NET RETURNS FOR GRAIN SORGHUM AND CORN UNDER

ALTERNATIVE IRRIGATION SYSTEMS IN WESTERN KANSAS*

by

Jeffery R. Williams, Richard V. Llewelyn, Matthew S. Reed,

Freddie R. Lamm, and Daniel R. DeLano**

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**Professor, Research Associate, former Graduate Research Assistant, Department of Agricultural Economics, Research Agricultural Engineer, Northwest Research-Extension Center and former Graduate Research Assistant, Department of Agricultural Economics, Kansas State University.

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ABSTRACT

This study evaluates seven irrigation systems for use in production of grain sorghum and corn. These systems are medium pressure center-pivot (MPCP), low pressure center-pivot (LPCP), low drift nozzle center-pivot (LDN), low energy precision application center-pivot (LEPA), furrow flood (FF), surge flood (SF), and subsurface drip (SD). After-tax net present value estimates from investing in and using each system over a 10-year period to produce grain sorghum and corn are compared. The surge flood system, has the highest net returns under typical conditions for irrigation of both grain sorghum and corn. The furrow flood system generates the next highest net returns for both crops, followed by the subsurface drip system. The medium pressure center-pivot system is the least profitable for both crops. Of the center-pivot systems, the low drift nozzle system has the highest net return, but is followed very closely by the low energy precision application system. The results of the sensitivity analysis indicate that the net return estimates and ranking of the subsurface drip system are very sensitive to the yield response to irrigation. Higher than average crop prices also have a substantial impact on the ranking of this system. The original investment cost is also an important determinant of its net return.

INTRODUCTION

Many western Kansas irrigators are faced with the decision whether to invest in more efficient water distribution systems with greater application and fuel efficiencies or to remain with their existing systems. This dilemma has become commonplace as the majority of irrigators in the Ogallala aquifer area find themselves faced with a declining water supply.

Several options are available to producers to partially abate the potential profit loss from declining water availability. As noted by Kromm and White (1990), these options can be classified as either field practices, management strategies, or system modifications. Field practices would include, but are not limited to, a shift to conservation tillage, alternate furrow irrigation, and chiseling compacted soils. Management strategies include scheduling irrigations based on either soil water need or crop water use, checking and improving pumping plant efficiency, and planting drought-tolerant crops. System modifications include installing surge valves on existing furrow systems, installing a center-pivot, or improving the application efficiency of an existing center-pivot by installing low pressure heads on drop tubes. Kromm and White (1990) found that nearly 35% of irrigators in the High Plains have opted to employ some type of system modification.

Objectives

The primary objective of this study is to compare the economic potential of several irrigation distribution systems under conditions typical of western Kansas. The analysis assesses the costs and returns for each distribution system for the irrigation of continuous grain sorghum and corn.

The specific objectives are as follows:

(1) Calculate the after-tax net present value of returns for each system and identify the most economical systems.

(2) Estimate the break-even yield required to equate the annual after-tax net revenues between the most economical system and the alternative systems to determine sensitivity to yield changes.

(3) Perform sensitivity analysis on the critical variables in the cash flow analysis to determine how the economic analysis changes for each system as conditions vary from the typical.

PROCEDURES

An after-tax net present value analysis of cash flows was used to assess the relative economic feasibility of seven irrigation systems for use on continuous grain sorghum and corn in western Kansas. The existing distribution system was assumed to be in need of replacement. The system types and the abbreviations used to identify the systems examined in this report are listed below.

(1) MPCP - Medium pressure center-pivot.

(2) LPCP - Low pressure center-pivot.

(3) LDN - Low drift nozzle center-pivot.

(4) LEPA - Low energy precision application center-pivot.

(5) FF - Furrow flood.

(6) SF - Surge flood.

(7) SD - Subsurface drip.

Net present value (NPV) analysis can be used to evaluate the economic worth of investments. In this case, the investment is an irrigation system. This method takes into consideration the time value of cash flows and the timing of expenditures and returns over a given investment life and then summarizes these costs and returns into a current dollar value. When the investment has returns over more than one year and also has income tax implications, NPV analysis is superior to an average annual budget comparison. The NPV of the investment can be thought of as the dollars earned on the investment after paying all costs. Annualization of the NPV provides an average annual estimate of net return. In this study, this represents a return to land and management.

SYSTEM DESCRIPTIONS AND INVESTMENT REQUIREMENTS

We assumed that each of the irrigation systems would be installed on a square quarter section where the terrain and soil type would not preclude the feasibility of any of the systems. Additionally, the study assumes that the upper corner of the field already contains a well that is fully depreciated, but not in need of replacement during the time period of the study. For each of the center-pivot systems, the nonirrigated corners of the field are planted to dryland wheat-fallow, and returns for this crop are included in the analysis.

Medium Pressure Center-Pivot

The MPCP system utilizes 60 impact sprinklers mounted on top of the lateral. These sprinklers have a 25o trajectory and are designed to operate at a nozzle pressure of 55 psi, resulting in a wetted diameter of 110 feet (DeBoer, Beck, and Bender, 1992). The pressure at the pump is approximately 75 psi. The application efficiency is assumed to be 80%, which is most likely at the high end of the range. The gross application depth per cycle for the MPCP is assumed to be 1.5 inches/acre, which translates to a net application of 1.2 inches/cycle. We assumed that the MPCP will irrigate 126 crop acres. Because of this system's high operating pressure, two stages must be added to the existing pump. The total initial capital outlay required to purchase and install this system is $64,765 (Table 1). This value includes the cost of the basic pivot system ($31,570), as well as costs of the sprinkler package, pumping plant, chemigation unit, and underground pipe and electrical cable to the center of the field. The sprinkler heads are replaced every 8 years.

Low Pressure Center-Pivot

The LPCP system consists of 70 impact sprinklers mounted on top of the lateral. These sprinklers have a 6o trajectory and are designed to operate at a nozzle pressure of 20 psi. This will require 30 psi at the outer end of the lateral and approximately 40 psi at the pump (Rogers, 1993). These sprinklers have a wetted diameter of 75 feet (DeBoer et al., 1992) The application depth/cycle is assumed to be 1.25 inches/acre. The smaller wetted diameter of the LPCP relative to the MPCP necessitates that the application depth be reduced (Skaggs, Miller, and Brooks, 1983). The application efficiency is assumed to be 85%, and we assumed that the system will irrigate 126 acres. One stage must be added to the existing pump for the LPCP system. The total initial investment required for this system is $61,054 (Table 1).

LDN/LEPA Center-Pivots

The LDN system and the LEPA system are discussed jointly because of their similar characteristics. The nozzles used on these systems are designed to operate in-canopy and are spaced 60 inches apart on the lateral with 245 nozzles per system (Spurgeon and Tomiseck, 1993). They are mounted to the lateral on drop tubes and are suspended 18 to 24 inches above the ground. This results in a significant reduction in wind drift loss of water and reduces canopy evaporation loss.

The LDN nozzle sprays a stream of water onto a pad, which dispenses it into smaller streams that break up into water droplets. This nozzle is designed to operate at 6 psi; pressure regulators are mounted before each nozzle to maintain the nozzle pressure at this delicate level. The pressure at the end of the lateral must be near 9 psi, which requires a pressure of 18 psi at the pump (Rogers, 1993).

The LEPA nozzles are very similar to the LDN nozzles except that they are enclosed in a shroud that allows for both a flat spray mode identical to the LDN spray pattern and a bubble mode, which is used very rarely in Kansas. The LDN nozzle, like the LEPA nozzles in the flat spray mode, have a wetted diameter of 20 feet (Spurgeon, 1994). Each of these systems can irrigate 126 crop acres.

Although these systems decrease evaporation losses, they increase the application intensity, which significantly increases the potential for runoff (Spurgeon and Makens, 1991). However, by reducing the depth applied per cycle and utilizing reservoir tillage, the application efficiency can be expected to be 90%. Overall irrigation efficiency remains high as long as the soil surface storage is fairly high and the field slope is relatively low. This analysis assumes an application depth per cycle of 1.0 inch/acre.

The initial investment estimates for the LDN and LEPA systems include the purchase of a specialized implement for the reservoir tillage operation. This additional implement mounts behind a cultivator shank and is designed to implant small basins in the furrow to retain runoff. A nine-row reservoir tillage tool generally is pulled behind an eight-row cultivator. That tool requires an investment of $5,850. The portion of this investment charged to the single 126-acre circle is $2,296. The total initial capital outlays are $66,621 for the LDN system and $67,909 for the LEPA system (Table 1).

Conventional Furrow Flood System

The FF system irrigates 158 crop acres with an application efficiency of 65%. The low application efficiency is due to nonuniform water distribution, resulting in deep percolation at the top of the field. The discharge pressure is very low and requires a pressure of only 5 psi at the pump (Rogers, 1993). The average depth applied per cycle is assumed to be 4 inches. Gate socks are replaced after 5 years of use. The FF system requires an initial investment of $37,061 (Table 1). This does not include any cost of land leveling, if it is required.

Surge Flood System

The application efficiency of the FF system may be improved with the SF system, which consists of the addition of four surge valves at an initial investment of $6,492 and some additional 8-inch pipe that costs $1,758. A surge valve causes an intermittent flow of water through the furrows. This surge system has the potential of increasing the application efficiency of the FF system by reducing tailwater volume and reducing deep percolation at the top of the furrows, which is a particular problem with the first irrigation after cultivation. The SF system is expected to have an application efficiency of 75%. All other operating characteristics are identical to those for the FF system. The initial investment required for the SF system is $46,301 (Table 1).

Subsurface Drip System

The SD system is designed to operate at a pressure of 10 psi in the laterals, which will require 20 psi at the pump (Rogers, 1993). The laterals are optimally spaced 60 inches apart (Lamm, Stone, and Manges, 1992). The system irrigates 158 crop acres (Manges, 1993). With proper management, the system is expected to achieve 95% application efficiency. The pressure gauges are replaced in the fifth year. The total initial capital outlay required to purchase and install this system is $107,555 (Table 1).

Pumping Plant Investment Cost

Initial investment costs for each system are provided in Table 1. These include the cost of the pumping plant required for each system. The initial investment is a function of the required brake horsepower (BHP) for each system's pumping plant. The initial investment is based on an industrial duty natural gas engine of the required rated horsepower, a rebuilt generator if applicable, and a geardrive to transfer power to the pump for each system.

The cost to overhaul and reset an existing pump that has three 12-inch bowls is included and estimated to be $2,375 plus another $500 per stage, if the new system requires additional stages. The overhauled pump is assumed to produce 89 feet of head per stage at 800 to 900 gpm. The overhauled pump will be 78% efficient when properly installed; this is approximately 90% of the original efficiency claimed by the manufacturer (Redmond, 1994).

ESTIMATION OF ANNUAL CASH FLOWS

The operating costs and returns are influenced by several factors. Table 1 reports some of the general economic and technical values used in the analysis, including wage rate, marginal tax rate, and interest rate.

The operating costs considered in this analysis are fuel costs, lubrication costs, distribution system maintenance costs, pumping unit maintenance costs, irrigation operation labor costs, and costs of performing field operations specific to the particular crop.

The annual cash flows include insurance costs, depreciation expenses that are deductible for purposes of estimating after-tax expenses, and gross crop returns. The terminal value of the original investment influences the cash flows. Salvage values of the major components are based on estimates supplied by irrigation equipment dealers in western Kansas. These estimates are increased by a 3% percent annual inflation rate for all salvageable components with useful lives of 10 years or beyond. An adjustment was made to account for the value of newer system components replaced prior to year 10. All components are not salvageable. The after-tax salvage values range from 9% for the SD system to 45% for the LEPA system.

Yields were estimated by entering an irrigation schedule, inches applied per application, and application efficiency in a yield simulator developed by Stone et al. (1995). The simulator assumes 16.4 inches of annual rainfall. Crop yield is determined in the model by evapotranspiration (ET) and available soil water. The program is based on long-term weather, soil, and crop yield-water use data from Tribune, Kansas.

Simulated yields were obtained by applying the available water in an economically optimal schedule given the depth per application feasible for each system and the time required for each irrigation event. Irrigation events were scheduled in an attempt to fully satisfy crop water requirements during the critical crop development stages. Priority was given to meeting the crop water needs during head emergence for sorghum and silking for corn. For corn, the critical growth stage is silking, which occurs on July 24, and for sorghum, the critical stage is head emergence, occurring on August 3. This process was continued until the economic return from irrigation of the crop was maximized or the available irrigation water was exhausted by a maximum property right of 24 acre inches per year or the limiting well capacity and time interval during the season in which additional irrigation events could potentially enhance crop yields. Determination of the optimum economic yield takes into account the rainfall and soil moisture information and delays or eliminates irrigation events as historical weather conditions allowed.

Economically optimal water amounts and yields are determined initially without consideration of rainfall events. Once this was done for each system and each crop, yields were estimated based on the scheduling process defined above, and then the results were compared with the initial results. If the net return of the new yield obtained from eliminating irrigations was higher than before, this value was used. The irrigation schedules used in this study are reported in Tables 2a and 2b. These schedules are based on application efficiencies, application depths, acreages reported, and a predetermined well capacity limit of 800 gallons per minute. The flow rate is based on 1991 data from the Kansas State Board of Agriculture, Division of Water Resources (Kansas Board of Agriculture, 1993). In summary, water was applied according to schedules that would maximize the net return to irrigation of the crop given the amount of water available per season (24 inches/acre) and the time constraints for each irrigation.

The net irrigation inches per season varies across distribution systems because of the differing amount of gross inches that can be applied optimally during the season and the application efficiency of the irrigation system. Therefore, crop yield estimates for those systems with higher application efficiencies are higher than those for systems with lower efficiencies but have the same gross application. For example, the SF system has higher yields than the FF system, despite having the same gross application. Tables 2a and 2b report the net irrigation inches applied per season under each system and the resulting yields for the crops used in the model to calculate the value of the crop production.

The crop prices used to estimate the gross revenue with the estimated yields are $2.10/bu. for grain sorghum and 2.22/bu. for corn. These prices were obtained from the

Food and Agriculture Policy Research Institute and represent 5-year average price projections for 1995/96 to 1999/2000 (FAPRI, 1995). For the center-pivot systems, the net crop returns of producing dryland fallow wheat on the corners are included as well.

RESULTS

The SF system had the highest net return for grain sorghum (Table 3). The second and third highest net returns for grain sorghum were from the FF and LDN systems. The lowest estimate was for the MPCP system. For the corn crop, the SF system gave the highest returns. The system was followed very closely by the FF system. Once again, the MPCP system had the lowest ranking. Of the center- pivot systems, the highest net return for both grain sorghum and corn production was achieved by the LDN system. Table 3 also reports each of the corresponding annuity values per acre (based on 160 acres) under the initial analysis conditions. The annuity values are the equal annual payments equivalent to the values of the discounted cash flows over the 10-year planning horizon. They can be interpreted as annual average net returns.

The present values of net return estimates also were split into their major components: (1) the after-tax present value of crop production, (2) crop production costs excluding irrigation, (3) the after-tax present value of the irrigation system ownership costs, and (4) the after-tax present value of the irrigation system operating costs. This allows a more detailed explanation of the costs and returns. Table 4 provides a breakdown of the net return estimates per net acre-inch for each system into each of the major components of cash flows considered in this analysis. After-tax operating costs per net acre-inch of water pumped are reported in Table 5.

The SF system had the highest return for irrigation of both corn and grain sorghum. The after-tax present value of the ownership cash flows of ($31,108) makes this one of the least expensive systems to acquire. It also had relatively low maintenance costs. Its low operating pressure, low water horsepower requirement, and 75% application efficiency result in relatively low fuel and lubrication costs per net acre-inch. The surge technology allowed this system to achieve the lowest operating cost per net-inch pumped for grain sorghum and next to lowest for corn (Table 5). Although the SF system had the next to the lowest yields for both crops, the relatively large number of acres irrigated and the low ownership and operation costs resulted in the highest net value.

The FF system had the second highest net return. It had many characteristics similar to the SF system except that its operating costs are higher and yields are lower because the application efficiency is less.

The SD system had the sixth highest net return of all systems for both crops. This system had the highest after-tax present value of ownership cash flows ($84,139), primarily because of its high initial investment requirement. It had the next to the lowest operating costs per net acre-inch pumped of all systems for corn and the second lowest cost for grain sorghum (Table 5). It also had the highest after-tax present value of annual crop production for both crops (Table 4). The high application efficiency, assumed to be 95%, allowed this system to obtain high yields at low operating costs.

The MPCP system had the lowest net return ranking for both crops (Table 3). The high operating pressure and assumed application efficiency of only 80% for this system resulted in the highest operating cost per net acre-inch of water. (Table 5).

The net return estimates do not indicate any incentive to use the LEPA system rather than the LDN system (Table 4). These systems have been assumed to have similar operating characteristics when used in the geographic region under consideration. Therefore, the present values of all cash flows, except those of the ownership cash flows and distribution system maintenance, associated with these systems will be equal under all conditions. The present values of the ownership cash flows and system maintenance costs differ only because of the lower investment requirement for LDN nozzles relative to LEPA nozzles. Therefore, the net return rankings of these two systems will always show the LDN system to be economically superior.

Table 6 indicates the percent that each of the cash flow components contributes to the total cash flows and the percent that each operating cost contributes to total operating costs. The percentage weight of a particular component provides a means to compare the importance of each cash flow component to the net return estimate for each system. The values in Table 6 indicate that the after-tax present value of crop production was of most importance to the net return estimates. Yields resulting from each system are important components of the cash flows. The results also indicate that the after-tax present values of the ownership and operating cash flows had a greater influence on the net return estimates for the system when grain sorghum was the irrigated crop.

Fuel costs make up the largest percentage of operating cost expenditures. Distribution system maintenance was the second highest percentage expenditure of the operating costs for all systems, with the exception of the FF and SF systems. Labor made up the second largest percentage of expenditures for these systems. Pumping plant maintenance costs made up the next largest percentage of operating costs for the remaining systems.

SENSITIVITY ANALYSIS

Additional sensitivity analysis was conducted on key components of the model in order to determine how the alternative systems compared under various conditions. Sensitivity analysis indicated that the net returns are more sensitive to the initial investment costs, yields, and prices received for crops than to the other parameters. This result is similar to the results achieved by Boggess and Amerling (1983) and Bosch, Taylor, and Ross (1988).

Yield Sensitivity

The initial yields used in the analysis are the result of applying irrigation water in an optimal fashion. The yield estimates derived from the yield simulator used in this analysis are based on crop performance test data from the Southwest Research-Extension Center at Tribune, Kansas. The goal of the performance test plot is to determine a crop variety's yield potential and not to maximize profits. Therefore, the estimated yields, which are of extreme importance to the validity of the results of this study, may be somewhat high. Application rates of pesticides and fertilizers, as well as seeding rates, were held constant across all irrigation systems; these cash flows were not considered incremental. In reality, they may be somewhat dependent on the system type and the net application level and, therefore, influence yield and costs. However, the incremental portion of these cash outflows is likely to be too small to significantly impact the net return estimates and rankings.

Kansas Farm Management Association yield data from western Kansas irrigated farms show a considerable amount of variation. In the 1990 crop year, rainfall was very close to the average of 16.4 inches assumed in the yield simulator. Yields for grain sorghum and corn produced under irrigation in southwest Kansas in 1990 averaged 91 bushels per acre and 160 bushels per acre, respectively. The standard deviations were 31 bushels per acre and 35 bushels per acre, respectively. This indicates that approximately 83% of the farms had yields less than 122 bushels per acre for grain sorghum and less than 195 bushels per acre for corn. Northwest Kansas yields average about 8% lower for grain sorghum and 6% lower for corn. Although the yields used in the initial analysis are achievable, they are statistically higher than the average yield data. The farm data could be lower because of a number of factors, such as variable weather; managerial ability; and available water, which is a function of the flow rate (GPM) of the well. Also, irrigation water may not be applied at the optimal time period because of competing demands on farm labor and other management constraints. Therefore, yield sensitivity analysis was conducted to determine if the ranking of the net returns changes under other possible yield scenarios. This was done by reducing the yield directly.

Table 7 reports the net return per acre under 10 and 20% yield reductions in all systems. The results indicate that rankings of the systems change little from the initial analysis, except that the SD system rapidly falls in the ranking from 6 to 7 as corn yields decline by 20 percent. The ranking of the SD system improves from 6 to 3 with a 10% increase in corn yield.

Sensitivity analysis was performed to determine how much the yield would need to drop for a system with a higher net return to be equivalent to another system with a lower net return. The SF system was preferred economically to others. Therefore, the amounts that the yield would need to fall in the SF system for it to be economically equivalent to the SD and other systems for grain sorghum and corn were determined. If the grain sorghum yield declined by 1.5 bushels in the SF system because of managerial constraints or other factors, it would be equivalent to the FF system (Table 8). The LDN system and the SD systems would be economically equivalent to the SF system, if the yield in the SF system was 19.0 bushels and 22.9 bushels lower, respectively. Further analysis compares the LDN system to the LPCP, LEPA, and MPCP systems. If the yield in the LDN system was 1.4 bushels less, it would be economically equivalent to the LPCP system. The LEPA and MPCP system would be economically equivalent to the LDN system, if the grain sorghum yield in the LDN system was 0.4 bushel and 8.3 bushels less, respectively.

The same type of analysis was conducted to determine how much the corn yield from the SF system would have to decline to make this system economically equivalent to the other systems. If the corn yield was 3.7 bushels less in the SF system, it would be economically equivalent to the FF system (Table 8). This analysis then was repeated for all systems that had a higher net return than other systems. Again, the difference was very small between the LDN, LPCP, and SD systems. The overall analysis indicates that the results are very sensitive to small differences in yield levels between systems.

Crop Prices

The initial analysis assumes constant real crop prices of $2.10/bushel for grain sorghum and $2.22/bushel for corn. The sensitivity analysis performed on this variable varied the crop price by plus and minus 20%. The net return estimates are very sensitive to changes in this variable (Table 9). However, little change occurred in the overall rank of the systems, with the exception that the SD system was ranked 7th rather than 6th under a 20% lower price and 3rd rather than 6th under a 20% higher price. Increases in the crop price increases the relative advantage to those systems with higher total crop production. This implies that irrigators will be able to afford to own and operate more expensive and higher yield-producing systems, if the crop price rises. Current (March, 1996) prices are high relative to the averages used in the study. When these high prices are used, the rankings do not change with the exception that the SD system is ranked 3rd rather than 6th (Table 9).

Natural Gas Price

We assumed the real fuel price ($2.00/mcf) was constant. However, the potential exists for a wide variance in this cost, depending on the irrigator's situation. An increase in the real fuel price will have the greatest adverse effect on systems with higher operating pressures and/or lower application efficiencies because of the greater importance of the fuel cost component in determining the estimated net return of these systems. However, the ranking of systems did not change as the fuel cost was increased from $2.00/mcf to $3.50/mcf in $0.50/mcf increments.

Investment Cost

If the initial investment cost in the SD system is 10% higher than originally estimated, the annualized net return falls by $6.58/acre, resulting in a net return of $63.17/acre for grain sorghum and $77.57/acre for corn. The SD system would have the next to the smallest net return. Alternatively, if the investment costs are 10% less, the net return per acre increases by $6.58/acre. The SD system would then have the third highest net return for both grain sorghum and corn.

If the investment cost for the center-pivot systems were 10% higher than the original estimate, the annualized net returns for corn for these systems decrease enough that the SD system has the third highest net return. The ranking for grain sorghum did not change.

SUMMARY

Recent developments in irrigation system technology have resulted in a number of investment alternatives for western Kansas irrigators. An economic analysis was conducted to determine the net returns of obtaining and operating seven different systems for producing two crops, grain sorghum and corn, with a 10-year planning horizon.

The surge flood system had the highest net return estimate under typical conditions for irrigation of grain sorghum and corn. The furrow flood system was second best for both crops. Of the center-pivot systems, the low drift nozzle system had the highest returns. The subsurface drip system had the sixth highest net returns for both crops, but these returns were affected dramatically by small changes in yields or crop prices and were also sensitive to changes in investment costs.

The results of the sensitivity analysis showed that net return estimates were most sensitive to the yield response to irrigation, crop prices received, and initial investment. Therefore, the yield that an individual farm could produce under each respective system would easily influence the selection of an irrigation system.

Although the subsurface drip system shows some potential under high yields and/or prices, some practical considerations should make one cautious about an investment in this system. It requires a high initial investment, and uncertainty exists about how long the drip tape will function effectively and how difficult and expensive replacement will be. Although operating labor costs are relatively low, the installation labor requirement is relatively high.

Additional analysis needs to be conducted under more limited water rights restrictions. More efficient water-use systems should be more economical, but the resulting yields and net returns need to be examined more closely under such conditions, particularly for those systems that have high investment costs, such as the subsurface drip system.

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Table 1. Initial Investment Costs and Economic and Technical Values Used in the Initial Analysis.

Table 2a. Irrigation Schedule Information and Yields for Grain Sorghum by System.

Table 2b. Irrigation Schedule Information and Yields for Corn by System. MPCP LPCP LDN/LEPA FF SF

Table 3. Net Present Values of Cash Flows for each System by Crop.

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1 MPCP - Medium Pressure Center-Pivot

LPCP - Low Pressure Center-Pivot

LDN - Low Drift Nozzle

LEPA - Low Energy Precision Application

FF - Furrow Flood

SF - Surge Flood

SD - Subsurface Drip

2 The net present values are the total current values of net returns over the

10-year planning horizon.

3 The annuity value is equal to the annual payment per acre (based on 160 acres)

per year over the 10-year planning horizon that is equivalent to the reported

net present value.

Table 4. Annualized After-tax Value of Production, Crop Production Cost, Ownership Cost, and Operating Cost Components of the Net Pr

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Table 5. After-tax Annualized Fuel, Lubrication, System Maintenance,Pumping Plant Maintenance, and Labor Cost per Net Acre Inch of Water Pumped.1 Crop and

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1 Costs are estimated by annualizing the net present value of the cost over a 10-

year period and dividing by the net inches of water applied and the number of

acres irrigated by each system.

Table 6. After-tax Value of Production, Crop Production Cost, Ownership Cost, and Operating Cost as a Percent of Total Net Present Value of C

Table 7. After-tax Annuity Values per Acre as a Function of Yield Sensitivity.1

1 The annuity value is equal to the annual payment per acre (based on 160 acres) per year over the 10-year planning horizon that is equivalent to the after-tax net present value of using the irrigation system.

Table 8. Yield Sensitivity Analysis of Economically Preferred Irrigation System. Yield Reduction (Bushels/Acre) of PreferredCrop

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Table 9. After-tax Annuity Values per Acre as a Function of Commodity Prices.1

1 The annuity value is equal to the annual payment per acre (based on 160 acres) per year over the 10-year planning horizon that is equivalent to the after-tax net present value of usingthe irrigation system.

2 Results for cash prices as of March 20, 1996 for Garden City, Kansas.