



Management characteristics of beef cattle production in the western United States

Senorpe Asem-Hiablíe,* C. Alan Rotz,*¹ Robert Stout,* and Kathleen Fishert†

*Pasture Systems and Watershed Management Research Unit, USDA-ARS,² University Park, PA 16802; and

†National Cattlemen's Beef Association, Centennial, CO 80112

ABSTRACT

A comprehensive life cycle assessment of the beef value chain in the United States is being conducted to provide benchmarks and identify opportunities for improvement. Region-specific data are being collected to accurately characterize cattle production practices. This study reports production information obtained via surveys and on-site visits from 2 of 7 regions: the Northwest (Idaho, Montana, Oregon, Washington, and Wyoming) and the Southwest (Arizona, California, Colorado, Nevada, New Mexico, and Utah). Responses from ranches (defined as primarily grazing operations) included herd sizes ranging up to 28,500 cows and in total represented 3% of beef cows maintained in both regions according to inventories of the National Agricultural Statistics Service. Feedlot responses included operations ranging in capacities from 30 to 150,000 cattle and in total represented 33 and 19% of cattle finished in the Northwest and Southwest, respectively. Management information collected also included stocking rates; feed production and use; housing facilities; BW; diets; and machinery, energy, and labor use. Few differences in management were found between the 2 regions due primarily to the relatively dry conditions prevailing across much of the western United States. Stocking rates were relatively low in both regions, and more feed crops were grown on operations in the Northwest. In the Southwest, there was a trend toward smaller ranches (<100 cows) and more Holstein cattle were finished due to the large numbers of cull calves available from the dairy industry. Information gathered provides insights into management characteristics needed for modeling and evaluating production systems and conducting a comprehensive life cycle assessment.

Key words: cattle management, feedlot, ranch, beef cattle survey, grazing land

INTRODUCTION

The United States beef industry defines sustainability as meeting the growing demand for beef by balancing environmental responsibility, economic opportunity, and social diligence. To quantify the sustainability of beef in the United States, a national assessment was launched in 2010. The goal is to quantify sustainability through a nationwide cradle-to-grave life cycle assessment (LCA). The LCA is being conducted to establish benchmarks in various measures of sustainability and to identify opportunities for improvement but is not intended to promote particular management practices or regional preferences. Diverse management practices have developed around the climate, soils and other resources, and culture of various regions of the country. Due to the diverse nature of management systems across the nation, production practices must be studied within and across regions.

The country has been divided into 7 cattle-producing regions according to climate, differences in regional management systems, and geographical location. These are the Northeast, Southeast, Midwest, Northern Plains, Southern Plains, Northwest, and Southwest regions. The data gathered are used to form representative operations within each region to develop farm-gate partial LCA reporting carbon emissions, energy use, water use, and reactive N footprints. After all regions are completed, regional production data will be combined with information gathered from packing, marketing, and consumer segments of the beef value chain to complete a cradle-to-grave LCA.

Production and management data have been gathered (Asem-Hiablíe et al., 2015, 2016) and farm-gate assessments have been completed (Rotz et al., 2015) for the Southern and Northern Plains and Midwest regions. The objective of the current study was to survey and report beef cattle management and production practices for 2 more regions: the Northwest (Washington, Oregon, Idaho, Montana, and Wyoming) and the Southwest (Arizona, California, Colorado, Nevada, New Mexico, and Utah). Management practices for these regions were compared with other regions to identify unique region-specific characteristics and gather information needed to develop a robust national assessment.

¹ Corresponding author: al.rotz@ars.usda.gov

² USDA is an equal opportunity provider and employer.

MATERIALS AND METHODS

Surveys and Visits

In all states of the western regions, voluntary ranch and feedlot surveys (Supplementary Information SI 1a and 1b; <https://doi.org/10.15232/pas.2017-01618>) were developed in consultation with state beef council and state cattlemen's associations to take account of region-specific management practices. Similar to the previous regional surveys (Asem-Hiablie et al., 2015, 2016), internet addresses of the surveys were disseminated in letters to the producers from either the state beef council or cattlemen's association. Additionally, the web addresses of the surveys were distributed through periodicals and websites maintained by the beef council or cattlemen's associations. Hence, it was impossible to obtain the total number of survey recipients. On-site visits were also made to operations recommended by state representatives based on the operations' representativeness of the diversity within each state and availability of records to share. Confidential production data from individual producers were collated for each state.

Operation types as previously defined (Asem-Hiablie et al., 2016) for the purposes of this national study are as follows: ranches are any operation that predominately includes cattle on pasture or rangeland and includes cow-calf-to-finish operations where calves are weaned, raised, and finished on the same operation. Feedlots are operations where cattle are predominantly fed in confinement (open lot or barn) either for backgrounding on a high-forage diet or finishing on a high-concentrate diet. Background and stocker cattle both refer to the intermediate stage of development between weaning of the calf and finishing of the animal on a high-concentrate diet. Backgrounders are referred to as cattle predominately fed in confinement, whereas stockers are predominately on grazing land. Overlaps occur where stockers may be fed a diet of harvested feed, particularly during winter. Feeder cattle are raised on ranches or feedlots and fed a high-concentrate diet to provide a finished carcass. Terminology for different operations sometimes varied among regions, but for consistency, these terms are used.

Ranches consisted of cow-calf only, cow-calf and stocker or backgrounding, cow-calf-to-finish, and stocker-to-finish operations. Total ranch responses from survey and visits were 371: Northwest (144) and Southwest (227). Alaska was included in the Northwest survey, but no responses were received. Due to the very low number of cattle in this state, they were not included in our analysis. Hawaii was surveyed along with the mainland Southwest. Due to its unique ecosystem and the different management practices used in this state, a different survey tool was used, which was part of a more extensive survey of their cattle industry. Data collected will be reported separately. Ranch visits numbered 16 in the Northwest and 19 in the Southwest. One to five operations were visited per state depending on the size and diversity of the industry in the state. According to the 2014 survey of the National Agricultural

Statistics Service (NASS, 2015), beef cows totaled 3.37 million in the Northwest and 2.47 million in the Southwest. Based on these reported populations, the number of cows represented in our surveys and visits was approximately 3.2% of the beef cow inventory in the Northwest and 2.7% in the Southwest.

Information on equipment, fuel, and electricity use was obtained through the ranch visits. Ranches visited in the Northwest consisted of 11 cow-calf operations (120 to 1,400 brood cows), 4 cow-calf and stocker operations (85 to 28,500 brood cows and 20 to 4,500 stockers), and a cow-calf-to-finish operation (about 300 brood cows, 25 stockers, and 250 feeder cattle). In the Southwest, 11 of the operations visited were cow-calf-only operations ranging in size from 53 to 6,000 brood cows. Also visited were a cow-calf and stocker operation (about 120 brood cows and 550 stockers), 6 cow-calf-to-finish operations (250 to 800 cows and 150 to 6,600 feeder cattle), and a stocker-only ranch with about 1,500 cattle.

Feedlot responses totaled 27 with 12 from the Northwest and 15 from the Southwest. This included visits to 6 facilities finishing 300 to 187,000 cattle/yr. The 2012 census (NASS, 2015) reported annual sales of cattle on feed of 1.33 million for the Northwest and 3.23 million for the Southwest. Although the number of operations surveyed was small, they represented a large portion of the cattle finished in each region (33% in the Northwest and 19% of those finished in the Southwest).

For summarizations and comparisons of operations, some data were expressed on a per-animal basis. For cow-calf-only operations, the average number of cows maintained throughout the year was used. While stockers or feeder cattle were included in the count when present on the ranch, bulls and replacement heifers were considered proportional to the number of cows and were not counted. Thus, on a cow-calf-to-finish operation, the sum of cows, stockers, and feeder cattle made up the number of animals counted. On feedlots, the number of cattle backgrounded or finished annually were counted.

Ranch and feedlot visits provided additional detailed information such as equipment and energy use. The average annual fuel use was estimated as the sum of reported gasoline and diesel use in diesel equivalent expressed per animal (1 L of gasoline \approx 0.877 L of diesel). As with previous regions, reported values of energy use varied widely among operations, and obtaining accurate estimates was sometimes difficult for ranches and smaller operations. Because of combined home and cattle production use, producers had difficulty estimating the portion used for cattle production. Due to these challenges, the numbers reported provide general guidance on typical or average energy use, and the wide-ranging values show the uncertainty in quantifying energy use.

Statistics

Descriptive statistics of cattle production data were computed at the regional levels and summaries of man-

agement practices were explored for trends across the 2 regions. Due to similarities in climate across a major portion of each region, and the limited data available, it was not possible to statistically compare data across states or sub-regions. Statistically significant differences ($P < 0.05$) in selected management variables were tested among regions using the SURVEYREG procedure with the LSMEANS statement and PDIF option of SAS version 9.4 (SAS Institute Inc., Cary, NC). An operation's response was one experimental unit. Each response was weighted by the ratio of the total number of beef cows in that region (NASS, 2015) to the sum of cows reported in the survey for the region. The sampling weight was the number of brood cows within a region represented by the survey response.

RESULTS AND DISCUSSION

Ranches

The number of cows represented by survey responses received from each state were related to cow numbers in those states, but the correlation was low ($r = 0.47$). For the Northwest, the number of beef cows reported in the survey ranged from the highest in Idaho (47,160) to Montana (30,450), Wyoming (20,044), Washington (6,511), and Oregon (4,120). Compared with reported cow inventories in these states (NASS, 2015), Idaho was over-represented and Oregon was under-represented relative to the other states by our data. In the Southwest, survey cow numbers were Utah (20,224), Colorado (19,753), California (14,861), Nevada (10,331), Arizona (1,350), and New Mexico (800). Compared with cow inventories, New Mexico is under-represented and Nevada is over-represented. Considering the similarity among states though, our data provide an appropriate representation of the management practices of the regions.

Ranch Types and Sizes. Responses from both regions indicated that 96% of the ranches surveyed included cows, whereas the remaining 4% raised stockers only or both stockers and feeders (Table 1). Ranches reporting that some portion of their cattle were finished on the ranch were 15% in the Northwest and 22% in the Southwest. About 54% of the cows were on cow-calf-only operations in both regions. The remainder raised calves after weaning, with about 25% selling them to finishing operations and 21% finishing them on their operation. These data were relatively consistent across the 2 regions (Table 1).

Herd size in these regions ranged from 0 to 28,500 cows or 6,595 stockers with larger cow-calf ranches in the Northwest ($P < 0.05$; Table 2). In the Northwest, 19% of the ranches maintained 100 cows or fewer, but in the Southwest 37% were of this size (Table 1). These small ranches maintained only 1.5% of the cows in the Northwest and 7% of those in the Southwest. These ranch sizes were much larger than those found in the Midwest and Southern Plains but similar to those found in the western side of the Northern Plains (Asem-Hiablíe et al., 2015,

2016). Comparatively, NASS (2015) beef cow inventory data reported about 25% of cows on operations with less than 100 cows in both regions, which indicates that our survey data were biased toward larger operations.

About 40% of ranches in these regions maintained stocker cattle, with the majority maintaining more than 100 animals (Table 1). About 80% of these cattle were maintained on cow-calf operations, with 20% on stocker-only operations. Very few stocker-to-finish operations were reported because these animals would normally be raised on feedlot operations. Herd sizes were similar in the 2 regions, averaging around 400 cattle (Table 2).

Cattle Management. Cattle in these regions consisted of several breeds and crossbreds, primarily of British and continental origin. Over all ranches, about 85% of the cattle were purebred or crossed with black or red Angus. Mean brood-cow BW for the regions was 572 ± 62 kg (Table 2). Compared with other regions, this BW was less than that found throughout much of the Midwest and Northern Plains but greater than that reported in the Southern Plains (Asem-Hiablíe et al., 2015, 2016). Weaning age was similar for both regions with an average of 7.7 mo and range of 5 to 12 mo (Table 2). For those finishing cattle, the average age at finish was 20 mo with a range from 12 to 40 mo. The average finishing period was longer in the Southwest than the Northwest ($P < 0.05$) primarily because of the higher number of Holstein operations in the south, which require more time on feed.

The mean cow-to-bull ratio over all operations in both regions was about 20:1. The reported values ranged from 2 to 150. Several ranches reporting no bulls were often smaller operations, which presumably used AI. The mean heifer replacements raised was 23% of the number of cows, with similar numbers for both regions (Table 2). A few operations ($n = 24$) appeared to be raising and selling replacement heifers or rebuilding their herd sizes (replacement rate >0.3). Also, a few ranches reported no replacement heifers ($n = 6$ and 10 in the Northwest and Southwest, respectively), which indicated the sale of all calves and purchase of replacement animals when needed.

Reported stocking rates were similar in both regions. A wide range was reported for cow-calf pairs across the regions, with a mean of 15.6 ha and a median around 10 ha per pair (Table 2). For stockers, the mean and median were 8.9 and 4.0 ha per animal, respectively. These stocking rates were much greater than that reported for most other areas of the country but similar to those reported in the western side of the Southern Plains (Asem-Hiablíe et al., 2015, 2016).

Very little use of animal housing was found (Table 1). Almost all operations reported that animals were maintained on pasture or rangeland all year. About 5% reported use of an open lot, and 1% had some use of a barn. About 40% of the operations transported cattle to a different location for summer grazing, with a trend toward more of this strategy in the Southwest compared with the

Table 1. Beef cattle ranch survey results for the Northwest and Southwest regions¹

Ranch characteristic	Units	Northwest	Southwest	Combined regions ²
Ranches with cows	% of ranches	95.8	95.6	95.7
Small ranch, 100 cows or less	% of ranches	18.8	36.6	26.3
Cow-calf only	% of cows	1.5	6.8	3.7
Cow-calf and stocker	% of cows	57.1	50.7	54.4
Cow-calf to finish	% of cows	24.5	24.8	24.6
Cow-calf to finish	% of cows	18.4	24.5	21.0
Ranches with stockers	% of ranches	42.4	36.1	39.7
Small ranch, 100 stockers or less	% of ranches	17.3	27.5	21.6
Cow-calf and stocker	% of stockers	3.1	4.7	3.7
Stocker only	% of stockers	77.9	80.1	78.9
Stocker-to-finish only	% of stockers	21.5	19.9	20.8
Stocker-to-finish only	% of stockers	0.5	0.0	0.3
Ranches finishing cattle	% of ranches	15.3	22.0	18.1
Grass-finished cattle	% of finished cattle	48.0	14.4	33.8
Growth implants used	% of ranches	5.6	6.6	6.0
Portion of stockers	% of stockers	35.8	22.9	30.3
Cattle transported for summer grazing	% of stockers	57.6	68.7	62.3
Type of housing (some use >1 type)	% of ranches	32.4	43.7	37.1
None (on pasture or range only)	% of ranches	95.1	99.1	96.8
Open lot	% of ranches	4.9	4.4	4.7
Barn	% of ranches	1.4	0.4	1.0
Harvested pasture land	% of ranches	59.8	47.1	54.5
Portion harvested each year	% of land	3.6	4.1	3.8
Clipped but not harvested	% of land	1.2	2.3	1.7
Pasture reestablishment	% of ranches	19.2	19.3	19.3
Little or no reestablishment	% of land	98.6	97.1	97.9
Reestablishment period	yr	10.0	11.0	10.4
Public lands grazed	% of ranches	58.2	—	—
Small grain grazed	% of ranches	17.0	11.7	14.8
Crop residue grazed	ha/animal	0.58	0.39	0.50
Purchased forage	kg of DM/animal daily	28.6	14.1	22.5
Purchased concentrate	kg of DM/animal daily	0.48	0.57	0.52
Nitrogen fertilizer use	kg of N/ha	1.97	1.72	1.87
Fertilizer used	% of land	0.36	0.44	0.39
Amount used by those that fertilize	% of land	14.2	14.8	14.4
Fertilizer used	% of land	0.3	0.4	0.3
Amount used by those that fertilize	kg of N/ha	87	125	103
Phosphate fertilizer	% of ranches	4.9	7.7	6.1
Fertilizer used	% of land	0.1	0.2	0.1
Amount used by those that fertilize	kg of P ₂ O ₅ /ha	24.3	104	57.8
Potash fertilizer	% of ranches	1.8	2.8	2.2
Fertilizer used	% of land	0.1	0.1	0.1
Amount used by those that fertilize	kg of K ₂ O/ha	11.2	116	55.5
Lime use	% of land	0.01	0.2	0.1
Other feed crops grown	% of ranches	57.3	33.2	47.1
ha/animal	ha/animal	0.48	0.42	0.46

¹Northwest responses include Idaho (n = 17), Montana (n = 55), Oregon (n = 11), Washington (n = 19), and Wyoming (n = 42). Southwest responses include Arizona (n = 5), California (n = 66), Colorado (n = 84), Nevada (n = 14), New Mexico (n = 2), and Utah (n = 56).

²Average of the 2 regions weighted by the portion of cows maintained in each. Cow numbers for the regions were from the 2012 survey of the National Agricultural Statistics Service (NASS, 2015).

Northwest (Table 1). Fifty-eight percent of the ranches in the Northwest reported the use of public lands for grazing, and this question was not asked in the Southwest survey.

About 6% of all operations in both regions reported that at least a portion of cattle were finished on an all-forage diet (Table 1). In the Northwest, 48% of those ranches reporting the finishing of cattle on their operation were doing this on an all-forage diet. In the Southwest, this portion was 14%. The portion of cattle finished on grass in both regions was much greater than that found in other regions surveyed thus far (Asem-Hiablíe et al., 2015, 2016).

About 36% of the ranches in the Northwest and 23% of those in the Southwest reported the use of growth-promoting implants (Table 1). This represented about 62% of the stocker cattle, which was similar to that reported in other regions (Asem-Hiablíe et al., 2015, 2016).

About half of the responding operations in the regions reported the purchase of forage to supplement that produced on their operation. Of those that purchased forage, the average daily amount used was about 1.9 kg of DM/animal, and this amount was relatively consistent across the regions (Table 1). For the operations reporting the purchase and use of concentrate feeds, average daily use per animal was 0.36 kg of DM in the Northwest and 0.44 kg of DM in the Southwest. Grain, various protein supplements, and mineral blocks were fed to meet nutrient requirements.

Crop Production and Grazing Practices. Based on reported stocking rates and animal numbers, the estimated area used for grazing was about 8,600 ha per ranch in both regions, with sizes ranging from 0.6 to 340,000 ha. This included the grazing of small grain crops and crop

Table 2. Summary of management practices used on beef cattle ranches (cow-calf only, cow-calf and stocker, and cow-calf to finish) in the Northwest and Southwest regions¹

Management characteristic	Region	Mean	Median	Minimum	Maximum	SD	Responses
Brood cows maintained (no. of cows)	Northwest	785 ^a	360	10	28,547	2,636	138
	Southwest	309 ^b	150	3	6,000	505	217
	Full region	494	240	3	28,547	1,703	355
Cows per bull (ratio)	Northwest	19.2 ^a	18.8	2	38	6.9	135
	Southwest	20.0 ^a	20.0	2	150	11.7	209
	Full region	19.7	20.0	2	150	10.1	344
Replacement heifers per cow (ratio)	Northwest	0.22 ^a	0.19	0	2.5	0.23	134
	Southwest	0.23 ^a	0.17	0	6.0	0.42	209
	Full region	0.23	0.18	0	6.0	0.36	343
Stocker (no. of animals)	Northwest	456 ^a	150	1	4,500	815	65
	Southwest	365 ^a	100	2	6,595	820	94
	Full region	402	140	1	6,595	816	159
Brood cow BW (kg)	Northwest	578 ^a	567	454	726	50	135
	Southwest	569 ^a	567	363	998	69	218
	Full region	572	567	363	998	62	353
Average annual stocking rate for cows (ha/cow-calf pair)	Northwest	13.0 ^a	11.1	0.4	81	13.0	127
	Southwest	17.4 ^a	8.1	0.2	324	30.7	189
	Full region	15.6	9.9	0.2	324	25.2	316
Average annual stocking rate for stockers (ha/stocker)	Northwest	7.8 ^a	4.5	0.02	81	14.1	33
	Southwest	9.6 ^a	4.0	0.40	202	28.1	56
	Full region	8.9	4.0	0.02	202	23.8	89
Weaning age (mo)	Northwest	7.3 ^a	7.0	5.0	11.0	1.1	97
	Southwest	7.9 ^a	8.0	5.0	12.0	1.5	154
	Full region	7.7	7.0	5.0	12.0	1.4	251
Finish age (mo)	Northwest	19.2 ^a	18.0	14.0	30.0	4.3	23
	Southwest	20.1 ^a	20.0	12.0	40.0	5.6	44
	Full region	19.8	19.0	12.0	40.0	5.2	67
Annual labor to feed and maintain cattle (person-h/animal)	Northwest	15.1 ^a	10.4	0.78	104	15.8	119
	Southwest	16.5 ^a	11.3	0.14	139	19.0	186
	Full region	15.9	10.9	0.14	139	17.8	305

^{a,b}Values of a management characteristic with different superscripts are significantly different ($P < 0.05$).

¹Northwest responses include Idaho (n = 17), Montana (n = 55), Oregon (n = 11), Washington (n = 19), and Wyoming (n = 42). Southwest responses include Arizona (n = 5), California (n = 66), Colorado (n = 84), Nevada (n = 14), New Mexico (n = 2), and Utah (n = 56).

residue in addition to native dryland and irrigated pastures. About 15% of ranches used small grain crops, with a slight trend toward more use in the Northwest (Table 1). For those using this strategy, on average 0.5 ha was grazed per animal. Crop residues were grazed on about 29% of ranches in the Northwest and 14% of those in the Southwest, with an average area around 0.5 ha per animal. Other feed crops were grown by 57% of the ranches in the Northwest and 33% in the Southwest, with an average land use of 0.46 ha/animal. Alfalfa was grown on 59% of the ranches producing other feeds. Other common feed crops were perennial grass hay and annual forage crops such as small grains grown on 34 and 28% of ranches, respectively. These crops included oat, wheat, and millet in both western regions. The Northwest reported a wider variety including barley, triticale, ryegrass, teff, and forage peas, whereas sorghum was mentioned in the Southwest.

About half of the ranches harvested some portion of their grazing land for winter feed, with a slightly greater portion in the Northwest than in the Southwest (Table 1). The amount harvested averaged 3 to 4% of all pasture and rangeland grazed, and this portion was relatively consistent across the 2 regions. About 9% of all ranches reported the clipping of some of their grazing land for control of weeds and improvement of forage quality. The amount clipped was estimated to be 1 to 2% of all grazing land.

Pasture reestablishment was not common in these regions (Table 1). The portion of ranches reporting some reestablishment was 19% in both regions. The amount of land reestablished was relatively small, with about 98% receiving little or no reestablishment. For pastures that were reestablished, they were replanted about every 10 yr. When pastures were planted, 41% reported using a no-till system, with 32% using minimum tillage and 27% using a conventional tillage system.

Very little inorganic fertilizer was used on grazing land (Table 1). Nitrogen fertilizer use was reported by 14% of ranches in both regions, and the amount of land fertilized was less than 1% of all grazed land. When applied, the application rate was around 100 kg/ha. The form of N applied was normally ammonium sulfate (36%), urea (26%), or urea ammonium nitrate (18%). Other reported N sources included anhydrous ammonia (14%) and various manures. Phosphate and potash fertilizer use were reported by only 6 and 2% of ranches, respectively, and the portion of land fertilized was on the order of 0.1%. Lime application was reported by 3% of the ranches, and the estimated amount of land covered was trivial. Although not specifically reported, these soil amendments were likely used on small grain land or relatively small areas of irrigated pasture land.

Annual labor required to feed and maintain animals varied widely among ranches, with a mean of 16 person-h/animal (Table 2). Reported labor use was very similar between the 2 regions. No relationship was found between herd size and labor requirement, but there was a slight trend toward less labor per animal with larger herds ($r =$

-0.19). Labor requirements for these regions were similar to those found for the Northern Plains but less than those found in the Southern Plains (Asem-Hiablie et al., 2015, 2016).

Equipment. Information on equipment use was obtained through visits. Ranch equipment typically included tractors, skid-steer loaders, all-terrain vehicles, and various types of trucks. Most ranches ($n = 16$) included 1 or 2 tractors, and the rest ($n = 8$) reported more. Tractor number and sizes were similar in the 2 regions, with little relationship between the number of tractors and herd size. Tractor sizes mainly ranged from 11 to 260 kW, but most were between 41 and 160 kW. On average, tractor use was 270 h/yr. Skid-steer type loaders were found on 43% of the ranches in the Northwest and 21% of those in the Southwest. Annual use ranged from 80 to 1,500 h/yr, with an average of 328 ± 436 h/yr; most were used about 150 h/yr.

Almost all ranches used pickup trucks, with 1 to 40 per operation, and the number of trucks was proportional to the number of cattle managed. Twenty percent of the operations included other light duty trucks for hauling feed and water. On average, 270 cattle were managed per truck across all operations visited, and trucks were typically operated about 16,000 km/yr. Semi-tractor trailers were also owned on 34% of the ranches for animal transport.

Horses were found on 88% of the ranches in the Northwest and 74% of those in the Southwest. The number of horses on each ranch ranged from 2 to 310. Cattle managed per horse varied from 16 to 700, with an average of 150 in the Northwest and 100 in the Southwest.

Energy Use. Due to differences in management and the uncertainty producers had in monitoring energy use, reported values varied widely among ranches. In the Northwest, reported fuel use on a diesel equivalent basis ranged from 1 to 84 L/animal, with both a mean and median of 29 L/animal. For cow-calf-only operations, fuel use was 36 L/cow. Cow-calf and stocker operations averaged a little less per animal (23 L/animal), where animals were defined as cows plus stockers. Much greater use was reported in the Southwest, with a mean of 62 L/animal and median of 46 L/animal. For cow-calf-only operations, mean fuel use was 71 L/cow, and a cow-calf and stocker operation used 7 L/animal. The reason for the large difference between the 2 regions is unknown. The reported fuel use in the Northwest was less than that found in the Great Plains and Midwest, whereas that in the Southwest was much greater (Asem-Hiablie et al., 2015, 2016). The average over the 2 regions (54 L/animal) was similar to that found in the other regions.

Reported annual electricity use was similar across the regions, with mean values of 122 kWh/animal in the Northwest and 130 kWh/animal in the Southwest. For cow-calf operations, similar averages were also found, with 119 kWh/cow in the Northwest and 133 kWh/cow in the Southwest. Values varied widely across ranches from 1 to 579 kWh/animal. This large variation is due to differences

in the source of energy used to pump water, the depth of available water, and perhaps the use of electric fence. This wide variation in reported values and the overall means is similar to that found in the other regions surveyed thus far (Asem-Hiablíe et al., 2015, 2016).

Feedlots

A total of 27 feedlot responses were received with 12 from the Northwest and 15 from the Southwest. The responses included 6 feedlot visits, 5 in the Northwest and 1 in the Southwest. Although there was not a strong correlation ($r = 0.37$) between the cattle produced in each state (NASS, 2015) and the cattle represented in our survey, states producing most of the finished cattle (Idaho, Wash-

ington, Montana, Colorado, and California) were represented with the most cattle in our survey.

Feedlot Sizes and Types. Feedlot sizes were similar in the 2 regions, with average one-time capacities around 30,000 cattle and maximum capacities on the order of 150,000 cattle (Table 3). Cattle finished per unit of capacity averaged 1.6 in the Northwest and 1.3 in the Southwest, and the range in these values was wide in both regions. This mean and range in size was similar to that found in the Southern Plains states and much greater than that in the Northern Plains and Midwest (Asem-Hiablíe et al., 2015, 2016). The largest feedlots were found in Washington, Colorado, and California. This agrees with NASS (2015) data, where most of the cattle in these states are finished on very large operations.

Table 3. Summary of feedlot and feeding characteristics from survey responses in the Northwest and Southwest regions¹

Location and management characteristic	Unit	Range				SD	Responses
		Mean	Median	Minimum	Maximum		
Northwest							
Maximum capacity	Cattle	29,246	15,000	2,700	150,000	42,254	12
Cattle finished/capacity	Ratio	1.6	1.5	0.11	3.6	1.13	9
Entering BW, backgrounding	kg	277	283	204	354	54	10
Entering BW, finish	kg	392	386	386	408	10	5
Finished BW	kg	632	624	590	680	28	9
Portion backgrounded	%	71.1	90.0	10.0	100	36.2	9
Backgrounding period	d	98	91	75	150	22.6	9
Backgrounding feed intake	kg of DM/animal daily	9.8	9.1	8.2	11.3	1.5	5
CP of backgrounding diet	%	14.4	14.5	12.5	16.0	1.5	4
Finish period	d	161	147	110	225	42	9
Finishing feed intake	kg of DM/animal daily	11.4	10.9	10.9	13.6	1.0	7
CP of finish diet	%	14.3	13.3	12.5	20.0	2.8	6
Labor use	h/animal annually	1.5	1.0	0.1	3.7	1.3	9
Southwest							
Maximum capacity	Cattle	31,370	21,500	30	120,000	36,989	14
Cattle finished/capacity	Ratio	1.3	0.9	0.6	3.3	0.8	12
Entering BW, beef breeds	kg	298	272	249	391	56	8
Entering BW, Holstein	kg	136	136	125	147	6.5	7
Finished BW	kg	612	618	544	658	31	10
Portion backgrounded	%	69	80	15	100	36	5
Backgrounding period	d	82	84	35	140	39	5
Backgrounding feed intake	kg of DM/animal daily	9.8	8.4	6.8	15.4	3.9	4
CP of backgrounding diet	%	15.0	14.0	12.0	19.0	3.6	3
Finish period	d	95	91	60	130	27	5
Finish period, Holstein	d	358	357	336	385	17	6
Finishing feed intake	kg of DM/animal daily	8.4	8.2	6.8	11.3	1.4	9
CP of finish diet	%	13.0	13.1	12.0	12.5	0.6	8
Labor use	h/animal annually	3.4	2.4	0.8	14.9	4.2	10

¹Northwest responses include Idaho (n = 3), Montana (n = 4), Oregon (n = 2), Washington (n = 3), and Wyoming (n = 0). Southwest responses include Arizona (n = 0), California (n = 10), Colorado (n = 3), Nevada (n = 1), New Mexico (n = 0), and Utah (n = 1).

Table 4. Summary of feedlot management characteristics from survey responses in the Northwest and Southwest regions¹

Characteristic	Units	Northwest	Southwest	Overall
Feed crops produced	% of operations	55	43	46
	ha/animal finished ²	0.06	0.18	0.15
Housing facilities				
Maintained on open land	% of operations	8	29	21
Open lot	% of operations	100	79	85
Barn	% of operations	0	0	0
Stocker cattle maintained on pasture	% of operations	33	27	29
Portion of cattle finished on operation ³	% of finished cattle	25	19	21
Portion of cattle finished in region	% of finished cattle	3.5	1.4	2.0
Holstein cattle finished	% of operations	17	57	45
Portion finished on operation ⁴	% of finished cattle	17	79	61
Portion finished in region	% of finished cattle	4.6	33	25
Cattle produced natural	% of operations	36	57	51
Portion produced on natural operations ⁵	% of cattle	23	76	61
Portion finished in region	% of finished cattle	9.1	16	14
Manure removal				
Once per yr	% of operations	30	50	44
Twice per yr	% of operations	30	43	39
3 or 4 times per yr	% of operations	40	7	17
Manure use				
Applied to feed-producing cropland	% of manure	30	11	17
Applied to nonfeed crops	% of manure	3	21	16
Processed and sold as compost	% of manure	67	68	68

¹Northwest responses include Idaho (n = 3), Montana (n = 4), Oregon (n = 2), Washington (n = 3), and Wyoming (n = 0). Southwest responses include Arizona (n = 0), California (n = 10), Colorado (n = 3), Nevada (n = 1), New Mexico (n = 0), and Utah (n = 1).

²Hectares produced per finished animal for all operations producing crops (Northwest minimum, maximum = 0.04, 0.11; Southwest minimum, maximum = 0.0008, 0.44, respectively).

³The portion of total cattle finished that are grazed on those operations that include grazing of stockers.

⁴The average portion of Holsteins in the herd on those operations that include Holstein cattle.

⁵The portion of cattle produced without growth-promoting technologies on operations that produce some or all of their cattle without these technologies.

Similar portions of backgrounding and finishing cattle were produced on feedlots in each region. About 20% of the lots only backgrounded cattle, 20% only finished cattle, and 60% both backgrounded and finished cattle. The largest operations only finished cattle, so 60 to 70% of the cattle in each region were finished on feedlots that only finished cattle. About 30% of the operations in each region grazed some stockers, but the number of cattle grazed was usually a small portion of those finished (Table 4).

Holsteins culled from dairies were finished on 57% of the operations in the Southwest (primarily in California) but only 17% of operations in the Northwest (Table 4). This included 6 feedlots in southern California that produced only Holstein cattle. Holsteins represented about 5% of the cattle finished in the Northwest and 33% of those finished in the Southwest (Table 4). The number of Holstein cattle fed in the Southwest was very high compared with other regions (Asem-Hiablie et al., 2015, 2016) because of the large number of cull calves available from the dairy industry in California and other Southwest states.

All of the operations surveyed and visited in the Northwest used an open lot for cattle housing. In the Southwest, 79% reported the use of an open lot, with the remainder maintaining their cattle on open land all year. No barn of any type was found in either region.

Cattle Management. The entering BW on feedlots in the Northwest was 277 ± 54 kg (Table 3). In the Southwest, the entering BW on Holstein operations was 136 ± 6.5 kg, and for all other operations, the entering BW was 298 ± 56 kg (Table 3). In general, feedlots bringing in lighter weight cattle backgrounded their cattle before putting them on a finish diet. The mean entering BW for finish-only operations was 383 ± 38 kg. The average final BW reported was more consistent at 632 ± 28 kg and 612 ± 31 kg for the Northwest and Southwest, respectively. These entering and final BW are similar to those reported in other regions (Asem-Hiablie et al., 2015, 2016).

For those operations that backgrounded cattle, the portion backgrounded averaged about 70% in both regions, with the remaining 30% more quickly adapted to a high-

grain finish diet (Table 3). The average backgrounding period was 98 d in the Northwest and 82 d in the Southwest. Reported daily DMI for backgrounding cattle averaged 9.8 kg of DM in both regions (Table 3). Diets reported for the 2 regions were similar in that a little over half consisted of some type of forage, about 20% was corn grain with about 25% being by-product feeds (Figure 1a). In the Northwest, forage primarily came from silage, whereas in the Southwest it was mostly dry hay. More distillers grain was used in the Northwest as a by-product feed. Other by-product feeds used in the Northwest included wheat middlings and cull apples and pears. In the Southwest, almond hulls and whey were common by-product feeds. Average CP content of backgrounding diets was $14.4 \pm 1.5\%$ in the Northwest and $15.0 \pm 3.6\%$ in the Southwest (Table 3).

On operations finishing cattle, the finish period in the Northwest was 161 ± 42 d. This was a little longer than that found in the Great Plains states and a little less than that reported in the Midwest (Asem-Hiablíe et al., 2015, 2016). In the Southwest, the finish period was about 1 yr on Holstein operations and only 95 ± 27 d on other cattle feedlots. Reported daily feed intakes were much greater in the Northwest (11.4 ± 1.0 kg of DM) than in the Southwest (8.4 ± 1.4 kg of DM). An explanation for this difference is not available; reported values were relatively consistent in both regions. Feed intake in the Northwest was a little greater than that found in other regions, and

that in the Southwest was less (Asem-Hiablíe et al., 2015, 2016). Finish diets were also different, with more forage and by-product feeds fed in the Northwest (Figure 1b). Corn grain made up about 60% of the diets for all feedlots reporting in the Southwest, but this value was much more variable in the Northwest. Distillers grain was used similarly in both regions. By-product feeds in the Northwest included potato waste, and in the Southwest bakery waste was commonly reported. The average CP content of diets was $14.3 \pm 2.8\%$ in the Northwest and $13.0 \pm 0.6\%$ in the Southwest. The higher value in the Northwest was due to a feedlot that reported 20% CP.

Finishing of cattle without growth-enhancing technologies (i.e., natural) was common in the Southwest, with 50% of feedlots reporting some naturally finished cattle (Table 4). This represented 16% of the cattle finished in the region. Feedlots producing a large portion of natural cattle included 2 Holstein feedlots in California and 2 smaller cattle operations in Colorado. In the Northwest, 36% of the feedlots finished some of their cattle naturally, representing 9% of all cattle finished in the region. This level of natural finishing is greater than that found in the central United States (Asem-Hiablíe et al., 2015, 2016). Over both regions, 81% of the operations used growth-promoting technologies on at least a portion of their cattle. Of these, essentially all used growth implants and monensin, 55% used β -agonist, and 41% used tylosin.

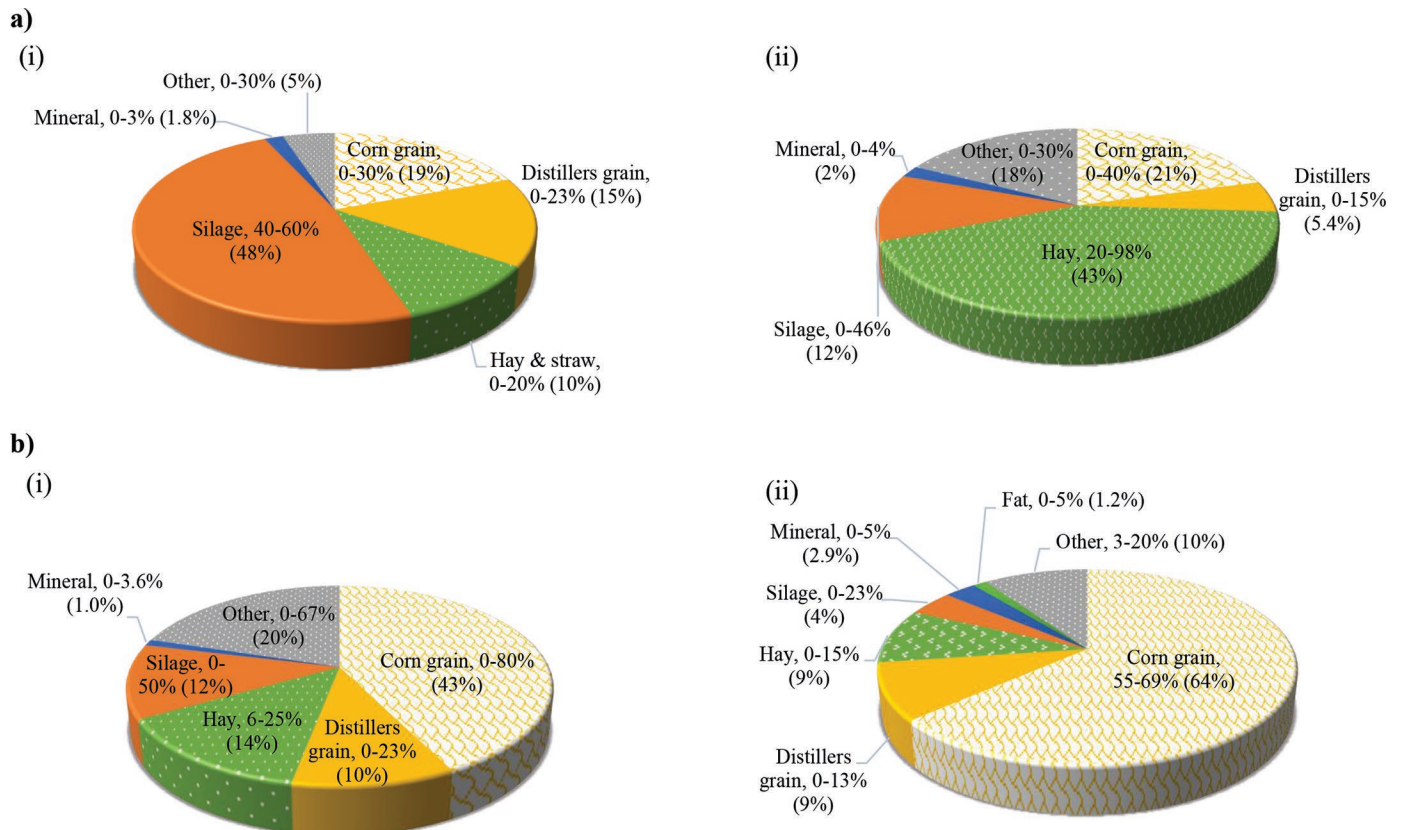


Figure 1. Range and (mean) of (a) backgrounding-diet and (b) finishing-diet constituents making up total DMI averaged over all participating feedlots in (i) the Northwest and (ii) the Southwest. Color version available online.

Feed Production Practices. About half of the operations in each region reported the production of a portion of their feed on land they managed. The land area farmed on these operations averaged 0.06 and 0.18 ha/animal finished in the Northwest and Southwest, respectively. This crop area was greater than that found in the Southern Plains but similar to that found in the Northern Plains and Midwest (Asem-Hiablíe et al., 2015, 2016). Similar crops were produced in each region. The most common crop was some type of small grain, which was found on 75% of the operations producing feed. These crops were produced and fed as grain, silage, or hay. Corn was produced on 58% of these operations and was harvested as silage or grain. Other crops included grass hay or silage on 25% of operations and alfalfa on 17%.

Soil amendment use on cropland producing feed was similar in both regions. Around 80% of all operations producing corn applied N fertilizer. Application rates varied from 50 to 280 kg of N/ha, with a mean of 153 kg of N/ha. The most common form of N applied was urea, with 80% applied in this form, and 10% each indicating anhydrous ammonia and ammonium sulfate. Phosphate and potash fertilizers were not commonly used, indicating that these nutrient needs were met through manure application. Among operations producing small grains, 55% applied N fertilizer, with little application of P and no K. Reported N application rates for small grains varied from 67 to 299 kg of N/ha, with most reported values between 112 and 168 kg of N/ha. For grass and alfalfa crops, no N fertilizer use was reported, but a few operations applied P (112 to 140 kg of P_2O_5 /ha; $n = 2$) and K (56 kg of K_2O /ha; $n = 1$) fertilizers. Lime application was rare, but an operation in California applied lime to small grain land at an average annual rate of 2.2 t/ha.

Essentially all cropland was irrigated in both regions, with greater amounts used in the Southwest. Nonprecipitation water use is an important environmental consideration in these regions. Because water consumption other than that used for irrigation is relatively small (Rotz et al., 2015) and difficult for producers to estimate, only irrigation water was recorded. Irrigation included the application of wastewater captured in runoff catchments. For corn land, reported irrigation amounts were 511 ± 140 mm in the Northwest and 660 ± 176 mm in the Southwest. For small grain, amounts were 339 ± 235 mm and 788 ± 535 mm for the Northwest and Southwest, respectively. Irrigated grass and alfalfa lands were only found in the Southwest, with 762 ± 515 mm applied.

Tillage and planting practices were different between the regions, but in both regions similar tillage practices were reported for grain and forage crops. In the Northwest, over 80% of the crops were established using a no-till system (defined as 1 pass for seeding), with the remainder established using a minimum tillage system (2 to 3 passes). The use of no-till systems was not reported in the Southwest. In this region, two-thirds of the crops were established

using a minimum tillage system and the rest used conventional tillage (4 or more passes).

When dry hay was produced or purchased, it was stored indoors, outdoors with a cover, or outdoors uncovered. Similar portions of each type of hay storage were reported in both regions. In the Northwest, no hay was stored indoors, about 40% of operations stored hay outside and covered, and 80% stored some of their hay outside and uncovered (20% used both methods). In the Southwest, 15% of operations stored hay indoors, 54% used outdoor storage with a cover, and 69% used an outside storage with no cover (23% used both methods). Silage was typically stored in a bunker or covered pile in the Northwest, with all silage-producing operations reporting the use of this type of storage. One operation also reported the use of bagged silage. Few operations ($n = 3$) produced or purchased silage, all of whom used bags for storage, and a couple used bunker silos or covered piles in addition. In the Southwest, silage storage was more equally split between the use of bags and bunker silos or piles. Dry grain was stored in a bin or under a roof on all operations. In the Northwest, 57% of operations also reported the use of high-moisture corn storage in a bunker or tower silo.

Manure Management. As stated above, most of the cattle in both regions were fed in open lots. Therefore, most of the manure was handled as a relatively dry material where the manure was removed from a pen when those cattle were finished or moved to a different pen. The data indicate that the pens were cleaned more frequently in the Northwest than the Southwest (Table 4). In the Northwest, 40% of the operations reported removing manure 3 to 4 times annually, whereas in the Southwest only 7% reported cleaning this frequently, with 50% cleaning only once annually. In both regions, about half of the manure produced on individual operations was reported to be composted and exported from the operations (Table 4). Because most of the composting was done by larger operations, this represented about two-thirds of the manure produced by backgrounding and finishing cattle in these regions. The portion of manure produced that was applied to land producing feed on those operations was estimated to be 30% in the Northwest and 11% in the Southwest. This use of the manure was similar to that found in the Northern Plains region, but in the South Plains Midwest most of the manure was applied to cropland producing feed (Asem-Hiablíe et al., 2015, 2016).

Labor Requirement. The mean annual labor required per animal produced in the feedlot was 1.5 ± 1.3 person-h in the Northwest and 3.4 ± 4.2 person-h in the Southwest (Table 3). This labor use was less than that found in the Northern Plains and Midwest, but the Southwest value was very similar to that found on the larger operations in the Southern Plains (Asem-Hiablíe et al., 2015, 2016). In both regions, the labor requirement was inversely related to operation size ($r = 0.5$), with less labor per animal on larger operations. Therefore, totaled over all operations,

the mean labor requirement was 0.8 person-h per animal in the Northwest and 1.2 person-h in the Southwest.

Equipment. Common equipment on feedlots in both regions were tractors, all-terrain vehicles, loaders, and various types of trucks (pickup, single, tandem, and tri-axle). The number of tractors ranged from 1 to 5, with 4 per operation being common. Tractor size ranged from 82 to 210 kW, with an average annual use of 3,000 h per tractor. The number of tractors was related to the number of cattle managed, with an average of 20,000 cattle per tractor. Payloaders were used for feeding on all of the larger feedlots, with 2 to 5 on each operation. On an annual average, about 22,000 cattle were fed per payload. A smaller skid-steer loader was also found on about half of the operations. All-terrain vehicles were found on most operations, with 3 to 6 per operation used.

Pickup trucks were used on most operations, with 3 to 16 on each. The number used was related to the size of the operation, with each truck serving about 9,000 cattle. Other trucks included feed trucks, with 2 to 5 per operation with each serving an average of 15,000 cattle. A third of the operations also included trucks for hauling manure, and a few ($n = 2$) owned tractor trailers for hauling cattle.

Energy Use. Annual energy use information was also obtained from feedlot visits in both regions, with similar values from each. For most operations, reported fuel use ranged from 4 to 15 L of diesel equivalent/animal finished, with a small operation reporting 158 L/animal finished. This small feedlot with high fuel use grew all its feed and finished 300 cattle, about one-tenth of its reported capacity. Averaged over all operations, fuel use was 8.1 L/animal finished, which was similar to that found in the Northern and Southern Plains regions (Asem-Hiablíe et al., 2015, 2016).

Natural gas and propane use were reported by 2 operations. The largest feedlot reported an annual use of natural gas of 14 m³/animal finished. A second operation used a combination of natural gas and propane, with an equivalent of 3.9 m³/animal finished. These rates of use are within the range of the limited data obtained from other regions on gas use (Asem-Hiablíe et al., 2015, 2016).

Reported electricity use ranged from 8 to 53 kWh/animal finished, with a mean over all operations of 25 kWh/animal. This range and mean are similar to those found for finishing operations in other regions (Asem-Hiablíe et al., 2015, 2016). A wide variation in electricity use among operations is expected due to differences in water use and pumping requirements, irrigation use, and perhaps lighting requirements. No important differences were found between the Northwest and Southwest regions.

IMPLICATIONS

Regional characterization of cattle production systems is providing the basis for a comprehensive life cycle assessment to help quantify the sustainability of United States beef. This study reports data gathered from ranches and feedlots in 2 of 7 United States cattle-producing regions: the Northwest and Southwest. The number of cows represented by our data was about 3% of those in each region, and feedlot cattle represented 33% of all cattle finished in the Northwest and 19% of those finished in the Southwest. Considering the wide range in sizes of operations and the consistency in management across the regions, our data appropriately reflect the management practices used. Relatively few differences in management practices were found between these 2 regions due primarily to the relatively dry conditions that prevail across much of the western United States. There was a trend toward smaller ranches in the Southwest compared with the Northwest. Stocking rates on ranches were relatively low in both regions and a little lower in the Southwest than the Northwest. More feed crops were grown on ranches and feedlots in the Northwest. A much greater portion of Holstein cattle are finished in the Southwest, particularly California, due to the large number of cull calves available from the dairy industry in this region.

ACKNOWLEDGMENTS

This project was funded in part by The Beef Checkoff and the USDA's Agricultural Research Service. The authors thank the producers and members of the National Cattlemen's Beef Association for their help in providing information supporting this analysis.

LITERATURE CITED

- Asem-Hiablíe, S., C. A. Rotz, R. Stout, J. Dillon, and K. Stackhouse-Lawson. 2015. Management characteristics of cow-calf, stocker, and finishing operations in Kansas, Oklahoma, and Texas. *Prof. Anim. Sci.* 31:1–10. <https://doi.org/10.15232/pas.2014-01350>.
- Asem-Hiablíe, S., C. A. Rotz, R. Stout, and K. Stackhouse-Lawson. 2016. Management characteristics of cow-calf, stocker, and finishing operations in the Northern Plains and Midwest regions of the United States. *Prof. Anim. Sci.* 32:736–749. <https://doi.org/10.15232/pas.2016-01539>.
- NASS. 2015. Quick Stats 2.0. National Agricultural Statistics Service. USDA. Accessed Nov. 12, 2015. <http://quickstats.nass.usda.gov/>.
- Rotz, C. A., S. Asem-Hiablíe, J. Dillon, and H. Bonifacio. 2015. Cradle-to-farm gate environmental footprints of beef cattle production in Kansas, Oklahoma, and Texas. *J. Anim. Sci.* 93:2509–2519. <https://doi.org/10.2527/jas.2014-8809>.