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# Feasibility of a Federally Inspected Custom Livestock Processing Facility in Tennessee

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Farm Bureau

By: David W. Hughes[1], Hannah Wright[2], Andrew Griffith[3], and Hal Pepper[4]

[1]Contact Author, Professor and Greever Endowed Chair in Agribusiness Development

Department of Agricultural and Resource Economics

227B Morgan Hall

University of Tennessee

Knoxville, TN 37996

dhughe17@utk.edu

Phone: 865-974-7463

[2]Extension Specialist, Department of Agricultural and Resource Economics, University of Tennessee [3]Assistant Professor, Department of Agricultural and Resource Economics, University of Tennessee and [4]Extension Specialist, Center for Profitable Agriculture, University of Tennessee

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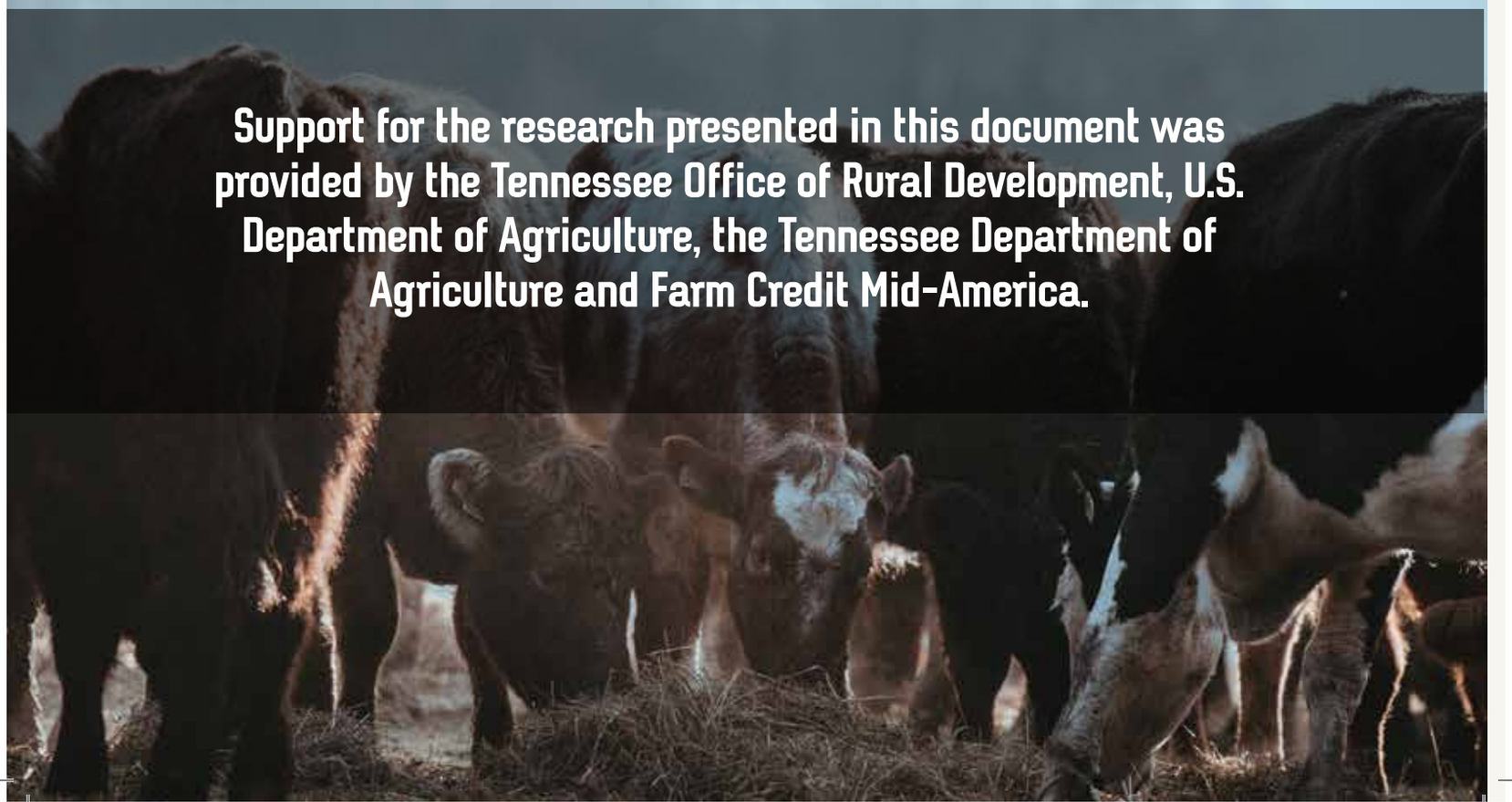

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# Report Summary

An operation harvesting 1,800 cattle a year (36 per week for 50) is projected to have total operating costs of $672,351, total revenue of $752,400, and an annual profit of $80,049.

Anecdotal evidence and a variety of studies nationally and for Tennessee indicate interest in smaller, locally oriented livestock harvest (slaughter) facilities. However, despite this interest, there are many barriers to developing such a facility, including financial solvency. In response to this interest, the feasibility of a custom-harvest, federally inspected cattle processing facility in Tennessee is examined. While analysis of projected profitability form the core of the feasibility study, other elements must be considered in examining the feasibility of such a facility including food safety, worker safety, and animal welfare regulations. Also important is disposing of waste by-products including wastewater but especially non-utilized parts of the animal, an adequate and at least somewhat steady supply of cattle for harvest, and retaining an appropriately trained workforce.

An analysis of these factors indicate a facility that is assumed to provide slaughter (harvest), deboning, cutting and wrapping of major cuts and grinding other cuts into hamburger could be a feasible and profitable venture, based on the assumptions of this study. Specifically, an operation harvesting 1,800 cattle a year (36 per week for 50) is projected to have total operating costs of $672,351, total revenue of $752,400, and an annual profit of $80,049. However, interested parties are encouraged to evaluate the assumptions made in this study and their own situation before moving forward with such a project.

# Introduction

Anecdotal evidence and a variety of studies nationally (Curtis, et al., 2007, Dickenson et al., 2013b, Food & Livestock Planning, 2011, Gwin et al., 2011, Holcomb et al., 2011a, Holcomb et al., 2011b, Swenson, 2011, and Thiboumery, 2011) and for Tennessee (McLeod, 2017) indicate interest in smaller, locally oriented (where the supply of cattle is from nearby areas and meat produced are also sold in nearby markets) livestock harvest (slaughter) facilities. Despite this interest, there are many barriers to developing such facilities, including financial solvency. Therefore, the economic feasibility of a custom-harvest, federally inspected cattle processing facility in Tennessee is examined.

The basic element of any feasibility study is the financial analysis with profitability being one of the most important elements for a privately-owned facility. However, other elements can be equally important in determining feasibility. For a small meat processing facility, such as the one examined here, these other elements include food safety, worker retention, worker safety, animal welfare regulations, disposal of waste by-products, such as wastewater and the non-utilized parts of the animal, and an adequate and at least somewhat steady supply of cattle for harvest.[1] Accordingly, each of these major topics is examined in determining the possible feasibility of a custom-charge (where farmers pay for the processing and own all processed meat), United States Department of Agriculture (USDA) inspected, cattle harvest and basic processing facility. The facility is assumed to provide harvest, deboning, cutting, and wrapping of major cuts of meat and grinding other cuts into ground beef.

[1]While all of the topics are important for all animal processing operations, for reasons to be discussed these topics are especially problematic for small, locally-or-ented facilities.

# Offal Disposal

Offal is the nonmeat part of the animal. Typically called the drop in the harvest industry, it includes the entrails and inedible parts of a harvested animal that are removed in dressing. Offal consists largely of the viscera and the trimmings, which may include, but are not limited to, thymus, pancreas, liver, heart, kidney, and tongue, usually intended for use other than for human food consumption. The disposal of offal can be a challenge to starting or expanding a harvest facility (Food and Livestock Planning, Inc. 2011), especially with regard to environmental protection and sustainability (Russ and Pittroff, 2004).

By-products (i.e., the organs, fat or lard, skin, feet, abdominal and intestinal contents, bone and blood) of beef represent 44 percent of the live weight (Vidussi and Rynk, 2001). More than half the animal by-products are not suitable for edible consumption, because of their unusual physical and chemical characteristics. On average, edible beef by-products comprise 27 percent and inedible by-products 17 percent of live weight with an average overall dressing percentage of 62 percent (Hedrick, 2001).

For a smaller operation like the one examined in this study, offal disposal can be a major issue and is a cost because small plants lack the volume necessary to receive payment for their offal and most other non-meat disposal items. Thus, unlike larger harvest operations, disposal of non-meat parts of the animal is an expense rather than an income source. (For larger operations, by-products are generally valuable sources of revenue, with one study indicating that 11.4% of the gross income from beef and 7.5% of the income from pork is due to nonmeat by-products (USDA ERS, 2001). Over time, the cost of offal disposal has tended to increase (Gwin et al., 2013, Gwin et al, 2011, Livestock & Planning, 2011, Rime et al., 2004).

Offal disposal can occur through rendering, composting, landfill, or incineration. We assume the plant manager chooses to work with a rendering facility. In rendering, the by-products of meat processing are converted into marketable products, including edible and inedible fats and proteins for agricultural and industrial use.

Offal disposal is heavily regulated by the USDA and new regulations have been imposed, especially regarding cattle disposal. (These regulations are further described in Appendix A.) Rendering companies have responded in a variety of ways, ranging from refusing to accept offal to requiring waste separation and liability insurance.

The cost of handling and disposal of rendering for small-scale slaughterhouses can be problematic. Offal pick-up charges by a rendering company depend on volume and distance from the rendering plant. A common pricing strategy is to charge by volume (e.g., per 55 gallon drum or barrel). Many rendering companies will take blood as well as bones, inedible organs, meat scraps, fat, hooves, and heads. Some companies' pick-up hides and debit the value from the cost of the rendering pick-up (Food & Livestock Planning, 2011). Slaughterhouses in the Upper Cumberland region of Tennessee are paying renderers $50 per load. Tennessee slaughterhouses have the option of utilizing at least one rendering companies to dispose of their offal and wastes. Typically, Upper Cumberland slaughterhouses have two loads a week; however, some weeks three loads are necessary.

# Wastewater Disposal

The first step in the process of USDA inspection is obtaining an approved water source and sewage system letter.

Harvesting and processing facilities must meet federal and state environmental regulations. The disposal of wastewater presents additional considerations. Blood and other liquid waste such as urine and liquids generated by cleanup actions are considerations in treating wastewater (Environmental Protection Agency, (EPA), 2004).

The first step in the process of USDA inspection is obtaining an approved water source and sewage system letter. The facility must also have a potable water certification on file. If the plant will use water from a municipal water supply system then an approval letter must be obtained from the municipality. State or local health authorities can provide a letter stating that the plant's sewage system is acceptable. If a private water supply is used, the approval letter must be issued by the state or county public health service. If the water is supplied from private wells, the letter must state the wells are on the premises of the establishment and are effectively protected from pollution. The letter should identify the source and state that the source is approved and that the water is both potable and meets tests prescribed by the U.S. EPA (eXtension, 2013). Waste effluent regulations are further described in Appendix B.

The most accessible tactic for managing effluent is accessing a municipal sewage line and allowing the municipality to treat the effluent. If a municipal plant is not available or does not have the capacity, the plant will have to treat their effluent. There are several options for the plant to treat its own effluent and a licensed wastewater engineer should be engaged to design a system specific for the plant and its own area of the country (Food & Livestock Planning, Inc. 2011). In the financial analysis, we assume the facility has access to a municipal sewage line.

# Food Safety, Animal Welfare, Worker Welfare Regulations

## Meat Safety

Meat production is a vital part of the U.S. agriculture sector, representing more than half the value of all agricultural products (USDA Economic Research Service, 2012). Out of concern for consumer safety (and more recently animal welfare), meat is a highly regulated product. The production and sale of meat is governed at the federal level by the USDA. The objective of this section is to provide a better understanding of the regulatory environment of the meat processing industry and to provide information to address this environment, both on the federal and state level.

It is important for any party aspiring to establish a meat processing business to fully understand the USDA's requirements for processing facility infrastructure, documentation, inspection, transportation, and labeling. Any processing business will require an approved facility, Hazard Analysis and Critical Control Point (HACCP) plan, and Sanitation Standard Operating Procedures (SSOP) plan, and will be monitored by a USDA inspector.

There are seven steps to becoming an inspected meat processing plant and this process is often referred to as "obtaining a grant of inspection" (eXtension, 2014). These steps are as follows:

- Step One: Obtain Approved Water Source Letter
- Step Two: Obtain a Sewage System Letter
- Step Three: Facilities Must Meet Regulatory Performance Standards
- Step Four: File an Application for Inspection
- Step Five: Obtain Approved Labels and/or Brands
- Step Six: Provide a Written Standard Operating Procedure for Sanitation
- Step Seven: Provide a Written HACCP Plan.

Food safety regulations and how to meet those regulations are further described in detail in Appendix C.

While food safety requirements and regulations are daunting, significant assistance is provided in Tennessee in implementing food safety programs such as HACCP and SSOP. The University of Tennessee has available resources through the Department of Food Science and Technology, with faculty and staff members dedicated to food safety and meat quality assurance. For more information on Food Microbiology and Food Safety Extension, contact: Mr. Nathan Miller at nathan.miller@tennessee.edu or (865) 974-7287; for meat quality and development information, contact: Dr. Dwight Loveday at hloveday@utk.edu or (865) 974-7344. The Tennessee Department of Agriculture (TDA) also has resources within the divisions of Consumer and Industry Services and Market Development to assist with programs and regulations specifically TDA Livestock Marketing Specialist, Wendy Lofton Sneed at wendy.sneed@tn.gov or (615) 837-5309; and Food Administrator, Shanna Lively at shanna.lively@tn.gov or (615) 837-5176.

# Animal Welfare

Another major issue faced by all meat processors is animal welfare. Inhumane harvest methods can cause major issues with government regulators and contribute to bad publicity for the operation or the industry in general. For example, an improper kill can result in a temporary mandated shutdown of operations. Inappropriate pre-harvest handling practices can generate these concerns and issues and reduce the quality of carcasses because of elevated stress hormones.

Animal welfare is more of a challenge for smaller operations because kill methods are usually by stun bolts or firearms, and can be more easily botched than in more mechanized approaches used in larger harvest operations. In this study, we assume a stun bolt method of kill, which requires operation by a competent employee. We also recommend following the approach to animal care pioneered by Dr. Temple Grandin (1996). In this approach, animals are not unnecessarily restricted and are not introduced to the kill floor until absolutely necessary. Humane and adequate restraints are also employed in the kill operations to minimize pain and suffering Grandin (1996) as further explained in Appendix D.

Stunning an animal accurately will yield a higher meat quality; however, erroneous stunning procedures can precipitate bone fractures and bloodspots in the meat (Grandin et al., 2002). Erroneous stunning procedures can also lead to legal action with plant closings or other penalties. To comply with the Humane Methods of Slaughter Act of 1978 (HMSA) requirement of humane handling of livestock for harvest, regulations mandate animals be driven at a normal walking speed, and forbid driving animals using anything that could injure them or cause unnecessary pain. [2]For this study, we assume the mechanical captive bolt kill method.

The Food Safety and Inspection Service (FSIS) has the enforcement authority to temporarily or terminally suspend operations from processing meats until compliance with HMSA is achieved. For the noncompliant facilities, the FSIS determines the length of the suspension. It is contingent on how quickly the company responds to the allegations. The plant must identify what went wrong and what led to it; describe specific actions taken to eliminate the cause of the problem; and what sort of monitoring activities the company plans to ensure that new violations do not occur.

The facility must have Standard Operating Procedures (SOPs) for live animal handling and facility design. Choosing the design of the facility may be the most important decision made when building a meat processing plant. A USDA inspected plant will have the most stringent requirements, although a state-inspected plant follows the requirements of federal regulations. Building a plant that will meet all requirements for federal inspection may be more expensive in the beginning, but it will position the plant for future growth.

There are seven steps to becoming an inspected meat processing plant:

**Step One**: Obtain Approved Water Source Letter

**Step Two**: Obtain a Sewage System Letter

**Step Three:** Facilities Must Meet Regulatory Performance Standards

**Step Four**: File an Application for Inspection

**Step Five**: Obtain Approved Labels and/or Brands

**Step Six**: Provide a Written Standard Operating Procedure for Sanitation

**Step Seven**: Provide a Written HACCP Plan

[2]HMSA excludes animals killed in ritual slaughter to avoid unconstitutionally hindering the practice of religion under the First Amendment.

## Worker Welfare

The meat packing industry can pose some safety and health hazards. Data from the Bureau of Labor Statistics shows the rate of illness and injuries for workers in animal processing was more than twice as high as the national average with the rate of illnesses a staggering ten times the national average (U.S. Department of Labor, 2017). The meat industry's Occupational Safety and Health Administration (OSHA) recordable rates have improved by 72 percent since the industry adopted ergonomics guidelines in 1990 and made worker safety a non-competitive issue (American Meat Institute, 2009). In 1990, the meat industry, together with Occupation Safety and Health Administration (OSHA) and the United Food and Commercial Workers (UFCW) Union, developed Voluntary Ergonomic Guidelines for the Meat Packing Industry— guidelines that OSHA called a "model" for other industries (NAMI Factsheet, 2016).

The liability of live animals, high noise levels, precarious equipment, slippery floors, as well as exposure to biological and chemical hazards must be treated appropriately to minimize risks. Meat processing workers are exposed to biological agents during harvest, when handling meat that is freshly harvested, and with exposure to diseased animals. The most specific diseases and biological agents of concern are brucellosis, influenza viruses, livestock-associated methicillin-resistant staphylococcus aureus (MRSA), and Q-Fever (MMWR, 2011). Workers in Meat Packing Plants, including cleaning crews, are exposed to hazardous chemicals. Potential health effects of chemical exposures include skin rashes, eye, nose and throat irritation, burns to the skin and eyes from splashes, cough, shortness of breath, and other symptoms, depending on the chemical (OSHA -Hazard Solutions, 2016). Specific chemical hazard to the meat packing industry include ammonia, chlorine, carbon dioxide, hydrogen peroxide, and peracetic acid (Richardson et al., 1998).

OSHA has produced some common hazard control measures (Safety and Health Guide for the Meatpacking Industry, 1988) and these are listed below:

- Implementing an effective ergonomics program;
- Hearing conservation methods;
- Providing required personal protective equipment (PPE);
- Guarding dangerous equipment;
- Following OSHA's process safety management standard to protect workers from accidental leaks of ammonia;
- Incorporating engineering controls, such as improving sanitation and ventilation measures, to protect workers from chemical and biological hazards;
- Maintaining walking/working surfaces to prevent slips, trips, and falls; and
- Implementing OSHA standards that require exit doors are not blocked and not locked while employees are in the building. Employees must be able to open an exit route door from the inside at all times without keys, tools, or special knowledge.

In summary, all the federal and state regulations and prescribed plans for livestock processing facilities work together to ensure that a safe and quality product is provided for consumers. Each element of the prescribed regulatory standard is designed to protect the business, the employees, and the consumer.

# Supply of Cattle

## Supply and Producer Commitment

Survey results of Tennessee beef farmers, discussions with local, regional, and state agricultural leaders, and national-based trends, such as the growth in grass fed beef and local foods, all point to a need for an increase in harvest capacity in Tennessee. This increase could be accomplished through expanding existing facilities or building new facilities. However, several barriers have been identified that have precluded the establishment of such facilities. In particular, sufficient and steady demand for such a facility by farmers is an important consideration because small processing plants must annually procure a certain volume that is spread out fairly evenly over the year to cover the costs of equipment, labor, other operating costs and (usually) repayment of initial financing of the facility (Gwin et al., 2013)[3].

Research focusing on the success stories of seven operations (Gwin et al., 2013) and on facilities that have failed indicates a committed business relationship between livestock producers and processor is key to success. Commitment is a continuous relationship in which each party promises to deliver for the other and consistently follows through. It also requires communication about needs, roles, abilities, and responsibilities. This definition of commitment echoes the theory of values-based supply chains models. In these business models, importance is placed on both the values correlated with the production of food and on the values affiliated with business relationships (Agriculture of the Middle, 2011).

The important factor is that livestock producers commit, individually or in coordinated groups or brands, to providing the processor with sufficient, steady business. Comity and communication between livestock producers and harvesting facilities are vital; however, a commitment to bringing enough livestock on a steady basis is the most decisive component. Steady supply insures effective utilization of the workforce and other inputs and insures adequate cash flow (Gwin et al., 2013).

Livestock producers' investment in their processors financially for mutual growth is the strongest form of commitment. Some processors are their own key customers, providing most or all their throughput. Because scheduling is crucial, many harvest facilities utilize mechanisms like active scheduling systems, variable pricing, and penalties to incentivize stable throughput (Gwin et al., 2013).

[3] For their part, livestock producers often complain that the limited local processing infrastructure restricts the supply of local meats (Gwin et al., 2013). Further, operations that offer more sophisticated services require significantly higher volumes, making it more challenging to reach the critical mass of local livestock to support such plants.

# Analysis of Survey Data

A survey was conducted as discussed in McLeod (2017) in part to evaluate the interest of Tennessee cattle farmers in supplying an in-state harvest facility. Responses to relevant survey questions are discussed for the entire state and for three regions in Tennessee due to serious local interest in establishing a custom-harvest facility.

## Current Behavior

With respect to current behavior for at least some of their cattle, out of 62,647 cattle marketed by responding Tennessee beef cattle farmers, 2,869 (4.7%) cattle were retained by the farmer while finished at a custom feedlot while 4,493 (7.2%) were finished on their farm.

## Possible Future Behavior

Beef cattle producers were asked "If profitable, would you be willing to finish cattle and sell your cattle to an in-state federally inspected slaughterhouse? Among 804 respondents, 618 (or 76.9%) responded yes, thus indicating strong interest in a Tennessee harvest facility. **This response reflects a high level of potential interest by Tennessee beef cattle producers in supplying an in-state federally inspected slaughter facility.**

The average number of head marketed per farm for those interested in the facility was 63 head per year with an average weight per head of 1,074.9 pounds. The potential total supply as indicated by the survey results was 38,904 cattle (that is, the 618 interested farmers multiplied by the 63 head per farm). These results imply strong interest but do not necessarily indicate that 38,904 cattle would be available for harvest at a new set of facilities. We assumed a premium of $9 per hundredweight or $117 per head with the question. We also do not know how far farmers would be willing to drive to a harvest facility (although anecdotally at least some farmers indicate a willingness to drive quite far).

Besides the statewide analysis of survey results, we conducted a separate analysis for three possible harvest facilities in areas of the state where we were aware of serious local interest in having such a facility. In each analysis, we separately evaluated survey results for very nearby (with a few exceptions neighboring counties) and nearby counties (based on Tennessee counties within 100 miles of Carthage (Smith County Seat), within 130 miles of Spencer (Van Buren County Seat) and within 130 miles of Jonesborough (Washington County Seat).

Among 804 respondents, 618 (or 76.9%) responded yes, thus indicating strong interest in a Tennessee harvest facility.

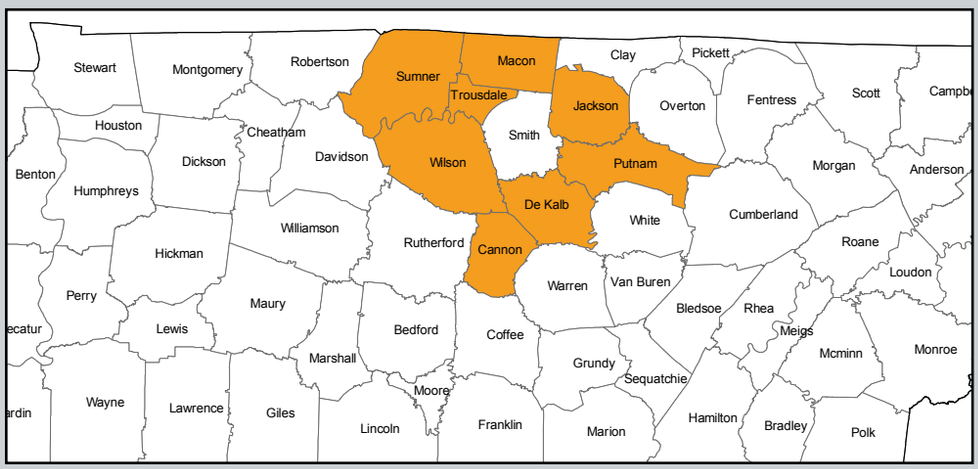
## Analysis for Possible Smith County Livestock Harvest Facility

With respect to survey results pertinent to a possible facility in Smith County, the first set (Smith County Region One) is for all neighboring counties and Smith County itself plus Cannon and Sumner Counties (because they are very close). The county seat for all of these counties is within 40 miles of Carthage, the County Seat of Smith County, as shown in Table 1.

**Table 1.** Smith County Region One: Counties that border Smith County and Distance to Carthage (Smith County Seat).

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Cannon[2] | Woodbury | 39.1 | 49 minutes |
| DeKalb | Smithville | 33.8 | 40 minutes |
| Jackson | Gainesboro | 25.2 | 38 minutes |
| Macon | Lafayette | 26.6 | 34 minutes |
| Putnam | Cookeville | 36.6 | 42 minutes |
| Sumner[2] | Gallatin | 33.8 | 46 minutes |
| Trousdale | Hartsville | 17.1 | 23 minutes |
| Wilson | Lebanon | 20.9 | 27 minutes |

[1]Based on the Google Maps distance from Carthage to the respective county's seat.
[2]Not a bordering county; but very close.



The second set is for all other Tennessee Counties within 100 miles of Carthage (Smith County Region Two) as shown in Table 2.

**Table 2.** Smith County Region Two: Counties within 100 Miles of Carthage (Smith County Seat).

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Bedford | Shelbyville | 83.1 | 1hr 26 min |
| Bledsoe | Pikeville | 86 | 1hr 40 min |
| Clay | Celina | 47.4 | 1hr 3 min |
| Cheatham | Ashland City | 78.6 | 1hr 24 min |
| Coffee | Manchester | 63.6 | 1hr 19 min |
| Cumberland | Crossville | 69.8 | 1hr 8 min |
| Davidson | Nashville | 55.8 | 56 minutes |
| Dickson | Charlotte | 94.3 | 1hr 42 min |
| Fentress | Jamestown | 83.1 | 1hr 30 min |
| Franklin | Winchester | 86.7 | 1hr 47 min |
| Grundy | Altamont | 80.2 | 1hr 41 min |
| Maury | Columbia | 95.9 | 1hr 34 min |
| Moore | Lynchburg | 99.2 | 1hr 47 min |
| Morgan | Wartburg | 99.5 | 1hr 44 min |
| Overton | Livingston | 56.7 | 58 minutes |
| Pickett | Byrdstown | 77.3 | 1hr 23 min |
| Roane | Kingston | 100 | 1hr 31 min |
| Robertson | Springfield | 81.1 | 1hr 27 min |
| Rutherford | Murfreesboro | 56.7 | 1hr 2min |
| Sequatchie | Dunlap | 93.7 | 1hr 36 min |
| Van Buren | Spencer | 64.1 | 1 r 6 min |
| Warren | McMinnville | 53.6 | 1hr 8 min |
| White | Sparta | 51.7 | 54 minutes |
| Williamson | Franklin | 72.1 | 1hr 15 min |

[1]Based on the Google Maps distance from Carthage to the respective county seat.

Smith County Region One, the average number of head marketed per farm for interested farms was 69.6%.

Smith County Region Two, the average number of head marketed per farm for interested farms was 94.6%.

## Current Behavior

With respect to current behavior for at least some of their cattle, 32 (34.4%) out of 93 responding farmers in Smith County Region One either currently retain cattle ownership in a custom feedlot or finish cattle on their farm. With respect to current behavior for at least some of their cattle, 63 (35.4%) out of 178 responding farmers in Smith County Region Two either currently retain cattle ownership in a custom feedlot or finish cattle on their farm.

## Possible Future Behavior

For Smith County Region One, 67.7% (63) of responding farmers were interested in retaining and finishing cattle for local harvest. For Smith County Region Two, 73% (130) of responding farmers were interested in retaining and finishing cattle for local harvest. Both sets of numbers reflect a high level of potential interest. For Smith County Region One, the average number of head marketed per farm for interested farms was 69.6. For Smith County Region Two, the average number of head marketed per farm for interested farms was 94.6. For farms in Smith County Region One interested in local harvest, the total number of cattle marketed was estimated at 4,386 head (i.e., the 63 interested farmers' times the average 69.6 head per farm). For farms in Smith County Region Two interested in local harvest, the total number of cattle marketed was estimated at 12,205 head. These results imply strong interest, but do not mean that 16,591 (4,386 plus 12,205) cattle would be available for harvest. Reiterating, we also do not know how far farmers would be willing to drive to a harvest facility. On the other hand, there are probably farmers in both regions who are interested in local harvest but who did not fill-out the survey.

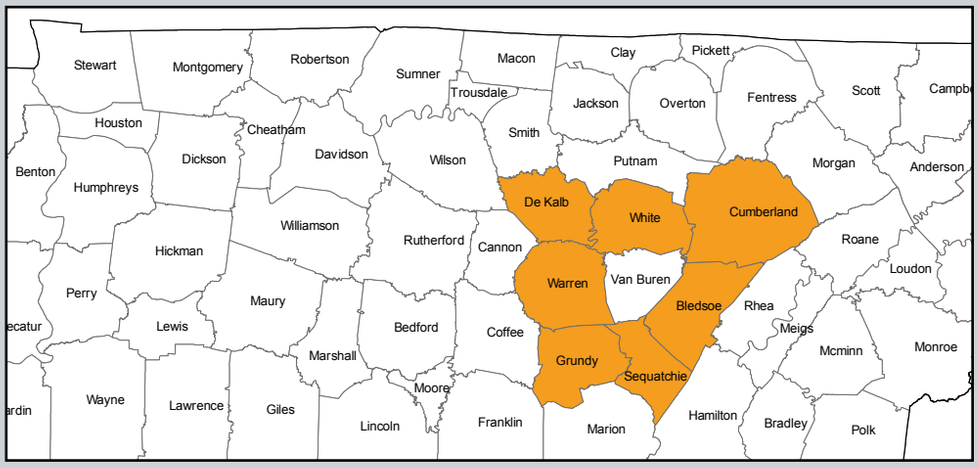
# Analysis for Possible Van Buren County Livestock Harvest Facility

With respect to survey results pertinent to a possible facility in Van Buren County, the first set (Van Buren County Region One) is for all neighboring counties and the County itself plus DeKalb and Grundy Counties (because they are very close). The county seat for analyzed counties is within 42.1 miles of Spencer, the County Seat of Van Buren County, as shown in Table 3.

**Table 3.** Van Buren County Region One: Counties that border Van Buren County and Distance to Spencer (Van Buren County Seat).

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Bledsoe | Pikeville | 23.8 | 38 minutes |
| Cumberland | Crossville | 41.4 | 52 minutes |
| DeKalb[2] | Smithville | 34.7 | 42 minutes |
| Grundy[2] | Altamont | 42.1 | 51 minutes |
| Sequatchie | Dunlap | 29.9 | 37 minutes |
| Warren | McMinnville | 21.2 | 29 minutes |
| White | Sparta | 14.4 | 18 minutes |

[1]Based on the MapQuest distance from Spencer to the respective county's seat.
[2]Not a bordering county; but very close.



The second county set is for all other Tennessee Counties within 100 miles of Spencer (Van Buren County Region Two) as shown in Table 4.

**Table 4.** Van Buren County Region Two: Counties within 100 Miles of Spencer (Van Buren County Seat).

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Anderson | Clinton | 95.7 | 1hr 52 min |
| Bedford | Shelbyville | 78.2 | 1hr 37 min |
| Bradley | Cleveland | 85.5 | 1hr 41 min |
| Cannon | Woodbury | 41.7 | 53 min |
| Clay | Celina | 66.3 | 1hr 13 min |
| Coffee | Manchester | 45.8 | 58 min |
| Fentress | Jamestown | 76.7 | 1hr 29 min |
| Franklin | Winchester | 62.1 | 1hr 24 min |
| Hamilton | Chattanooga | 66.7 | 1hr 9 min |
| Jackson | Gainesboro | 52 | 1 hour |
| Lincoln | Fayetteville | 85.6 | 1hr 53 min |
| McMinn | Athens | 68.7 | 1hr 38 min |
| Macon | Lafayette | 90 | 1hr 41 min |
| Marion | Jasper | 55.3 | 1hr 8 min |
| Meigs | Decatur | 56.5 | 1hr 23 min |
| Moore | Lynchburg | 70.2 | 1hr 32 min |
| Morgan | Wartburg | 88.6 | 1hr 43 min |
| Overton | Livingston | 50 | 55 min. |
| Pickett | Byrdstown | 69.4 | 1hr 17 min |
| Putnam | Cookeville | 30 | 37 min |
| Rhea | Dayton | 41.9 | 1 hour |
| Roane | Kingston | 78 | 1hr 31 min |
| Rutherford | Murfreesboro | 61 | 1hr 18 min |
| Scott | Huntsville | 97.7 | 1hr 58 min |

[1]Based on the MapQuest distance from Spencer to the respective county's seat.

Van Buren County Region One, 64.8% (46) of responding farmers were interested in retaining and finishing cattle for local harvest.

Van Buren County Region Two, 76.4% (81) of responding farmers were interested in retaining and finishing cattle for local harvest.

## Current Behavior

With respect to current behavior for at least some of their cattle, 29 (37.7%) out of 77 responding farmers in the Van Buren County Region One either currently retain cattle ownership in a custom feedlot or finish cattle on their farm. With respect to current behavior for at least some of their cattle, 50 (42.0%) out of 119 responding farmers in the Van Buren County Region Two either currently retain cattle ownership in a custom feedlot or finish cattle on their farm.

## Possible Future Behavior

For Van Buren County Region One, 64.8% (46) of responding farmers were interested in retaining and finishing cattle for local harvest. For Van Buren County Region Two, 76.4% (81) of responding farmers were interested in retaining and finishing cattle for local harvest. Both sets of numbers reflect a high level of potential interest. For Van Buren County Region One, the average number of head marketed per farm for these interested farms was 52.3. For Van Buren Region Two, the average number of head marketed per farm for these interested farms was 50.6. For Van Buren County Region One farms interested in local harvest, the total number of cattle marketed was estimated at 2,408 head (i.e., the 46 interested farmers' times the average 52.3 head per farm). For Van Buren County Region Two farms interested in local harvest, the total number of cattle marketed was estimated at 4,097 head for (i.e., the 46 interested farmers' times the average 52.3 head per farm). These results imply strong interest but do not mean that 6,505 (2,408 plus 4,097) cattle would be available for harvest. Same as for the state and in the other regions we analysis, there are probably farmers in the Van Buren County Region One and Van Buren County Region Two who are interested in local harvest but who did not fill-out the survey.

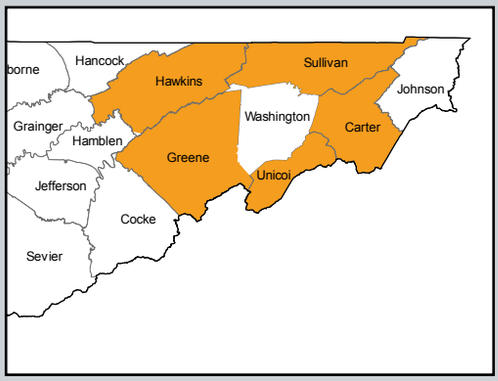
# Analysis for Possible Washington County Livestock Harvest Facility

With respect to survey results pertinent to a possible facility in Washington County, the first set (Washington County Region One) is for all neighboring counties and Washington County itself. The county seat for all of these counties is within 50 miles of Jonesborough, the County Seat of Washington County, as shown in Table 5.

[1]Based on the MapQuest distance from Jonesborough to the respective county's seat.

**Table 5.** Washington County Region One: Counties that border Washington County and Distance to Jonesborough (Washington County Seat):

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Carter | Elizabethton | 14.3 | 25 min. |
| Greene | Greeneville | 24.9 | 36 min |
| Hawkins | Rogersville | 50.0 | 1 hr 2 min |
| Sullivan | Blountville | 28.8 | 34 min |
| Unicoi | Erwin | 16.1 | 27 min |

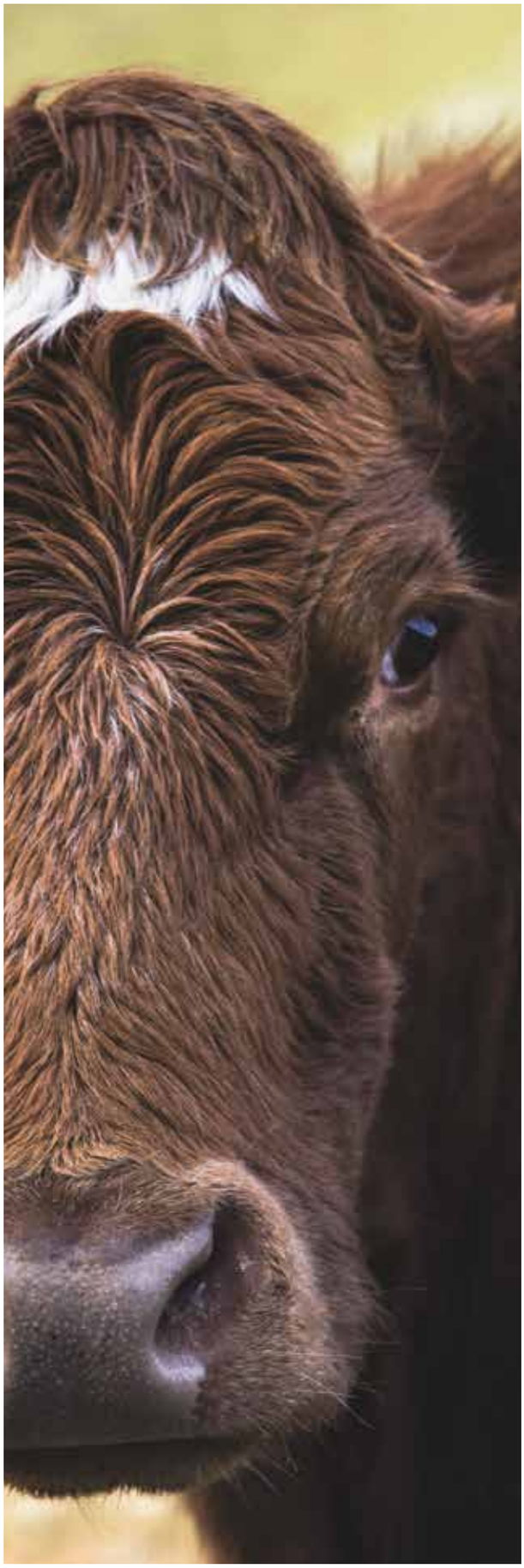



The second set is for all other Tennessee Counties within 130 miles of Jonesborough (Washington County Region Two) as shown in Table 6.

**Table 6.** Washington County Region Two: Counties within 130 miles of Jonesborough (Washington County Seat).

| County | County Seat | Distance (Miles)[1] | Distance (Hours/Minutes)[1] |
|---|---|---|---|
| Anderson | Clinton | 111 | 2hr 4 min |
| Blount | Maryville | 112 | 2hr 3 min |
| Campbell | Jacksboro | 125 | 2hr 14 min |
| Claiborne | Tazewell | 83.7 | 1hr 44 min |
| Cocke | Newport | 51 | 1hr 10 min |
| Grainger | Rutledge | 77 | 1hr 33 min |
| Hamblen | Morristown | 54.1 | 1hr 8 min |
| Hancock | Sneedville | 73.9 | 1hr 37 min |
| Jefferson | Dandridge | 66.2 | 1hr 6 mi |
| Johnson | Mountain City | 50.3 | 1hr 16 min |
| Knox | Knoxville | 94 | 1hr 42 min |
| Loudon | Loudon | 128 | 2hr 19 min |
| Roane | Kingston | 130 | 2hr 18 min |
| Sevier | Sevierville | 83 | 1hr 36 min |
| Union | Maynardville | 113 | 2hr 5 min |

[1]Based on the MapQuest distance from Jonesborough to the respective county seat.



## Current Behavior

With respect to current behavior for at least some of their cattle, 18 (32.1%) out of 56 responding farmers in the Washington County Region One either currently retain cattle ownership in a custom feedlot or finish cattle on their farm. With respect to current behavior for at least some of their cattle, 41 (45%) out of 91 responding farmers in the Washington County Region Two either currently retain cattle ownership in a custom feedlot or finish cattle on their farm.

## Possible Future Behavior

For Washington County Region One, 76.8% (43) of responding farmers were interested in retaining and finishing cattle for local harvest. For Washington County Region Two, 78% (71) of responding farmers were interested in retaining and finishing cattle for local harvest. Both sets of numbers reflect a high level of potential interest.

For Washington County Region One, the average number of head marketed per farm for interested farms was 130.3. For Washington County Region Two, the average number of head marketed per farm for interested farms was 82.5. For Washington County Region One farms interested in local harvest, the total number of cattle marketed was estimated at 5,602 head (i.e., the 43 interested farmers' times the average 130.3 head per farm). For Washington County Region Two farms interested in local harvest, the total number of cattle marketed was estimated at 5,855 head. These results imply strong interest, but do not mean that 11, 457 (5,602 plus 5,855) cattle would be available for harvest.  On the other hand as for the entire state and for Smith, and Van Buren Counties, there are probably farmers in the Washington County Region One and Washington County Region Two who are interested in local harvest but who did not fill-out the survey. In particular, given the closeness of both North Carolina and Virginia, farmers from both states could also use the facility.

# Summary Livestock Supply

A sufficient and at least fairly steady supply of livestock is a very important consideration for any small livestock harvest facility. Survey results of Tennessee cattle farmers imply that they would be willing to supply a sufficient number of cattle for harvest for the state in general and for the three Tennessee locations analyzed here.

# Financial Analysis

The financial analysis was based on our evaluation of numerous reports and case studies as well as discussions with several current local harvest operations. We extensively reviewed the literature and conducted internet searches in determining the nature of the processing facility under study and all relevant assumed relationships, values, and parameters. The financial analysis includes a discussion of facility construction costs and costs of required equipment. The section also includes a discussion of labor requirements and costs and other operating costs tied to the facility. Also analyzed is our estimate of annual revenue. Finally, the profitability of the processing facility is assessed for one year and the assumed 10 year planning horizon. Sensitivity of profitability to changes in revenue due to lower prices and less animal flow through is also evaluated.

## Construction Requirements and Costs

Construction requirements and costs were primarily based on the values found in Holcomb et al., 2011 adjusted for size of the facility and inflation (because their values are for 2011). As shown in Table 7, construction cost included land acquisition and preparation, shell building and interior space construction, and refrigeration space construction. Land acquisition 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. The requirement of three acres was based on Holcomb (2011) but also our evaluation of the Food & Livestock Planning (2011) study. Three acres is a reasonable estimate for access and for the building and pen footprint. Our decision to exclude composting of waste as an option also limited the amount of land required for the facility. However, the acquisition of a developed site is very much subject to local conditions, so the estimated cost of $45,000 ($15,000 per acre) should be considered a general guide.

In terms of shell building, interior space construction, and refrigeration space construction, the values found in Holcomb (2011) were adjusted for a 5,800 square feet facility versus the original value of 5,000 square feet (Table 7). The resulting values were then adjusted for any changes in inflation in construction cost based on the producers' price index (U.S. Bureau of Labor Statistics, 2017) for new industrial building construction. The interior space is also assumed to have sufficient office space for the federal inspector, the plant manager, and a clerical assistant. Construction costs for the shell building were estimated to be $200,000, estimated cost of refrigeration for the building was $110,000, and estimated cost for cooler construction & doors and other interior work was estimated to be $130,000. Dirt work for construction and building roads was estimated at $110,000, and the construction of the livestock holding pen and unloading area was estimated to cost $24,000.

**Table 7.** Facility Construction Cost and Equipment Purchase Necessary to for Starting a Custom-Harvest Facility.

| Breakdown of Construction Cost and Equipment Purchase: | |
|---|---|
| 5800 square feet facility | $200,000 |
| Refrigeration | $110,000 |
| Interior construction | $130,000 |
| Dirt work-roads (road) | $110,000 |
| **Building construction Subtotal:** | **$550,000** |
| land (3 acre) | $45,000 |
| Holding pens and Livestock unloading area | $24,000 |
| **Construction Subtotal:** | **$619,000** |
| Equipment Purchase | $131,345 |
| **Total** | **$750,345** |

## Equipment Complement and Cost

We extensively reviewed the literature with an emphasis on prior studies and information regarding meat processing for cattle and in general to determine equipment needs for the custom- harvest facility. Equipment needs were determined based on a line harvest method of operation, where the carcass is hoisted into an overhead rail system ensuing with bleeding and "all subsequent harvesting and dressing procedures are carried out with the carcass suspended on and moving along" (p.14 Heinz, 2008) the rail (or line). Required equipment was determined based on discussions with current operations, and our review of numerous studies (Curtis et al., 2007, Dickenson et al., 2013a, Gwin et al., 2011, Holcomb et al., 2011, Food & Livestock Planning, 2011, and Thiboumery, 2010), meat processing in general (Romans et al., 2001, Toldra, 2010 and Rankin, 2000) and our review of animal harvest and processing requirements on-line.

We conducted internet searches of equipment supplier websites for equipment price estimates. When estimates from these sources were unavailable, we obtained prices directly from equipment dealers (LeFiell Company and UltraSource). The list of equipment required for the operation, our estimate of equipment cost, and the source of information for each item's cost are provided in Table 8. Total estimated equipment cost was $131,435. The equipment is necessary for a hanging carcass and rail processing system including appropriate equipment for killing livestock (knock box and stun bolt). Such a system facilitates ease of processing and inspection by both plant workers and USDA personnel. Other equipment is necessary to insure food safety such as the saw sterilizer, knife sterilizer, and lavatories with sterilizers (Romans et al., 2001, Toldra, 2010 and Ranken, 2000). Some items, such as a hide puller (Heinz, 2008) might not be required for a basic custom-harvest operations but do enhance the efficiency of the operation.

Among the equipment items, the most expensive items were the mixer grinder required for ground beef production at $14,007 (10.7% of total equipment cost), followed closely by a vacuum packaging machine at $14,000 (10.7%) required for final packaging of cuts, a hide puller at $9,500 (7.2%), a saw sterilizer at $9,000 (6.9%), and a knocking box at $7,000 (5.3%). As a group, the various types of saws needed for evisceration and meat cutting were a major cost component as were the different platforms required to facilitate production and carcass inspection.

**Table 8.** Equipment Cost, Percent, and Date Sources.

| Equipment Item | Cost | % Equipment Cost | Source |
|---|---|---|---|
| Knocking box | 7,000 | 5.3% | Brandon Camp, LeFiell Company |
| Captive bolt stunner | $1,750 | 1.3% | QC Supply |
| Hoist | $4,078 | 3.1% | Brandon Camp, LeFiell Company |
| Retaining Rail | $1,200 | 0.9% | Brandon Camp, LeFiell Company |
| Bleeding Rail | $3,500 | 2.7% | Brandon Camp, LeFiell Company |
| Rail Stops | $2,300 | 1.8% | Brandon Camp, LeFiell Company |
| Bleeding Shackles (3 at $272.67 each) | $818 | 0.6% | Brandon Camp, LeFiell Company |
| Hide Puller | $9,500 | 7.2% | Brandon Camp, LeFiell Company |
| Hide pulling hoist | $2,650 | 2.0% | Watson's Incorporated |
| Blood and Water Drain | $410 | 0.3% | Brandon Camp, LeFiell Company |
| Spreader for Evisceration | $4,315 | 3.3% | Brandon Camp, LeFiell Company |
| High Skinning Platform | $6,000 | 4.6% | Brandon Camp, LeFiell Company |
| Low Skinning Platform | $3,500 | 2.7% | Brandon Camp, LeFiell Company |
| Inspection Platform | $3,500 | 2.7% | Brandon Camp, LeFiell Company |
| Splitting Saw | $5,100 | 3.9% | Watson's Incorporated |
| Brisket saw | $4,100 | 3.1% | Amazon listed price |
| Breaking saw | $1,930 | 1.5% | Watson's Incorporated |
| Lavatories with Sterilizers | $4,000 | 3.0% | Brandon Camp, LeFiell Company |
| Knife Sterilizer | $3,000 | 2.3% | Brandon Camp, LeFiell Company |
| Saw Sterilizer | $9,000 | 6.9% | Brandon Camp, LeFiell Company |
| Skinning cradles | $1,500 | 1.1% | Brandon Camp, LeFiell Company |
| Evisceration cart | $4,500 | 3.4% | Ed Lonergan at UltraSource |
| Electronic rail scale | $3,500 | 2.7% | Brandon Camp, LeFiell Company |
| Two Trolleys | $240 | 0.2% | Brandon Camp, LeFiell Company |
| Carcass dropper | $1,600 | 1.2% | Knase Co. Inc. on-line |
| Stainless steel landing table | $2,500 | 1.9% | Ed Lonergan at UltraSource |
| Boning table | $1,650 | 1.3% | Koch Quote March 2011 |
| Packaging table | $1,450 | 1.1% | Koch Quote March 2011 |
| Band saw | $5,199 | 4.0% | Pleasant Hill Grain online |
| Mixer Grinder | $14,007 | 10.7% | online Hess Meat Machines |
| Vacuum packaging machine | $14,000 | 10.7% | Ed Lonergan at UltraSource |
| 2 Desk | $1,000 | 0.8% | Staples (Holcomb et al.) |
| 2 Chair | $325 | 0.2% | Staples (Holcomb et al.) |
| Computer | $1,100 | 0.8% | Best Buy (Holcomb et al.) |
| Printer/copier/fax | $447 | 0.3% | Best Buy (Holcomb et al.) |
| Lockers | $276 | 0.2% | Global Industries |
| Miscellaneous employee kitchen equipment | $400 | 0.3% | Livestock & Planning |
| **Total Equipment Cost** | **$131,345** | **100%** | |

# Other Operating Costs

A breakdown of other operating costs is provided in Table 9. As described in this section, these costs are based on our analysis of previous studies primary Holcomb et al., 2011a, 2011b, Food & Livestock Planning, 2011, Gwin et al., 2011, and Dickerson et al., 2013. The largest cost item was packing cost estimated on a per animal basis at $47.50 for a total cost of $85,500 assuming 1,800 head are processed per year. This cost item in other studies ranged from $47.50 (adjusted for inflation from Dickerson et al., 2013) to $52.00 per head in Holcomb et al., 2011, but the larger costs included packaging tied to further value added processing (which was not considered in this study). Cost of electricity was the second largest cost item among these values at $72,000 or 27.1% of all such costs. Electricity costs were based on the original value as provided in Holcomb et al., (2011) but adjusted for differences in power charges between the states of Oklahoma and Tennessee and on differences in the years of analysis (based on data published by the Energy Information Administration as provided by Nebraska State Government, 2017). Packing material costs (the largest cost item) was based on the CISA Meat Processing Business Template (Dickenson et al., 2013a) adjusted for inflation from 2013 for a combination of corrugated shipping containers and plastic products manufacturing (for plastic vacuum bags). This cost was estimated at $85,500 or 32.3% of all other cost items. Electricity costs were estimated at $72,000 or 27.1% of all cost items (Table 9). Other larger cost items were other utilities (water, sewer, and solid waste) and a host of general supplies ($9,000). Interestingly, pick-up by a rendering operation of offal was not one of the largest costs at $6,600 or 2.5% of all other cost items. But as discussed in the barrier section, offal is usually a profit center for major livestock processing facilities. For example, according to the Beef Cutout calculator (Colorado State University, 2017), bone, fat, tissue, and skin constitute 0.9% ($13.60) of the total value of a 1,300 live weight harvested beef animal. Also, renderers may be difficult to find in certain areas and at times could be unreliable in terms of pickup as a small operation is only a small part of their business.

**Table 9.** Other Annual Costs for Custom- Harvest Operation.

| Item | Cost | Percent of Total |
|---|---|---|
| Legal Fees | $2,900 | 1.1% |
| Dues and Subscripts | $1,240 | 0.5% |
| Accounting | $4,400 | 1.7% |
| Travel | $2,000 | 0.8% |
| Postage | $1,160 | 0.4% |
| Pest Control | $1,200 | 0.5% |
| Laundry | $2,500 | 0.9% |
| **Miscellaneous (subtotal)** | **$15,400** | |
| Electric | $72,000 | 27.1% |
| Gas | $18,000 | 6.8% |
| Water | $12,000 | 4.5% |
| Sewer | $12,000 | 4.5% |
| Phone-Internet | $1,800 | 0.7% |
| Inedible Expense (renderer pick-ups) | $7,500 | 2.8% |
| Solid waste | $6,600 | 2.5% |
| Lab Fees | $1,860 | 0.7% |
| **Utilities Subtotal** | **$131,760** | |
| Supplies (gloves, cleaning, etc.) | $9,000 | 3.4% |
| Insurance | $16,315 | 6.1% |
| Maintenance (3% of equipment) | $3,940 | 1.5% |
| Property Tax | $3,752 | 1.4% |
| Packing Material Cost (1,800 head at $47.5 per head) | $85,500 | 32.2% |
| **Total** | **$265,727** | **100.0%** |

## Labor Requirements and Costs

Labor requirements were primarily based on Holcomb et al., 2011a and 2011b, but were also based on our review of the estimates presented in Dickenson et al., (2013a), Food & Livestock Planning (2011), Swenson (2011), and Thiboumery, 2011. We assumed sufficient labor to insure a harvest rate of 36 cattle per week. (As discussed in the section on input supply, steady and adequate flow through of animals where the workforce is not under-utilized or over-utilized is a must for efficient operation and sufficient cash flow.) Besides animal processing, we assumed the need for a clerical staffer who would also play a major role in recruiting and coordinating activities with farmers. This person could also play a role in developing wholesale and retail outlets if a decision is made in the future to move into animal ownership and/or further fabrication of value added products. A plant manager is also a critical position; such a person should hopefully have experience in the animal processing industry. Besides the skills needed to organize and run the operation, it would be best if the plant manager could fill-in for the butcher or other line personnel on an as needed basis. The plant manager is also assumed to be responsible for insuring USDA compliance.

In terms of costs, labor for six workers (including the plant manager) is the largest annual cost item at a total annual labor bill of $306,599 (Table 10). Salary levels were based on our analysis regarding the distribution of salaries for the appropriate occupation as provided by the U.S. Bureau of Labor Statistics. Benefits as a percentage of salaries (35%) were based on Holcomb et al. (2011) and include all payroll taxes and payments for employee retirement and health care benefits. Pay levels were determined primarily based on the importance of the position to the operation.

For example, the pay level for the butcher is in the 90% percentile for pay as indicated by the Bureau of Labor Statistics data because retaining the services of a skilled butcher is very important to the success of the operation. The pay level for the plant manager of $63,000 per year is a somewhat downward adjustment to the median pay for industrial production managers and less than the value ($80,000) used in one report (Food & Livestock Planning, 2011); but markedly more than the values for plant manager provided by Holcomb ($48,210) in 2011 or by Dickerson et al. in 2013, at $52,000, or the $30,000 through 32,690 values reported by Gwin et al. in 2013.

**Table 10**. Labor Cost for Custom-Harvest Operation.

| Labor Category | Salary | Benefits | Total Labor Cost |
|---|---|---|---|
| Plant Manager | $63,000 | $22,050 | $85,050 |
| Butcher | $39,750 | $13,913 | $53,663 |
| Packaging/ Cutting | $28,120 | $9,842 | $37,962 |
| Sales-Clerical | $40,000 | $14,000 | $54,000 |
| Packaging/ Cutting | $28,120 | $9,842 | $37,962 |
| Packaging/ Cutting | $28,120 | $9,842 | $37,962 |
| **Total Labor Cost** | **$227,110** | **$79,489** | **$306,599** |

## Loan-Based Financing of the Facility

We assumed that the loan $750,345 used to finance construction of the facility and purchase all equipment would be completely paid off over a ten year period (based on Holcomb et al., 2011b). We assumed for completeness of analysis that the project would be completely funded by external sources. [4]Similar to Eatherly (2017), we assume a loan interest rate of 5.6% based on a five year average of the agricultural interest rates for machinery and intermediate loans from 2012 through 2016 from the Federal Reserve Bank of Kansas City. Amortizing the loan over ten years leads to total annual debt service (interest plus principal) of $100,025. Total repaid interest over the ten year repayment schedule is $249,900. Of course, a more aggressive repayment schedule would reduce the amount of total interest payment required to finance the project.

**Table 11.** Total Annual Cost of Harvest Operation.

| Category | Cost |
|---|---|
| Total Labor & Other annual costs[1] | $572,326 |
| Annual Payment for loan[2] | $100,025 |
| **Total Annual Costs** | **$672,351** |

[1]Total Labor Costs of $306,599 plus Other Annual Costs $265,727.
[2]Amortizing the $750,345 over ten years at a 5.6% rate of interest.

## Total Cost, Revenue, and Profitability

Total annual cost is estimated as indicated in Table 11 including paying off the loan note under the terms as previously discussed.

**Table 12.** Estimated Annual Revenue.

| Category | Value |
|---|---|
| Hanging (hot carcass weight (lbs.) per head): | 700 |
| Base Harvest Fee per Head | $75.00 |
| Boning/Cutting/ Packaging Fee Per Pound | $0.49 |
| Total Revenue Per Head ($75+(700*0.49)) | $418.00 |
| **Annual Number of Head[1]** | **1,800** |
| **Total Annual Revenue (1,800 head X revenue per head of $418.00)** | **$752,400** |

[1]Assuming harvest rate of 36 head per week for 50 weeks.

## Annual Revenue

We analyzed numerous studies and information from the Internet to arrive at the charge for custom-harvest and processing (Table 12). Such charges are usually based on a flat fee plus a fee per pound of processed animal based on carcass weight (after harvest and evisceration but before any further processing). Per pound charge rates ranged from $0.45 per pound to $0.65 per pound. Flat fee rates ranged from $35 to $93 per head but were subject to other fees (for example, the $35 fee carried an additional fee of $1 charge per box of final product). Based on values for Tennessee and Kentucky, annual revenue is based on a flat fee of $75 per processed cattle plus a charge of $0.49 per pound for a 700 pound hot weight

[4]Even self-funded projects would have an opportunity cost in terms of the capital being applied in alternative investments.

[5]Short term storage of processed meats is also assumed to occur (for example up to several weeks) free of charge. After that time, the customer would incur a hanging fee.

carcass or $418 per processed animal.[5] Our total revenue estimate per processed animal is intentionally conservative; for example, Holcomb et al. (2011a) indicated revenues of $518 per processed cow (23.9% higher). The plant is assumed to provide harvest at a rate of 36 animals for 50 weeks a year for 1,800 head harvested per year.[6] This rate is within the values provided by Holcomb et al. (2011) adjusted for size of the workforce and lack of fabrication and by Food and Livestock for a facility exclusively devoted to cattle processing. Total annual revenue is projected at $752,400 assuming 50 weeks of plant operation a year.

Based on our analysis, the plant would be profitable with an estimated annual pre-income tax profit of $80,049 after covering operating cost and the payback and interest on the loan (Table 13). We attempted to be conservative in our estimates. For example, purchasing used equipment or using an extended shell building could lower our cost estimates. Also, it might be possible to utilize a part-time worker on the line rather than the full time positions employed in our evaluation. This approach would be especially recommended for consideration if animal flow through was not consistent from week to week. However, it is not recommended for the butcher or plant manager positions.

**Table 13.** Annual Pre-Tax Profit and Sensitivity Analysis for Yea One.

| Item | Value |
|---|---|
| Total Annual Revenue | $752,400 |
| Total Costs | $672,351 |
| Pre- Income Tax Profit | $80,049 |
| Break-Even Price Per Pound | $0.438 |
| Break-Even Price Kill Charge Per Head | $67.02 |
| Break-Even Price, Per Pound, All Nonfinancial Costs | $0.373 |
| Break-Even Price Kill Charge Per Head, All Nonfinancial Cost | $57.05 |
| Break-Even, Number of Cattle Processed Annually | 1,584 |

[6]The appropriate animal flow through rate was complicated to calculate because examined studies either included further fabrication (especially problematic) or the processing of other species.

Discounted, annualized costs, returns, and profits for the entire ten year period of analysis are provided in Table 14. The values in Table 14 follow Holcomb et al. (2011) in assuming an annual increase of 1% in both revenues and operating cost. A discount rate of 10% is assumed based on a federal discount rate of 7% (Congressional Research Service, 2016) adjusted for risk. At this rate, discounted pre-tax profits are $41,103 after the tenth year of operation. The benefit cost ratio of the project is 1.1 and the internal rate of return on the investment is 21.34%.

We also conducted sensitivity analysis regarding the per pound and flat rate charges to determine a break-even price for the long run (i.e., all pretax estimated profits go to zero) and for covering all costs except financing costs (Table 14). A reduction of 10.6% in charges to 43.8 cents per pound and $67.02 in the flat rate charge would drive profits to zero. A reduction of 23.9% to 37.3 cents per pound and $57.05 in the flat rate charge would drive revenue to the point where all costs except financing costs were covered. A reduction in the rate of processed animals would have similar implications, assuming that packing costs also reduced at the same rate as the decline in processed animals. Based on our estimates, a reduction in the number of processed animals to 1,584 from 1,800 (a decline of 12%) would also drive long run profits to zero. (Once again, we are assuming no adjustments in costs other than packing costs.)

**Table 14.** Cattle Processing Facility Annual Costs, Revenue, Profit, and Discounted Revenue over a Ten Year Planning Horizon.

| Item: | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Total Annual Operating Costs[1] | $572,326 | $578,049 | $583,830 | $589,668 | $595,565 | $601,520 | $607,536 | $613,611 | $619,747 | $625,945 |
| Annual Debt Service | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 | $100,025 |
| Total Annual Costs | $672,351 | $678,074 | $683,855 | $689,693 | $695,590 | $701,545 | $707,561 | $713,636 | $719,772 | $725,970 |
| Total Annual Revenue[1] | $752,400 | $759,924 | $767,523 | $775,198 | $782,950 | $790,780 | $798,688 | $806,675 | $814,741 | $822,889 |
| Annual Pre-Tax Profit | $80,049 | $81,850 | $83,668 | $85,505 | $87,361 | $89,235 | $91,127 | $93,039 | $94,969 | $96,919 |
| Profit Discounted at 10% rate of interest | $80,049 | $74,409 | $69,148 | $64,241 | $59,669 | $55,408 | $51,439 | $47,744 | $44,304 | $41,103 |

[1] Assumed to increase at an annual rate of 1%.

# Summary and Conclusions

The financial analysis provided here indicates that based on all the assumptions of this study, a well-managed custom livestock facility could be a profitable venture. The annual estimated pre-tax profit was estimated at $80,049 based on projected (first year) annual revenues of $752,400 and costs of $672,351. Our analysis indicated sufficient revenue would be generated to pay off the cost of constructing and equipping a facility over ten years. While we attempted to be conservative in our estimates, an investment decision should be based on actual costs and projected revenues faced by potential investors.

Sufficient and steady supply of cattle, providing a high quality service to cattle farmers, and other factors such as adequate concern for animal welfare, food safety, access to sufficient waste disposal and water supply as well as an acceptable site are all important to the success of any custom-harvest operation. Accordingly, these factors must be strongly considered as well as the assumptions that were made in the financial analysis, before moving forward with the decision to start a USDA inspected, custom cattle harvest facility in Tennessee. In particular, one set of topics not examined is the need for a harvest facility in given locations. While we did evaluate the potential supply of cattle for some regions of the state, even in those areas we did not evaluate the potential for competition with existing USDA approved harvest facilities. Expanding existing facilities is another option for meeting the need of increased harvest capacity in the state, but this issue is also not evaluated in our study.

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# Appendices

# Appendix A. Solid Waste Disposal Recommendations and Regulations

USDA regulations require the removal of specified risk materials (SRMs) in cattle 30 months of age and older processed for human food. SRMs are tissues in cattle that are evaluated to be of high risk for prion contamination. Prions are the potential carries for transmissible spongiform encephalopathies or more commonly, diseases of the brain. The removal of SRMS from all cattle submitted for slaughter is the most significant defense tactic against Bovine Spongiform Encephalopathies (BSE), i.e. "Mad Cow" disease (Specified Risk Material Control, 2016). Additionally, the 2008 changes in FDA federal regulations, specific to BSE concerns found in 21 CFR 589.2001, requires the additional removal of certain cattle material prohibited in animal feed (CMPAF) and will make the rendering of specific portions of the by-products utilized for all animal feed unlawful.

The Tennessee Department of Agriculture (TDA) (2012) provides guidance and options for disposal via rendering. It is important to understand that all the non-edible byproducts of cattle harvesting and processing can be taken by a renderer and utilized for other uses). These options include:

- Option 1. If you currently use a renderer for the disposal of the non-edible byproducts from your operation and your renderer certifies to you (in writing) that they do not process the byproducts into any animal feed, no changes to your operation are required.
- Option 2. If you currently use a renderer for the disposal of the non-edible byproducts from your operation and your renderer has refused to accept any byproducts from your facility in the future, your option is disposal in a permitted landfill. Incineration or composting may also be options for disposal but approval from TDEC is necessary.
- Option 3. If you currently use a renderer for the disposal of the non-edible byproducts from your operation and your renderer is willing to accept the non-restricted byproducts, then you must separate the restricted byproducts of the harvested cattle (brain and spinal cord) from the other offal. There are also certification requirements for the slaughter facility and the renderer. The restricted byproducts may be disposed in a permitted landfill. Incineration or composting may also be options for disposal but approval from TDEC is necessary. If the owner of the harvested cow also owns a farm, the restricted byproducts may be transferred back to him or her for on-farm disposal.
- Option 4. If you harvested cattle that are less than 30 months of age only, the renderer can agree to accept the non-edible byproducts from your operation based on this fact.

# Appendix B. Wastewater Regulations

The EPA proposes and promulgates water effluent discharge limits for industrial sectors. The Federal Water Pollution Control Act or the "Clean Water Act," (CWA, 33 U.S.C. § 1251 et seq.) establishes a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The main components of meat processing wastewaters are a variety of readily biodegradable organic compounds, primarily fats and proteins, present in both particulate and dissolved forms (EPA, 2004). To decrease the concentrations of particulate matter, wastewater (in particular all effluent from the harvest floor) is usually screened to catch and separate solids (Vats, 2013). The resulting meat processing wastewater remains "high strength wastes" with high concentrations of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen, and phosphorus (EPA, 2004).

A five-day Biological Oxygen Demand (BOD) value is used to measure the level of treatment required to discharge effluent safely. Blood not collected, solubilized fat, urine, and feces are the primary sources of BOD in meat processing wastewaters (Food & Livestock Planning, 2011). The BOD for all food-processing effluent is relatively high compared to other industries. A high BOD level indicates that effluent contains elevated amounts of dissolved and suspended solids, minerals and organic nutrients containing nitrogen and phosphorus (Food & Livestock Planning, 2011).

Another significant factor in determining the BOD of meat processing wastewaters is the procedure in which manure is controlled at the facility. Typically, manure is separated from the main waste stream and treated as solid waste. Beef cattle manure has a BOD of approximately 27,000 mg/kg on an as excreted basis (American Society of Agricultural Engineers, 1999).

The efficiency of fat separation and removal from the waste stream is an important factor in determining the BOD concentration in meat processing wastewaters. Fat removed from wastewater can be handled as solid waste or by-product. Blood and manure are also consequential sources of nitrogen in meat processing effluent. The primary form of nitrogen in these wastewaters before treatment is organic nitrogen with some ammonia nitrogen (EPA, 2004). The phosphorus in meat processing wastewaters is primarily from blood, manure, and cleaning and sanitizing compounds (EPA, 2004).

Any facility or persons discharging pollutants directly from point sources into surface waters of the state must obtain a National Pollutant Discharge Elimination System (NPDES) discharge permit from the Tennessee Division of Water Resources. Direct Dischargers include industrial and commercial wastewater, industrial storm water, and municipal wastewater discharges.

Processing plants transmitting wastewater to public sewers, referred to as publicly owned treatment works (POTW), are classified as indirect dischargers, and do not require a NPDES discharge permit. However, the processing facilities must obtain a discharge permit from their local POTW. The POTW standards and requirements are specified in local sewer ordinances. Facilities wishing to pursue this route of discharge must contact their respective municipality to secure a discharge permit. The municipality would detail the conditions or management approach required to accommodate the high nutrient value in blood waste. An alternative approach would be to compost as much blood as possible by designing appropriate drains and collection systems.

# Appendix C. Humane Treatment of Cattle

According to Grandin (1996), "there are five basic causes of animal welfare problems in harvest plants:

1. Poorly designed or improper stunning and handling equipment.
2. Distractions which impede animal movement, such as sparkling reflections on a wet floor, air hissing, high-pitched noise or air drafts blowing down the race towards approaching animals. These distractions can ruin the performance of a well-designed system and cause animals to become excited. When this happens, prodding will be required to make them move.
3. Lack of employee training and poor supervision of employees by management.
4. Poor maintenance of equipment and facilities, such as malfunctioning stunners or worn, slick, floors which cause animals to slip and fall.
5. Poor condition of animals arriving at the plant, such as cripples and sick animals" (p.22).

"Stress can be minimal in a well-designed head restraint where the animal is stunned immediately after the head is caught" (p.23, Grandin, 1996).

To properly account for animal welfare, all five areas should be addressed. In terms of facility design a properly designed curved race and a sufficient space in the forcing pen is important. "Stress can be minimal in a well-designed head restraint where the animal is stunned immediately after the head is caught" (p.23, Grandin, 1996). Distractions such as sparkling reflections, air blowing at the animal, and high pitch noise can make cattle balk and increase their stress level. When plant managers appropriately train and supervise employees, good animal management by employees is the result. Problems can be eliminated or minimized and behavioral principles may be used to induce cattle movement easily and quietly. Exploiting natural animal behavior is important, especially by not crowding animals or rushing them through races or holding pens and by remaining calm and by avoiding sudden motions. As a result, the use of electric prods is minimized.

The legal framework for treatment of animals is provided by the: Humane Slaughter Act of 1978. Humane treatment and harvest of all animals is a crucial component of the harvesting establishment. Ethical obligations and commitments to humane treatment for the well-being of the animals are vital components of a processing facility. The USDA's agency, Food Safety Inspection Service (FSIS), is charged with certifying industry compliance with the Humane Methods of Slaughter Act of 1978 (HMSA). This statute prescribes for the regulations for humane handling prior-to and during the harvesting process. Humane handling procedures are verified at FSIS-inspected livestock harvest establishments every 12 to 18 months. FSIS responsibilities for enforcing proper treatment methods and humane handling of all food animals for harvest is derived from the Humane Methods of Slaughter Act (HMSA; 7 U.S.C. §§ 1901 et seq.), which governs the humane handling and harvest of livestock. Its key provision (§1902) states:

"No method of slaughtering or handling in connection with slaughtering shall be deemed to comply with the public policy of the United States unless it is

humane. Either of the following two methods of slaughtering and handling are hereby found to be humane:

> (a) in the case of cattle, calves, horses, mules, sheep, swine, and other livestock, all animals are rendered insensible to pain by a single blow or gunshot or an electrical, chemical or other means that is rapid and effective, before being shackled, hoisted, thrown, cast, or cut; or
>
> (b) by slaughtering in accordance with the ritual requirements of the Jewish faith or any other religious faith that prescribes a method of slaughter whereby the animal suffers loss of consciousness by anemia of the brain caused by the simultaneous and instantaneous severance of the carotid arteries with a sharp instrument and handling in connection with such slaughtering (CRS pgs. 3 and 4)."

The first humane harvest law, passed in 1958 (P.L. 85-765), covered only plants that wanted to sell meat to the federal government. It was expanded in 1978 (by P.L. 95445, which amended the Federal Meat Inspection Act at 21 U.S.C. §§ 603 and 610) to cover all federally inspected establishments that slaughter livestock; the 1978 law also added the phrase "and handling in connection with such slaughtering."

To implement the 1958 act, FSIS issued regulations (at 9 C.F.R. parts 313 and 500), and a directive (6900.2) for inspection personnel covering the proper maintenance of pens and ramp ways; how to handle livestock during unloading and movement to the stunning area, including the use of electric prods and other instruments; and the methods of stunning the animals. For each, the directive spells out how personnel are to verify compliance and specifically what to do if there is noncompliance.

The FSIS released the 2011 directive to update the prescribed requirements for inspectors, verification activities, and implementation for guaranteeing the handling and harvest of livestock is humane. This directive also provides for humane direction with disabled livestock and those harvested by religious methods (Food Safety and Inspection Service, 2013).

> No method of slaughtering or handling in connection with slaughtering shall be deemed to comply with the public policy of the United States unless it is humane.

The Wholesome Meat Act of 1967 (Government Printing Office) as this legislation prescribed modernized provisions for the inspection standards and stipulations for harvesting and processing of meats.

There is no regulatory requirement for a written systematic approach to humane handling; however, without a written plan, verification of an effective, humane program will be difficult. Four aspects of a systematic approach must be addressed (Food Safety and Inspection Service, 2013). These four steps are:

"1. Conduct an initial assessment of where, and under what circumstances, livestock may experience excitement, discomfort, or accidental injury while being handled in connection with slaughter, and of where, and under what circumstances, stunning problems may occur;

2. Design facilities and implement practices that will minimize excitement, discomfort, and accidental injury to livestock;

3. Evaluate periodically the handling methods the establishment employs to ensure that those methods minimize excitement, discomfort, or accidental injury and evaluate those stunning methods periodically to ensure that all livestock are rendered insensible to pain by a single blow; and

4. Respond to the evaluations, as appropriate, by addressing problems immediately and by improving those practices and modifying facilities when necessary to minimize excitement, discomfort, and accidental injury to livestock (FSIS, pg. 6)."

Appropriate stunning methods are required for a facility to be in compliance with regulations. Livestock are to be rendered unconscious by a single blow or gun shot or an electrical, chemical, or other means that is deemed rapid and effective. The stunning impact method must be accurate and induce immediate unconsciousness. In an effort to maintain a high level of accuracy, the stunning area needs to be designed to limit free movement. Satisfactory stunning practices are required for compliance with the Humane Slaughter Act and for animal welfare. HMSA approves of the following four methods:

- Chemical- carbon dioxide systems;
- Mechanical- captive bolt;
- Mechanical- gunshot;
- Electrical- stunning or harvesting with an electric current.

# Appendix D. Meeting Meat Industry Safety Regulations

The meat industry is regulated by various regulations and inspection requirements. The meat industry has been directed by progressive legislation since the Federal Meat Inspection Act of 1906. However, it is most notably impacted by the Wholesome Meat Act of 1967 (Government Printing Office) as this legislation prescribed modernized provisions for the inspection standards and stipulations for harvesting and processing of meats. These federal acts define the process for pre-and post-mortem inspections as well as explicit marking labels, and packing stipulations.

Meat products that will be sold must originate from a harvesting and processing facility that is directly or indirectly approved by the USDA and operated under the guidance of federally mandated procedures. The Federal Meat Inspection Act of 1906 sets forth four major requirements for the meat packing industry. Meat inspectors identify meat as healthy (free of disease), clean and sanitary, wholesome (unadulterated), and properly labeled. The Act requires mandatory inspection of livestock before harvest and mandatory postmortem inspection of every carcass. It also sets explicit sanitary standards for slaughterhouses.

USDA Federally inspected establishments are required to have a USDA inspector on-site for the entire process. This process includes live animal arrival, post-mortem inspection, and fabrication. Tennessee is home to thirteen USDA slaughter operations that are permitted to provide harvesting and processing services (Center for Profitable Agriculture, 2016). Some states have their own inspection programs[7] or have a Talmadge-Aiken plant inspection[8] program (state employed inspectors with USDA inspection privileges (Dunlap et al., No Date). However, neither option is available in Tennessee (Holland and Leffew, 2013). A custom-exempt operation is an option in Tennessee; however, such facilities cannot produce meat for sale to the general public and hence are excluded from our analysis.[9]

Tennessee is home to thirteen USDA slaughter operations that are permitted to provide harvesting and processing services (Center for Profitable Agriculture, 2016).

[7]State inspection programs must execute inspection protocols that are at least equal to federal inspection requirements. These state programs must be authorized by USDA and sustain annual comprehensive reviews of slaughtering, preparation, processing, storage, handling, and distribution (Dunlap et al). Meat derived from state-inspected plants is only permitted to be sold through intrastate commerce, (i.e., federal law prohibits state-inspected plants from marketing their products across state lines). Individual states are responsible for the funding of their programs. Twenty-seven states have implemented state inspection programs under a cooperative agreement with the Food Safety and Inspection Service (eXtension, 2003).

[8]The Talmadge-Aiken plants proceed as a result of the Talmadge—Aiken Act of 1962; a law passed to help coordinate state and federal food safety guidelines. This law allows trained inspectors that are state employees to staff meat packing plants with USDA inspection privileges (Dunlap et al.). A "TA plant" is a "federally-inspected" plant, which means that meats from this facility bear the USDA Inspection Legend and thus can be sold across state lines (eXtension, 2003).

[9]In such facilities, the meat is the legal property of the person who owns the animal (livestock or wild game). The meat is cut, packaged, and labeled "not for sale." These meats are returned to the owner of the animal and cannot be sold (Leffew and Holland, 2015). These facilities do not have a state or federal inspector on duty (i.e., resulting processed meats facilities are not considered to be state- or federally-inspected). The state does conduct regular inspected such facilities for overall sanitation, but the animals themselves are not inspected for disease. In December 2009, there were 164 custom-exempt processing facilities registered with the Tennessee Department of Agriculture (Leffew and Holland, 2015).

Processing plants have a duty to provide sanitized facilities, first with construction and then with maintenance of proper plant protocols for sanitation practices.

## Meat Plant Sanitation

Adherence to slaughterhouse food safety and sanitation can be the difference in profitability and even survival. Processing plants have a duty to provide sanitized facilities, first with construction and then with maintenance of proper plant protocols for sanitation practices. The use of applicable equipment, employee training, and appropriate time dedication are important elements for retaining sanitation objectives.

Every establishment should have a documented food safety program that contains current HACCP plan, (SSOPs, and Good Manufacturing Practices (GMPs) (Mikel, 2010). A commercial meat-processing facility must create and maintain a variety of plans, primarily HACCP and SSOP plans, aimed at reducing contamination of food products.

HACCP plans became a requirement for small processing facilities in 2000. A HACCP plan is a "written food safety plan covering biological, chemical and physical food safety hazards that may arise during the production process" (Page 2. Minnesota Dept. Agriculture, 2017). A processor first develops their own procedures and performance standards for producing food products, following the HACCP guidelines, and then submits this plan to the USDA for approval. A HACCP plan is required for each type of product produced or fabricated at a facility. All HACCP plans must annually be reviewed and signed by the trained parties bearing responsibility (Dickenson et al., 2013a).

Hazard analysis refers to the identification and prevention of significant food-safety hazards, whereas critical control points are steps within the manufacture of a food product

where specific critical control limits may be exceeded. A HACCP plan typically contains seven components (Dickenson et al., 2013b).

HACCP plan components include:

- Identification of each Critical Control Point (CCP);
- Critical limits for each CCP;
- Monitoring procedures for each CCP;
- Corrective action that will be taken when there is a loss of control at a CCP;
- Verification procedures ensuring proper monitoring of each CCP;
- Written procedures for employee training;
- A list of food service equipment used at each CCP.

In 1997, the USDA started requiring inspected commercial meat processors to develop a SSOPs plan. This plan specifies which sanitation activities will occur daily in order to prevent contamination of food products within the facility. At minimum, this plan must describe how surfaces which come in contact with food products, in addition to equipment and utensils, will be cleaned each day. The plans identify who in the facility will perform these duties, such as employees, or more commonly, a contract cleaning service, in addition to who will sign and date the appropriate documentation to verify the completion of these activities (Dickenson et al., 2013b).

A meticulous, and all-inclusive, sanitation program must be implemented with the necessary safeguards to avoid a food borne illness outbreak. The sanitation plan must be verified in accordance with the written SSOPs plan. Verification is the use of methods, procedures, or tests in addition to those used in monitoring to determine if the operation is in compliance with the plan. These methods will illustrate whether the sanitation program is attending to the needs of the plant and if it requires adjustments. Verification is long term; however, it may require some modifications of the current sanitation program to guarantee a safe meat product (Mikel, 2010).

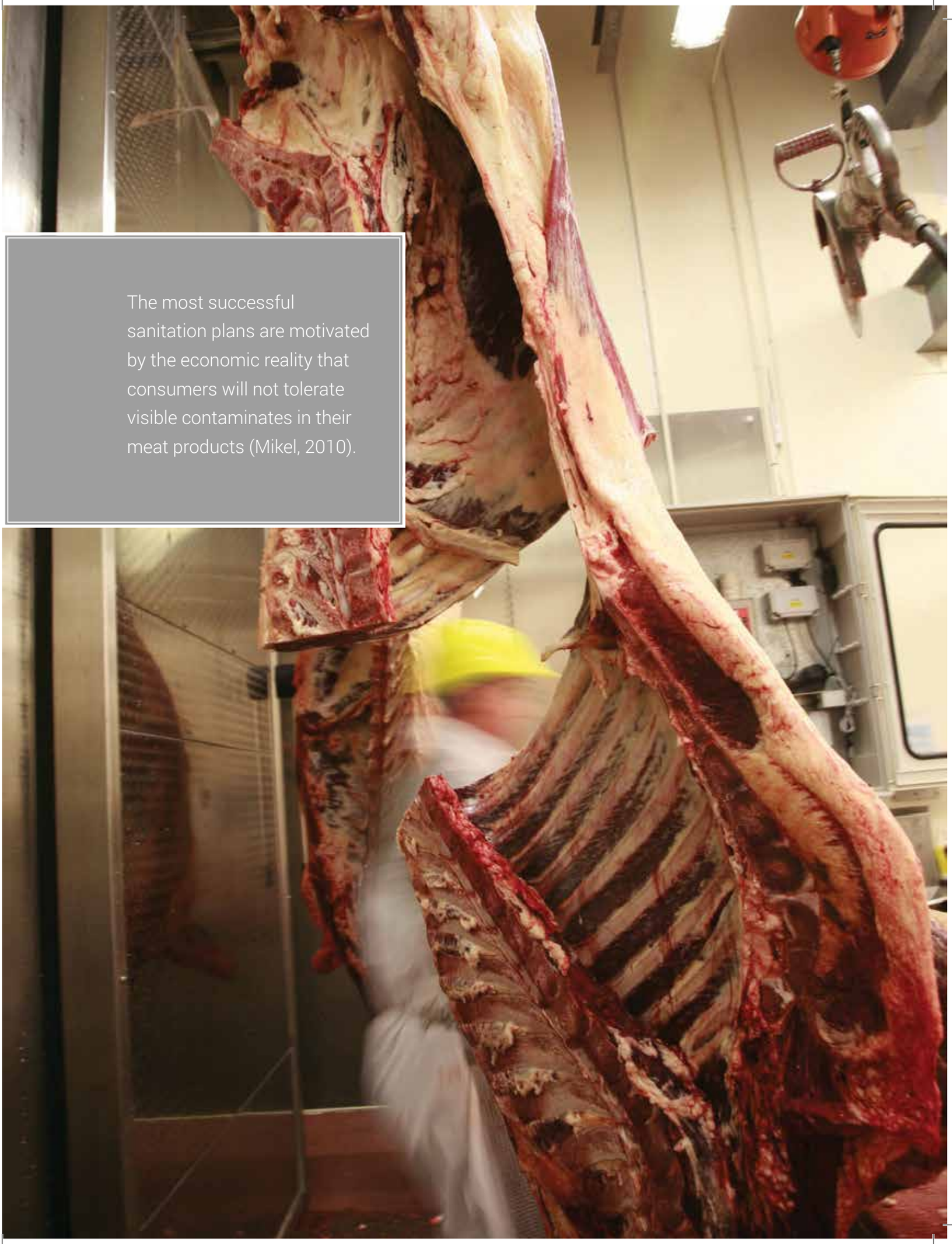
In 1997, the USDA started requiring inspected commercial meat processors to develop a SSOPs plan. This plan specifies which sanitation activities will occur daily in order to prevent contamination of food products within the facility.

All portions of the operation must be thoroughly cleaned followed by sanitization. Cleaning is the removal of all the organic materials (i.e. dirt, manure, meat scraps, etc.). A facility and/or piece of equipment must be completely cleaned or it will not be possible to sanitize. Plant equipment, used in both the harvesting and fabrication processes, should be created out of materials and installed so it can easily be cleaned, sanitized, and maintained. The meat industry utilizes four types of sanitizers: hot water, chlorine, iodophors, and quaternary ammonia. It is recommended to use these chemicals in a rotational system to prevent resistance. It is important to follow the prescribed usage levels and areas of applications as indicated on the product label and to discuss specific needs with the chemical supplier (Mikel, 2010).

The slaughter floor, offal rooms, and holding pens should have pre-operational and post-operational sanitation procedures. Unloading facilities and holding pens for animals should be constructed of such material so they do not harbor bacteria. Concrete paddocks with metal railings versus dirt pens are preferred for cleaning reasons. All floors, walls, and equipment should be visually inspected for contamination. A boot dip mat filled with hot water and bleach should be placed in front of the entry doors. In some cases, general cleaning and sanitizing methods may be needed as part of the pre-operation process. At the conclusion of each harvest, all floors, walls and equipment must adequately cleaned and sanitized in accordance with specific practices (Mikel, 2010).

A plan must be implemented in the processing room for pre-operational, operational, and post-operational sanitation. As part of the pre-operational protocol, all floors, walls and equipment should be visually inspected for contamination. All condensation should be wiped from the rails and oil applied to equipment. During the fabricating of the meat, operational sanitation methods should be fulfilled. Employees must wash hands and arms with soap and hot water as soon as they enter the processing room and when necessary during fabrication to block contamination. All of the equipment and parts (i.e. knives, meat hooks, hand saws, grinders, etc.) should be cleaned and sanitized with hot water as necessary during processing. The water needs to be 140 degrees Fahrenheit for cleaning and 180 degrees Fahrenheit for sanitizing. Cleaning and sanitizing of the equipment must be done prior to changing species. Post-operational methods follow the same cleaning and sanitizing protocols as the operational stage. After fabricating and processing, all floors, walls, tables, and equipment must be properly cleaned and sanitized as previously described (Mikel, 2010).

These prescribed methods and plans serve as safeguards for the harvesting establishment. The most successful sanitation plans are motivated by the economic reality that consumers will not tolerate visible contaminates in their meat products (Mikel, 2010). It is important for all meat processors to realize the importance of their actions when harvesting and fabricating meat products.



The most successful sanitation plans are motivated by the economic reality that consumers will not tolerate visible contaminates in their meat products (Mikel, 2010).

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