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Economic Importance of Production Agriculture, Agricultural Processing and Water Resources in the East Locust Creek Reservoir 10-County Region

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Extension
Commercial Agriculture Program

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Housed in the Department of Agricultural and Applied Economics at the University of Missouri, the Commercial Agriculture Program completed this report. An interdisciplinary group of the university's agricultural economics, agricultural engineering, animal science, plant science and veterinary medicine faculty contribute to the Commercial Agriculture Program. Their mission is to create new opportunities for Missouri entrepreneurs and develop partnerships with firms that are dedicated to profitable and sustainable agriculture and food systems.

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Introduction

This report presents the economic impact of agricultural production and processing in the East Locust Creek Reservoir 10-county region, and it explains the potential effect that a proposed water supply and recreation reservoir would have on the region. The reservoir would be developed in Sullivan County on East Locust Creek.

The East Locust Creek Reservoir would serve north central Missouri. The 10-county region, highlighted in Figure 1, comprises all or portions of the following Missouri counties: Adair, Chariton, Grundy, Linn, Livingston, Macon, Mercer, Putnam, Schuyler and Sullivan. This region has three regional councils or commissions that serve the various counties, which include the Green Hills Regional Planning Commission (Chariton, Grundy, Linn, Livingston, Mercer, Putnam, and Sullivan), Northeast Missouri Regional Planning Commission (Adair and Schuyler) and the Mark Twain Regional Council of Governments (Macon).

Figure 1. East Locust Creek Reservoir 10-County Region

Water cost and availability directly influence the current and future sustainability of the 10-county region's agricultural sector. To examine the influence of water cost, availability and potential future scarcity, this report does the following:

1.) Describes the region's agriculture activity
2.) Estimates the economic impact of the region's agricultural production and related industries
3.) Measures water usage by the region's agricultural production and agricultural processing industries
4.) Projects the impact of potential water scarcity on the region's livestock operations and agricultural processing operations

Section 1: Agriculture Sector in the 10-County Region

Agricultural Change in the 10-County Region

During the past 30 years, agricultural industries in the 10-county region underwent significant structural change. Nominal farm sales increased but not as quickly as inflation. In 1978, the 10-county region's agricultural sales totaled $321 million. By 2012, those sales exceeded $779 million, which is a 143 percent increase. Measured by the consumer price index, inflation increased by 352 percent, however. Incomes that grow but don't keep pace with inflation create challenges for U.S. farms.

Several factors have changed the region's farm operations during the past few decades. For example, government programs and commodity prices influenced producer decisions and agriculture output. Initiated in the 1985 Farm Bill, the USDA Conservation Reserve Program (CRP) created an opportunity for some landowners in the 10-county region to convert highly erodible cropland into fallow acreage. During the late 1980s, sharply lower grain prices facilitated a rapid enrollment of marginal cropland into the program, and farm operations and agricultural supply industries that supported grain farming declined. After 2007, a rapid rise in commodity prices lifted farm incomes and began shifting acreage back to crop production. See Table 1. Despite the latest transition to crop production, the area's recent CRP acreage exceeds the first acreage enrollment data available. Between 1987 and 2012, the region's CRP acreage grew from 252,784 acres to 350,024 acres.

Table 1. Conservation Reserve Program (CRP) Acreage in the 10-County Region

COUNTY	1987	1992	1997	2002	2007	2012	% CHANGE 1987 TO 2012
ADAIR	16,963	24,873	24,825	31,342	32,273	25,070	48%
CHARITON	19,420	34,157	38,274	39,048	38,908	31,052	60%
GRUNDY	27,984	41,196	43,792	47,225	46,604	36,089	29%
LINN	35,635	57,334	63,296	67,291	65,075	54,089	52%
LIVINGSTON	14,508	31,967	37,318	39,379	38,658	31,587	118%
MACON	24,599	43,110	47,605	52,353	51,477	43,093	75%
MERCER	31,104	38,580	37,550	43,187	40,721	34,303	10%
PUTNAM	22,854	29,033	28,286	34,308	35,121	29,207	28%
SCHUYLER	13,496	20,276	20,173	18,375	19,336	13,473	(1%)
SULLIVAN	46,221	57,244	54,517	57,380	59,400	52,061	13%
TOTAL	**252,784**	**377,770**	**395,636**	**429,887**	**427,572**	**350,024**	**39%**

Source: USDA Farm Service Agency

Shortly after the turn of the 21st century, a new larger-scale swine industry emerged. The 10-county area's inexpensive, open land and available resources attracted such next-generation swine production facilities. Swine processing and support industries grew with the new swine farms, and these forces greatly increased employment opportunity and economic output in parts of the region.

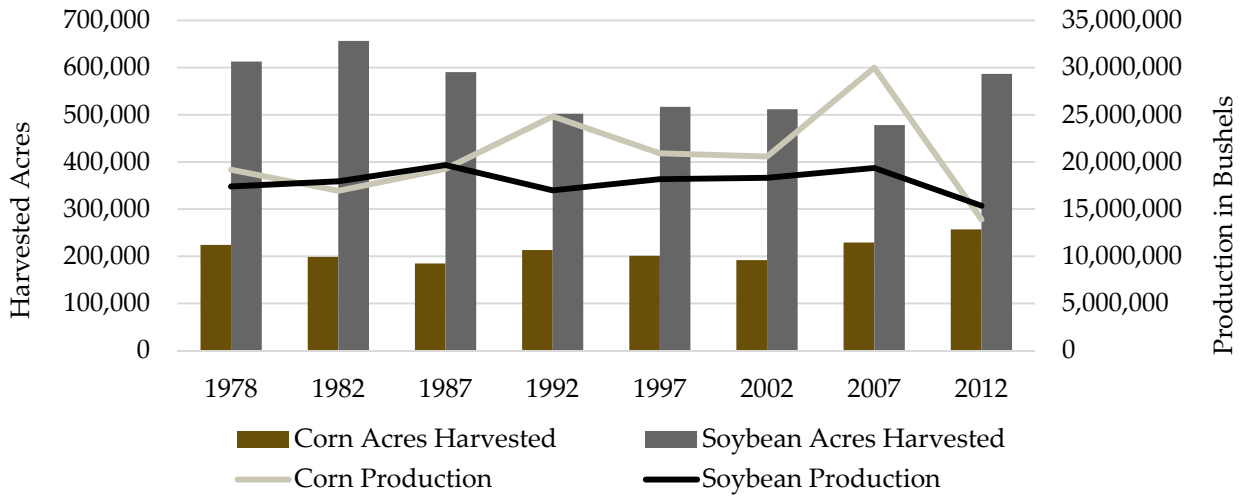
On-farm productivity has also improved. Increasing productivity allowed producers to sell commodities at lower prices, and it drove farmers to expand the scale of their farms in order to maintain or expand their incomes. As a result, fewer but larger farms operate today. Different agricultural sectors in the 10-county region experienced farm consolidation at different paces during the past 30 years. Still, the consolidation familiar to most of U.S. agriculture was quite apparent in the region's recent history. Within the 10-county region, the number of farms dropped by 12 percent from 1978 to 2012. Although the number of farms in the region has decreased, the extent of the farm reductions has been less significant than those recorded statewide. The number of all Missouri farms decreased by 19 percent during the same period. Farm consolidation has not prevented the 10-county region from being a major Missouri agricultural region.

From a livestock production perspective, the 10-county region considered in this report, like the other 104 counties in Missouri, has experienced significant declines in the number of farms raising livestock. See Table A1, Table A2, Table A3 and Figure A1 in the appendix. From 1978 to 2012, the number of farms raising hogs and pigs declined by 95 percent. Farms raising beef cows dropped 47 percent, and farms raising dairy cows decreased by 84 percent.

Crop Production in the 10-County Region

Since 1978, the region's acres devoted to agriculture have not changed, but its use has evolved. Corn acreage increased from 224,125 acres in 1978 to 256,962 acres in 2012 (Figure 2). During the same period, soybean acres decreased from 612,878 acres to 586,943 acres, and wheat acres decreased from 224,125 acres to 31,581 acres. Table A4 and Table A5 in the appendix share more detail about corn and soybean acreage trends.

Figure 2. Corn and Soybean Acres and Production in the 10-County Region



Source: USDA National Agricultural Statistics Service

Livestock Production in the 10-County Region

The livestock inventory, or the number of animals that farms maintain on a single day, varies somewhat relative to the number of farms with livestock. Although the number of farms with beef cows declined by 47 percent between 1978 and 2012, the beef cow inventory drop was less significant. Table 2 shares that the region's beef cow inventory decreased 31 percent from 1978 to 2012. In contrast, during this period Missouri's beef cow inventory dropped 23% and the U.S. beef cow inventory dropped 22%. Beef slaughter weights increased, allowing more beef to be produced with fewer cows.

Table 2. Beef Cow Inventory in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012	CHANGE 1978-2012
ADAIR	21,250	20,959	21,836	19,728	21,431	17,907	19,540	17,792	(16%)
CHARITON	23,676	19,908	16,369	16,576	17,509	17,749	21,320	18,712	(21%)
GRUNDY	14,757	12,180	9,701	11,217	9,952	10,644	11,167	7,848	(47%)
LINN	24,284	22,472	19,796	21,705	25,747	26,818	24,296	18,675	(23%)
LIVINGSTON	15,200	12,371	10,926	8,832	10,357	10,243	10,457	6,977	(54%)
MACON	25,913	25,357	23,826	22,385	24,203	26,893	25,388	20,185	(22%)
MERCER	21,592	18,777	13,917	13,964	14,060	15,206	(D)	11,478	(47%)
PUTNAM	24,580	23,706	23,440	22,298	21,695	20,647	22,624	17,827	(28%)
SCHUYLER	12,467	12,763	12,301	12,301	13,865	13,653	14,244	10,644	(15%)
SULLIVAN	33,774	30,883	26,085	29,001	29,410	29,203	30,851	20,169	(40%)
TOTAL	**217,493**	**199,376**	**178,197**	**178,007**	**188,229**	**188,963**	**179,887**	**150,307**	**(31%)**

Source: USDA National Agricultural Statistics Service. (D) Not Disclosed

The number of dairy cows decreased 82 percent during the same period. See Table 3. This reduction is similar to the drop in the number of farms with dairy cows as milk production shifted to western states and U.S. milk production per cow rose annually at 1.5% to 2% during the period.

Table 3. Milk Cow Inventory in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012	CHANGE 1978-2012
ADAIR	1,256	953	1,028	539	460	187	35	80	(94%)
CHARITON	938	599	492	441	187	299	159	26	(97%)
GRUNDY	2,341	1,670	740	474	503	927	423	893	(62%)
LINN	1,584	1,466	1,322	1,269	878	1,383	576	444	(72%)
LIVINGSTON	906	812	357	503	260	185	110	307	(66%)
MACON	967	745	710	492	573	279	211	139	(83%)
MERCER	1,847	929	522	226	247	62	(D)	336	(82%)
PUTNAM	700	867	846	396	453	451	128	4	(99%)
SCHUYLER	1,803	1,129	709	546	443	327	216	169	(91%)
SULLIVAN	1,322	967	412	327	365	276	164	65	(95%)
TOTAL	**13,664**	**10,137**	**7,138**	**5,213**	**4,369**	**4,376**	**2,022**	**2,463**	**(82%)**

Source: USDA National Agricultural Statistics Service. (D) Not Disclosed

One unique livestock production development in the 10-county region involves the pig inventory data. From 1978 to 2002, the number of hogs on the region's farms decreased by 80 percent. See Table 4. This is a more rapid decline than the inventory reductions of dairy cows and beef cows. Then, from 2002 to 2007, the hog and pig inventory jumped more than 500 percent because Premium Standard Farms (eventually purchased by Murphy-Brown (MB) of Missouri) located its production facilities in the region. Intensive hog production generates more economic output on a single acre of land than do grazing cattle or producing grain.

Table 4. Hog and Pig Inventory in the 10-County Region

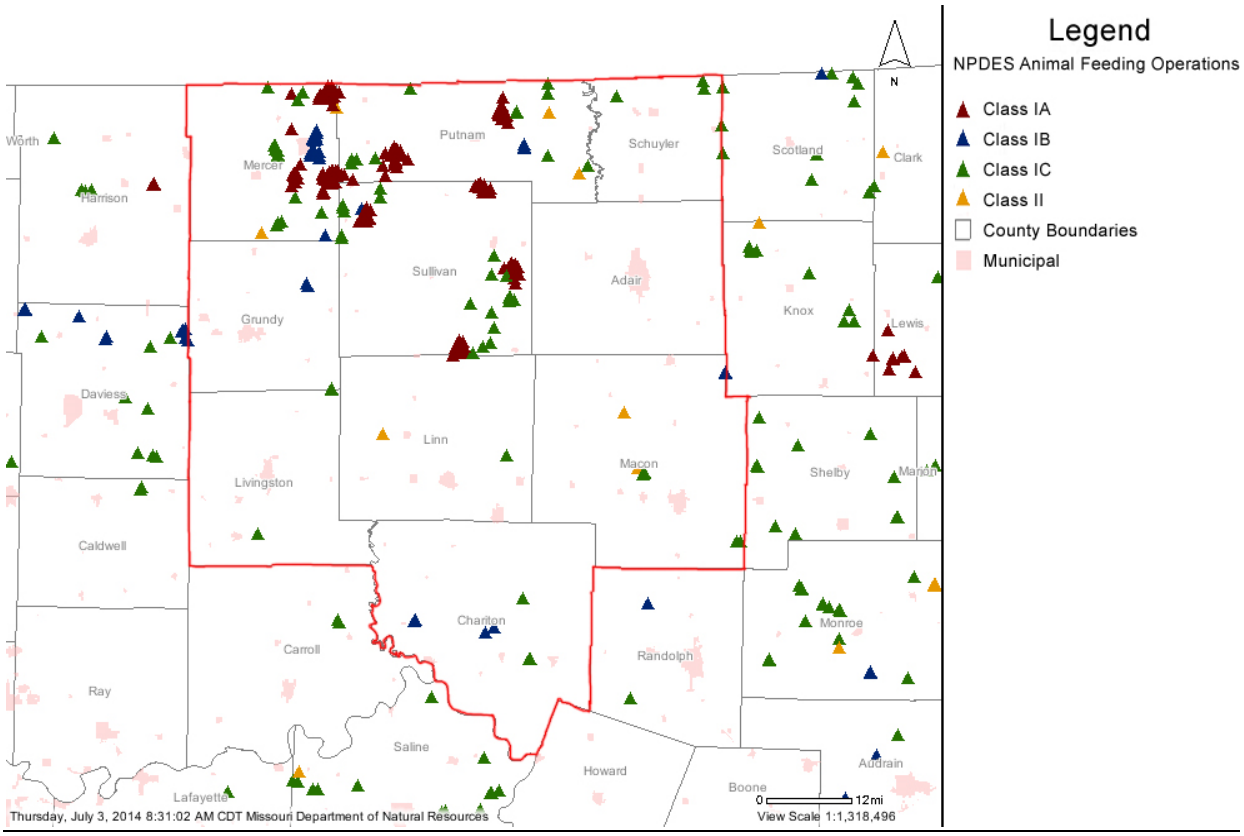
COUNTY	1978	1982	1987	1992	1997	2002	2007	2012	CHANGE 1978-2012
ADAIR	20,669	15,228	11,092	12,263	5,920	2,662	1,144	(D)	(D)
CHARITON	68,791	65,155	50,362	51,444	32,579	13,193	14,452	6,282	(91%)
GRUNDY	36,370	29,725	26,089	17,880	4,771	13,250	20,120	(D)	(D)
LINN	49,724	43,775	33,209	31,966	27,497	6,299	5,160	919	(98%)
LIVINGSTON	31,875	25,997	16,846	17,548	4,040	8,851	11,111	8,078	(75%)
MACON	47,847	46,794	31,445	27,336	11,821	20,652	34,707	16,525	(66%)
MERCER	20,672	18,218	6,593	(D)	(D)	(D)	(D)	(D)	(D)
PUTNAM	19,260	11,345	8,090	6,011	1,315	(D)	(D)	(D)	(D)
SCHUYLER	16,394	13,650	7,919	8,061	4,247	1,024	722	7,790	(53%)
SULLIVAN	21,327	18,950	14,344	15,842	(D)	(D)	348,167	358,146	1,579%
TOTAL	**332,929**	**288,837**	**205,989**	**188,351**	**92,190**	**65,931**	**435,583**	**397,740**	**20%**

Source: USDA National Agricultural Statistics Service. (D) Not Disclosed

Note that the animal inventory numbers from the USDA Census of Agriculture – see Table 2, Table 3 and Table 4 – don't necessarily represent all animals in the given counties and region. Some counties don't report animal inventory data due to USDA confidentiality reporting rules, which preclude data disclosure when just a few operations own most livestock in a given geographical area.

Figure 3 pinpoints the large confinement livestock facilities permitted in the 10-county region. An animal feeding operation (AFO) or concentrated animal feeding operation's (CAFO) class size is based on the operating level in animal units of an individual animal type at one operating location. The animal units of all confined animals at the operating location are summed to determine whether the operation is Class IA, IB, IC or II (see Table 5). Most large confinement operations in the 10-county region are swine facilities, and they tend to locate in Mercer, Sullivan and Putnam counties.

Figure 3. Animal Feeding Operations in the 10-County Region



Source: Missouri Department of Natural Resources

Table 5. Missouri Animal Unit and Size Classifications (Number of Head)

	Class IA	Class IB	Class IC	Class II
Dairy cows	4,900	2,100 to 4,899	700 to 2,099	210 to 699
Beef cows	7,000	3,000 to 6,999	1,000 to 2,999	300 to 999
Swine weighing over 55 lbs.	17,500	7,500 to 17,499	2,500 to 7,499	750 to 2,499
Swine weighing under 55 lbs.	70,000	30,000 to 69,999	10,000 to 29,999	3,000 to 9,999

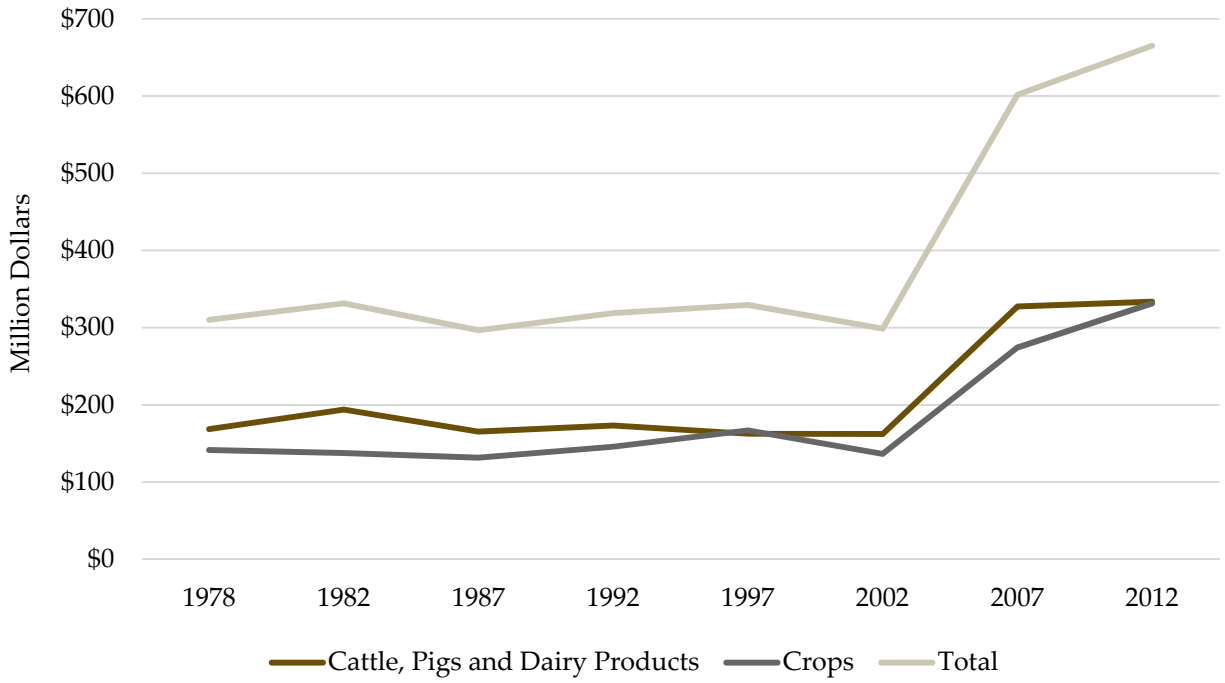
Source: Missouri Department of Natural Resources

Value of Agriculture Production in the 10-County Region

The nominal value of crop sales increased 134 percent from 1978 to 2012. In real terms, it decreased 33 percent. Figure 4 illustrates crop sales and livestock sales in the 10-county region during the past 30 years. Livestock sales increased significantly from 2002 to 2007, primarily because of the increasing hog inventory and farms located in this region. Given finite land availability and a decreasing per acre production value, increasing total agricultural revenue commonly requires investing in capital to add productivity or value to production. Investing in higher valued crops such as fruits and vegetables can increase revenue. However, within the 10-county region, major capital investments have emphasized developing confined swine facilities and increasing irrigation system use.

Regarding irrigation's use, land under irrigation increased from 30,529 acres in 1978 to 55,426 acres in 2012. More irrigation from crop producers in river-bordering counties and effluent irrigation in areas with expanding swine operations drove the growth.

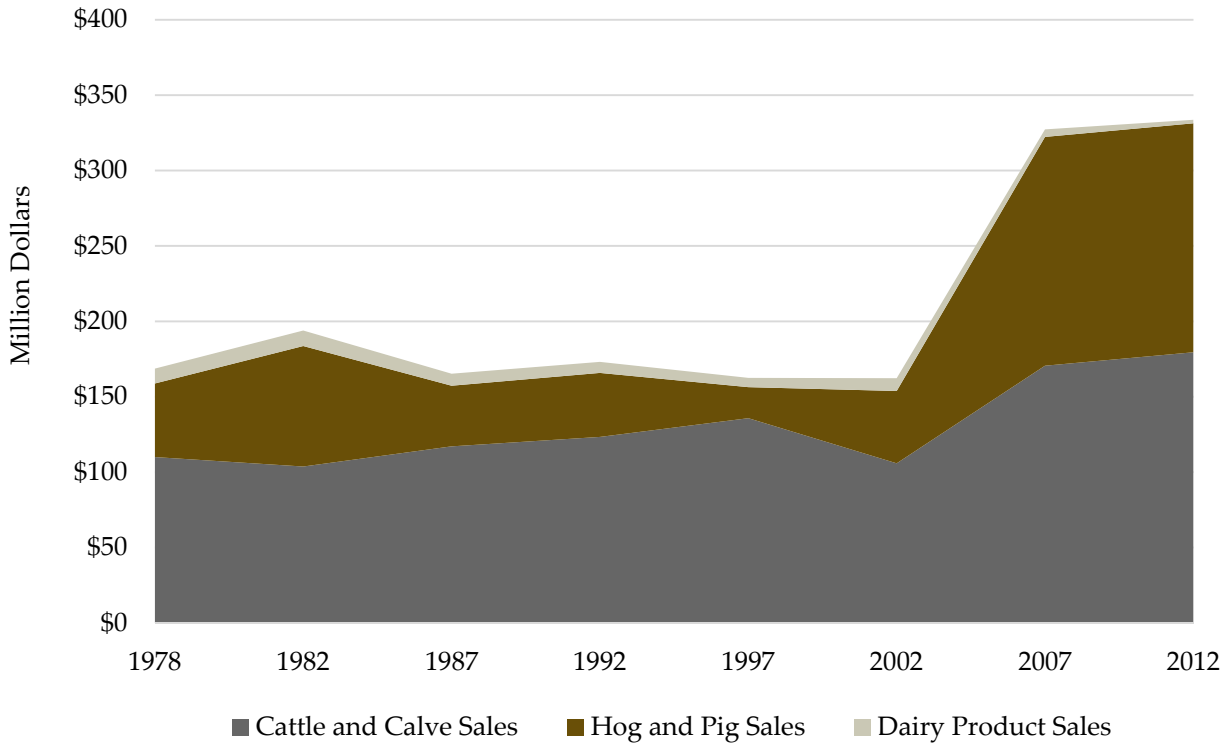
Figure 4. Crop[1] and Livestock Sales[2] in the 10-County Region



Source: USDA National Agricultural Statistics Service
[1]Crop sales includes all major and minor crops grown.
[2]Several counties did not disclose livestock sales data

Between 1978 and 2012, animal product sales in nominal terms decreased 76 percent for dairy cows, increased 63 percent for beef cows and increased 221 percent for hogs and pigs. See Figure 5. In real terms, the value of livestock sold decreased by 46 percent. If the region hadn't increased pig production, then the value of livestock product sales would have decreased 50 percent in real dollars. Note that data aren't available for several counties because they didn't report data or had limited response.

Figure 5. Milk Cow, Hog/Pig and Beef Cow Sales in the 10-County Region[1]



Source: USDA National Agricultural Statistics Service
[1]Several counties did not disclose livestock sales data

Section 2: Economic Impact of the Region's Agricultural Production and Related Industries

Significant agriculture and agriculture-related industries operate in the 10-county region surrounding the proposed reservoir in Sullivan County. Table 5 shows the region's agricultural and related industry sectors and lists their total production value and jobs from the 2012 IMPLAN data set. IMPLAN offers county-level information for more than 440 industry sectors. Among academia, industry and government, IMPLAN is a well-respected resource. Its current sector scheme is based on the latest Benchmark Input-Output Study from the U.S. Bureau of Economic Analysis.

Recently, the region's largest agricultural or related industry sector in terms of production value was animal slaughtering/processing (see Table 6). In 2012, it represented 10.2 percent of all industries' production value (agriculture and non-agriculture) and provided 2,151 jobs. Please note this value of production data only refers to the direct economic effects from each respective industry. Oilseed farming – predominantly, soybean production – was the second largest industry. The third largest sector was animal production, except cattle and poultry/eggs. This animal industry sector mainly represents swine production.

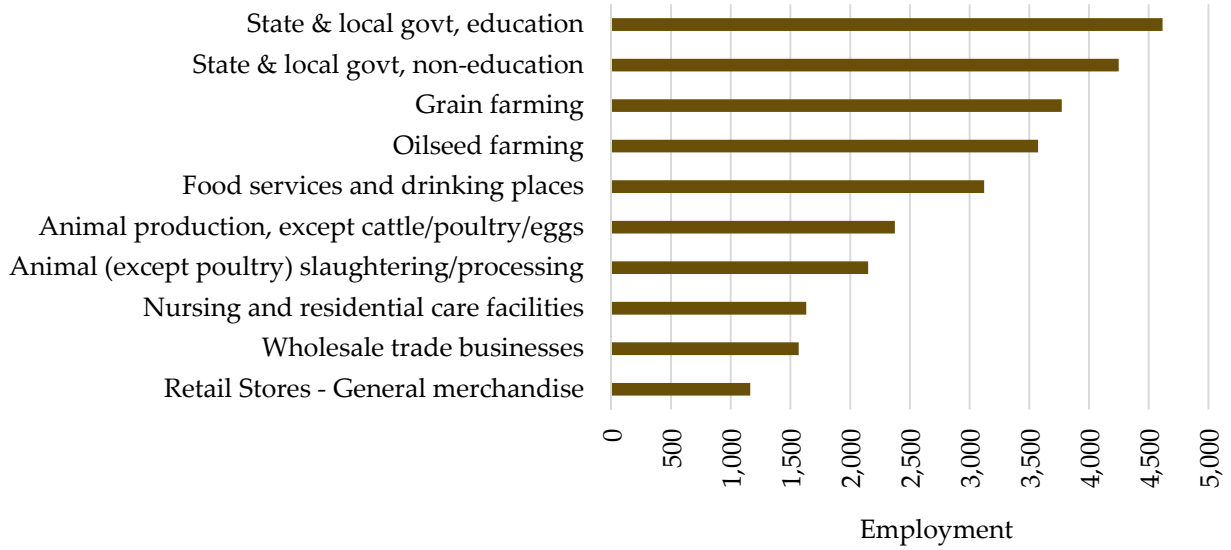
Table 6. Agriculture and Related Industries in the 10-County Region, 2012

AGRICULTURAL AND AGRICULTURAL MFG SECTOR DESCRIPTIONS	VALUE OF PRODUCTION	% OF ALL SECTORS	JOBS
ANIMAL (EXCEPT POULTRY) SLAUGHTERING/PROCESSING	$717,463,074	10.2%	2,151
OILSEED FARMING	$235,352,524	3.3%	3,574
ANIMAL PRODUCTION, EXCEPT CATTLE AND POULTRY/EGGS	$184,462,952	2.6%	2,375
CATTLE RANCHING AND FARMING	$166,438,782	2.4%	797
GRAIN FARMING	$150,224,472	2.1%	3,772
OTHER ANIMAL FOOD MANUFACTURING	$91,835,129	1.3%	67
ALL OTHER CROP FARMING	$83,673,340	1.2%	267
SOYBEAN AND OTHER OILSEED PROCESSING	$74,535,294	1.1%	36
POULTRY AND EGG PRODUCTION	$30,613,119	0.4%	36
VETERINARY SERVICES	$6,664,988	0.1%	131
DAIRY CATTLE AND MILK PRODUCTION	$5,522,869	0.1%	20
SUPPORT ACTIVITIES FOR AGRICULTURE AND FORESTRY	$3,577,830	0.1%	463
FORESTRY, FOREST PRODUCTS, AND TIMBER PRODUCTION	$3,462,689	0.0%	8
GREENHOUSE, NURSERY, AND FLORICULTURE	$2,604,473	0.0%	13
VEGETABLE AND MELON FARMING	$2,093,586	0.0%	10
FRUIT FARMING	$812,777	0.0%	4
COMMERCIAL LOGGING	$548,134	0.0%	12
TREE NUT FARMING	$135,506	0.0%	2

Source: IMPLAN

Considering the manufacturing, retail and other industry sectors in the 10-county region, agriculture represents a significant portion of the region's employment. Figure 6 lists the top 10 industries that create jobs within the 10-county region. Four of the top 10 industries involve agricultural production or processing.

Figure 6. Top 10 Job Industries for All Sectors in the 10-County Region, 2012



Source: IMPLAN

The total economic contributions of the 10-county region's agricultural and related manufacturing sectors were prepared using the IMPLAN economic impact software system. As an input-output model, IMPLAN includes economic data sets, multipliers and demographic statistics for the U.S. economic infrastructure. Estimations in this report used the 2012 IMPLAN data set for Missouri counties included in the 10-county region. This data set was the most current data available.

To quantify total economic contribution of the 23 industry sectors studied, the authors used existing production value data from each agricultural and related industry. Sectors 1 to 19 in IMPLAN represent agriculture production sectors. The four related sectors were "veterinary services," sector 379; "other animal food manufacturing," sector 42; "soybean/oilseed processing," sector 45; and "animal slaughter/processing," sector 59. Each aligns closely with production agriculture sectors.

IMPLAN computes three types of economic effects: direct, indirect and induced. A **direct** effect measures direct changes in an area that result from a change in an industry. For example, estimated sales revenue from a beef operation is considered a direct economic effect. Businesses create an **indirect** effect when they purchase and/or sell goods or

services from or to other industries (i.e., inputs, transportation, utilities, repairs). As an example, the beef operation may rely on transportation providers to haul animals, and the trucking receipts create an indirect economic effect. **Induced** effects are changes in household spending by employees from income generated by direct and indirect effects. For instance, employees will spend their income to buy real estate, shop at grocery stores or purchase other goods or services in the local economy.

Economic impacts from IMPLAN are categorized by value-added, jobs and output indicators. **Value-added** refers to the difference between the industry output (value of production) and the cost of the inputs used in an industry's production. The value-added indicator can also be interpreted as the net gain or contribution to the state's gross domestic product. Salaries, wages, taxes and profit would be included in this value-added classification. Another economic indicator is the number of **jobs** supported by the industry, which can be either full-time or part-time employment. **Output** reflects the total value of industry production.

Value-added contributions vibrantly communicate an industry or sector's additions to the state's GDP. For 2014, the region's agricultural and related sectors created $652 million in additional value when considering all economic effects. See Figure 7.

Figure 7. Value-Added Economic Impact of Agricultural and Related Sectors in the 10-County Region, 2014

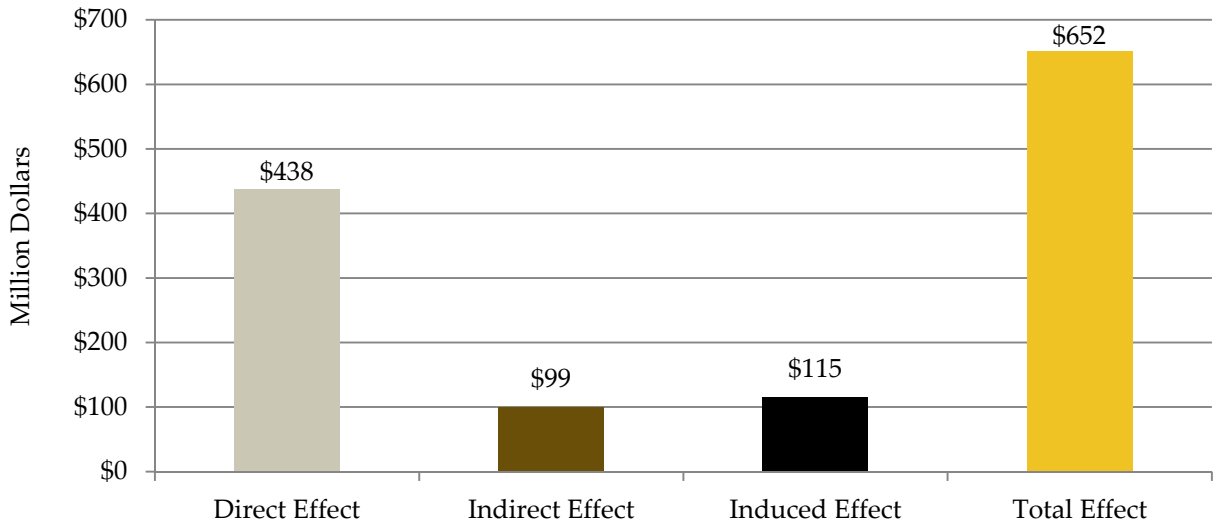


Figure 8 shares total jobs sustained from the agricultural and related manufacturing sectors in the 10-county region. The direct effect totaled 13,752 jobs from these sectors, and it reached 16,803 jobs after accounting for all economic effects.

Figure 8. Jobs Economic Impact of Agriculture and Related Sectors in the 10-County Region, 2014

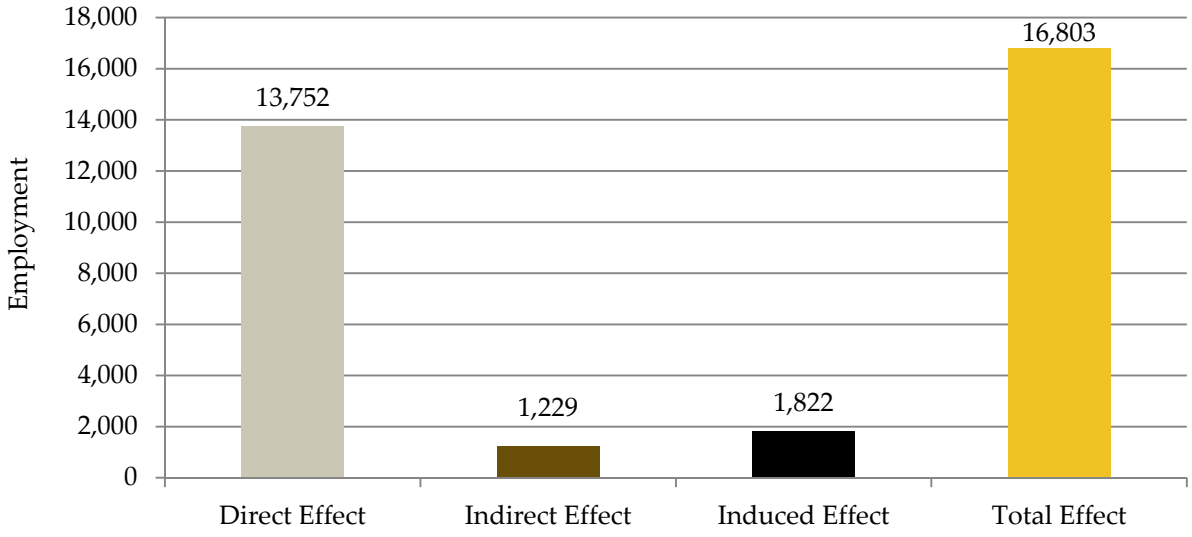
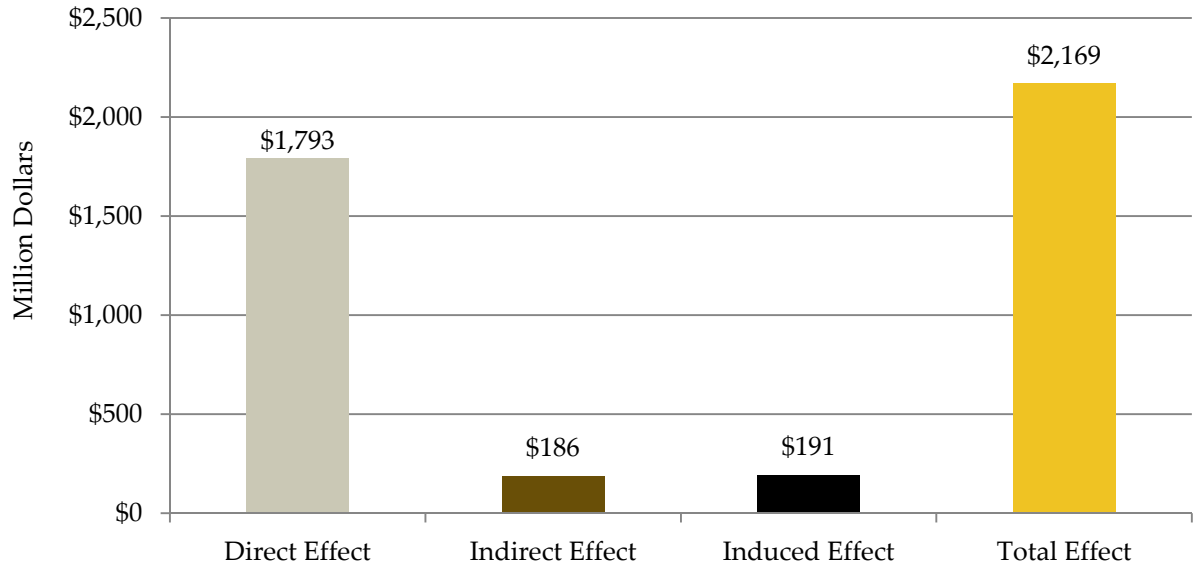


Figure 9 indicates the total output of the agricultural and related sectors in the 10-county region in 2014 dollars. The direct effect from these sectors totaled $1.793 billion. After accounting for indirect and induced effects, the total economic contribution of these sectors to the 10-county region reached $2.169 billion.

Figure 9. Output Economic Impact of Agricultural and Related Sectors in the 10-County Region, 2014



Section 3: Regional Water Use for Production Agriculture and Processing

Water Use for Livestock Production in the 10-County Region

Reliable water access is a critical resource for livestock production. Primary water uses on a livestock operation include drinking water, supplemental cooling water and building and/or equipment wash water; see Table 7. Secondary water uses include animal wash water and worker uses like restroom and shower activities and farm clothes washing. The secondary uses can be estimated by adding 5 percent to 20 percent to the primary use quantity, depending on operation size and management preferences.

Table 7. Primary Water Uses and Quantities for Various Livestock Operations

Livestock Type	Drinking Water (gal./head/day)	Supplemental Cooling Water (gal./head/day)	Wash Water (gal./head/day)
SWINE			*Building*
BREEDING & GESTATION	6	1 to 5	0.1
FARROWING	8	20	1
NURSERY	1	0 to 2	0.05
GROW-FINISH	4	1	0.1
DAIRY			*Milking Parlor*
CALVES	6 to 10		
HEIFERS	10 to 15		
DRY COWS	20 to 30	8 to 12	
MILKING COWS	35 to 50	10 to 15	10 to 50
BEEF			
COW-CALF PAIRS	30 to 35		
DRY COWS	30		
CALVES	12		
GROWING CATTLE *(400-800 LBS.)*	12 to 24		
BRED HEIFERS *(800 LBS.)*	24		
BULLS	30 to 40		

Source: Zulovich (2012)

Given this water use data, Table 8 presents an estimate for overall annual water demand for the 10-county region. To derive these estimates, livestock inventory in each county was multiplied by the primary water consumption rates to estimate water consumption in gallons consumed during a one-year period. Rates were assumed at 32.5 gallons per day for a cow-calf pair, 85 gallons per day for a milking cow and 6 gallons per day for an average size hog or pig. Total livestock demand was estimated to be 3,038,829,107 gallons or 9,326 acre-feet. The beef industry had the largest water demand. Swine operations and dairies followed.

Table 8. Livestock Inventory and Water Demand in the 10-County Region, 2012

	BEEF COWS		MILK COWS		HOGS & PIGS	
	Inventory[1]	Yearly Water Demand (gal.)	Inventory[1]	Yearly Water Demand (gal.)	Inventory[2]	Yearly Water Demand (gal.)
TOTAL	**150,307**	**1,783,016,788**	**2,463**	**76,414,575**	**538,538**	**1,179,397,744**

[1] USDA National Agricultural Statistics Service. Census of Agriculture 2012

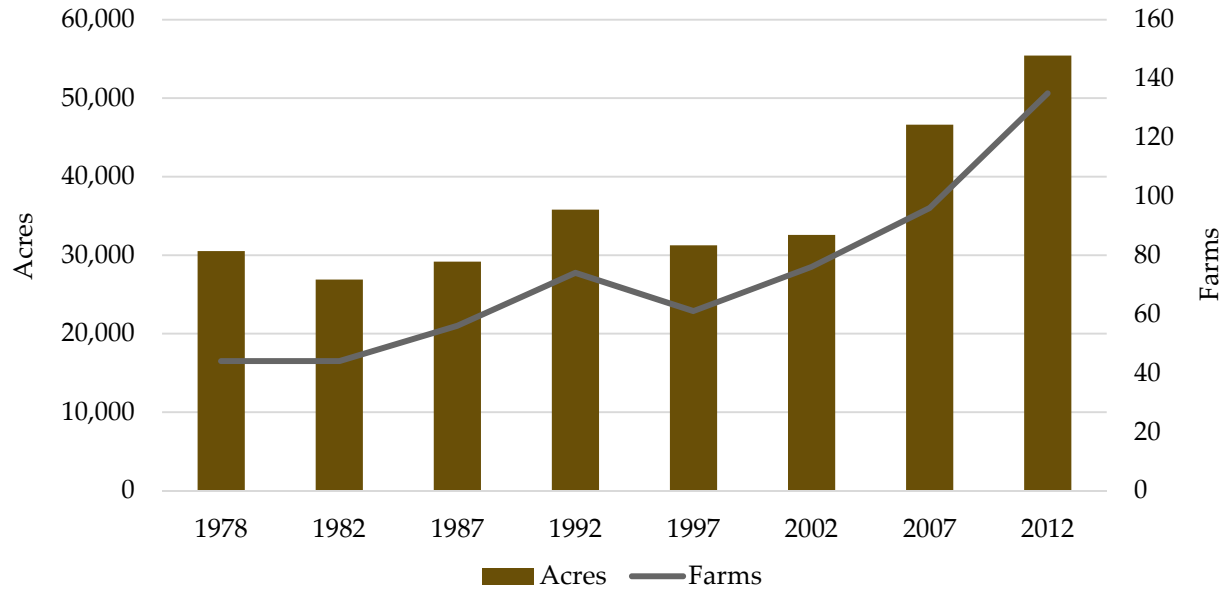
[2] Linn, Livingston and Macon from USDA NASS Census of Agriculture 2012. Other counties derived from IMPLAN and USDA NASS data.

Due to the cost of water from public water supplies versus the cost of water supplied by sources developed on farm, most livestock operations develop their own water sources. Geology in many parts of the region dictates that livestock water supplies are developed from surface impoundments rather than wells. While livestock operations most often do not use public water supplies, their risk mitigation planning does include using water expensively trucked from these public water suppliers during short term drought emergencies. Longer term drought contingency planning usually includes depopulating swine, beef, and dairy herds.

Water Use for Crop Production in the 10-County Region

Crop irrigation also consumes water in the 10-county region. Figure 10 details the number of farms using irrigation and the acres covered by irrigation in the 10-county region. During the past 30 years, the number of farms and acres using irrigation trended upward. In 2012, Sullivan County irrigated only 980 acres. Chariton, Livingston, Linn and Grundy counties accounted for 81 percent of the total irrigated acres.

Figure 10. Irrigation Farms and Acreage in the 10-County Region



Source: USDA National Agricultural Statistics Service

Water Use for Livestock Processing in the 10-County Region

For processors in the 10-county region, water availability and affordability influence a livestock processing facility's operational feasibility. Smithfield Farmland operates a pork processing location in Milan, Missouri, a community located in the 10-county region. In a 2014 survey completed for this report, Smithfield Farmland shared that it employs 1,160 people at the Milan facility. Annually, its Milan plant uses millions of gallons of water, and the water cost per gallon averages $0.0018. The plant sources water from a reservoir.

At the Milan facility, Smithfield Farmland closely monitors water use, and to conserve water resources, the plant has executed water-saving practices that manage the reservoir's water resources. Rainfall and reservoir levels do affect the plant's production schedule. Because of implementing the previously mentioned water conservation practices and benefiting from well-timed rainfall, though, Smithfield Farmland hasn't had to decrease its processing output at the Milan location. Limited water supply, however, caused Smithfield Farmland to forgo a proposal to process chitterlings in Milan. Adding the chitterling line would require high water volumes, and an uncertain water supply contributed to the company's hesitancy about the proposal.

If a water shortage were to occur and decrease slaughter throughput, then Smithfield Farmland would need to cut hours for its staff. If the water restrictions were extreme and prolonged, then the facility would possibly need to reduce its staff count.

Reliable water access alone wouldn't motivate Smithfield Farmland to expand a facility; however, if the company were to recognize an expansion opportunity, then water access would be an important concern to assess. Currently, Smithfield Farmland doesn't plan to expand the Milan slaughtering plant. If the company were to make capital investments at the facility, then an investment's effect on water consumption would be one of the top three factors considered when evaluating the possible improvement.

Similarly, water supply is a chief infrastructure concern for Smithfield Farmland as it assesses possible plant locations. Based on the survey response, drinking water and water supply ranked as the top infrastructure factor that would influence a plant location's viability. In order of their perceived importance, the other factors identified were power, transportation, storm sewer, sewer and fiber and communications.

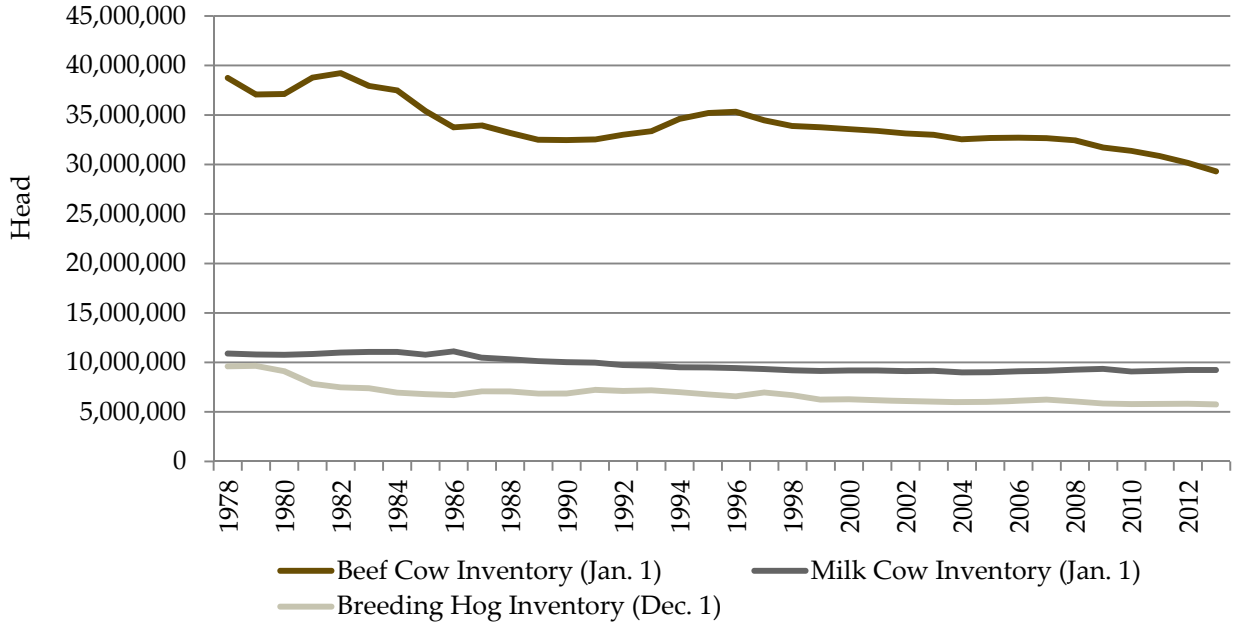
Section 4: Water Scarcity's Effect on Livestock Production and Processing Operations

For the livestock industry, water access affects the viability of animal production and processing. Constrained water resources, combined with other drought factors such as poor local forage quality and availability and high feed costs, force livestock producers to make tough choices. As livestock producers and ranchers respond to these factors and right size their operations, their production shifts influence other value chain stakeholders. The following sections explain the effect that limited water has had on livestock depopulation and processor decisions about slaughter facility investments.

Livestock Production and Water Scarcity

Within the past few years, much of the U.S. experienced a drought that stressed pastures and rangeland; dried ponds, reservoirs and other water supplies; and increased feed costs. Figure 11 tracks the trend in beef cow, milk cow and breeding hog inventories 1978 to 2013. This is relevant because declines in their levels suggest extended production reductions as long as the breeding animal inventories stay low. For beef cows, note the recent inventory drop. Because beef producers had limited resources available to maintain their herds during the drought, they were forced to liquidate. The effect was less pronounced on milk cow and breeding hog inventories.

Figure 11. Trend in U.S. Beef Cow, Milk Cow and Breeding Hog Inventories



Source: USDA National Agricultural Statistics Service

Several U.S. examples indicate that limited water availability has contributed to livestock depopulation. For the state of Missouri, the year 2012 presented a historic challenge with an extremely dry summer followed by a warm/dry winter and spring. The 2012 drought escalated Missouri cattle producers to market their animals earlier in the summer and thus auction barns saw a dramatic increase in numbers. Estimations were that financial losses to Missouri livestock and poultry operations in 2012 would amount more than $547 million, after factoring increased feed costs and changes in livestock sales and inventory (Office of Missouri Governor Jay Nixon, 2013). While Missouri enacted an emergency cost share program for the development of wells or other water sources to aid farmers due to this drought, the ten-county region only saw a limited amount of wells (6 out of 2,126 wells) drilled or enhanced due to limited quantities and poor quality of water.

In 2012, a Wyoming drought caused many ranchers to cull at least a portion of their cattle and ship them to market because they could no longer support their entire herds. Producers emptied wells and hauled water to their animals. During peak sell-off, Wyoming livestock auctions held weekly drought sales to accommodate the influx. In June 2012, Torrington Livestock Markets sold 17,000 cattle, which is five times the volume recorded during June 2011 (Healy, 2012).

In Texas, many cattle faced a similar fate as drought conditions stunned the southern U.S. In 2012, Texas ranchers halved their herds, and in the following year, they made further reductions (Zamudio, 2013). A story from *The New York Times* shared one Texas rancher's water management experience. Annually, his ranch requires 45 inches to 50 inches of rain to support forage growth and replenish pond water. During 2010, his ranch received 16 inches of rain, and in 2011, rainfall ranged from 12 inches to 14 inches. When water was tight, the rancher sourced it from a local municipality and incurred $200 to $300 each month in extra expense (Strom, 2013). Because of such conditions, the drought altered U.S. cattle production's geographic distribution. Texas led as the top cattle feeding state before the most recent drought, but Nebraska has surpassed Texas as the top cattle feeding state (Gerlock, 2014).

More recently, dry conditions have affected 90 percent of California (Woodruff and Michels, 2014). In the past 150 years, the current California dry period ranks as the fourth driest. Dams lack water, and many wells and aquifers are nearly dry (Bettles, 2014). Campbell (2014) chronicles the stories of two California ranchers in February 2014 coping with these conditions. One had already cut his herd by 20 percent, and if rain didn't come within two to three months, then he'd need to liquidate the remaining cattle. The second rancher shrunk his herd by 40 percent, yet feed costs grew. As producers depopulate their herds, many have saved a few cattle but sold the bulk of them (Bettles, 2014). Other

California ranchers have tried transporting their animals to Kansas or Nebraska feedlots (Waters, 2014).

Water constraints have also influenced dairies. Ponds and reservoirs lack enough water (Hansen, 2014). A major drought-related concern for California dairies has been insecure forage and feed access. Typically, dairies allocate 70 percent of their water to field irrigation. Cow intake, milking parlor and barn equipment account for the other 30 percent (Merlo, 2014b). To cope with the current drought, one California organic dairy producer shared that he may sell some cows because of limited grazing grass and a low local hay supply (Woodruff and Michels, 2014). Another producer estimated a 50-gallon daily water need per cow, and without adequate water access, he'll need to cull cows (NBC News, 2014). In 2012, dry weather led some to project a dairy "wipeout" in California. Cow depopulation reduced daily milk deliveries to Land O'Lakes in Tulare County by 1.1 million pounds within a week. By August, 65 dairies in California had closed that year (Sierra2theSea, 2012).

Both the California Farm Bureau and California Farm Water Coalition have called for dedicating more resources to water storage structures and guarding against future water insecurity (Bettles, 2014). Another short-term option involves trucking water to farms. The trucks, which haul as much as 7,000 gallons per trip, would carry spring water or recycled water from treatment plants. California last implemented this strategy in the 1970s. Hauling water adds expense, though (Roth, 2014). As an example, a California cheesemaker and creamery owner knows six producers relying on hauled water to meet their needs. Water costs average an estimated $175 per load. For some larger scale producers, the total water expense per day could total near $2,000 (Hansen, 2014). Producers themselves have also made water-related investments to support their California dairy operations. One producer drilled three wells during 2013. After making the $1 million investment, he'll have enough water to maintain his dairy farm (Merlo, 2014a). To fulfill water needs, California dairies increasingly rely on groundwater because they lack surface water (Hibma, 2014).

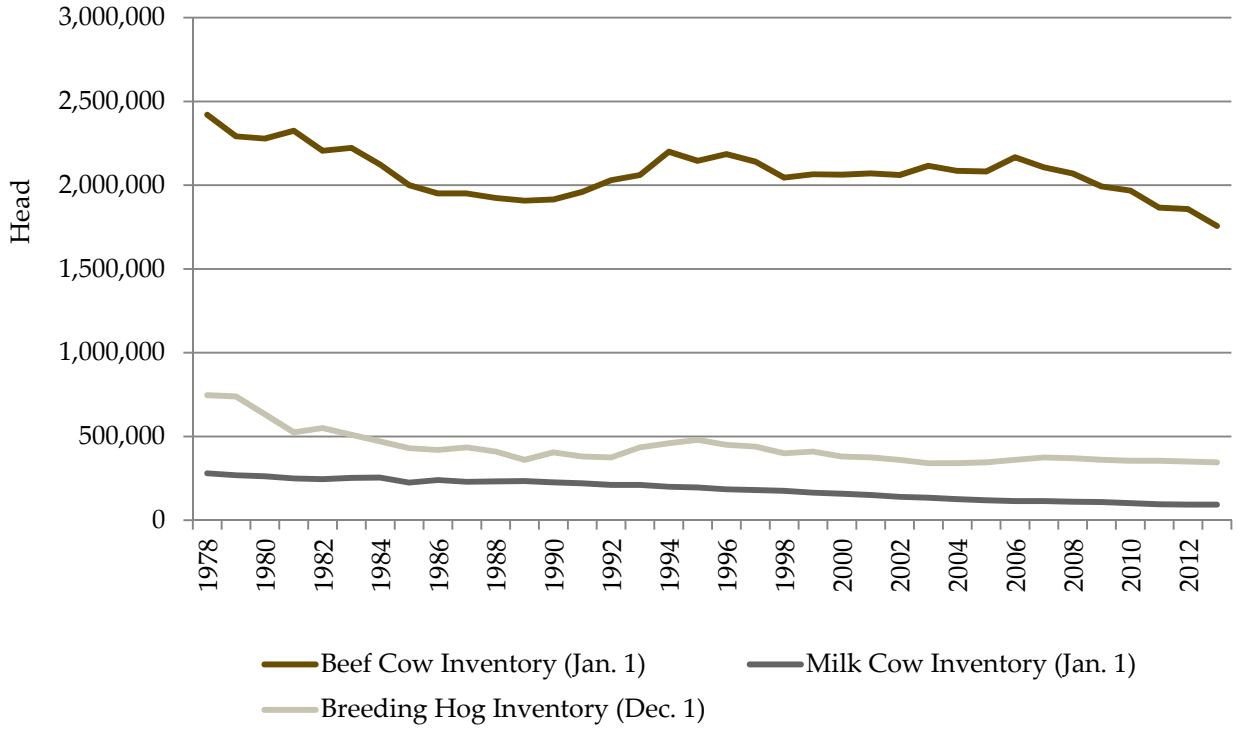
In addition to drought in Wyoming, Texas and California, several other states have experienced such conditions. After four or five dry years, cattle producers near McCracken, Kansas, have empty ponds and wells approaching dry levels. As producers wait for rain, they're shipping some beef cattle to Nebraska. Later, they'll move back the cows and sell the calves (Corn, 2014). Ponds in Oklahoma lack water because the state has had drought-like conditions since fall 2010 (Gerlock, 2014).

For other species, such as swine, a constrained water supply has been less connected to depopulation. Northern Missouri had dry conditions in 2000 that led to low water in ponds and reservoirs. At the time, Premium Standard Farms (PSF), located in Milan, Missouri, annually raised about 1.6 million hogs and slaughtered an estimated 7,000 hogs per day. It sourced water from Milan, and despite the dry weather, lake levels at the company's production locations were sufficient. For long-term security, however, PSF had considered other options, such as sourcing water from rural water districts. However, that would be expensive. During 2000, water availability also became critical for Iowa hog producers as ponds, wells and rivers had shrinking supplies. For producers who used private wells or ponds, the water supply issue was becoming dire (Waters, 2000). In California, too little water has made pig feed expensive. As such, one producer explained that culling would be necessary (CUESA, 2014).

Drought not only compromises water availability, but it also challenges water quality. With low water levels, nitrate and sulfate toxicity risks elevate, and hardness and salinity issues and coliform-related illnesses become more likely (Kansas State University, 2011).

Figure 12 presents the trend in Missouri beef cow, milk cow and breeding hog inventories. Like in the U.S. inventory data set, the Missouri beef cow inventory dropped markedly during the most recent drought as producers used depopulation as a strategy to manage the poor weather conditions. This indicates the importance of water in supporting beef cattle operations and inventory levels. Milk cow and breeding hog inventories didn't drop substantially in response to the most recent drought, and their levels have maintained less volatile levels since 1978.

Figure 12. Trend in Missouri Beef Cow, Milk Cow and Breeding Hog Inventories



Source: USDA National Agricultural Statistics Service

Internationally, depopulation has also been a strategy to manage cattle herds stressed by drought conditions. In 2009, the Kenya Meat Commission executed a cattle-purchasing program that intended to reduce financial losses incurred by Kenyan cattle producers. The program targeted purchasing at least 32,900 head, and producers received compensation by kilogram sold (Daily Nation correspondent, 2009).

In Australia, ranchers have also had to manage drought. Recently, some areas have had no rain for at least 21 months (Haxton, 2014). Dams that would typically supply water to animals are dry (Mercer, 2014). Some producers have hauled water to their animals. One account shares that an Australian cattle producer, whose farm lacks a water bore and artesian water, continuously ran nearly a 75-mile roundtrip to bring water to his cattle (Haxton, 2014). Poor water access combined with limited feed availability has given producers few options but to sell animals. One producer profiled by Mercer (2014) already liquidated 25 percent of his herd. Australian dairy producers in New South Wales have sold heifers and used the funds to buy feed. If the dry weather extends much longer, then it will force significant dairy depopulation. Milk production has already decreased by one-third (Honan, 2014). In 2007, water shortages caused South Australia's dairy producers to reduce the herd by 26.5 percent (Bildstien, 2007).

Droughts aren't new to Australia, though. The most recent follows the Big Dry, which stretched from 2003 to 2012. During the Big Dry, rivers and dams dried. Most cattle housed at the world's largest cattle station, which covered more than 5.9 million acres in South Australia, were sold. Others died. During the Federation Drought from 1895 to 1903, Australia reduced its sheep herd by half, and nearly 5 million cattle died. In the 20th century, the country experienced five notable drought periods (Breyfogle, 2010).

Livestock Processing and Water Scarcity

Fluctuating livestock inventories challenge livestock processors. The recent U.S. drought pressured livestock inventories and reduced demand for processing capacity. Texas ranchers shared their concern about the state's shrinking cattle industry and the subsequent effect on its infrastructure, feedlots and processors (Strom, 2013). From the processor's perspective, low cattle inventory and high prices have pressured their margins (Hughlett, 2014). Closing facilities balances the animal supply and processing demand variables in the short term, but it makes the value chain vulnerable to lacking adequate processing capacity when conditions improve and producers expand herds.

Because of drought, the U.S. processing industry structure has changed. On Feb. 1, 2013, Cargill closed a processing facility in Plainview, Texas (McDonough, 2014). The plant could process as many as 4,500 animals per day (Waters, 2014). It also supported an estimated 2,200 jobs (McDonough, 2014). After closing the Plainview facility, Cargill allocated its remaining work to other facilities located in Texas, Kansas and Colorado (Hegeman, 2013). Cargill has said that it will maintain the idled plant, but the company doesn't plan to bring the facility back online soon (McDonough, 2014). In March 2013, a second Texas packing plant closed. The San Angelo Packing Co. had too few animals to process since the drought prompted nearby herd depopulation. The plant typically sourced animals from a 100-mile radius, but before closing, it had expanded its footprint to include Kansas, Oklahoma and Arkansas. In 2011, before the drought effects were fully felt, the facility processed 700 animals per day, but daily throughput had dropped to 350 to 400 cattle. If conditions improve, then the facility could reopen. That would take at least three years, though (Zamudio, 2013).

California also hasn't been immune to livestock processing plant closures. A National Beef facility capable of processing 1,900 cattle each day closed on April 14, 2014. A large share of the facility's throughput was Holstein steers, likely a product of the state's dairy industry. Of the country's total slaughter capacity, the National Beef closure in California and Cargill plant closure in Texas reduced processing capacity by 6 percent (Waters,

2014). In January 2014, the Leucadia National Corp. plant located in California announced its impending closure (Campbell, 2014).

Given current market dynamics, an Oklahoma State University livestock specialist estimates that another one or two U.S. processing facilities may close (Hughlett, 2014). A CattleFax analyst projects that as many as three more packing plants may close (Campbell, 2014). If companies shutter processing locations, the closures reverberate through local economies. Typically, packing plants involve significant human capital, and when a plant closes, employees no longer have reliable work and pay (Hughlett, 2014). A closure's effects trickle to ranchers. For example, producers who relied on the Cargill facility in Plainview as a market for their cattle may incur greater freight costs to ship animals to other facilities (Rutherford, 2013). Closing the Cargill facility will cause the surrounding area to lose an estimated $1 billion in economic activity (Oliver, n.d.).

In New Zealand, the recent drought caused producers to sell animals and size their herds to an appropriate head count given available resources. The liquidation created incredible demand for processing capacity. Compared with first quarter 2012 lamb slaughter in the South Island, slaughter increased 14 percent in the first quarter of 2013. North Island lamb slaughter increased 25 percent during the same period, and beef slaughter grew 24 percent. To meet these needs, processors scheduled employees to work Saturdays and nine-hour days (Tipa, 2013).

Droughts in Northern Missouri

From 1981 to 2010, the annual precipitation for northwest Missouri, noted as Climate Division 1, averaged 39.14 inches. This division includes seven of the counties in the 10-county region discussed in this report. During this period, precipitation ranged from 21.41 inches per year to 56.68 inches per year. Median annual precipitation was 39.34 inches (Western Regional Climate Center, n.d.).

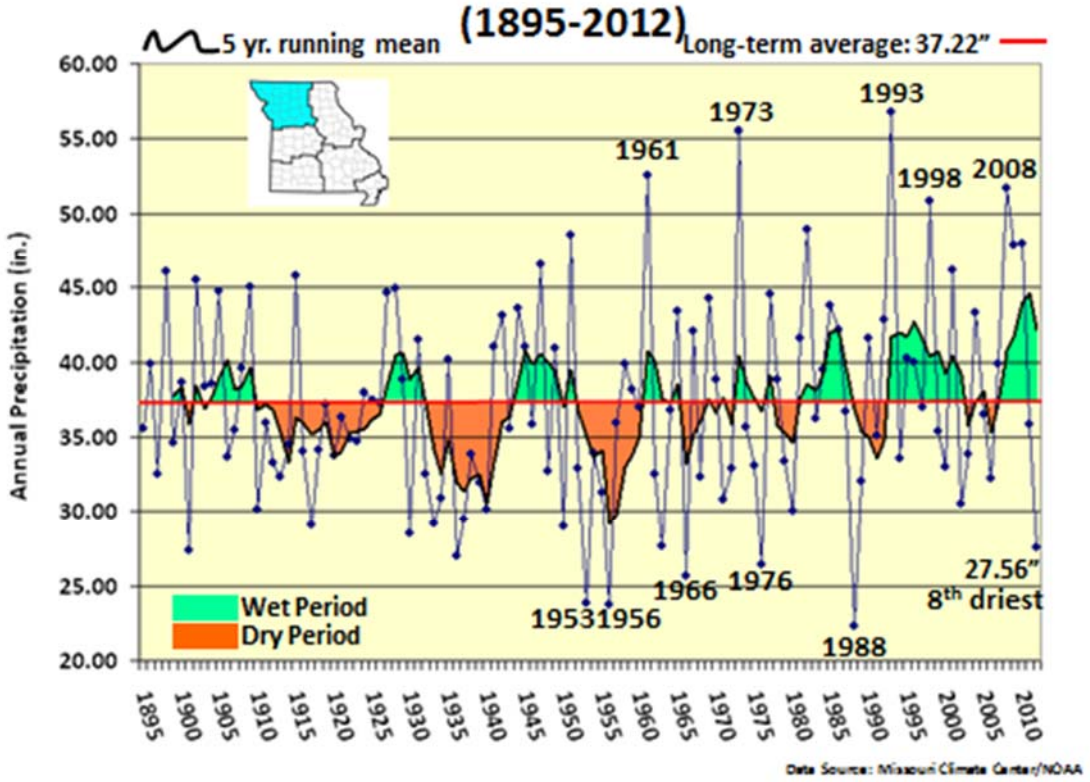
Since 1930, the northwest Missouri region has experienced several drought periods, and each had a varying duration that ranged from one year to 10 years. Table 9 reports average annual precipitation totals for the six drought periods analyzed. On average, the northwest Missouri area reported 36.99 inches of precipitation each year between 1930 and 2010. Based on the data shared in Table 8, drought periods' precipitation variance from this average ranged from 4.33 inches per year to 15.58 inches per year.

Table 9. Worst Varying Periods of Drought for Northwest Missouri

LENGTH OF PERIOD	YEARS	AVERAGE ANNUAL PRECIPITATION FOR PERIOD (INCHES)
10 YEAR	1930-39	32.66
5 YEAR	1952-56	28.92
4 YEAR	1953-56	28.01
3 YEAR	1953-55	29.42
2 YEAR	1988-89	26.43
1 YEAR	1988	21.41

Figure 13 highlights wet and dry periods experienced in northwest Missouri from 1895 to 2012. During this time span, the long-term average precipitation total was 37.22 inches. Generally, weather patterns alternate between wet and dry periods, which are computed using a five-year running mean. The data points illustrated in the figure also indicate that precipitation became volatile from the 1950s to 1990s. Since then, annual precipitation averages have had reduced volatility, though they still had some deviation from the long-term average.

Figure 13. Northwest Missouri Annual Average Precipitation



Source: Missouri Climate Center/NOAA

Historic climate data for northwest Missouri indicated 2012 was the 2nd driest May through August period on record; only this period in the year 1936 was drier. This is why this area witnessed drought impacts not seen in a lifetime. The combination of persistent above normal temperatures, low humidity, numerous sunny days, and lack of precipitation led to immense evaporative losses and rapid drought development and impacts to agriculture.

Livestock Water Cost Impact

The Missouri Rural Water Association conducts an annual survey to assess ongoing trends in local Missouri water rates. Table 10 reports data from the 2014 survey for the 10-county region in north central Missouri and the state. Based on the 10-county average, water is more expensive on average as a minimum charge and cost per 5,000 gallons in the 10-county region relative to all of Missouri. The minimum water charge average is $1.08 greater in the 10-county region compared with the state average, and the cost per 5,000 gallons is $14.87 more in the 10-county region.

Table 10. Average Water Costs in the 10-County Area and State, 2014

AREA	MIN. WATER CHARGE	COST PER 5,000 GALLONS
10-County Average in 2014	$17.26	$54.68
Missouri Average – All Systems in 2014	$16.18	$39.81
Difference	$1.08	$14.87

Source: Missouri Rural Water Association

Table 11 further outlines the raw data used to estimate the average water costs for the 10-county region presented in Table 10. Note that the data include district and city water systems, and they're alphabetized by county. In this data set, the minimum water charge ranges from $7.91 to $26.50, the cost per 5,000 gallons ranges from $24.51 to $85, and the all additional water charge ranges from $3.50 to $17.

Table 11. Detailed Water Information and Costs in the 10-County Region, 2014

TYPE OF SYSTEM	# OF CONNECTS	COUNTY	MIN. WATER CHARGE	COST PER 5,000 GALS.	ALL ADD. WATER
	124	Adair	$14.00	$42.00	$5.00
District	2,958	Adair	$16.06	$45.95	$4.84
City	276	Chariton	$26.50	$68.50	$10.50
District	420	Chariton	$20.00	$74.00	$12.50
City		Chariton	$7.91	$24.51	$4.15
City	98	Grundy	$17.00	$85.00	$17.00
City	121	Grundy	$13.50	$45.00	$7.50
District	590	Grundy	$21.00	$48.00	$6.75
	1,537	Grundy	$20.00	$38.00	$3.50
City	229	Linn	$12.75	$51.35	$9.65
District	546	Linn	$14.00	$50.00	$9.00
District	533	Livingston	$20.91	$64.19	$10.82
City	139	Macon	$15.42	$77.10	$15.42
	4,600	Macon	$18.00	$42.50	$5.50
City	514	Mercer	$11.34	$41.38	$7.51
City	1,060	Putnam	$13.72	$48.62	$6.98
District	1,525	Putnam	$17.00	$66.25	$11.75
City	210	Schuyler	$15.00	$35.00	$5.00
City	382	Schuyler	$19.50	$67.00	$9.50
District	1,339	Schuyler	$17.00	$55.00	$9.50
City		Schuyler	$20.00	$39.90	$6.00
City	84	Sullivan	$22.47	$80.15	$14.42
City	125	Sullivan	$19.63	$62.83	$10.80
City	330	Sullivan	$21.57	$60.02	$7.69
		Average	**$17.26**	**$54.68**	**$8.80**
		Maximum	**$26.50**	**$85.00**	**$17.00**
		Minimum	**$7.91**	**$24.51**	**$3.50**

Source: Missouri Rural Water Association

Because water is a critical resource for livestock operators, they need a reliable water supply. For most producers, building and maintaining their own surface water impoundments is more cost-effective than buying water from a rural water district. Table 12 presents the water cost that livestock producers would incur per animal if they were to purchase water from a rural water district. This table's gross margin data were estimated using the three year average (2012-2014) figures from Missouri enterprise

budgets; see Table A6, Table A7 and Table A8 in the appendix for details concerning the 2014 budgets. Based on these computations, gross margin would be negative for beef cattle watered from a rural water district's water supply. For milk cows and swine, the gross margin wouldn't be negative, but water would represent 61 percent and 7 percent, respectively, of the gross margin. To maximize their return, livestock producers would benefit from creating their own surface water impoundments and limiting their need to source and purchase water for their animals.

Table 12. Impact of Purchased Water to Livestock Enterprise in the 10-County Region

LIVESTOCK	ANNUAL DEMAND (GALLONS PER HEAD)	10-COUNTY WATER RATE (PER GALLON)	ANNUAL COST (PER HEAD)	AVERAGE INCOME OVER OPERATING COSTS* (GROSS MARGIN PER HEAD)	WATER AS A % OF GROSS MARGIN
BEEF COWS	11,863	$0.0109	$129.73	($42.89)	-302%
DAIRY COWS	31,025	$0.0109	$339.29	$552.62	61%
HOGS	2,190	$0.0109	$23.95	$358.93	7%

* From Missouri Budgets, 2012-2014

Loss of Livestock and Processing Industry

As indicated earlier, one industry's decline in a given region can have a devastating impact on the local economy. If water were to become scarce due to drought or other competing uses, then it is reasonable to expect that livestock sectors would need to depopulate or incur significantly higher expenses to accommodate the lack of water. In a livestock industry, such as beef, it would take several years before farmers could grow their inventories to pre-drought levels. Table 13 presents three scenarios that convey the impact on livestock inventory given varying loss levels: 1 percent, 10 percent and 25 percent losses. To interpret the table, the hog industry contracting by 25 percent would result in 134,635 fewer head not being raised in the 10-county region.

Table 13. Inventory Impact of Water Scarcity on Livestock Sector

INDUSTRY	EXISTING INVENTORY (2012)	ONE PERCENT LOSS OF INDUSTRY (HEAD LOST)	10 PERCENT LOSS OF INDUSTRY (HEAD LOST)	25 PERCENT LOSS OF INDUSTRY (HEAD LOST)
HOGS	538,538	5,385	53,854	134,635
BEEF COWS	150,307	1,503	15,031	37,577
DAIRY COWS	2,463	25	246	616

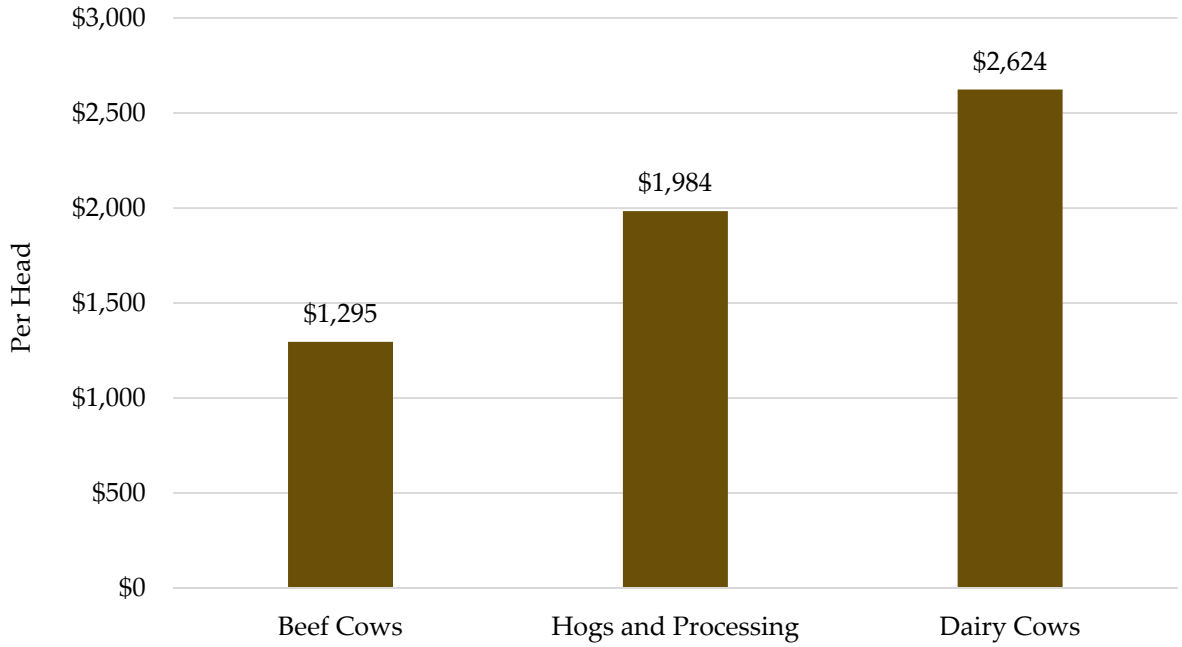
When an industry leaves an area, its loss creates an economic void that impacts the rural economy. If the scenarios in Table 13 were to occur, then the regional economy would experience an annual economic value-added and job impact because of these losses. Table 14 illustrates the economic impact adjustments that would be realized because of each corresponding production reduction. Because the hog industry processes locally, swine production and processing would be affected. To interpret the table, a 1 percent reduction in the hog production and processing industry would result in an annual loss of $10.7 million in economic output and 58 jobs. If the reduction was more severe and caused a 25 percent loss, then the hog and processing industry would lose $267.1 million in economic activity and 1,444 rural jobs.

Table 14. Value-Added and Jobs Impact of Water Scarcity on Livestock Sector

INDUSTRY	IMPACT METRIC	1 PERCENT LOSS OF INDUSTRY	10 PERCENT LOSS OF INDUSTRY	25 PERCENT LOSS OF INDUSTRY
HOGS & PROCESSING	Value-Added ($)	$2,925,377	$29,253,773	$73,134,433
	Jobs (#)	57.8	577.6	1,444.0
BEEF COWS	Value-Added ($)	$445,487	$4,454,865	$11,137,162
	Jobs (#)	9.8	98.3	245.9
DAIRY COWS	Value-Added ($)	$32,115	$321,145	$802,862
	Jobs (#)	0.3	2.8	6.9

In total, the hog production and processing industry would generate a major negative rural economic impact by leaving the area. It is important to note, however, that the economic impact value when evaluating livestock impacts is different on a per head basis. Figure 14 adjusts the economic output modeled in Table 14 to estimate economic impacts per head in the 10-county region. In the region, the dairy industry is not the largest livestock sector, but it does have the highest economic output on a per head basis. In other words, each dairy animal that leaves the region would result in an annual loss of $2,624. For beef cattle and hogs and the hog processing, the economic impact per animal is less and totals $1,295 and $1,984, respectively.

Figure 14. Economic Impact of Water Scarcity per Head on Livestock Sector



Economic Impact of Murphy-Brown and Smithfield Farmland

A report published by Edwards et al. (2011) discussed the economics of a large northern Missouri vertically integrated pork production business located within the 10-county region of the proposed reservoir. Formally known as Premium Standard Farms, Murphy-Brown (MB) of Missouri is headquartered in Princeton, Missouri, and the company currently owns 63 sow farms; nine grow/finish farms; and 44,000 acres of Missouri land in Mercer, Putnam, Sullivan, Grundy, Gentry, Daviess and Worth counties. MB currently employs approximately 1,070 people (1,022 full-time equivalents) who reside in north central Missouri and southern Iowa.

In response to the local pork production, Smithfield Farmland (SF) developed processing facilities to utilize the hog supply. SF pork processing facility is located in Sullivan County (Milan, Missouri), and its ham processing facility is in Jackson County (Martin City, Missouri). In 2009, they slaughtered approximately 2.3 million hogs at Milan and processed 104 million pounds of ham at Martin City, and it employed more than 1,700 people.

MB and SF significantly contribute to Missouri's economic vitality, especially in north central Missouri. For 2007 to 2009, average annual sales revenue for MB and SF exceeded

$265 million and $526 million, respectively. This revenue impacts the local counties where MB and SF conduct business, adjacent counties where many employees live and the state as a whole.

Using an IMPLAN economic input-output model, the authors estimated that MB's average annual revenue of $265 million had a total economic impact of $313 million on the counties where they conduct business and a $382 million impact to Missouri. Milan's plant average annual revenue of $425 million had a total economic impact of $469 million on Sullivan County alone and $601 million in the state. SF plant at Martin City average annual revenue of $100 million had a total impact of $133 million on Jackson County and $142 million on the state. The total economic impact of MB and SF on Missouri totaled $1.1 billion.

Table 15. Key Business Metrics for Murphy-Brown and Smithfield Farmland-Milan

YEAR 2009	MURPHY-BROWN	SMITHFIELD FARMLAND - MILAN PLANT
Sales (3 year avg.)	$265,845,136	$425,721,888
Property taxes paid	$2,621,589	$622,678
Sales tax & use tax		$40,006
Water purchases	$415,064	$234,520
Economic Impact to North Central Missouri		
Total Output (direct, indirect and induced effects)	$320,280,346	$512,216,165
Employment (direct, indirect and induced effects)	1,584	1,903

Source: Edwards et al. (2011)

Appendix

Table A1. Number of Hog and Pig Farms in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012
ADAIR	228	159	124	99	33	16	14	18
CHARITON	423	308	219	166	65	27	27	18
GRUNDY	264	174	144	98	32	22	26	12
LINN	314	224	166	127	61	22	24	16
LIVINGSTON	274	169	116	104	44	26	24	13
MACON	356	272	195	163	49	42	44	22
MERCER	174	111	64	49	21	7	6	5
PUTNAM	197	124	88	52	21	22	14	16
SCHUYLER	163	118	60	42	20	9	16	10
SULLIVAN	224	153	108	93	20	8	15	12
TOTAL	**2,617**	**1,812**	**1,284**	**993**	**366**	**201**	**210**	**142**

Source: USDA National Agricultural Statistics Service

Table A2. Number of Beef Cow Farms in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012
ADAIR	645	601	574	469	526	441	424	366
CHARITON	763	684	539	520	481	433	438	375
GRUNDY	458	372	320	291	280	271	272	231
LINN	591	550	529	477	519	452	445	375
LIVINGSTON	520	415	374	306	315	324	299	257
MACON	818	737	691	643	622	575	542	440
MERCER	489	423	345	310	307	266	227	206
PUTNAM	500	490	460	391	374	380	320	280
SCHUYLER	354	352	316	299	313	257	255	207
SULLIVAN	661	629	546	540	506	463	411	320
TOTAL	**5,799**	**5,253**	**4,694**	**4,246**	**4,243**	**3,862**	**3,633**	**3,057**

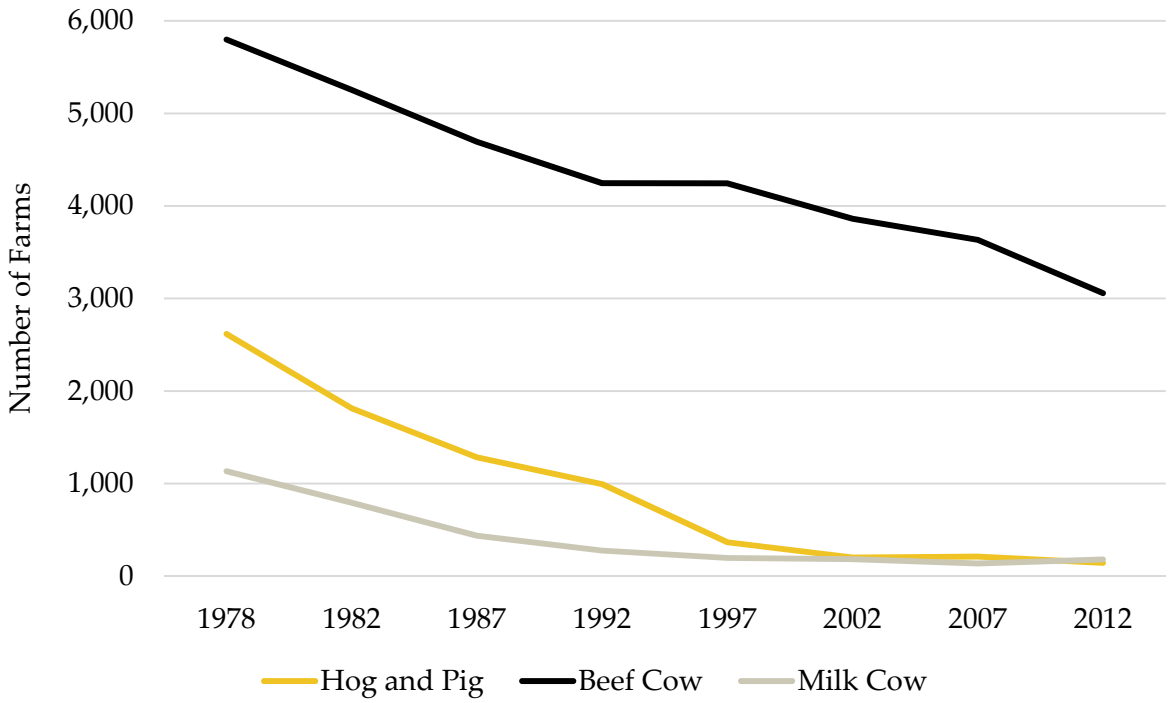
Source: USDA National Agricultural Statistics Service

Table A3. Number of Farms with Milk Cows in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012
ADAIR	132	90	53	27	24	12	9	17
CHARITON	104	66	38	21	9	10	10	5
GRUNDY	118	86	42	33	18	25	17	24
LINN	114	83	60	46	21	36	14	16
LIVINGSTON	77	51	30	20	16	11	11	25
MACON	142	100	63	38	38	36	42	50
MERCER	120	77	40	19	11	6	3	10
PUTNAM	84	78	45	24	12	15	6	3
SCHUYLER	118	73	33	24	26	16	11	19
SULLIVAN	124	88	33	23	21	15	12	9
TOTAL	**1,133**	**792**	**437**	**275**	**196**	**182**	**135**	**178**

Source: USDA National Agricultural Statistics Service

Figure A1. Milk Cow, Hog/Pig and Beef Cow Farms in the 10-County Region



Source: USDA National Agricultural Statistics Service

Table A4. Corn Acres Harvested in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012
ADAIR	20,553	17,087	13,507	15,474	13,365	11,394	12,334	14,150
CHARITON	50,151	45,407	50,578	60,222	63,461	59,716	62,372	71,298
GRUNDY	18,900	15,614	13,512	14,228	17,201	18,183	32,104	20,269
LINN	22,703	17,570	20,543	24,399	21,646	18,357	24,020	30,190
LIVINGSTON	13,074	9,134	14,944	17,834	18,468	24,110	24,694	34,723
MACON	31,381	25,122	22,578	25,079	21,930	22,112	25,491	30,492
MERCER	22,822	21,907	14,733	18,884	13,344	13,678	16,386	18,839
PUTNAM	15,278	15,383	12,664	12,932	12,928	9,703	13,701	13,898
SCHUYLER	11,830	15,124	9,626	11,671	7,716	4,702	6,547	9,459
SULLIVAN	17,433	16,343	11,983	12,681	10,944	10,017	11,587	13,644
TOTAL	**224,125**	**198,691**	**184,668**	**213,404**	**201,003**	**191,972**	**229,236**	**256,962**

Source: USDA National Agricultural Statistics Service

Table A5. Soybean Acres Harvested in the 10-County Region

COUNTY	1978	1982	1987	1992	1997	2002	2007	2012
ADAIR	44,689	45,081	34,350	28,925	30,993	35,097	29,470	34,619
CHARITON	131,733	132,240	131,607	115,918	124,998	112,000	100,792	128,318
GRUNDY	68,237	92,391	76,630	65,845	61,700	55,204	52,087	54,582
LINN	73,721	76,579	71,626	56,121	51,772	54,324	54,106	68,241
LIVINGSTON	99,569	102,409	107,491	94,335	102,566	103,984	104,929	101,494
MACON	86,985	85,975	82,578	67,453	62,810	68,557	63,690	78,141
MERCER	26,819	34,470	24,230	22,107	23,459	22,783	19,366	30,944
PUTNAM	21,918	22,974	17,109	13,496	15,937	18,141	21,649	28,083
SCHUYLER	20,773	18,200	16,674	14,296	17,447	10,526	10,964	24,465
SULLIVAN	38,434	46,353	28,399	23,958	25,394	31,201	21,153	38,056
TOTAL	**612,878**	**656,672**	**590,694**	**502,454**	**517,076**	**511,817**	**478,206**	**586,943**

Source: USDA National Agricultural Statistics Service

Table A6. North Missouri Beef Cow/Calf Budget, 2014 (Cow/Year)

CALF CROP, % WEANED	FALL '13 CALVING 88%	SPRING '14 CALVING 84%
ESTIMATED INCOME/COW		
Steer calf sales	$459.36	$414.12
Heifer calf sales	416.42	378.67
Cull cow sales	137.76	137.76
Other income	0.00	0.00
ESTIMATED TOTAL INCOME/COW	$1,013.54	$930.55
ESTIMATED OPERATING COSTS/COW		
Pasture (rental rate)	$121.00	$129.80
Hay and forage	189.60	153.60
Grain	12.09	13.35
Protein and mineral	13.31	33.08
Labor	60.00	60.00
Veterinary, drugs, and supplies	35.50	35.50
Marketing	25.34	23.26
Utilities and all machinery costs	90.32	90.32
Livestock facility repairs	8.00	8.00
Breeding charge		
Cow replacement (15% of herd)	232.99	232.99
Bull cost or A.I. charge	14.50	14.50
Interest on breeding stock	91.98	91.98
Insurance on breeding stock	15.33	15.33
Professional fees (legal, accounting, etc.)	1.00	1.00
Miscellaneous	6.00	6.00
Interest on 1/2 operating costs @ 6.0%	17.45	17.27
TOTAL OPERATING COSTS	$934.41	$925.98
ESTIMATED OWNERSHIP COSTS/COW		
Depreciation on livestock facilities	8.48	8.48
Interest on livestock facilities	7.83	7.83
Insurance and taxes on capital items	15.14	15.14
TOTAL OWNERSHIP COSTS	$31.45	$31.45
ESTIMATED TOTAL COSTS/COW	$965.87	$957.44
INCOME OVER OPERATING COSTS/COW	$79.12	$4.57
INCOME OVER TOTAL COSTS/COW	$47.67	-$26.89

Source: University of Missouri

Table A7. Missouri Conventional Dairy (150-Cow Herd), 2014 (Cow/Year)

	PRODUCTION LEVEL (LBS. MILK SOLD)			
	20,000		24,000	
	PER COW	PER CWT	PER COW	PER CWT
ESTIMATED INCOME				
Milk sales @ $23.25/cwt.	$4,649.95	$23.25	$5,579.92	$23.25
Quality premium	70.00	0.35	84.00	0.35
Calf sales: bulls and surplus heifers	83.70	0.42	83.70	0.35
Cull cows sales: 1,450 lbs x 28% x $95.00/cwt.	385.70	1.93	$385.70	1.61
ESTIMATED TOTAL INCOME	$5,189.35	$25.95	$6,133.31	$25.56
ESTIMATED OPERATING COSTS				
Feed	$2,609.40	$13.05	$2,902.10	$12.09
Labor	344.83	1.72	344.83	1.44
Veterinary, drugs, and supplies	105.00	0.53	110.00	0.46
Utilities and water	55.00	0.28	55.00	0.23
Fuel, oil, and all vehicle expense	61.59	0.31	61.59	0.26
Milk hauling and promotion	200.00	1.00	240.00	1.00
Building and equipment repair	168.86	0.84	168.86	0.70
Breeding/genetic charges:				
Capital replacement	0.00	0.00	0.00	0.00
Semen, A.I. services, and supplies	45.00	0.23	45.00	0.19
Interest on breeding herd	93.00	0.47	93.00	0.39
Insurance on breeding herd	15.50	0.08	15.50	0.06
Professional fees (legal, accounting, etc.)	10.00	0.05	10.00	0.04
Miscellaneous	20.00	0.10	25.00	0.10
Interest on 1/2 selected operating costs	103.06	0.52	112.14	0.47
TOTAL OPERATING COSTS	$3,831.23	$19.16	$4,183.01	$17.43
ESTIMATED OWNERSHIP COSTS				
Depreciation on buildings and equipment	$301.38	$1.51	$301.38	$1.26
Interest on land, buildings, and equipment	159.94	0.80	159.94	0.67
Insurance and taxes on land, buildings, and equip.	75.40	0.38	75.40	0.31
TOTAL OWNERSHIP COSTS	$536.72	$2.68	$536.72	$2.24
ESTIMATED TOTAL COSTS	$4,367.94	$21.84	$4,719.73	$19.67
INCOME OVER OPERATING COSTS	$1,358.12	$6.79	$1,950.30	$8.13
INCOME OVER TOTAL COSTS	$821.40	$4.11	$1,413.59	$5.89

Source: University of Missouri

Table A8. Missouri Farrow-Finish Budget, 2014 (Per Sow/Year)

Example is for raising 22 pigs/sow/yr., selling at 270 lbs.			UNITS	PER SOW (61.4 CWT.) TOTAL
ESTIMATED INCOME PER SOW				
	Market hogs sold	Cwt./sow	59.4	
		Price/cwt.	$63.00	$3,742.20
	Cull sows sold	Cwt./sow	2.0	
		Price/cwt.	$51.00	$102.00
ESTIMATED TOTAL INCOME (gross receipts/sow)				$3,844.20
ESTIMATED OPERATING COSTS PER SOW				
Feed:	Commercial	Lbs.	3,905	
		Price/lb.	$0.22	$859.10
	Grain	Lbs.	14,675	
		Price/lb.	$0.085	$1,247.38
Total feed cost				$2,106.48
Veterinary & medicine				$107.00
Breeding & replacement gilts				$200.00
Equipment operation, machine hire, transportation				$130.00
Utilities, insurance, miscellaneous				$125.00
Personal property taxes				$6.00
Hog facility repair & maintenance				$90.00
Operating interest		Rate/year	6.0%	
		Portion	0.50	$82.93
Total Operating Costs per Sow Except Labor				$2,847.41
Estimated labor cost		Hours	20	
		Rate/hour	$13.50	$270.00
Total Operating Costs per Sow Including Labor				$3,117.41
ESTIMATED OWNERSHIP (FIXED) COSTS PER SOW				
Real estate interest, depreciation, taxes				$200.00
Interest on breeding herd				$16.00
Machinery & equipment interest & depreciation				$110.00
Total Fixed Costs per Sow				$326.00
ESTIMATED TOTAL COSTS PER SOW				$3,443.41
		Income over Operating Costs		$726.79
		Income over Total Costs		$400.79

Source: University of Missouri

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