineering called tissue characterization. It adds to sound evaluation what color does to light. A better metaphor is that it brings in the timbre and harmonics of an orchestra when we had been hearing only the drumbeat. It removes the restrictions of resolution inherent in a .3 mm sound wave (about 1,000 times as long as light waves) and allows to us to detect and interpret tissue architectures that are much smaller than those projected from specular echoes.

Ultrasonic tissue characterization is based on acoustical parameters of the waveform such as frequency-dependent attenuation and echographic patterns resulting from backscattering. Some remarkable applications are under development. A group at Washington University in St. Louis has perfected an ultrasound procedure to evaluate scars and monitor healing after coronary occlusion in heart attack victims. At Riverside Hospital in New York City, a team has programed an ultrasound system to detect tumors and then stain the screen presentation according to type of malignancy, all in three dimensional viewing.

Ultrasound Speckle

A smooth tissue boundary, such as the layer between subcutaneous fat and muscle, results in a specular (mirror-like) reflection of sound that produces a congruent image on the monitor. However, the sound frequencies (3-5 MHz) used in meat animal evaluation do not register the fatty tissues that constitute marbling. The rough surface and small size of intramuscular fat deposits cause sound waves to scatter, much like ripples from a stone dropped into a pond. Constructive and destructive interference from phase differences in wave fronts from various scatters produce a graininess or mottling (acoustical noise) in ultrasound images, which is termed "speckle". Speckle patterns are affected by scatterer size and density.

We made an attempt to appraise the acoustical effects of marbling from visual examination of the image on the ultrasound monitor. A seven- point scheme (Figure 1) was devised to subjectively classify speckle scores. The scoring system included textural features from three primary regions of interest. (1) The coherent speckle density over the longissimus muscle. This provided a visual estimate of the gray-level cooccurrence matrix, or the spatial interdependencies between image elements. Specular echoes, as from blood vessels, were disregarded in our evaluation of echographic patterns. (2) Echogenicity of the rib bone. The rib, which served as a densitometer, was completely effaced at the highest speckle score because attenuation of the sound beam traversing an area that contained substantial marbling precluded enough wave energy reaching the bone to register its image. Marbling rapidly attenuates ultrasound beams because fat absorbs wave energy more than muscle, and the irregular surfaces of marbling depots produce backscattering. (3) Speckle that registered as originating in the nether region below the rib bone. This pattern may have been caused by reverberation of backscattered waves with other marbling deposits or organ boundaries.

Scanning Protocol

An Aloka 210, real-time, 8-mode, diagnostic ultrasound system with a 16 gray-shade monitor was used in this study. lnsonification was made with a 3 MHz, general purpose, linear array transducer (107 mm scanning width). The longer wave length from a 3, rather than a 5, MHz transducer resulted in more distinguishable speckle patterns that provided more precise and accurate estimates. System time gain controls were set for maximum sensitivity in the deeper regions. Cattle were not clipped, and mineral oil was used as a couplant. The probe was placed dorsally and parallel to the shaft of the twelfth rib bone and moved laterally until a full tomogram of the longissimus muscle came into view. The probe was sedulously oriented to be orthogonal to tissue structure; anisotropy can affect the ultrasound signal.

This research consisted of scanning just before slaughter 14 sets of cattle involving 619 animals representing various breeds, ages, and sexes. Individual carcass marbling scores were obtained after slaughter in a commercial packing plant Those marbling scores were quantified on a scale where 4 = slight amount and 5 = small amount. Linear regressions and simple correlations were calculated to measure the associations between ultrasound speckle scores and carcass marbling scores. All cattle were A maturity, so any carcass with at least a minimum small amount of marbling was classified as USDA Choice, whereas those with less marbling were classified as USDA Select. Other factors affecting quality grade, e.g., lean color, were disregarded in this study.

Correspondence of Speckle Score with Carcass Grade

Speckle scores from this procedure were highly repeatable, which indicated that the technique was valid. Figure 2 is a typical plot of carcass marbling score on speckle score. It shows the strong correlation between the two variables, but also the disturbing presence of outliers. The horizontal line is the boundary between Select and Choice; the vertical line is placed where the regression function equals 5 and separates the expected speckle score classification of Select or Choice. The first and third quadrants from those axes contain cattle that were correctly classified (68%). The average distance to the correct quadrant for the misclassified cattle was only .36 of a marbling score. Grade classification was correct for 77.5% of the 619 cattle in the entire experiment. Classification was more accurate from outlying speckle scores; accuracy reached 80% for scores of 4 and 6 and exceeded 90% for speckle scores of 3 and 7.

The procedure was also promising in predicting carcass grade at distant dates. Figure 3 presents individual values from a set of steers that were measured 148 days before slaughter. Carcass grade was correctly projected 67% of the time on 367 cattle measured between 64 and 148 days of slaughter.

Marbling scores tend to cluster near the borderline between grades. In this study the excess of borderline values concentrated near the mean (kurtosis) probably reduced classification accuracy, because the procedure did not resolve such small differences. If the 213 cattle with marbling scores between 4. 75 and 5.25 are omitted (leaving 406 head), then classification accuracy increases to 83.3%. Likewise, omitting the borderline values when estimating marbling score at future dates improved classification accuracy of the remaining 244 estimates to 75.4%. Not only is marbling score a subjective value vulnerable to human error, but marbling distribution in the longissimus muscle is fractal (irregular). Intramuscular fat is deposited in a tree-like pattern along the branches of the intercostal vascular network. Speckle scores may be more closely correlated with organoleptic properties of beef, such as juiciness, than with marbling score per se.

Future Applications

This procedure to estimate marbling score is instant and exploits portable, unmodified ultrasound equipment that is sufficiently rugged for feedlot use and is reasonably priced (ca $11,000 US). But it is subjective, probably dependent on transducer characteristics, and may not be easily tutored. An abundance of research reports mathematical analyses of the ultrasonic signal for diagnostic tissue characterization. Possibly, those techniques can be used to parameterize the speckle scores and create a more objective method.

Collagen-containing tissues (especially crosslinked collagen) also generate acoustic scattering. We obtained high speckle scores from a set of slaughter bulls, which may have been caused by scattering from connective tissue. A steer that had consistently high readings throughout the feeding period was found to have a callus in the scanning region. Discrepant values that overpredicted carcass grade may have resulted from speckle caused by scatterers that were not adipose tissue. If speckle from intramuscular fat could be distinguished from speckle caused by connective tissue, it might be possible to estimate the two most important components of beef palatability, juiciness and tenderness, on the live animal.

Summary

A procedure based on ultrasound speckle was a "quick and dirty" way to estimate carcass marbling score and carcass grade. It was about 80% accurate in grade classification, if borderline cattle were omitted. Speckle scores obtained as much as 148 days before slaughter were highly correlated with marbling score. This indicates that the method might help cluster cattle into outcome groups for more effective marketing. Considerable information from the ultrasound signal is lost when only a video image is produced. The results of this research with image texture suggest that interfacing a computer with an ultrasound system should improve accuracy and precision of the procedure. It might be possible to discover parameters of the waveform or pattern analysis that directly estimate specific attributes of meat palatability. Such technology would be a powerful herd selection tool as well as a breakthrough in instrument meat grading.

Behold, the bat! Despite the enormous advances in ultrasound technology the past few decades, the bat still humiliates us. Some species are totally blind and rely entirely on ultrasound for navigation and evaluating their environment. The bat employs a pulse-echo technique, similar to that in our instruments, to locate prey and measure distance. Then he switches to Doppler ultrasound to determine travel speed of the moth he has located. But it is a very sophisticated Doppler; the bat can adjust the frequency to compensate for his own motion. And with receivers in each ear, the bat is able to establish the prey's trajectory in addition to escape velocity. With that information, the bat engages intercept tactics instead of mere pursuit. The bat emits a much more complicated sound pulse than our diagnostic systems. It includes "chirp" technology, which we have not yet harnessed. The chirp involves a waveform with a glissando that slides across many frequencies and conceivably could be used to interrogate the echo and classify it; i.e. is the species of moth appetizing enough to warrant the chase? Perhaps someone will discover that the lowly bat carries an on-board computer with a hard wired, fast Fourier transform that abases our fastest Cray system. This incredible exploitation of ultrasound in nature provides an indication of the enormous future potential for this technology.

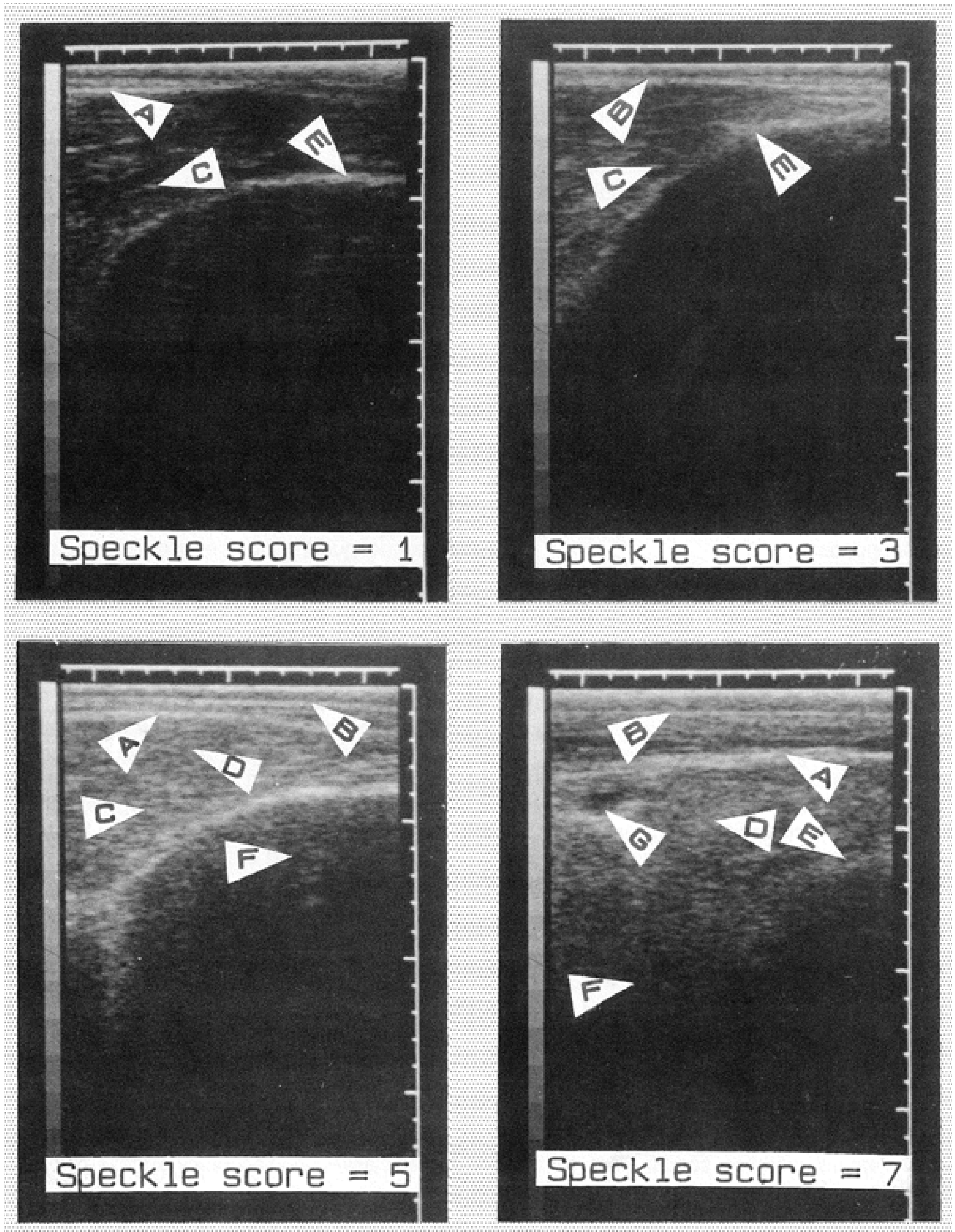

Figure 1. Photographs of images from the ultrasound monitor that show differences in speckle scores. A) boundary between subcutaneous fat and longissimus muscle; B) boundary between hide and subcutaneous fat; C) blood vessel; D) area of intense speckle; E) rib bone; F) reverberation from nether region; G) grub.

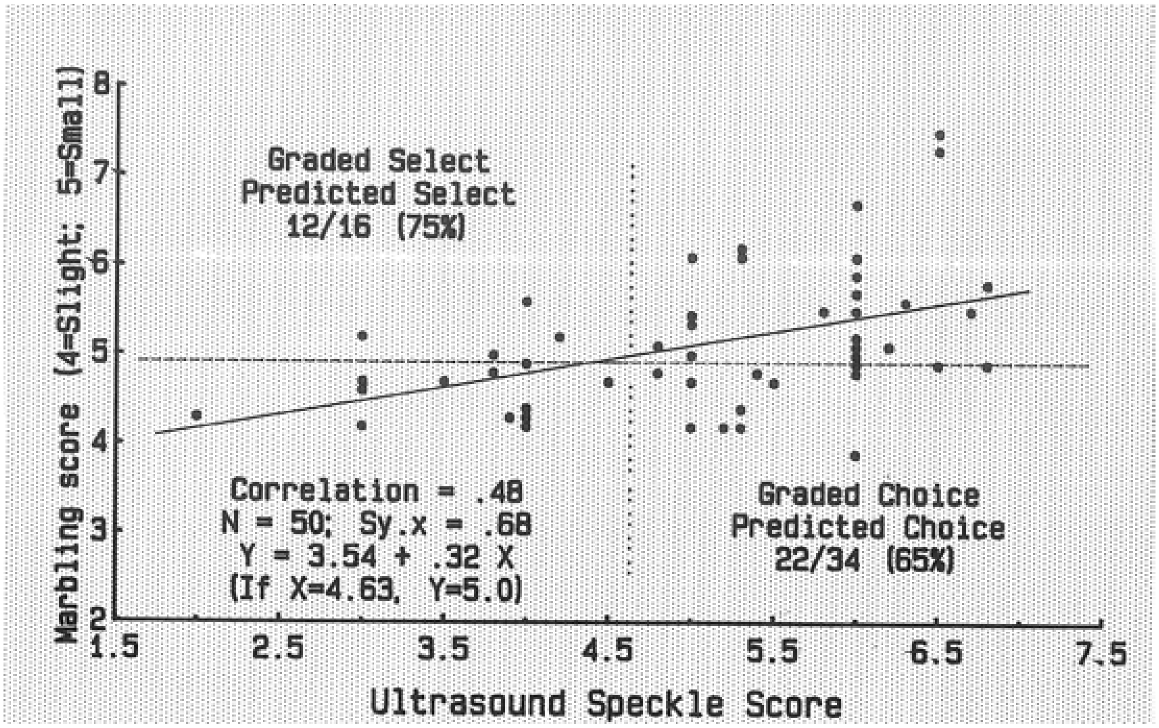

Figure 2. Relationship of carcass marbling score to ultrasound speckle score.

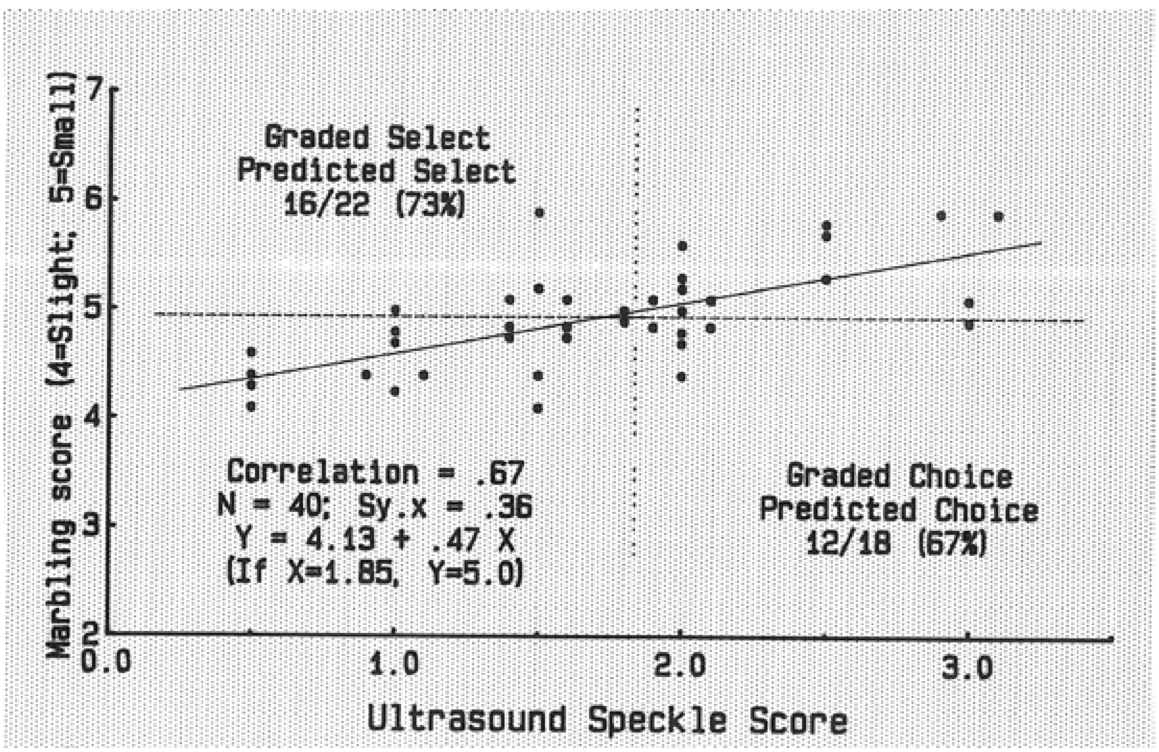

Figure 3. Predicting carcass marbling from ultrasound estimates taken 148 days before slaughter.

A Summary of 7 Years of Preconditioning Research at Kansas State University

E.A. Bailey[1] G.W. Preedy[1], J.R. Jaeger[2], J.W. Waggoner[3], and KC Olson[1]

What is Preconditioning?

Preconditioning is a management strategy executed on the ranch of origin designed to improve the health and performance of beef calves as they transition from their dam to other phases of beef production (e.g., feedlot, heifer development, or stocker). Weaning a calf from its dam imposes significant stress on the calf and increases the risk of illness, primarily from bovine respiratory disease (BRD; Thrift and Thrift, 2011). Other stressful management practices in the beef industry are also commonly imposed on calves at the time of weaning (marketing, transportation, processing, transition to novel environments such as feedlots, commingling with calves from other herds, dehorning, castration of intact male cattle, and transition to novel feedstuffs). The stressors associated with these practices is additive and increases the risk of morbidity in newly weaned calves.

Preconditioning has been advocated as a best management practice for newly weaned calves since the 1960s (Herrick, 1967). Over time, a number of management practices were developed that are now considered under the umbrella of preconditioning, including weaning on the ranch of origin and holding the calves for a period of time before transport and marketing, vaccination protocols designed specifically for preconditioning, various weaning methods, transition to a confinement setting, training to eat dry feed from a bunk and drink from an automatic watering device, and transition to a grain-based diet.

Producers who are accustomed to selling calves at weaning commonly express concerns about additional risk of economic loss from morbidity and mortality of calves during preconditioning, although a recent economic analysis of a preconditioning program in Indiana noted 0.09% morbidity in calves (n = 1103) enrolled during an 11-year period (Hilton and Olynk, 2011). In addition, management guidelines of a preconditioning program require capital investment in feed, labor, and vaccines. Structured preconditioning programs developed by beef industry stakeholders provide financial incentive for producers to participate in preconditioning programs by offering premiums above market price for calves certified as preconditioned. When following preconditioning programs, producers can expect an $8.00 per cwt premium for calves marketed as preconditioned (average premium from 1995–2005; King et al., 2006).

A recent review of preconditioning programs reported a return of $5.91 per calf (average of reported net return per calf from 33 observations; Thrift and Thrift, 2011). Despite the testimony provided by Thrift and Thrift (2011), adoption of preconditioning programs by the cow-calf segment of the beef industry has been modest (49.8% of cow-calf producers sold their calves immediately after weaning; NAHMS, 2007). Cost is a possible explanation for limited adoption of preconditioning. Dhuyvetter (2010) estimated the cost of a 45-day preconditioning program to be $83 per calf. Industry-sponsored preconditioning programs are generally recommended to be 45–60 days in length.

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Preconditioning program recommendations were originally developed based on anecdotal evidence (Herrick, 1967) or retrospective observational studies (McNeill and McCollum, 2000). Calves born in the Great Plains are also commonly finished and harvested in the Great Plains. When all aspects of finished beef production are confined to a single geographic region, calves may not be subject to the rigorous stressors that the original preconditioning management recommendations were based upon. Thus, the goal of this research was to systematically evaluate all major aspects of a typical preconditioning program in a research setting. This allowed us to identify which of the preconditioning management practices were most effective at improving calves' transition from the ranch of origin to the feedlot while identifying potential areas where costs could be reduced and minimizing risk to animal health and performance.

Kansas State University Preconditioning Research Program

Calves enrolled in the K-State Preconditioning Research program originated from two herds: the K-State Commercial Cow-Calf Unit herd in Manhattan and the K-State Western Kansas Agricultural Research Center (WKARC) herd in Hays. Most of the projects had at least 400 calves enrolled. Collection of data on cattle through harvest was a unique aspect of this research; the majority of previous preconditioning research did not report the effects of preconditioning on finishing performance and carcass characteristics.

All calves were dehorned and steer calves were castrated before 60 days of age. Unless otherwise noted, we simulated the stress of the marketing process by transporting calves to a commercial auction market and holding them on the premises for 14 hours at the end of the preconditioning phase. This general approach allowed us to evaluate the responses of calves subjected to various preconditioning treatments on the ranch of origin during receiving at the feedlot. Both steers and heifers were used during preconditioning and receiving phases at the feedlot, but a portion of the heifers were removed after receiving for use as herd replacements. Across all studies, calves were fed a growing diet during the receiving phase at the feedlot. Finishing and carcass data originated from steers and heifers not selected as herd replacements. Calves were finished at the WKARC Research Feedlot in Hays, KS. Across all studies, calves were finished to a common endpoint of approximately 0.5 in. of 12th-rib fat and harvested at a commercial packing plant.

Effect of Length of Preconditioning Period on Health and Performance of Calves Weaned at Early or Conventional Ages

In the beef industry, preconditioning programs are commonly recommended to be 45–60 days in length. Although longer preconditioning periods may support greater weight gain and larger calves for sale, they also cost more. Two experiments were conducted to evaluate the effects of preconditioning period length on the health and performance of calves weaned at early or conventional ages.

In Experiment 1, in 2006, 409 calves were early-weaned and preconditioned 0, 15, 30, 45, or 60 days on the ranch of origin before shipment to the feedlot. Across all treatments, calves in Experiment 1 were weaned at approximately 130 days of age. In Experiment 2, in 2007, 433 calves were weaned at conventional ages and preconditioned 0, 15, 30, 45, or 60 days on the ranch of origin before shipment to the feedlot. Across all treatments, calves in Experiment 2 were weaned at approximately 190 days of age. This allowed us to evaluate the effects of calf removal on cow performance, because calves were early-weaned in the summer (Experiment 1) or conventionally weaned in the fall (Experiment 2).

In both experiments, calves were preconditioned in drylot pens. In addition, cow body weights (BW) and body condition scores (BCS) were measured 60 days before calves were shipped to the feedlot and 60 days after calves were shipped to the feedlot. All calves were shipped to the feedlot on a common date, so weaning date differed in each treatment. Within each study, calves were transported to an auction market and held for 14 hours before shipment to the WKARC feedlot. At the feedlot, calves were fed a growing diet for 56 days before beginning the transition to finishing ration.

Preconditioned calves that were early-weaned (Experiment 1) weighed less at the time of shipment than non-preconditioned calves. The experimental design caused this effect because calves were weaned at various dates in an effort to vary the length of preconditioning prior to shipment to the feedlot. The pre-shipment plane of nutrition probably decreased with successively earlier weaning dates because calves that continued to suckle dams that grazed relatively high-quality forages outgained calves fed a growing diet in a drylot. Incidence of morbidity was mild (<4%) among treatments but increased linearly as the length of preconditioning increased.

In contrast, when preconditioning dates varied around the time of conventional weaning (205 days of age; Experiment 2), calf BW was greater at the time of shipment in calves that were preconditioned than for non-preconditioned cohorts. Fall forage quality on warm-season native pastures in Kansas is poor compared with summer forage, which likely led to a decrease in milk production by dams during the period of the study. Incidence of morbidity was greatest in calves preconditioned for 60 days and may have been related to environmental stress, as this group of calves was weaned in late summer when temperatures were high.

In both trials, cows with calves not weaned prior to shipment had lesser BCS 60 days post-shipment than cows with calves weaned prior to shipment. Cows with calves weaned 45 days before shipment had the greatest final BCS among treatments. Timed-AI pregnancy rate did not differ among treatments, but cows with calves not weaned before shipment to the feedlot had a lesser overall pregnancy rate. In Experiment 1 (early-weaned calves), calves in all preconditioning treatments would have been weaned during the natural-service breeding season, which occurred for 50 days starting in early July. By removing calves from the cows, we removed one of the strongest inhibitors of estrus in beef cows and may have facilitated a return to estrus in cows not bred by AI.

Through receiving, non-preconditioned calves that were early-weaned gained less weight than preconditioned calves. In older calves (Experiment 2), there were no differences in gains among preconditioned and non-preconditioned calves. Conversely, treatments retained their relative BW ranks from shipping through the end of the receiving period. Dry matter intake (DMI) was not affected by treatments in either experiment.

Morbidity during receiving was not different among treatments in the early-weaned study (Experiment 1) but was greater (9.26% average among treatments) than during the preconditioning phase. For calves weaned at conventional ages (Experiment 2), morbidity during receiving was 2.2 times more frequent among non-preconditioned calves than preconditioned calves. Across both studies, there were no differences in morbidity as preconditioning length increased from 15 to 60 days, suggesting that the health benefits of preconditioning were maximized for native Kansas cattle by ranch-of-origin weaning periods as short as 15 days.

Harvest BW and average daily gain (ADG) during finishing did not differ among treatments in either study. In addition, we noted only minor effects of preconditioning (lighter hot carcass weight [HCW] in non-preconditioned calves in the conventional weaning age study; Experiment 2). We concluded that preconditioning had the most meaningful effects on calf performance during the ranch-of-origin weaning period itself and during receiving. The effects of preconditioning on growth during finishing were minimal.

Vaccination Regimens in Preconditioning Programs

Cow-calf producers in the United States use many vaccination strategies. The most cautious strategy involves vaccination against respiratory disease pathogens 2 to 4 weeks before maternal separation followed by a booster at weaning. This strategy is used in instances in which time, labor, and facilities are available to gather and process calves while they are still suckling. Another common strategy is to defer vaccination until after calves have been shipped to a feedlot. Deferring vaccination until arrival in feedlots is thought to increase incidence of respiratory disease compared with vaccination programs implemented at the ranch of origin. This assumption has not been widely scrutinized for native Kansas cattle that are finished in Kansas feedlots.

The objective of the first experiment was to compare the effects of vaccination against respiratory diseases before weaning on the ranch of origin and after arrival at a feedlot for calves weaned 45, 15, or 0 days before feedlot arrival. The objective of the follow-up experiment was to evaluate the effects of 0, 1, 2, or 3 vaccinations for respiratory disease given 14 days apart on the ranch of origin on health and growth performance of ranch-preconditioned beef steers.

In Experiment 1, 437 calves were weaned on 1 of 3 dates to vary the length of a ranch-of-origin preconditioning period (45, 15, or 0 days) before shipment to the feedlot. Within each preconditioning period length, calves were assigned randomly to 1 of 2 BRD vaccination treatments: vaccinated 14 days prior to weaning and again at weaning (PRE) or vaccinated on the day of arrival at the feedlot and again 14 days later (POST). On a common shipping date, calves were transported 3 hours to an auction market and held for 12 hours. Calves were then transported 1 hour to the WKARC feedlot. Calves received a growing diet for the first 56 days in the feedlot and were subsequently transitioned to a finishing diet.

In Experiment 2, 430 calves were assigned randomly to 1 of 4 treatments: 0, 1, 2, or 3 BRD vaccinations prior to feedlot placement (NOVACC, VACC1, VACC2, or VACC3, respectively). Calves were removed from their dams 29 days prior to feedlot placement, 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-day intervals during the ranch-of-origin weaning phase of the experiment (PRE). On a common shipping date, calves were transported 3 hours to an auction market and held for 12 hours. Calves were then transported 1 hour to the WKARC feedlot. After a 56-day receiving period in the feedlot (POST), steers transitioned to a finishing diet.

Incidence of undifferentiated fever and preconditioning ADG during Experiment 1 were similar in PRE and POST calves. The pathogen challenge and the stress associated with maternal separation evidently were insufficient to increase incidence of BRD among unvaccinated calves during preconditioning. Calf BW at weaning and at shipping increased as the length of preconditioning period increased, largely driven by an increase in DMI.

Calf ADG during the first 30 days of receiving and receiving DMI was greater for 45- and 15-day calves than for 0-day calves. There were no differences in incidence of undifferentiated fever (0.92% across preconditioning treatments) during receiving, nor were there differences between calves that were vaccinated against BRD-causing organisms on the ranch of origin and those that were not vaccinated until feedlot arrival.

Steers weaned 45 days before shipping required fewer days on feed than steers weaned 15 or 0 days before shipping. Finishing ADG was greater for steers weaned 45 or 15 days before shipping than for steers weaned 0 days before shipping, whereas ADG was similar between PRE and POST. Consequently, 45-day steers had greater harvest BW than 15- or 0-day steers. Hot carcass weight was greater for steers weaned 45 or 15 days before shipping than for steers weaned 0 days before shipping. Marbling score, USDA yield grade, 12th-rib fat thickness, ribeye area, and kidney, pelvic, and heart fat were similar between weaning and vaccination treatments.

Incidence of liver abscesses was similar between weaning and vaccination treatments. Similarly, incidence of lung lesions was not affected by weaning treatment; however, POST had a numerically greater incidence of lung lesions than PRE. Carcass weight, carcass merit, and growth performance during finishing were similar between steers weaned for 45 or 15 days before shipping. Pre-shipping BRD vaccination did not improve growth performance or carcass merit of ranch-direct cattle compared with BRD vaccination deferred until feedlot arrival.

During preconditioning in Experiment 2, there were no differences in the incidence of undifferentiated fever or drug-therapy costs among treatments, but there was a numerically greater incidence of fever and drug-therapy costs for NOVACC calves. Calf ADG, DMI, and gain:feed (G:F) during the preconditioning period were similar among treatments. Upon arrival at the feedlot, calves were weighed and assigned to a receiving pen based on treatment. Calf BW was similar among treatments at feedlot placement, at 27 days post-receiving, and at 55 days post-receiving; moreover, calf ADG during receiving was similar among treatments. Degree of BRD vaccination had no effect on DMI or G:F during the receiving period; furthermore, incidence of undifferentiated fever was not different among treatments during the receiving period. Finishing ADG, DMI, G:F, days on feed, and final BW were similar among treatments. Likewise, marbling score, yield grade, longissimus area, and kidney, pelvic, and heart fat did not differ among treatments at harvest.

Vaccination regimens during preconditioning did not affect the incidence of liver abscesses or lung lesions. Vaccination for BRD, regardless of degree, may improve health during preconditioning, but did not improve receiving performance, finishing performance, or carcass characteristics of preconditioned calves under the conditions of our study.

Effects of Transport Following Preconditioning on Feedlot Health, Performance, and Carcass Characteristics

Transport of newly weaned beef cattle is a stressful event and can be a predisposing factor for disease upon arrival at the feedlot. Body weight lost during transport may be recovered slowly during receiving. Previous research evaluating the effects of preconditioning on transport stress focused on preconditioning vs. no preconditioning in calves subject to a single transport duration or on long-haul calves that were not preconditioned. Thus, our objective was to evaluate the feedlot-receiving performance of preconditioned calves after being transported either 4, 8, or 12 hours prior to feedlot placement.

Calves (n = 428) were weaned at approximately 183 days of age and preconditioned for 30 days on the ranch of origin. At the time of maternal separation, calves were weighed individually and given initial vaccinations against respiratory pathogens and *H. somnus*. Booster vaccinations were administered 14 days later. Following initial processing, calves were confined to 1 of 15 pens within each location and fed a diet formulated to promote 2.2 lb ADG at a DMI of 2.5% of BW during the weaning phase of the study.

After 30 days of preconditioning on the respective ranch of origin, calves from each location were transported 4 hours to a commercial auction market and commingled for 12 hours on the premises. Following commingling, calves within each treatment were loaded aboard a motor carrier and subjected to transport durations of either 4 (4HR), 8 (8HR), or 12 (12HR) hours from the auction market to the WKARC feedlot. Upon arrival at the feedlot, calves were stratified by sex and fed a common receiving diet for 57 days. After receiving, calves were gradually adapted to a finishing diet.

No treatment differences were detected in BW or ADG at the end of the preconditioning period. This result was expected because all calves were managed in the same manner before application of transportation treatments. The calves transported for only 4 hours shrank less than calves transported 8 or 12 hours, with no difference in shrinkage between calves transported 8 or 12 hours.

During receiving, ADG was greater in the 8HR and 12HR calves than in the 4HR calves. In addition, G:F improved in 8HR and 12HR calves compared with 4HR calves. Increased ADG and improved G:F observed in calves transported 8 or 12 hours during receiving can be explained by the replenishment of gut fill lost during transport. Dry matter intake did not differ because we limited receiving intake to 2.5% of BW/day. We observed no difference in incidence of undifferentiated fever among treatments during receiving, possibly because overall incidence of fever during receiving was small. Preconditioned calves did not show lasting effects of transport durations of up to 12 hours in length.

We noted no treatment differences in harvest BW among treatments, and ADG did not differ among treatments during finishing. We also noted no differences in days on feed or HCW among treatments. Measures of carcass fat content, such as marbling score and USDA yield grade, also did not differ among treatments. We evaluated lungs and livers at the packing plant because they can provide valuable evidence about subclinical disease incurred during finishing. Incidences of either lung lesions or liver abscesses were not different among treatments.

Under the conditions of our study, health and performance of preconditioned beef calves during feedlot receiving and finishing was not affected by transport durations of up to 12 hours. The calves in this study likely benefitted from the action of separating the stressors of weaning and transport with a 30-day ranch-of-origin preconditioning period.

Effects of Weaning Method on Feedlot Health, Performance, and Carcass Characteristics

Preconditioning methods that involve pasture weaning coupled with maternal contact (i.e., fence-line weaning) have been promoted as possible best management practices for minimizing stress. Prior studies focused on performance and behavior during preconditioning on the ranch of origin. Little information has been published relating to carryover effects of fence-line preconditioning compared with conventional drylot preconditioning on performance and behavior during feedlot receiving. In addition, pasture weaning without supplementation foregoes the opportunity to train cattle to eat dry feed from a bunk. One causative feature of poor initial feedlot performance is stress associated with learning to eat from a bunk. We hypothesized that provision of supplemental concentrates during pasture weaning would improve receiving performance compared with pasture weaning alone.

Our objectives were to measure growth and health during a 28-day ranch-of-origin preconditioning phase, during a 60-day feedlot receiving phase, and during finishing among beef calves subjected to 1 of 3 ranch-of-origin preconditioning programs: (1) drylot weaning + dam separation (D), (2) pasture weaning + fence-line contact with dams (PF), and (3) pasture weaning + fence-line contact with dams + supplemental feed delivered in a bunk (PF+S).

Angus × Hereford calves (n = 460) were weaned at approximately 180 days of age and preconditioned on the ranch of origin for 28 days before shipment to the WKARC feedlot. At weaning, calves were assigned randomly to 1 of the 3 ranch-of-origin preconditioning methods. Calves assigned to D were transported (<30 mi) to a ranch-of-origin weaning facility immediately after separation from dams and confined within location to a single earth-surfaced pen. Calves assigned to D were fed a diet formulated to promote 2.2 lb ADG at a DMI of 2.5% of BW during the preconditioning phase. Pasture-weaned calves were allowed fence-line contact with their dams (4-strand, barbed-wire fence with the bottom 2 wires electrified for 7 days). Calves assigned to PF had access to native forage only, whereas calves assigned to PF+S calves had access to native forage and received a ration of the diet fed to D at a rate of 1% of BW 3 times weekly. We used the supplement program not to increase weight gain in calves but to attempt to bunk-train them while in a pasture-preconditioning program.

After the 28-day preconditioning period, all calves were transported 4 hours from the ranch of origin to the WKARC feedlot and fed a grower ration for 56 days. Beginning on the morning after feedlot arrival, animal behavior was assessed 3 times daily for 7 days by 2 trained observers. The number of calves performing specific behaviors (eating, pacing, vocalizing, drinking, resting, and ruminating) were recorded for each pen. Observations were taken 1 hour before feeding, at the time of feeding, and 6 hours post-feeding. After a 56-day receiving period at the feedlot, calves were gradually stepped up onto a finishing ration.

Calf ADG during the 28-day preconditioning period was greater for drylot-weaned calves (D) than for pasture-weaned calves. Our treatments were designed such that calves assigned to D were on a greater plane of nutrition than calves assigned to PF or PF+S. This condition is typical of drylot- vs. pasture-preconditioning programs in Kansas. Supplement provided to PF+S in our study was designed to train pasture-weaned calves how to eat out of a bunk rather than to promote BW gains that were competitive with D. In our study, incidence of undifferentiated fever did not differ (2.85%) among treatments during the preconditioning phase.

We observed calves at the time of feeding to gauge their desire to eat from a bunk during the first 7 d of receiving. A greater proportion of D than PF came to the bunk at time of feeding during the first 5 days of receiving. Similarly, a greater proportion of D than PF+S came to the bunk at time of feeding during the first 4 days of receiving.

During the receiving period, D calves had greater ADG from arrival to day 60 and greater BW on day 60 than either pasture-weaned treatment. This increase in performance was driven by greater DMI by D than by PF or PF+S. In addition, G:F was greater for D than for PF calves; G:F of PF+S calves was intermediate and similar to D and PF. Providing calves with supplement in a bunk on pasture did not improve receiving ADG or DMI compared with pasture-weaned calves receiving no supplement.

Pasture-weaned calves in our study were supplemented infrequently (3 times weekly for 4 weeks) and ate less feed during receiving than drylot-weaned calves. Achieving greater performance and feed intake with pasture-weaned calves during receiving may be possible when supplementation is provided more frequently than in our study.

Incidence of undifferentiated fever during the receiving period was small (0.9%); therefore, we did not report summary statistics on this data. Previous work reported greater incidence of disease during receiving in drylot-weaned calves compared with pasture-weaned calves. In our study, the health of drylot-weaned calves was equivalent to that of pasture-weaned calves. Overall, our cattle were healthier than in the aforementioned research, so we were unable to detect health differences among treatments.

The BW difference between D calves and PF calves was 48 lb at the end of the receiving period. Conversely, calves assigned to PF gained weight at a greater rate during finishing than D calves or PF+S calves. Under the conditions of our experiment, the PF calves compensated for previous nutritional restriction during finishing. In contrast, measures of carcass attributes were not different among treatments, likely because we had a predetermined finishing-phase endpoint based on backfat thickness. Number of days on feed did not differ among treatments. Based on these data, it is possible for producers who wish to retain ownership during finishing to use pasture-weaning in conjunction with minimal supplementation without fear of sacrificing pounds of beef at harvest time or increasing the number of days on feed.

We interpreted this result to suggest that that pasture-preconditioned calves can compensate for previous nutritional restriction during finishing. There were no differences in days on feed, despite cattle being fed to a common-backfat endpoint. Low-input preconditioning programs that involve pasture-weaning do not negatively affect finishing performance or carcass characteristics of beef cattle and may be a means of reducing the cost of preconditioning.

Effects of Limit-Feeding a High-Concentrate Diet to Early-Weaned Beef Calves on Health and Performance

Early weaning can be used by cow-calf producers to reduce pasture stocking rates by 20% to 30% during drought. If selling calves at weaning, the decision to wean early is influenced by reduced calf weaning weights and the potential for reduced revenue compared with weaning calves at conventional ages. Calves can be retained and grown before selling; however, grain prices were well above historical averages from 2008 through 2012. In addition, feeding grain-based diets to calves less than 125 days of age has been associated with excessive fat accumulation early in the feeding period and decreased carcass weights. High feed costs and early fat deposition may be attenuated by limit-feeding a grain-based diet to early-weaned calves. Our goal was to measure performance and efficiency of lightweight, early-weaned beef calves during an 84-day post-weaning growing phase when feed intakes were varied to achieve targeted gains of 1, 2, or 3 lb/day.

Angus × Hereford calves (n = 243; initial BW = 343 ± 68 lb) were weaned at approximately 100 days of age and assigned to 1 of 3 rates of gain: 1 lb/day (Logain), 2 lb/day (Midgain), and 3 lb/day (Higain). Growth and health performance were evaluated during an 84-day backgrounding period.

One common grain-based diet was formulated; formulation software predicted calves to gain approximately 3 lb/day at maximum DMI. We fed this diet to all treatments but restricted the intake of the Logain and Midgain calves to a level that decreased their predicted gain to 1 and 2 lb/day, respectively. Initial feed allowances were determined based on initial BW and targeted rates of gain. Dry matter feed deliveries were adjusted every 28 days to match current BW.

Daily gain increased as feed allowance increased. At the end of the experiment, Higain calves weighed more than either Midgain or Logain calves. We were unsuccessful in reaching our targeted ADG for the Midgain and Higain treatments, likely due to limitations of the prediction equations used by our formulation software. Feed intake was greater for the Higain treatment than for the Midgain treatment; moreover, feed intake of the Midgain treatment was greater than for the Logain treatment. Feed efficiency did not differ among treatments, which was unexpected. Previous research noted that feed efficiency of older cattle increased dramatically when feed intake was restricted, so we expected comparable increases in efficiency in our lightweight, early-weaned calves. Incidence of undifferentiated fever was not different among treatments and was relatively mild (6% or less) overall.

Overall, early-weaned calves that were fed a grain-based diet at restricted rates did not exhibit improved feed efficiency compared with their full-fed counterparts. In addition, limitations appeared to be associated with predicting feed intake and performance of lightweight, early-weaned calves fed a grain-based diet.

General Recommendations Based on the Results of our Research

Industry-affiliated preconditioning programs follow specific guidelines for marketing a calf as preconditioned through their respective programs. Our data from 7 years of controlled preconditioning research suggest that a preconditioning program for calves raised and fed in the Great Plains does not need to be as labor- or cost-intensive as current industry practices suggest. In contrast, marketing a calf as preconditioned requires following specific, programmatic guidelines. We hope programmatic guidelines will be altered to reflect the inherently lower health risk of native Kansas cattle as established in our research. In the absence of this change, producers who retain ownership of their calves through backgrounding or finishing and do not participate in programmatic preconditioning plans can follow our recommendations.

Length of Preconditioning

Under the conditions of our experiments, the health of calves weaned early or at conventional ages was improved when subjected to preconditioning programs as short as 15 days. No additional health benefits accrued to calves by preconditioning calves for longer periods of time, up to 60 days. In addition, weaning calves early spared body condition on cows and improved pregnancy rates when calves were weaned during the breeding season.

Vaccination Protocols

The incidence of undifferentiated fever and drug-therapy costs increased during preconditioning when calves were not vaccinated against viral BRD-causing pathogens; however, there were no differences in morbidity between calves vaccinated at weaning or at feedlot arrival. Across both experiments, we observed no differences in feedlot morbidity among various vaccination protocols. At a modest cost ($1.00 per dose), however, vaccinating calves against viral BRD-causing pathogens is an inexpensive insurance policy.

Transportation Stress

Calves preconditioned for 28 days, according to guidelines established in previous research, were transported for up to 12 hours with no effects on health or performance in the feedlot. For calves born and fed in the Great Plains, transport of greater than 12 hours between the ranch of origin and the feedlot is unlikely. Calves likely benefitted from the action of separating the stressors of weaning and transport.

Weaning Method

Pasture-preconditioning systems offer an interesting alternative for producers who wish to retain ownership of their calves through finishing. When calves were fence-line weaned on pasture or drylot-weaned for 28 days, pasture-weaned calves gained 0.4 lb/day greater than drylot-preconditioned cohorts during finishing. If producers plan to market calves after preconditioning, maximizing weight gain during preconditioning is important to increase revenue and recover additional feed costs. In contrast, a pasture-preconditioning program, although not supporting weight gains equivalent to drylot-preconditioning, does not alter health performance and positions calves to fully compensate in terms of BW and carcass quality by harvest time. Significant cost savings may be realized for retained-ownership producers who opt for pasture weaning over drylot weaning.

Early-Weaning

Body condition of cows can be preserved by weaning calves early. In 2 different studies, we weaned calves at 100 days of age without significant health or performance issues after weaning. In addition, we successfully limit-fed a high-concentrate ration to calves immediately after weaning and had excellent performance during an 84-day growing period.

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Performance of Pregnant Beef Cows Limit-Fed Diets Containing Wheat Straw Treated With Two Rates of Anhydrous Ammonia and Wet Distillers Grain

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Introduction

The persistence of drought conditions across the southern Great Plains has renewed interest among beef cattle producers in chemical methods of enhancing the feed value of low-quality forages. The application of anhydrous ammonia is one of the most common chemical methods utilized due to its availability and ability to treat large quantities of hay in a single application. Application of anhydrous ammonia at a rate of 3.0% (wt/wt) on a dry matter basis traditionally has been recommended, but proportionally greater improvements in forage quality have been reported at lower rates of anhydrous ammonia application in previous research and in a large-scale case study conducted at six locations across Kansas in 2013. Evaluating the use of lower anhydrous ammonia application rates may be warranted because the cost of anhydrous ammonia has increased from an average of $217.00/ton from 1985–1995 to $593.00/ton from 2003–2013 (USDA, 2013). Beef producers also have speculated that performance responses associated with feeding forages treated with anhydrous ammonia will be diminished in diets containing wet distillers grain. Therefore, the objective of this study was to evaluate the dietary inclusion of wheat straw previously treated with 1.5% or 3.0% (wt/wt) anhydrous ammonia in combination with wet distillers grain on performance and body condition score (BCS) of pregnant beef cows.

Experimental Procedures

Animals and Experimental Design

Pregnant (2nd trimester), spring-calving, Angus-cross cows (n = 132; age = 4.78 ± 2.36 yr; initial body weight [BW] = 1,299 ± 119.1 lb; initial BCS = 6.0 ± 0.44), were stratified by age, BW, and BCS and assigned randomly to 1 of 3 dietary treatments (4 pen replicates per treatment; 11 cows per pen). Treatments consisted of 3 wheat straw-based (Table 1) diets: (1) 64.1% wheat straw (CON); (2) 64.1% wheat straw treated with 1.5% (wt/wt) anhydrous ammonia (1.5A); and (3) 64.1% wheat straw treated with 3.0% (wt/wt) anhydrous ammonia (3.0A). Diets were limit-fed (1.9% initial BW) once daily at 8:00 a.m. for the duration (84 days) of the experiment and were formulated to exceed the nutrient requirements of gestating beef cows NRC (2000).

Anhydrous Ammonia Application

Round bales (n = 140) of wheat straw were placed in 2 stacks, in a 3, 2 arrangement. Three 30-ft, ½-in.-diameter braided-polyvinyl anhydrous hoses connected to a ¾-in. black iron cross adapted to fit an anhydrous ACME fitting (Fairbank Equipment, Wichita, KS) were secured at approximately equal distances along the length of the stack to facilitate application of anhydrous ammonia. The stacks were then covered with 6-mil black plastic and sealed with approximately 12 in. of soil along the bottom edge of the stack. Anhydrous ammonia was applied at the predetermined rates of 1.5 and 3.0% of dry matter (DM) (wt/wt) basis (1 stack of each). Stacks treated with anhydrous ammonia remained covered with plastic for 14 days. All wheat straw

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was then ground through a 6-in. screen using a commercial hay grinder (Haybuster, Jamestown, ND).

Data Collection

Cow BW was measured on days 0 and 84 of the experiment. All cows were fed a common diet prior to the initiation of the experiment and for 12 days after to account for any potential differences in gut fill; therefore, cows were weighed again on day 96 of the experimental timeline. All performance calculations were conducted using BW obtained on days 0 and 96 of the experiment. Cows were weighed at approximately 9:00 a.m. on each respective weigh date prior to ration delivery. Body condition scores were assigned by two independent, qualified observers using a 9-point scale (1= extremely emaciated, 9 = extremely obese; Wagner et al., 1988) on days 0 and 84. In an effort to further quantify body condition status, backfat thickness at the 13th-rib and rump fat thickness at the midpoint between the tuber coxae (hip bone) of the ilium and the tuber ischia (pin bone) of the ischium were measured ultrasonically on days 0 and 84 using an Aloka 500V (Aloka Co., Ltd., Wallingford, CT) B-mode instrument equipped with a 3.5-MHz general purpose transducer array (UST 5021-12mm window). Ultrasound images were collected with Cattle Performance Enhancement Company (CPEC, Oakley, KS) software.

Diet samples were collected weekly and frozen at -4°F. Samples were composited at the conclusion of the experiment and submitted to a commercial laboratory (SDK Laboratories, Hutchinson, KS) for analysis of DM, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium, phosphorus, and sulfur.

Statistical Analysis

Performance and ultrasound data were analyzed using the MIXED procedure in SAS (SAS Institute Inc., Cary, NC). Pen was utilized as the experimental unit. Polynomial contrasts were used to evaluate linear and quadratic effects of anhydrous ammonia application. Least square means are presented, and differences were considered significant at $P \leq 0.05$. Tendencies were discussed when $0.05 < P \leq 0.10$.

Results and Discussion

Pregnant cows fed diets containing wheat straw previously treated with anhydrous ammonia resulted in greater ($P \leq 0.05$) total BW gain and average daily gain (ADG), and tended ($P = 0.09$) to result in greater BCS than CON throughout the 84-day feeding period (Table 2). Total BW gain was greater ($P \leq 0.05$) for cows fed 1.5A (160 lb) or 3.0A (163 lb) than for cows fed CON (130 lb). Overall ADG was greatest for 3.0A, intermediate for 1.5A, and least for CON (1.69, 1.66, and 1.35 lb/day, respectively). The observed response in both BW gain and ADG were linear ($P < 0.01$). Total BW gain and ADG of 1.5A did not differ from 3.0A ($P > 0.05$). The relative change in BW gain and ADG was greater from CON to 1.5A than from 1.5A to 3.0A, thus indicating a diminishing response to anhydrous ammonia application (quadratic; $P = 0.10$). However, final BW and BCS change did not differ among treatments ($P > 0.05$).

Although final BCS tended ($P = 0.09$) to be greater in cows fed 1.5A and 3.0A, final 13th-rib backfat thickness and final rump fat thickness (Table 3) were not influenced ($P \geq 0.20$) by anhydrous ammonia application. A tendency ($P = 0.10$) for a main effect was observed for 13th-rib backfat thickness change. The observed change in 13th-rib backfat thickness during the 84-day trial was greatest for 3.0A, intermediate for CON, and least for 1.5A (2.97, 2.17, and 1.91 mm, respectively).

Implications

The results of this study indicate that the performance of pregnant beef cows may be improved by applying anhydrous ammonia to low-quality forages such as wheat straw at a rate as low as 1.5% (wt/wt) of the DM content. In addition, these improvements in cow performance were observed in diets containing wet distillers grain. Treating wheat straw with 3.0% anhydrous ammonia resulted in the greatest BW gain and ADG. The observed improvement in these variables in response to the 1.5% application rate, however, suggests that application of 1.5% anhydrous ammonia (wt/wt; DM basis) may be optimal when anhydrous ammonia prices are relatively high.

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Table 1. Ingredient and nutrient composition of diets containing wheat straw treated with 0.0% (control), 1.5%, or 3.0% anhydrous ammonia (wt/wt; dry matter [DM] basis)

	Treatment[1]		
Item	CON	1.5A	3.0A
Ingredient composition, % DM			
Ground, wheat straw (CON)	64.1	–	–
Ground, wheat straw, 1.5%	–	64.1	–
Ground, wheat straw, 3.0%	–	–	64.1
Wet distillers grain	19.9	19.9	19.9
Rolled sorghum	14.9	14.9	14.9
Calcium carbonate	0.5	0.5	0.5
Salt	0.2	0.2	0.2
Vitamin and mineral premix[2]	0.4	0.4	0.4
Nutrient composition, DM basis[3]			
Crude protein, %	11.8	14.9	16.2
Neutral detergent fiber, %	44.51	42.59	42.05
Acid detergent fiber, %	34.20	35.25	35.24
Calcium, %	0.99	0.94	0.90
Phosphorus, %	0.30	0.29	0.30
Sulfur, %	0.29	0.27	0.31

[1] Treatments: CON = 64.1% wheat straw diet; 1.5A = diet containing 64.1% wheat straw previously treated with 1.5% (wt/wt) anhydrous ammonia; 3.0A = diet containing 64.1% wheat straw previously treated with 3.0% (wt/wt) anhydrous ammonia.
[2] Premix supplied 150 mg per head per day Rumensin (Elanco Animal Health, Greenfield, IN).
[3] Nutrient analysis conducted by SDK Labs, Hutchinson, KS.

Table 2. Performance of pregnant beef cows diets containing wheat straw treated with 0.0% (Control), 1.5%, or 3.0% anhydrous ammonia on (wt/wt; dry matter [DM] basis) for 84 days

	Treatment[1]					Significance of contrasts[2]	
Item	CON	1.5A	3.0A	SEM	*P*-value	Linear	Quadratic
Number of pens	4	4	4				
Body weight[2]							
Initial, lb	1,265	1,239	1,245	16.6	0.51	0.27	0.73
Final, lb	1,395	1,399	1,408	19.6	0.89	0.89	0.65
Total gain, lb	130[a]	160[b]	163[b]	3.9	0.01	0.01	0.10
Average daily gain, lb/day	1.35[a]	1.66[b]	1.69[b]	0.09	0.01	0.01	0.10
Body condition score[3]							
Initial	5.86	5.87	5.92	0.07	0.78	0.90	0.49
Final	5.86[a]	5.94[a]	6.08[b]	0.07	0.09	0.43	0.04
Change	0.00	0.08	0.16	0.04	0.13	0.30	0.08

[1] Treatments: CON = 64.1% wheat straw diet; 1.5A = diet containing 64.1% wheat straw previously treated with 1.5% (wt/wt) anhydrous ammonia; 3.0A = diet containing 64.1% wheat straw previously treated with 3.0% (wt/wt) anhydrous ammonia.
[2] To account for differences in gut fill, cows were fed a common diet prior to collection of initial weight and were fed a common diet for 12 days prior to collection of final weight. Thus, calculation of ADG is based on 96 days on feed.
[3] Significance of polynomial contrasts for anhydrous ammonia application: linear = linear effect of anhydrous ammonia application; quadratic = quadratic effect of anhydrous ammonia application.
[4] BCS scale : 1 to 9 (1 = emaciated, 9 = obese; Wagner et al., 1988).
[a,b] Within a row, means without a common superscript differ ($P \leq 0.05$).

Table 3. Effects of feeding diets containing wheat straw treated with 0.0% (Control), 1.5% or 3.0% anhydrous ammonia (wt/wt DM; basis) to pregnant beef cows for 84 days on 13th-rib backfat thickness and rump fat thickness

	Treatment[1]					Significance of contrasts[2]	
Item	CON	1.5%	3.0%	SEM	*P*-value	Linear	Quadratic
Backfat thickness, mm							
Initial	5.55	5.64	5.77	0.39	0.92	0.87	0.71
Final	7.72	7.55	8.74	0.51	0.20	0.81	0.07
Change	2.17[ab]	1.91[a]	2.97[b]	0.36	0.10	0.60	0.03
Rump fat, mm							
Initial	8.95	8.88	9.24	0.68	0.92	0.94	0.69
Final	24.75	24.92	26.15	1.37	0.73	0.92	0.43
Change	15.80	16.05	16.92	0.92	0.66	0.85	0.38

[1] Treatments: CON = 64.1% wheat straw diet; 1.5A = diet containing 64.1% wheat straw previously treated with 1.5% (wt/wt) anhydrous ammonia; 3.0A = diet containing 64.1% wheat straw previously treated with 3.0% (wt/wt) anhydrous ammonia.
[2] Significance of polynomial contrasts for anhydrous ammonia application: linear = linear effect of anhydrous ammonia application, quadratic = quadratic effect of anhydrous ammonia application.
[a,b] Within a row, means without a common superscript differ ($P \leq 0.05$).

Effects of Weaning Method on Weaning and Growing Phase Performance by Early-Weaned Calves

G.W. Preedy[1], J.R. Jaeger[2], J.W. Waggoner[3], and KC Olson[1]

Introduction

Cow-calf producers commonly use early weaning during periods of drought to reduce grazing pressure on pastures. This practice may result in calves having less value at weaning than calves weaned at conventional ages. Retained ownership through a short-term backgrounding period can be useful for improving the value of early-weaned calves. Conversely, feeding concentrate-based diets to calves weaned at less than 125 days of age has been associated with excessive fat deposition early in life and decreased carcass weights at harvest compared with feeding concentrate based-diets to calves weaned at greater than 125 days of age. In addition, early-weaned calves consume more total concentrate during the finishing period than calves weaned at conventional ages, a circumstance that could negatively affect profit margins during times of high grain prices.

Post-weaning growing programs based on either pasture or high-roughage diets fed in confinement are a viable means of reducing the usage of concentrates without negatively affecting returns. Similar days on feed (DOF) without affecting harvest body weight (BW) have been achieved by grazing early-weaned calves for 82 days before placement into a feedlot compared with early-weaned calves fed a high-concentrate diet from weaning to harvest. Calves previously have been weaned into drylot or pasture environments for 28 days before feedlot placement. Despite reduced BW gain during the weaning and receiving periods, pasture-weaned cattle achieved full compensation of BW by harvest with no differences in finishing dry matter intake (DMI), DOF, or carcass quality compared with drylot-weaned cattle. Therefore, the objective of our study was to evaluate the performance and health of early-weaned steer calves subject to a 56-day weaning period in either a pasture or a drylot environment.

Experimental Procedures

Angus × Hereford steers originating from the commercial cow-calf herds of Kansas State University (n = 123; initial BW = 292 ± 58.2 lb; 113 ± 13 days of age; Source 1) in Manhattan, KS, and the Western Kansas Agricultural Research Center (n = 116; initial BW = 428 ± 51.6 lb; 144 ± 15 days of age; Source 2) in Hays, KS, were used in this study. All steers were castrated, dehorned, and vaccinated against clostridial diseases (Ultrabac 7; Pfizer Animal Health, Exton, PA) at approximately 60 days of age. At weaning, steers were stratified by source and assigned randomly to 1 of 2 weaning treatments: drylot weaning for 56 days (DRYLOT) at the Western Kansas Agricultural Research Center or pasture weaning for 56 days (PASTURE) on native tallgrass pastures at the Kansas State University Commercial Cow-Calf Unit.

Weaning Phase

Steers from both sources were weighed individually and given initial vaccinations against respiratory pathogens (Bovi-Shield Gold 5; Pfizer Animal Health) and clostridial pathogens (Ultrabac 7; Pfizer Animal Health) as they were separated from dams. Calves were also given an

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injection of trace minerals (Multimin 90; Multimin USA Inc., Fort Collins, CO), treated for internal and external parasites (Dectomax Injectable; Zoetis Inc., Kalamazoo, MI), and given a growth-promoting implant (Ralgro; Intervet Inc., Merck Animal Health, Summit, NJ). Steers were re-vaccinated 14 days after maternal separation.

After initial processing, all steers were transported via motor carrier for a common shipping duration of 4 hours to their designated weaning locations. Steers from both sources that were assigned to DRYLOT were transported to the Western Kansas Agricultural Research Center feedlot, where they were stratified by source assigned randomly to 1 of 8 pens. Pens (minimum area = 656 ft^2/calf; bunk space = 1.51 ft/calf) afforded *ad libitum* access to water via concrete tanks.

Calves were fed a diet formulated to promote a 2.2-lb average daily gain (ADG) at a DMI of 2.5% of BW during the weaning phase of the study (Table 1). Feed was delivered once daily at 7:00 a.m.; bunks were evaluated each morning at 6:30 a.m.. Bunks were managed using a slick-bunk management method to minimize feed refusals. If all feed delivered to a pen was consumed, delivery at the next feeding was increased to approximately 102% of the previous delivery. Diet samples were collected from bunks weekly and frozen at -4°F. Samples were composited at the conclusion of the experiment and submitted to a commercial laboratory (SDK Laboratories, Hutchinson, KS) for analysis of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium, phosphorus, and sulfur (Table 1). Dry matter intake was estimated by dividing the total feed DM delivered to each pen during the weaning period by the average aggregate BW of all steers in the pen during the weaning period.

Steers from both sources assigned to PASTURE were transported to the Kansas State University Commercial Cow-Calf Unit, where they were stratified by source and assigned randomly to 1 of 8 previously ungrazed, native tallgrass pastures (240 ± 99 acres). Upon arrival, steers were confined to a single earth-floor pen (minimum area = 656 ft^2/calf) and allowed *ad libitum* access to native tallgrass prairie hay (89.2% DM, 9.08% CP) via two ring feeders (diameter = 10 ft) for 4 days. On the afternoon of day 4, steers were released into assigned pastures. Each pasture provided continual access to surface water and was stocked at 8 acres/steer. Additional non-study cattle of similar age and weight were added to pastures to achieve the desired stocking density.

Pasture forage quality was estimated by clipping all plant material from within randomly placed sampling frames (2.8 ft^2; n = 2/pasture) at a height of 0.4 in. on August 7, September 4, and October 2 (Table 2).

Health

Steers assigned to both DRYLOT and PASTURE were monitored daily for symptoms of respiratory disease and conjunctivitis. Steers with clinical signs of bovine respiratory disease (BRD), as judged by animal caretakers, were removed from pens or pastures and evaluated. Steers were assigned a clinical illness score (scale: 1 to 4; 1 = normal, 4 = moribund), weighed, and assessed for febrile response. Steers with a clinical illness score >1 and a rectal temperature >104.0°F were treated with therapeutic antibiotics according to label directions (first incidence = Baytril, Bayer Animal Health, Shawnee Mission, KS; second incidence = Resflor Gold, Merck Animal Health). Steers were evaluated 72 hours following treatment and re-treated if clinical signs of BRD persisted.

Steers showing signs of conjunctivitis (i.e., pinkeye) were treated using oxytetracycline (LA 200; Zoetis Inc.). Steers were evaluated 14 days following treatment and re-treated if clinical signs of disease persisted.

Receiving Phase

Following the 56-day weaning period, all steers were weighed at their respective weaning sites, implanted with Revalor IS (Intervet Inc.; Merck Animal Health), and transported via motor carrier for 4 hours to the Western Kansas Agricultural Research Center for a 56-day feedlot receiving period. At that time, steer calves assigned to PASTURE were stratified by source and assigned randomly to 1 of 8 pens, adjacent to those assigned to DRYLOT (minimum area = 656 ft^2/calf; bunk space = 1.51 ft/calf).

To establish a common gut-fill between treatments, all steers were fed the weaning diet (Table 1) at a pre-determined percentage of aggregate pen BW for 7 days. Steers were weighed on day 7; this BW was used as both the ending BW of the weaning phase of the study and the initial BW of the receiving phase of the study.

Thereafter, all steers were fed a common growing diet once daily at 7:00 a.m. (Table 3). Bunks and feed delivery were managed according to procedures described for the DRYLOT treatment during the weaning phase of the study. Bunk samples were collected and analyzed as during the weaning phase of the study (Table 3). Dry matter intake was estimated by dividing the total feed DM delivered to each pen during the receiving period by average aggregate BW of all steers in the pen during the receiving period.

Cattle health was monitored as during the weaning phase of the study. Steers were weighed individually on day 28 and day 56 of the receiving period.

Results and Discussion

Weaning Performance

Body weight after and ADG during the 56-day weaning period were greater ($P \leq 0.01$) for DRYLOT than for PASTURE (Table 4). Based on the quality of the forage available to PASTURE steers, these results were expected. Greater BW gains for calves weaned in a drylot environment for 28 days are expected compared with calves weaned on dormant native range for 28 days.

Incidence of undifferentiated fever during the weaning phase of our study tended to be greater ($P = 0.10$) in DRYLOT steers than in PASTURE steers (Table 4). Increased morbidity is associated with calves weaned in a drylot compared with pasture-weaned calves. Because identical vaccination and health protocols were applied to both treatments in our study, a high occurrence of respiratory disease was not expected from either treatment. Preconditioned calves are known to be less susceptible to disease during the post-weaning period than calves sold through auction markets immediately following separation from dams.

Incidence of conjunctivitis (i.e., pinkeye) during the weaning phase of our study was greater ($P \leq 0.01$) for PASTURE steers (40.2%) than for DRYLOT steers (0%; Table 4). This was anticipated because it was assumed that pasture conditions (e.g., abundant, mature forage) presented a greater risk for corneal lesions than drylot conditions.

Receiving Performance

Steers assigned to DRYLOT had greater (*P* ≤ 0.01) BW at the beginning of the receiving period, on day 28 of the receiving period, and at the end of the receiving period (day 56; Table 5) than steers assigned to PASTURE. Steers assigned to DRYLOT also had greater (*P* = 0.02) ADG from day 1 to 28 than steers assigned to PASTURE. Conversely, there was no difference (*P* = 0.95) in ADG between treatments from day 28 and day 56.

Steers assigned to PASTURE had greater DMI (*P* ≤ 0.01; expressed as a percentage of BW) during the receiving period than steers assigned to DRYLOT (Table 5). In contrast, G:F was similar (*P* = 0.18) between treatments.

Incidence of undifferentiated fever did not differ (*P* = 0.99) between DRYLOT and PASTURE during the receiving phase of our trial. Preconditioned, ranch-direct calves are less susceptible to disease during receiving than market-sourced calves with no known health history. Preconditioning management was applied to both of our treatments before feedlot arrival. Incidence of conjunctivitis was greater (*P* ≤ 0.01) for steers assigned to PASTURE (14.3%) than for steers assigned to DRYLOT (1.6%) during the receiving period. We speculated that the pasture environment had significant residual effects on corneal health that lasted well into the receiving period.

Implications

Growth and health during weaning and receiving were improved when steers were weaned in a drylot environment and fed a concentrate-based diet for 56 days rather than when steers were weaned in a pasture environment for 56 days. The drylot-weaned steers in our study were approximately 126 lb heavier at the end of the weaning period than pasture weaned steers. K-State previously reported similar results from 28-day drylot or pasture weaning periods; however, no treatment differences were detected in harvest BW, DMI, DOF, or carcass quality. We speculated that the compensatory effects observed in prior K-State research during finishing could be sustained for longer periods of time, thus reducing overall feed costs.

Table 1. Composition of the weaning diet

Ingredient composition	% dry matter (DM)
Sorghum silage	13.1
Sorghum grain	57.4
Dried distillers grains	20.1
Soybean meal	5.1
Supplement[1]	4.3
Nutrient composition	DM basis
Crude protein, % DM	18.7
NEm[2], Mcal/lb DM	0.52
NEg[2], Mcal/lb DM	0.85

[1] Supplement contained ammonium sulfate, limestone, urea, salt, Rumensin 90 (300 mg/head/day; Elanco Animal Health, Greenfield, IN), Tylan 40 (90 mg/head/day; Elanco Animal Health), and a trace-mineral premix.
[2] Calculated using NRC (2000) equations.

Table 2. Nutrient composition of range forage

Sampling date	Crude protein, % dry matter (DM)	Neutral detergent fiber, % DM	Acid detergent fiber, % DM
August 7, 2013	6.7	60.6	41.0
September 4, 2013	6.1	61.1	40.3
October 2, 2013	4.8	66.3	46.3

Table 3. Composition of the receiving diet

Ingredient composition	% dry matter (DM)
Sorghum silage	13.1
Sorghum grain	57.5
Dried distillers grains	25.9
Supplement[1]	3.5
Nutrient composition	DM basis
Crude protein, % DM	17.6
NEm[2], Mcal/lb DM	0.87
NEg[2], Mcal/lb DM	0.54

[1] Supplement contained ammonium sulfate, limestone, urea, salt, Rumensin 90 (300 mg/head/day; Elanco Animal Health, Greenfield, IN), Tylan 40 (90 mg/head/day; Elanco Animal Health), and a trace-mineral premix.
[2] Calculated using NRC (2000) equations.

Table 4. Post-weaning growth and health performance of early-weaned steers managed in pasture or drylot weaning environments

Item	DRYLOT[1]	PASTURE[2]	SEM	*P*-value
Weaning body weight (BW), lb	360.7	359.0	5.07	0.82
Final BW, lb	490.8	364.9	5.75	<0.01
Average daily gain, lb	2.04	0.09	0.042	<0.01
Dry matter intake, % BW/day	2.22	–	–	–
Gain:feed	0.247	–	–	–
Undifferentiated fever, %	6.7	0.0	2.71	0.10
Conjunctivitis, %	0.0	40.2	3.17	<0.01

[1] Steer calves were weaned in a drylot environment and fed a concentrate-based diet for 56 days (8 pens; 14 or 15 steers/pen).
[2] Steer calves were weaned in a pasture environment and not supplemented for 56 days (8 pastures; 14 or 15 steers/pasture).

Table 5. Feedlot-receiving growth and health performance of early-weaned steers managed in pasture or drylot weaning environments

Item	DRYLOT[1]	PASTURE[2]	SEM	*P*-value
Initial body weight (BW), lb	490.8	364.9	5.75	<0.01
Day 28 BW, lb	568.5	424.7	6.55	<0.01
Day 56 BW, lb	661.2	517.2	7.27	<0.01
Average daily gain, lb				
Day 1 to day 28	2.73	2.13	0.154	0.02
Day 28 to day 56	3.32	3.31	0.102	0.95
Dry matter intake, % BW/day	2.55	2.63	0.019	<0.01
Gain:feed	0.177	0.194	0.0082	0.18
Undifferentiated fever, %	2.5	2.5	1.53	0.99
Conjunctivitis, %	1.6	14.3	2.56	<0.01

[1] Steer calves were weaned in a drylot environment and fed a concentrate-based diet for 56 days (8 pens; 14 or 15 steers/pen).
[2] Steer calves were weaned in a pasture environment and not supplemented for 56 days (8 pastures; 14 or 15 steers/pasture).

Relationships Between Docility and Reproduction in Angus Heifers

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Introduction

Reproductive success is relevant in beef cattle operations because income generated by the sale of calves is often a large portion of an operation's income. Selecting for fertility is difficult because it is influenced by a variety of factors. Temperament could be a factor affecting fertility. Physiological responses associated with temperament can influence the probability of cows becoming pregnant, as stress hormones in the bloodstream can negatively affect the release of reproductive hormones.

Methods have been developed to assess temperament in cattle. Exit velocity measures the time it takes for an animal to cover a predetermined distance after vacating a chute. Chute scores range from 1 (quiet) to 6 (aggressive) and are based on the animal's behavior when confined in a chute. Positive correlations of chute score and exit velocity with cortisol indicate that both scores are reliable indicators of temperament. Handling of cattle is associated with changes in concentrations of stress hormones. Blood serum collection can provide insight into short-term stressors, and fecal sampling can be reflective of stress experienced 2–3 days before sampling.

This study was conducted to investigate the relationship between animal temperament and heifer fertility as indicated by first-service artificial insemination conception rate.

Experimental Procedures

Data for this project were collected from three different cooperator herds. A total of 337 first-calf heifers were used in this study. Ranch 1 (n = 117) heifers were synchronized using a combined melengestrol acetate (MGA)/prostaglandin (PGF)/gonadotropin-releasing hormone (GnRH) synchronization protocol. Melengestrol acetate was fed at 0.5 mg per head per day for 14 days. On day 33, 5 ml of PGF was injected, exit velocity and chute score were recorded, and fecal samples were collected. Heifers were visually detected for standing estrous for 2 days and bred 10–14 hours after observed standing estrous. On the third day after PGF injection (day 36), all females not previously detected in heat were injected with 2 ml of GnRH and inseminated. Blood samples were collected for cortisol analysis at this time. Cleanup bulls were put in with the females on day 37. Heifers were ultrasounded at 30 days to check pregnancy status.

Ranches 2 (n = 133) and 3 (n = 87) employed CoSynch-controlled internal drug release (CIDR) protocols to synchronize their heifers. On day 0, CIDRs were inserted in addition to a 2-ml injection of GnRH. Exit velocity and chute score were recorded at this time, and fecal samples were collected for cortisol analysis. On day 7, CIDRs were then removed and a 2-ml injection of PGF was given. On day 9, the heifers were given a second 2 ml injection of

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GnRHand inseminated, and blood samples were collected for cortisol analysis. Heifers were ultrasounded at 30 days to check pregnancy status.

Fecal samples were taken while the animal was in the chute. Samples were stored in individual containers on ice until they could be delivered to the lab and frozen at -4°F. Blood samples were collected via venipuncture into 15 ml Vacutainer tubes with 18 G × 1.5-inch needles at breeding. Samples were immediately put on ice until they could be transported to the lab, where they were refrigerated for at least 8 hours before centrifugation.

Laboratory Analysis

Refrigerated blood samples were centrifuged at 2,400 × g for 20 minutes at 39°F. Plasma was stored at -4°F until assayed. Plasma concentrations of cortisol were determined using a radioimmunoassay kit specific to bovine serum (Coat-A-Count Cortisol, Siemens Medical Solutions Diagnostics, Malvern, PA). The average intra- and inter-assay coefficients of variation were 12% and 3.5%, respectively.

Quantification of fecal corticosterone levels was modeled after protocols outlined by other researchers. Concentrations of fecal corticosterone were determined using a commercial radioimmunoassay kit (MP Biomedicals, Solon, OH) validated for use on bovine samples in July 2012. For extraction, 0.017 oz of thawed fecal matter was placed into a 0.5-oz centrifuge tube. To this, 0.15 oz of 80% methanol was added, and the tubes were placed in a lab rack vortexer for 40 minutes. Following vortexing, tubes were centrifuged at 3,000 × g for 15 minutes. The amount of corticosterone in the supernatant was determined by the I25-corticosterone radioimmunoassay. The average intra- and inter-assay coefficients of variation were 3.5% and 5.5%, respectively.

Statistical Analysis

Logistic regression was used to determine the factors that influenced pregnancy rate. Contemporary group was fit as a fixed effect, whereas fecal cortisol, blood cortisol, exit velocity, chute score, weight, and age were included as covariates. Contemporary group was based on ranch. Correlation coefficients were also calculated between fetal cortisol, blood cortisol, exit velocity, chute score, weight, and age.

Results and Discussion

Summary statistics for the study are presented in Table 1. The power of our test could not detect any significant predictors of 30-day pregnancy for ranches 2, 3, and the combined data; however, chute score ($P < 0.0348$) and weight ($P < 0.0082$) were found to have odds ratio estimates different from 1 as significant predictors of 30-day pregnancy. The odds ratio estimate for chute score (Table 2) has a significant interpretation, meaning that a 1-unit increase in average chute score will reduce the probability of pregnancy at ranch 1 by 48.1%. Therefore, poor temperament indicated by increasing chute score was associated with a decreased probability of becoming pregnant. This is consistent with the findings of Cooke et al. (2009), who reported that physiological responses associated with temperament can influence the probability of cows becoming pregnant during the breeding season. The odds ratio estimate for weight is more difficult to interpret, because a 1-lb increase in weight will decrease the probability of pregnancy by 1%. In contrast to expectations, an increase in heifer weight at breeding was associated with a decrease in the probability of becoming pregnant.

A positive correlation between fecal cortisol and age ($P < 0.0003$) was found for ranch 1, meaning that as age increased, so did fecal corticosterone concentration. Fecal cortisol positively correlated with blood cortisol at ranch 3 ($P < 0.0109$), meaning that as fecal cortisol concentrations increased, so did blood cortisol concentrations.

Blood cortisol positively correlated with exit velocity for the combined data ($P < 0.0001$) and for ranch 2 ($P < 0.0062$). This means that as blood cortisol increased, EV also increased, which is consistent with findings of other researchers. Blood cortisol negatively correlated with age for the combined data ($P < 0.0369$) and for ranch 2 ($P < 0.0327$); in other words, as blood cortisol increased, age seemed to decrease, meaning younger animals tended to have higher blood cortisol concentrations.

Exit velocity positively correlated with chute score for the combined data ($P < 0.0001$), ranch 1 ($P < 0.0302$), and ranch 2 ($P < 0.0001$). This correlation is logical, meaning that as exit velocity increased for an animal, average chute score increased as well. This is consistent with another study which found that exit velocity and chute score were positively correlated. Exit velocity was negatively correlated with both weight and age for both the combined data ($P < 0.0084$ and $P < 0.0321$, respectively) and for ranch 2 ($P < 0.0001$ and $P<0.0061$, respectively). This relationship suggests that as exit velocity increased, both weight and age decreased.

Average chute score was found to negatively correlate with age for the combined data ($P < 0.0127$). According to this result, older animals would have lower average chute score than younger animals. Weight positively correlated with age for the combined data ($P < 0.0001$), ranch 1 ($P < 0.0001$), ranch 2 ($P < 0.0001$), and ranch 3 ($P < 0.0002$). This result is obvious, meaning that weight increased steadily with age.

Implications

Although the results from our combined data were not conclusive for predictors of 30-day pregnancy, results from ranch 1 and the amount of variation in measures of temperament and reproductive status at all locations showed that these traits can be improved.

Table 1. Summary statistics for combined data of all ranches

Variable	N	Mean	SD[1]	Minimum	Maximum
Fecal cortisol, ng/0.5g	333	119.53	34.54	15.80	315.00
Blood cortisol, ng/ml	336	40.96	21.85	4.45	113.50
Exit velocity, ft/second	329	1.89	0.77	0.23	7.32
Chute score[2]	337	1.87	0.74	1.00	4.00
Weight, lb	336	763.64	77.84	510.00	964.00
Age, day	336	413.25	17.19	359.00	464.00

[1]SD = standard deviation.
[2]1 = quiet, 6 = aggressive.

Table 2. Odds ratio estimates (ORE), confidence limits, and *P*-value for the logistic regression of 30 day pregnancy on fecal cortisol, blood cortisol, exit velocity, average chute score, weight, and age for all data

Variable	ORE	Confidence limits		*P*-value
Fecal cortisol, ng/0.5g	1.006	0.998	1.015	0.1451
Blood cortisol, ng/ml	1.007	0.995	1.018	0.2379
Exit velocity, ft/second	0.949	0.677	1.332	0.7639
Chute score[1]	0.706	0.494	1.009	0.0560
Weight, lb	0.993	0.986	1.001	0.0724
Age, day	1.001	0.984	1.017	0.9316

[1]1 = quiet, 6 = aggressive.

Comparing Season-Long Stocking and a Modified Intensive Early Stocking Strategy for Western Kansas

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Introduction

Beef production on western Kansas rangelands is primarily dominated by cow-calf operations. To ensure management flexibility during years of low precipitation, producers may also include in their livestock program young stocker animals that can be marketed at any time to enable them to destock and restock rangelands without liquidating their main breeding herd. Intensive early stocking (IES), a practice that stocks young animals at greater densities for the first half of the growing season then removes the animals for the last half of the growing season, effectively utilizes early season vegetation at its highest level of nutrition. On shortgrass rangeland in western Kansas, stocker animals are typically stocked from May through October under continuous season-long stocking (SLS) strategies, whereas animals are stocked from May to mid-July in IES strategies. Individual animal gains during the early growing season are similar in animals stocked at twice the normal moderate season-long stocking density (2X IES) and animals stocked at a normal moderate SLS density (Table 1). Triple-stocked IES (3X IES) also has been evaluated in western Kansas, but early season individual animal gains and end-of-season grass dry matter production are significantly lower. Therefore, 3X IES has negative impacts on animal gain and decreases rangeland vegetative productivity. Total beef production on a land area basis is similar between 2X IES and SLS in western Kansas, but 2X IES has significantly greater beef production in eastern Kansas. Vegetative composition and production are also similar under SLS and 2X IES in western Kansas. Western Kansas rangelands tend to have less variability between early season and late season animal gains than eastern rangelands, thus the advantages of increased stocking density early in the season are not as pronounced as in eastern Kansas systems.

Rangelands also can be stocked with a modified IES system, but not all modified IES systems are beneficial. In western Kansas, implementing a modified IES system stocked at a 2X IES rate during the early season then removing half the animals at mid-season (2X + 1 IES) led to early season animal gains 15% lower than for SLS in two out of four years, and full-season individual animal gains were 25% lower for the 2X + 1 IES system in three of four years. Lowering the initial stocking rate in a modified system may increase early and late-season animal gains.

Experimental Procedures

A modified IES system was implemented that reduced the density of animals early in the season to less than the 2X IES density then removed the heaviest animals at mid-season to leave a lighter set of animals on pasture at a normal 1X density for the last half of the season (1.6X + 1 IES). The goal of this system was to retain maximum early season gains experienced by SLS systems, but with greater animal density, and to increase late-season gains per animal and gains per acre by allowing more forage regrowth to be available for the late-season animals stocked. Removal of the heaviest animals at mid-season was used rather than random selection of animals to produce a heavier, more uniform set ready for direct placement into the feedlot when coming off grass. Animals were weighed at the onset of grazing, at the time of July animal removal, and at the time of October animal removal. Pastures were sampled for available dry

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matter in July and October, and plant species composition was sampled by step-point analysis in October. Animals were transported directly to a feedlot for the finishing phase of the study, and were harvested at a target average of 0.40 inches of backfat. This modified 1.6X + 1 IES system was compared to continuous SLS for animal performance and resulting changes in vegetative characteristics from 2002 to 2008 at the Kansas State University Agricultural Research Center in Hays.

Results and Discussion

Average daily gains and total animal gain were slightly greater for SLS than the 1.6X + 1 system during the first half of the season, but no difference was present for gains during the last half of the season (Table 2). Unlike the previous modified 2X + 1 IES study, animal gains were not reduced during the late grazing season, and total season-long gain from animals that remained on pasture from May through October in both the SLS and the modified 1.6X + 1 systems were equal. Because animal gains were only slightly lower despite the greater stocking rate for the modified 1.6X + 1 IES system, beef production per acre was greater for the modified IES system than the SLS system (Table 2). The increased beef production also created an increase in net income above SLS of $9.84/acre above purchase and interest costs. Biomass in pastures (Figure 1) at the end of the season, and vegetation composition of blue grama, sideoats grama (Figure 2), and western wheatgrass (Figure 3) was generally similar throughout the study between the two systems. The only minor change in vegetation was that buffalograss composition (Figure 4) in the modified 1.6X + 1 IES system increased by 0.5 percentage points per year more quickly than the SLS system. The total season stocking rate with the modified 1.6X + 1 system was about 23% greater than the SLS stocking rate and was likely at the maximum level before animal gains or vegetative productivity would decline because 3X IES and 2X + 1 IES, with stocking rates 50% greater than SLS rates, previously resulted in rapid declines in animal gain and vegetative productivity.

Animals from the SLS system weighed more entering the finishing phase (Table 3). The heavy animals removed at mid-July from the 1.6X + 1 system did not have the opportunity to gain weight during the last half of the grazing season, and removal of the heaviest animals from pasture at mid-July in the 1.6X + 1 system resulted in the lightest calves being left on pasture during the last half of the grazing season. Total individual gain during the finishing phase was similar among all groups. Continuous SLS animals retained greater body weight at pasture removal through the finishing phase, which resulted in greater carcass weights. Ribeye area was greater for continuous SLS animals compared with the July- and October-removed animals from the 1.6X + 1 system. Marbling score and dressing percentage were greater for the continuous SLS animals than the animals removed in early July. The net value of animals (net value = end live value – live value entering feedlot – feed and mineral costs) at the end of the finishing phase was $46.00, $38.92, and $89.70/head for the SLS, October-removed, and July-removed IES 1.6X +1 animals, respectively. Although animals were smaller, the net value of IES 1.6X + 1 animals was as good as SLS animals following the finishing phase.

Implications

If cow-calf producers want flexibility in their beef cattle operation, the addition of stocker grazing can provide that flexibility. The research summarized here used steers as the stocker animals, but stocker heifers or young replacement heifers may also fit as the animal of choice for producers to initiate a stocker grazing program. Furthermore, the option to implement different stocking strategies, SLS, 2X IES, or 1.6X + 1 IES, provides even greater flexibility by offering different times and proportions of animals ready to market. Regardless of the operation, a stocker strategy likely exists that could fit into most beef cow-calf production systems.

Table 1. Animal gain and beef production from season-long stocking (SLS) and intensive early stocking at 2X (IES 2X) or 3X density (IES 3X) utilized on native pastures during the 1980s at Hays, KS[1, 2]

Stocking system	Early season (~May 1–July 15)		Late season (~July 15–Oct 1)		Beef
1980–83, 87–88	ADG	Total gain	ADG	Total gain	production
	---------- lb ----------				(lb/acre)
SLS	1.48[a]	116[a]	1.17	88	60[b]
IES 2X	1.39[a]	109[a]	–	–	64[b]
IES 3X	1.21[b]	89[b]	–	–	73[a]

[1] Adapted from Olson et al., 1993, Journal of Range Management 46:127–132.
[2] Similar letters following values within columns indicate values are statistically similar ($P < 0.10$).

Table 2. Animal gain and beef production from season-long stocking (SLS) and modified intensive early stocking (IES 1.6X + 1) strategies utilized on native pastures during the 2000s at Hays, KS[1]

Stocking system	Early season (~May 1–July 15)		Late season (~July 15–Oct 1)		Beef
2002–2008	ADG	Total gain	ADG	Total gain	production
	---------- lb ----------				(lb/acre)
SLS	1.71[a]	128[a]	1.35[a]	106[a]	69[b]
IES 1.6X + 1	1.54[b]	115[b]	1.37[a]	107[a]	85[a]

[1] Similar letters following values within columns rows indicate values are statistically similar ($P < 0.10$).

Table 3. Individual animal performance during the feedlot finishing phase following July or October removal of a modified intensive early stocking (IES 1.6X + 1) system and a continuous season-long stocking (SLS) system on shortgrass rangelands near Hays, KS, from 2002 through 2008[1]

Production trait	IES 1.6X + 1 July	IES 1.6X + 1 October	SLS
Feedlot start weight, lb	783[c]	801[b]	846[a]
Feedlot final weight, lb	1335[b]	1331[b]	1394[a]
Feedlot gain, lb	552[a]	531[a]	546[a]
Days on feed	144[a]	150[a]	150[a]
Carcass weight, lb	820[b]	827[b]	868[a]
Dressing %	63.2[b]	64.4[ab]	64.5[a]
Marbling score	5.23[b]	5.42[ab]	5.54[a]
Ribeye area, sq. in.	12.9[b]	13.0[b]	13.4[a]

[1] Similar letters following values within rows indicate values are statistically similar ($P < 0.10$).

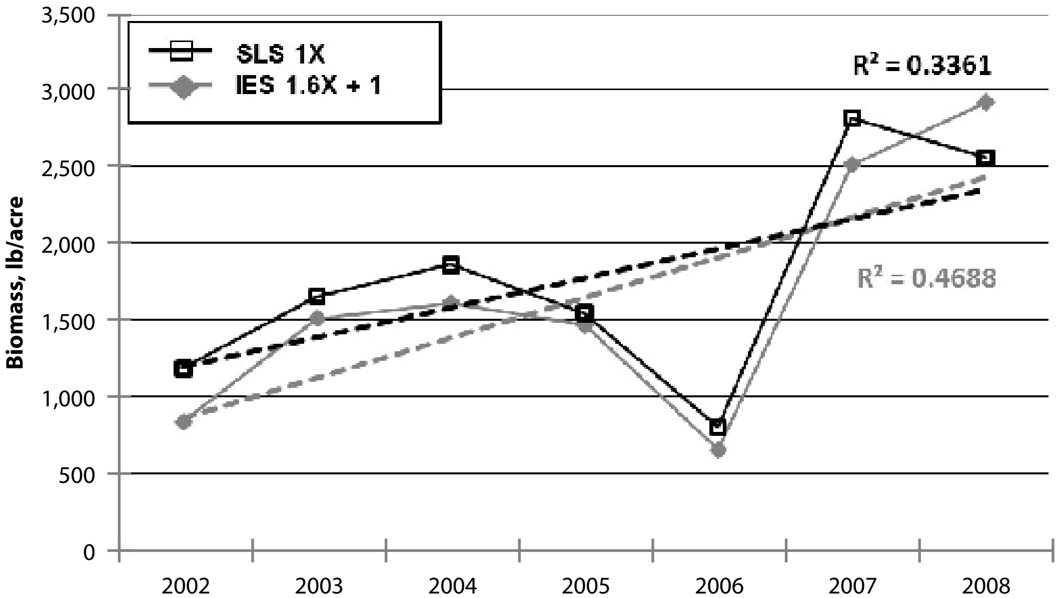

Figure 1. Residual biomass at the end of the grazing season in each of two grazing systems, continuous season-long stocking (SLS) and modified intensive early stocking (IES) 1.6X + 1.

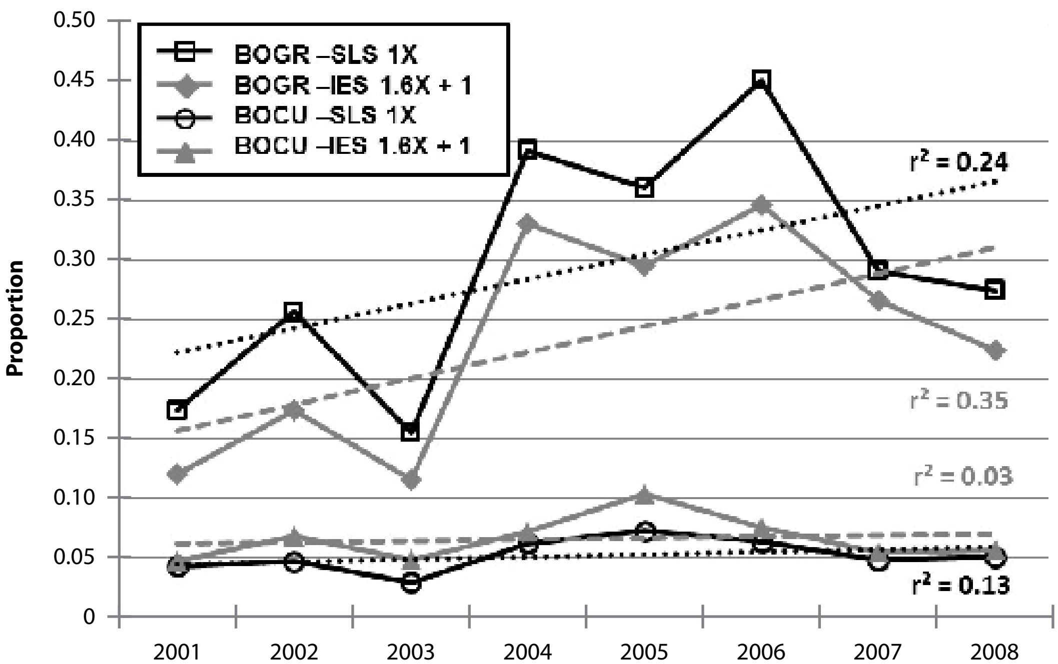

Figure 2. Proportion of blue grama (BOGR) and sideoats grama (BOCU) at the end of the grazing season in each of two grazing systems, continuous SLS and a modified IES 1.6X + 1.

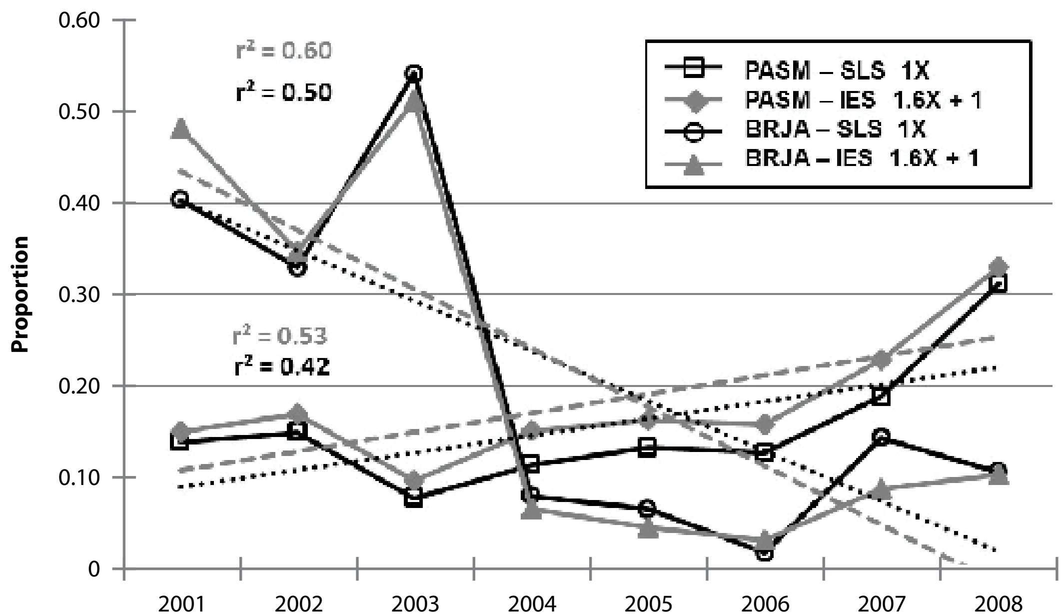

Figure 3. Proportion of western wheatgrass (PASM) and Japanese brome (BRJA) at the end of the grazing season in each of two grazing systems, continuous SLS and a modified IES 1.6X + 1.

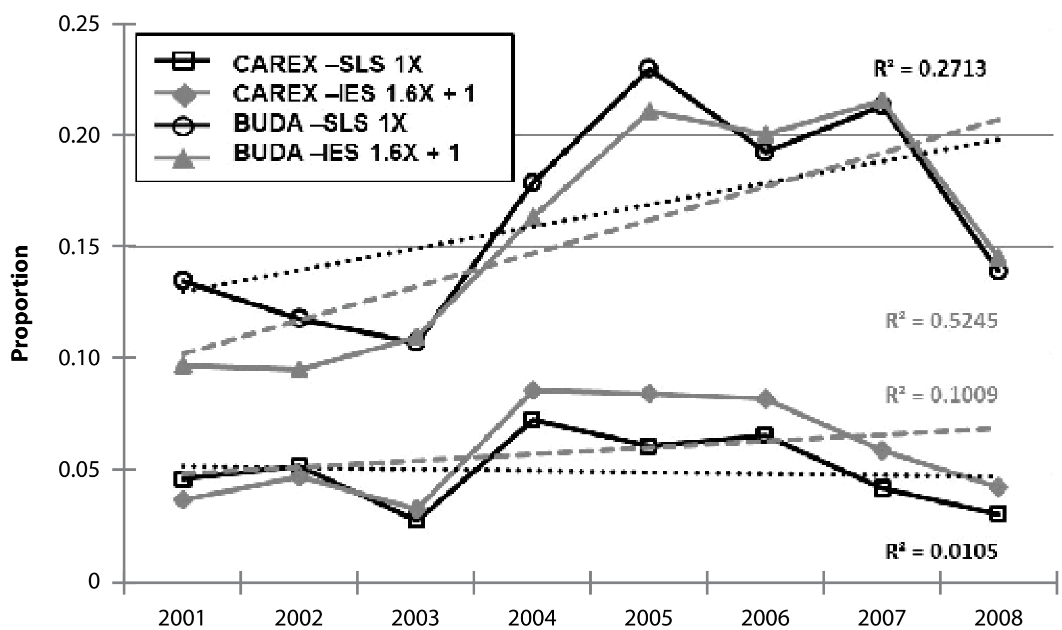

Figure 4. Proportion of sedges (CAREX) and buffalograss (BUDA) at the end of the grazing season in each of two grazing systems, continuous SLS and a modified IES 1.6X + 1. Rate of increase of buffalograss was statistically greater in the IES 1.6X + 1 system.

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