ECONOMIC FEASIBILITY OF CONVERSION TO A LOWER ENERGY PRECISION APPLICATION IRRIGATION SYSTEM IN THE TEXAS HIGH PLAINS

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ABSTRACT

The objective of this study was to determine the farm level economic feasibility of converting a standard 1/4 mile center pivot low pressure sprinkler irrigation system to a low energy precision application (LEPA) irrigation system for corn production in the Texas High Plains. It was found that the irrgation system results in increased water use efficiency, which further results in increased corn yields. Thus, LEPA is a viable irrigation option to producers in the Texas High plains because the benefits from its use outweigh the costs.

Key Words: Economic Feasibility, Irrigation, LEPA

INTRODUCTION

The 31-county Texas High plains (THP) land resource area is located in the southern portion of the Great Plains Region of the United States. Due to average rainfall in the THP ranging from 10 to 20 inches per year, agricultural activities use supplementary irrigation. Most of the water used for irrigation of agricultural crops in the THP is drawn from the Ogallala Formation, a major underground aquifer covering 220,000 square miles and extending over parts of the states of Colorado,Kansas, Nebraska, New Mexico, Oklahoma, and Texas (High Plains Associates 1982).

Agricultural production increased in the THP as a result of the widespread use of irrigation practices in agriculture since the 1940's. However, declines in water tables ranging from 50 to 200 feet have occurred in the area because the Ogallala Formation is a closed basin with little or no recharge (Lee 1987; Mapp 1988).

Deeper water tables have induced rising water extraction costs resulting in significant changes in irrigated acres of the four major crops (corn, cotton, sorghum,and wheat) grown in the THP area. For example, combined irrigated acreage of those four crops declined from a high of 4.8 million acres in 1976 to 3.2 million acres in 1985, a reduction of over 33 percent. In particular, acres of corn and sorghum (about 90 percent of which were irrigated declined by 40 percent from 1975 to 1985 (Lansford, Harman, and Musick 1987). Those changes have occurred mostly from the lower profitability levels per unit of production when compared to other production areas in which irrigation is used extensively (Mapp 1988). Thus, because of declining water tables and increased energy costs, efficient utilization of irrigation inputs availble to producers in the THP area has become a key component in the profitability of enterprises and firm survival.

In this paper, the conversion of a center pivot low pressure sprinkler irrigation system to a low energy precision application (LEPA) irrigation system for corn production in the area is investigated. The conversion of a center pivot low pressure sprinkler system to a LEPA irrigation system is achieved by the attachment of flexible tubing which extends downward having a nozzle on the end of the low pressure system.

The primary objective of this study is to determine the farm level economic feasibility of that conversion. Although the adoption of a LEPA irrigation system could result in reduced consumption of water to obtain crop yields similar to those resulting from other irrigation systems, we assume that producers continue to use the same amount of water and consider the benefits of increased yields due to the LEPA system. Issues of contemporary social interest such as implications of adopting LEPA to conserve underground water resources for use by future generations are not addressed.

The Low Energy Precision Application (LEPA) Irrigation System

Irrigation could be considered to be the least efficient operation involved in the production process of irrigated agricultural crops (Lyle and Bordovsky 1981). Also, because irrigation activities are high consumers of energy, they are amoung the most expensive activities in the production process. The amount of energy used in irrigation depends on two factors: quantity of water pumped (gallons/minute) and depth from which water is extracted. Nearly two thirds of the irrigation systems in the THP are powered by the use of natural gas while the remainder are powered by electricity. Low water application efficiency and excess energy consumption impair profitability and thus, regional competitiveness in agricultural production (e.g., comparative advantage). However, these conditions may be beyond agricultural producers control, who rely on current irrigation system technologies available.

Precise control of water applications to the root zone of plants with surface irrigation methods are difficult due to variabiltiy in soil intake rates, length of run, slope, and many other factors (Lyle and Bordovsky 1981). Developments in irrigation system technologies after World War II evolved rapidly with the introduction of light weight steel and aluminum pipe. Center pivot, straight and solid set high pressure irrigation systems enabled agricultural producers to possess greater control over water application rates.

Gains in control of water applications were largely possible at the expense of greater levels of energy used to distribute water on croplands. Howevr, water application efficiency levels of sprinkler irrigation systems, can be impaired by climatological conditions. For example, Clark and Finley (1975) found that spray evaporation losses from solid set high pressure sprinklers ranged form 17 percent at wind speeds of 15 mph to 30 percent at wind speeds of 20 mph. The THP experiences occasional wind velocities higher than those reported by Clark and Finley (1975) during the growing season. Because center pivot high pressure sprinkler irrigation has been the most popular type of irrigation system used in the area, water application efficiency is impaired in the THP.

Low pressure sprinkler irrigation systems were developed in an attempt to alleviate some of the water application efficiency problems as well as the high levels of energy required to operate high pressure sprinkler irrigation systems. These low pressure systems were of the same basic design as the high pressure systems. Water application efficiency levels of 80 to 85 percent can be attained with low pressure sprinkler irrigation systems. Because water pressure is decreased over 50 percent with these low pressure systems, energy savings are attained when compared to the energy requirements of the high pressure systems.

Recent technological advances in irrigation systems have provided agricultural producers with a new system referred to as Low Energy Precision Application or LEPA. Although this irrigation system is still in experimental stages, it has already proven to be efficient when compared to other low pressure irrigation systems (Lyle and Bordovsky 1982). This system can be added onto the existing low pressure system by adding flexible tubing to the pipe drops on the low pressure system. The tubing extends down to approximately twelve to sixteen inches above the ground. Although the tubes have a nozzle on the end similar to the nozzles in other low pressure systems, LEPA nozzles spray water in a more horizontal

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manner (for details on LEPA specifications see Lyle and Bordovsky 1981; Stoecker and Lloyd 1984).

One of the two major advantages of LEPA over other low pressure irrigation systems is that evaporation losses are cut resulting in water application efficiency in excess of 98 percent. The other advantage is that LEPA requires only five to ten pounds of end pressure, whereas other low pressure irrigation systems require fifteen to twenty pounds.

Conversion of a Center Pivot Low Pressure Sprinkler System to a Low Energy Precision Application Irrigation System

Two partial budgets were used along with a cost analysis to evaluate the conversion of a standard 1/4 mile center pivot low pressure sprinkler irrigation system to a LEPA irrigation system for corn production. The study area was Dallam county bordering New Mexico and Oklahoma in the north-west corner of the Texas panhandle. The budgets included fuel costs for both centerpivot low pressure sprinkler and LEPA irrigation systems. The budget for LEPA also included additional labor and maintenance costs associated with the operation of the 1/4 mile radius irrigation system. Because levels of other variable inputs in corn production for both irrigation systems were assumed to be the same, costs such as fertilizer, labor, insecticide, herbicide, and harvesting were not included in those budgets. Also, LEPA evaporation loss reduction information provided by the Texas Agricultural Experiment Station in Bushland, Texas, was considered in the economic evaluation of the system conversion (Devin 1977 and New 1987).

County wide per acre average fuel cost under both low pressure and LEPA irrigation systems for corn was estimated through primary data collected from personal records of several farmers in Dallam county (Crossland 1988, Moore 1988, and Snead 1988). Other variables such as per acre average amounts of water applied and corn yields were collected from farmers' records and used in the budgets. Conversion costs of LEPA were obtained from Peeples Irrigation in Dalhart, Texas. The total cost of that conversion for a standard 1/4 mile center pivot sprinkler system is $7,082.53 (Table 1).

Table 1. Itemized Conversion Costs of a Standard 1/4 mile Pivot Low Pressure Irrigation System to LEPA, Dallam County, Texas, 1988.

Item	Cost
260 Gooseneck pipes	$ 585.00
260 3'drops	756.60
260 Steel Collars	192.40
260 PVC collars	231.40
2080 Feet LEPA hose	1,352.00
520 LEPA hose clamps	94.64
520 3/4" H.B. x3/4" M.P.T.	169.00
130 Low flow regulators	633.75
130 Medium flow regulators	456.30
520 Stainless steel ties	60.84
260 Lepabird sprikler heads	1,250.60
Labor to install LEPA	1,300.00
TOTAL CONVERSION COST	$ 7,082.53

Source: D. Peeples, Peeples Irrigation, Dalhart, Texas. 1988.

The annual irrigation fuel cost for operating the 1/4 mile radius (125.66 acres) low pressure sprinkler irrigation system for corn production, assuming 26 inches of water application over the growing season was $6,844.57. Coupling the annual irrigation fuel cost of $6844.57 with the additional annual labor and maintenance costs of $40.00 and $197.24, respectively, for the 1/4 mile radius LEPA system, and assuming the application of 26 inches of water, the resulting cost of operation for the LEPA irrigation system is $7,081.81. This is equivalent to $54.46 per acre, or $2.09 per acre inch of water applied. The associated per acre average yield of corn was 191 bushels.

The primary difference between the LEPA and other irrigation systems is that the LEPA system prevents water evaporation which further results in increased corn yields. Assuming an average wind speed of 13.65 mph and an average temperature of 90 degrees, it was found that water application efficiency can be increased from an average of 74.02 percent under the low pressure sprinkler irrigation system to 98 percent under the LEPA irrigation system. This results in an increase in corn yields of 20 bushels per acre (Devin 1977; New 1987).

Assuming the 1987-88 corn price for Dallam county, this increase in corn yield provides an additonal $68.80 per acre for an increase in annual total gross revenue to land, risk, overhead and management of $8,645.41 over the low pressure sprinkler irrigation system. Adjusting this for the additional LEPA labor and maintenance operation costs of $237.24 results in a total gross return increase of $8,408.17 for LEPA when compared to the low pressure sprinkler irrigation system. Table 2 is provided to assist in the understanding of the cost comparision between systems. The cost of other variable inputs of production must be subtracted from the gross revenue figures above to estimate the "profit" above variable cost for corn production in the 1/4 mile radius area.

Corn prices will not always remain at the 1987-88 values and output price variability must be considered by agricultural producers in their decision to convert their low pressure sprinkler systems to LEPA. Alternative valuations of the additional annual gross revenue generated by the adoption of the LEPA irrigation system under alternative corn prices are illustrated in Figure 1. This figure illustrates that as the corn price increases the additional annual gross revenue generated by the adoption of LEPA also increases.

Given the associated conversion costs and the increase in corn yields due to LEPA, it can be found that a minimum corn price of $2.82 (cost of LEPA, $7,082.53, divided by total area benefiting from LEPA, 125.66 acres, then that ratio divided by additional corn yield, 20 bushels) will generate enough additional gross income in one year to pay for the irrigation system conversion. However, agricultural producers may not want to invest that much money in a single year. For this reason it is useful to discuss financing alternatives available to producers from which they could choose.

Table 2. Partial Budgets Comparing the Low Pressure to the LEPA System

System	Yield	Operating Cost(OC)	Total Gross Revenue(TGR)	TGR-OC	Change in Revenue
Low Pressure	191	$6,844.57	$82,563.64*	$75,719.07	
LEPA	211	$7,081.81	$91,209.05	$84,127.24	$8,408.17

*Assumes $3.44 as the 1987-88 average corn price. Therefore, TGR for the low pressure system is the product of number of acres (125,66), yield (191), and crop price (3.44).

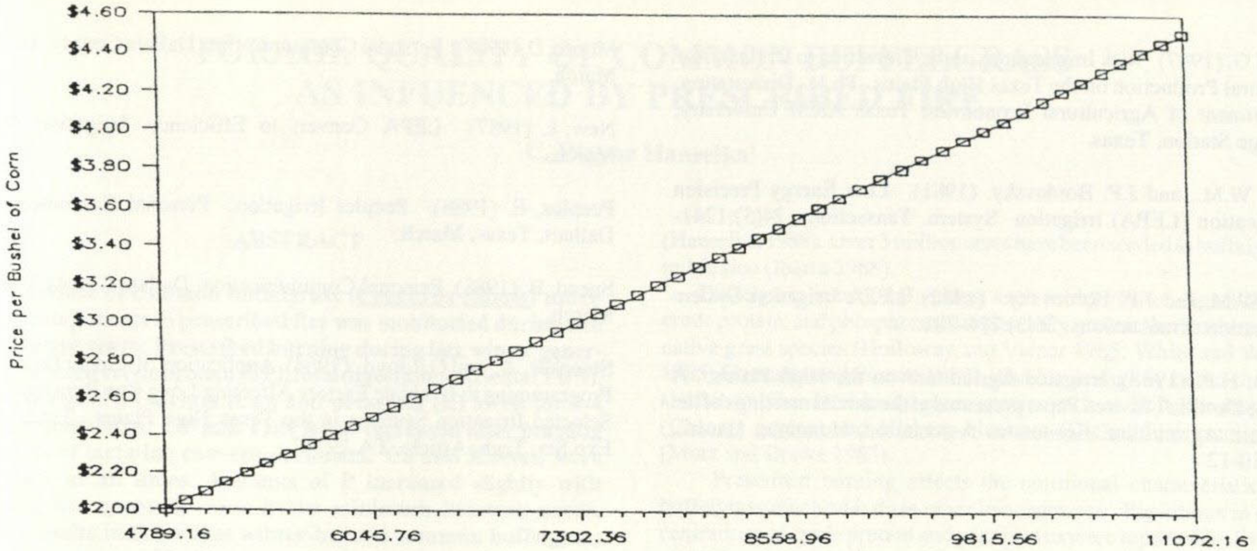

Figure 1. Annual Total Gross Returns Increases Across Alternative Corn Prices Due to LEPA's Increased Water Efficiency in Corn Production for a 1/4 mile Circle, Dallam County, Texas.

If an agricultural producer can only afford to invest ten percent of the $7082.53 cost required for the conversion of the irrigation system, he/she would need to borrow ninety percent of the cost, or $6374.28. Figure 2 illustrates alternative scenarios for repayment of that loan presenting annuity payments which depend on the length of the loan (from one to eight years) and the interest rate being used (from six to twenty percent). Thus, for a given interest rate on the loan, as the length of time of the loan increases the level of the annuity payment decreases. Conversely, for a given time period or length of the loan as the interest on the loan increases the level of the annuity payment increases. The loan repayment scenarios assume a ten percent down payment. Therefore, in determiming the most appropriate purchase plan, agricultural producers should consider: (1) how much he/she is willing to pay as a down payment; (2) what levels of interest rate he/she can obtain for the loan; and (3) what are his/her time preferences with respect to the length of the loan.

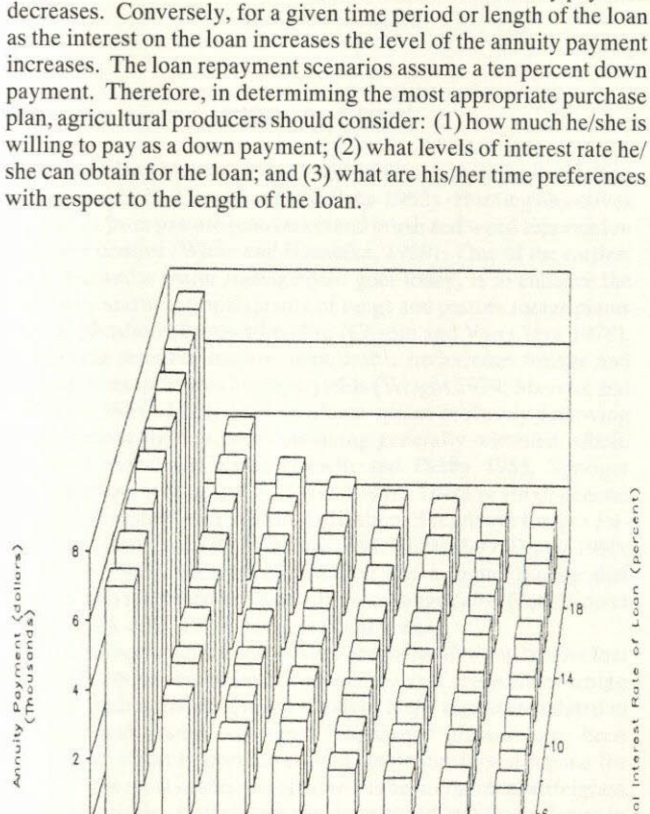

Figure 2. Annuity Payment Scenarios of the $6,374.28 Loan for the Conversion of the Irrigation System According to Alternative Lengths of the Loan and Interest Rates.

CONCLUDING REMARKS

The primary objective of this study was to determine the farm level economic feasibility of converting a standard 1/4 mile center pivot low pressure sprinkler irrigation system to a LEPA irrigation system for corn production in the THP. Enterprise budgets were developed for both irrigation systems. Considering the costs involved in the conversion, it was found that because of increased water application efficiency obtained with the LEPA irrigation system resulting in increased corn yields, the irrigation system conversion is economically feasible because associated increases in annual gross revenues would be more than sufficient to cover conversion costs. Although some drawbacks are associated with the use of LEPA, such as increased awareness of row spacing, increased maintenance costs, and labor requirements when compared to other irrigation systems, LEPA is a viable option to farmers in the THP because the benefits from its use outweigh the costs.

There are few LEPA systems currently in use. Widespread adoption of LEPA in the THP would add to agricultural water efficiency, resulting in a more rational utilization of the underground water resources available not only to agricultural producers, but to the remainder of users in the area as well.

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