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The Impact of Ethanol in the Southern High Plains of Texas

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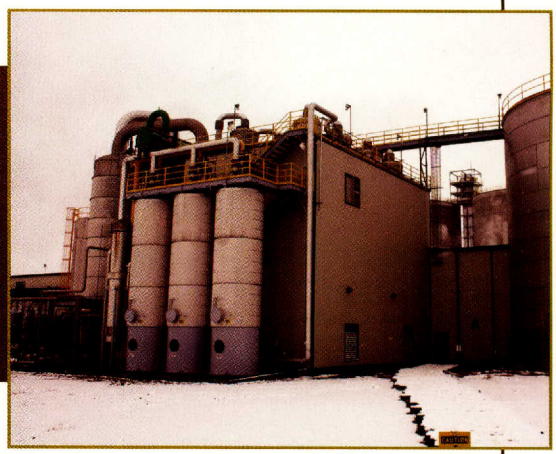

Figure 1. Levelland Hockley County Ethanol Plant.

The ethanol industry is one of the newest contributors to the economy of the Southern High Plains of Texas. The Levelland Hockley County Ethanol (LHCE) plant is a one-of-a-kind operation that was built in a cotton producing region of the Southern High Plains with the goal of using only grain sorghum as a feedstock. It was designed to use municipal wastewater for 90 percent of its water requirement. The plant is owned by Levelland Hockley County Ethanol, LLC, a private firm comprising more than 135 local farmers, business people, and others. Rex Stores Corporation of Dayton, Ohio, is the largest investor with 56 percent ownership. The plant, which has been in operation since 2008, was constructed on a 223-acre site 3 miles east of Levelland. It produces approximately 40 million gallons of ethanol annually, using mostly local grain sorghum (Table 1).

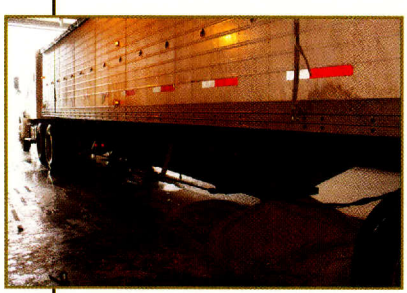

Figure 2. Truck unloading sorghum feedstock at the ethanol plant.

This 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 24-county region extending from the southern border of

Table 1. Characteristics of the Levelland Hockley County Ethanol plant.

Location	Hockley County
Ethanol produced	40 million gallons annually
Began construction	January 2007
Began operation	March 2008
Number of full-time employees	35

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Parmer, Castro, Swisher and Briscoe Counties westward into New Mexico and south to the southern border of Midland and Glasscock Counties (Fig. 3).

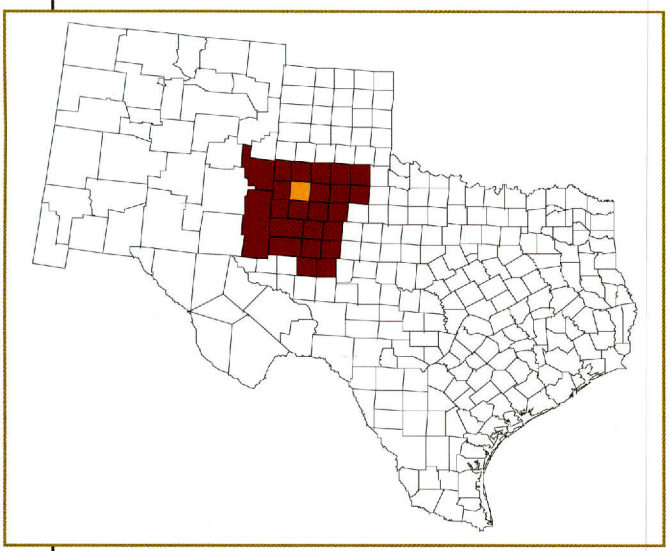

Figure 3. Study region (Hockley County in orange).

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).

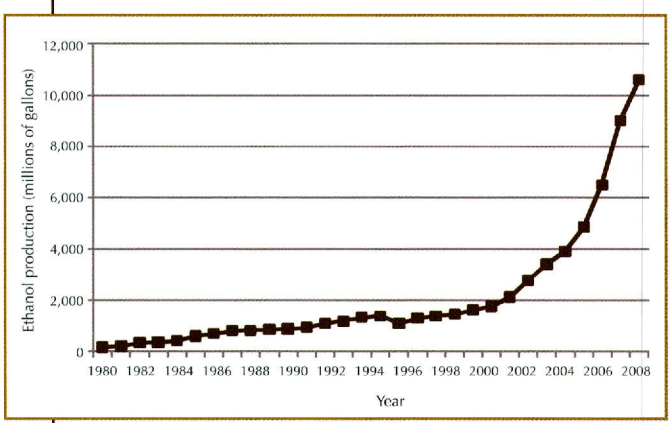

Figure 4. U.S. ethanol production, 1980-2009. (Source: Renewable Fuels Association, 2010)

Production Inputs

Many inputs are required at the LHCE plant, and the purchase of those inputs generates economic activity in the region. Inputs include grain sorghum, 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 88 percent of total operating costs.

Labor

The plant created 35 full-time jobs that would not have existed in this rural community 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 plant currently uses 100 percent sorghum feedstock, about 15 million bushels per year, in the production of ethanol. Sorghum is obtained from as far north as Amarillo, Texas, and as far south as 100 miles south of Lubbock, Texas. Most of the sorghum used by the plant is obtained from local sources within the study region. The plant contracts with local producers and elevators, which provides a stable local

market upon which sorghum producers can rely. It is transported by truck and rail to the ethanol plant, with transportation costs included in the contract price.

Water

The LHCE plant uses an estimated 2.7 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 sorghum and water in the ethanol production process. The plant uses about 108 million gallons of water per year or 300,000 gallons per day (Fig. 5).

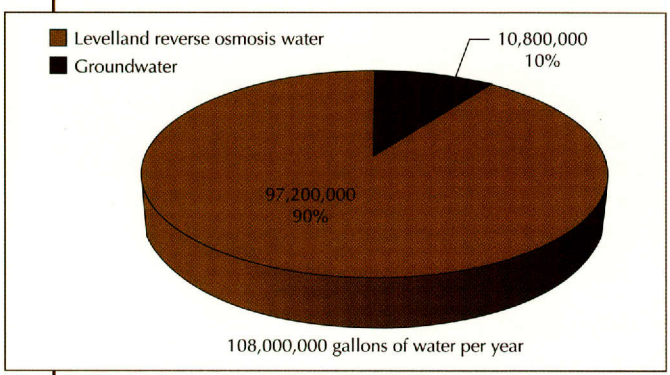

Figure 5. Annual water use of the Levelland Hockley County Ethanol plant.

One of the unique aspects of this ethanol plant is that it uses recycled wastewater from the city of Levelland that has been treated by reverse osmosis. The treated water is used in the boilers to provide steam to the plant and in the cooling tower. The wastewater is mixed with water from the Ogallala Aquifer because the treated water alone would not keep yeast alive during the production process. The two sources of water together give the plant approximately 300 gallons per minute (gpm). Reverse osmosis water accounts for 270 gpm or 90 percent of the water used in the production process, while groundwater accounts for the remaining 30 gpm or 10 percent. In addition to using recycled water, 63 percent of the total water requirement is reused in the production process.

Ethanol production also uses water indirectly in the growth of sorghum feedstock. Though most of the sorghum is grown within the study region, it is difficult to determine how much of the feedstock is irrigated. Neither is there enough data to determine how or whether the crop mix has changed in the region with the introduction of the ethanol plant. Sorghum was typically exported outside of the region before the establishment of the ethanol plant, and the plant essentially created a local market for the feedstock. It is likely that there has been little or no change in crop mix in the region, but rather a change in local use of the feedstock. As a result, not as much emphasis has been placed on the indirect water requirements of the ethanol plant. The region is known primarily for cotton production, and sorghum can be actively rotated with cotton or planted as a second crop behind failed cotton.

Products and By-products

Ethanol

The primary product of the plant is 40,000,000 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

Figure 6. Ethanol storage tanks at the Levelland Hockley County Ethanol plant.

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. Approximately 80 percent of the ethanol produced at the plant is transported by truck to nearby areas in Texas and New Mexico. Gasoline sold in the Texas cities of Amarillo, Lubbock and El Paso contains ethanol produced at the Hockley County plant. The remainder of the ethanol (20 percent) is transported by railway and sold to markets in other areas of Texas, California and Arizona.

Distillers grains

The primary by-product of ethanol is approximately 130,000 tons of wet and dried distillers grains per year. Dried distillers grains account for 40 percent of the total or 51,000 tons, while wet distillers grains account for 60 percent or 77,000 tons. Distillers grains contain nutrients that make them a good feed for livestock. They are dried (at a cost of $40 to $60 per ton) to extend their shelf life so they can be transported longer distances. Wet distillers grains are sold locally to dairies and feedlots in nearby areas such as Hereford, Texas, and Clovis, New Mexico. Dairies prefer sorghum distillers grains over corn distillers grains in many cases because they contain more protein. May et al. (2010) reported that wet sorghum distillers grains have a crude protein content of about 40 percent, while wet corn distillers grains have a crude protein content of about 34 percent.

Figure 7. Dried distillers grains, a by-product of ethanol production.

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. A portion of the syrup is added back to the distillers grains to give it a "sweet" flavor, which makes the roughage more palatable to livestock. The rest of the syrup, 7,800 tons, is sold separately and used as a feed additive.

Figure 8. Syrup, or condensed distillers solubles, a by-product of the ethanol distilling process.

Distribution

Ethanol and the by-products of ethanol are transported via truck and railway. The plant has approximately 300 trucks coming in and out every day either delivering grain sorghum or picking up ethanol or by-products. This has had a big impact on the local trucking industry, and even led to the formation of new trucking companies to meet the demand.

The plant has a direct link to the Burlington Northern Santa Fe (BNSF) railway via the West Texas and Lubbock Railway (WTLC). The construction of the ethanol plant helped to justify the rehabilitation of 14 miles of rail line to Levelland, a $4 million dollar project funded by WTLC. The ethanol plant has since added rail volume for WTLC with outbound shipments of ethanol and inbound shipments of grain sorghum. In December 2009, it was announced that an $8.6 million industrial rail park will be built in the town of Levelland, and WTLC is

completing 6 additional miles of rail line to the industrial park site. These projects would not have occurred without the construction of the LHCE plant. The impact of these future projects is not accounted for in this study, but they will surely benefit the regional economy.

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 Hockley County and the Southern High Plains 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

Figure 9. Equipment operator moving wet distillers grains.

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 LHCE plant was a $65 million project. Approximately $500,000 of this total was spent within Hockley County. These purchases had a total impact of $610,127 on the county's economy, with value added accounting for $209,228. More than 350 employees were on site during the construction phase. Three of those employees were from Hockley County and two additional jobs were created through indirect and induced effects, for a total employment impact of five jobs in Hockley County. Some construction purchases were made outside of Hockley County but within the defined region. As shown in the regional analysis, accounting for these purchases resulted in an increase of $4.8 million in industry output and almost $2.0 million in value added. Employment increased by 35 jobs in the region (Table 2).

Sales of ethanol and by-products from the LHCE plant were approximately $128.6 million in 2008. This had a total economic impact of $132.8 million in Hockley County, with value added accounting for $10.1 million. In

addition to the 35 people employed in full-time positions to operate the plant, another 27 jobs were created through indirect and induced effects for a total of 62 jobs. The total economic impact to the region as a whole was $155.6 million, with value added accounting for $21.7 million. Within the region, 169 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 of the Levelland Hockley County Ethanol plant in 2007.

Hockley County				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$500,000	$58,797	$51,330	$610,127
Value added	$143,505	$33,905	$31,818	$209,228
Employment	3	1	1	5

Region				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$2,900,000	$1,061,289	$849,328	$4,810,617
Value added	$832,330	$612,117	$518,764	$1,963,211

Table 3. Economic impacts of the operation of the Levelland Hockley County Ethanol plant in 2008.

Hockley County				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$128,596,000	$3,509,224	$698,108	$132,803,332
Value added	$7,690,107	$1,966,418	$431,692	$10,088,217
Employment	35	18	9	62

Region				
	Direct	**Indirect**	**Induced**	**Total**
Industry output	$128,596,000	$22,570,113	$4,438,324	$155,604,437
Value added	$7,690,107	$11,320,659	$2,708,341	$21,719,107
Employment	35	86	48	169

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, the Southern High Plains region depends on the Ogallala Aquifer for irrigated crop production. Irrigated crops account for about 96 percent of the total water use in the region (Llano Estacado Regional Water Planning Group, 2010).

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 corn, cotton, sorghum and wheat. The acres of these crops that would use 108 million gallons of water (equivalent to ethanol production) were estimated to be 199 acres of corn, 331 acres of cotton, 284 acres of sorghum, or 265 acres of wheat (Guerrero, 2010).

The socioeconomic impacts of ethanol production are significantly higher than the impacts of irrigated crop production when both use the same amount of water. Ethanol production creates 169 jobs in the region, while irrigated corn production creates only eight jobs, irrigated cotton production six jobs, and irrigated sorghum or wheat four jobs. In terms of total industry output, ethanol production generates $155,604,437 in economic activity, whereas the economic activity generated from irrigated crop production is $345,603 for corn, $425,549 for cotton, $177,587 for sorghum, and

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

Alternative use	Industry output	Value added
Ethanol (40 million gallons)	$155,604,437	$21,719,107
Corn (199 acres)	$345,603	$172,405
Cotton (331 acres)	$425,549	$171,504
Sorghum (284 acres)	$177,587	$87,153
Wheat (265 acres)	$151,479	$77,762

*Estimated impacts include direct, indirect and induced effects.

$151,479 for wheat. Value added, or the income portion of industry output, was $21,719,107 for ethanol versus much lower values of $172,405 for corn, $171,504 for cotton, $87,153 for sorghum, and $77,762 for wheat (Guerrero, 2010).

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.

Figure 10. Dryer to dry distillers grains, a by-product of ethanol production.

Summary and Conclusions

The contribution of the Levelland Hockley County Ethanol plant to the economy of the Southern High Plains of Texas is substantial. While construction expenditures were a one-time occurrence, the region will continue to benefit from the almost $156 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 greater impact on the economy. For example, the ethanol plant generates 21 to 42 times more employment than irrigated crop production.

There are some economic benefits from ethanol production not accounted for in this study. First, because of the demand for sorghum used in ethanol production, farmers can incorporate grain sorghum into their crop rotation planning rather than using grain sorghum primarily as a second crop behind failed cotton. This has created the opportunity for local farmers to become more diversified in their farming practices. It has also decreased problems with plant disease and improved the quality of cotton. Second, although higher corn prices initially hurt confined livestock operations in the region, the by-products of ethanol production (distillers grains and syrup) have provided relatively inexpensive feed substitutes. Finally, the transportation industry (locally owned trucking businesses and the West Texas and Lubbock Railway) has expanded significantly because of increased

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

References

Aden, A. 2007. Water Usage for Current and Future Ethanol Production. *Southwest Hydrology,* 6(5): 22,23. *http://www.swhydro.arizona.edu/archive/V6_N5/SWHVol6Issue5.pdf.*

Energy Information Administration. 2009. Annual Energy Review 2008. DOE/EIA-0384(2008). *http://www.eia.doe.gov/aer.*

Guerrero, B. 2010. Renewable Energy and Agriculture. Doctoral Dissertation, Texas Tech University, Lubbock, Texas.

Llano Estacado Regional Water Planning Group. 2010. Llano Estacado Regional Water Planning Area Initially Prepared Regional Water Plan. Prepared for the Texas Water Development Board with administration by the High Plains Underground Water Conservation District No. 1 with technical assistance by HDR Engineering, Inc. *http://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2010_IPP/RegionO/.*

May, M.L., J.C. DeClerck, M.J. Quinn, N. DiLorenzo, J. Leibovich, D.R. Smith, K.E. Hales, and M. L. Galyean. 2010. Corn or sorghum wet distillers grains with solubles in combination with steam-flaked corn: Feedlot cattle performance, carcass characteristics, and apparent total tract digestibility. *Journal of Animal Science* 88: 2433–2443.

Minnesota IMPLAN Group. 1999. *IMPLAN.* Stillwater, Minnesota.

Minnesota IMPLAN Group. 2004. *IMPLAN Professional Version 2.0; User's Guide; Analysis Guide; Data Guide.* 3rd ed.

Renewable Fuels Association. 2010. 2010 Ethanol Industry Outlook: Climate of Opportunity. *http://www.ethanolrfa.org/page/-/objects/pdf/outlook/RFAoutlook2010_fin.pdf?nocdn=1.*

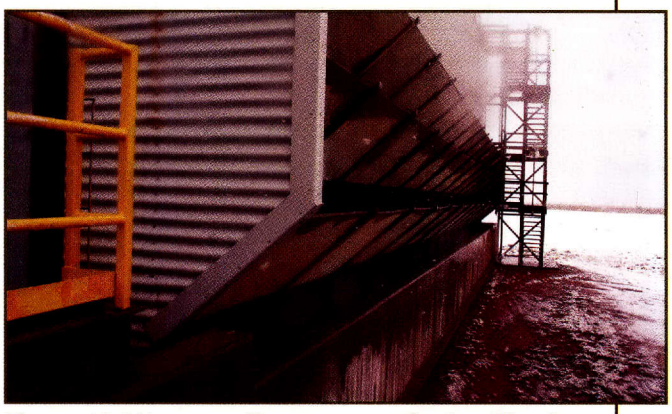

Figure 11. Water cooling tower at the Levelland Hockley County Ethanol plant.

Photos by Samantha Yates, Publications Specialist, Cotton Economics Research Institute, Texas Tech University.

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