THE ENERGY IMPACT ON IRRIGATED AGRICULTURAL PRODUCTION OF THE ESTANCIA BASIN, NEW MEXICO

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ABSTRACT

A linear programming model was utilized to simulate a 20 year (1979-1998) crop production and irrigation water utilization pattern in the Estancia Basin of New Mexico under four alternative energy price projections--base, low, medium and high.

Under the simulation approximately 31,300 acres of land would be farmed in 1978, rising to 46,300 acres in 1998 with 94 percent of the total being flood irrigated and the balance irrigated with sprinklers. Alfalfa accounted for 40 percent of the irrigated cropland, corn for silage 25 percent, corn for grain 11 percent, wheat 10 percent, pinto beans 7 percent, and potatoes 5 percent. However, under the high energy price alternative, irrigated cropped agriculture would cease after 1996.

Net returns to land and risk varied widely among the four energy price projections ranging from an increase of 158 percent in the base alternative from 1978 to 1998 to a 90 percent reduction in net returns in the high energy price alternative through 1996 and a 100 percent reduction by 1998. The reduction in net returns from 1978 to 1998 for the low energy price alternative was about 11 percent and about 58 percent for the medium energy price alternative. The reduction in net returns was due primarily to the rapid escalation of diesel fuel prices. The diesel fuel cost for the high alternative was expected to increase 469 percent, 375 percent for the medium alternative, and about 220 percent for the low alternative over present costs.

The returns to risk, after imposing a charge for the use of irrigated cropland valued at $1,000 per acre, was a negative $37 per acre in the base year of 1978. The negative returns to risk became even greater under the low ($60) and medium ($80) energy price alternatives in 1998, and high ($96) in 1996. Under the base price alternative, the net return to risk was estimated at a negative $33 per acre.

The amount of irrigation water pumped in the Estancia Basin would increase 2.4 percent per year over the 20 year period for the energy price alternatives. The total declines in the water tables were estimated to be 26.5 feet (1.3 feet per year). In addition, there were changes in energy sources for pumping irrigation water, irrigation pumping plant efficiencies and energy costs for pumping irrigation water among the alternative energy price projections.

The annual labor requirements and cost increased in relation to the increase in acreage, as did the annual operating capital requirements.

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INTRODUCTION

The Estancia Basin is a productive, groundwater-irrigated agricultural area in the state (Figure 1). The groundwater-irrigated acreage of the Estancia Basin represents about 3.4 percent of the irrigated acreage in New Mexico (Lansford, et al., November, 1979) and accounts for less than three percent of the cash receipts from crop sales in the state (New Mexico Crop and Livestock Reporting Service, 1979). The area is faced with a declining water table and rising energy costs. Some of the developed areas are now discontinuing irrigation. Concern has been voiced about the rapidly rising energy costs and the declining water tables and their impact on the economy of the region.

Objectives

The primary objective of this study was to evaluate the economic impacts of alternative energy prices and declining groundwater levels on irrigated agriculture in the Estancia Basin of New Mexico. To pursue this objective, it was necessary to develop an economic model to measure these impacts. The following sub-objectives were required to carry out the overall objectives:

1. Hydrology - To estimate availability and potential decline of the groundwater resource in the Estancia Basin.
2. Agriculture - To estimate current and future water use for irrigated agriculture in the Estancia Basin at alternative energy prices.
3. Energy - To estimate alternative future energy prices for a 20 year period (1978-1998).
4. Economic - To develop a mathematical programming model with net farm returns to land and risk for the basis of economic comparison. Constraints on the model are water availability, cropping patterns, irrigated cropland available, and the price of energy.

GENERAL DESCRIPTION

The Estancia Basin, located in central New Mexico, is the northern-most component of the Central Closed Basin. The topographic divides surrounding the oblong-shaped Estancia Basin are the Manzano and Sandia Mountains on the west, Chupadera Mesa and Gallinas Peak on the south, the Pedernal Hills on the east, and the Ortiz Mountains on the north. The area is a closed basin system, having no drainage to the Rio Grande Basin which lies to the north and west, the Pecos River Basin to the east, or the

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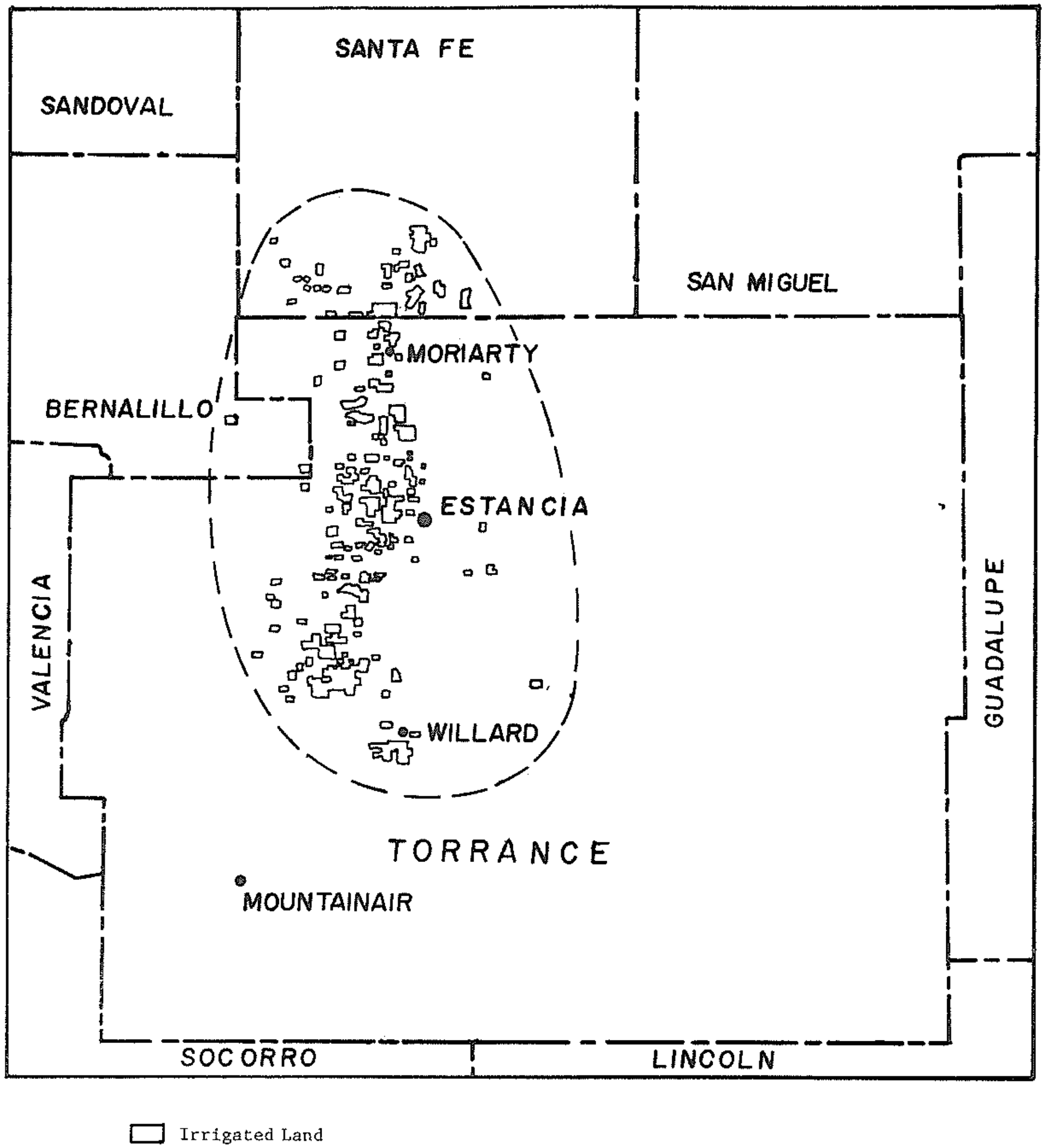

Figure 1. Location of irrigated land in the Estancia Basin, New Mexico, 1978

Jornada del Muerto and Tularosa Basins to the south. The basin is roughly 60 miles long and 40 miles wide, with a total drainage area of approximately 2,400 square miles.

The Estancia Basin lies mostly in Torrance County, but also includes a portion of southern Santa Fe and southeastern Bernalillo Counties. The principal communities in the area are the towns of Estancia and Mountainair and the villages of Willard and Moriarty, all in Torrance County.

Topography and Climate

The Estancia Basin constitutes the northern-most component of the basin and range physiographic province of New Mexico, which consists of isolated mountain ranges separated by wide desert plains. It is physically separated from the other basins in the region by low-lying hills, mesas and ridges on the south. The Manzano and Sandia Mountains on the west and a series of low hills on the north separate the basin from the Rio Grande Basin. Similarly, on the east, the basin is separated from the Pecos River Basin by low hills and ridges.

The surface terrain of the Estancia Basin varies from mountains in the west to open plains in the center, and broken mesas and ridges on the north, east and south. The centripetal channels around the edges of the basin carry runoff only after local rainfall. These channels broaden and disappear before they reach the basin floor. The basin floor is characterized by wide level plains which slope gently south, giving way to a series of playas. The playas vary in size from small to large, with their surfaces approximately 20 feet below the general level of the basin floor.

The climate in the Estancia Basin is characterized by clear, cool, sunny days, high diurnal temperatures, low humidity, and low rainfall. The mean annual precipitation averages about 12 inches. The majority of precipitation occurs in the summer and early fall months, at irregular and infrequent intervals. The precipitation in the area is usually accounted for by the replacement of soil moisture, evaporation, and surface runoff. Much of this runoff eventually flows to playas in which the water either infiltrates the soil, possibly percolating to the water table, or is evaporated. The relatively low humidity and frequent winds result in high evaporation rates.

Temperatures in the area average about 50 degrees Farenheit. Winters are cool with a mean temperature of about 30 degrees Farenheit in January, and a mean temperature of about 70 degrees Farenheit in July. The growing season usually begins in mid-May and lasts about 113 days, through the end of September.

Drainage Area

The Estancia Basin in New Mexico is a closed drainage system, having no outlet to adjacent river basins. The drainage area encompasses a total of approximately 2,400 square miles which lie in Torrance, Santa Fe, and Bernalillo Counties.

The basin has no permanent streams. A few streams on the west side of the basin are perennial in their upper reaches, however, no other surface water exists, with the exception of the salt playas in the southern portion of the basin.

Water Resources

The vast majority of water used for irrigation, municipal, industrial, and domestic purposes comes from groundwater sources. The principal aquifer in the Estancia Basin is that of bolson deposits. This aquifer alone probably accounts for more water in the Estancia Basin than all other aquifers combined. The bolson deposits consist of both lacustrine and alluvial sediments. The lacustrine sediments are composed mainly of minutely bedded silt and clay with large amounts of secondary gypsum, whereas the alluvial sediments are poorly sorted and consist of sand, gravel, silt, and clay. The floor of the central portion of the Estancia Basin is composed of unconsolidated bolson deposits of the Quaternary age. These deposits consist of material deposited in lakes in the center of the basin and from deposits of streams that once fed the lakes. Underlying these Quaternary bolson deposits are older Paleozoic, Mesozoic, and early Cenozoic (Tertiary) formations which also occur in the mountainous areas surrounding the basin. The alluvial bolson deposits, which interfinger with lacustrine deposits in the center of the basin, range in thickness from zero to 300 feet. The alluvial bolson deposits yield large volumes of potable to saline water while the lacustrine bolson deposits yield small amounts of highly saline water. The Estancia Basin is confined both topographically and structurally and the groundwater reservoir is continuous throughout most of the basin. It is discontinuous where older rock formations protrude through the bolson deposits.

The principal source of groundwater recharge in the Estancia Basin is runoff from western mountains with lesser amounts from precipitation and subsequent infiltration into the aquifer. Any recharge to the aquifer, however, is outweighed by withdrawals due to pumping.

About 1940, development of the groundwater reservoir began, even though earlier efforts had failed. By 1944, farmers were rapidly developing the groundwater resources. In 1950, the State Engineer declared the Estancia Underground Water Basin in an attempt to protect and conserve the relatively fixed water supply.

The yield of typical irrigation wells ranges from 400 to over 1,500 gallons per minute, with water depths ranging from 60 feet to over 200 feet below the surface. The saturated thickness of the aquifer ranges from 40 feet to 300 feet. The amount of groundwater withdrawn annually exceeds the recharge, as is evident from an average decline of less than one foot per year to over three feet per year in some areas. This rate of consumption is about 40 percent greater than annual recharge. The declining water table will increase pumping lifts and possibly decrease well yields in addition to increasing the possibility of deteriorating water quality. Also, in time, the decreasing saturated thickness may make pumping water impractical or economically infeasible.

While the quality of groundwater in the north and southwestern portions of the Estancia Basin is relatively good, that of the central portion is rather poor. The water is hard and contains high concentrations of sulfate and chloride, thus rendering it only marginally suitable for irrigation purposes.

Land Resources

There are approximately 1.5 million acres within the Estancia Basin drainage area. Nearly 600,000 acres lie on the floor of the basin, with slightly more than 70 percent of this acreage in

Torrance County, and the balance in Santa Fe County. The ownership of land in the Estancia Basin is approximately 15 percent Federal, 15 percent State, and 70 percent private, and other miscellaneous public uses (roads, towns, etc.) (Table 1).

Table 1. Land Ownership in the Estancia Basin, 1978

Land	Torrance County	Santa Fe County	Total
	----- (acres) -----		
Indian Lands	16,300	--	16,300
Federal Lands	174,630	5,120	179,750
Forest Service	(132,806)	--	(132,806)
BLM	(41,557)	(5,120)	(41,677)
Defense	(102)	--	(102)
Miscellaneous	(145)	--	(145)
State Land	193,855	14,080	207,935
Private & Other	991,855	153,600	1,145,455
Total Area	1,376,640	172,800	1,549,440

Source: Adapted from New Mexico State Engineer Office, Land Ownership and Administration by County and Drainage Basin, Open File Report, Santa Fe.

Agricultural use of land in the Estancia Basin accounts for about 97 percent of the total land (Table 2). Included in the agricultural use category are croplands, grazing lands, and commercial timber lands. Crop production accounts for only about 7 percent of the land, and commercial timber another 7 percent, while grazing uses comprise the balance of 86 percent. The commercial timber land was commonly utilized for grazing purposes, resulting in a dual use for this acreage.

Irrigated Cropland

The irrigated cropland in the Estancia Basin is located principally on the basin floor. The acreages of the various crops produced are reported in Table 3. The most important crops in 1978 were alfalfa at 28.7 percent, followed by pasture at 28 percent, corn at 18.1 percent, and wheat at 8.6 percent. Idle and fallow land accounted for 38.6 percent of the total irrigated cropland of 46,793 acres.

Table 2. Land Use in the Estancia Basin, 1978

Item	Torrance County	Santa Fe County	Total
	- - - - - - - - - - - - - - - - - - (acres) - - - - - - - - - - - -		
Inland Waters	6,020	--	6,020
Urban & Built Up	8,950	1,627	10,577
Roads	10,660	1,938	12,598
Crops (total)	87,880	29,740	117,620
Irrigated	(36,880)	(9,913)	(46,793)
Dry	(51,000)	(19,827)	(70,827)
Defense	102	--	102
Parks, fish and wildlife	240	--	240
Commercial timber	103,227	2,304	105,531
Grazing lands (total)	1,159,561	137,191	1,296,752
Non-commercial timber	(259,719)	(82,315)	(342,034)
Range land	(899,842)	(54,876)	(954,718)
Total Area	1,376,640	172,800	1,549,440

Source: Adapted from New Mexico State Engineer Office, Land Use by Counties and River Basins, Open File Report, Santa Fe, June 6, 1974.

Dry Cropland

The dry cropland in the Estancia Basin is located primarily along the western margin of the basin floor. The acreages of the various dry crops produced in the Estancia Basin are reported in Table 3. In terms of acreage, the most important dryland crop in 1978 was wheat, which accounted for 6.2 percent of the total dry cropland acreage. Wheat was the only significant dryland crop in the Estancia Basin, with only small amounts of other crops planted. Idle and fallow land accounted for the bulk of the dry cropland at 92.7 percent of the total.

Table 3. Estimated irrigated and dry land crop acreage in the Estancia Basin, by crop, 1978

Item*	Santa Fe	Torrance	Total Estancia Basin	
	- - - - - - - - - -(acres)- - - - - - - - -			percent
Irrigated Crops				
Corn	3,250	5,200	84,50	18.1
Sorghum-grain	100	250	350	0.7
Sorghum-all other	--	750	750	1.6
Wheat	1,025	3,000	4,025	8.6
Barley	--	750	750	1.6
Other small grains	50	800	850	1.8
Cotton-upland	--	--	--	--
Cotton-American/pima	--	--	--	--
Peanuts	--	--	--	--
Sugar Beets	--	--	--	--
Dry Beans	--	380	380	0.8
All Other Field	--	130	130	0.3
Potatoes	--	600	600	1.3
Lettuce	--	--	--	--
Onions	--	--	--	--
Chile	--	--	--	--
All other vegetables	--	10	10	0.0
Orchards and vineyards	--	20	20	0.0
Alfalfa	4,425	9,000	13,425	28.7
Planted pasture	100	1,220	1,320	2.8
Native pasture	--	210	210	0.5
Sub-Total All Crops	8,950	22,320	31,270	66.8
Multiple-Cropped	--	2,520	2,520	5.4
Total Acres Irrigated	8,950	19,800	28,750	61.4
Idle and Fallow	963	17,080	18,043	38.6
Total Irrigated Cropland	9,913	36,880	46,793	100.0
Dry Land Crops				
Corn	50	250	300	0.4
Sorghum-grain	60	50	110	0.2
Sorghum-all other	--	--	--	--
Broomcorn	--	--	--	--
Wheat	2,422	2,000	4,422	6.2
Barley	--	--	--	--
Other small grains	--	200	200	0.3
Cotton-upland	--	--	--	--
Dry Beans	60	100	160	0.2
All other field	--	--	--	--
All hay	--	--	--	--
Planted pasture	--	--	--	--
Sub-Total All Crops	2,592	2,600	5,192	7.3
Multiple-Cropped	--	--	--	--
Total Acres Dry Cropped	2,592	2,600	5,192	7.3
Idle and Fallow	17,235	48,400	65,635	92.7
Total Dry Cropland	19,827	51,000	70,827	100.0

* Hyphens (--) represent zero.

METHODS AND PROCEDURES

An interdisciplinary approach to the solution of the water resource problems in the Estancia Basin was made possible by the integration of hydrology with economics. Research procedures developed to carry out this study were closely coordinated by the investigators to achieve the stated objectives. Inputs into the economic model were obtained from separate area studies covering hydrology, crop agriculture, energy price projections, and the cost of farm fuels.

The economic model was designed to represent the cropped agricultural economy of the Estancia Basin and to obtain the optimal combination of irrigated crop activities (acres), resultant income, water pumpage, and direct agricultural employment under conditions of increasing energy costs and increasing depths to water. It consists primarily of a linear programming (LP) model, with other sub-models determining fuel cost and pumping cost, to provide input into the LP model, with a set of constraints placed upon land, water, and energy related resources. These constraints include:

1. Ground water resources
2. Land resources -- groundwater irrigated cropland
3. Sources of energy for irrigation water pumpage
4. Risk and agronomic considerations

Model Description

A linear programming model was developed, incorporating crop enterprise cost and returns budgets, a pumping cost model, hydrologic data, and projected energy prices for the Estancia Basin. The model incorporates the outputs of each sub-investigation and is utilized to project future water-use patterns and crop agriculture economic activity under alternative energy costs.

An optimal solution of the model for a given set of economic and hydrologic conditions can be obtained by maximizing the model's objective function. The model was designed to maximize regional farm return to land and risk. Each crop contributes to total farm returns according to its level of production, while increased energy costs and declining water table levels impose additional costs on the region's economy.

The model's basic behavioral assumption is that farmers are profit maximizers, and that they adjust their decisions in a time-lag manner, i.e., that the producer's behavior in the current time period is a function of economic and groundwater conditions in previous time periods. This behavioral assumption indicates that the farmer's decision making process is dependent on historical information with the most recent information being the most important.

In summary, the basic methodology of the projections for any year are as follows: first, the effects of an energy price increase upon farm machinery fuel prices and irrigation water fuel prices would be determined. Second, the pumping plant efficiency would be determined based upon the time period and engineering data. Third, the total aquifer decline based upon groundwater withdrawals in previous time periods would be determined by hydrologic relationships. Fourth, the total water horse-power requirements would be estimated for both flood and sprinkler systems. Fifth, the actual fuel cost per acre-foot of water pumped would be determined by considering fuel prices, pumping plant efficiency, and total water decline for both flood and sprinkler irrigation systems by fuel type. Sixth, the fuel costs for both farm machinery operation and irrigation water pumping would be moved into the objective function of the LP model. The technical coefficients and the returns in the LP model are based on the crop cost and returns budgets for the Estancia Basin. At this point, a solution to the model would be obtained. Seventh, the time period would be advanced and the amount of water pumped added to that previously pumped, and this process would be repeated.

A detailed formulation of the LP model is presented in Appendix A.

Model Components

Results and interpretations from the economic model are only as good as the assumptions within the model and the reliability of the basic input data. Consequently, a major portion of the time and effort of this study went into the preparation of the basic hydrologic, agricultural, and economic data. The year 1978 was chosen as the base year for the coefficients in the model.

Hydrologic Data

Economic analysis of irrigated agriculture required the evaluation of the groundwater characteristics and quantification of parameters regarding existing and future conditions. The groundwater and well characteristics of prime interest are: aquifer saturated thickness, depth to water, well yield, and pumping lift. A comprehensive alternative water-use analysis also requires information on the condition and response of the aquifer under various projected stresses. The numerous groundwater and well characteristics vary according to the magnitude of these projected stresses. A sufficient data source of these characteristics under future usage does not exist, and methods of indirect assessment are required. It was assumed that estimates of the rate of decline of the water table and representative well yields provide the necessary input for assessing projected stresses. Historic data on water levels, rates of decline, pumping lift, and well yield were obtained from various publications and open-file reports of the New Mexico State Engineer Office.

Crop Costs and Returns Budgets

Per acre crop costs and returns enterprise budgets will be developed for the more important irrigated crops for the Estancia Basin. These budgets were developed for farms that are above-average in both size and management on the basis of soil, water quality, and water quantity conditions. The measure of profit used in constructing the enterprise budgets was net return to land and risk. Net return to land and risk does not include an interest charge on the land investment. However, a charge is made for all purchased inputs such as seed, fertilizers, insecticides and herbicides. Labor, fuel, repairs for machinery and equipment, fixed machinery equipment costs consisting of depreciation and personal property taxes, overhead expenses consisting of insurance and taxes, employee benefits, interest on operating, and interest on machinery investment are similarly charged against gross income.

The crop cost and returns budgets were developed by a computer-based whole farm cost-and-return budget generator, written by the Agricultural Economics and Agricultural Business Department at New Mexico State University. A more detailed description of the budget generator and assumptions for the crop budgets, as well as the crop budgets, can be found in Appendix B.

For purposes of this report, "above-average" management of farms, and therefore, above-average yields in 1978, were assumed to be the average yields and net returns over the 20-year time horizon of this study. This assumption overstates the expected net returns in the early years of the projections and probably underestimates the expected net returns in the latter years of the 20 year projection. The yields used in the budgets were approximately 20 to 30 percent above those reported in New Mexico Agricultural Statistics for 1978. The upward trend in crop yields over the past 20 years is due mainly to improved crop varieties and better irrigation water management, etc. Therefore, it was felt that by choosing above-average managed farms for 1978, the average farmers should achieve those expected yields in 10 to 15 years. Since average farm size has been increasing over the past 40 to 50 years, it was felt that by using an above-average farm size, increases in farm sizes in the next 10 to 20 years would be adequately reflected.

Energy Price Projections

Because of the emergence of OPEC as a world price leader after the 1973-1974 oil embargo, the projection of possible energy price increases over the next two decades becomes clouded with a high degree of uncertainty. The energy price increase projections for this analysis were based on the U.S. Department of Energy (DOE) Project Independence Evaluation System (PIES) projection as presented in the 1978 Annual Report to the Congress. The PIES model is the DOE's major mid- to long-term energy forecasting and analysis model. It consists of a number of complex interrelated econometric models and associated data bases which can be used to project the state of the energy market in the years 1980, 1985, and 1990.

The (PIES) model determines the equilibrium of supply and demand for eight different fuel types in each of the Nation's nine Census Regions. Demand estimates are provided separately by log-linear approximations to a collection of econometric models. A variety of techniques are used to develop supply curves for oil, coal and natural gas, and also to develop costs of converting fuels into the energy forms in which they are used by consumers. An elaborate transportation network is included in order to model the transport of fuels and products across the nation. The sum of production, conversion and transportation costs, and the price paid for imports is the cost of supplying energy to the nation. At the center of PIES is the Integration Model, which combines the supply and demand sides of the overall model with a linear programming model (MacRea, 1977).

The U.S. DOE 1978 Annual Report to the Congress contained five scenarios based on various supply, demand, and world price situations. The lowest scenario indicated almost no real increases in the price of energy, while the highest scenario considered low supplies, high demand, and high world prices for energy resources. Scenario B is probably the most reasonable scenario for estimating real annual increases in the price of energy for the southwestern United States. Energy prices in the commercial sector (which includes irrigation) were estimated to increase by the following percentages by 1985: electricity 5.18%, natural gas 8.27%, distillants 6.01%, and liquid products by 6.42%. The same scenario projected annual real price increases to the year 1990 for the commercial sector to be electricity 3.74%, natural gas 4.43%, distillants 4.36% and liquid products 4.65%.

The PIES projections only forecasted prices to 1990. However, the time horizon for this study is to the year 1998. The time factor, combined with rapidly rising escalating energy prices during 1978-1979, led to the decision to develop alternative energy price projections.

In cooperation with Los Alamos Scientific Laboratory personnel, a set of real energy price projections were developed for the years 1979 through 1998 based on PIES scenarios as presented to the Congress in 1978. One price projection is that of no real increase in the price of energy products purchased by farmers in New Mexico during the period 1979-1998. A second energy price projection estimates a low annual real energy price increase (based on Scenario B), a third projection estimates a medium real annual price increase for energy which essentially will be 1.5 times the low alternative, and a fourth projection estimates a high real annual increase in energy prices of about two times the low energy alternative.

The impact of increasing energy prices on fertilizer costs were evaluated using secondary data. Two recent studies of the fertilizer industry by Dvoskin and Heady (1976) and Whittlesey and Lee (1975) were the primary sources of data for this evaluation.

Farm Fuel Costs

The base fuel costs for natural gas, electricity, and diesel were developed in the regional crop budgets. The base fuel costs were increased by the energy price alternatives to project fuel costs. The estimate of future fuel costs under the four energy price alternatives was determined by utilizing equations 2 through 8 in Appendix A.

A model was developed to determine the cost per acre-foot of pumping water which incorporated hydrologic information, engineering relationships and information, and energy price projections to compute fuel costs for the pumping irrigation model. Hydrologic information provided the model with depth to water, specific well yield, and drawdown data. Engineering relationships include the formulas necessary to determine the amount of fuel necessary to pump the required amount of water and engineering information provided the initial well efficiencies. The energy price projections provided the rate of adjustment of fuel prices in real term over time. The model was designed to represent a dynamic situation where several variables may move in the same or different directions at the same time. In keeping with the dynamic nature of the model, farmers were assumed to assimilate present and new technology in their irrigation water pumping systems which results in more efficient systems.

RESULTS AND IMPLICATIONS

The comprehensiveness of the study was made possible through the inclusion of a wide range of disciplines and area studies. These disciplinary activities were designed primarily to provide necessary information for the linear programming model, included data collection, analysis, and interpretation. Secondary data were compiled whenever possible. In a number of study areas, more detailed investigations were necessary for incorporation into the model. Some of these activities resulted in additional information beyond the needs of the model and the scope of this report, and will be published as separate reports.

Hydrologic Data

Economic analysis of irrigated agriculture required the evaluation of existing groundwater conditions and the projection of future conditions regarding quantity and availability. The principal aquifer has a practical maximum thickness of 300 feet. Saturated thickness will decrease with time in response to groundwater depletion, which is almost entirely due to irrigated agriculture. A saturated thickness of 20 feet was selected as the minimum value which would yield sufficient water to wells to support irrigated agriculture. When the saturated thickness diminishes to approximately 20 feet, all irrigated agriculture, as it presently exists, will cease. For an unconfined aquifer, the decline in the saturated thickness is identical to the decline in the water table. Although the decline will vary with location in response to geologic conditions, sources of recharge, and imposed stress, an average value of one foot per year decline in saturated thickness was found to be representative of historic water table declines.

Availability of groundwater was parameterized in terms of depth to water, drawdown at the pumping well, and well yield. A typical value for the present depth to water is 125 feet, and typical irrigation wells in the area yield approximately 800 gpm. The drawdown at the pumping well can be determined from the specific capacity, which is the yield in gallons per minute divided by the drawdown. The wells in the Estancia Basin presently have specific capacities of approximately 27 gpm per foot of drawdown. The present pumping lift of typical wells is 125 feet of static lift plus 30 feet of drawdown, resulting in 155 feet. For sprinkler irrigation systems there is an additional 116 feet of pressure head resulting in 271 feet of pumping lift.

A comprehensive alternative water use analysis also requires information on the condition and response of the aquifer under various projected stresses. The numerous groundwater and well characteristics will vary according to the magnitude of these projected stresses. It was assumed that future groundwater response will be comparable with past response. Specifically, it was assumed that near future decline in water level can be estimated by a historical decline of one foot per year as long as the water withdrawals remain at their historic level. The water level data was obtained from the State Engineer Office in cooperation with the U.S. Geological Survey.

Crop Costs and Returns Budgets

Per acre crop cost and return enterprise budgets were developed for the Estancia Basin. Much of the information for the budgets was obtained from local farmers during a series of meetings in 1979 and 1980. A more detailed discussion of the individual crop budgets may be found in "Costs and Returns for Producing Selected Irrigated Crops on Farms with Above-Average Management in the Estancia Basin, Torrance and Santa Fe Counties, 1979" by Lansford, et al. (1980). The 1979 enterprise budgets were adjusted for 1978 conditions for a 640-acre farm.

Costs and returns per acre were budgeted for production of seven major irrigated crops (alfalfa, corn for grain, corn silage, potatoes, pinto beans, Jose wheatgrass pasture, and wheat). Both flood and center-pivot irrigation systems were included in the budgets. The typical flood-irrigated farm was estimated to contain 640 acres, of which 600 acres would be cropped as follows: about 50 percent alfalfa, 10 percent corn for grain, 25 percent corn silage, 3 percent pinto beans, 3 percent Jose wheatgrass pasture, and 10 percent wheat. Pinto beans and Jose wheatgrass pasture were budgeted only under flood irrigation. This farm was estimated to have five irrigation wells producing 800 gpm each pumping from a depth of 130 feet. The typical sprinkler-irrigated farm was also estimated to contain 640 acres, with 520 acres in crops and a similar cropping pattern as the flood-irrigated farm, except potatoes are substituted for the pinto beans and pasture. Potatoes were budgeted only with center-pivot sprinkler irrigation. Such a farm was estimated to have four center-pivot sprinkler systems and four irrigation wells producing 800 gpm each pumping from a depth of 130 feet.

The major items of costs and returns are summarized in Table 4. Yields, and therefore, gross returns, were estimated to be higher on crops produced under the sprinkler systems. Typically, the increased yields and reduced labor costs nearly offset the higher fixed and variable costs associated with the center-pivot sprinkler system. The difference in net operating profit between flood- and sprinkler-irrigated crops ranged from less than $1 to nearly $11 per acre. However, when an interest charge was assessed for operating capital and equipment investment, the differences in net return to land and risk became larger, varying from $8 per acre for corn for grain to nearly $28 per acre for alfalfa. The flood-irrigated crops had higher net returns to land and risk than did the center-pivot irrigated crops.

Potatoes and pinto beans were the most profitable crops budgeted. The net operating profit for potatoes was budgeted at $463.69 per acre for sprinkler irrigation, and $241.31 per acre for pinto beans under flood irrigation. However, when an interest charge was assessed for the use of operating capital and equipment investment, the returns to land and risk were reduced to $401.39 for potatoes and $209.41 for pinto beans. Alfalfa was the third most profitable crop. The net operating profit was $70.82 per acre for sprinkler-irrigated alfalfa and $73.87 per acre for flood-irrigated alfalfa. Alfalfa was estimated to return more to land and risk when flood-irrigated ($46.51 per acre) then when sprinkler-irrigated ($18.62 per acre). In terms of net operating profits, corn silage was the fourth most profitable crop, yielding $70.78 per acre for the flood irrigation alternative and $71.18 under sprinkler irrigation. The net return to land and risk for flood-irrigated corn silage was $40.37 per acre and sprinkler-irrigated corn silage was $29.92 per acre. Corn for grain had a net return to land and risk at $7.51 per acre for flood irrigation and a negative $0.70 per acre for sprinkler-irrigation. Sprinkler-irrigated wheat was the least profitable when all costs (including a charge for capital) were considered, yielding a net return to land and risk of a negative $65.71 per acre. The per acre net return to land and risk for flood-irrigated wheat was estimated at a negative $39.13. Also yielding a negative return to land and risk was Jose wheatgrass pasture at a negative $36.33 (Table 4).

Energy Prices

Increasing energy costs affect agriculture through increased fertilizer prices, increased fuel costs for pumping irrigation water, and increased fuel costs for operating farm machinery. The magnitude of these impacts will depend upon the rate of the energy price increase. To provide for a wide range of real energy price increases, this study presents the effects under four energy price increases: base, low, medium, and high.

Energy Price Projections

The first energy price (base) alternative assumed that, in real terms, energy prices would not increase above the general price level of 1978, i.e., energy price increases move at the same rate as general price inflation (Table 5).

Recently, the prices of diesel and LP gas have increased sharply, and are expected to increase at a real rate faster than those projected for the general economy. In order to expand the range of

Table 4. Summary of costs and returns per acre for alfalfa, corn for grain, corn for silage, wheat for grain, fresh market potatoes and pinto beans by type of irrigation system, Estancia Basin, New Mexico, 1978

Item	Alfalfa Center-Pivot Sprinkler	Alfalfa Flood	Corn for Grain Center-Pivot Sprinkler	Corn for Grain Flood	Corn for Silage Center-Pivot Sprinkler	Corn for Silage Flood	Wheat for Grain Center-Pivot Sprinkler	Wheat for Grain Flood	Fresh Market Potatoes Center-Pivot Sprinkler	Pinto Beans Flood	Jose Wheat Grass Flood
	---------tons---------		---------bushels-------		---------tons--------		-------bushels-------		cwt.	cwt.	AUM of grazing
Yield	5.75	5.25	130.00	120.00	23.00	22.00	55.00	50.00	325.00	18.00	15
Gross Returns	$355.00	$325.00	$332.50	$307,50	$299.00	$286.00	$182.50	$167.50	$1,056.25	$450.00	$210.00
Costs											
Purchased Inputs	$ 64.41	$ 64.29	$ 89.00	$ 89.00	$ 74.00	$ 74.00	$ 46.00	$ 46.00	$ 274.75	$ 45.00	$ 69.55
Pre-harvest											
Purchased Inputs	--	--	--	--	--	--	--	--	--	$ 7.00	--
Labor	$ 6.08	$ 12.40	$ 9.86	$ 15.23	$ 9.45	$ 14.13	$ 5.18	$ 5.33	$ 14.84	$ 10.12	$ 2.46
Fuel, Oil and Repairs	$ 79.13	$ 64.99	$ 60.90	$ 50.51	$ 55.16	$ 46.63	$ 59.42	$ 50.05	$ 83.35	$ 30.07	$ 19.12
Fixed	$ 36.22	$ 13.40	$ 30.81	$ 18.22	$ 28.19	$ 17.43	$ 28.89	$ 14.50	$ 39.74	$ 23.65	$ 78.23
Total Pre-harvest	$121.43	$ 90.79	$101.57	$ 83.96	$ 92.80	$ 78.19	$ 93.49	$ 69.88	$ 137.93	$ 70.84	$ 99.81
Harvest	$ 49.36	$ 45.67	$ 41.08	$ 38.69	$ 13.87	$ 14.42	$ 22.39	$ 21.45	$ 115.00*	$ 50.31*	--
Overhead	$ 48.98	$ 50.38	$ 49.04	$ 50.23	$ 47.15	$ 48.61	$ 39.01	$ 38.20	$ 64.88	$ 42.54	$ 43.19
Total Operating Expense	$284.18	$251.13	$280.69	$261.88	$227.82	$215.22	$200.89	$175.53	$ 592.56	$208.69	$212.55
Net Operating Profit	$ 70.82	$ 73.87	$ 51.81	$ 45.62	$ 71.18	$ 70.78	$-18.39	$ -8.03	$ 463.69	$241.31	$ -2.55
Interest on Operating Capital	$ 6.71	$ 6.51	$ 8.70	$ 8.62	$ 7.69	$ 7.67	$ 5.75	$ 5.48	$ 20.34	$ 5.89	$ 6.03
Interest on Equipment Investment	$ 45.49	$ 20.85	$ 43.81	$ 29.49	$ 33.57	$ 22.74	$ 41.57	$ 25.62	$ 41.96	$ 26.01	$ 27.75
Net Return to Land and Risk	$ 18.62	$ 46.51	$ -.70	$ 7.51	$ 29.92	$ 40.37	$-65.71	$-39.13	$ 401.39	$209.41	$-36.33

* Custom harvested

Table 5. Projected annual real energy price increases (1978 dollars) for the four energy price alternatives by source of energy

Energy Price Alternative	Natural Gas	Electricity	Diesel	LP Gas
	(percent)			
Base	0	0	0	0
Low	4	2	4	4
Medium	6	3	6	6
High	8	4	8	8

revelant real energy price increases three alternate energy price alternatives were developed. These alternatives are based on the 1978 PIES Scenario B, where electricity prices were based on typical rates for January, 1979; natural gas rates were based on the American Gas Association rates for early 1979; and diesel and LP gas prices were based on early 1979 heating oil prices. The first real energy price increase projection assumes increases of 4 percent per year for natural gas, diesel, and LP gas, and 2 percent per year for electricity. This alternative is considered the "low alternative" (Table 5). Two additional energy price increase alternatives were developed. They were estimated to be 1.5 times the low alternative (medium) and two times the low alternative (high) (Table 5).

Fertilizer Prices

A number of recent studies on the energy impacts upon demand for commercial nitrogen fertilizer point to conclusions contrary to intuition. Currently, 87 percent of the nitrogen in chemical fertilizer is from ammonia derived from natural gas (USDA, 1974). An average of 38,000 cubic feet of natural gas is required to produce a ton of anhydrous ammonia (White, 1974). A recent national simulation study by Dvoskin and Heady (1976) indicated that the energy crisis would definitely cause sharp increases in commercial nitrogen fertilizer prices as well as sharp reduction in its supply, but the existence of close substitutes from legume crops carry-over and manure tended to offset such energy price. Under their hypothesized 10 percent energy shortage, doubled energy prices, and energy minimization practices, total nitrogen use declined less than five percent, but with a sharp decline in commercial fertilizer usage. Whittlesey and Lee (1975) predicted a similar result: a 100 percent increase in natural gas price would add about 15 percent to the farm cost of nitrogen fertilizer which in turn would add about two percent to the farmers' cost of producing wheat. Based on the studies by Dvoskin and Heady and Whittlesey and Lee, fertilizer prices were held at constant 1978 prices in this analysis.

Irrigation Water Fuel Costs

The fuel cost of irrigation water effectively applied to a crop is a function of many factors. A list of some of the most important factors would include: efficiency, depth to water, well output and pressurization, if any. The depth to water as it relates to pumping costs is composed of two parts, the static water level and drawdown. The static water level was estimated to be the same as that in the crop budgets by Lansford, et al. (1980). The drawdown was based on the hydrology section of this report.

The base pumping unit efficiencies used in this study were based on a study by Abernathy (1978). Abernathy conducted well tests in the Estancia Basin in 1977 and 1978. Tests were conducted on free-discharge irrigation wells powered by natural gas and electricity, and pressurized irrigation wells powered by natural gas. The base pumping unit efficiencies for free-discharge natural-gas powered wells was 10.6 percent. The efficiency for free-discharge electric wells was 50.8 percent, while diesel efficiency as 15.3 percent and LP gas (propane) efficiency was 14.3 percent (Table 6). The base pumping unit efficiencies for pressurized natural-gas powered wells was 12.6 percent, while the efficiency of electric units was 60.4 percent. The efficiency of diesel units was 18.2 percent, and LP gas efficiency was 17.0 percent (Table 6).

Table 6. Irrigation pumping plant efficiencies by fuel type, Estancia Basin, 1978

Pumping Plant Efficiency	Natural Gas	Electricity	Diesel	LP Gas
	- - - - - - - -	- - - - - (percent)	- - - - -	- - - - - - - -
Original - Flood	10.6	50.8	15.3	14.3
Optimal - Flood	13.8	66.1	19.9	18.6
Original - Sprinkler	12.6	60.4	18.2	17.0
Optimal - Sprinkler	13.8	66.1	19.9	18.6

The overall efficiencies adapted from Abernathy were far below those of a good pumping plant. The reported efficiency of a good natural gas pumping plant is 13.8 percent, 66.1 percent for electric powered plants, 19.9 percent for diesel powered plants, and 18.6 percent for LP gas powered plants (High Plains Underground Water Conservation District No. 1, 1976).

It was also assumed that the base efficiencies determined above would not be fixed over the 20 year projections of the study. As energy costs increase it was assumed that farmers would adopt existing and forthcoming technologies. Studies such as those by Abernathy (1978) and Young and Coomer

(1979) emphasize the need to maintain good pumping plant efficiencies. Current research indicates that technological increases in pumping plant efficiency represent a "cheap" method to reduce fuel consumption. For this study it was assumed that the pumping plant efficiency would be increased by one-half the difference between present efficiency and good efficiency every two years. Thus, the pumping plant efficiencies increase for all 20 years of the projections with the greatest increase occuring in the early time periods. The formula for calculation of pumping plant efficiencies is presented in Appendix A.

The pumping fuel cost model is presented in equations 4 through 7 in Appendix A. Equation 4 presents the method used for determining total water decline. The method for calculating water horsepower requirements is presented in Equation 5, while Equation 6 presents the calculations for determining the fuel cost per hour. Equation 7 converts the fuel cost per hour to fuel cost per acre foot. The impacts of the cost of fuel for pumping irrigation water from the alternative energy price projections are presented in the following economic sections.

Farm Machinery Fuel Costs

The increased fuel costs for operating diesel powered farm machinery were used as an estimate of the increased fuel costs of all farm machinery. Future fuel costs for farm machinery were obtained from Equation 8 in Appendix A. The impacts of increased diesel fuel prices for the four energy price alternatives are presented in the following economic section.

Impact Projections

The linear programming model was utilized to simulate a 20 year (1978-1998) crop production and irrigation water utilization pattern in the Estancia Basin of New Mexico under alternative energy price projections. Each simulation process begins with the same basic solution of the model, and continues with bi-annual changes to satisfy the alternative energy price projections for a period of 20 years. The basic solution used 1978 conditions and closely approximated the actual crop acreages and other resources used in the base year 1978. Differences between the basic solution of the model and the actual production levels in 1978 resulted from the optimization procedures used.

The results of the linear programming model for the 20 year simulation period for the four alternative energy price projections are presented in the following sections.

Base Year - 1978

Approximately 31,300 acres of land were farmed, of which 94 percent was flood-irrigated, with the balance composed of sprinkler-irrigated cropland (Table 7). Alfalfa accounted for 40 percent of the total irrigated cropland, while corn for silage accounted for 25 percent, corn for grain 11 percent, wheat 10 percent, pinto beans 8 percent, and potatoes 5 percent. The net return to land and risk for the Estancia Basin for the base year 1978 was estimated to be nearly $2 million (Table 7).

The amount of irrigation water pumped in the Estancia Basin during the base year was estimated to be approximately 98,800 acre-feet with an annual decline in the water table of one foot (Table 7). The primary source of energy for pumping irrigation water was estimated to be natural gas. Farm

Table 7. Impacts of real energy price increases on the crop agriculture sector, Estancia Basin, New Mexico -- Base energy price projection, 1978-1998

Item	Unit	1978	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998
Cropping Pattern												
Flood Irrigated Crops												
Alfalfa	acres	12,509	13,009	13,530	14,071	14,634	15,219	15,828	16,461	17,120	17,804	18,517
Corn for Grain	acres	3,596	3,740	3,889	4,045	4,207	4,376	4,551	4,733	4,922	5,119	5,324
Corn for Silage	acres	7,818	8,131	8,456	8,794	9,146	9,512	9,893	10,288	10,700	11,128	11,573
Wheat for Grain	acres	3,127	3,252	3,382	3,517	3,659	3,805	3,957	4,115	4,280	4,451	4,629
Pinto Beans	acres	2,502	2,601	2,706	2,814	2,927	3,044	3,166	3,292	3,424	3,561	3,703
Total Flood Irrigated	acres	29,552	30,733	31,963	33,241	34,573	35,956	37,395	38,889	40,446	42,063	43,746
Sprinkler Irrigated Crops												
Potatoes	acres	1,720	1,788	1,860	1,935	2,012	2,093	2,176	2,263	2,354	2,448	2,546
Total Irrigated Crops	acres	31,273	32,524	33,825	35,178	36,585	38,049	39,571	41,152	42,800	44,511	46,292
Net Returns	dollars	1,969,217	2,190,995	2,320,732	2,427,439	2,525,171	2,619,755	2,714,006	2,809,302	2,906,323	3,005,470	3,106,946
Water Pumped	acre-feet	98,834	102,787	106,898	111,174	115,621	120,245	125,055	130,058	135,260	140,670	146,299
Flood Irrigation	acre-feet	93,106	96,830	100,703	104,731	108,921	113,277	117,808	122,521	127,421	132,518	137,821
Energy Source	type	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Cost	$/ac.-ft.	9.57	8.17	7.76	7.63	7.63	7.68	7.76	7.86	7.98	8.10	8.23
Sprinkler Irrigation	acre-feet	5,727	5,957	6,195	6,442	6,701	6,968	7,247	7,537	7,839	8,152	8,472
Energy Source	type	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Cost	$/ac.-ft.	14.39	13.13	12.93	12.89	12.92	13.00	13.09	13.20	13.31	13.44	13.56
Total Water Decline	feet	2.0	4.0	6.1	8.4	10.7	13.1	15.6	18.2	20.9	23.8	26.5
Farm Machinery Fuel Cost	dollars	259,849	270,243	281,053	292,295	303,987	316,143	328,789	341,942	355,619	369,844	384,642
Labor and Management												
Hours	man-hours	198,871	206,827	215,099	223,703	232,651	241,955	251,634	261,700	272,167	283,054	294,380
Cost	dollars	1,264,519	1,315,103	1,367,708	1,422,417	1,479,309	1,538,465	1,600,007	1,664,015	1,730,571	1,799,796	1,871,810
Capital Requirements												
Operating Capital	dollars	6,006,206	6,246,469	6,496,336	6,756,189	7,026,414	7,307,394	7,599,705	7,903,732	8,219,858	8,548,660	8,890,714
Fixed Capital	dollars	1,818,493	1,891,238	1,966,889	2,045,565	2,127,381	2,212,453	2,300,956	2,393,006	2,488,719	2,588,270	2,691,834
Sunk Capital	dollars	167,967	174,686	181,674	188,941	196,498	204,356	212,530	221,033	229,873	239,069	248,634

machinery fuel was assumed to be diesel with an annual cost for crop agriculture of slightly less than $260,000 for over 577,000 gallons in the base year. The annual labor requirements of over 198,000 man-hours of labor was estimated to cost $1.3 million annually. The annual operating capital requirements (excluding energy costs) were estimated at slightly more than $6 million.

Base Energy Price Alternative

The acreage farmed under this alternative increased approximately four percent every two years over the 20 year projection period (Table 7). There were no shifts in the cropping pattern, only an increase in the acreage of each crop. The net return to crop agriculture in the Estancia Basin increased from the base year level of $1.96 million to $3.1 million in 1998. This rise in net return was due to reduced costs from the increasing efficiency of the pumping plant and to increasng irrigated acreages. Pumping costs declined from 1978 to 1984, however, beyond 1984, the cost of pumping irrigation water increased because of the greater pumping depths due to the declining water table, which more than offset gains in efficiency of the pumping plant.

Approximately 98,800 acre-feet of water would be pumped in the base year, increasing 2.4 percent per year through 1998, to 146,300 acre-feet. The total water decline was estimated to be 26.5 feet for the twenty year period or 1.33 feet per year. Natural gas was estimated to be the source of energy for the pumping plant for the entire 20 year period. The per acre-foot cost of irrigation water for both flood and sprinkler decreased from 1978 to 1984. An initial decrease in water cost per acre-foot was due to a gain in efficiency of the pumping plant. From an initial pumping plant efficiency of 10.6 percent for flood and 12.6 percent for sprinkler in 1978, the efficiency increased to 13.4 percent for flood and 13.7 percent for sprinkler by 1984. The cost per acre-foot of water declined from $9.57 to $7.63 for flood irrigation and from $14.39 to $12.89 for sprinkler irrigation. Since optimal efficiency for a natural gas pumping plant has been estimated to be 13.8 percent for both flood and sprinkler, it is evident that the majority of the projected efficiency increase had been realized. Small gains in efficiency were realized from 1986 to 1998, but these were outweighed by increases in lift of over one foot per year, resulting in increases in the fuel cost for pumping irrigation water from $7.63 per acre-foot in 1986 to $8.23 in 1998 for free discharge flood units and from $12.92 to $13.56 for pressurized units.

Farm machinery fuel cost for crop agriculture was estimated to be slightly less than $260,000 for over 577,000 gallons of diesel fuel in 1978. The cost of diesel fuel and quantity used for the farm machinery rose to over $384,000 and nearly 855,000 gallons in response to the increase in the acreage farmed.

The man-hours of labor required under the base alternative increased from nearly 199,000 in 1978 to over 294,800 in 1998, this increase of 2.4 percent per year is due to the increase in acreage cultivated. Labor and management cost rose from $1.26 million in 1978 to $1.87 million in 1998. The 2.4 percent per year increase in labor cost was also attributed to increases in the cultivated acreage (Table 7).

The capital requirement for cropped agriculture in the Estancia Basin was divided into three components: operating capital, fixed capital, and sunk capital. Operating capital consisted of all purchased inputs, labor, repairs, and interest on operating capital. Fixed capital was composed of the depreciation and taxes on farm machinery and equipment, one-half the depreciation and taxes on irrigation equipment, and the interest on equipment investment. Sunk capital was comprised of only one item, one-half of the depreciation and taxes on irrigation equipment.

The operating capital required in 1978 of slightly over $6 million increased to about $8.9 million in 1998, while fixed capital rose from the 1978 level of $1.8 million to $2.7 million in 1998. In the same period, sunk capital rose from $168,880 to over $248,000. Capital requirements increased an average of 2.4 percent per year over the 20 years examined.

Low Energy Price Alternative

Neither the cropping pattern nor the acreage farmed under this alternative changed from the base alternative. The net return to crop agriculture in the Estancia Basin increased from the base year level of nearly $2 million to $2.1 million in 1986. This increase in net return was due partly to increases in acreage farmed and partly to reduced costs from the increasing efficiency of the pumping plant. The net return decreased from the 1986 level to $1.75 million in 1998. This decrease translates to a net decrease of somewhat less than one percent per year in net returns from 1978 to 1998 (Table 8).

Approximately 98,800 acre-feet of water would be pumped for crop agriculture in 1978 (Table 8), increasing to over 146,300 acre-feet in 1998, for an average yearly increase of over two percent. The total water decline was estimated to be 26.5 feet by 1998 or an average of 1.33 feet per year. The primary energy source utilized for pumping irrigation water from 1978 to 1982 was natural gas. In 1982, electricity became a cheaper source of fuel because of the lower annual price increase of two percent, therefore, it was expected to become the principal fuel source for pumping plants for the remainder of the study period.

The cost of pumping water for flood irrigation increased nearly 48 percent from 1978 to 1998, from $9.57 to $14.13 per acre-foot. The cost of irrigation water for sprinkler irrigation also rose from 1978 to 1998, from $14.39 per acre-foot to $23.30 per acre-foot, or an increase of about 62 percent. In this alternative, gains in pumping plant efficiency and water table declines were less important than the increasing costs of energy. The price of energy increased at a rate of two percent per year for electricity and four percent per year for natural gas, which quickly overcame any gains in pumping plant efficiency. The increased depth to water also added to the total water cost.

Farm machinery fuel costs were estimated to be slightly less than $260,000 for over 577,000 gallons of diesel for the base year. The yearly increase of four percent in the price of diesel fuel as well as the 2.4 percent per year increase in cropped acreage resulted in a total fuel cost of nearly $843,000 in 1998 or a yearly increase of over 11 percent. Neither the man-hours of labor, the total cost of labor and management nor the capital requirements changed from the base alternative (Table 8).

Medium Energy Price Alternative

The net return to crop agriculture in the Estancia Basin decreased from the base year level of $2 million to $847,000 in 1998 (Table 9). This represented a reduction in net returns of nearly three

Table 8. Impacts of real energy price increases on the crop agriculture sector, Estancia Basin, New Mexico -- Low energy price projection, 1978-1998

Item	Unit	1978	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998
Cropping Pattern												
Flood Irrigated Crops												
Alfalfa	acres	12,509	13,009	13,530	14,071	14,634	15,219	15,828	16,461	17,119	17,804	18,516
Corn for Grain	acres	3,596	3,740	3,889	4,045	4,207	4,375	4,550	4,732	4,921	5,118	5,323
Corn for Silage	acres	7,818	8,131	8,456	8,794	9,146	9,512	9,892	10,288	10,699	11,127	11,573
Wheat for Grain	acres	3,127	3,252	3,382	3,517	3,658	3,804	3,957	4,115	4,279	4,451	4,629
Pinto Beans	acres	2,502	2,602	2,706	2,814	2,926	3,043	3,165	3,292	3,423	3,560	3,703
Total Flood Irrigated	acres	29,552	30,734	31,963	33,241	34,571	35,953	37,392	38,888	40,441	42,060	43,744
Sprinkler Irrigated Crops												
Potatoes	acres	1,720	1,789	1,860	1,934	2,012	2,092	2,176	2,263	2,353	2,448	2,546
Total Irrigated Crops	acres	31,272	32,523	33,823	35,175	36,583	38,045	39,568	41,151	42,794	44,508	46,290
Net Returns	dollars	1,969,217	2,012,275	2,056,030	2,083,108	2,087,601	2,074,565	2,045,504	2,000,226	1,937,453	1,855,390	1,751,750
Water Pumped	acre-feet	98,834	102,787	106,898	111,174	115,621	120,244	125,055	130,057	135,259	140,670	146,298
Flood Irrigation	acre-feet	93,106	96,830	100,703	104,731	108,920	113,276	117,807	122,520	127,421	132,518	137,820
Energy Source	type	NG	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL
Cost	$/ac.-ft.	9.57	9.56	9.72	9.94	10.33	10.82	11.38	12.00	12.66	13.37	14.13
Sprinkler Irrigation	acre-feet	5,727	5,927	6,195	6,442	6,700	6,968	7,247	7,537	7,838	8,152	8,478
Energy Source	type	NG	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL
Cost	$/ac.-ft.	14.39	15.36	16.18	16.78	17.50	18.31	19.19	20.13	21.13	22.18	23.30
Total Water Decline	feet	2.0	4.0	6.1	8.4	10.7	13.1	15.6	18.2	20.9	23.8	26.5
Farm Machinery Fuel Cost	dollars	259,849	292,295	328,776	329,841	416,036	467,954	526,391	592,107	666,074	749,230	842,790
Labor and Management												
Hours	man-hours	198,871	206,826	215,099	223,703	232,651	241,954	251,633	261,700	272,167	283,054	294,380
Cost	dollars	1,264,519	1,315,103	1,367,708	1,422,417	1,479,308	1,538,465	1,600,007	1,664,015	1,730,571	1,799,795	1,871,810
Capital Requirements												
Operating Capital	dollars	6,006,206	6,246,470	6,496,336	6,756,189	7,026,414	7,307,394	7,599,705	7,903,732	8,219,858	8,548,660	8,890,714
Fixed Capital	dollars	1,818,493	1,891,238	1,966,889	2,045,565	2,127,381	2,212,453	2,300,955	2,393,005	2,488,719	2,588,270	2,691,833
Sunk Capital	dollars	167,967	174,686	181,674	188,941	196,498	204,355	212,530	221,032	229,873	239,068	248,634

Table 9. Impacts of real energy price increases on the crop agriculture sector, Estancia Basin, New Mexico -- Medium energy price projection, 1978-1998

Item	Unit	1978	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998
Cropping Pattern												
Flood Irrigated Crops												
Alfalfa	acres	12,509	13,009	13,530	14,071	14,634	15,219	15,828	16,461	17,119	17,804	18,516
Corn for Grain	acres	3,596	3,740	3,889	4,045	4,207	4,375	4,550	4,732	4,921	5,118	5,323
Corn Silage	acres	7,818	8,131	8,456	8,794	9,146	9,512	9,892	10,288	10,699	11,127	11,573
Wheat for Grain	acres	3,127	3,252	3,382	3,517	3,658	3,804	3,957	4,115	4,279	4,451	4,629
Pinto Beans	acres	2,502	2,601	2,706	2,814	2,926	3,043	3,165	3,292	3,423	3,560	3,703
Total Flood Irrigated	acres	29,552	30,733	31,963	33,241	34,571	35,953	37,392	38,888	40,441	42,060	43,744
Sprinkler Irrigated Crops												
Potatoes	acres	1,720	1,788	1,860	1,934	2,012	2,092	2,176	2,263	2,353	2,448	2,546
Total Irrigated Crops	acres	31,273	32,521	33,823	35,175	36,583	38,045	39,568	41,151	42,794	44,508	46,290
Net Returns	dollars	1,969,217	1,939,390	1,964,952	1,945,016	1,891,777	1,808,231	1,693,697	1,545,223	1,358,562	1,128,111	847,178
Water Pumped	acre-feet	98,834	102,787	106,898	111,174	115,621	120,244	125,055	130,057	135,259	140,670	146,298
Flood Irrigation	acre-feet	93,106	96,830	100,703	104,731	108,920	113,276	117,807	122,520	127,421	132,518	137,820
Energy Source	type	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL	EL
Cost	$/ac.-ft.	9.57	10.22	10.30	10.74	11.39	12.16	13.05	14.02	15.09	16.25	17.52
Sprinkler Irrigation	acre-feet	5,727	5,956	6,195	6,442	6,700	6,968	7,247	7,537	7,838	8,152	8,478
Energy Source	type	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL	EL
Cost	$/ac.-ft.	14.39	16.42	17.16	18.14	19.30	20.59	22.00	23.53	25.18	26.96	28.88
Total Water Decline	feet	2.0	4.0	6.1	8.4	10.7	13.1	15.6	18.2	20.9	23.8	26.5
Farm Machinery Fuel Cost	dollars	259,849	303,645	354,802	414,621	484,493	566,148	661,556	773,097	903,379	1,055,646	1,233,587
Labor and Management												
Hours	man-hours	198,871	206,826	215,099	223,703	232,651	241,954	251,633	261,700	272,167	283,054	294,380
Cost	dollars	1,264,519	1,315,103	1,367,708	1,422,417	1,479,308	1,538,465	1,600,007	1,664,015	1,730,571	1,799,795	1,871,810
Capital Requirements												
Operating Capital	dollars	6,006,206	6,246,469	6,496,336	6,756,189	7,026,414	7,307,394	7,599,705	7,903,732	8,219,858	8,548,660	8,890,714
Fixed Capital	dollars	1,818,493	1,891,238	1,966,889	2,045,565	2,127,381	2,212,453	2,300,955	2,393,005	2,488,719	2,588,270	2,691,833
Sunk Capital	dollars	167,967	174,686	181,674	188,941	196,498	204,355	212,530	221,032	229,873	239,068	248,634

percent per year. The primary reason for the decrease in net returns was the rapid escalation of the price of diesel fuel utilized in farm machinery. Diesel fuel prices increased at an annual rate of six percent per year, as did that of natural gas. The cost of electricity (which was used as the principal source of power in the pumping plant from 1980 onward) increased at a rate of three percent annually. The effects of these rising energy prices are readily seen in the 56 percent reduction of net returns to crop agriculture.

The major energy source for pumping irrigation water was natural gas from 1978 through 1980, at which time it changed to electricity. A steady increase in the cost per acre-foot of irrigation water throughout the 20 year time period illustrates the impact of energy price increases which were greater than the gains in pumping plant efficiency. While the pumping plant progressed from original to good efficiency, energy prices increased much faster, resulting in water cost increases of 4.2 percent per year for flood units and 5.7 percent per year for sprinkler units. In 1978 the cost of pumping one acre-foot of water was $9.57 for flood and $14.39 for sprinkler. The cost increased to $17.52 for flood and and $28.88 for sprinkler in 1998 (Table 9).

The amount of water pumped for irrigation was 98,800 acre-feet in 1978. As the cropped acreage increased, the amount of water pumped also increased, rising to 146,300 acre-feet in 1998. Irrigation water pumpage increased an average of 2.4 percent per year. The water declines averaged 1.33 feet per year for a total of 26.5 feet in 1998.

The farm machinery fuel cost for crop agriculture in the Estancia Basin was estimated to be over $1.2 million by 1998. This represents a rise of over 375 percent from the 1978 level. This increase was due to the increasing crop acreage and the increasing price of diesel. Labor requirements and capital requirements (other than for fuel) did not change from the base projection (Table 9).

High Energy Price Alternative

The net return to crop agriculture decreased from $1.96 million in the base year to zero in 1998, even though the cropping pattern and acreage farmed remained unchanged from the previous energy price alternatives until 1998 when irrigated cropped agriculture ceased. This decrease was due to the higher prices paid for diesel fuel, natural gas, and electricity. Of greatest importance was diesel fuel, which increased eight percent per year, thereby greatly reducing the amount of net returns to agriculture. The pumping plant fuels, primarily natural gas and electricity increased eight percent and four percent per year, respectively. Once again, the price increase in these fuels quickly cancelled any savings due to increases in pumping plant efficiency, resulting in higher costs and lower returns (Table 10).

The cost of pumping the increasing amounts of water each year rose from 1978 to 1996 when irrigation ceased in the Estancia Basin. The cost per acre-foot of irrigation water rose 106 percent for free discharge units and 127 percent for pressurized systems from 1978 to 1996. The principal fuel for pumping plants changed from natural gas to electricity, the least costly fuel source, in 1980 (Table 10). Also embodied in the increasing cost of irrigation water was the increased energy requirement to lift water as the water table declined. The amounts of water pumped in each time period did not change from the previous energy price alternatives except in 1998 when irrigation

Table 10. Impacts of real energy price increases on the crop agriculture sector, Estancia Basin, New Mexico -- High energy price projection, 1978-1998

Item	Unit	1978	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998
Cropping Pattern												
Flood Irrigated Crops												
Alfalfa	acres	12,509	13,009	13,530	14,071	14,634	15,219	15,828	16,461	17,119	17,804	--
Corn for Grain	acres	3,596	3,740	3,889	4,045	4,207	4,375	4,550	4,732	4,921	5,118	--
Corn for Silage	acres	7,818	8,131	8,456	8,794	9,146	9,512	9,892	10,288	10,699	11,127	--
Wheat for Grain	acres	3,127	3,252	3,382	3,517	3,658	3,804	3,957	4,115	4,279	4,451	--
Pinto Beans	acres	2,502	2,601	2,706	2,814	2,926	3,043	3,165	3,292	3,423	3,560	--
Total Flood Irrigated	acres	29,552	30,733	31,963	33,241	34,571	35,953	37,392	38,888	40,441	42,060	--
Sprinkler Irrigated Crops												
Potatoes	acres	1,720	1,788	1,860	1,934	2,012	2,092	2,176	2,263	2,353	2,448	--
Total Irrigated Crops	acres	31,273	32,521	33,823	35,175	36,583	38,045	39,568	41,151	42,794	44,508	--
Net Returns	dollars	1,969,217	1,884,968	1,869,122	1,795,954	1,674,625	1,504,766	1,281,544	997,042	640,758	199,706	--
Water Pumped	acre-feet	98,834	102,787	106,898	111,174	115,621	120,244	125,055	130,057	135,259	140,670	--
Flood Irrigation	acre-feet	93,106	96,830	100,703	104,731	108,920	113,276	117,807	122,520	127,421	132,518	--
Energy Source	type	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL	--
Cost	$/ac.-ft.	9.57	10.62	10.92	11.61	12.54	13.66	14.94	16.37	17.96	19.72	--
Sprinkler Irrigation	acre-feet	5,727	5,956	6,195	6,442	6,700	6,968	7,247	7,537	7,838	8,152	--
Energy Source	type	NG	EL	EL	EL	EL	EL	EL	EL	EL	EL	--
Cost	$/ac.-ft.	14.39	17.07	18.18	19.60	21.26	23.12	25.19	27.47	29.97	32.71	--
Total Water Decline	feet	2.0	4.0	6.1	8.4	10.7	13.1	15.6	18.2	20.9	23.8	23.8
Farm Machinery Fuel Cost	dollars	259,849	315,212	382,345	463,814	562,648	682,520	827,923	1,004,318	1,218,315	1,477,897	--
Labor and Management												
Hours	man-hours	198,871	206,826	215,099	223,703	232,651	241,954	251,633	261,700	272,167	283,054	--
Cost	dollars	1,264,519	1,315,103	1,367,708	1,422,417	1,479,308	1,538,463	1,600,007	1,664,015	1,730,571	1,799,795	--
Capital Requirements												
Operating Capital	dollars	6,006,206	6,246,469	6,496,336	6,756,189	7,026,414	7,307,394	7,599,705	7,903,732	8,219,858	8,548,660	--
Fixed Capital	dollars	1,818,493	1,891,238	1,966,889	2,045,565	2,127,381	2,212,453	2,300,955	2,393,005	2,488,719	2,588,270	--
Sunk Capital	dollars	167,967	174,686	181,674	188,941	196,498	204,355	212,530	221,032	229,873	239,068	--

ceased. The total water decline of 23.8 feet (average of 1.19 feet per year) was less than the other three alternatives since there was no water pumped in 1998.

Farm machinery fuel costs for agriculture were estimated to increase 469 percent (to $1.47 million) by 1996. Farm machinery fuel cost accounted for most of the reduction in net returns. It should be noted that this increase was due to the change in the price of diesel fuel, as well as increasing acreages.

Labor hours required under this projection were identical to the requirement for the previous projections through 1996, rising from 199,000 in 1978 to 283,000. The cost was also the same as in previous energy price alternatives rising to $1.8 million in 1996 from the base year level. Capital requirements did not change from the levels stated in the base, low and medium projections through 1996 (Table 10).

Implications

The impact of increasing energy costs and increasing pumping lifts on the irrigated agriculture in the Estancia Basin, may be characterized by expanding acreages and declining per acre returns if energy price increased faster than the general price level. Even though the per acre returns declined, there was sufficient return to land and risk to encourage expansion of the irrigated agriculture sector. The acres irrigated increased by about 43 percent under all energy price alternatives. The expanding irrigated acreage required increased labor hours which develops increased dollar payments to labor and management, and increases overall capital requirements.

The declining per acre returns to land and risk on the low, medium, and high energy price alternatives resulted from increased farm machinery fuel costs, increasing irrigation fuel costs, and increasing pumping lifts. Under the base energy price alternative there was an increase in net returns of seven percent which was due to increased pumping plant efficiency and constant fuel costs. The low energy price increase resulted in per acre declines in returns to land and risk of 40 percent. The medium energy price alternative resulted in decline to average per acre return of 70 percent. The decline in per acre returns to land and risk were 93 percent in 1996 and 100 percent when irrigated agriculture stopped in 1998 under the high alternative.

This constant decline in returns to land and risk indicates that farmers will be forced to acquire increased capital for both operating and machinery purposes under lowered per acre profit margins. This will cause farmers to have increased difficulty in obtaining operating and machinery capital over the long run.

The agricultural impacts on the water resources in the Estancia Basin will be numerous. As the irrigated acreage expands, the amount of water pumped for irrigation will increase, causing the rate of decline to be greater than the historic rate. However, if the higher energy price alternative as described is the actual situation, water depletions for irrigated agriculture may be reduced to zero by the year 1998.

The returns to risk, after imposing a charge for the use of irrigated cropland valued at $1,000 per acre, was a negative $37 per acre in the base year (1978). The negative returns to risk became even greater under the high alternative ($96) in 1996 and the low ($60) and medium ($80) alternatives in 1998. Under the base price alternative the net return to risk was estimated at a negative $33 per acre in 1998.

The negative returns to risk in the base year indicate that the land prices are higher than irrigated agriculture can support in the long run. The base year land price of $1,000 per year was due not only to the value of the land for agricultural purposes, but also the value of the water rights, urban pressure, and inflationary expectations. However, if the valuation of the water resources is either for speculation or other future uses and if the water rights are basically controlled by the land ownership, then overvaluation of the land and water resources are likely to continue in the short-run. The value of the water rights and land must decline in the long run or force out irrigated agriculture, if the prices received for agricultural outputs do not increase at a rate faster than the general price level.

SUMMARY

The primary purpose of this study was to evaluate the economic impacts of alternative energy prices and declining groundwater levels on the irrigated agricultural sector in the Estancia Basin for the period 1978 to 1998.

The comprehensiveness of the study was made possible through the inclusion of a wide range of disciplines and area studies. These disciplinary activities were designed primarily to provide necessary information for the linear programming model. These activities included data collection, analysis, and interpretation. Secondary data were compiled whenever possible.

Economic Model

A linear programming (LP) model was developed, incorporating crop enterprise cost and returns budgets, a pumping cost model, hydrologic data, and projected energy prices for the Estancia Basin. The LP model incorporates the outputs of each sub-investigation and was utilized to project future water-use patterns and irrigated agricultural economic activity under alternative energy costs. The model is designed to maximize regional farm return to land and risk. Each crop contributes to the total farm return according to its level of production, while increased energy costs and declining water table levels impose additional costs on the region's economy.

Hydrologic Data

Economic analysis of irrigated agriculture required the evaluation of the groundwater characteristics and quantification of parameters regarding existing and future conditions. Historic data on water levels, rates of decline, pumping lift, and well yield were obtained from various publications and open-file reports of the New Mexico State Engineer Office for use in this analysis. The principal aquifer has a practical maximum thickness of 300 feet. A saturated thickness of 20 feet was selected as the minimum value which would yield sufficient water to support irrigated agriculture. Typical irrigation wells in the area yield about 800 gpm. The present pumping lift is 125 feet of static lift plus 30 feet of drawdown, resulting in a total lift of 155 feet. For sprinkler irrigation systems an additional 116 feet of lift was added for pressurizing the sprinkler system resulting in 271 feet of pumping lift. The wells presently have specific capacity of approximately 27 gpm per foot of drawdown. It was estimated that water level decline was one foot per year.

Cost and Returns Budgets

Per acre crop cost and returns enterprise budgets were developed for the more important irrigated crops for the Estancia Basin for farms that are above-average in both size and management. Much of the information for the budgets was obtained from local farmers during a series of meetings in 1979 and 1980. These budgets were developed on the basis of soil, water quality and water quantity conditions. The measure of profit used in constructing the enterprise budgets was net return to land and risk. Cost and returns per acre were budgeted for production of seven major irrigated crops (alfalfa, corn for grain, corn silage, potatoes, pinto beans, Jose wheatgrass pasture, and wheat). Both flood and center-pivot irrigation systems were included in the budgets.

The typical flood-irrigated farm was estimated to contain 640 acres, of which 600 acres would be cropped as follows: about 50 percent alfalfa, 10 percent corn for grain, 25 percent corn silage, 3 percent pinto beans, 3 percent Jose wheatgrass pasture, and 10 percent wheat. This farm was estimated to have five irrigation wells producing 800 gpm each. The typical sprinkler-irrigated farm was also estimated to contain 640 acres, with 520 acres in crops and a similar cropping pattern as the flood-irrigated farm, except potatoes are substituted for the pinto beans and pasture. Such a farm was estimated to have four center-pivot sprinkler systems and four irrigation wells producing 800 gpm each.

Yields, and therefore, gross returns were estimated to be higher on crops produced under the sprinkler systems. Typically, the increased yields and reduced labor costs nearly offset the higher fixed and variable costs associated with the center-pivot sprinkler system. The difference in net operating profit between flood- and sprinkler-irrigated crops ranged from less than $1 to nearly $11 per acre. However, when an interest charge was assessed for operating capital and equipment investment, the differences in net return to land and risk became larger, varying from $8 per acre for corn for grain to nearly $28 per acre for alfalfa. The flood-irrigated crops had higher net returns to land and risk than did the center-pivot irrigated crops.

Energy Price Projections

Increasing energy costs affect agriculture through increased fertilizer prices, increased fuel costs for pumping irrigation water, and increased fuel costs for operating farm machinery. The magnitude of these impacts will depend upon the rate of the energy price increase. To provide for a wide range of real energy price increases, this study presents the effects under four energy price increases: base, low, medium, and high. The base energy price projection was no real increase in the price of energy products purchased by farmers in New Mexico during the period 1978-1998. A low energy price projection estimated a low annual real energy increase, a third projection estimated a medium real annual price increase for energy which essentially was 1.5 times the low alternative, and a high projection estimated a high real annual increase in energy prices or about two times the low energy alternative.

Impact Projections

The linear programming model was utilized to simulate a 20 year period (1978-1998) crop production and irrigation water utilization pattern in the Estancia Basin under alternative energy price projections. Each simulation process begins with the same basic solution of the model, and continues with bi-annual changes to satisfy the alternative energy price projections for the 20 year period. The basic solution used 1978 conditions and closely approximated the actual crop acreages and other resources used in the base year 1978.

The results of the linear programming model for the 20 year simulation period for the four alternative energy price projections follows:

Base Year - 1978

Approximately 31,300 acres of land would be farmed, of which 94 percent was flood-irrigated, with the balance composed of sprinkler-irrigated cropland (Table 11). The net return to land and risk for the Estancia Basin for the base year 1978 was estimated to be nearly $2 million. The amount of irrigation water pumped in the Estancia Basin during the base year was estimated to be approximately 98,800 acre-feet with an annual decline in the water table of one foot. The primary source of energy for pumping irrigation water was natural gas. Farm machinery fuel was assumed to be diesel with an annual cost for crop agriculture of slightly less than $260,000. The annual labor requirements was over 198,000 man-hours of labor and estimated to cost $1.5 million annually.

The capital requirement for cropped agriculture in the Estancia Basin was divided into three components: operating capital, fixed capital, and sunk capital. Operating capital consisted of all purchased inputs, labor, repairs, and interest on operating capital. Fixed capital was composed of the depreciation and taxes on farm machinery and equipment, one-half the depreciation and taxes on irrigation equipment, and the interest on equipment investment. Sunk capital was comprised of only one item, one-half of the depreciation and taxes on irrigation equipment. The annual operating capital requirements (excluding energy costs) were estimated at slightly more than $6 million. Fixed capital requirements were estimated at approximately $1.8 million and sunk capital at $168,880.

Base Energy Price Alternative

The acreage farmed under this alternative increased approximately two percent per year over the 20 year projection period (Table 11). There were no shifts in the cropping pattern, only an increase in the acreage of crops. The net return to crop agriculture in the Estancia Basin increased from the base year level of $1.96 million to $3.1 million in 1998. This rise in net return was due to reduced costs by the increased efficiency of the pumping plant and increased irrigated acreages. Approximately 146,300 acre-feet of water would be pumped in 1998. Natural gas would be the source of energy for the pumping plant for the entire 20 year period. Pumping costs declined from 1978 to 1984, however, beyond 1984 the cost of pumping irrigation water increased because of the greater pumping depths due to the declining water table, which more than offset gains in efficiency of the pumping plant. The per acre-foot cost of irrigation water for both flood and sprinkler decreased from 1978 to 1998. The fuel cost for pumping irrigation water was estimated to be $8.23 per acre-foot in 1998 for free discharge flood units and $13.56 for pressurized units.

Table 11. Comparisons of the impacts resulting from the four energy price projections on the crop agricultural sector, Estancia Basin, New Mexico 1978-1998

Item	Units	Base Year 1978	Energy Price Projection Base	Low	Medium	High	High Energy Price Projection
			- - - - - - - - - - -1998- - - - - - - - - - -				- - - 1996 - -
Acres Irrigated							
Flood	acres	29,552	43,746	43,744	43,744	0	42,060
Sprinkler	acres	1,720	2,546	2,546	2,546	0	2,448
Net Returns to Land and Risk - Region	dollars	1,969,217	3,106,946	1,751,750	847,178	0	199,706
	$/acre	62.92	67.12	37.84	18.30	0	4.49
Net Returns to Risk[b] - Region	dollars	-1,157,983	-1,522,254	-2,777,250	-3,681,822	0	-4,251,094
	$/acre	-37.03	-32.88	-59.99	-79.53	0	-95.51
Water Pumped	acre feet	98,834	146,299	146,299	146,298	0	132,518
Energy Cost							
Flood	acre feet	9.57	8.23	14.13	17.52	0	19.72
Sprinkler	acre feet	14.39	13.56	23.30	28.88	0	32.71
Farm Machinery Fuel Costs	dollars	259,849	384,642	842,790	1,233,587	0	1,477,897
	$/acre	8.30	8.30	18.20	26.65		33.20
Capital Requirements							
Operating	dollars	6,006,206	8,890,714	8,890,714	8,890,714	0	8,548,660
Fixed	dollars	1,818,493	2,691,834	2,691,834	2,691,833	0	2,588,270
Sunk	dollars	167,967	248,634	248,634	248,634	0	239,068

[a] In 1998 there would be no irrigated agricultural production under this energy price projection because the net return to land and risk would be negative.

[b] Returns to risk = net returns to land and risk - (10% x acres irrigated x $1,000 per acre).

Farm machinery fuel cost for crop agriculture was estimated to increase to over $384,000 for nearly 855,000 gallons in 1998 due to the increase in the acreage farmed and rising energy costs. The man-hours of labor are expected to increase to over 294,800 hours in 1998 or 2.4 percent per year increase because of the increased acreage farmed. Labor and management costs rose from $1.26 million in 1978 to $1.87 million in 1998. The operating capital increased to about $8.9 million in 1998, fixed capital rose to $2.7 million in 1998, and sunk capital rose to over $248,000.

Low Energy Price Alternative

Neither the cropping pattern nor the acreage farmed under this alternative changed from the base energy price alternative. The net return to crop agriculture in the Estancia Basin decreased from the base year level of nearly $2 million to $1.75 million in 1998 (Table 11). Approximately 146,300 acre-feet of water would be pumped in 1998. The primary energy source for pumping irrigtion water from 1978 to 1982 would be natural gas. In 1982, electricity would become a cheaper source of fuel because of the lower annual price increase of two percent. The cost of pumping water for flood irrigation increased from $9.57 to $14.13 per acre-foot (48 percent) from 1978 to 1998. The cost of irrigation water for sprinkler irrigation also rose from $14.39 per acre-foot to $23.30 per acre-foot or an increase of about 62 percent from 1978 to 1998. Farm machinery fuel costs were estimated to be slightly less than $843,000 in 1998 or a yearly increase of over 11 percent. Neither the man-hours of labor, the total cost of labor and management, nor capital requirements changed from the base energy price alternative.

Medium Energy Price Alternative

The net return to crop agriculture in the Estancia Basin decreased from the base year level of $2 million to $847,000 in 1998 or nearly three percent per year (Table 11).

The primary reason for the decrease in net returns was the rapid escalation of the price of diesel fuel utilized in farm machinery. The major energy source for pumping irrigation water was natural gas from 1978 through 1980, at which time it is expected the source will change to electricity. The effects of these rising energy prices are readily seen in the 56 percent reduction of net returns to crop agriculture. The cost of pumping irrigation water increased to $17.52 per acre-foot for flood and $28.88 for sprinkler in 1998, (Table 11), while the amount of water pumped remained at 146,300 acre-feet.

The farm machinery fuel cost for crop agriculture was estimated to be over $1.2 million by 1998 which is over 375 percent above the 1978 level. This increase was due to increased crop acreage and increased price of diesel. Labor requirements and capital requirements (other than for fuel) did not change from the base energy price projection.

High Energy Price Alternative

The net return to crop agriculture decreased from $1.96 million in the base year to zero in 1998, even though the cropping pattern and acreage farmed remained unchanged from the previous energy price alternatives until 1996 after which irrigated agriculture would cease (Table 11). This decrease was due to the higher prices paid for diesel fuel, natural gas, and electricity. Of greatest importance was diesel fuel, which increased eight percent per year. The pumping plant fuels, primarily natural gas and electricity increased 8 percent and 4 percent per year, respectively. The cost of pumping water each year increased 106 percent for free discharge units and 127 percent for pressurized systems from 1978 to 1996. The principal fuel for pumping plants changed from natual gas to electricity. Also embodied in the increasing cost of irrigation water was the increased energy requirement to lift water as the water table declined.

Farm machinery fuel costs for agriculture were estimated to increase 469 percent (to $1.47 million) by 1996. Farm machinery fuel cost accounted for most of the reduction in net returns. Labor hours and capital under this projection were identical to the requirement for the previous projections through 1996, rising to 283,000 man-hours in 1996 at a cost of $1.8 million.

Returns to Risk

The returns to risk, after imposing a charge for the use of irrigated cropland valued at $1,000 per acre, was a negative $37 per acre in the base year (1978). The negative returns to risk become even greater under the high alternative ($96) in 1996 and the low ($60) and medium ($80) alternatives in 1998. Under the base price alternative the net return to risk was estimated at a negative $33 per acre in 1998. The base year land prices of $1,000 per year was due not only to the value of the land for agricultural purposes, but also the value of the water right, urban pressure, and inflationary expectations. However, if the valuation of the water resources is either for speculation or other future uses, and if the water rights are basically controlled by the land ownership, the overvaluation of the land and water rights and land must decline in the long run or force out irrigated agriculture, if the prices received for agricultural outputs do not increase at a rate faster than the general price level.

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APPENDIX A: LINEAR PROGRAMMING MODEL

APPENDIX A: LINEAR PROGRAMMING MODEL

The basic economic model is a linear programming (LP) model. The other models (fuel costs, pumping cost) provide input into the LP model. The objective function for the model (regional returns to land and risk) can be represented by the following equation:

$$\text{Maximize} \quad \sum_c \sum_j \sum_k R_{cikt} X_{cikt} - (FCAF_{ijkt} WP_{jkt}) - MFC_{it} - OC_{ckt} - FC_{ckt} - SC_{ckt} \qquad [1]$$

where:

R_{cikt} = Gross crop returns in dollars per acre for crop c under energy price increase i, under well type k, in time period t

X_{cikt} = Acres of crop c given an energy price increase i, under well type k, in time period t

$FCAF_{ijkt}$ = Fuel cost per acre-foot of water pumped under energy price increase i, fuel type j, well type k, in time period t

WP_{jkt} = Water pumped with fuel j, under well type k in time period t

MFC_{it} = Regional machinery fuel cost (diesel cost) under energy price increase i, in time period t

OC_{ckt} = Operating capital (purchased inputs, labor and management, repairs, and interest on operating capital) for crop c, under well type k, in time period t

FC_{ckt} = Fixed capital (depreciation and taxes on machinery and equipment, one-half the depreciation and taxes on irrigation equipment, and interest on equipment investment) for crop c, under well type k, in time period t

SC_{ckt} = Sunk capital (one-half the depreciation and taxes on irrigation equipment) on crop c, under well type k, in time period t

Pumping Cost Model

The fuel cost per acre-foot of water effectively applied to a crop is a function of many factors. Some of the most important factors include: efficiency of the distribution and application system, base fuel costs, pumping unit efficiency, depth to water, well output and pressurization, if any.

The efficiency of the distribution and application system in this study refers to how efficiently the water is applied to crops after leaving the well. The more efficient the distribution and application system the fewer the gallons of water that must be pumped to meet crops needs plus losses. The assumed average efficiencies for the distribution and application system were derived from the crop budgets for the region by Lansford, et al. (1980).

The base fuel costs for natural gas, electricity, and diesel were those reported by Lansford, et al. (1980), in the regional crop budgets. The base fuel costs were increased by the real energy price increases presented in Table 5 to project fuel costs. The estimate of future fuel costs were determined by equation 2.

$$FC_{ijt} = BC_j \ (1 + EPI_{ij})^t \qquad [2]$$

where: FC_{ijt} = Fuel cost for fuel type j, in time period t, under energy price increase i

j = Fuel type; natural gas, electricity, diesel, or LP gas

i = Energy price increase

t = Time period where 1978 is the base year to 1998 for a 20 year period beyond the base year

BC_j = Base cost of fuel j in 1978

EPI_{ij} = Energy price increase for fuel j, for energy price i, in constant 1978 dollars as a percent per year

The base pumping unit efficiencies were based on a study by Abernathy (1978), presented in Table 6 and discussed earlier in this report. In this study it was assumed that the pumping plant efficiency would be increased by one-half the difference between present efficiency and good efficiency every two years. Thus, the pumping plant efficiencies increase for all 20 years of the projections, with the greatest increase occuring in the early time periods. The method of increasing pumping plant efficiencies is presented in equation 3:

$$E_{jkt} = E_{jk(t-2)} + [(GE_j - E_{jk(t-2)}) \div 2] \qquad [3]$$

where: E_{jkt} = Pumping plant efficiency for fuel type j, well type k in time period t

k = Well type: flood or sprinkler

t = Time period where 1978 is the base year and 1998 represents a 20 year period beyond the base

GE_j = Good efficiency for a pumping plant utilizing fuel j

The depth to water as it relates to pumping costs is composed of two parts, the static water level and the drawdown. The static water level was determined for the region from the crop budgets by Lansford, et al. (1980). The drawdown was based on the hydrology section of this report for each region. The original depth to water is presented in Table A-1. The well output was determined from the crop budgets by Lansford, et al. (1980), and is also presented in Table A-1.

The pumping fuel cost model is presented in equations 4 through 7. Equation 4 presents the method used for determining total water decline. The method for calculating water horsepower requirements are presented in Equation 5. Equation 6 presents the calculations for determining the fuel cost per hour. Equation 7 converts the fuel cost per hour to fuel cost per acre foot.

$$TD_t = WP_{(t-n)} (WD \div WP_{1977}) \qquad [4]$$

where: TD_t = total decline in water table in year t

$WP_{(t-n)}$ = total water pumped in each of the previous time periods (t-n)

Table A-1. Assumptions for pumping cost model for the Estancia Basin, New Mexico, 1978

Item	Unit	Estancia Basin
Water Decline*	ft/yr	1.0
Water Pumped in 1977	ac-ft	99,492
Original Depth to Water**		
Flood	feet	125
Sprinkler***	feet	241
Gallons per Minute Pumped		
Flood	gallons	800
Sprinkler	gallons	800

* From results section dealing with hydrology

** Depth to water includes the static water table and average drawdown for the area

*** Includes the pressurization equivalent of 116 feet of head

WD = Water decline based on historical data (Table A-1)

WP_{1977} = water pumped in 1977 (Table A-1)

$(WD \div WP_{1977})$ = decline of water table in feet per year per acre foot of water pumped for crops in 1977

n = a time period greater than one and less than t

$$WHP_k = (TD_t + D_k + P_k)\ GPM \div 3960 \qquad [5]$$

where:

WHP_k = Water horsepower for well type (k)

TD_t = Total decline in water table (from equation 4)

D_k = Depth to water for well type k (Table A-1)

P_k = Pressurization required for well type k (sprinkler is 50 psi which equals 116 feet of static head; flood is 0 psi included in depth to water in Table A-1).

GPM = Gallons per minute pumped (Table A-1)

3960 = BTU's required to lift one gallon one foot

$$FCH_{ijkt} = (WHP_k FR_j)\ FC_{ijt} \qquad [6]$$

where: FCH_{ijkt} = Fuel cost per hour for fuel type j under energy price increase i, and well type j in time period t

WHP_k = Water horsepower for well type k (from equation 5)

FR_j = Quantity of fuel required to develop one water horsepower for fuel type j (High Plains Underground Water Conservation District Number 1, 1976)

FC_{ijt} = Fuel cost for fuel j under energy price i in time period t (from equation 2)

$$FCAF_{ijkt} = (GE_j/E_{jkt})\ FCH_{ijkt}\ (325{,}851/(GPM \times 60)) \qquad [7]$$

where: $FCAF_{ijkt}$ = Fuel cost per acre-foot of water pumped under energy price increase i, fuel type j, well type k, in time period t

GE_j = Good pumping plant efficiency for pumping plants using fuel j

E_{jkt} = Present pumping plant efficiency for fuel type j and pumping plant (well) type k in time period t (from equation 3).

FCH_{jkt} = Fuel cost per hour for fuel type j, under energy price increase i, well type k, in time period t (from equation 6)

325,851 = Gallons per acre foot

60 = Minutes per hour

The fuel cost per acre foot of water pumped was then included directly in the linear programming model.

Base fuel costs for tractors and harvesting equipment were obtained from the crop budgets by Lansford, et al. (1980). In the study by Lansford, all farm machinery was assumed to be diesel powered. The fuel costs were based on $0.45 per gallon diesel fuel and fuel consumption rates from the 1978 Nebraska Tractor Test Data.

In this study the increased fuel costs for operating diesel powered farm machinery was used as an estimate of the increased fuel costs of all farm machinery. Future fuel costs for farm machinery were obtained from the following equation:

$$MFC_{it} = BC_j\ (1 + EPI_{ij})^t \qquad [8]$$

where: MFC_{it} = Machinery fuel cost (diesel fuel cost) in time period t under energy price increase i

t = Time period where 1978 is the base year and 1998 is 20 years beyond the base year

i = Energy price increase scenerio

BC_j = Base cost of diesel fuel in 1978

EPI_{ij} = Energy price increase i in constant 1978 dollars in percent per year

Resource Constraints

The objective function, Equation [1], was maximized subject to regional resource availability. The resource constraints also consider "typical" farming practices such as crop rotation and risk diversification. The general constraints were as follows:

1. The summation of all irrigated cropping activity levels cannot exceed the total irrigable land.

$$\sum_{c} \sum_{k} I_{cikt} \leq TI$$

   The total irrigated land TI was allowed to increase at four percent per time period due to the large idle and fallow acreage in the area and the large saturated thickness of the acquifer.

2. For rotational practices and risk and uncertainty diversification, each single irrigated crop activity level was assumed to not exceed a percentage of the total irrigated cropland.

$$\sum_{k} I_{cikt} \leq Y_c \, TI$$

   In addition, for crop rotational practices it was necessary to include a minimum acreage for some crops in the subregions.

$$\sum_{k} I_{cikt} \geq Q_c \, TI$$

3. Counting rows were included in the model to sum the different capital requirements to subtract from the objective function and for informational purposes. They are:

   a. Operating capital requirements,

$$\sum_{c} \sum_{k} o_{cikt} = Or$$

   b. Fixed capital requirements,

$$\sum_{c} \sum_{k} f_{cikt} = Fr$$

   c. Sunk capital requirements,

$$\sum_{c} \sum_{k} s_{cikt} = Sr$$

   d. Labor hours,

$$\sum_{c} \sum_{k} lh_{cikt} = Lh$$

   e. Labor and supervision and management cost,

$$\sum_{c} \sum_{k} lc_{cikt} = Lc$$

   f. Fuel cost,

$$\sum_{c} \sum_{k} fc_{cikt} = BC$$

where:

I = Acres of irrigated crops

TI = Total irrigated land available

Y_c = Maximum percentage of total irrigated land that can be planted in crop c

Q_c = Minimum percentage of total irrigated land that must be planted in crop c

Or = Total operating capital requirements

Fr = Total fixed capital requirements

Sr = Total sunk capital requirements

Lh = Total hours of labor required

Lc = Total cost of labor, supervision and management

BC = Total base fuel cost

c = Type of crop

i = Energy price increase

k = Well type

t = Time period

o_{cikt} = Operating capital requirements (purchased inputs, labor and management, repairs, and interest on operating capital)

f_{cikt} = Fixed capital requirements (depreciation and taxes on machinery and equipment, one-half the depreciation and taxes on irrigation equipment, and interest on equipment investment)

s_{cikt} = Sunk capital requirements (one-half the depreciation and taxes on irrigation equipment)

lh_{cikt} = Labor hours required

lc_{cikt} = Labor supervision and management cost

fc_{cikt} = Dollars of fuel used by crop c

Estancia Basin

The specific resource constraints in the Estancia Basin were as follows:

$$\sum_c \sum_k I_{ckit} \leq 31{,}273 \text{ acres} + TI\,(1 + a)^t$$

a = Zero in 1978 and then a positive 4 percent for each time period through 1998

$$\sum_k I_{ckit} \leq Y_c\, TI \quad \text{and} \quad \sum_k I_{cikt} \geq Q_c\, TI$$

where the values Y_c and Q_c are given below for each crop:

	Y_c	Q_c
alfalfa	0.40	
pasture	0.40	
small grains	0.30	0.10
corn for silage	0.25	
corn for grain	0.15	
pinto beans	0.08	
potatoes	0.055	

APPENDIX B: BUDGET GENERATOR

APPENDIX B: BUDGET GENERATOR

A computer-based crop cost-and-return budget generator, developed by the Agricultural Economics and Agricultural Business Department at New Mexico State University was used to compile the crop budgets. With an engineering cost approach, the budget generator develops costs per acre for each operation performed for each crop. The budget tables present the cost per acre of purchased inputs (materials such as seed and fertilizer); the labor, fuel and repairs, and fixed costs associated with pre-harvest and harvest operations; as well as overhead costs such as taxes, insurance and interest cost for a particular crop.

The budget generator provides estimates of per acre machinery cost, based on a prorated share of the total farm variable and fixed cost of owning and operating the required farm machinery.

The budgets are developed in a two-step process. The first step involves the determination of the machinery and equipment costs for the particular farm size and cropping pattern. The second step involves the determination of the cost and returns per acre for each crop. For each item of equipment, the size, number per farm, value, and annual use is reported. Also reported for equipment are the variable costs, which include fuel, oil and lubricants, repairs, and total variable costs per hour of annual use. Fixed costs included annual depreciation, and taxes on equipment, and total fixed costs per hour of annual use.

Annual crop production costs are divided into four major categories. These are purchased inputs, pre-harvest costs, harvest costs, and overhead costs. The purchased inputs include costs for such items as seed, fertilizer, insecticides, and baling wire. Quantities and costs per acre are reported for each. The second category of annual costs is the pre-harvest operations. Pre-harvest costs for fertilizer application, land preparation, cultural operations, irrigation water and insecticide applications are reported per acre. These costs include labor, fuel, oil and repair; and fixed costs per acre for this phase of production. Harvest operations are reported in hours of use per acre for each item of equipment and associated labor, fuel, oil and repairs, fixed costs and total costs per acre. Overhead expenses include other purchased inputs, insurance, labor downtime, employee benefits, supervision costs, land taxes, and other overhead expenses per acre.

Farm Characteristics

Construction of the budgets required compilation of information typical of farms that were above-average in both size and management. The information included farm size, irrigation water source and application rates, cropping patterns, yields, and equipment requirements. The farm characteristics used in this study are presented in Table B-1.

Irrigation Water

Irrigation water application rates were typically higher under flood irrigation than under sprinkler irrigation. Typical irrigation water application rates are presented in Table B-1.

Table B-1. Farm and crop characteristics of the Estancia Basin, 1978

Item	Unit	Sprinkler Irrigated Farm	Flood Irrigated Farm
Farm Size	acres	640	640
Crop Acreage:			
Alfalfa establishment	acres	45	50
Alfalfa annual	acres	215	250
Pinto beans	acres	--	15
Corn for grain	acres	50	60
Corn for silage	acres	130	150
Pasture establishment	acres	--	3
Pasture annual	acres	--	12
Potatoes	acres	30	--
Wheat	acres	50	60
Fallow and idle*	acres	120	40
Total	acres	640	640
Well Characteristics:			
Number of wells	number	4	5
Depth to water	feet	125	125
Yield	gpm	800	800
Fuel	type	NG	NG
Sprinkler system	type	center pivot	--
Water Application:			
Alfalfa establishment	acre-inches	8	10
Alfalfa annual	acre-inches	44	50
Pinto beans	acre-inches	--	12
Corn for grain	acre-inches	28.2	31.0
Corn for silage	acre-inches	25.0	28.0
Pasture establishment	acre-inches	--	9
Pasture annual	acre-inches	--	41.7
Potatoes	acre-inches	40	--
Wheat	acre-inches	17.0	21.3
Crop Yields:			
Alfalfa	tons hay	5.75	5.25
	acre grazing	1	1
Pinto beans	cwt	--	18
Corn for grain	bushels	130	120
	acre grazing	1	1
Corn for silage	ton	23	22
Pasture	AUM grazing	--	15
Potatoes	cwt	325	--
Wheat	bushels	55	50
	acre grazing	1	1
Crop Prices:			
Alfalfa	$/ton	70	70
	$/acre grazing	10	10
Pinto beans	$/cwt	--	25
Corn for grain	$/bushel	2.80	2.80
	$/acre grazing	7.50	7.50
Corn for silage	$/ton	13	13
Pasture	$/AUM grazing	--	14
Potatoes	$/cwt	3.25	--
Wheat	$/bushel	4	4
	$/acre grazing	17.50	17.50

* Idle lands include land in machinery lots, roads, livestock corrals, barns, and farm home.

Crop Yields and Prices

Crop yields under sprinkler irrigation were typically higher than those under flood irrigation. These yields, estimated for above-average farms, are higher than the county average yields. The prices farms received for crops were those typically received for the 1978 crop year. Crop yields and prices are presented in Table B-1.

Returns

Returns were defined as the net return to land and risk. They were based on gross returns from the sale of the crop less total operating expenses, which yields net operating profit. From net operating profit, the interest charge for the use of capital (operating and machinery) was subtracted to obtain net return to land and risk. An interest charge was not assessed for land investment. Return to risk is defined as the residual return after an additional charge is specified for the land investment. The interest charge on operating and machinery capital was viewed as an opportunity cost for the use of the capital whether owned or borrowed.

Costs

Production costs were categorized as variable, fixed, or overhead. Variable costs differ with the quantity of use. Fixed costs do not vary with the quantity of use but are fixed at the farm level. Overhead costs cover items not directly associated with production, such as insurance and taxes. The basic cost data used in preparing the crop budgets are presented in Table B-2.

Variable Costs

Labor Costs. On the cost and return budgets, labor was valued at $3.00 per hour for equipment operators and $2.75 per hour for irrigators and other general farm labor.

Materials and Other Purchased Inputs. Fertilizer, seed, wire, and other purchased input costs were developed from 1978 prices typically paid by farmers in the sub-regions. The unit prices are reported in Table B-2.

Fuel, Oil, Lubricants, and Repair Costs. Fuel consumption rates were determined from the Nebraska Tractor Tests (1978) for the typical size and type of tractors found in the area. The specific fuel prices utilized are reported in Table B-2. Oil costs were estimated to be 15 percent of the hourly fuel costs. Lubrication costs were calculated as a percentage of current value of the machine and adjusted for the annual hours of use. Repairs and maintenance costs are calculated as a percentage of the price of the new machinery, and adjusted for the annual use and remaining expected life. Repair costs are adjusted for used machinery by assuming that the ratio of the price of used machinery to the price of new machinery is a measure of the percentage of remaining expected life of the used machinery.

Fixed Costs

Fixed costs included annual depreciation expenses and personal property taxes. Annual depreciation expenses were calculated as one-third of current equipment value times the tax rate in the area.

Table B-2. Basic farm information for the Estancia Basin, 1978

Item	Unit	Sprinkler Irrigated Farm	Flood Irrigated Farm
Labor Wage Rate			
Equipment operators	$/hour	3.00	3.00
General and irrigators	$/hour	2.75	2.75
Purchased Inputs:			
Nitrogen (N)	$/lb	.15	.15
Phosphorus (P_2O_5)	$/lb	.20	.20
Seed:			
Alfalfa	$/lb	1.75	1.75
Corn	$/lb	.85	.85
Pinto beans	$/lb	--	.06
Pasture (Jose wheatgrass)	$/lb	--	1.60
Potatoes	$/cwt	5.00	--
Wheat	$/lb	.20	.20
Herbicide:			
Corn	$/acre	12.00	12.00
Potatoes	$/acre	12.00	--
Insecticide:			
Alfalfa	$/acre	6.00	6.00
Corn	$/acre	12.00	12.00
Potatoes	$/acre	19.50	--
Pinto beans	$/acre	--	6.00
Fungicide:			
Potatoes	$/acre	12.00	--
Seed dust	$/lb	1.75	--
Trace elements:			
Corn	$/acre	5.00	5.00
Potatoes	$/acre	10.00	--
Gasoline	$/gal	.50	.50
Diesel fuel	$/gal	.45	.45
Natural gas	$/MFC	2.06	2.06
Electricity	¢/kwh	3.3	3.3
LP Gas	$/gal	.35	.35
Wire	$/lb	1.00	1.00
Livestock Facilities and Equipment	$/acre	3.00	3.00
Farm Insurance	$/acre	3.30	3.30
Employee Liability Insurance Rate	$/$1000 wages	15	15
Labor Downtime	percent	25	25
Interest on Operating Capital	percent	10	10
Interest Rate on Equipment	percent	10	10
Land Taxes	$/acre	2.23	2.23
Personal Property Tax Rate	$/$1000 AV	22.28	22.28
Supervision Factors			
Field crop--irrigation	$/labor-hour	0.90	0.90
Field crop--equipment and general	$/labor-hour	0.45	0.45
Vegetable crop*--irrigation	$/labor-hour	2.65	2.65
Vegetable crop*--equipment and general	$/labor-hour	0.90	0.90
Management Rate	percent of gross returns	5	5
Non-productive Machine Adjustment Factor**	percent of machine hours	25	25
Employee Benefits	percent of total labor cost	15	15
Other Expenses	$/acre	20	20

* Potatoes and beans were considered as vegetable crops.

** Allowance for machine hour accumulations not directly associated with crop operations such as travel to and from fields and general farm clean-up operations.

The annual depreciation and tax expense for each item of equipment was based on the aggregate annual hours of use for each item. These costs per hour were then prorated according to the crop requirements.

Overhead Expenses

Overhead expenses included insurance, labor downtime, land taxes, supervision and management, and other overhead expenses. These overhead expense rates are presented in Table B-1.

Insurance. Farm liability and property insurance costs were estimated to be $3.30 per acre for both flood and sprinkler-irrigated farms. Employee liability insurance was estimated to cost $15.00 per $1,000 of wages paid per acre.

Labor Downtime. Labor downtime was based on 25 percent of the direct labor time involved in machine operations at the respective wage rates. This was an allowance for getting to and from the fields and other non-productive labor time.

Employee Benefits. Employee benefits were calculated at 15 percent of total labor costs. These included social security taxes, unemployment compensation taxes, and other fringe benefits.

Land Taxes. Land taxes were estimated to be $2.23 per acre for the Estancia Basin based on local tax rates and assessed valuations (Table B-2).

Management and Supervision Costs. Management costs were calculated at five percent of the gross returns. Supervision costs were based on the type of labor involved per acre from information developed by Sweetzer (1975).

Other. Other overhead expenses include such items as the farm share of the telephone, other utilities, farm pick-up, buildings, accounting fees, etc. The other overhead expenses were estimated at $20.00 per acre.

Interest on Operating Capital

The opportunity cost in the use of operating capital were calculated at 10 percent. The purchased inputs were charged for six months, variable costs of pre-harvest operations for three months, and variable costs of harvest operations for one month.

Interest on Machinery Investment

The opportunity cost in the use of capital invested in machinery and equipment was calculated on the average investment, at an interest rate of 10 percent.

Crop Budgets

The crop budgets for flood and sprinkler-irrigated crops are presented in Tables B-3 through B-16. The typical flood-irrigated farm budgets are presented in Tables B-3 through B-10. The typical sprinkler-irrigated budgets are presented in Tables B-11 through B-16.

TABLE B-3. ALFALFA ESTABLISHMENT, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: JULY 15 - AUG 15 YIELD:
HARVEST DATES: PRICE:

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
ALFALFA SEED		20.00 LB	35.00				35.00
PHOSPHORUS (P2O5)		120.00 LB	24.00				24.00
NITROGEN (N)		15.00 LB	2.25				2.25
IRRIGATION WATER		10.00 AC.IN.					
SUBTOTAL			61.25				61.25
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	2.75	7.12
DISC (3X)	125 HP	.60 HR		1.80	3.11	3.44	8.35
LAND PLANE (2X)	125 HP	.20 HR		.60	1.05	1.45	3.10
FERT. APPL.	60 HP	.10 HR		.30	.22	.11	.63
DRILL	60 HP	.20 HR		.60	.50	.96	2.06
BORDER DISC	60 HP	.10 HR		.30	.23	.33	.86
IRRIGATE (3X)		1.20 HR		3.30	12.95	2.66	18.91
SUBTOTAL		2.90 HR		8.40	20.93	11.70	41.03
OVERHEAD EXPENSES							
DOWNTIME		.42 HR		1.28			1.28
EMPLOYEE BENEFITS				1.26			1.26
FARM INSURANCE			.04				.04
SUPERVISION AND MANAGEMENT				7.02			7.02
SUBTOTAL		.42 HR	.04	9.56			9.60
TOTAL OPERATING EXPENSES		3.32 HR	61.29	17.96	20.93	11.70	111.88

TABLE B-4. ANNUAL ALFALFA, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: YIELD: : 5.25 TON GRAZING: 1.00 ACRE
HARVEST DATES: JUNE 1 - SEPT 15 PRICE: : $60.00/TON GRAZING: $10.00/ACRE GROSS RETURNS: $325.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			- - - - - - - -	- - - - - - -(DOLLARS)	- - - - - - - -	- - - - - - - -	
PURCHASED INPUTS							
PHOSPHORUS (P2O5)		90.00 LB	18.00				18.00
INSECTICIDE (CUSTOM)		1.00 ACRE	6.00				6.00
WIRE		11.60 LB	11.60				11.60
ESTABLISHMENT		1/6				25.69	25.69
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		50.00 AC.IN.					
SUBTOTAL			35.60			28.69	64.29
PREHARVEST OPERATIONS							
FERT. APPL.	60 HP	.10 HR		.30	.22	.11	.63
IRRIGATE (11X)		4.40 HR		12.10	64.77	13.29	90.16
SUBTOTAL		4.50 HR		12.40	64.99	13.40	90.79
HARVEST OPERATIONS							
SWATHER (3X)	14 FT.	.75 HR		2.25	3.02	3.74	9.01
BALER, PTO (3X)	60 HP	.90 HR		2.70	2.42	2.04	7.16
LOAD & HAUL (CUSTOM)	BALE WAGON		29.50				29.50
SUBTOTAL		1.65 HR	29.50	4.95	5.44	5.78	45.67
OVERHEAD EXPENSES							
DOWNTIME		.44 HR		1.31			1.31
EMPLOYEE BENEFITS				2.60			2.60
FARM INSURANCE			3.24				3.24
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				21.00			21.00
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.44 HR	23.24	24.91		2.23	50.38
TOTAL OPERATING EXPENSES		6.59 HR	88.34	42.26	70.43	50.10	251.13
NET OPERATING PROFIT							73.87
INTEREST ON OPERATING CAPITAL							6.51
INTEREST ON EQUIPMENT INVESTMENT							20.85
RETURN TO LAND AND RISK							46.51

TABLE B-5. CORN FOR GRAIN, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: APRIL 30 - MAY 15 YIELD: : 120.00 BUSHEL GRAZING: 1.00 ACRE
HARVEST DATES: OCT 15 - NOV 15 PRICE: : $2.50/BUSHEL GRAZING: $7.50/ACRE GROSS RETURNS: $307.50

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			- - - - - - - - - - - - - -(DOLLARS) - - - - - - - - - - - -				
PURCHASED INPUTS							
CORN SEED		20.00 LB	17.00				17.00
NITROGEN (N)		160.00 LB	24.00				24.00
PHOSPHORUS (P2O5)		80.00 LB	16.00				16.00
INSECTICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
HERBICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
TRACE ELEMENTS		1.00	5.00				5.00
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		31.00 AC.IN.					
SUBTOTAL			86.00			3.00	89.00
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	2.75	7.12
DISC (2X)	125 HP	.40 HR		1.20	2.08	2.30	5.58
LAND PLANE (2X)	125 HP	.20 HR		.60	1.05	1.45	3.10
FERT. APPL.	60 HP	.10 HR		.30	.22	.11	.63
LISTER	125 HP	.25 HR		.75	1.44	1.49	3.68
PRE-IRRIGATE		.50 HR		1.38	6.48	1.33	9.19
HARROW	60 HP	.10 HR		.30	.24	.21	.75
PLANTER	60 HP	.25 HR		.75	.63	.83	2.21
CULTIVATOR	60 HP	.25 HR		.75	1.82	.84	3.41
IRRIGATE (7X)		2.80 HR		7.70	33.68	6.91	48.29
SUBTOTAL		5.35 HR		15.23	50.51	18.22	83.96
HARVEST OPERATIONS							
CORN HEAD	COMBINE	.50 HR		1.50	4.16	9.42	15.08
TRUCK	2 TON	.50 HR		1.50	3.44	2.23	7.17
CORN DRYER (CUSTOM)	SYSTEM		16.44				16.44
SUBTOTAL		1.00 HR	16.44	3.00	7.60	11.65	38.69
OVERHEAD EXPENSES							
DOWNTIME		.76 HR		2.29			2.29
EMPLOYEE BENEFITS				2.73			2.73
FARM INSURANCE			3.25				3.25
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				19.72			19.72
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.76 HR	23.25	24.75		2.23	50.23
TOTAL OPERATING EXPENSES		7.11 HR	125.69	42.98	58.11	35.10	261.88
NET OPERATING PROFIT							45.62
INTEREST ON OPERATING CAPITAL							8.62
INTEREST ON EQUIPMENT INVESTMENT							29.49
RETURN TO LAND AND RISK							7.51

TABLE B-6. CORN FOR SILAGE, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: APRIL 30 - MAY 15 YIELD: 22.00 TON
HARVEST DATES: AUG 15 - SEPT 15 PRICE: $13.00/TON GROSS RETURNS: $286.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
CORN SEED		20.00 LB	17.00				17.00
NITROGEN (N)		160.00 LB	24.00				24.00
PHOSPHORUS (P2O5)		80.00 LB	16.00				16.00
HERBICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
TRACE ELEMENTS		1.00	5.00				5.00
IRRIGATION WATER		28.00 AC.IN.					
SUBTOTAL			74.00				74.00
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	2.75	7.12
DISC (2X)	125 HP	.40 HR		1.20	2.08	2.30	5.58
LAND PLANE (2X)	125 HP	.20 HR		.60	1.05	1.45	3.10
FERT. APPL.	60 HP	.10 HR		.30	.22	.11	.63
LISTER	125 HP	.25 HR		.75	1.44	1.49	3.68
PRE-IRRIGATE		.50 HR		1.38	6.48	1.33	9.19
HARROW	60 HP	.10 HR		.30	.24	.21	.75
PLANTER	60 HP	.25 HR		.75	.63	.83	2.21
CULTIVATOR	60 HP	.25 HR		.75	1.82	.84	3.41
IRRIGATE (6X)		2.40 HR		6.60	29.80	6.12	42.52
SUBTOTAL		4.95 HR		14.13	46.63	17.43	78.19
HARVEST OPERATIONS							
ENSILAGE CHOPPER	125 HP	.50 HR		1.50	2.56	3.19	7.25
TRUCK	2 TON	.50 HR		1.50	3.44	2.23	7.17
SUBTOTAL		1.00 HR		3.00	6.00	5.42	14.42
OVERHEAD EXPENSES							
DOWNTIME		.76 HR		2.29			2.29
EMPLOYEE BENEFITS				2.57			2.57
FARM INSURANCE			3.24				3.24
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				18.28			18.28
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.76 HR	23.24	23.14		2.23	48.61
TOTAL OPERATING EXPENSES		6.71 HR	97.24	40.27	52.63	25.08	215.22
NET OPERATING PROFIT							70.78
INTEREST ON OPERATING CAPITAL							7.67
INTEREST ON EQUIPMENT INVESTMENT							22.74
RETURN TO LAND AND RISK							40.37

TABLE B-7. WHEAT FOR GRAIN, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: AUG 15 - SEPT 15 YIELD: : 50.00 BUSHEL GRAZING: 1.00 ACRE
HARVEST DATES: JUNE 15 - JULY 5 PRICE: : $3.00/BUSHEL GRAZING: $17.50/ACRE GROSS RETURNS: $167.50

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			-(DOLLARS)-				
PURCHASED INPUTS							
WHEAT SEED		100.00 LB	20.00				20.00
NITROGEN (N)		100.00 LB	15.00				15.00
PHOSPHORUS (P2O5)		40.00 LB	8.00				8.00
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		35.30 AC.IN.					
SUBTOTAL			43.00			3.00	46.00
PREHARVEST OPERATIONS							
DISC (2X)	125 HP	.40 HR		1.20	2.08	2.30	5.58
WATER FURROW	125 HP	.25 HR		.75	1.52	1.74	4.01
FERT. APPL.	60 HP	.10 HR		.30	.22	.11	.63
DRILL	60 HP	.20 HR		.60	.50	.96	2.06
IRRIGATE (6X)		.90 HR		2.48	45.73	9.39	57.60
SUBTOTAL		1.85 HR		5.33	50.05	14.50	69.88
HARVEST OPERATIONS							
GRAIN HEAD	COMBINE	.50 HR		1.50	4.08	8.70	14.28
TRUCK	2 TON	.50 HR		1.50	3.44	2.23	7.17
SUBTOTAL		1.00 HR		3.00	7.52	10.93	21.45
OVERHEAD EXPENSES							
DOWNTIME		.49 HR		1.46			1.46
EMPLOYEE BENEFITS				1.25			1.25
FARM INSURANCE			3.19				3.19
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				10.07			10.07
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.49 HR	23.19	12.78		2.23	38.20
TOTAL OPERATING EXPENSES		3.34 HR	66.19	21.11	57.57	30.66	175.53
NET OPERATING PROFIT							-8.03
INTEREST ON OPERATING CAPITAL							5.48
INTEREST ON EQUIPMENT INVESTMENT							25.62
RETURN TO LAND AND RISK							-39.13

TABLE B-8. PINTO BEANS, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: MAY 1 - MAY 15 YIELD: 18.00 CWT
HARVEST DATES: NOV. 1 - NOV. 15 PRICE: $25.00/CWT GROSS RETURNS: $450.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			-(DOLLARS)-				
PURCHASED INPUTS							
BEAN SEED		45.00 LB	27.00				27.00
NITROGEN (N)		20.00 LB	3.00				3.00
PHOSPHORUS (P2O5)		45.00 LB	9.00				9.00
INSECTICIDE (CUSTOM)		1.00 ACRE	6.00				6.00
IRRIGATION WATER		12.00 AC.IN.					
SUBTOTAL			45.00				45.00
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	4.57	8.94
DISC (2X)	125 HP	.40 HR		1.20	2.08	3.90	7.18
LAND PLANE (CUSTOM)			7.00				7.00
LISTER	125 HP	.25 HR		.75	1.44	2.50	4.69
PRE-IRRIGATE		.50 HR		1.38	5.18	1.27	7.83
FERT. APPL.	60 HP	.10 HR		.30	.22	.30	.82
PLANTER	60 HP	.25 HR		.75	.63	2.17	3.55
CULTIVATOR (4X)	60 HP	1.00 HR		3.00	7.29	6.41	16.70
IRRIGATE (3X)		.45 HR		1.24	10.36	2.53	14.13
SUBTOTAL		3.45 HR	7.00	10.12	30.07	23.65	70.84
HARVEST OPERATIONS							
SWATHER	14 FT.	.25 HR		.75	1.01	3.55	5.31
BEAN HEAD (CUSTOM)	2 ROW		15.00				15.00
CLEAN & SACK (CUSTOM)			30.00				30.00
SUBTOTAL		.25 HR	45.00	.75	1.01	3.55	50.31
OVERHEAD EXPENSES							
DOWNTIME		.69 HR		2.06			2.06
EMPLOYEE BENEFITS				1.63			1.63
FARM INSURANCE			3.21				3.21
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				13.41			13.41
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.69 HR	23.21	17.10		2.23	42.54
TOTAL OPERATING EXPENSES		4.39 HR	120.21	27.97	31.08	29.43	208.69
NET OPERATING PROFIT							241.31
INTEREST ON OPERATING CAPITAL							5.89
INTEREST ON EQUIPMENT INVESTMENT							26.01
RETURN TO LAND AND RISK							209.41

TABLE B-9. JOSE WHEATGRASS ESTABLISHMENT, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: AUG 15 - SEPT 15 YIELD:
HARVEST DATES: PRICE:

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
JOSE WHEATGRASS SEED		15.00 LB	24.00				24.00
NITROGEN (N)		70.00 LB	10.50				10.50
IRRIGATION WATER		9.00 AC.IN.					
SUBTOTAL			34.50				34.50
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	4.57	8.94
DISC (2X)	125 HP	.40 HR		1.20	2.08	3.90	7.18
LAND PLANE (CUSTOM)			7.00				7.00
WATER FURROW	125 HP	.25 HR		.75	1.52	3.09	5.36
HARROW	60 HP	.10 HR		.30	.24	.54	1.08
DRILL	60 HP	.20 HR		.60	.50	2.43	3.53
FERT. APPL.	60 HP	.10 HR		.30	.22	.30	.82
IRRIGATE (2X)		.80 HR		2.20	11.66	2.85	16.71
SUBTOTAL		2.35 HR	7.00	6.85	19.09	17.68	50.62
OVERHEAD EXPENSES							
DOWNTIME		.39 HR		1.16			1.16
EMPLOYEE BENEFITS				1.03			1.03
FARM INSURANCE			.04				.04
SUPERVISION AND MANAGEMENT				5.73			5.73
SUBTOTAL		.39 HR	.04	7.91			7.95
TOTAL OPERATING EXPENSES		2.74 HR	41.54	14.76	19.09	17.68	93.07

TABLE B-10. JOSE WHEATGRASS PASTURE, FLOOD IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: | YIELD: 15.00 AUM OF GRAZING
HARVEST DATES: APRIL 1 - NOV 1 | PRICE: $14.00/AUM OF GRAZING | GROSS RETURNS: $210.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
NITROGEN (N)		200.00 LB	30.00				30.00
PHOSPHORUS (P2O5)		60.00 LB	12.00				12.00
LIVESTOCK FAC & EQUIP						3.00	3.00
ESTABLISHMENT		1/5				24.55	24.55
IRRIGATION WATER		41.70 AC.IN.					
SUBTOTAL			42.00			27.55	69.55
PREHARVEST OPERATIONS							
FERT. APPL. (3X)	60 HP	.30 HR		.90	.65	.91	2.46
CLIP GRASS (3X)		.90 HR		2.70	3.63	12.79	19.12
IRRIGATE (10X)		4.00 HR		11.00	54.02	13.21	78.23
SUBTOTAL		5.20 HR		14.60	58.30	26.91	99.81
OVERHEAD EXPENSES							
DOWNTIME		.30 HR		.90			.90
EMPLOYEE BENEFITS				2.19			2.19
FARM INSURANCE			3.23				3.23
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				14.64			14.64
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.30 HR	23.23	17.73		2.23	43.19
TOTAL OPERATING EXPENSES		5.50 HR	65.23	32.33	58.30	56.69	212.55
NET OPERATING PROFIT							-2.55
INTEREST ON OPERATING CAPITAL							6.03
INTEREST ON EQUIPMENT INVESTMENT							27.75
RETURN TO LAND AND RISK							-36.33

TABLE B-11. *ALFALFA ESTABLISHMENT, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN,* 1978

PLANTING DATES: JULY 15 - AUG 15 *YIELD:*
HARVEST DATES: *PRICE:*

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			-(DOLLARS)-				
PURCHASED INPUTS							
ALFALFA SEED		20.00 LB	35.00				35.00
PHOSPHORUS (P205)		120.00 LB	24.00				24.00
NITROGEN (N)		15.00 LB	2.25				2.25
IRRIGATION WATER		8.00 AC.IN.					
SUBTOTAL			61.25				61.25
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	1.88	6.25
DISC (3X)	125 HP	.60 HR		1.80	3.11	2.20	7.11
FERT. APPL.	60 HP	.10 HR		.30	.22	.13	.65
DRILL	60 HP	.20 HR		.60	.50	1.13	2.23
IRRIGATE (3X)		.45 HR		1.24	14.35	6.56	22.15
SUBTOTAL		1.85 HR		5.44	21.05	11.90	38.39
OVERHEAD EXPENSES							
DOWNTIME		.35 HR		1.05			1.05
EMPLOYEE BENEFITS				.82			.82
FARM INSURANCE			.03				.03
SUPERVISION AND MANAGEMENT				6.07			6.07
SUBTOTAL		.35 HR	.03	7.93			7.96
TOTAL OPERATING EXPENSES		2.20 HR	61.28	13.37	21.05	11.90	107.60

TABLE B-12. ANNUAL ALFALFA, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: YIELD: 5.75 TON GRAZING: 1.00 ACRE

HARVEST DATES: JUNE 1 - SEPT 15 PRICE: $60.00/TON GRAZING: $10.00/ACRE GROSS RETURNS: $355.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
PHOSPHORUS (P205)		90.00 LB	18.00				18.00
INSECTICIDE (CUSTOM)		1.00 ACRE	6.00				6.00
WIRE		12.70 LB	12.70				12.70
ESTABLISHMENT		1/6				24.71	24.71
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		44.00 AC.IN.					
SUBTOTAL			36.70			27.71	64.41
PREHARVEST OPERATIONS							
FERT. APPL.	60 HP	.10 HR		.30	.22	.13	.65
IRRIGATE (14X)		2.10 HR		5.78	78.91	36.09	120.78
SUBTOTAL		2.20 HR		6.08	79.13	36.22	121.43
HARVEST OPERATIONS							
SWATHER (3X)	14 FT.	.75 HR		2.25	3.02	4.33	9.60
BALER, PTO (3X)	60 HP	.90 HR		2.70	2.42	2.39	7.51
LOAD & HAUL (CUSTOM)	BALE WAGON		32.25				32.25
SUBTOTAL		1.65 HR	32.25	4.95	5.44	6.72	49.36
OVERHEAD EXPENSES							
DOWNTIME		.44 HR		1.31			1.31
EMPLOYEE BENEFITS				1.65			1.65
FARM INSURANCE			3.36				3.36
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				20.43			20.43
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.44 HR	23.36	23.39		2.23	48.98
TOTAL OPERATING EXPENSES		4.29 HR	92.31	34.42	84.57	72.88	284.18
NET OPERATING PROFIT							70.82
INTEREST ON OPERATING CAPITAL							6.71
INTEREST ON EQUIPMENT INVESTMENT							45.49
RETURN TO LAND AND RISK							18.62

TABLE B-13. CORN FOR GRAIN, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: APRIL 30 - MAY 15 YIELD: : 130.00 BUSHEL GRAZING: 1.00 ACRE
HARVEST DATES: OCT 15 - NOV 15 PRICE: : $2.50/BUSHEL GRAZING: $7.50/ACRE GROSS RETURNS: $332.50

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			- - - - - -	- - -	-(DOLLARS) -	- - - -	- - -
PURCHASED INPUTS							
CORN SEED		20.00 LB	17.00				17.00
NITROGEN (N)		160.00 LB	24.00				24.00
PHOSPHORUS (P205)		80.00 LB	16.00				16.00
INSECTICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
HERBICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
TRACE ELEMENTS		1.00	5.00				5.00
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		28.20 AC.IN.					
SUBTOTAL			86.00			3.00	89.00
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	1.88	6.25
DISC (3X)	125 HP	.60 HR		1.80	3.11	2.20	7.11
FERT. APPL.	60 HP	.10 HR		.30	.22	.13	.65
LISTER	125 HP	.25 HR		.75	1.44	1.20	3.39
HARROW	60 HP	.10 HR		.30	.24	.34	.88
PLANTER	60 HP	.25 HR		.75	.63	.96	2.34
CULTIVATOR	60 HP	.25 HR		.75	1.82	.97	3.54
IRRIGATE (9X)		1.35 HR		3.71	50.57	23.13	77.41
SUBTOTAL		3.40 HR		9.86	60.90	30.81	101.57
HARVEST OPERATIONS							
CORN HEAD	COMBINE	.50 HR		1.50	4.16	10.20	15.86
TRUCK	2 TON	.50 HR		1.50	3.44	2.47	7.41
CORN DRYER (CUSTOM)	SYSTEM		17.81				17.81
SUBTOTAL		1.00 HR	17.81	3.00	7.60	12.67	41.08
OVERHEAD EXPENSES							
DOWNTIME		.76 HR		2.29			2.29
EMPLOYEE BENEFITS				1.93			1.93
FARM INSURANCE			3.37				3.37
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				19.22			19.22
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.76 HR	23.37	23.44		2.23	49.04
TOTAL OPERATING EXPENSES		5.16 HR	127.18	36.30	68.50	48.71	280.69
NET OPERATING PROFIT							51.81
INTEREST ON OPERATING CAPITAL							8.70
INTEREST ON EQUIPMENT INVESTMENT							43.81
RETURN TO LAND AND RISK							-0.70

TABLE B-14. CORN FOR SILAGE, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: APRIL 30 - MAY 15 YIELD: 23.00 TON
HARVEST DATES: AUG 15 - SEPT 15 PRICE: $13.00/TON GROSS RETURNS: $299.00

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			(DOLLARS)				
PURCHASED INPUTS							
CORN SEED		20.00 LB	17.00				17.00
NITROGEN (N)		160.00 LB	24.00				24.00
PHOSPHORUS (P205)		80.00 LB	16.00				16.00
HERBICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
TRACE ELEMENTS		1.00	5.00				5.00
IRRIGATION WATER		25.00 AC.IN.					
SUBTOTAL			74.00				74.00
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	1.88	6.25
DISC (3X)	125 HP	.60 HR		1.80	3.11	2.20	7.11
FERT. APPL.	60 HP	.10 HR		.30	.22	.13	.65
LISTER	125 HP	.25 HR		.75	1.44	1.20	3.39
HARROW	60 HP	.10 HR		.30	.24	.34	.88
PLANTER	60 HP	.25 HR		.75	.63	.96	2.34
CULTIVATOR	60 HP	.25 HR		.75	1.82	.97	3.54
IRRIGATE (8X)		1.20 HR		3.30	44.83	20.51	68.64
SUBTOTAL		3.25 HR		9.45	55.16	28.19	92.80
HARVEST OPERATIONS							
ENSILAGE CHOPPER	125 HP	.50 HR		1.50	2.56	2.40	6.46
TRUCK	2 TON	.50 HR		1.50	3.44	2.47	7.41
SUBTOTAL		1.00 HR		3.00	6.00	4.87	13.87
OVERHEAD EXPENSES							
DOWNTIME		.76 HR		2.29			2.29
EMPLOYEE BENEFITS				1.87			1.87
FARM INSURANCE			3.36				3.36
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				17.40			17.40
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.76 HR	23.36	21.56		2.23	47.15
TOTAL OPERATING EXPENSES		5.01 HR	97.36	34.01	61.16	35.29	227.82
NET OPERATING PROFIT							71.18
INTEREST ON OPERATING CAPITAL							7.69
INTEREST ON EQUIPMENT INVESTMENT							33.57
RETURN TO LAND AND RISK							29.92

TABLE B-15. WHEAT FOR GRAIN, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: AUG 15 - SEPT 15 YIELD: : 55.00 BUSHEL GRAZING: 1.00 ACRE
HARVEST DATES: JUNE 15 - JULY 5 PRICE: : $3.00/BUSHEL GRAZING: $17.50/ACRE GROSS RETURNS: $182.50

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			-(DOLLARS)-				
PURCHASED INPUTS							
WHEAT SEED		100.00 LB	20.00				20.00
NITROGEN (N)		100.00 LB	15.00				15.00
PHOSPHORUS (P2O5)		40.00 LB	8.00				8.00
LIVESTOCK FAC & EQUIP						3.00	3.00
IRRIGATION WATER		31.00 AC.IN.					
SUBTOTAL			43.00			3.00	46.00
PREHARVEST OPERATIONS							
DISC (3X)	125 HP	.60 HR		1.80	3.11	2.20	7.11
FERT. APPL.	60 HP	.10 HR		.30	.22	.13	.65
DRILL	60 HP	.20 HR		.60	.50	1.13	2.23
IRRIGATE (6X)		.90 HR		2.48	55.59	25.43	83.50
SUBTOTAL		1.80 HR		5.18	59.42	28.89	93.49
HARVEST OPERATIONS							
GRAIN HEAD	COMBINE	.50 HR		1.50	4.08	9.40	14.98
TRUCK	2 TON	.50 HR		1.50	3.44	2.47	7.41
SUBTOTAL		1.00 HR		3.00	7.52	11.87	22.39
OVERHEAD EXPENSES							
DOWNTIME		.47 HR		1.42			1.42
EMPLOYEE BENEFITS				1.23			1.23
FARM INSURANCE			3.34				3.34
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				10.80			10.80
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.47 HR	23.34	13.44		2.23	39.01
TOTAL OPERATING EXPENSES		3.27 HR	66.34	21.62	66.94	45.99	200.89
NET OPERATING PROFIT							-18.39
INTEREST ON OPERATING CAPITAL							5.75
INTEREST ON EQUIPMENT INVESTMENT							41.57
RETURN TO LAND AND RISK							-65.71

TABLE B-16. FRESH MARKET POTATOES, SPRINKLER IRRIGATED, BUDGETED PER ACRE COSTS AND RETURNS FOR AN ABOVE-AVERAGE MANAGED FARM, ESTANCIA BASIN, 1978

PLANTING DATES: MAY 1 - JUNE 15 YIELD: 325.00 CWT
HARVEST DATES: AUG. 20 - OCT. 20 PRICE: $3.25/CWT GROSS RETURNS: $1056.25

ITEM	POWER UNIT	QUANTITY	PURCHASED INPUTS	LABOR	FUEL, OIL, REPAIRS	FIXED COST	TOTAL
			-(DOLLARS)-				
PURCHASED INPUTS							
POTATO SEED		25.00 LBS	125.00				125.00
NITROGEN (N)		200.00 LB	30.00				30.00
PHOSPHORUS (P2O5)		200.00 LB	40.00				40.00
TRACE ELEMENTS		1.00	10.00				10.00
INSECTICIDE (CUSTOM)		1.00 ACRE	19.50				19.50
SEED DUST		15.00 LB	26.25				26.25
FUNGICIDE		1.00	12.00				12.00
HERBICIDE (CUSTOM)		1.00 ACRE	12.00				12.00
IRRIGATION WATER		40.00 AC.IN.					
SUBTOTAL			274.75				274.75
PREHARVEST OPERATIONS							
PLOW	125 HP	.50 HR		1.50	2.87	1.98	6.35
DISC (2X)	125 HP	.40 HR		1.20	2.08	1.58	4.86
HARROW	60 HP	.12 HR		.36	.29	.26	.91
LISTER	125 HP	.25 HR		.75	1.44	1.25	3.44
CUT & DIP SEED	HAND	.70 HR		2.10			2.10
POTATO PLANTER	60 HP	.35 HR		1.05	.83	.99	2.87
CULTIVATOR (2X)	60 HP	.50 HR		1.50	3.65	1.56	6.71
FERT. APPL.	60 HP	.10 HR		.30	.22	.12	.64
SPRAYER	60 HP	.10 HR		.30	.24	1.00	1.54
IRRIGATE (14X)		2.10 HR		5.78	71.73	31.00	108.51
SUBTOTAL		5.12 HR		14.84	83.35	39.74	137.93
HARVEST OPERATIONS							
HARVEST & HAUL (CUSTOM)			100.00				100.00
GRADING (CUSTOM)			15.00				15.00
SUBTOTAL			115.00				115.00
OVERHEAD EXPENSES							
DOWNTIME		.75 HR		2.26			2.26
EMPLOYEE BENEFITS				2.23			2.23
FARM INSURANCE			3.38				3.38
LAND TAXES						2.23	2.23
SUPERVISION AND MANAGEMENT				34.79			34.79
OTHER EXPENSES			20.00				20.00
SUBTOTAL		.75 HR	23.38	39.27		2.23	64.88
TOTAL OPERATING EXPENSES		5.87 HR	413.13	54.11	83.35	41.97	592.56
NET OPERATING PROFIT							463.69
INTEREST ON OPERATING CAPITAL							20.34
INTEREST ON EQUIPMENT INVESTMENT							41.96
RETURN TO LAND AND RISK							401.39