



Management characteristics of beef cattle production in the eastern United States

Senorpe Asem-Hiablíe,* C. Alan Rotz,*¹ Robert Stout,* and Sara Place†

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

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

ABSTRACT

As part of the United States Beef Sustainability Program, a nationwide characterization of regional beef production practices was conducted. Data on cattle production practices were gathered through voluntary surveys and on-site visits in the Northeast and Southeast, the last of 7 cattle-producing regions studied. Participating farms and ranches ($n = 817$) represented 1.2 and 1.0% of beef cows in the Northeast and Southeast, respectively. Responses from finishing operations ($n = 55$) represented 4 and 23% of cattle fed in the Northeast and Southeast, respectively. Herd sizes reported were larger in the Southeast than in the Northeast; however, stocking rates were similar. Cow-to-bull ratios were slightly greater in the Southeast, and the proportions of replacement heifers were comparable in both regions. Supplemental feed production and indoor housing were more prevalent in the Northeast compared with the warmer Southeast, where longer grazing periods were possible. Fewer feedlots were reported in the Southeast, with most being backgrounding facilities. Finishing on grass was more common in the east than in other regions. Feed intake estimated by survey respondents was comparable across regions, but relatively more silage was fed in the Northeast, whereas hay was dominant in the Southeast. Cropland producing cattle feed received most of the manure in both regions, although 25% was composted and sold in the Northeast. Labor, equipment, and energy use information was also gathered from the various operation types. The data collected help guide the development of representative production systems used in the life cycle assessment of beef.

Key words: cattle management, feedlot, farm, beef

INTRODUCTION

Nationwide, region-specific data collection on cattle production was initiated as part of a comprehensive life cycle

assessment (LCA) under the United States (US) Beef Sustainability Research Program. The purpose of this LCA is to quantify metrics of sustainability for the beef industry, establish benchmarks, and identify opportunities for improvement.

Beef production practices vary regionally based on climate, available natural and man-made resources, and culture. The purpose of region-specific data collection is to characterize the various production and management practices in each region. The data collected are used along with other sources of information to develop representative operations in each region that are analyzed to produce a farm gate partial LCA based on methods developed by Rotz et al. (2013). As such, the data collected are not used directly to support the LCA, but they help guide the development of representative cattle production systems for the regions.

Production and management data have already been collected for 5 regions (Southern and Northern Plains, Midwest, Northwest, and Southwest), and a farm gate assessment was completed for the Southern Plains (Asem-Hiablíe et al., 2015, 2016, 2017; Rotz et al., 2015). The objective of the present study was to survey and record beef production and management practices in the final 2 regions of the country, the Northeast and Southeast. These data provide information that is not readily available from other sources to help characterize cattle production systems.

MATERIALS AND METHODS

States of the eastern US were divided into the 2 regions: the Southeast (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North and South Carolina, Tennessee, and Virginia) and the Northeast (Connecticut, Delaware, New Hampshire, Maine, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and West Virginia). The climate varied across these states, with much warmer ambient temperatures in the south and the coldest in the northern states of the Northeast (Table 1). Annual precipitation also varied with 18% more in the Southeast than in the Northeast and the greatest precipitation in the Gulf Coast states of Florida, Alabama, Mississippi, and Louisiana. Within the

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

²USDA is an equal opportunity provider and employer.

Table 1. Average annual temperature and precipitation for the 24 states making up the Northeast and Southeast of the United States¹

State	Temperature (°C)	Precipitation (mm)
Northeast		
Connecticut	9.4	1,279
Delaware	12.9	1,160
Maine	5.0	1,072
Maryland	12.3	1,131
Massachusetts	8.8	1,211
New Hampshire	6.6	1,103
New Jersey	11.5	1,196
New York	7.4	1,062
Ohio	10.4	993
Pennsylvania	9.3	1,089
Rhode Island	10.1	1,218
Vermont	6.1	1,085
West Virginia	11.0	1,147
Region	9.3	1,134
Southeast		
Alabama	17.1	1,480
Arkansas	15.8	1,284
Florida	21.5	1,385
Georgia	17.5	1,287
Kentucky	13.1	1,242
Louisiana	19.1	1,528
Mississippi	17.4	1,499
North Carolina	15.0	1,279
South Carolina	16.9	1,264
Tennessee	14.2	1,376
Virginia	12.8	1,125
Region	16.4	1,341

¹Climate data are from the National Oceanic and Atmospheric Administration website: <https://www.climate.gov/maps-data>.

Northeast, precipitation was greater along the east coast and least in Ohio.

Surveys and Visits

In both the Northeast and Southeast regions, surveys were administered via the Internet and through on-site interviews. Two surveys were used: one for farm or ranch cattle producers and the other for finishing operations. Survey questions for each region were developed in consultation with state beef councils and cattlemen's associations to ensure the inclusion of region-specific characteristics. Similar to procedures followed in previous regions (Asem-Hiablie et al., 2015, 2016, 2017), invitation letters providing web addresses to the surveys were sent to producers by each participating state's beef council or cattlemen's association. In addition, Internet addresses of the surveys were distributed through periodicals and websites of the state councils. For this reason, it was impossible to

adequately quantify the total number of survey recipients. Both surveys were kept as short as possible to encourage participation, requiring approximately 15 min for farms and ranches and slightly more for finishing operations. On-site interviews were conducted to obtain more detailed information including energy and equipment use. The operations visited were chosen following recommendations by state beef council representatives and were based on the representativeness of the operations of the state's production systems, availability of records, and willingness to participate. Survey responses from individual producers were treated as confidential information and were collated and analyzed in spreadsheet format. The survey and visits were not a randomized sample, but they did provide wide representation in operation size and management practices. Survey questions are available in the Supplementary Material (SM 1a and 1b; <https://doi.org/10.15232/pas.2018-01728>).

We have defined 2 major categories of operations for use in this paper. "Farms" or "ranches" are operations that predominately include cattle on pasture or rangeland and include cow-calf-to-finish operations where calves are weaned, raised, and finished on the same operation. For these regions, we refer to these as "farms." "Feedlots" are operations where cattle are predominantly fed in confinement (open lot or barn) for either 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; however, the former refers to cattle fed predominately in confinement and the latter, on grazing land. Cattle raised on farms or feedlots and fed a high-concentrate diet with the goal of providing finished carcasses were termed "feeders." The common names for different operations vary, but for consistency, these terms are used as defined.

Respondents consisted of cow-calf only, cow-calf and stocker, stocker only, cow-calf-to-finish, and stocker-to-finish operations. A total of 817 responses were compiled from surveys and visits of farms in the eastern region: 158 from the Northeast and 659 from the Southeast. Farm visits numbered 26 in the Northeast and 30 in the Southeast. On-site visit data were collected from 8 states in each region with 1 to 5 operations visited per state depending on the size and diversity of the industry in the state and the availability of those making visits. The 2015 inventory of beef cattle by the National Agricultural Statistics Service (NASS, 2017), reported total beef cows of 0.80 million in the Northeast and 6.87 million in the Southeast. Based on these inventories, our surveys and visits represented approximately 1.2% of the beef cow inventory in the Northeast and 1.0% in the Southeast.

During farm visits, information on equipment as well as fuel and electricity use was collected from beef producer records. Those visited in the Northeast consisted of 7 cow-calf operations (12 to 260 brood cows), 6 cow-calf and stocker operations (39 to 750 brood cows and 14 to 800

stockers), and 11 cow-calf-to-finish operations (24 to 600 brood cows, 6 to 3,000 stockers, and 6 to 400 feeder cattle). A stocker-only operation and a stocker-to-finish operation both maintaining an average of 243 cattle were also visited in the Northeast. Farms visited in the Southeast included 14 cow-calf only operations (50 to 12,223 brood cows), 9 cow-calf and stocker operations (18 to 466 brood cows and 12 to 3,000 stockers), 2 stocker-only operations (with an average of 5,716 stockers), 2 stocker-backgrounder operations (with an average of 6,000 stockers or backgrounders), and 3 cow-calf-to-finish operations (85 to 1,000 cows and 5 to 400 feeder cattle).

Fifty-five responses were received from feedlots: 35 from the Northeast and 20 from the Southeast. In the Northeast, 11 operations were visited that fed 70 to 4,024 cattle per year, and 2 feedlots in the Southeast were visited that, combined, finished up to 17,000 cattle annually. In the 2012 census of "sales of cattle on feed" (NASS, 2017), 358,208 and 66,620 cattle were reported for the Northeast and Southeast, respectively. The cattle fed on the surveyed feedlots subsequently represented approximately 4 and 23% of cattle fed in the Northeast and the Southeast, respectively.

Information on equipment, fuel, and electricity collected during visits was expressed on a per-animal basis. The average amount of fuel used annually is reported as diesel equivalent per animal, with 1 L of gasoline being equal to 0.877 L of diesel. The numbers reported for energy use only provide general guidance on average or typical use. Accurate records were not often obtained. Separating portions used for home or other enterprises such as commercial crop production from that used for cattle production was often difficult, especially for relatively small operations. We relied on the producer's estimate in dividing among farm enterprises.

Statistics

Summaries of management practices were obtained using descriptive statistics of cattle production data and explored for trends across the 2 regions. As done in previous regions, to help summarize and compare operations, some data were expressed on a per-animal basis (Asem-Hiablue et al., 2015, 2016, 2017). For cow-calf only operations, the average number of cows maintained throughout the year was used. When stockers and feeder cattle were present, they were included in the total number of cattle, but bulls and replacement heifers were not counted because they were considered proportional to the number of cows. Therefore, on cow-calf-to-finish operations, the number of animals counted was the sum of cows, stockers, and feeder cattle. On feedlots, both backgrounders and feeders fed annually were summed.

Owing to the limited data available from some areas and minor distinctions in climate across a large section of the regions (Table 1), statistical comparisons among states or subregions were not done. Where possible, using

an operation's response as one experimental unit, statistically significant differences ($P < 0.05$) in selected management variables were tested among the 2 regions with the SURVEYREG procedure using the LSMEANS statement and PDIF option of SAS version 9.4 (SAS Institute Inc., Cary, NC). Each response was weighted by the sampling weight. The sampling weight was defined as the portion of brood cows within a region represented by a survey response and was found as the ratio of the total number of beef cows in that region (NASS, 2017) divided by the total cows reported in the survey.

RESULTS AND DISCUSSION

Grazing-Based Farms

The total numbers of brood cows maintained on participating farms in the Northeast and Southeast regions according to the survey reports were 66,294 and 812,000, respectively. Generally, the cow numbers represented by survey responses received from each state were moderately correlated ($r = 0.75$, Northeast, and $r = 0.71$, Southeast) to the NASS (2017) inventory of beef cows in that state (Figure 1). These correlations were not statistically significant ($P > 0.05$) for both regions, likely due to the large variation in values. Brood cow totals recorded in surveys from South Carolina, North Carolina, and Arkansas were 410 ($n = 5$), 1,346 ($n = 21$), and 3,920 ($n = 25$), respectively, representing less than 0.5% of cows in these states (NASS, 2017). In the Northeast, Connecticut, Massachusetts, and Rhode Island collectively reported close to 0.5% of the cows inventoried in these states as did Ohio and Delaware individually (Figure 1). Because these states (excluding Arkansas and Ohio) were minor cattle-producing states in their respective regions, and because there are similarities in practices among states within each region, the data collected were deemed an appropriate representation of the management practices of the region.

Types and Sizes. Survey responses indicated that 97% of the farms in both regions maintained brood cows, whereas the remainder had stocker-only or stocker-to-finish animals (Table 2). A smaller portion of brood cows in the Northeast (21.5%) were maintained on cow-calf only operations whose calves were typically sold at an average age of 6.9 ± 1.4 mo (mean \pm SD). A larger portion of the Northeast region's cows (56%) were maintained on cow-calf-to-finish operations (Table 2) where at least a portion of their cattle were sold after reaching slaughter weight at an average age of 20.1 ± 4.4 mo. Conversely, in the Southeast, the majority of cows (59%) were maintained on cow-calf only operations where weaned calves were sold at an average age of 7.9 ± 2.1 mo. For cow-calf-to-finish operations (18.5% of cows), cattle were fed until they reached slaughter weight at 18.2 ± 4.0 mo of age. The results for the Southeast region agree with McBride and Matthews (2011), who observed in a 2008 survey of US beef cow producers that few US cow-calf operators (mostly located

in the Southeast and Southern Plains) maintained their calves after weaning.

Reported brood-cow herd sizes ranged from 2 to 750 in the Northeast and 2 to 12,223 in the Southeast (Table 3). Herd sizes for stockers were up to 3,000 and 8,000 animals in the Northeast and Southeast, respectively (Table 3). Larger herd sizes were reported in the Southeast region ($P < 0.05$), and this is supported by the national beef cow inventory, where 4 times as many cows were reported on Southeast farms with more than 100 cows compared with those in the Northeast (NASS, 2017).

Eighty percent of the farms surveyed in the regions were small, maintaining less than 100 cows. These small operations maintained 48 and 31% of the brood cows in the responses for the Northeast and Southeast, respectively

(Table 2). These farm sizes were comparable to reports from the Midwest but smaller than those found in the western US (Asem-Hiablie et al., 2016, 2017). Most operations with stockers recorded in the Northeast (65%) were small, maintaining only 24% of the stockers within the region (Table 2). In the Southeast also, small operations with stockers maintained 14% of the stockers. In both regions, therefore, most of the stockers were kept on large operations, although such farms were fewer in the Southeast.

Cattle Management. Angus cattle were dominant in both regions, with pure breed and predominately Angus crosses being reported on 70% of the operations (data not shown). Hereford was next in preference. Reported mean cow-to-bull ratios were 18 cows per bull in the Northeast

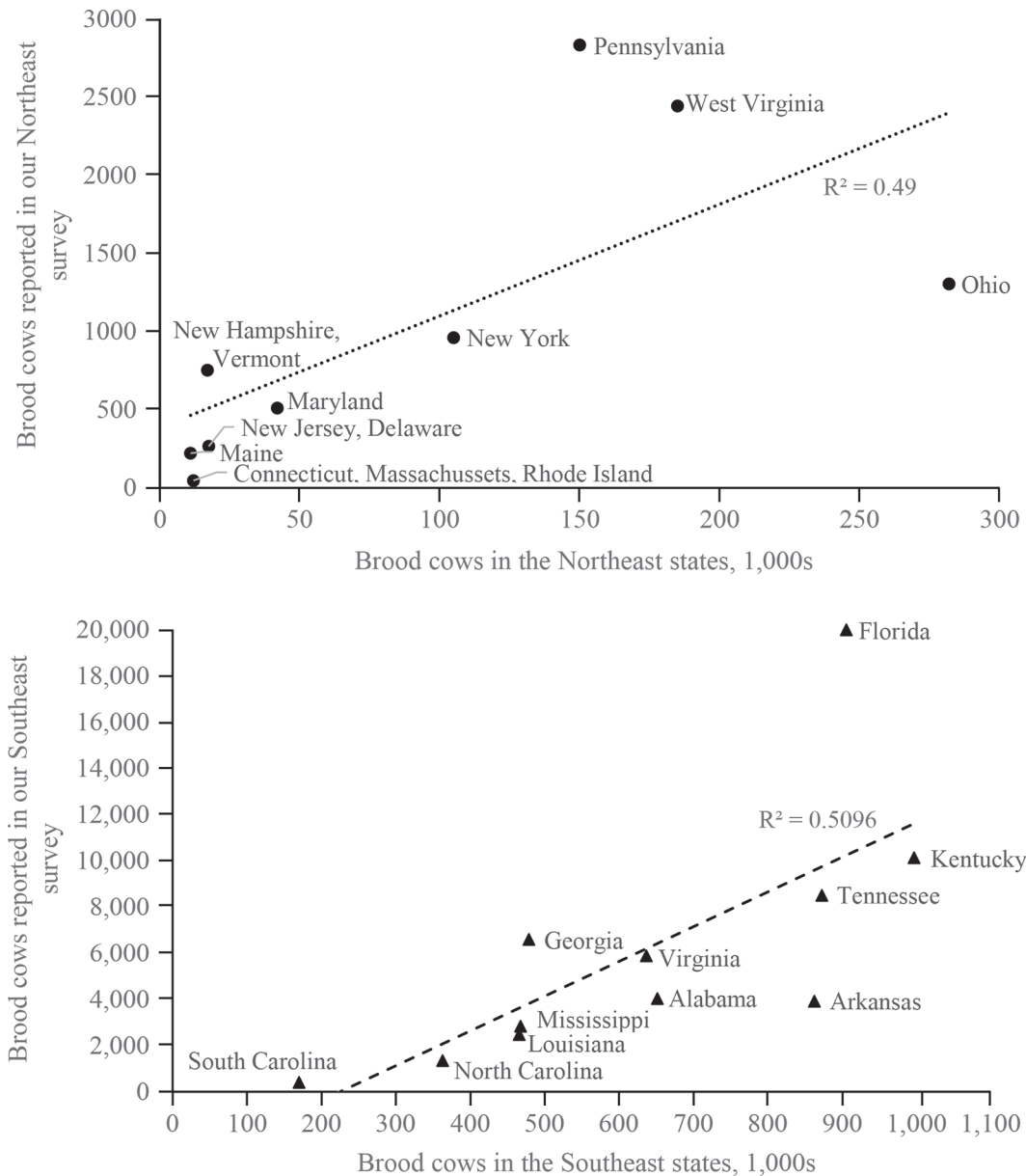


Figure 1. Number of beef cows in each state represented in the regional surveys compared with the total number in each state reported by NASS (2017).

Table 2. Results from the beef cattle farm survey for the Southeast (n = 659) and Northeast (n = 156)

Characteristic	Unit	Northeast ¹	Southeast ²	Combined ³
Farms with cows	% of farms	98.1	96.7	96.9
Small farm, 100 cows or less	% of farms	85.9	78.0	78.9
Cow-calf only	% of cows	47.8	31.0	32.8
Cow-calf and stocker	% of cows	21.5	58.8	54.7
Cow-calf to finish	% of cows	24.9	22.7	22.9
Farms with stockers	% of farms	56.3	18.5	22.3
Small farm, 100 stockers or less	% of farms	72.4	47.2	49.9
Cow-calf and stocker	% of stockers	64.7	38.8	41.6
Stocker only	% of stockers	23.6	14.2	15.2
Stocker to finish only	% of stockers	94.1	51.7	56.3
Farms finishing cattle	% of farms	4.1	48.2	43.4
Grass-finished cattle	% of finished cattle	1.8	0.1	0.3
Portion of farms	% of farms	61.5	47.2	48.8
Growth implants used	% of farms	41.5	36.8	37.3
Portion of stockers	% of stockers	60.3	13.5	18.6
Housing type (some use multiple types)		10.5	31.4	29.1
Primarily on pasture	% of farms	61.2	77.2	75.5
Open lot	% of farms	80.6	96.8	95.0
Bedded pack barn or open shed	% of farms	25.8	9.9	11.6
Freestall barn	% of farms	34.2	4.0	7.3
Harvested pasture land	% of farms	15.5	9.1	9.8
Portion harvested each year	% of land	57.6	62.8	62.2
Clipped	% of land	16.5	7.7	8.7
Pasture reestablishment	% of farms	43.9	6.6	10.7
Little or no reestablishment	% of land	44.3	52.8	51.9
Reestablishment period	yr	67.1	76.2	75.2
Small grain grazed	% of farms	9.6	8.9	9.0
Crop residue grazed	ha/animal	10.6	22.1	20.8
Purchased forage	kg of DM/animal per day	0.13	0.31	0.3
Purchased concentrate	kg of DM/animal per day	13.3	5.9	6.7
Nitrogen fertilizer use	% of farms	0.17	0.17	0.2
Fertilizer used	kg of DM/animal per day	3.30	3.52	3.5
Amount used by those that fertilize	kg of N/ha	0.59	0.59	0.6
Phosphate fertilizer	% of farms	43.1	64.9	62.5
Fertilizer used	% of land	29.4	25.7	26.1
Amount used by those that fertilize	kg of P ₂ O ₅ /ha	79.3	104.8	102.0
Potash fertilizer	% of farms	17.5	45.8	42.7
Fertilizer used	% of land	11.5	13.7	13.5
Amount used by those that fertilize	kg of K ₂ O/ha	48.8	67.7	65.6
Lime use	% of farms	24.6	50.0	47.2
Fertilizer used	% of land	12.3	19.3	18.5
Amount used by those that fertilize	kg of K ₂ O/ha	57.7	70.1	68.7
Other feed crops grown	% of farms	57.4	79.2	76.8
Lime use	% of land	6.1	17.7	18.2
Other feed crops grown	ha/animal	60.7	28.9	32.4
		0.63	0.35	0.40

¹The Northeast region includes Connecticut, Massachusetts, and Rhode Island (n = 2); Maine (n = 8); Maryland (n = 5); New Jersey and Delaware (n = 5); New York (n = 23); Ohio (n = 19); Pennsylvania (n = 66); Vermont and New Hampshire (n = 18); and West Virginia (n = 10).

²The Southeast region includes Alabama (n = 29), Arkansas (n = 26), Florida (n = 23), Georgia (n = 96), Kentucky (n = 208), Louisiana (n = 23), Mississippi (n = 31), North Carolina (n = 21), South Carolina (n = 5), Tennessee (n = 155), and Virginia (n = 42).

³Weighted average with 10.9% of beef cows in the Northeast (NASS, 2017).

and 21 cows per bull in the Southeast and ranged between 1 to 100 cows and 1 to 50 cows per bull, respectively, in the Northeast and Southeast (Table 3). Earlier surveys reported the number of cows per bull as 18.2, 19.0, 19.8, and 19.3 in the Southern Plains, Northern Plains, Midwest, and West US, respectively (Asem-Hiablíe et al., 2015, 2016, 2017), and these were comparable to the Northeast. The mean cow-to-bull ratios reported for the Northeast were greater than those for the Southeast ($P < 0.05$).

Reported brood cow BW were 595 ± 73 kg in the Northeast, which was greater than the 553 ± 66 kg reported in the Southeast ($P < 0.05$, Table 3). This difference follows a trend found across the country with larger animals in the north (Asem-Hiablíe et al., 2015, 2016, 2017). These BW also correspond well with a reported average carcass weight of 288 kg for cows assuming 50% dressing (NASS, 2017).

Reported annual stocking rates for cow-calf pairs were similar across both regions, with means of 1.0 ha/cow-calf pair (Table 3). The given ranges per cow-calf pair were 0.1 to 6.5 ha in the Northeast and 0.1 to 8.1 ha in the Southeast (Table 3). Mean and median annual stocker stocking

rates for the Northeast were similar to values for cow-calf pairs but the reported range was smaller at 0.1 to 2.4 ha/stocker. Stocker stocking rates in the Southeast were almost twice that of cow-calf pairs, with a mean and median of 0.6 and 0.4 ha, respectively, and ranged up to 4.9 ha. In comparison with previous surveys, these stocking rates were among the greatest recorded for mainland US (Asem-Hiablíe et al., 2015, 2016, 2017). The greater stocking rates found in the East were largely due to the greater yielding grasslands in the wetter regions of the eastern US (Table 1) along with more intensive fertilization practices (Table 2).

A large number of farms in the eastern regions kept their cows on pasture year-round (Table 2). However, those in the Northeast also used bedded pack barns or open sheds (34.2%) and freestall barns (15.5%), primarily for winter housing. Less than 10% of the Southeast producers reported using each of these types of housing. The warmer climate in the Southeast is more supportive of year-round grazing and calving in the open than the colder Northeast (Table 1). Compared with previous studies, the greatest proportion of farms using animal housing was reported

Table 3. Summary of management practices used on beef cattle farms (cow-calf only, cow-calf and stocker, and cow-calf to finish) in the Northeast (n = 156) and Southeast (n = 659)

Management characteristic	Mean	Median	Minimum	Maximum	SD	Responses
Northeast¹						
Brood cows maintained (no. of cows)	61 ^a	30	2	750	101	153
Cows per bull (ratio)	18 ^a	17	1.2	50	11	127
Replacement heifers per cow (ratio)	0.25	0.24	0.0	0.83	0.15	137
Stockers (no. of animals)	75	15	1	3,000	299	113
Average brood cow BW (kg)	595 ^a	590	363	817	73	150
Average annual stocking rate for cows (ha/cow-calf pair)	1.0	0.8	0.1	6.5	0.8	126
Average annual stocking rate for stockers (ha/stocker)	0.8	0.8	0.1	2.4	0.5	37
Weaning age (mo)	7.2	7.0	3	12	1.4	94
Finish age (mo)	19.9	20.0	7	36	4.8	89
Annual labor to feed and maintain cattle (person-h/animal)	47	26	2	780	89	125
Southeast²						
Brood cows maintained (no. of cows)	104 ^b	40	2	12,223	508	637
Cows per bull (ratio)	21 ^b	20	1.0	100	11	594
Replacement heifers per cow (ratio)	0.25	0.20	0.0	2	0	549
Stockers (no. of animals)	176	30	1	8,000	748	311
Average brood cow BW (kg)	553 ^b	545	363	863	66	622
Average annual stocking rate for cows (ha/cow-calf pair)	1.0	0.8	0.1	8.1	0.6	597
Average annual stocking rate for stockers (ha/stocker)	0.6	0.4	0.1	4.9	0.7	137
Weaning age (mo)	7.8	7.0	2.0	18	2.0	461
Finish age (mo)	18.2	18.0	12	36	4.0	75
Annual labor to feed and maintain cattle (person-h/animal)	33	22	1	520	44	565

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

¹The Northeast region includes Connecticut, Massachusetts, and Rhode Island (n = 2); Maine (n = 8); Maryland (n = 5); New Jersey and Delaware (n = 5); New York (n = 23); Ohio (n = 19); Pennsylvania (n = 66); Vermont and New Hampshire (n = 18); and West Virginia (n = 10).

²The Southeast region includes Alabama (n = 29), Arkansas (n = 26), Florida (n = 23), Georgia (n = 96), Kentucky (n = 208), Louisiana (n = 23), Mississippi (n = 31), North Carolina (n = 21), South Carolina (n = 5), Tennessee (n = 155), and Virginia (n = 42).

in the Northeast, whereas the Southeast more closely resembled other regions (Asem-Hiablíe et al., 2016).

Of the farms finishing cattle in both regions, about 37% of their cattle were reported as grass finished (that is, fed all-forage diets; Table 2). More farms in the Northeast (60%, $n = 131$) reported finishing portions of their cattle on all-forage diets compared with the Southeast (13.5%, $n = 579$); however, they each reported similar portions of grass-fed cattle. This was because most grass-finishing farms in the Northeast were small (<100 brood cows), finishing less than 40 animals. Across all regions, only the Northwest region reported a similar portion of grass-fed animals among cattle finished on farms, i.e., on the operation in which they were born (Asem-Hiablíe et al., 2017).

About 11 and 31% of farms in the Northeast and Southeast, respectively, reported administering growth-promoting treatments to at least a portion of their cattle. Responses indicated that close to three-fourths of the stockers in the eastern regions received growth-promoting treatments (Table 2). Similar to the Southeast, 30% of farms in the Western Plains and Southern Plains regions also administered growth treatments to 62 and 77% of the stockers produced in those regions, respectively (Asem-Hiablíe et al., 2015, 2017).

Supplemental forage was purchased by 24 and 38% of responding operations in the Northeast and Southeast, respectively. This represented the amount of forage required beyond that produced as pasture or harvested on the farm. The estimated average amount of purchased forage was similar for both regions at 3.5 kg of DM/d per animal (Table 2). Likewise, the average amount of purchased concentrate fed as supplemental feed in both regions was about 0.6 kg of DM/d per animal with no correlation to farm size. Amounts of purchased forage fed were comparable to values reported for the Northern Plains and Midwest (Asem-Hiablíe et al., 2016). Supplemental forage was mostly dry hay or bale silage, whereas more variations in concentrates were reported. These included creep, starter, and finishing feeds as well as food industry by-products such as corn gluten, soybean hulls, distillers grains, citrus pulp, and bakery waste bread in the Northeast. Purchased concentrates reported in the Southeast included commercial starter, grower, and finish feeds and industry by-products including soybean hulls, corn gluten feed, cottonseed, peanut skins, hominy, wheat middlings, molasses, chocolate processing residuals, and cotton gin residuals. Mineral supplements in the form of salt blocks and protein supplements were also purchased.

Crop Production and Grazing Practices. In the northeastern states, pastures were dominated by cool-season grasses and legumes, including orchardgrass (*Dactylis glomerata* L.); bluegrass (*Poa pratensis* L. and *Poa annua* spp.) species; bromegrass (*Bromus inermis* L.); timothy (*Phleum pratense* L.); and white and red clovers (*Trifolium repens* L. and *Trifolium pratense* L., respectively), which produced forage for 5 to 9 mo of the year depending on climate and soil conditions. Plant species that com-

monly comprised pasturelands in the Southeast included warm-season grasses such as bermudagrass (*Cynodon dactylon* L.) and bahiagrass (*Paspalum notatum* Flueggé), as well as legumes such as alfalfa (*Medicago sativa* L.), clovers (mostly white and red), and joint (deer) vetch (*Aeschynomene* L.). Cool-season grasses [e.g., annual ryegrass (*Lolium* spp.), winter cereal rye (*Secale cereale* L.), winter wheat (*Triticum aestivum* L.), and so on] were used commonly in the Southeast during winter months to extend the grazing season, and they were sometimes harvested in spring for conserved feeds. Tall fescue (*Schedonorus arundinaceus* Schreb.) was the dominant perennial cool-season grass in states of the northernmost latitude in the southeast region, including Tennessee; Kentucky; Virginia; North and South Carolina; and northern Alabama, Mississippi, and Arkansas. Tall fescue permitted near year-round grazing opportunities for beef producers in those states when stockpiled.

Reported stocking rates aided in estimating the pasture land areas on which animals were grazed. A trend toward larger pasture areas per farm in the south was observed, with reported average sizes of 85 ha ($n = 137$) in the Northeast and 236 ha ($n = 603$) in the Southeast. This was primarily because herd sizes were typically larger in the Southeast than in the Northeast (Table 3). Pastureland areas of individual farms were up to 75,700 ha in the Southeast and 4,600 ha in the Northeast for cow-calf operations.

More than half the respondents in both regions reported harvesting some of their pasture as stored forage for winter feed. More pasture harvesting occurred in the Northeast than in the Southeast, with reported areas of 16.5 and 7.7% of available pasture, respectively (Table 2). When pastureland was harvested, it was mostly stored as dry hay under cover, dry hay uncovered, or bale silage by 29, 23, and 12% of farms, respectively, on Northeast farms. In the Southeast, harvested pasture was stored as dry hay under cover, dry hay uncovered, and bale silage by 40, 20, and 3%, of farms, respectively. Of the unharvested grazed pastureland, a major portion in the Northeast (44%) and much less in the Southeast (7%) was clipped to help manage forage quality and control weeds.

Pasture reestablishment was practiced in both regions. Although more producers reestablished their pasture in the Southeast, the total portion of land reestablished was slightly larger in the Northeast (Table 2). Combined, 75% of the pastureland in the eastern regions received little or no reestablishment. About half of the respondents reported reestablishing pasture with the period between plantings averaging 9 yr. When establishing grazing lands, no-tillage systems were the predominant practice, with 61 and 78% of farms reporting this practice in the Northeast and Southeast, respectively. Minimum tillage (3 passes) was the next in preference, reported for 21 and 16% of farms in the Northeast and Southeast, respectively. Conventional tillage (more than 3 passes) was practiced by 16% of farms in the Northeast and 6% in the Southeast.

Wheat and other small grains were grazed in both regions, although more commonly in the Southeast (0.31 ha/animal grazed annually) than in the Northeast (0.13 ha/animal, Table 2). Additionally, when available, crop residue (mostly corn stalks) was grazed in both regions and averaged 0.2 ha/animal (Table 2).

Soil amendment use on grazing lands was reported for some farms. Nitrogen fertilizer use on pasture was prominent among farms in the Southeast (65%) compared with the Northeast (43%); however, almost equal portions of pastureland in both regions received nitrogen, with a combined total of 26% (Table 2). The types of nitrogen fertilizer used were similar in both regions, with most (close to 35%) using urea, 15% using urea-ammonium nitrate, 10% using ammonium sulfate, and under 5% reporting anhydrous ammonia. In the Southeast, other sources of nitrogen were reported for 10% of farms, about 8% of which used organic manure sources such as poultry litter. Manure sources used by 18% of farms in the Northeast were primarily dairy manure. A few farms ($\geq 6\%$) relied on more than one type of nitrogen source. When used, the annual amounts reported averaged 79 and 105 kg of N/ha in the Northeast and Southeast, respectively. About half of the responding farms in the Southeast used phosphate and potash fertilizers, whereas a quarter or less used either in the Northeast (Table 2). Slightly more land was reported to receive both fertilizers in the Southeast than in the Northeast. In the Northeast, about 12% of land received annual rates of 49 kg of P_2O_5 /ha and 58 kg of K_2O /ha. Responses from the Southeast indicated that 14 and 19% of land received P_2O_5 and K_2O fertilizers, respectively, at annual rates close to 70 kg/ha each. Lime was used on about 6 and 18% of pastureland in the Northeast and Southeast, respectively.

In addition to pasture, about 61 and 29% of responding farms in the Northeast ($n = 85$) and Southeast ($n = 176$), respectively, produced other feed crops for their beef cattle, using 0.63 ha/animal in the Northeast and 0.35 ha/animal in the Southeast (Table 2). Of the total land area cultivated with additional feed crops in the Northeast, about 70% was forage crops of which alfalfa made up 12%. Various grasses including sorghum-sudangrass (*Sorghum bicolor* \times *S. bicolor* var. *sudanese*), triticale (\times *Triticosecale*), and timothy were grown with clover and other legumes. Corn (*Zea mays* L.) was grown on 11% of the cropland, and the remaining 20% was composed of barley (*Hordeum vulgare* L.), soybeans (*Glycine max* L.), spelt (*Triticum spelta* L.), and cereal rye. Cover-cropping and over-seeding (broadcasting or drilling forages, such as red clover, onto existing perennial pastures) were observed practices in the Northeast. In the Southeast, perennial forages including alfalfa (4%) made up 55% of the additional feed producing cropland. The main forage types included fescue, orchardgrass, millet (*Echinochloa esculenta* L.), sorghum-sudan, rye, and clovers. Mixes of up to 5 forages, often including oat (*Avena sativa* L.), rye, triticale, clover, and radish (*Raphanus* L.), were also reported. There

was a greater prevalence of feed crop cultivation in the Northeast demonstrated by the greater portion of farms cultivating feed crops and larger areas per animal than in the Southeast. Most of these crops in the Northeast were fed as silage, haylage, or corn earlage. The climate of the Southeast (Table 1) favored a longer growing season and almost year-round grazing; hence, there was less need for additional feed production and storage. The intensive management required by cultivated feed crops may also have been more suitable for the smaller-sized operations of the Northeast.

Labor. The annual labor required for cattle feeding and maintenance varied widely among farms, with reported means of 47 person-h/animal in the Northeast and 33 person-h/animal in the Southeast (Table 3). These labor requirements were the greatest recorded among the cattle producing regions in the US (Asem-Hiablie et al., 2017). This is likely due to more small operations (less than 20 cows) in these regions, which require more labor per animal. Due to the large range in reported data, no strong correlation was found between herd size and labor needs per animal in either region. The maximum labor requirements per animal though were recorded on very small operations maintaining 5 brood cows or less.

Equipment. Equipment type and use information was obtained from farm visits. Equipment recorded in both regions were tractors, utility vehicles, assortments of trucks, trailers, loaders (mostly, skid-steers and payloaders), and semi-trucks and trailers. Crop production equipment were also recorded on farms producing their own feed, and this was more common in the Northeast. These included planting, harvesting, and hay processing equipment as well as manure applicators.

Tractors reported in both regions ranged in power from 30 to 160 kW. There was a maximum of 6 tractors on operations, with the number of tractors used being proportional to the herd size managed. On the average, cow-calf farms reported one tractor for every 37 brood cows (range of 3 to 130 cows) in the Northeast and 163 brood cows (range of 22 to 764 cows) in the Southeast. Tractor use per operation averaged 350, 1,215, and 709 h/yr on cow-calf, cow-calf and stocker, and cow-calf-to-finish operations, respectively, in the Northeast. In the Southeast, average reported tractor use was 2,220, 607, and 1,383 h/yr on cow-calf, cow-calf-to-finish, and stocker-only operations.

About 70% of operations in each of the 2 regions operated utility vehicles and all-terrain vehicles, with a maximum number of 4 units per farm. Usage per unit averaged one per 64 brood cows on cow-calf farms, 388 animals on cow-calf and stocker operations, and 269 animals on cow-calf-to-finish operations in the Northeast. In the Southeast, each unit served on the average 724 brood cows, 371 animals, and 2,667 animals on cow-calf only, cow-calf and stocker, and stocker-only operations. Similar to tractors, the number of utility vehicles and all-terrain vehicles increased with operation size.

Different types of trucks suited to a variety of purposes were recorded during farm visits. On average, 2 or 3 trucks were listed per farm, with 174 and 348 animals served per truck, respectively, in the Northeast and Southeast, respectively. Average annual traveling distances given per farm were 32,400 km in the Northeast and 52,240 km in the Southeast. Generally, truck units increased proportionally with animal numbers on cow-calf and stocker operations. Compared with the majority (85%) who may have custom hired in the Northeast, a considerable number of farms in the Southeast (46%) owned semi-trucks and trailers for feed and animal hauling. One to three trailers were reported per farm and each served on the average 350 or 940 animals in the Northeast or Southeast, respectively.

Horses for herding cattle and donkeys for predator control were more common in the Southeast, where 42% of responding operations owned up to 30 horses with each servicing 256 animals on the average. Similar to some farm equipment, the number of horses was proportional to herd size in the Southeast. Only 2 operations reported owning horses or donkeys in the Northeast, and they were used in managing between 45 and 120 animals each.

Energy Use. Similar to previous regions, energy use records were not readily available and when obtained, varied widely among farms due to uncertainty in estimates by producers as well as differences in management (Asem-Hiablíe et al., 2015, 2016, 2017). Average fuel use estimates for the Northeast in diesel equivalents was 78 L/brood cow and varied between 25 and 126 L/cow on cow-calf operations ($n = 4$), whereas on cow-calf-to-finish operations, the average was 33 L/animal with a range of 1.4 to 71 L/animal ($n = 6$). Comparatively, Asem-Hiablíe et al. (2016) reported fuel use of 38 L/animal on cow-calf-to-finish operations in the Midwest and Northern Plains. Rotz et al. (2013) and Asem-Hiablíe et al. (2015, 2017) also reported fuel use estimates of 33 L/cow at the US Meat Animal Research Center, Nebraska, 32 L/cow in the Southern Plains, and 36 L/cow in the Northwest, respectively, for cow-calf operations. A cow-calf and stocker operation estimated 21 L/animal as fuel use, and this was similar to the value of 23 L/animal estimated for the same kind of operation in the Northwest (Asem-Hiablíe et al., 2017). A stocker-to-finish operation reported 11 L/animal, comparable to that recorded for stocker-only operations in the Southern Plains and Midwest (Asem-Hiablíe et al., 2015, 2016). In the Southeast, estimated average fuel use for cow-calf operations and cow-calf and stocker operations were given as 71 L/cow ($n = 14$) and 67 L/animal ($n = 9$), respectively. Fuel use ranges for these operations in the Northeast and Southeast were between 1 and 126 L/animal and 6 and 207 L/animal, respectively. Meanwhile, stocker-backgrounder operators in the Southeast reported an average of 9 ± 2 L/animal. The reported mean fuel use for the Southeast was similar to the Southwest region but greater than reported use for other regions (Asem-Hiablíe et al., 2015, 2016).

Reported electricity use was similar for cow-calf and cow-calf-to-finish operations at 30 kWh/cow (range of 4 to 87 kWh/cow) and 26 kWh/animal (range of 11 to 53 kWh/animal), respectively, in the Northeast. Electricity use was relatively low for cow-calf stocker at 12 kWh/head. In the Southeast, reported electricity use varied between 20 and 181 kWh/cow, with a reported average of 64 kWh/cow ($n = 9$). Cow-calf stocker operations reported a mean electricity use of 81 kWh/animal and a range of 4 to 254 kWh/animal ($n = 8$). As with fuel use and similar to other regions (Asem-Hiablíe et al., 2016), stocker operations reported low mean electricity values of 3 to 11 kWh/stocker (mean of 7 kWh, $n = 5$). The estimated electricity use values reported for the eastern regions fell within similar ranges as for the Southern Plains, Midwest, and Northern Plains (Asem-Hiablíe et al., 2015, 2016).

Feedlots

A total of 35 feedlot responses, including 11 on-site interviews, were received from the Northeast, and in the Southeast, 20 feedlot responses, including 2 visits, were recorded (Table 4). According to national census data for beef cattle (NASS, 2017), the number of cattle finished in the eastern regions is relatively small compared with other regions, with approximately 407,000 finished annually in the Northeast with 100,000 in the Southeast. Our survey accounted for 15,635 and 23,150 feeder cattle in the Northeast and Southeast, or about 4 and 23% of the beef cattle produced in these regions, respectively.

Feedlot Sizes and Types. Reported feedlot sizes were larger in the Southeast compared with the Northeast, with average maximum one-time capacities of 317 and 807 cattle, respectively (Table 4). The larger capacity of the Southeast region was primarily due to a feedlot with one-time capacity of 8,000 without which the mean reduced to 327 cattle. Mean finished cattle per one-time capacity was 1.0 ± 0.50 in the Northeast and greater in the Southeast (1.4 ± 1.25) due the presence of a relatively high portion of backgrounding operations, which produced a quicker turnover in the south. The Southeast was similar to the Midwest, Northern Plains, and Southwest in the ranges of capacities versus number of cattle finished annually, with all finishing 20 to 30% over their one-time capacities (Asem-Hiablíe et al., 2015, 2016, 2017).

Of the 20 operations reported in the Southeast, only one was characterized as a finishing-only facility, and the remainder were either backgrounding only or combinations of backgrounding and finishing. The majority of the participating operations in the Northeast finished cattle only (58%), and fewer (35%) backgrounded and finished cattle. Compared with observations from other regions, the east maintained the fewest number of finishing cattle (Asem-Hiablíe et al., 2015, 2016, 2017). A major portion of cattle are likely shipped west to finishing facilities closer to feed sources.

Table 4. Summary of survey results for feedlot and feeding characteristics in the Northeast (n = 35) and Southeast (n = 20)

Management characteristic	Unit	Mean	Median	Minimum	Maximum	SD	Responses (no.)
Northeast¹							
Maximum capacity	Cattle	317	175	20	2,200	442	35
Cattle finished/capacity	Ratio	1.0	1.0	0.35	2.2	0.50	35
Stocker cattle grazed	Cattle	28.1	0	0	300	72	12
Enter weight, finish	kg	304	295	181	397	52	27
Finished weight	kg	608	612	510	680	41	27
Portion backgrounded	%	65	90	0	100	44	16
Backgrounding period	d	134	84	28	364	118	12
Backgrounding feed intake per day	kg of DM/animal	8.6	9.1	5.6	12.3	1.9	9
CP of background diet	%	13.8	14.0	12.0	16.0	1.2	10
Finish period	d	164	155	56	364	83	26
Finishing feed intake per day	kg of DM/animal	10.9	10.9	7.0	14.5	2.1	18
CP of finish diet	%	12.8	12.5	11.3	15.0	1.0	18
Annual labor use	person-h/animal	12.9	5.6	0.9	53.0	14.7	22
Southeast²							
Maximum capacity	Cattle	807	175	16	8,000	1,960	16
Cattle finished/capacity	Ratio	1.4	0.9	0.10	4.0	1.25	16
Stocker cattle grazed	Cattle	709	185	12	3,000	909	14
Enter weight, background	kg	223	227	136	329	53	13
Enter weight, finish	kg	336	306	272	454	64	8
Finished weight	kg	502	485	431	636	75	6
Portion backgrounded	%	75.5	100	30	100	30	11
Backgrounding period	d	108	70	28	280	84	9
Backgrounding feed intake per day	kg of DM/animal	8.0	6.4	2.7	22.7	6.8	7
CP of background diet	%	12.2	12.0	10.0	14.0	1.5	8
Finish period	d	154	200	28	260	99	5
Finishing feed intake per day	kg of DM/animal	10.1	9.5	9.1	11.8	1.5	3
CP of finish diet	%	14.3	14.5	13.0	15.5	1.3	3
Annual labor use	person-h/animal	57.4	43.3	1.3	138.7	60.4	9

¹Northeast responses include Connecticut, Massachusetts, and Rhode Island (n = 1); Maine (n = 2); New Jersey and Delaware (n = 3); New York (n = 6); Ohio (n = 5); Pennsylvania (n = 12); Vermont and New Hampshire (n = 3); and West Virginia (n = 3).

²Southeast responses include Florida (n = 3), Kentucky (n = 11), North Carolina (n = 1), Tennessee (n = 4), and Virginia (n = 1).

A few responding operations in the Northeast (15%, n = 3) and the Southeast (33%, n = 4) finished at least some Holsteins obtained from dairies (Table 5). Proportionately, finished Holstein cattle made up an average of 34% of cattle reported on these northeastern feedlots and 2.5% of cattle finished in the region. Considering the large dairy industry in the Northeast, more cull Holstein calves are produced than traditional beef breeds (NASS, 2017). Large portions of these calves are shipped to other regions, but we still apparently missed most of those operations finishing Holsteins through our survey. In the Southeast, Holsteins made up about 1% of feeder cattle reported in the region. This low percentage appears reasonable compared with the number of dairy cows relative to beef cows in the region (NASS, 2017).

Most the operations surveyed in the Northeast used barns for cattle housing, whereas those in the Southeast preferred open land and open lots (Table 5). The cold winter climate of the Northeast (Table 1) requires greater use of enclosed housing facilities.

Cattle Management. Some operations maintained stockers on pastures along with their feedlots. In the Northeast, about a third of the operations maintained 13% of their stockers (Table 5). The Southeast, with almost year-around grazing, seemed better suited to this practice as the majority of operations (70%) maintained stockers grazed on pastures. Compared with other regions, the Southeast feedlots grazed the greatest portion of stockers (Asem-Hiablie et al., 2015, 2016, 2017).

Table 5. Summary of feedlot management characteristics from survey responses in the Northeast (n = 35) and Southeast (n = 20)

Characteristic	Unit	Northeast ¹	Southeast ²	Combined ³
Feed crops produced ⁴	% of operations	89	69	86
	ha/animal produced ⁵	0.58	0.20	0.52
Housing facilities				
Maintained on open land	% of operations	3	78	14
Open lot	% of operations	22	33	24
Barn	% of operations	69	28	63
Stocker cattle maintained on pasture	% of operations	32	70	38
Portion of cattle finished on operation ⁶	% of finished cattle	13	>100	36
Portion of cattle finished in region	% of finished cattle	6	43	12
Holstein cattle produced	% of operations	15	33	18
Portion on operation ⁷	% of cattle	34	15	31
Portion in region	% of cattle	2.5	0.9	2.3
Cattle produced "natural"	% of operations	46	31	44
Portion produced on "natural" operations ⁸	% of cattle	88	35	80
Portion produced in region	% of cattle	51	26	47
Manure removal				
Once per year	% of operations	0	60	9
Twice per year	% of operations	17	10	16
Three or more times per year	% of operations	83	30	75
Manure use				
Applied to cropland producing feed	% of manure	70	99	74
Applied to nonfeed crops	% of manure	5	1	4
Processed and sold as compost	% of manure	25	0	21

¹Northeast responses include Connecticut, Massachusetts, and Rhode Island (n = 1); Maine (n = 2); Maryland (n = 1); New Jersey and Delaware (n = 3); New York (n = 6); Ohio (n = 5); Pennsylvania (n = 12); Vermont and New Hampshire (n = 3); and West Virginia (n = 3).

²Southeast responses include Florida (n = 3), Kentucky (n = 11), North Carolina (n = 1), Tennessee (n = 4), and Virginia (n = 1).

³Weighted average with 85% of beef cattle on feed in the Northeast (NASS, 2017).

⁴Hectares produced per finished animal for all operations producing crops.

⁵Excludes grass-finishing operations, where feed-crop production averaged 1.5 ha/animal finished.

⁶The portion of total cattle finished that are grazed on those operations that include grazing of stockers.

⁷The average portion of Holsteins in the herd on those operations that include Holstein cattle.

⁸The portion of cattle produced without growth-promoting technologies on operations that produce some or all of their cattle without these technologies.

The mean incoming BW on feedlots was 304 ± 52 kg in the Northeast with a range of 295 to 397 kg (Table 4). Where cattle BW was in the lower range, incoming cattle were backgrounded. In the Southeast, backgrounding operations were mostly distinct from finishing operations. The entering BW for backgrounding facilities in the Southeast was 223 ± 53 kg, whereas on finishing-only operations, cattle entered weighing 336 ± 64 kg. Finished cattle in the Northeast weighed on the average 608 ± 41 kg, similar to the values reported for the Midwest, Northern Plains, and Southwest regions (Asem-Hiablíe et al., 2016, 2017). The average finished BW of all responding operations in the Southeast was 502 ± 75 kg, which was less than that found in other regions within the continental US. A couple of large operations in this region finished

cattle at weights similar to those reported in other regions, so most cattle observed were produced at greater weights. Several smaller operations, including grass-finishing operations, created the relatively low average for the region.

The portion of cattle backgrounded on operations that included backgrounding averaged 65 and 76% in the Northeast and Southeast, respectively (Table 4). As previously mentioned, some operations (mostly in the Northeast) did not background cattle. All other cattle that were not backgrounded were fed high-concentrate feeds upon entering the finishing operations. The average backgrounding periods were 134 ± 118 d and 108 ± 84 d in the Northeast and Southeast, respectively, which were long compared with other regions (Asem-Hiablíe et al., 2015, 2016, 2017).

The daily DMI during the backgrounding period was 8.6 ± 1.9 kg of DM/animal in the Northeast and 8.0 ± 6.8 kg of DM/animal in the Southeast. Typical backgrounding diets varied between the regions; the Northeast fed more silage, whereas hay was predominant in the Southeast rations (Figure 2). In the western regions also, silage was the predominant forage source in the north, whereas hay was primary in the south (Asem-Hiablíe et al., 2017). The warmer weather of the lower latitudes supported longer growing seasons and hay making unlike the colder weather of the north (Table 1). Distillers grains and other by-products such as soybean hulls and cottonseed meal were also fed by more operations in the Southeast than in the Northeast. The average CP content of backgrounding diets was reported to be $13.8 \pm 1.2\%$ in the Northeast and $12.2 \pm 1.5\%$ in the Southeast (Table 4).

Cattle were fed finishing rations for a period of 56 to 364 d in the Northeast and 28 to 260 d in the Southeast (Table 4). The mean finishing periods for cattle from both regions were comparable with those recorded in the Northwest but longer than those in the Southwest (Asem-Hiablíe et al., 2017) and shorter than those in the Midwest (Asem-Hiablíe et al., 2016). The daily finishing feed intake was similar in both regions and comparable with other regions (Asem-Hiablíe et al., 2015, 2016), with reported averages of 10.9 ± 2.1 kg of DM/animal and 10.1 ± 1.5 kg of DM/

animal from the Northeast and Southeast, respectively. There were differences in typical finishing rations between regions as seen for backgrounding diets. More corn grain and silage were fed in the Northeast compared with the Southeast, where hay was dominant as a forage source. The typical constituents of the total DMI amounts used on participating feedlots are shown in Figure 3. The reported CP of finishing diets were slightly less for the Northeast ($12.8 \pm 1.0\%$) than for the Southeast ($14.3 \pm 1.3\%$). The reported values were, however, consistent within the regions and fell within ranges observed in other regions (Asem-Hiablíe et al., 2015, 2016, 2017).

Finishing cattle “natural” (i.e., without growth-enhancing technologies) was common in the Northeast, with almost half of the responding operations producing 88% of their cattle (which represents 51% of cattle in the region) this way (Table 5). Although to a lesser extent, feedlots in the Southeast also produced a portion of their cattle without growth-enhancing technologies. Close to a third of the operations produced 35% of their cattle naturally, and these comprised 26% of cattle reported by the survey within the Southeast region. The most common growth enhancers used were growth implants, β -agonists, ionophores, and antibiotics (usually, tylosin).

Feed Production Practices. The majority of feedlots (69% and above; Table 5) produced feed crops on their

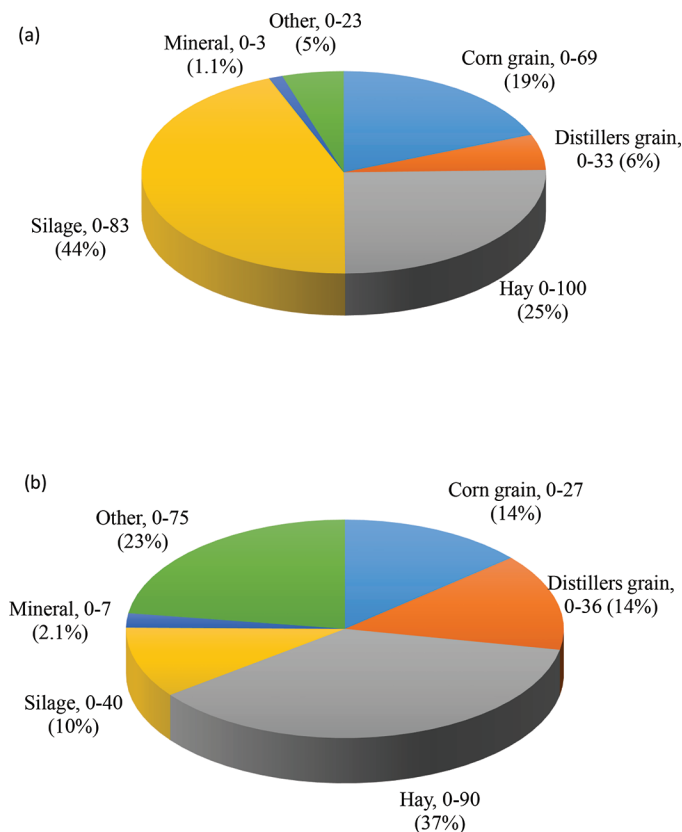


Figure 2. Range (and mean) of backgrounding diet constituents of total DMI for all participating feedlots in the Northeast (a) and Southeast (b). Color version available online.

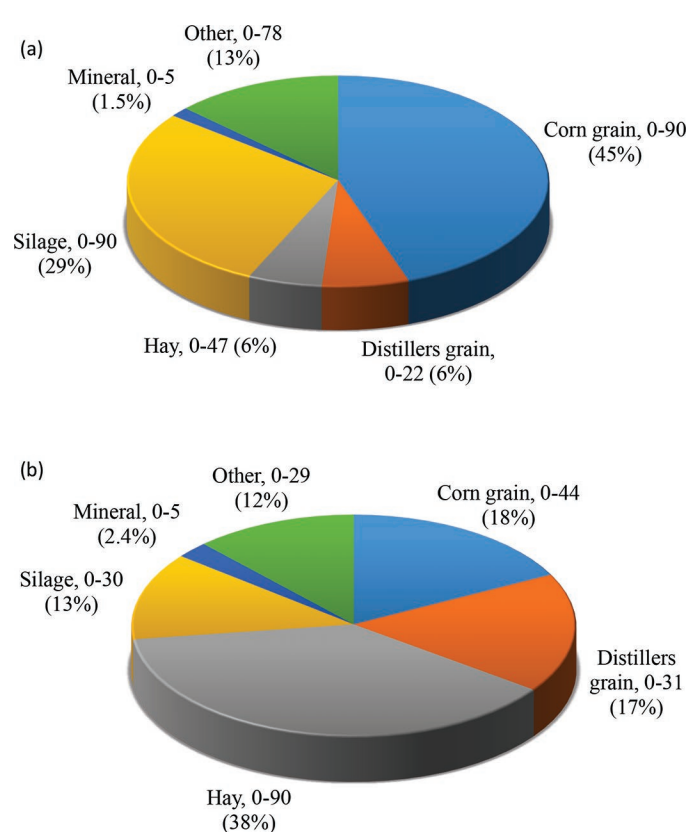


Figure 3. Range (and mean) of finishing diet constituents of total DMI for all participating feedlots in the Northeast (a) and Southeast (b). Color version available online.

operations for their cattle, and crop areas cultivated were 0.58 ha/animal in the Northeast and 0.20 ha/animal in the Southeast (Table 5). These crop areas were greater than those cultivated in other regions studied except for the Midwest, where the total crop area was 0.24 ha/animal (Asem-Hiablie et al., 2015, 2016, 2017). Similar crops (corn grain or silage, alfalfa or other legumes for hay, grass hay or silage, small grain hay or silage) were cultivated in both regions. Additionally, barley was cultivated in the Northeast by a few operations along with wheat, soybean, and fescue. Among producers who grew feed crops in the Northeast, corn was cultivated by 72% of operations for grain and 60% for silage. Grass harvested for hay or silage was grown by 48% of producers in the Northeast and 78% in the Southeast. Also in the Northeast, 24% of operations cultivated alfalfa and small grains harvested as hay or silage. In the Southeast, 33% of producers reported cultivating corn for grain or silage, legumes including alfalfa for hay, and small grains as hay or silage.

The majority of operations who cultivated feed crops applied soil amendments on cropland. Ninety percent of operations cultivating corn in the Northeast applied N fertilizer at rates ranging from 39 to 336 kg/ha with an average of 160 kg/ha. All operations in the Southeast cultivating corn applied N fertilizer at annual rates from 67 to 336 kg of N/ha with reported averages of 224 kg of N/ha for corn grain and 173 kg of N/ha for corn silage. In the Northeast, 75% of growers of grass hay or silage and 100% of those who grew small grains applied N fertilizer. Two-thirds of both grass and small grain growers applied N fertilizer. In both regions, urea ammonium nitrate was the most used form of N-fertilizer followed by urea, anhydrous ammonia, and ammonium sulfate. Other sources of N in the Northeast were additional manure from swine and poultry. Phosphate and potash were applied by about a third of corn growers and 41% of grass hay or silage producers, whereas neither was applied on small grains in the Northeast. Reported annual application rates for P_2O_5 and K_2O ranged from 22 to 224 kg/ha on corn. For grass silage or hay, applications ranged between 29 to 56 kg of P_2O_5 /ha and 29 to 224 kg of K_2O /ha. In the Southeast, phosphate and potash fertilizers were often applied together with N, and annual application rates ranged from 45 to 112 kg of P_2O_5 /ha and 56 to 112 kg of K_2O /ha on alfalfa and other legumes, grass, and small grains and up to 224 kg of P_2O_5 /ha and 336 kg of K_2O /ha on corn. Lime was applied on about 45% of corn-growing operations in the Northeast at annual rates ranging from 0.67 to 4.5 t/ha with an average of 2.6 t/ha. Sixteen percent of grass growers applied lime at annual rates between 2.2 and 4.5 t/ha. In the Southeast, lime was often applied on operations who also applied fertilizers and at rates between 2.2 and 4.5 t/ha.

No cropland was reported as receiving irrigation in the Northeast. A single operation in the Southeast reported irrigation for all crops grown including corn grain (51 cm), corn silage and alfalfa harvested as hay or silage (38 cm),

grass or small grains harvested as hay or silage (51 cm), and soybeans (76 cm).

Tillage practices differed between regions, but within regions similarities existed among crop types. In the Northeast, a similar proportion of grain and forage growers, 59 and 63%, respectively, practiced no-tillage seeding (i.e., 1 pass). It was also reported that 41 and 43% of operations cultivating grain or forage, respectively, employed minimum or conventional tillage (3 or more passes). In the Southeast, 86% of operations producing grain and forage used no-tillage seeding, whereas 14% used minimum tillage when growing grains.

Dry hay, when produced, was stored indoors, outdoors under cover, or outdoors uncovered by 69, 19, and 25% of operations in the Northeast ($n = 16$). Alfalfa- or grass-producing operations ($n = 13$) stored the forage in bunkers or as covered piles, bales (38%), bags (31%), or tower silos (8%). Corn silage was produced by 21 feedlots and stored in bags (43% of operations), or in bunkers, covered piles, or tower silos by at least a third of producers. Twenty-one feedlots reported producing dry corn grain, which was mostly stored in grain bins (62%), whereas producers of high-moisture corn ($n = 21$) used tower silos. In the Southeast, 82, 54.5, and 18.2% of the 11 hay-producing operations stored the forage indoors, outdoors under cover, or outdoors without cover, respectively. Few feedlots produced corn silage in the Southeast ($n = 3$), and two-thirds of them preferred storage in bags, whereas a third each used a bunker or pile uncovered, bunker or pile covered, or tower silo. Most feedlots producing corn (80%, $n = 5$) in the Southeast stored the dry grain in bins, and others stored dry grain in piles (40%) or high-moisture grain in bunker or tower silos (20%). For most feeds produced in both regions, more than one storage type was often reported.

Manure Management. Manure removal from cattle in confinement was done more frequently than twice a year by 83% of responding operations in the Northeast compared with 30% of operations in the Southeast (Table 5). As previously stated, fewer feedlots in the Southeast used barns, and hence, there were fewer operations with the need to remove manure as frequently. In both regions, 16% of operations were likely to remove manure from confinement facilities about twice a year. When manure was removed, it was reported to be applied to cropland by all operations ($n = 8$) in the Southeast and 70% of the 21 responding operations in the Northeast (Table 5). Five percent or less of feedlot manure from both regions was reported to be applied to land other than cropland producing feed. In the Northeast, 25% of the manure generated (the majority of which came from relatively large operations) was composted and sold to retailers.

Labor Requirement. Reported mean annual labor requirements per animal fed varied considerably between the regions (Table 4). In the Northeast, annual labor requirements averaged 12.9 person-h/animal and ranged from 0.9 to 53.0 person-h/animal. In the Southeast,

greater labor use was reported at an average value of 57 person-h/animal, ranging between 1.3 and 139 person-h/animal. No relationship was found between operation size or type and labor needs per animal. It was noted, however, that among the 9 responding feedlot operations in the Southeast, those reporting the greatest labor requirements (up to 130 person-h/animal; $n = 3$) finished at or below their one-time capacities (0.1 to 1), whereas those operations reporting the least labor requirements (down to 2.6 person-h/animal, $n = 4$) operated above capacity (1.5 to 4 turns). These labor requirements were the greatest reported compared with other regions, probably due in part to the smaller operations (Asem-Hiablie et al., 2015, 2016, 2017).

Equipment. Information on equipment use on feedlot operations was obtained from 11 feedlots in the Northeast and 2 in the Southeast during on-site visits. Equipment found common to both regions included tractors, trailers, loaders, utility vehicles, and trucks. The number of tractors per operation ranged from 2 to 10, with each serving on the average 85 fed cattle in the Northeast and 2,140 cattle in the Southeast. Average annual tractor hours per operation was 735 in the Northeast and 2,700 for an operation in the Southeast. The number of tractors was not proportional to the number of cattle managed. Payloaders were uncommon in the Northeast, with just one operation reporting its use as 1 per 1,341 cattle, and in the Southeast, a front loader was assigned to 8,000 fed cattle. Skid-steer loaders were owned by the majority of operations in the Northeast, with each being used to maintain an average of 327 cattle. Utility vehicles were reported on about half the operations in the Northeast, with a range of 1 to 6 and an average of 3 per operation and each unit supporting between 12 and 2,289 cattle in the Northeast and 8,140 cattle in the Southeast.

On average, there were 2 and 4 pickup trucks per operation in the Northeast and Southeast, respectively, with the number of these vehicles proportional to the number of animals produced annually. Each pickup truck was used to support between 53 and 2,289 animals in the Northeast and between 275 and 4,000 animals in the Southeast. Feed trucks were owned by a few operations (27%) in the Northeast, whereas one was reported in the Southeast. Trailers for hauling animals were also reported on operations in both regions. Manure trucks were recorded by a couple of operations in the Northeast. Other equipment recorded included feed mixers, and crop-producing equipment for those finishing operations cultivating feed crops.

Energy Use. Energy use information was also collected through farm visits. Fuel use ranged between 3 and 95 L/animal of diesel equivalent with an average of 37 L/animal in the Northeast ($n = 5$) and 3 L/animal for the Southeast ($n = 1$). The fuel use value for the Southeast was similar to that reported for the large feedlots of the Southern Plains, and the greater value for the Northeast was similar to that found in the other regions (Asem-Hiablie et al., 2015, 2017). Average electricity use was estimated as $41 \pm$

16 kWh/animal in the Northeast ($n = 4$) and 21 kWh/animal in the Southeast. Electricity values reported for the Northeast were comparable to the Southern Plains (32–38 kWh/finished animal; Asem-Hiablie et al., 2015) and Northern Plains (45 kWh; Asem-Hiablie et al., 2016). Use in the Southeast was similar to that reported for the western US (25 kWh/animal; Asem-Hiablie et al., 2017). The variability in fuel and electricity values was due to differences in management and energy choices. Some farms for instance reported using solar energy for pumping water.

IMPLICATIONS

The characterization of regional beef production practices provides guidance in preparing representative production systems to support more comprehensive analyses such as an LCA quantifying the sustainability of US beef. Although not a randomized sample, the survey and visit data provide information for a wide range in operation size and management for characterizing cattle production systems. Cow numbers represented by survey responses received from each state were moderately correlated with the NASS (2017) data by state, which implies that cattle production is appropriately represented throughout the regions. The major differences in management practices (feed crop cultivation, form of forage fed, and housing type) occurring between the colder north and warmer south demonstrate the influences of climate across regions. These eastern regions maintained the fewest number of finished cattle nationwide, supporting that cattle born in these regions are often finished in the western regions, closer to feed sources. Fuel and energy use estimates, although wide-ranging, were generally comparable with values reported for other regions, validating the usage values obtained in these regional studies.

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