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## EXTENSION

The Impact of the
# Beef Industry
in the Southern Ogallala Region

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### Bridget Guerrero
Extension Program Specialist

### Steve Amosson
Regents Fellow, Professor and Extension Economist–Management

### Ted McCollum
Professor and Extension Beef Cattle Specialist

Texas A&M AgriLife Extension Service
The Texas A&M System

Cow-calf and stocker operations have been an integral part of agriculture in the Southern Ogallala Region for decades. Sparse population, the availability of feed grains and favorable environmental conditions led to the development of fed beef facilities in the 1960s. In the last six decades, the expansion of these operations has significantly enhanced the economic importance of the beef industry to the region.

The concentration of feedlot operations from Southwest Kansas through the Texas High Plains has led to this area being known as the Cattle Feeding Capital of the World. More than 36 percent of the fed beef produced annually in the United States comes from the region. In 2010, sales of fed beef exceeded $11.8 billion with approximately 10.3 million head being marketed.

Fed beef operations are capital-intensive and labor-efficient. A typical 30,000 head feedlot requires 29 full-time employees, but direct employment represents only a small portion of the economic impact. Satellite industries such as slaughtering and processing industries, consulting services, processing crews, and feed companies support the industry and provide even more economic activity and employment opportunities. Beef operations also have a significant positive impact on the transportation industry with the equivalent of 1.5 million semi-loads of feeder cattle, feed, and fed cattle in the region each year.

The beef industry enhances the profitability of other agricultural enterprises in the area. Corn is a primary ingredient in fed beef rations. Overall, the region is grain deficit—the demand for corn is greater than the area produces. Because of this demand, corn produced in the region receives up to a 50-cent higher price per bushel compared to

grain grown in the Midwest. In addition, area ranches, cow-calf, and stocker operations supply feeder cattle for local feedlots. The proximity of feedlots results in price premiums for these operations relative to other areas of the country.

The primary water source in the region is the Ogallala Aquifer, which is declining as withdrawals exceed recharge. Beef operations use water directly for livestock drinking, feed processing, and facility maintenance, and indirectly for water to grow the grain and forage that supports the feeding operation. The beef industry's demand for water has local leaders concerned whether fed beef production in the region is an appropriate use of these scarce water resources. This study evaluates the beef industry in terms of water use and its contribution to the regional economy.

## Study Area

The High Plains is a semiarid region and depends on the Ogallala Aquifer for water. The aquifer stretches from the Dakotas to the southern plains of Texas and comprises approximately 174,000 square miles. The aquifer averages 200 feet of saturated thickness, ranging from less than 1 foot to 1,300 feet, depending on the location. The Southern Ogallala Region is defined in this study as the 97,000 square miles of the aquifer from the north-

Figure 1. Southern Ogallala Region (shaded area below dashed line).

ern border of Kansas to just north of the Midland-Odessa area of Texas (Fig. 1).

The region consists of 19.7 million acres of cropland and more than 6.4 million acres enrolled in the Conservation Reserve Program (CRP); the rest is pastureland. Of the cropland, 7.3 million acres are irrigated and 12.4 million acres are dryland (Fig. 2).
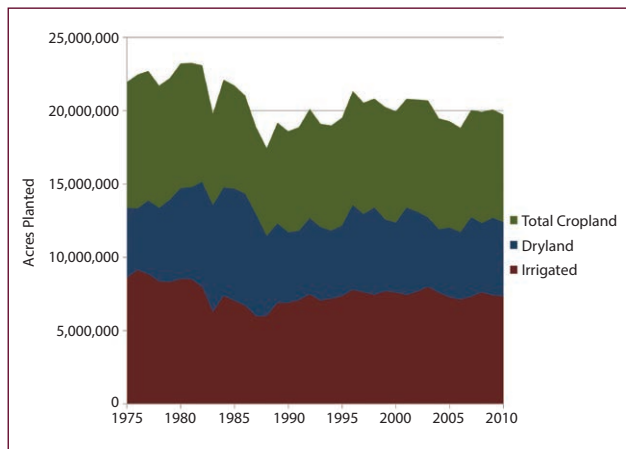
The primary irrigated crops are:

- corn—2.8 million acres
- cotton—1.8 million acres
- wheat—1.7 million acres
- sorghum—0.3 million acres

Other irrigated crops include alfalfa and silage to support the livestock industry.

Dryland crop acreage in the study area stood at 12.4 million acres in 2010, down significantly from the high of 15.1 million acres in 1982. The decrease can be traced directly to the implementation of the CRP, which retired millions of acres from production.

Major dryland crops are:

- wheat—7.4 million acres
- cotton—2.0 million acres
- corn—1.6 million acres
- sorghum—1.5 million acres

Although wheat has decreased from a high of 10.6 million acres in 1983, it still dominates dryland production, accounting for 59 percent of the acreage. Dryland corn production, basically nonexistent 20 years ago, reached 1.6 million acres in 2010 due to improved varieties, management, and profitability.



Figure 2. Southern Ogallala Region irrigated and dryland crop acres, 1975–2010. Source: National Agricultural Statistics Service
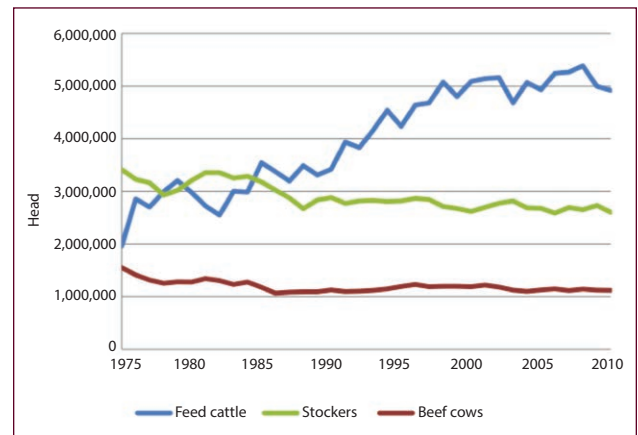


Figure 3. Southern Ogallala Region beef inventory, 1975–2010. Source: National Agricultural Statistics Service

Historically, the number of beef cows has been stable and totaled 1.1 million head in 2010 (Fig. 3). Stocker cattle inventories fluctuate somewhat more than beef cows, depending on conditions in the region. Summer stockers graze on rangeland and pasture, while winter stockers typically graze irrigated and dryland wheat. The estimated stocker inventory totaled 2.6 million head in 2010.

Sparse population, availability of feed grains, and favorable environmental conditions have made the region a popular place for confined livestock operations (CLOs). Cattle feedlots first appeared in the 1960s and grew steadily until inventories stabilized over the last decade. In 2010, cattle on feed topped 4.9 million head.

The growth in the region's fed beef industry has been geographically uneven. From 1975 to 2010, fed beef inventories in Colorado, New Mexico, and Oklahoma had virtually no growth (Fig. 4), while Texas and Kansas had substantial increases in fed beef numbers. The Texas High Plain's inventory rose from 909,000 head in 1975 to 2.4 million head in 2010. Kansas experienced similar growth during that time with inventory increasing from 627,600 head to 1.9 million head.
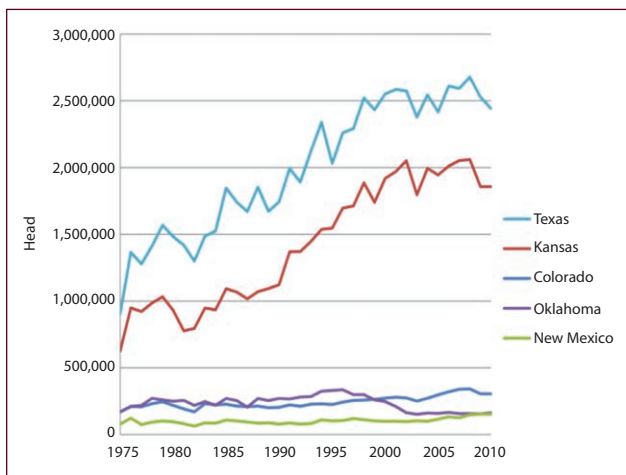


The same conditions that attracted feedlots have more recently attracted swine operations, dairies, and associated businesses. The swine industry had 338,000 head in 1989, grew rapidly in the 1990s, and had 3.4 million hogs in 2010. Dairy cows in the Southern Ogallala Region increased more than 11-fold, from 41,500 head in 1990 to 453,200 head in 2010.

## Water Use in the Beef Industry

The beef industry's growing demand for water has local leaders concerned about the future of the Ogallala Aquifer. Beef operations use water *directly* for drinking, feed processing, and facility maintenance, and *indirectly* to grow grain and forage for feed. The type of use affects agricultural production since a portion of the water requirements comes from existing supplies.

In balance, the amount of water beef operations use directly has to be offset by an equivalent decrease in the amount of water used for irrigation. This decrease is partially achieved when acreage is retired from irrigated production to build facilities that house cattle and store feed.

The indirect water use for cow-calf and stocker operations is minimal since grazing is a secondary benefit for wheat producers and pastureland is typically not irrigated. However, the amount



Figure 4. Southern Ogallala Region fed beef inventory by state, 1975–2010. Source: National Agricultural Statistics Service

of water feedlots use indirectly within the region depends on the type of feed produced. Indirect water required for silage comes from within the region, because it must be produced relatively close to where it is used. On the other hand, there is not enough grain produced in the region to meet the demands of the feedlots, let alone the swine and dairy industries, making it necessary to import it from other parts of the country.
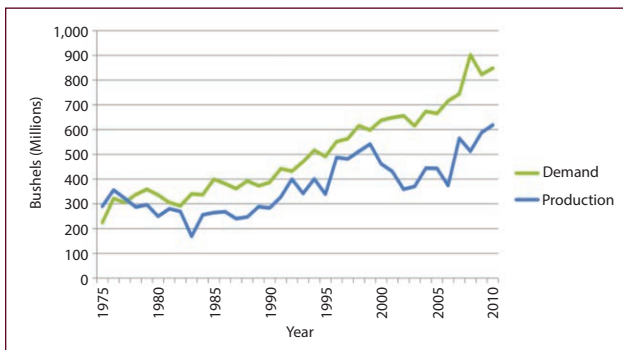


Figure 5. Southern Ogallala Region feed grain production and demand from confined livestock operations and ethanol plants, 1975–2010.

The region has been grain deficit (using more than it produces) since the late 1970s because of the development of the fed beef industry and later the swine and dairy operations (Fig. 5). Irrigated grain acreage to support these industries peaked from the 1970s through the early 1980s, but has remained stable since 1990 (Fig. 2). At the same time, production has doubled due to better technologies and management. However, the increase has not been enough to satisfy the demand for grains in livestock rations.

Growing dairy inventories and the recent development of the ethanol industry has continued to escalate the demand for feed grains in the region. Feed-grain imports have provided 35 percent of feed-grain needs on average over the last decade. The grain-deficit nature of the region suggests that any additional indirect water use by the beef industry through feed grains will have to be provided through increases in imports rather

than pumping more water from the aquifer. This study estimates the potential draw on the aquifer from indirect water use by feedlot operations in the study region, assuming that all required feed comes from irrigated acreage within the study area. Then, a regional estimate of indirect water use is made, considering only the percentage of feed supplies that are available locally.

## Direct Water Use

The amount of water a beef facility uses for drinking, cleaning, feed processing, and maintenance varies by operation. Industry specialists estimate the average direct water use for each head of fed beef in the Texas High Plains is 12.5 gallons per day, while beef cows require an estimated 20 gallons per day. Summer and winter stockers require 10 gallons and 8 gallons of water per unit per day, respectively. These water requirements are assumed to be typical across the entire study region.

The *direct water* use from 1975 to 2010 is illustrated in Figure 6. Direct water use was less than 77,800 acre-feet in 1975 and reached a peak of 112,900 acre-feet in 2008. In 2010, direct water use was approximately 105,600 acre-feet.
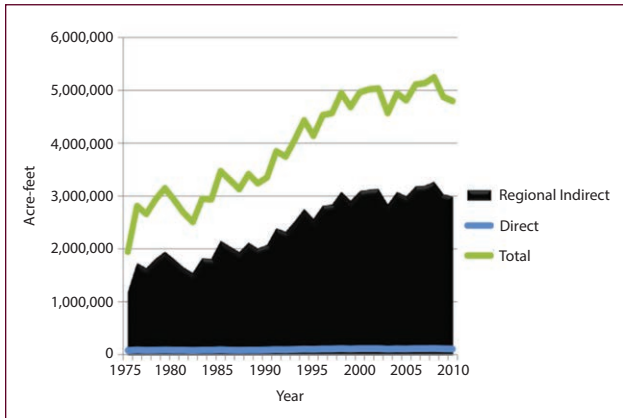
Figure 6. Southern Ogallala Region estimated direct and indirect water use by beef operations, 1975–2010.

The amount of direct water that beef operations use affects the rest of the region's agricultural sector. In general, water that beef operations use is offset by a decrease in irrigated acreage. Irrigated water use varies considerably across the region and by crop. An average of 15 acre-inches (or 1.25 acre-feet) per acre was assumed in this study to illustrate the impact of direct water use by beef operations on irrigated acreage.

The estimated reduction in irrigated acreage is shown in Table 1. A total of 84,508 irrigated acres

would need to be taken out of production to offset the direct water requirements in 2010. The reduction represents 1 percent of the 7.3 million irrigated acres in the region. Texas was estimated to have the largest reduction of irrigated acreage (36,576 acres), followed by Kansas (28,393 acres).

## Indirect Water Use

*Indirect water* use refers to the water used to produce corn grain, silage, and hay for feed. Most feed for stocker and cow-calf operations comes from grazing wheat and pastureland acreage. Hay is fed only as a supplement to grazing, especially in the winter.



Table 1. Estimated annual direct water use and displaced irrigated crop acreage by beef operations in the study area, 2010.

| State | Fed beef Inventory (head) | Beef Cow Inventory (head) | Stocker Inventory (head) | Direct Water Use (acre-feet)[a] | Displaced Crop Acreage[b] |
|---|---|---|---|---|---|
| Colorado | 306,000 | 191,000 | 397,869 | 10,429 | 8,344 |
| Kansas | 1,856,300 | 275,400 | 787,950 | 35,492 | 28,393 |
| New Mexico | 152,900 | 213,900 | 293,895 | 8,569 | 6,856 |
| Oklahoma | 163,800 | 96,300 | 211,499 | 5,424 | 4,339 |
| Texas | 2,441,000 | 340,000 | 910,285 | 45,720 | 36,576 |
| Total | 4,920,000 | 1,116,600 | 2,601,498 | 105,635 | 84,508 |

[a]Assumes 12.5, 20, 10, and 8 gallons per day per unit for fed beef, beef cows, summer stockers, and winter stockers, respectively (Source: Freese and Nichols Inc., 2010)
[b]Assumes 15 acre-inches applied per acre

Pasture in the region is mostly dryland and relies on rainwater, while grazing is a secondary benefit for producers with wheat acreage. As a result, indirect water use for stocker and cow-calf operations is minimal. Thus, this study focuses primarily on the indirect water use of the fed beef industry.

An estimate of industry feed requirements is necessary to understand the potential impact of indirect water use by feedlot operations. An example ration per head of fed beef is presented in Table 2. On average, each head requires 30.5 pounds (as-fed) of feed per day. The ration primarily consists of corn grain (16.3 pounds), co-products (9.6 pounds), and roughage (3.2 pounds). This corresponds to a total feed requirement of 5.6 tons per head fed each year.

The estimated regional demand for feed based on the 2010 fed beef inventory equals:

- 14,647,385 tons of corn grain
- 2,885,988 tons of roughage
- 8,633,316 tons of co-products
- 1,219,797 tons of liquid feeds

Thus, the estimated total feed requirement for fed beef operations in 2010 was almost 27.4 million tons (Table 2). This is an approximation, whereas actual fed beef rations are determined on a least-cost basis and are subject to ingredient availability.

The *potential* draw on the aquifer from indirect water use by feedlots is estimated in Table 3. This extreme case assumes that all required feed comes from irrigated acreage within the study area. Then, the amount of indirect water use from within the region is estimated, considering the amount of major feed components available locally. Indirect water use for the primary components (corn grain, corn silage, other silage, alfalfa, and other hay) is estimated, assuming that irrigated sorghum silage is the other silage used and other hay is irrigated. In reality, some of the feed grains, silage, and hay that are fed will come from dryland production.

Indirect water use was estimated by transforming the feed requirements into acres of production and applying

Table 2. Estimated feed requirements for fed beef operations in the study area, 2010.

| Ingredient | Fed Beef Unit | | Study Region |
| --- | --- | --- | --- |
| | Daily Ration as fed (lbs.)[a] | Annual Ration as fed (tons)[a] | Feed Requirements (tons)[b] |
| Corn Grain | 16.31 | 2.98 | 14,647,385 |
| Roughage | 3.21 | 0.59 | 2,885,988 |
| Silage | 2.12 | 0.39 | 1,907,609 |
| Hay and Other | 1.09 | 0.20 | 978,379 |
| Co-Products | 9.62 | 1.75 | 8,633,316 |
| Distiller's grains | 8.37 | 1.53 | 7,518,452 |
| Other | 1.24 | 0.23 | 1,114,864 |
| Liquid Feeds | 1.36 | 0.25 | 1,219,797 |
| Total | 30.50 | 5.57 | 27,386,486 |

[a]Assumes dry matter content of 86 percent for corn grain, 35 percent for silage and wet distiller's grains, 90 percent for hay, cotton burrs, and dried distiller's grains, 60 percent for wet corn, 89 percent for cottonseed meal, and 50 percent for liquid feeds
[b]Based on an estimated fed beef inventory of 4,920,000 head in 2010

Table 3. Estimated indirect water use and corresponding irrigated crop acreage required by feedlot operations in the study area, 2010.

| | Corn Grain | Corn Silage | Other Silage | Alfalfa | Other Hay | Total |
|---|---|---|---|---|---|---|
| Feed Requirements (tons) | 14,647,385 | 1,192,255 | 715,353 | 251,180 | 705,696 | 17,511,870 |
| Yield/Acre (tons)[a] | 6.30 | 27.00 | 21.00 | 5.50 | 3.09 | |
| Acreage | 2,324,982 | 44,158 | 34,064 | 45,669 | 228,381 | 2,677,254 |
| Irrigation Applied (ac-in per acre)[a] | 22 | 20 | 13 | 24 | 12 | |
| Total Indirect Water Use (ac-ft) | 4,262,467 | 73,596 | 36,903 | 91,338 | 228,381 | 4,692,685 |
| Regional Indirect Water Use (ac-ft) | 2,770,603 | 73,596 | 36,903 | 68,504 | 38,321 | 2,987,928 |

[a]Source: Amosson et al., 2009

the typical irrigation water use by crop. The estimated total indirect water use was 4,692,685 acre-feet, which accounts for 97.8 percent of the total water use of the beef industry in 2010; direct water use (105,635 acre-feet) makes up the other 2.2 percent. However, only 64 percent of the indirect water comes from within the region. The resulting regional indirect water use, which accounts for only locally grown crops, was 2,987,928 acre-feet. The estimated total water use of the beef industry from 1975–2010 mirrors the growth of fed beef inventory (Fig. 6).

The amount of indirect water supplied locally depends on the characteristics of the study area. The Southern Ogallala Region has been grain deficit since the mid-70s and faces reduced water availability due to the declining aquifer. Imports of corn and, to a lesser extent, alfalfa are required because there are not enough local supplies to meet livestock demand. In addition, the region's stable-to-declining irrigated acreage (due to limited water availability) suggests that any silage requirements of livestock operations be met by silage production replacing corn or other irrigated crops. These characteristics imply indirect water demands for new beef operations will have relatively little impact on the aquifer and that the primary effect will be an increase in grain importation.

The proportion of the region's water needed to support the beef industry is illustrated in Figure 7. In 2010, agricultural enterprises required an estimated 10.8 million acre-feet. Irrigated crop production accounted for 98.6 percent of water use, while the remaining 1.4 percent was used directly by livestock sectors. Approximately 27.6 percent of water use is for locally produced irrigated crops fed to cattle in feedlots (beef indirect water use). In total, the beef industry accounts for 28.6 percent of agricultural water use in the region. The remaining 71.4 percent of agricultural water use is attributed to other irrigated crop production (71 percent) and other direct livestock use (0.4 percent).

The expansion of any industry, including confined livestock operations, will result in a relative
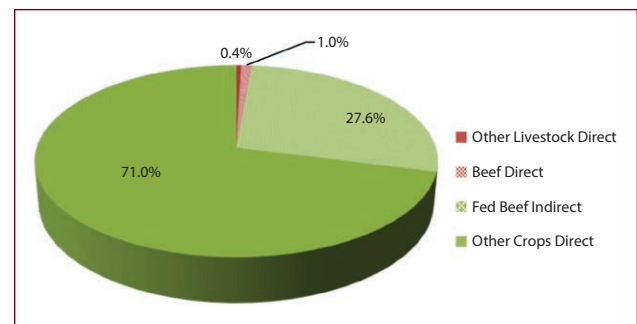


Figure 7. Southern Ogallala Region estimated water use by livestock and irrigated crop production in comparison to beef industry water use, 2010.

increase in water usage despite declining water availability. The value of water rises with the resultant increase in demand. Areas of the region that have stopped irrigating because of increased pumping costs as the aquifer declines may resume pumping when the value of water rises above the cost of extraction.

## Regional Economic Impacts

The beef industry has always been an important component of the regional economy, and the development of the fed beef industry over the last six decades has made it even more significant. A computer analysis program, IMPLAN (IMpact analysis for PLANning), was used to estimate the beef industry's economic contribution to the Southern Ogallala Region including the ripple effects on economic sectors directly and indirectly related to the beef industry.

The IMPLAN model estimates direct, indirect, and induced effects. The *direct effects* of the beef industry are the sales, income, and employment generated by operations that produce beef products. The *indirect effects* include the purchase of inputs such as feed, veterinary services, energy, and transportation services to produce and deliver beef products. *Induced effects* occur when employees of beef operations and input suppliers use their income to buy goods and services from businesses such as grocery stores, restaurants, and department stores.

These effects are captured for three different economic measures:

- *Industry output*—the total economic activity that occurs within a region
- *Value added*—the income or wealth portion of industry output that includes employee compensation, proprietary income, other property income, and indirect business taxes
- *Employment*—the number of jobs created and/or supported

The beef industry produces and processes beef for consumption. The different stages of production (cow-calf, stockers, and fed beef) and processing (slaughter/processing and leather) are modeled
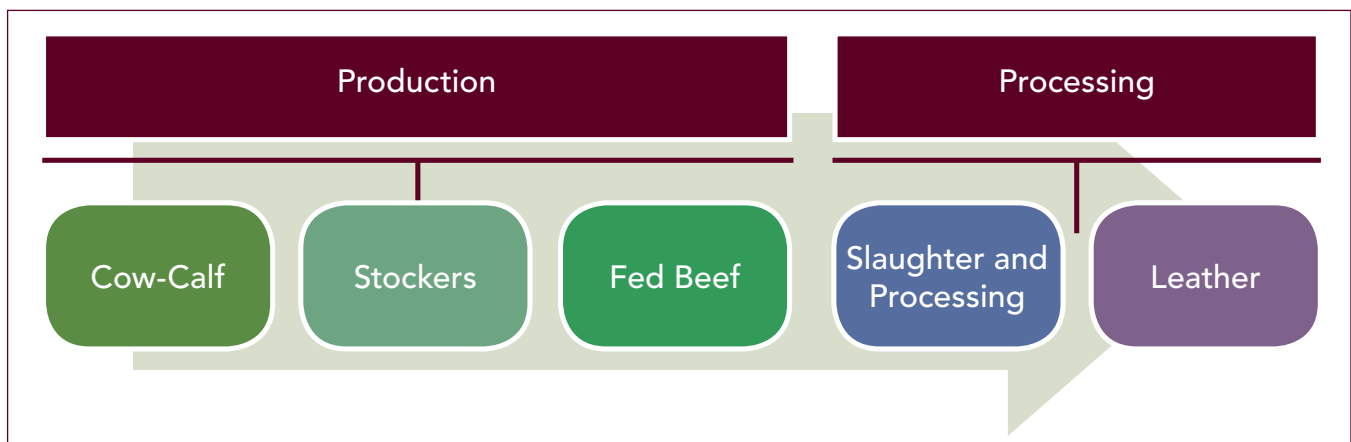


Figure 8. Beef Industry Flowchart

Table 4. Sales from the beef production sector and subsectors in the Southern Ogallala Region, 2010.

| Region | Cow-Calf | Stockers | Fed Beef | Total Beef Production |
|---|---|---|---|---|
| Colorado | $86,460,864 | $300,815,771 | $682,009,677 | $1,069,286,312 |
| Kansas | $124,666,608 | $595,742,622 | $4,642,058,281 | $5,362,467,511 |
| New Mexico | $96,827,115 | $222,204,224 | $280,364,848 | $599,396,186 |
| Oklahoma | $43,592,572 | $159,907,131 | $389,424,072 | $592,923,775 |
| Texas | $153,909,392 | $688,236,070 | $5,792,705,153 | $6,634,850,616 |
| Total | $505,456,551 | $1,966,905,818 | $11,786,562,031 | $14,258,924,400 |

Table 5. Sales from the beef production and beef processing sectors in the Southern Ogallala Region, 2010.

| Region | Beef Production | Beef Processing | Total Beef Industry |
|---|---|---|---|
| Colorado | $1,069,286,312 | $13,113,976 | $1,082,400,288 |
| Kansas | $5,362,467,511 | $5,135,066,538 | $10,497,534,049 |
| New Mexico | $599,396,186 | — | $599,396,186 |
| Oklahoma | $592,923,775 | $14,214,482 | $607,138,257 |
| Texas | $6,634,850,616 | $4,749,179,512 | $11,384,030,128 |
| Total | $14,258,924,400 | $9,911,574,508 | $24,170,498,908 |

separately (Fig. 8). Payments to previous stages of production are excluded in each forward-linked sector in order to avoid double-counting contributions.

The direct value (gross sales) of beef production in the region during 2010 was estimated to be $505 million, $2 billion, and $11.8 billion for the cow-calf, stocker, and fed beef sectors, respectively (Table 4). The total value of beef production was $14.3 billion. Texas and Kansas, which have the largest areas among the five states overlying the Southern Ogallala, also had the most sales in all three beef production subsectors (cow-calf, stockers, and fed beef). Combined, Texas and Kansas accounted for 55.1 percent, 65.3 percent, and 88.5 percent of the estimated 2010 sales from cow-calf, stocker, and fed beef operations, respectively.

Processors in the region include beef slaughtering and processing plants as well as leather and hide-finishing operations. Slaughtering and processing plants include Cargill Meat Solutions, Tyson Foods, JBS-USA, and National Beef. These operations are forward-linkages to beef production, which add value to the product through processing and packaging meats to be sold at local grocery stores and/or served in restaurants. Leather and hide-finishing is also a forward-linked sector that adds value to beef; however, production is relatively small and only occurs in Texas. In total, the beef-processing sector accounted for more than $9.9 billion in sales during 2010 in the region (Table 5). Combining the processing sales with

Results of the IMPLAN analysis for the beef-production sector and subsectors are shown in Table 6. The fed beef subsector had the largest economic contribution with $14.1 billion in industry output, supporting more than 12,500 jobs. For every person directly employed with a feedlot, an additional 1.7 jobs were created within the region to support the fed beef industry through indirect and induced effects. The stocker subsector generated $2.4 billion in output and 3,200 jobs followed by the cow-calf subsector at $940 million and 5,300 jobs. The total contribution of the beef-production sector was $17.5 billion in output and 21,000 jobs.

The beef-processing sectors add substantial value to the beef industry in the region, contributing $12.3 billion and supporting 39,300 jobs (Table 7). The total direct output of the beef industry, including beef production and processing, was $24.2 billion in 2010. Including the impact of the

production sales ($14.3 billion) results in a total direct output for the beef industry of approximately $24.2 billion. These values were used to estimate the regional economic contribution of the industry.

Table 6. Economic contribution of the beef-production sector and subsectors to the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Cow-Calf** | | | | |
| Output | $505,456,551 | $334,084,014 | $100,069,251 | $939,609,816 |
| Value Added | $126,809,880 | $206,608,969 | $57,678,598 | $391,097,447 |
| Employment | 2,381 | 1,997 | 929 | 5,307 |
| **Stockers** | | | | |
| Output | $1,966,905,818 | $377,781,115 | $83,668,467 | $2,428,355,400 |
| Value Added | $85,516,031 | $220,849,904 | $48,232,978 | $354,598,913 |
| Employment | 1,270 | 1,129 | 777 | 3,176 |
| **Fed Beef** | | | | |
| Output | $11,786,562,032 | $2,016,208,418 | $319,965,604 | $14,122,736,054 |
| Value Added | $3,463,990,241 | $938,445,647 | $184,528,717 | $4,586,964,605 |
| Employment | 4,681 | 4,846 | 2,977 | 12,504 |
| **Total Beef Production** | | | | |
| Output | $14,258,924,400 | $2,728,073,547 | $503,703,322 | $17,490,701,269 |
| Value Added | $3,676,316,152 | $1,365,904,520 | $290,440,293 | $5,332,660,965 |
| Employment | 8,333 | 7,972 | 4,683 | 20,987 |

[a]Direct employment represents full-time equivalent jobs

indirect and induced effects, the total regional economic output generated by the beef industry was estimated to be $29.8 billion. Of this total, $9 billion was value added or wealth generated in the economy. Employment supported by the beef industry, including direct, indirect, and induced effects, was estimated at 60,300 jobs.

Each forward-linked sector of the beef industry adds value to the previous stage of production. In this study, the gross sales were used to generate impacts to the economy, and purchases made to previous production sectors were subtracted to avoid double-counting effects. Thus, the total multiplier effect may appear to be small (1.2 for the fed beef sector, for example). However, when comparing the total economic output generated to only the added value to previous production, the multiplier effects are much larger (3.5 for the fed beef sector).

The economic impact of the beef industry to the Southern Ogallala Region varies considerably by state, (Fig. 9), largely because of the amount of land located over the Southern Ogallala Region
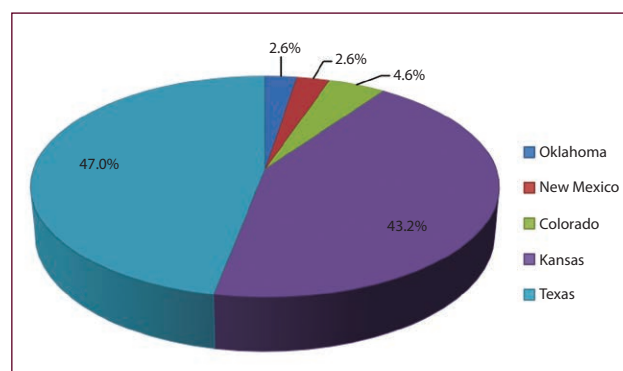


Figure 9. Percentage of total economic contribution of the beef industry to the Southern Ogallala Region by state, 2010.

within the respective states. The Texas High Plains contributes 47 percent of the economic impacts as a result of having the largest fed beef inventory and multiple processors. Kansas accounts for 43.2 percent of the total impact, while Colorado contributes 4.6 percent. Oklahoma and New Mexico each contribute 2.6 percent of the total regional impact. Detailed results by state are presented in the Appendix.

Table 7. Economic contribution of the beef industry to the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $14,258,924,400 | $2,728,073,547 | $503,703,322 | $17,490,701,269 |
| Value Added | $3,676,316,152 | $1,365,904,520 | $290,440,293 | $5,332,660,965 |
| Employment | 8,333 | 7,972 | 4,683 | 20,987 |
| **Beef Processing** | | | | |
| Output | $9,911,574,508 | $1,789,548,855 | $641,888,393 | $12,343,011,756 |
| Value Added | $2,316,812,504 | $946,459,371 | $370,025,008 | $3,633,296,883 |
| Employment | 20,614 | 12,767 | 5,960 | 39,342 |
| **Total Beef Industry** | | | | |
| Output | $24,170,498,908 | $4,517,622,402 | $1,145,591,715 | $29,833,713,025 |
| Value Added | $5,993,128,656 | $2,312,363,891 | $660,465,301 | $8,965,957,848 |
| Employment | 28,947 | 20,739 | 10,643 | 60,329 |

[a]Direct employment represents full-time equivalent jobs

The declining aquifer and water use in the agricultural sector has many stakeholders questioning whether the economic benefits to the regional economy from agricultural operations justify their water use.

Cattle production has long been a staple of the Southern Ogallala Region with annual production of more than 1.1 million cows and 2.6 million stockers. The importance of beef production to the area has grown dramatically since the development of the fed beef industry in the 1960s. In 2010, more than 10.3 million fed cattle were marketed.

Beef operations use water directly for livestock drinking, feed processing, and facility maintenance, and indirectly through grain and forage grown to support the feeding operation. The

As the regions' leaders plan for water conservation, they will consider the economic return on different types of water use. Beef production's $17.5 billion economic impact gauged against direct water use of 105,635 acre-feet and indirect water use of 4,692,685 acre-feet yields an estimated value of water used by the beef-production sector. Direct water use alone generates $165,576 per acre-foot. The value, when combining direct and indirect water use, is $3,645 per acre-foot. These values are relatively high compared to other industries. In assessing the economic contribution of beef production, note that a portion of the indirect water used comes from outside the region in the form of imported grain and not from the Ogallala Aquifer. When accounting for only the direct and regional indirect water used, beef operations generate $5,654 per acre-foot.

## Summary and Conclusions

Water use in the Southern Ogallala Region has greatly exceeded the recharge rate for the past several decades, leading to a steady decline in the aquifer. Agriculture accounts for more than 90 percent of the water use in the region each year.
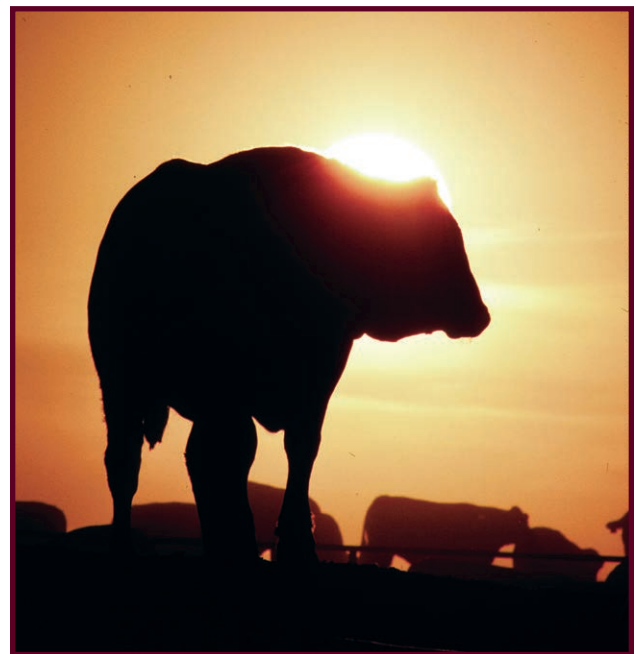
direct water used by beef operations accounts for only 1 percent of agricultural water use within the region. Indirect water use totals 4.7 million acre-feet annually. However, 36 percent of indirect water use is virtual water, which is imported in the form of feed grains and is not pumped from the Ogallala Aquifer. In total, the direct and regional indirect water use of the beef industry accounts for 28.6 percent of the agricultural water usage, most of which is used by feedlot operations. Since cow-calf and stocker operations typically graze dryland pasture or wheat acreage, their indirect water requirements are minimal compared to feedlots, which rely heavily on feed grains. The remaining 71.4 percent of agricultural water use is attributed to other irrigated crop production (71 percent) and other direct livestock use (0.4 percent).

The beef industry, including production and processing sectors, contributes substantially to the regional economy with $29.8 billion in annual economic output and 60,329 jobs. Beef production accounts for $17.5 billion of the total, supporting 20,987 jobs. Beef production creates a relatively high economic value per unit of water pumped from the aquifer, generating $165,576 per acre-foot of direct water use (105,635 acre-feet) or $5,654 per acre-foot of direct and indirect water use (3,093,563 acre-feet) from the aquifer. These values

may be underestimated since all feedstock in this analysis is assumed to originate from irrigated production.

Study results suggest that any expansion of the beef industry in the Southern Ogallala Region will have minimal impact on water resources while increasing economic activity and employment opportunities. New or expanding operations will increase localized water use or result in a decline in irrigated acreage to account for the direct water use. More importantly, additional indirect water usage would come primarily in the form of virtual water imported through feed grains, since the region is already grain deficit. Increased economic activity from beef operations will help offset eventual losses resulting from irrigated crop production shifting to dryland due to aquifer depletion.

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## Appendix

Table A1.  Economic impacts of the beef industry in the area of Colorado located in the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $1,069,286,312 | $231,452,916 | $48,496,686 | $1,349,235,914 |
| Value Added | $235,208,158 | $123,343,779 | $27,962,422 | $386,514,359 |
| Employment | 896 | 794 | 451 | 2,141 |
| **Beef Processing** | | | | |
| Output | $13,113,976 | $2,530,641 | $803,234 | $16,447,851 |
| Value Added | $2,037,332 | $1,340,286 | $463,039 | $3,840,657 |
| Employment | 27 | 18 | 8 | 53 |
| **Total Beef Industry** | | | | |
| Output | $1,082,400,288 | $233,983,557 | $49,299,920 | $1,365,683,765 |
| Value Added | $237,245,490 | $124,684,065 | $28,425,461 | $390,355,016 |
| Employment | 923 | 812 | 458 | 2,193 |

[a]Direct employment represents full-time equivalent jobs

Table A2.  Economic impacts of the beef industry in the area of Kansas located in the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $5,362,467,511 | $990,990,082 | $176,947,998 | $6,530,405,591 |
| Value Added | $1,421,447,243 | $487,505,280 | $102,032,276 | $2,010,984,799 |
| Employment | 2,728 | 2,744 | 1,645 | 7,116 |
| **Beef Processing** | | | | |
| Output | $5,135,066,538 | $921,380,810 | $302,243,144 | $6,358,690,492 |
| Value Added | $1,239,220,363 | $487,190,940 | $174,242,836 | $1,900,654,139 |
| Employment | 10,669 | 6,578 | 2,807 | 20,054 |
| **Total Beef Industry** | | | | |
| Output | $10,497,534,049 | $1,912,370,892 | $479,191,142 | $12,889,096,083 |
| Value Added | $2,660,667,606 | $974,696,220 | $276,275,112 | $3,911,638,938 |
| Employment | 13,396 | 9,322 | 4,452 | 27,170 |

[a]Direct employment represents full-time equivalent jobs

Table A3. Economic impacts of the beef industry in the area of New Mexico located in the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $599,396,186 | $154,632,947 | $36,108,963 | $790,138,096 |
| Value Added | $116,350,355 | $86,849,414 | $20,816,155 | $224,015,924 |
| Employment | 760 | 625 | 335 | 1,721 |
| **Beef Processing** | | | | |
| Output | — | — | — | — |
| Value Added | — | — | — | — |
| Employment | — | — | — | — |
| **Total Beef Industry** | | | | |
| Output | $599,396,186 | $154,632,947 | $36,108,963 | $790,138,096 |
| Value Added | $116,350,355 | $86,849,414 | $20,816,155 | $224,015,924 |
| Employment | 760 | 625 | 335 | 1,721 |

[a]Direct employment represents full-time equivalent jobs

Table A4. Economic impacts of the beef industry in the area of Oklahoma located in the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $592,923,775 | $126,231,023 | $25,860,763 | $745,015,561 |
| Value Added | $132,338,019 | $66,829,926 | $14,908,356 | $214,076,301 |
| Employment | 465 | 425 | 240 | 1,130 |
| **Beef Processing** | | | | |
| Output | $14,214,482 | $2,382,506 | $1,113,754 | $17,710,742 |
| Value Added | $4,473,194 | $1,257,734 | $641,969 | $6,372,897 |
| Employment | 30 | 17 | 10 | 57 |
| **Total Beef Industry** | | | | |
| Output | $607,138,257 | $128,613,529 | $26,974,517 | $762,726,303 |
| Value Added | $136,811,213 | $68,087,660 | $15,550,325 | $220,449,198 |
| Employment | 495 | 442 | 251 | 1,187 |

[a]Direct employment represents full-time equivalent jobs

Table A5. Economic impacts of the beef industry in the area of Texas located in the Southern Ogallala Region, 2010.

| | Direct[a] | Indirect | Induced | Total |
|---|---|---|---|---|
| **Beef Production** | | | | |
| Output | $6,634,850,616 | $1,224,766,579 | $216,288,912 | $8,075,906,107 |
| Value Added | $1,770,972,378 | $601,376,121 | $124,721,084 | $2,497,069,583 |
| Employment | 3,484 | 3,384 | 2,011 | 8,879 |
| **Beef Processing** | | | | |
| Output | $4,749,179,512 | $863,254,898 | $337,728,261 | $5,950,162,671 |
| Value Added | $1,071,081,615 | $456,670,411 | $194,677,164 | $1,722,429,190 |
| Employment | 9,889 | 6,154 | 3,135 | 19,178 |
| **Total Beef Industry** | | | | |
| Output | $11,384,030,128 | $2,088,021,477 | $554,017,173 | $14,026,068,778 |
| Value Added | $2,842,053,993 | $1,058,046,532 | $319,398,248 | $4,219,498,773 |
| Employment | 13,373 | 9,538 | 5,146 | 28,057 |

[a]Direct employment represents full-time equivalent jobs