Feasibility of a Tennessee Cull-Cow Processing Facility

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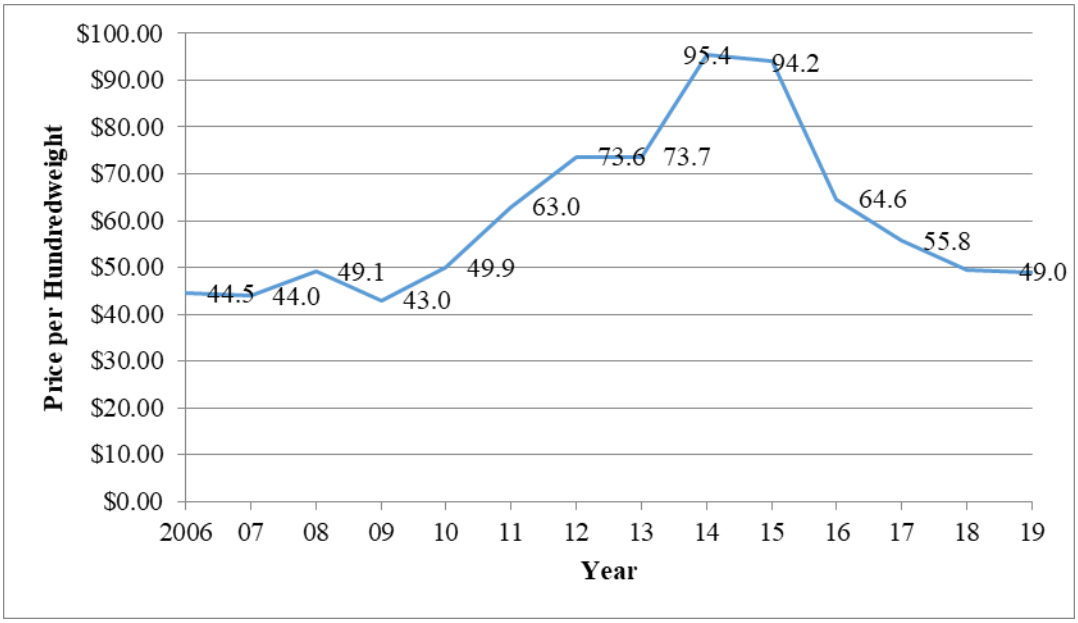
Introduction

Beef cattle and dairy farmers seek local markets for their culled livestock. Livestock processing facilities offer such opportunities and also assist rural communities in need of economic growth. Provided here is an analysis regarding the feasibility of a cull cattle processing facility in one of the 15 economically distressed counties in Tennessee. Initially examined is the cost of obtaining cows for processing at the facility, followed by a facility location analysis. A discussion of estimates regarding facility construction, facility equipment and facility labor needs and costs is followed by a discussion regarding facility output and revenue. Financial analysis regarding total cost and profitability including sensitivity analysis with respect to key variables is provided. Finally, overall feasibility of the facility is discussed and summary and conclusions are drawn.

Cost of Purchased Cows

The price of cull cattle (breakers, boners and lean) to be processed at the facility is based on analysis of over 13 years of live cow sales data (2006 through the spring of 2019) for 14 Tennessee livestock markets (86,854 observed sales for 404,871 cows sold) (USDA, 2019a). As shown in **Figure 1**, annual per hundred (live) weight prices

have ranged from $42.97 in 2009 to $95.42 in 2014. A fairly conservative (i.e., markedly higher than the last year average of $49) cost of $58 per hundredweight was used in our calculations. Average weight for all sold culls was 1,202.2 pounds, resulting in a cost of $697.25 per cow. We assume that the facility would process 55,000 cows annually. Accordingly, the annual cost of obtaining cattle for the facility was estimated at $38.349 million.



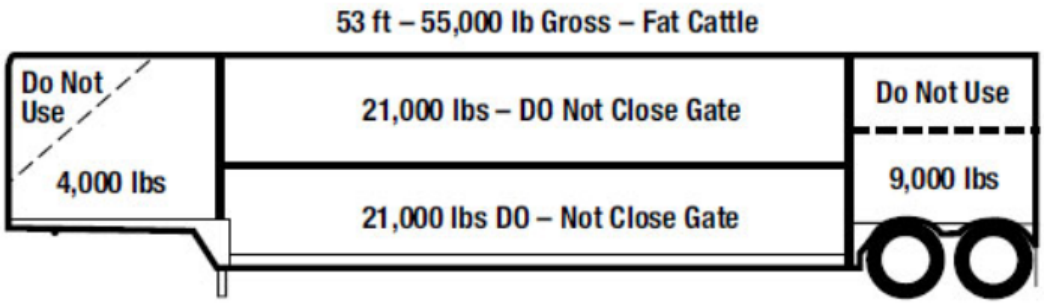
Source: USDA, AMS. 2019.

Figure 1. Annual Average Price Per Hundredweight Paid for Live Cows, Tennessee Livestock Markets, 2006 Through Spring of 2019.

Facility Location

While it was assumed that farmers would cover the costs of transporting animals to the processing facility, transportation costs were calculated to determine the optimal or least input transportation cost location of the facility.

Cattle were assumed to be transported on a 53-foot semitrailer truck (**Figure 2**). Based on the Texas A&M Extension's Custom Rate Survey in 2016 and 2018 and on Thayer et al. (2019), average hauling cost (including labor and equipment) for a semitruck trailer in 2016-2018 was estimated as $3.895 per loaded mile. We also assumed a 53-foot (55,000 pounds gross weight) semitrailer that can carry 44 cattle weighing an average weight of 1,200 pounds. An average load of 42 cattle was assumed per semitrailer with a fully loaded truck, traveling an average of 50 miles per hour. The resulting average cattle transportation cost is $0.093 per head-mile.



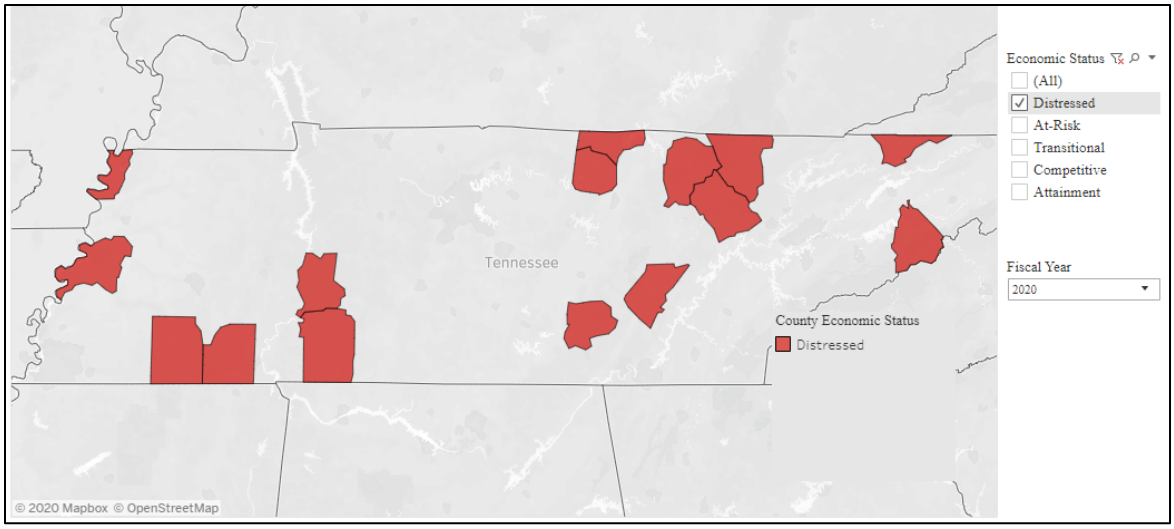
Source: Livestock Network, 2020.

Figure 2. Semitruck Used to Haul Cattle.

Cull cattle were assumed to be sourced from the nearest location. Beef and dairy cattle levels were estimated at the county based on NASS data for 2012. Cattle were then assigned to 5 square mile hexagons based on the location of pasture extracted from cropland data layers as provided by CropScape for 2017 (U.S. Department of Agriculture, NASS, 2019). Based on the literature, conservative annual saleable cull rates of 10 percent (Griffith and Bowling, 2019) was assumed for beef cows and 28.7 percent (Hughes and Holland 2016) for dairy cows.

Candidate sites for the cull-cattle processing facility were 19 industrial park locations in the 15 economically distressed counties in Tennessee in fiscal year 2020, as shown in **Figure 3** (Bledsoe, Clay, Cocke, Fentress, Grundy, Hancock, Hardeman, Jackson, Lake, Lauderdale, Morgan, McNary, Perry, Scott and Wayne) (Transparent Tennessee, 2020). The Bioflame model (Wilson, 2009) was used to route the cull cattle to each of the 19 sites based on current road networks in the model. The least cost site was determined to be in Grundy County, Tennessee (Pelham Industrial Park, as shown in **Figure 4**). The cull cows consisted of 52,103 beef and 2,897 dairy culls. Total transportation cost was $368,440. The longest trip was 102.5 miles. The distribution of cows by county is shown in **Figure 5**. Among the 15 distressed counties, 1,586 cows were projected to be processed from five counties (Bledsoe, Clay, Fentress, Grundy and Morgan).[1] Based on our assumed value of $697.25 per cow, the total estimated annual value across these five counties is $1.106 million.

[1] The distressed designation is a composite measure based on equal weights for the three-year unemployment rate, per capita income and poverty rate in the county (Transparent Tennessee, 2020).



Source: Transparent Tennessee

Figure 3. Economically Distressed Counties in Tennessee, 2020.

Source: The Grundy County Herald, 2019.

Figure 4. Pelham Industrial Park, Grundy County, Tennessee.

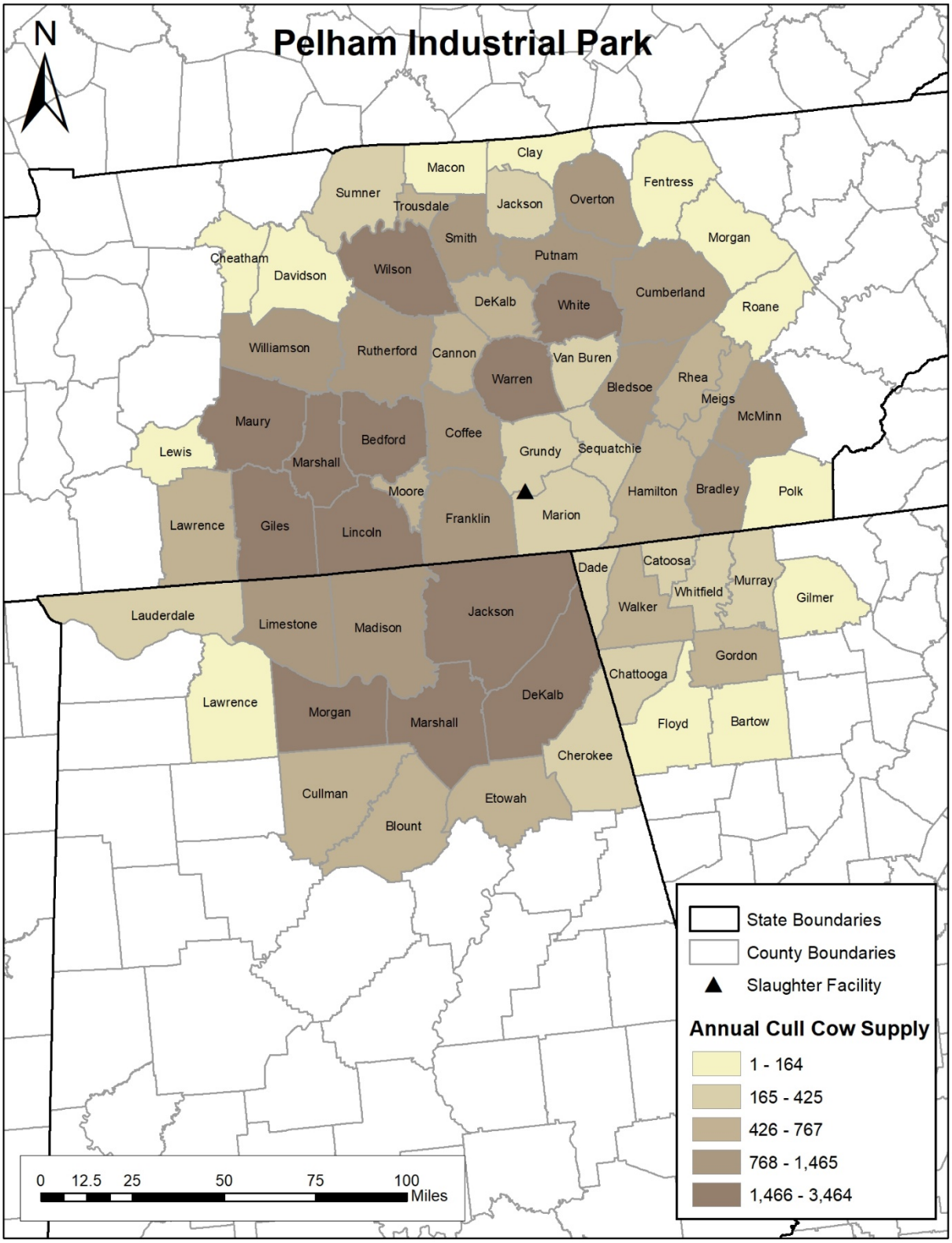


Figure 5. Source of Cull Cows, Grundy County Facility Location.

Construction Costs

Construction costs were estimated based on our analysis of numerous other studies (Snyder and Johnson 1995; Lee et al., 2001; Meyers Norris Penny LLP, 2004; Blitz, 2016; Hughes et al., 2017; Bowser and Holcomb, No Date). We assumed a building of 24,000 square feet for the facility. We estimate that a slaughter facility of this size would cost $9.5 million to build. Also included in construction is the cost of livestock holding pens, an unloading area and a wastewater treatment facility (costing $1.650 million). Based on Grandin (2010), 20 square feet per held animal is assumed for the concrete pad for the hold pens. Based on Meyers Norris Penny LLP, we assume that a maximum of 400 animals (two-day supply) would be held for processing at any one time.

Land acquisition and development costs ($15,000 per acre) were based on our evaluation of acquiring land with ready access to sewer and city water for several communities in Tennessee. A requirement of 12 acres was based on our evaluation of various studies (Snyder and Johnson, 1995; Lee et al., 2001; Meyers Norris Penny LLP, 2004; Blitz, 2016; Hughes et al., 2017; Bowser and Holcomb, No Date), which is a reasonable estimate for access and for the building, pen and waste treatment facility footprint. However, the acquisition of a developed site is very much subject to local conditions, so the estimated cost of $170,000 ($15,000 per acre) should be considered a general guide.

Equipment Cost

We estimated equipment cost for the facility to be $1.994 million. This covered equipment necessary for slaughter and fabrication for the meat and other parts as provided in **Table 1**. Because we assumed that meat would be shipped as combo bins, no grinding was done for the hamburger (the major revenue source). A substantial portion of equipment costs are due to the need to meet necessary food safety requirements such as a Steam Sterilization Cabinet for $400,000.

Labor Costs

Labor costs were based on our review of other studies (Lee et al., 2001; Snyder and Johnson 1995; Blitz, 2016), unpublished information for a similar facility and our analysis of labor needs based on tasks in the plant. We determined that 115 workers (including management, secretarial and sales) were needed to maintain operations at the plant. We assumed two shifts with an additional night cleaning crew. The average of the most recent published data for wages and salaries for workers at a Tennessee cattle slaughter facility ($55,100) was used to estimate the total wage bill (U.S. Department of Labor, 2019). Worker benefits were estimated at 26.7 percent based on national data for 2016 (U.S. Department of Commerce, 2017). Total costs for plant labor was estimated at $6.336 million.

Table 1. Facility Equipment Including Cost Estimates

Item	Quantity	Cost Per Unit	Total	Rank
Freezer Room Sq Ft	2,000	200	400,000	2
Cooler Room Sq Ft	4,000	135	540,000	1
Data System for Inventory	1	5,000	5,000	32
Restraining Conveyor	1	100,000	100,000	4
Knocking Box (pneumatic reverse)	1	33,000	33,000	7
Captive Bolt Stunner	1	2,000	2,000	40
Hoist	2	5,000	10,000	23
Bleeding Rail	2	4,000	8,000	29
Rail Stops	2	2,500	5,000	32
Trolley Hooks	425	27	11,475	20
Bleeding Shackles	6	300	1,800	42
Hide Puller	2	10,000	20,000	11
Bleeding Trough 12′	2	6,000	12,000	17
Spreader for Evisceration	2	5,000	10,000	23
Fabrication Table 12′	2	12,000	24,000	10
Pneumatic Elevator	3	10,000	30,000	8
Splitting Saw	2	5,500	11,000	21
Brisket Saw	2	4,500	9,000	27
Breaking Saw	2	2,200	4,400	34
Skinning Knives	12	100	1,200	45
Whizard Knives	4	2,020	8,080	28
Sink with Sterilizers	1	10,000	10,000	23
Sink with Sterilizers	1	10,000	10,000	23
Knife Sterilizer	4	3,500	14,000	16
Knife Sterilizer	3	3,500	10,500	22
Saw Sterilizer	2	10,000	20,000	11
Skinning Cradles	4	1,500	6,000	31
Evisceration Carts	4	4,500	18,000	14
Rail Scale	2	4,000	8,000	29
Synchronous Quarantine Line	1	20,000	20,000	11
Viscera Trough	1	1,000	1,000	46
Viscera Receiving Platform	2	7,500	15,000	15
Rail System 200′	2	20,000	40,000	6
Dividing and Conveyor Line	2	50,000	100,000	4
Handwashing Stations	8	200	1,600	43
Head Rack	1	1,000	1,000	46
Jaw Breaker or Puller	1	1,000	1,000	46
Steam Sterilization Cabinet	1	400,000	400,000	2
Steam Vacs	2	150	300	49

Item	Quantity	Cost Per Unit	Total	Rank
Organic Acid Sprayer	1	300	300	49
Fat Analyzer	1	3,995	3,995	36
Vaccum Pack Machines	2	14,000	28,000	9
CO2 Snow Machine	1	2,500	2,500	38
Fork Lifts	2	6,000	12,000	17
Pallet Movers	4	3,000	12,000	17
Lockers	1	4,000	4,000	35
Miscellaneous Employee Kitchen Equipment	1	2,400	2,400	39
Desks	4	500	2,000	40
Chairs	8	175	1,400	44
Computers	3	1,100	3,300	37
Total			**1,994,250**	

Overall Costs Analysis

Costs by major spending category is provided in Table 2. Purchased livestock was by far the largest cost category at $38.349 million or 70.3 percent of total cost ($55.384 million). Labor was the second-largest cost category at $5.510 million or 10.1 percent of total cost. Cost of other items were based on Lee et al. and other studies. We adjusted these costs for size and inflation. Packaging of final product was estimated to be $2.860 million or 5.3 percent of total cost. Annual principal payment for the $13.410 million loan required for plant construction and equipment was estimated at $0.958 million, while loan interest payments were estimated at $0.625 million. Transportation of the final products was estimated to cost $2.368 million or 4.4 percent of total cost. Quality control at $0.338 million (0.6 percent) is a particularly important component of plant operations, especially with respect to food safety. Cost items included in this category include consultant fees and travel associated with developing, maintaining and conducting employee training for Hazard Analysis and Critical Control Point (HACCP), Sanitation Standard Operating Procedures (SSOPs), sampling plans and meat sample testing by an outside vendor, all related to food safety and, to a lesser extent, animal welfare (Viator et al., 2015; Viator, et al., 2017).

Revenue

Revenue sources include ground beef (81 percent lean), selected meat cuts that we deemed to be marketable, and other marketable parts of the processed cow including the hide (**Table 3**). Dress (usable) weights were based on Lee et al. (2001), adjusted for animal size based on average size from the Tennessee livestock market data (1,202.2 pounds) with a dressing weight of 47 percent. The price of ground beef

was based on reported USDA prices for January 1, 2019, through September 30, 2019 (USDA, 2019b). Prices for each of the other selected meat cuts, such as the loin tenderloin, were based on reported USDA box beef prices by cut for January 1, 2019, through September 30, 2019. Prices for each subcategory of other parts of the processed cow (e.g., the liver) were based on USDA-reported prices for the same period. The hide price was based on prices reported in "Drovers Magazine" (Peel, 2019), due to the currently unstable nature of that market.

Total revenue per processed cow was estimated at $1,015.35 (**Table 3**). Ground beef was the primary source of revenue at $760.94 or 74.9 percent of total revenue per processed cow. The total value of other meat parts was $189.98 or 18.7 percent of total revenue per processed cow; the total value of other parts was $34.42 (3.4 percent); and the hide was assumed to contribute $30 in revenue (3.0 percent). Assuming 55,000 cows will be processed per year, annual total revenue for the facility was estimated at $55.844 million.

Table 2. Major and Total Annualized Cost Items and Pretax Profit

Cost Item	Cost	Percentage	Rank
Cow Purchases	$38,348,768	70.5%	1
Packaging	$2,860,000	5.3%	3
Quality Control	$338,088	0.6%	10
Labor	$5,509,986	10.1%	2
Electric	$808,822	1.5%	6
Gas	$202,205	0.4%	13
Water	$134,804	0.2%	16
Solid Waste	$200,000	0.4%	15
Pest Control	$5,000	0.0%	24
Laundry	$35,000	0.1%	20
Supplies	$100,000	0.2%	17
Phone	$6,895	0.0%	23
Repair/Maintenance	$402,308	0.7%	9
Freezing	$522,414	1.0%	8
Transportation of Finished Product	$2,367,965	4.4%	4
Accounting	$21,867	0.0%	22
Legal	$29,553	0.1%	21
Insurance	$201,154	0.4%	14
Miscellaneous-Contingency	$300,000	0.6%	11
Wastewater Operation	$90,185	0.2%	18
Short-term Capital Interest Payment	$261,551	0.5%	12
Property Taxes	$55,000	0.1%	19
Interest-Investment Capital	$624,593	1.1%	7
Depreciation	$958,096	1.8%	5
Total Expenses	**$54,384,254**	**100.0%**	
Revenue Estimate	$55,844,262		
Net Income Excluding Income Taxes	**$1,460,008**	**2.6%**	

Table 3. Estimated Revenue Per Processed Cow by Major Source, Tennessee Cull-Cow Processing Facility

Category	Weight (Pounds)	Price (Per Pound)	Revenue	Percent Total Revenue
Other Meat:				
Loin, Strip	16.20	$2.61	$42.30	
Loin, Tenderloin	9.00	$4.84	$43.58	
Loin Partially Deboned Butt	19.80	2.23	$44.21	
Ribeye Roll, Lip On	16.20	$3.70	$59.89	
Subtotal	61.20		**$189.98**	18.7%
Other Parts:				
Tongues, Swiss #1 0-3%, Export	3.28	$3.68	$12.06	
Hearts, Regular, Bone Out	3.70	$0.59	$2.19	
Livers, Selected, Export	10.57	$0.22	$2.31	
Tripe, Scalded, Edible	10.76	$1.25	$13.44	
Tripe, Honeycomb, Bleached	2.01	$2.20	$4.43	
Subtotal	30.32		**$34.42**	3.4%
Hides			**$30.00**	3.0%
Ground Beef (81% Lean)	398	$1.91	**$760.94**	74.9%
Total Revenue Per Processed Cow			**$1,015.35**	100.0%

Financial Feasibility

Our analysis of financial feasibility is centered on our estimates of all annualized costs and revenues for the facility. We also include a discussion of the return and risk associated with the entire livestock slaughter sector.

General Sector Financial Analysis

The industry is characterized by economies of scale and dominance by large production facilities, meaning that larger facilities, in general, have higher profit rates. For example, Paul (2001) estimates an economies of size cost elasticity of 0.95, indicating significant reductions in costs for large-scale facilities (i.e., a 1 percent increase in size leads to a 0.05 percent decline in marginal cost). A facility that processes 55,000 animals annually is considered to be a small operation (Ward, 2010) with average slaughter levels of 1,302,643 head in 2006 for the 14 largest plants. In 2007 (Ward), the four largest firms accounted for 80 percent of U.S. bovine slaughter sales, a percentage that has held through 2018 (USDA, 2019c). Finally, the sector is also characterized by thin margins (difference between costs and revenues) (Ward). Industry analysts also see the slaughter sector (NAICS 36111) as being relatively high risk (AlphaCalc, 2020). They indicate that the sector has a higher loan payback failure rate than 84 percent of all industrial sectors (i.e., the likelihood of bankruptcy is relatively high) (AlphaCalc).

Facility Financial Feasibility

Annualized production costs and revenues are provided in **Table 3**. We assume 80 percent capacity in the first year of operation, followed by 100 percent utilization in year two and all subsequent years of operation. The facility loses money ($304,959) in the first year of operation but obtains profitability at $1.46 million in profits starting in year two, as shown in **Table 3**.[2] The rate of profitability in year two and subsequent years is 2.6 percent, which is comparable to the levels found for studies of similar facilities (2.5 percent in Lee et al., and 2.2 percent in Snyder and Johnson).

We also conducted sensitivity analysis with respect to livestock supply, the cost of obtaining livestock and prices received for facility products. In general, sensitivity analysis indicates the thin margins found for the facility and demonstrates that small changes in key costs or revenues could result in the loss of profitability. A 16.1 percent reduction in livestock supply to 46,158 head would cause facility profits to decline to zero. A 3.8 percent increase in the average annual price paid for livestock, from $58 to $60.21 per live hundredweight, would also result in zero profits. Finally, a 2.6 percent decline in the price of sold products would result in zero profits. The major part of this decline is 5 cents drop in the price received for ground beef from $1.91 to $1.86 per pound. Access to capital and cash flow requirements would arise as issues under any of these slight changes in our assumptions and in general calling into question the feasibility of the project.

One factor not included in our analysis is various subsidies would be available because the facility is assumed to be located in an economically distressed county. Grants and subsidized loans from state and federal government agencies should be forthcoming because of the need for economic growth in Grundy County. For example, the U.S. Department of Agriculture's (Rural Development) Business and Industry Guaranteed Loan Program could serve as a source of financing (U.S. Department of Agriculture, 2020).

Key Factors in Overall Feasibility

Supplying the Facility with Livestock and Selling Output

Ability to supply the plant with cull cows is of vital importance. As demonstrated in our sensitivity analysis, adequate supply of cull cows is vital to the overall feasibility of the facility. A 16.2 percent decline in supply reduces profitability to zero. Hence, reduction in supply of cull cattle would mean the plant is financially infeasible. Further, anecdotal evidence indicates that the failure of a Mississippi plant in the early 2000s (Ablaza, 2017) was in part due to the inability to obtain cows for processing (Barefield, 2020). Decreases in the supply of cattle was cited as the sole

[2] Based on training costs provided in Viator et al., (2015), we estimate worker training and food safety plan development costs of $170,946 in the first year of operation. This increase in costs is included in the first-year loss estimate.

reason for the San Antonio, Texas, L&H Packing plant closure in 2014 (Bailey). Because of its obvious importance, at least one individual, and probably more than one in the first few years of operation, should be devoted to obtaining cull cows.

Likewise, marketing the output of the meat products produced by the facility is an important element in the success of the facility. At least one person should be devoted to marketing the meat and other products produced by the facility. The marketing program should include a strong local foods element by making a concerted effort to market to grocery stores, especially in Tennessee, but also in nearby parts of neighboring states. An example of such an effort is the Kentucky Cattlemen's Ground Beef program, which is own-branded beef raised, harvested and fully processed in Kentucky that is being sold at 85 Kroger grocery stores throughout the state (Miller, 2018).

Labor Supply

Another key issue is meeting the labor needs for the facility. Turnover of employment has been a perennial issue for the meat processing industry (Grey, 1999). Currently, low unemployment rates make hiring qualified workers even more difficult. For example, a recent poultry processing project in North Carolina has been delayed because of the inability to hire and retain qualified local workers (Kelly, 2019). While H-2A (foreign guest) workers are a possible source of labor, the process for obtaining such workers is cumbersome and somewhat costly (at least $2,000 in extra cost per worker but probably markedly higher based on Roka et al., 2017). Introducing a large number of H-2A workers could also breed resentment in the local community where the facility locates. Accordingly, to the degree possible, the new facility should emphasize obtaining, properly training and retaining local workers. Developing training programs (in skills such as butchering) through partnerships with local or regional high schools, community colleges or Tennessee College of Applied Technology (TCAT) should help with these efforts.

Excellent Management

The results and conclusions made here are all based on the assumption of excellent management. An inability to obtain livestock at a reasonable price, market facility products, maintain workforce management, meet food safety requirements, and manage day-to-day operations would lead to a failed project.

Summary and Conclusions

Analyzed here is the feasibility of a 55,000-head-per-year cull-cow slaughter facility in Tennessee in one of the 15 distressed counties in the state. While our analysis indicates that the facility is feasible, all of the risk factors should be considered before progressing with an actual project.

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