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Figure 1. Feedstock storage at an ethanol plant.

The Impact of Ethanol in Western Kansas

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The ethanol industry is one of the newest contributors to the economy of Western Kansas. The construction of the Western Plains Energy (WPE) ethanol plant was organized by a group of local individuals, and the plant is owned by Western Plains Energy, LLC. The plant, which began operating in 2004, is located 6 miles east of Oakley in Gove County. It produces approximately 48 million gallons of ethanol annually, using mostly local corn and grain sorghum (Table 1).

Table 1. Characteristics of the Western Plains Energy ethanol plant.

Location	Gove County
Ethanol produced	48 million gallons annually
Began construction	April 2003
Began operation	January 2004
Plant expansion complete	January 2005
Number of full-time employees	35

The ethanol plant has created jobs and boosted the local economy. However, there are concerns about using scarce water resources for ethanol production. In this study, the importance of ethanol production and its impact on water supplies are examined for a 40-county region in Western Kansas and Eastern Colorado. Counties in this region overlie the Ogallala Aquifer and extend from the northern to the southern border of Kansas and westward into Colorado (Fig. 2).

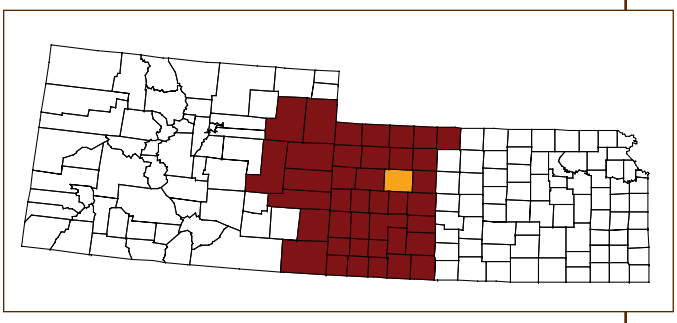

Figure 2. Study region (Gove County in orange).

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Figure 3. Inside of an ethanol plant.

The Ethanol Industry

In the United States, energy consumption continues to increase while domestic energy production has remained stable since about 1980. Oil is a very important component of the energy mix in the U.S., accounting for 37 percent of energy consumption. Almost 57 percent of the oil consumed is supplied by foreign imports (Energy Information Administration, 2009). Industrialization in China and India has increased worldwide demand for oil, sending oil prices skyrocketing. This causes great concern for consumers who feel the effect on gasoline prices at the pump.

Increasing the production of renewable fuels and energy from alternative sources is a way to reduce the demand for oil and other non-renewable fuels in the U.S. and our dependence on foreign oil. The production of bio-energy fuels such as ethanol has increased more than 550 percent since 2000 in response to new standards for renewable fuels. There are now ethanol plants in 29 states, and in 2009 an estimated 10.6 billion gallons of ethanol was produced from 189 biorefineries (Renewable Fuels Association, 2010) (Fig. 4).

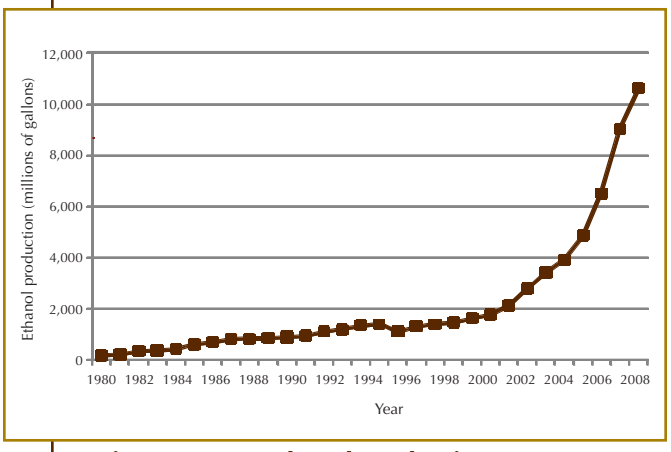

Figure 4. U.S. ethanol production, 1980-2009. (Source: Renewable Fuels Association, 2010)

Production Inputs

Many inputs are required at the Western Plains Energy plant, and the purchase of those inputs generates economic activity in the region. Inputs include feedstock, natural gas, electricity, denaturant, enzymes, yeasts, chemicals, water, labor, and waste management. The bulk of the plant's operating expense is the purchase of feedstock and energy, which account for approximately 80 percent of total operating costs.

Labor

The construction and expansion of the plant created 35 full-time jobs in Gove County that would not have existed without the plant. Managers, equipment operators, lab technicians, and office personnel keep the plant running smoothly 24 hours a day, 7 days a week.

Feedstock

The Western Plains Energy ethanol plant currently uses a mix of corn and sorghum feedstock in the production of ethanol. Feedstock varies depending on the season and commodity prices. In the winter, 80 percent of the grain used is corn and 20 percent is sorghum; in the summer, 85 percent is sorghum and 15 percent is corn. Most grain is acquired within a 50-mile radius of the plant. The plant processes about 8.8 million bushels of grain sorghum and 7.9 million bushels of corn per year into ethanol. Grain is transported to the plant by truck.

Water

The plant uses an estimated 3.3 gallons of water for every gallon of ethanol produced. To put this water use into perspective, it takes

approximately 2 to 2.5 gallons of water to produce 1 gallon of gasoline (Aden, 2007). Water is used primarily for cooling and to create mash by mixing milled feedstock and water in the ethanol production process. The plant uses about 160 million gallons of water per year or 444,000 gallons per day. The water comes from four irrigation wells to which the plant has rights. The ethanol plant uses water reclamation systems so that a portion of the total water required in the production process can be reused.

Ethanol production also uses water indirectly in the growth of sorghum feedstock. Most of the grain used comes from within the study region, but it is difficult to determine how much of the feedstock is irrigated.

Products and By-products

Ethanol

The primary product of the plant is 48,000,000 gallons of ethanol per year. The finished product is 200-proof ethanol. Pure ethanol cannot be used directly in vehicles as a motor fuel, but is blended with unleaded gasoline. Most gasoline pumps have a blend of regular unleaded gasoline with up to 10 percent ethanol. Another common blend is E85, which contains 85 percent ethanol and 15 percent unleaded gasoline that can be used in flexible-fuel vehicles. Most of the ethanol produced is transported by rail to Colorado and California.

Figure 5. Ethanol storage tanks at an ethanol plant.

A small portion of ethanol is sold to local buyers with 1,000-gallon tanks. The remainder is shipped by truck to Coffeyville, Kansas, or locations in Colorado.

Figure 6. Wet distillers grains, a by-product of ethanol production.

Distillers grains

The primary by-product of ethanol is approximately 188,000 tons of wet and dried distillers grains per year. Dried distillers grains account for 3 percent of the total or 6,000 tons, while wet distillers grains account for 97 percent or 182,000 tons. Distillers grains contain nutrients that make them a good feed for livestock. A small portion of the distillers grains are dried, which extends their shelf life and allows them to be transported longer distances. Wet distillers grains are sold to feedlots within a 100-mile radius of the plant, such as those in Hoxie and Scott City, Kansas. Some wet distillers grains are sold as far away as Garden City, Kansas. Distillers grains are transported by truck to their final destination.

Syrup

In the process of making ethanol, a liquid is separated from the mash during the distilling process. This liquid is then partially dehydrated into syrup. The syrup is added back to the distillers grains to give it a "sweet" flavor, which makes the roughage more palatable to livestock.

Distribution

Ethanol and by-products of ethanol are transported via truck and railway. The plant has more than 100 trucks coming in and out every day, either delivering grain sorghum or picking up ethanol or distillers grains. This has had a big impact on the local trucking companies. The railway has also seen an increase in volume with the shipment of ethanol from the plant. While the plant's impact on transportation is not accounted for in this study, it is very important to the regional economy.

Figure 7. Truck delivering feedstock to an ethanol plant.

Regional Economic Impacts

IMPLAN (IMpact analysis for PLANning), a widely known socioeconomic input-output model (Minnesota IMPLAN Group, 1999), was used to estimate the economic impact of the ethanol plant on Gove County and the western Kansas region. This model captures the backward-linked "ripple effects" on other economic sectors directly and indirectly related to ethanol production. IMPLAN uses comprehensive data sets compiled from a wide variety of sources, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, the U.S. Census Bureau, the U.S. Department of Agriculture, and the U.S. Geological Survey.

The location of ethanol plants in rural communities has had a positive impact on those local economies. Many small communities have struggled to survive as more people move into urban areas for employment. Ethanol plants have brought jobs and additional economic activity to some of these areas. Input-output modeling is a way to understand the links between elements of an economy and to estimate the impact of changes in the economy. These changes are referred to as direct, indirect and induced effects.

For example, an ethanol plant directly affects the natural gas industry because natural gas is used in the production process. The local natural gas company may then be able to purchase an additional work truck for its employees (indirect effect). Employees hired by the ethanol plant and natural gas company will spend a portion of their income at local businesses such as retail and grocery stores (induced effect), affecting an even larger portion of the economy. The result is an increase in total industry output, value added, and jobs created in the region. Industry output is the value of the total production of an economy or the total economic activity that occurs in a region. Value added is the income or wealth portion of industry output that includes employee compensation, proprietary income, other property income, and indirect business taxes. Employment is simply the number of jobs in an economy (Minnesota IMPLAN Group, 2004).

The construction of the 30-million-gallon Western Plains Energy ethanol plant in 2003 was a $41 million project. In 2005, the plant was expanded to a capacity of 40 million gallons at a cost of $20.5 million. Actual production of the plant exceeds the expanded capacity with 48 million gallons of ethanol annually. Approximately $473,076 of the expansion total cost involved purchases within Gove County. These purchases had a total impact of $534,867 on the county's economy, with value added accounting for $176,722. It was estimated that more than 300 employees were on site during the construction phase. Three jobs were generated in Gove County from the construction and expansion of the plant. Some construction purchases were made outside of Gove County

but within the defined region. As shown in the regional analysis, accounting for these purchases resulted in an increase of $3.8 million in industry output and $1.4 million in value added. Employment increased by 29 jobs in the region (Table 2).

Sales of ethanol and by-products from the Western Plains Energy ethanol plant were approximately $117.2 million in 2008. This had a total economic impact on Gove County of $119.8 million, with value added accounting for $13.4 million. In addition to the 35 people employed in full-time positions to operate the plant, another 16 jobs were created through indirect and induced effects for a total of 51 jobs in Gove County. The total economic impact to the region was $139.3 million, with value added accounting for $21.4 million. Within the region, 159 jobs were created (direct, indirect and induced effects) (Table 3). These impacts are expected to occur annually as long as the plant is in operation.

Table 2. Economic impacts of the construction (2003) and expansion (2005) of the Western Plains Energy ethanol plant.

Gove County				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$473,076	$30,210	$31,581	$534,867
Value added	$139,867	$17,365	$19,490	$176,722
Employment	3	0	0	3

Region				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$2,743,847	$549,572	$511,599	$3,805,018
Value added	$811,230	$312,095	$313,715	$1,437,040
Employment	16	6	7	29

Table 3. Economic impacts of the operation of the Western Plains Energy ethanol plant in 2008.

Gove County				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$117,213,720	$2,116,602	$455,330	$119,785,652
Value added	$12,104,186	$1,043,962	$277,902	$13,426,050
Employment	35	11	5	51

Region				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$117,213,720	$19,262,975	$2,792,619	$139,269,314
Value added	$12,104,186	$7,547,482	$1,701,483	$21,353,151
Employment	35	91	33	159

Socioeconomic impacts of alternative uses of water resources

In spite of the economic benefits, the water required for ethanol production has some people questioning whether locating ethanol plants in semi-arid regions is a good use of scarce water resources. Because it gets little rainfall, Western Kansas depends on the Ogallala Aquifer for irrigated crop production.

This study compared the socioeconomic impacts of the ethanol plant with the socioeconomic impacts of irrigated crop production when both enterprises use the same amount of water. The main irrigated crops grown in the region are alfalfa, corn, sorghum, soybeans and wheat. The acreages of these crops that would use 160 million gallons of water (equivalent to ethanol production) were estimated to be 310 acres of alfalfa, 327 acres of corn, 491 acres of sorghum, 392 acres of soybeans, or 589 acres of wheat (Kansas State University Department of Agricultural Economics, 2009). The results of this comparison are shown in Table 4.

The regional socioeconomic impacts of ethanol production are significantly higher than

Table 4. Comparative regional socioeconomic impacts of ethanol versus irrigated crop production with equivalent water use.*

Alternative use	Industry output	Value added
Ethanol (48 million gallons)	$139,269,314	$21,353,151
Alfalfa (310 acres)	$466,815	$256,833
Corn (327 acres)	$502,298	$245,171
Sorghum (491 acres)	$403,763	$192,343
Soybeans (392 acres)	$337,164	$161,247
Wheat (589 acres)	$379,464	$179,931

*Estimated impacts include direct, indirect and induced effects.

the impacts of irrigated crops requiring the same amount of water. Ethanol production in Western Kansas and Eastern Colorado created a total of 159 jobs for the region, while irrigated alfalfa production creates only four jobs, irrigated corn production six jobs, irrigated soybean production three jobs, and irrigated sorghum or wheat production five jobs. In terms of total industry output, ethanol production generates $139,269,314 in economic activity, whereas the economic activity generated from irrigated crop production is $466,815 for alfalfa, $502,298 for corn, $403,763 for sorghum, $337,164 for soybeans, and $379,464 for wheat. Value added, or the income portion of industry output, was $21,353,151 for ethanol versus much lower values of $256,833 for alfalfa, $245,171 for corn, $192,343 for sorghum, $161,247 for soybeans, and $179,931 for wheat.

The economic impacts estimated are from the farm-gate backward and any forward linkages to local gins, elevators, or further processing sectors tied to irrigated crop production are not captured in this study. Thus, the difference in economic impacts between ethanol production and irrigated crop production would not actually be as great when including forward linkages since most irrigated crops are processed further within the region, whereas ethanol is a finished product of which a portion is exported out of the region.

Summary and Conclusions

The contribution of the Western Plains Energy ethanol plant to the economy of Western Kansas is substantial. While construction expenditures were a one-time occurrence, the region will continue to benefit from the $139 million in economic activity the plant generates each year. The ethanol plant is located in a rural region where irrigated agricultural crop production dominates. Water comes from the Ogallala Aquifer, which is being depleted; this has raised concern over the use of scarce water resources to produce ethanol. However, the socioeconomic benefit of ethanol production versus irrigated crop production when both use the same amount of water indicates that ethanol production has a greater impact on the economy. For example, the ethanol plant generates 83 to 132 times more employment than irrigated crop production.

There are some benefits from ethanol production not accounted for in this study. First, although higher corn prices initially hurt confined livestock operations in the region, the by-products of ethanol production (dried and wet distillers grains and syrup) have provided relatively inexpensive feed substitutes. Second, the local transportation industry (trucking and rail) has benefitted significantly because

Figure 8. Railcars at an ethanol plant.

of increased demand for the transportation of feedstock to the ethanol plant and the transportation of ethanol and by-products to their final destinations.

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