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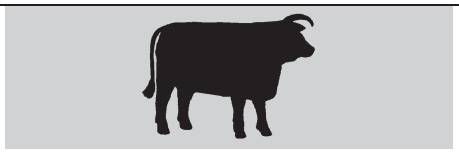

Management characteristics of cow-calf, stocker, and finishing operations in Kansas, Oklahoma, and Texas[1]

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ABSTRACT

An assessment of the sustainability of beef production in the Kansas, Oklahoma, and Texas region requires information on their production practices. A voluntary survey was conducted for ranches and feedyards in the region along with site visits to gather information on production practices. Responses to the survey along with site visits represented 0.8% of the cows maintained and 9% of the cattle finished in the region, with a wide range in size and types of operations. Most characteristics of cow-calf and stocker ranches did not vary much across states, but there were differences in cow stocking rates and forage production from the wetter east side of the region to the drier, semiarid conditions of the west side. Average stocking rate decreased from 2.4 ha/cow (1.3 ha/stocker) in the east to 15.7 ha/cow (4.6 ha/stocker) in the west, and more forage was harvested in the east along with greater use of fertilizers. The largest feedyards were located on the west side of the region; no other consistent differences in feedyard management were found across the region or among states. Two feedyards in central Kansas produced a major portion of their feed, whereas most of the others appeared to manage just enough cropland to dispose of feedyard runoff and minor amounts of manure. The information gathered is being used to develop representative operations for a comprehensive life-cycle assessment of the economic and environmental sustainability of beef cattle production in the region.

Key words: beef cattle, management, ranch, feedyard

INTRODUCTION

Both producers and consumers of animal products have concern for the sustainability of production systems. The beef industry has defined sustainability as meeting the growing demand for beef by balancing environmental responsibility, economic opportunity, and social diligence. Measuring sustainability is challenging because the beef supply chain is one of the most complex food systems in the world. In a proactive effort to identify opportunities to improve sustainability, the US Beef Sustainability Research Program was launched in 2011. The objective of this program is to conduct comprehensive life-cycle assessments based on regional production practices throughout the nation.

A methodology has been developed to characterize and evaluate the environmental and economic sustainability of beef cattle production systems (Rotz et al., 2013). Production information is then used along with information gathered from the processing, marketing, and consumer portions of the industry to define economic, social, and environmental factors of sustainability using the BASF socio-eco-efficiency tool (SEEBALANCE;

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Kölsh et al., 2008). To verify this methodology, an assessment was done for the beef produced by the US Meat Animal Research Center, Clay Center, Nebraska (Rotz et al., 2013). Through this analysis, the sustainability of beef was found to have improved by 5% between 2005 and 2012 (Stackhouse-Lawson et al., 2013).

The first region for in-depth study consists of Kansas, Oklahoma, and Texas. Our objective was to conduct surveys to obtain information on common management practices of cow-calf, stocker, and finishing operations for use in representing and modeling representative production systems for the region. The ultimate goal is to identify and quantify environmental, social, and economic inputs and outputs of representative production systems for all cattle-producing regions of the United States. Because the Kansas, Oklahoma, and Texas region maintains 25% of the beef cows and finishes 37% of the beef cattle produced in the United States (NASS, 2014), this region plays an important role in the nation's production of beef.

MATERIALS AND METHODS

Two surveys were developed and implemented through the Internet to gather information on management practices of beef cattle producers in Kansas, Oklahoma, and Texas. The first survey was developed for cow-calf, stocker, and cow-calf–to–finish ranches. A second survey was developed for feedyard finishing operations. Participation was voluntary and encouraged by state beef-council staff. The ranch survey was designed to be completed in approximately 15 min to encourage greater participation and completion. The feedyard survey required a little more time and information. The intent was to avoid asking for information that required time for gathering data. Questions were developed for more general responses relying on the general knowledge of the producer. Survey questions are available in the Supplemental Materials (http://dx.doi.org/10.15232/pas.2014-01350).

A total of 352 and 14 responses were obtained from ranch and feedyard operations, respectively. The ranch responses represented a wide range in size and type of operations producing calves, stockers, and in some cases finished cattle. The 2012 agricultural census reported an inventory of 7.3 million beef cows in 3 states (NASS, 2014). Survey responses represented 59,054 brood cows or about 0.8% of the cows maintained in the region. The feedyard responses also represented a wide range in size and other characteristics. The number of cattle finished on these feedyards in 2012 was 1.03 million, which was about 9% of the finished cattle sold for slaughter from this region in the 2012 census (NASS, 2014).

Ranch and feedyard visits were also conducted to gather more specific information on a few operations in all 3 states. These visits included 9 ranches and 3 feedyards. Information collected included that in the survey, and these data were included in the survey analysis. Additional information was gathered on feeding practices; truck and equipment use; and fuel, electricity, and chemical use.

Responses from cow-calf operations were summarized into 3 areas as the east, central, and west portions of each state. The Texas panhandle and High Plains area was included in the west area. These divisions were made to characterize the effects of precipitation patterns across the 3-state region. The east area obtained relatively high annual precipitation, but rainfall decreased across each state with a drier, semiarid climate in the west. This difference in precipitation creates differences in stocking rates and other important management characteristics. Responses from cow-calf operations were also summarized by state to determine any differences from the northern to the southern part of the region.

Where possible, data were statistically compared to determine differences across the region. These data included animal numbers per operation, cow BW, stocking rates, and labor requirements. The means of each were visually inspected for a trend across the 3 areas and states. Where trends were observed, significant differences ($\alpha = 0.05$) in those management characteristics among states and areas within states as well as interactions between states and areas were assessed using the general linear model procedure of SAS/STAT software, Version 9.2 (SAS Institute Inc., Cary, NC). Where significant differences were found, mean comparisons were done post hoc with Tukey's honestly significant difference (SAS, 2008).

RESULTS AND DISCUSSION

Ranch Survey

Of the 356 responses received for the ranch survey, 25 were from Kansas, 40 from Oklahoma, and 291 from Texas. For Kansas and Oklahoma, the number of responses was similar from each area of the state, but in Texas about 60% of the responses came from the center of the state. Over the 3-state region, 23% of the responses were from the east, 59% from the center, and 18% from the west (Table 1).

Of all the ranches surveyed, about 94% included cows, with the remainder being stocker only, or combined stocker and finish operations. This proportion did not vary much from the east to west areas of the state (Table 2). Among the operations with cows, the predominant type in the east was cow-calf and stocker operations (70.7%) followed by cow-calf only (19.5%) and cow-calf to finish (9.8%). In the central and west areas, there were more cow-calf and cow-calf–to–finish operations (Table 2). The types of operations were more uniformly distributed across the whole region with 34% being cow-calf only, 42% cow-calf with stockers, and 24% cow-calf to finish. Most of the ranches in the east that included finishing were in Kansas and Oklahoma, with one operation in Texas maintaining 12,000 stockers and finishing 2,000 cattle per year. In the central region, the majority of the operations that in-

Table 1. Survey results of animal numbers and characteristics for ranches (cow-calf only, cow-calf and stocker, and cow-calf to finish) in the east, central, and west areas of the Kansas, Oklahoma, and Texas region[1]

Management characteristic	Unit	East (n = 82)				Central (n = 211)				West (n = 63)				Full region (n = 356)			
		Min.	Median	Mean	Max.	Min.	Median	Mean	Max.	Min.	Median	Mean	Max.	Min.	Median	Mean	Max.
Brood-cows maintained	Cows	4	65	232	4,500	2	40	124	5,000	5	75	288	3,800	2.0	50	176	5,000
Cows/bull	Ratio	3.0	20.0	20.3	53.0	1.5	16.9	17.7	50.0	0.70	17.9	16.9	40.0	0.70	18.0	18.2	53.0
Replacement heifers/cow	Ratio	0.0	0.20	0.25	4.0	0.0	0.16	0.22	2.7	0.0	0.13	0.16	0.96	0.0	0.16	0.21	4.0
Stockers	Cattle	3	125	944	12,000	2	40	648	25,000	1	175	786	4,400	1	80	758	25,000
Average cow BW	kg	386	539	537	953	272	544	535	748	267	512	505	668	272	544	532	953
Average stocking rate/cow	ha/cow	0.10	1.94	2.43[a]	8.09	0.51	4.05	6.26[b]	53.02	2.02	12.14	15.65[c]	52.61	0.10	4.04	7.17	53.0
Average stocking rate/stocker	ha/stocker	0.20	1.21	1.29	4.86	0.40	2.02	3.71	24.28	0.81	4.05	4.59	16.19	0.20	1.62	3.20	24.28
Labor to feed and maintain cattle	person-h/animal per yr	0.6	13.9	28.7	521.0	0.9	15.7	30.5	365	0.03	16.9	26.3	193.0	0.1	15.6	29.8	521.0

[a–c]Values within a row with different superscripts are significantly different ($\alpha \leq 0.05$).

[1]n = number of responses in each area of region; Min. = minimum; Max. = maximum.

cluded finishing (14 out of 17 ranches) were located in north-central Texas.

The majority of ranches in the east (65%) had 100 cows or fewer, and these smaller ranches maintained 12% of the cows in that regional area (Table 2). The proportion of smaller operations was highest in the center of the states at 77%. Ranches were a little larger in the west, with only 59% maintaining 100 cows or less. For the full region, 71% of the ranches had 100 or fewer cows, with these smaller ranches maintaining 15% of the cows in the region.

About 37% of the ranches surveyed included stocker cattle, with a smaller portion of stocker operations in the center compared with the east and west (Table 2). A major portion (53%) of these ranches reported maintaining 100 animals or fewer, but their animals made up only 2.1% of the total stockers reported in the region. This size distribution was relatively uniform across the east, central, and west areas of the states (Table 2).

Ranch Size and Types. A wide range in ranch sizes was found in all 3 states and all areas of the states. The number of brood cows maintained on a given ranch varied from 2 to 5,000, and the number of stockers varied from 1 to 25,000 (Table 1). The maximum number of brood cows recorded was from central Texas, but large ranches were also found in east Oklahoma (4,500 cows), west Texas (3,800 cows), and east Texas (3,300 cows). The median and mean of reported brood-cow numbers for the whole region were 50 and 176 cows per operation, respectively. As reflected by this large difference between the mean and median values, there were only a few very large operations. The distribution in the size of operations was similar from east to west, with a trend toward smaller cow-calf operations moving south from Kansas to Texas (Table 3).

Ranches with stockers also reported more small operations and a few very large operations creating a much lower median size (80 cattle) compared with the mean of 758 cattle (Table 1). The largest operation of 25,000

Table 2. Ranch survey results for the east, central, and west areas of the Kansas, Oklahoma, and Texas region

		Regional area			
Ranch characteristic	**Unit**	**East**	**Central**	**West**	**Full region**
Ranches with cows	% of ranches	90.2	95.3	93.7	93.8
Equal to or less than 100 cows	% of ranches	64.9	77.1	59.3	71.3
Equal to or less than 100 cows	% of cows	12.2	22.6	7.9	15.3
Cow-calf only	% of cows	19.5	47.4	28.9	33.9
Cow-calf and stocker	% of cows	70.7	25.0	37.4	41.8
Cow-calf to finish	% of cows	9.8	27.6	33.7	24.2
Calves sold per cow	Number	0.69	0.75	0.80	0.74
Ranches with stockers	% of ranches	46.3	30.3	46.0	36.8
100 or less stockers	% of ranches	47.4	64.1	35.7	53.08
100 or less stockers	% of stockers	1.7	2.7	1.5	2.1
Cow-calf and stocker	% of stockers	47.6	85.5	81.5	70.9
Stocker only	% of stockers	52.4	14.5	18.5	30.0
Grass-finished cattle	% of finished cattle	2.7	2.4	15.2	6.9
Growth implants used	% of ranches	39.7	26.0	30.4	30.2
Portion of stockers	% of stockers	89.0	69.2	68.6	76.7
Harvested grazinglands	% of ranches	60	44.4	11.1	42.1
Portion harvested each year	% of land	5.9	3.9	0.3	2.48
Clipped but not harvested	% of land	15.3	8.95	1.0	6.1
Pasture reestablishment	% of ranches	37.7	28.6	19.7	28.2
Little or no reestablishment	% of land	75.1	90.6	97.1	91.2
Average reestablishment period	Years	8.2	8.9	10.5	8.9
Nitrogen fertilizer use	% of ranches	57.7	50.8	15.8	46.2
Fertilizer used	% of land	7.8	7.7	0.9	4.4
Amount used by those that fertilize	kg of N/ha	87.8	102.3	102.3	98.3
Phosphate fertilizer	% of ranches	50.0	41.8	8.8	38.1
Fertilizer used	% of land	7.7	6.2	0.2	3.5
Amount used by those that fertilize	kg of P_2O_5/ha	31.4	26.8	25.3	28.3
Potash fertilizer	% of ranches	47.2	33.9	7.0	32.4
Fertilizer used	% of land	7.6	7.3	0.2	3.5
Amount used by those that fertilize	kg of K_2O/ha	49.1	47.8	33.7	47.9
Lime use	% of ranches	58.9	20.2	1.72	25.5
	% of land	6.9	6.9	0.03	3.5
Other feed crops grown	% of ranches	17.6	18.0	14.0	17.4
	ha/animal	0.26	0.57	0.26	0.46

stockers was in central Texas, but large ranches in other areas reported 2,000 to 12,000 stockers. The mean stocker numbers per ranch for Kansas, Oklahoma, and Texas were 1,607, 333, and 703, respectively (Table 3). The mean numbers for the east, central, and west areas of the region were 944, 648, and 786, respectively (Table 1).

The ratio of brood-cow numbers to bulls varied widely among ranches from a low of 0.7 to a high of 53.0 cows/bull (Table 1). The mean for the region was 18.2 cows/bull, and the median was 18.0 cows/bull, with a trend toward ranches in Oklahoma and Texas maintaining fewer cows per bull than those in Kansas (Table 3). Some bulls were raised for purposes other than the breeding of brood cows, and artificial insemination was apparently practiced on some ranches given their very high cow/bull ratios. A more representative measure of the bull requirements for the region was obtained using those ranches identified as cow-calf only. For these operations alone, the mean ratio of cows/bull was 18.2. This ratio was similar throughout the region at 18.8, 19.0, and 16.2 in the east, central, and west, respectively.

The ratio of replacement heifers to brood cow numbers ranged from 0.0 to 4.0 (Table 1). The upper limit was recorded for one ranch in Texas that reported 16 heifers with 4 brood cows. The mean heifer/cow ratios showed a declining trend from the east (0.25) to the central (0.22) and west (0.16) areas (Table 1), with similar ratios across the 3 states (Table 3). For cow-calf operations alone, the ratio in the east, central, and west areas was 0.18, 0.16, and 0.17 heifers/cow, which reflects a cow replacement rate of 16 to 18% across the region. The current number of replacement heifers maintained may be greater than normal for this region because of a recent drought in the region. With low pasture productivity during the drought, cow inventory was reduced, creating a current need to replenish the herd.

Table 3. Summary of management practices used on ranches (cow-calf only, cow-calf and stocker, and cow-calf to finish) in Kansas, Oklahoma, and Texas[1]

Management characteristic	Unit	Kansas (n = 25) Min.	Median	Mean	Max.	n	Oklahoma (n = 40) Min.	Median	Mean	Max.	n	Texas (n = 291) Min.	Median	Mean	Max.	n
Brood-cows maintained	Cows	15	250	364	1,400	23	5	75	222	4,500	38	2	45	155	5,000	273
Cows/bull	Ratio	5.0	22.1	23.4	40.0	22	1.67	18.9	17.7	35.0	38	0.70	17.0	17.8	53.0	273
Replacement heifers/cow	Ratio	0.0	0.20	0.22	0.80	23	0.0	0.15	0.20	0.96	38	0.0	0.16	0.21	4.00	273
Stockers	Cattle	20	450	1607	10,000	15	3	123	333	2,000	17	1	60	703	25,000	99
Average cow BW	kg	408	567	567^{a}	680	23	463	544	558^{a}	726	37	272	522	525^{b}	953	272
Average stocking rate per cow	ha/cow	1.6	3.0	3.8	12.1	21	0.1	2.6	3.2	8.1	32	0.3	4.0	8.0	53.0	244
Average stocking rate per stocker	ha/stocker	0.2	1.2	1.3^{a}	3.6	11	0.4	0.8	1.3^{a}	4.0	11	0.4	2.0	4.0^{b}	24.3	54
Labor to feed and maintain cattle	person-h/ animal per yr	0.6	6.4	10.5	40.0	23	2.5	15.6	25.9	171	37	0.03	16.7	32.4	521	249

[a,b]Values within a row with different superscripts are significantly different ($\alpha \leq 0.05$).

[1]n = number of responses; Min. = minimum; Max. = maximum.

Cattle Management. Reported brood-cow BW varied from 272 to 953 kg, with a mean value for the region of 532 kg and a median value of 544 kg (Table 1). Among the brood-cow operations, Texas reported the lightest cows, with a mean BW of 525 kg, whereas Kansas and Oklahoma reported 567 and 558 kg, respectively (Table 3). From survey responses, the overall mean brood-cow BW for the east, central, and west areas of the 3 states were 537 ± 75.2, 535 ± 75.1, and 505 ± 69.3 kg, respectively, but these differences were not statistically significant. Median values for the 3 areas were 539, 544, and 512 kg, respectively.

Reported stocking rates for cows (including associated bulls and replacements) varied from 0.1 to 53 ha/cow (Table 1). There were statistically significant differences ($\alpha = 0.05$) in cow stocking rates across the region, with the highest mean rate in the east (2.4 ha/cow), a moderate value in the center (6.3 ha/cow), and the lowest in the west (15.7 ha/cow). The large variation across the region was primarily due to differences in precipitation, with annual averages of 85 cm or more in the east, 60 to 85 cm in the center, and less than 60 cm in the west. The reported mean stocking rate was also lower in Texas (8 ha/cow) than in Kansas (3.8 ha/cow) and Oklahoma (3.2 ha/cow; Table 3). There was a significant interaction between state and region, with west Texas having a lower stocking rate than the other areas.

Throughout the region, reported stocking rates for stockers varied from 0.2 to 24.3 ha/animal (Table 1). Mean rates varied across the region, with 1.3, 3.7, and 4.6 ha/stocker in the east, central, and west, respectively. As with the cow-calf operations, this trend was directly related to the annual precipitation across the region. These stocking rates were about double that reported for cow-calf pairs in the east and central areas but over 4 times that reported in the west. Average stocking rates were 1.3 ha/stocker in both Kansas and Oklahoma and 4.0 ha/stocker in Texas (Table

3). The greater land-area requirement for both cows and stockers in Texas is likely due to a drier climate (less precipitation and greater evapotranspiration due to warmer temperatures) when averaged over the whole state.

Feed supplements in the form of grain, protein cubes, minerals, molasses, cottonseed cubes, and mixes with soybean hulls and corn gluten were reported to be fed in the range of 0.0 to 2.2 t of DM/animal per year. The mean feed supplementation was 0.23 t of DM/animal per year or 0.6 kg of DM/animal per day. Supplementation was similar across the region, with mean values of 0.25, 0.21, and 0.27 t of DM/animal per year reported for the east, central, and west, respectively. Growth implants were reported to be used by 30% of the ranches in the region (Table 2). Among the ranches producing stockers, 77% of the cattle were treated. This varied across the region, with 89% treated in the east and 69% treated in the central and west areas.

Crop-Production Practices. Ranches in this region primarily consist of grazingland, which includes native warm-season grasses, improved perennial pastures, and annual forage crops. Most grazingland is not tilled and reestablished. About 28% of the ranches reported that some replanting was done, but this constituted less than 10% of the total grazed land (Table 2). This proportion varied across the region, with about 38% of the ranches in the east and 20% in the west reestablishing pastures every 9 yr, on average. Reestablished pasture made up 25% of the grazingland in the east and only 3% in the west.

A portion of the grazingland in the region is harvested and preserved for feed during periods when grazed forage is not available. In the east, 60% of the ranches reported some harvest of forage, but this was reported for only 11% of the ranches in the west (Table 2). Almost all of this forage was harvested as baled dry hay that was often stored outside but sometimes under cover. In east Kansas, 100% of the ranches reported harvesting 50% or less of their grazingland. This decreased to 93% of ranches in east Oklahoma and 78% in east Texas. The increasing use of harvested feed from Kansas through Oklahoma and Texas may partially explain why more labor was reported to be required to feed and maintain cattle in this area. Of the land not harvested, 6% was reported to be clipped at some time each year for weed and brush control. This portion varied across the region, with 15% clipped in the east and only 1% in the west.

About 17% of the ranches reported that other crops were produced to feed beef cattle, and this portion was relatively consistent across the region (Table 2). These feed crops consisted of a wide variety of grains, grasses, and cover crops, with the average land use for these crops being 0.46 ha/animal. The highest reported in the west was 0.6 ha/animal of corn in both Kansas and Texas. In west Oklahoma only oats were reported as being cultivated at 0.4 ha/animal. In the east, corn and alfalfa emerged as the major crop types in Kansas, whereas no particular crop dominated over the others in both Oklahoma and Texas. In central Kansas, sorghum was often produced as hay or silage. Crops reported in the whole region included alfalfa, bermudagrass hay, cane hay, clover hay, corn, oats for grain and hay, rye, sorghum-sudan grass, sorghum, brown midrib sorghum, soybeans, and wheat.

For establishing grazingland and crops, no-tillage systems were reported as the predominant practice by 74% of the respondents in the east and 63% in the central area. In the east part of each state, respondents reported the use of no-tillage establishment on 92, 100, and 51% of the ranches in Kansas, Oklahoma, and Texas, respectively. In east Texas conventional and minimum tillage were reported as being practiced by 20% of respondents, whereas 16% reported using strip tillage. All of the ranches that responded in central Kansas practiced no-till, whereas conventional tillage was reported by 22 and 13% of ranches in central Oklahoma and Texas, respectively. The percentages using strip and minimum tillage in central Texas were similar at 12 and 13%, respectively. In west Kansas, no response was received on the type of tillage used, implying that there was no reestablishment of forage crops. In west Oklahoma, 33% of the survey respondents each reported using no-tillage, strip tillage, or minimum tillage. Eighty percent of responses in west Texas practiced no-tillage, whereas 8, 5, and 8% reported using strip, minimum, and conventional tillage, respectively.

Soil amendments (i.e., fertilizer and lime) were used on ranches throughout the region in rather low and varying amounts. In the east, 58% of the ranches reported using some nitrogen fertilizer, but this dropped to 16% in the west (Table 2). This represented about 8% of the grazingland in the east and central areas and only 1% in the west. When nitrogen was applied, the average annual amount used was relatively consistent ranging from 88 to 102 kg/ha throughout the region. Urea was the most common form of nitrogen fertilizer used. Phosphorus (in the form of phosphate) was reported to be used on 50% of the ranches in the east but only 9% in the west (Table 2). The portion of the grazing land fertilized in the east was 8%, with almost none fertilized in the west. When phosphate was used, the typical amount applied was 25 to 31 kg/ha. The use of potassium (potash) fertilizer was similar to that of phosphate, with a typical application rate near 50 kg/ha (Table 2). Lime was reported to be applied by 59% of the ranches in the east, 20% in the center, and less than 2% in the west. This represented about 7% of the land in the east and central areas and essentially no land in the west.

Labor Requirement. Reported annual labor requirements for feeding and maintaining cattle varied from 0.03 to 521 person-h/animal (Table 1). These reported requirements were highly variable among ranches, and differences are difficult to explain with the limited information available from this survey. In general, the highest labor values reported were

associated with the smaller ranches. The mean annual labor requirement for ranches with fewer than 100 cows was 38 person-h/cow and for larger ranches 11 person-h/cow. The mean annual labor for the total region was 30 person-h/animal, with a median value of 16 person-h/animal. There were no differences across the region, with mean values of 29, 31, and 26 person-h/animal in the east, central, and west areas, respectively. Among the states, average annual labor requirement increased from 10.5 person-h/animal in Kansas to 26 in Oklahoma and 32 in Texas. The reported increase in labor needed to maintain cattle in Texas and Oklahoma compared with Kansas may be due to differences in ranch size and crop-production practices as previously discussed.

Equipment. Equipment found on ranches normally included tractors, pickup trucks, and all-terrain vehicles. The number and size of tractors used was not found to be related to ranch size. Of the 9 ranches visited, most used 2 tractors varying in size from 34 to 164 kW of available power. All ranches used pickup trucks, with one pickup for about every 500 cattle maintained. All-terrain vehicles were often used with one for every 300 to 500 cattle maintained. Other equipment sometimes found on ranches included trucks for hauling cattle or feed, hay-making equipment, brush-removal equipment, and tillage and planting equipment. The amount and type of equipment used on ranches depended upon the amount of feed crops grown in addition to grazingland and the amount of custom hiring used to produce those crops. Horses were found on 67% of the ranches visited with one horse used for each 100 to 300 animals managed on the ranch.

Energy Use. Information on fuel and electricity use was obtained from the 9 ranches visited. For cow-calf operations, reported annual fuel use varied from 32 to 56 L/cow and annual electricity use ranged from 9 to 100 kWh/cow. These values were comparable to the fuel and electricity use (33 L/cow and 70 kWh/cow) found by Rotz et al. (2013) on the cow-calf operation of the US Meat Animal Research Center in Nebraska. With fuel and electricity use combined, this gives a total energy use on the order of 1,800 MJ/cow, which is about 30% less than that reported by Zilverberg et al. (2011) for cow-calf operations in Texas. On a per animal basis, stocker operations used less energy, with annual fuel use being about 11 L/animal and electricity use at 25 kWh/animal. For combined cow-calf and stocker operations, the range in fuel use was 19 to 66 L/animal with a mean of 47 L/animal. Electricity use varied from 20 to 241 kWh/animal, with a mean of 140 kWh/animal. The wide range in electricity use likely varied with the amount of electrical-powered pumping of water. Use of wind power for pumping drinking water reduced electrical use on some ranches.

Feedyard Survey

From a 2007 survey by the National Agricultural Statistics Service (NASS, 2014), Kansas had the highest number of feedyards (276) followed by Texas (165) and Oklahoma (26); however, feedyards with the largest capacity (32,000 or more cattle) were most abundant in Texas (Figure 1). In terms of total numbers of cattle and calves on farms and ranches nationally, Texas ranked first (11.9 million), Kansas third (6.1 million), and Oklahoma fifth (4.5 million; TCFA, 2012).

Feedyard Size. Fifteen responses were received from feedyard operators in the 3 states. Of these, 10 were from Kansas (east, central, and west), 2 from Oklahoma (west), and 3 from the Texas Panhandle and High Plains region. Maximum capacities of the feedyards from all 3 states ranged from 3,800 to 115,000 cattle, with a mean and SD of 39,220 ± 26,564 and a median of 30,000 cattle (Table 4).

A closer look at Kansas, from which the most responses were received, showed that feedyards in the western part of the state had the highest capacities with 60,625 ± 37,326 cattle compared with 27,260 ± 14,046 cattle for central and 15,500 cattle in the east. Although our sample size was small (n = 10), this agrees with a report by the Kansas Livestock Association, which showed that feedyards were highly concentrated in the west, with the highest densities in the southwestern corner of the state (KLA, 2014), likely due to water supply from the Ogallala aquifer. Statewide, the majority of cattle feedyards have capacities below 16,000 cattle, with 49% having capacities of 1,000 to 3,999 cattle and 28% reporting capacities of 4,000 to 15,999 cattle. The percentage of feedyards with capacities ranging between 16,000 and 32,000 was 12% and with a capacity greater than 32,000 was 11% (NASS, 2014).

From our survey, feedyard capacities were similar across the 3 states, with an average capacity of 35,000 to 40,000 in each state. With the greater number of responses from Kansas, the largest variation in size was found in this state. The ratio of the number of cattle finished versus the maximum one-time capacity of the feedyards showed that the annual turnover rate of animals was almost always greater than one (Table 4). Ten of the feed yards had turnover rates of 1.7 to 2.1, indicating that they were operating at near capacity, finishing cattle in 6 mo or less. The turnover rate of the remaining 5 feedyards varied from 0.9 to 1.3, so these yards were operating under capacity getting about one cycle of cattle finished per year.

Cattle Management. The reported percentage of stockers maintained on grazinglands associated with the feedyard varied from none to a maximum of 24% of the cattle finished by that operation. The mean response from all participating feedyards was 6.9% (Table 4), and 20% of the feedyards did not maintain any stockers. Holstein cull cattle from dairy operations represented 10% or less of the total animals finished by most of the feedyards (80%). The remaining 3 feedyards, which were located in central and west Kansas, finished between 20 and 50% Holsteins.

The average incoming BW reported for cattle ranged from 227 to 375 kg

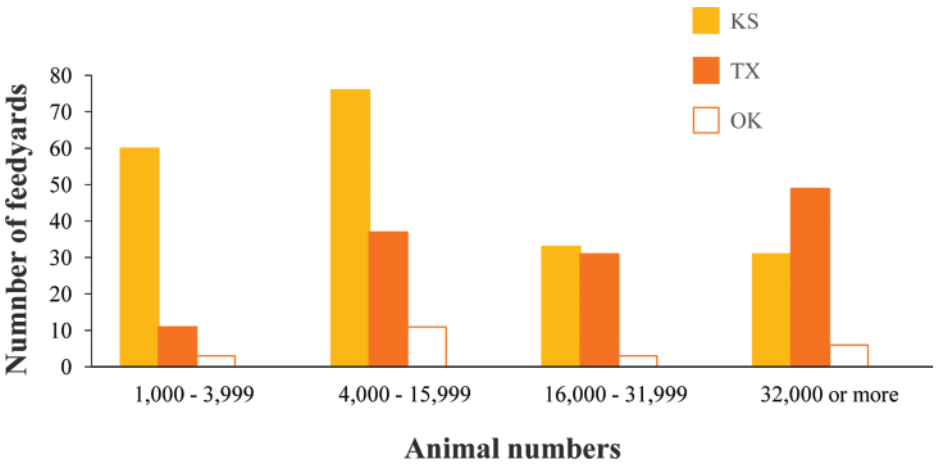

Figure 1. Survey of feedyard capacities and totals in Kansas, Oklahoma, and Texas (NASS, 2014). Color version available online.

with an average over all 3 states of 326 ± 27 kg (Table 4). Lighter-BW animals were normally backgrounded or finished over a longer period. Final BW were relatively uniform across feedyards at 581 ± 21 kg. About half of the feedyards reported backgrounding 10 to 30% of their cattle, which represented 5.5% of all cattle finished. The backgrounding period ranged from 40 to 90 d with an average of 60 d. Daily feed consumption reported by feedyards during this period varied from 6.8 to 11.4 kg of DM/animal. The mean and median feed intakes were similar at 9.1 kg of DM/animal per day. Figure 2 shows the average ration reported for the backgrounding period. The average ration consisted of 34% forage and 66% concentrate on a DM basis.

The reported finishing period ranged from 100 to 200 d across the participating feedyards with a mean of 149 ± 26 d (Table 4). Mean daily DMI of the finishing diets was 10.0 ± 1.3 kg of DM/animal. Figure 3 shows the typical ration reported for the finishing period on a DM basis. The amount of forage fed in finishing rations ranged from 5 to 21% with a median value of 10.5% of the DM fed. The reported typical CP concentration in the finish diets ranged from 12 to 15.3% with mean and median values of 13.6 and 13.3%, respectively.

Growth implants were reported to be used on all but one feedyard, which represented about 97% of the finished cattle. Feed additives such as monensin and tylosin were used by 87% of the responding feedyards. Both antibiotics and β-agonists were reported to be used simultaneously by 80% of the feedyards. Only one feedyard reported the finishing of cattle as "natural" (i.e., without the use of any treatment). This feedyard sold 75% of their 32,000 cattle finished in 2012 as natural, which represented about 2.5% of all cattle reported in our survey.

Crop-Production Practices. All but one of the feedyards (93%) who responded to the survey engaged in some crop production for the purpose of producing cattle feed. For those feedyards producing feed, the land area used varied widely from 0.001 to 0.19 ha per finished animal with a mean of 0.036 ± 0.059 ha/animal (Table 4). Two of the feedyards produced a major portion of their feed

Table 4. Summary of management characteristics from the feedyard survey responses in Kansas (n = 10), Oklahoma (n = 2), and Texas (n = 3)

					Range	
Management characteristic	**Unit**	**Mean**	**SD**	**Median**	**Minimum**	**Maximum**
Maximum capacity	Cattle	39,220	26,564	30,000	3,800	115,000
Cattle finished/capacity	Ratio	1.7	0.4	1.8	0.9	2.1
Stocker cattle on grazed forage	Cattle	2,967	3,815	1,800	0	12,000
Stocker cattle/finished cattle	%	6.9	7.8	2.6	0.0	24.0
Entering BW	kg	326	37	336	227	375
Finished BW	kg	581	21	581	529	613
Portion backgrounded	%	15.0	8.7	11.0	5.0	30.0
Backgrounding period	d	60	18	60	40	90
Backgrounding feed consumption	kg of DM/animal per d	9.1	1.3	9.1	6.8	11.4
Finish period	d	149	26	150	100	200
Finishing feed consumption	kg of DM/animal per d	10.0	1.3	9.5	8.2	13.4
Cattle finished natural	%	5.0	19.4	0.0	0.0	75.0
Holsteins finished	%	9.1	13.5	3.0	0.0	50.0
Crop area/finished animal	ha/animal	0.036	0.059	0.012	0.001	0.19
Manure removal	times/yr	2.0	0.85	2.0	1	3
Labor use	person-h/animal per yr	3.4	1.0	3.4	2.1	5.7

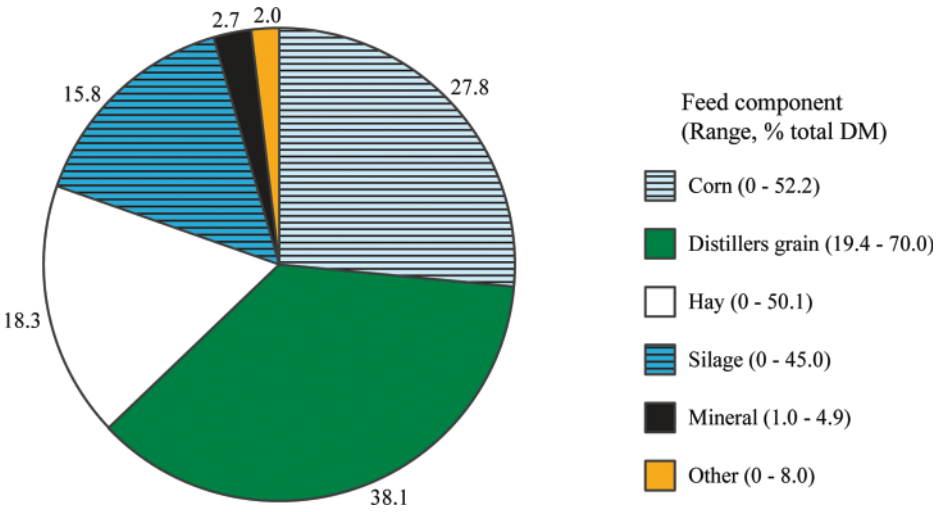

Figure 2. Average backgrounding ration (% of total DMI) reported by feedyards surveyed in Kansas, Oklahoma, and Texas. Color version available online.

needs, whereas the remainder primarily used their cropland for disposal of runoff and minor amounts of manure from the feedyard.

Corn grain production was reported by 47% of feedyards, with areas ranging from 49 to 10,120 ha (mean area of 2,780 ± 4,130 ha). Corn silage (177 ± 53 ha) was cultivated on 53% of feedyards, and alfalfa (196 ± 96 ha) was produced on 27% of feedyards. Small grain crops for grain or silage production were grown by 60% of the feedyards on a mean area of 164 ± 63 ha. Grass hay was produced by one feedyard, and the area was only 49 ha.

As runoff waste water and manure were typically applied to cropland, annual commercial fertilizer use was generally low. Nitrogen application rates ranged between 28 and 168 kg/ha among the 60% of feedyards that reported the use of nitrogen fertilizer. The types of fertilizer applied were urea, urea and ammonium nitrate solution, and anhydrous ammonia. Only one feedyard reported the use of substantial amounts of phosphate fertilizer, and that feedyard produced a major portion of their feed requirement. Very little potash fertilizer was used on cropland, and lime was not applied by any feedyard. Irrigation was used on most of the corn grain, corn silage, and alfalfa land. The reported maximum annual irrigation varied from 5.1 cm on small grain to 61.0 cm on corn silage (Figure 4). For establishing crops, 60% reported the use of no-tillage systems (only one pass for seeding) and 40% used a minimum tillage system with up to 3 passes including seeding.

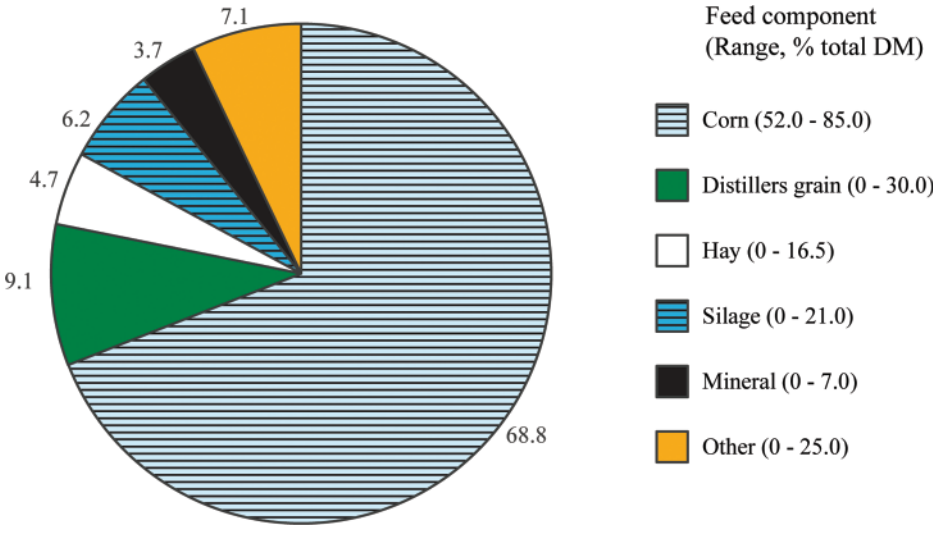

Figure 3. Typical finishing ration (% of total DMI) for the major feed ingredients fed on feedyards surveyed in the Kansas, Oklahoma, and Texas region. Color version available online.

Dry hay was reported as stored outdoors by 53% of feedyards, indoors by 13%, or both indoors and outdoors by 7%. When alfalfa or corn silage was stored, bunker silos or covered piles were used on 83% of the feedyards with the remaining 17% using bags. Corn grain was stored dry in grain bins on all feedyards, with 20% also using high-moisture grain preserved in bunker silos.

Manure Management. Manure removal was reported as 1 to 3 times per year with an average rate of 2.0 ± 0.9 times per year (Table 4). Manure was reported to be applied to cropland for production of cattle feed for 60% of the manure produced. Thirty-three percent of the manure was reported to be used to produce crops not intended for cattle feed. Two of the feedyards reported processing and selling all manure produced as compost, which made up about 6% of the manure produced by all feedyards.

Labor Requirement. Average labor use reported by all respondents was 3.4 ± 1.0 person-h/animal per year (Table 4). This mean labor requirement was consistent across the 3 states. Among the feedyards, the lowest value reported was 2.1 person-h/animal per year with the highest value being 5.7. Although the number of observations was small, generally, the labor requirement was observed to decrease with increasing size of the operation, with the largest feedyards reporting a requirement of 2.1 person-h/animal per year.

Equipment. Common equipment found on feedyards included feed trucks, loaders, tractors, dump trucks, pickup trucks, and all-terrain vehicles. From the feedyards visited, a loader and 2 feed trucks were required to feed about 20,000 cattle. This equip-

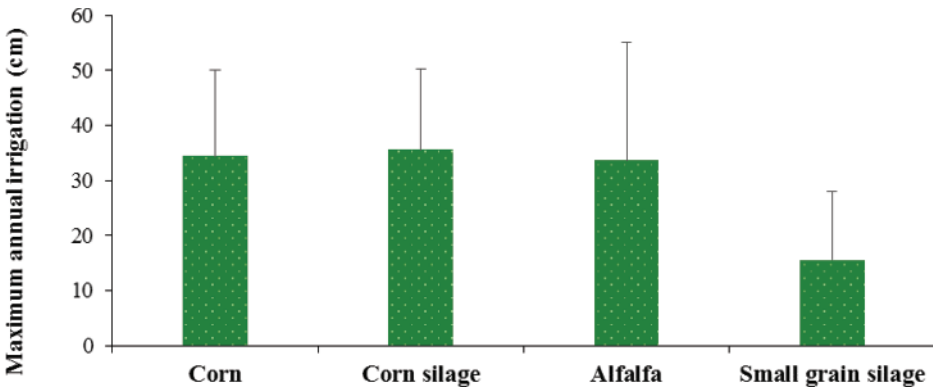

Figure 4. Maximum annual irrigation reported for crops produced by feedyards in the Kansas, Oklahoma, and Texas region. Color version available online.

ment was operated about 10 h/d for every day of the year. Other equipment requirements were more variable with a tractor required for every 7,000 to 20,000 cattle maintained on the feedyard, a dump truck for every 12,000 to 40,000 cattle, a pickup truck for every 3,000 to 6,000 cattle, and an all-terrain vehicle for every 9,000 to 25,000 cattle. Equipment requirements varied depending upon the amount of feed produced and the amount and type of custom operations used for both feed harvest and manure removal.

Energy Use. Information on energy use was obtained from 2 relatively large feedyards finishing 74,000 and 158,000 cattle per year. Reported diesel-fuel and gasoline use were 8.2 and 2.7 L per finished animal for the 2 operations, respectively. Reported use of natural gas also varied widely from 34 m^3 per finished animal on the smaller operation to 10 m^3 per finished animal on the larger. Electricity use was more consistent at 38 and 32 kWh per finished animal.

The large difference in fuel and natural gas use between the operations was due to several management differences. Both of the operations visited produced similar feeds on a similar amount of cropland, which would require a little more fuel per animal for the smaller operation. The smaller operation also included 12,000 stocker cattle, whereas the larger operation did not graze any stockers. Additional fuel would be required to operate additional trucks and all-terrain vehicles for managing these grazing animals. The smaller operation included the backgrounding of 12% of their cattle for 45 d before finishing, and they fed about 30% more flaked corn grain in the finishing diet. The greater use of grain per animal finished would contribute to greater use of natural gas. The smaller operation reported greater use of irrigation, which also may have contributed to greater natural-gas use.

IMPLICATIONS

A proper assessment of the sustainability of beef production is important for the beef industry. A vital step in this assessment is an accurate characterization of cattle-production practices. These surveys and visits provide useful information for characterizing the practices of cow-calf, stocker, and finishing operations in the Kansas, Oklahoma, and Texas region. Production practices vary throughout the region, with the major differences occurring between the wetter climate in the east side of the states and the semiarid climate on the west side. Moving from east to west, there was a strong trend toward a decrease in cattle stocking rates, the amount of harvested feed produced, and the use of fertilizer. Because of variability in the number of survey responses across the region and variations in response data, statistically significant differences were difficult to detect. Grazing of grass, rangeland, and small grains is heavily used in cow-calf and stocker operations in the region. Most cattle are finished on high-concentrate rations in large feedyards on the west side of the states, where most of the feed is produced on separate operations within and outside of the region.

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