ECONOMICS OF GROUND WATER IRRIGATION

W. P. Stephens[1/]

Economics has been defined as "the allocation of scarce resources among competing ends." It is easy to understand that if we had enough ground water to supply all the water desires of present and future users there would be little need for a discussion such as this. From what has been said here at this conference, it is obvious that ground water is a scarce resource and many users are competing for it.

First, I would like to discuss briefly the macro or general approach to the use of ground water for irrigation. From an economist point of view, I believe many of the decisions made by the office of our State Engineer, with regard to the Lea County basin, have been wise. The number of irrigation wells in that basin have been limited.

The cost of pumping water in Lea County in 1960 was about $6.70 per acre foot or $16.08 per acre (based on 2.4 ac/ft. per acre). In 47 years or by 2007 the cost per acre will have increased to about $30.76 per acre (table 1). This is the return per acre after all costs except water have been deducted. This could be called the economic limits of pumping. The year 2007,

Table 1. Increasing Cost of Water and Residual Returns to Water, Lea County, New Mexico[1/]

Year	Cost of Water Per Acre
1955	$14.52
1960	16.08
1965	17.64
1975	20.76
1985	23.88
1995	27.00
2005	30.12
2007	30.76[2/]
2015	33.24

1/ Cole, James F., Masters Thesis, New Mexico State University, August 1960, p. 90.
2/ Residual returns to water, per acre.

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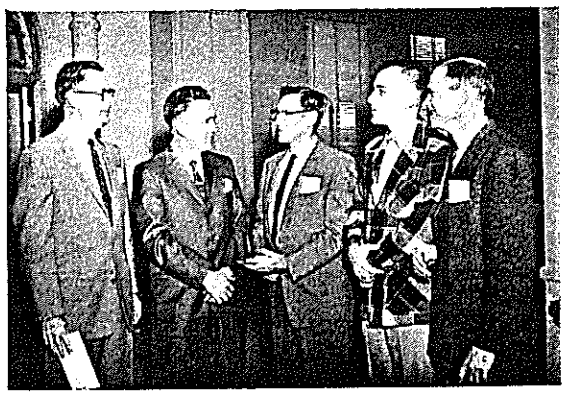
A discussion among the program members prior to the final Conference session. Left to Right: Jack Lacy, Deputy Director, Department of Development; Steve Reynolds, State Engineer; James F. Cole, Assistant to the President, N.M.S.U.; Charles C. Royall, Lawyer, Arizona State Land Department; and John H. Cuykendahl, Colorado Groundwater Commission.

Left to Right: Jay Stow, District Chemist, U. S. Geological Survey; Dean P. J. Leyendecker, N.M.S.U.; and Robert W. Stellman, Engineer, U. S. Geological Survey.



Left to Right: James W. Young, District Manager, Bureau of Land Management, Las Cruces; Claude A. Martin, District Manager, Bureau of Land Management, Albuquerque; K. A. Valentine, Professor of Animal Husbandry, N.M.S.U.; Clarke Leedy, Extension Soil Conservationist; Edward H. Wallace, District Supervisor, Extension Service.

Left to Right: Harold Elmendorf, Irrigation Engineer, Mesilla Park; George Worley, Pack Foundation, University of New Mexico; Roy Calkins, Farmer, Sacramento, N.M.; and Reverend Bruce Potter, First United Presbyterian Church, Las Cruces, looking over the State water map, on exhibit during the Conference. Hats off to Mr. Worley and the Pack Foundation for this fine educational exhibit.

when it is estimated that economic limits will be reached, corresponds very close to the estimate of physical limitations for pumping irrigation water. Physical limitations are based on estimates of present ground water supply and withdrawals during the next 47 years.

This is quite a contrast to the Texas side of the basin where well drilling is not controlled and it is very likely that both economic and physical limits of pumping irrigation water will be reached much sooner than in New Mexico.

Another general question might be asked for the dry land farmer on the east side of the state--should he put in an irrigation well? One of the first things any farmer will want to know is--how much will it cost to install an irrigation well and pumping plant? Figure 1 and Table 2 show the relation between investment in well and pumping plant and depth of pump setting.

Figure 1. Investment in Well, Pumping Plant and Depth of Pump Setting, New Mexico

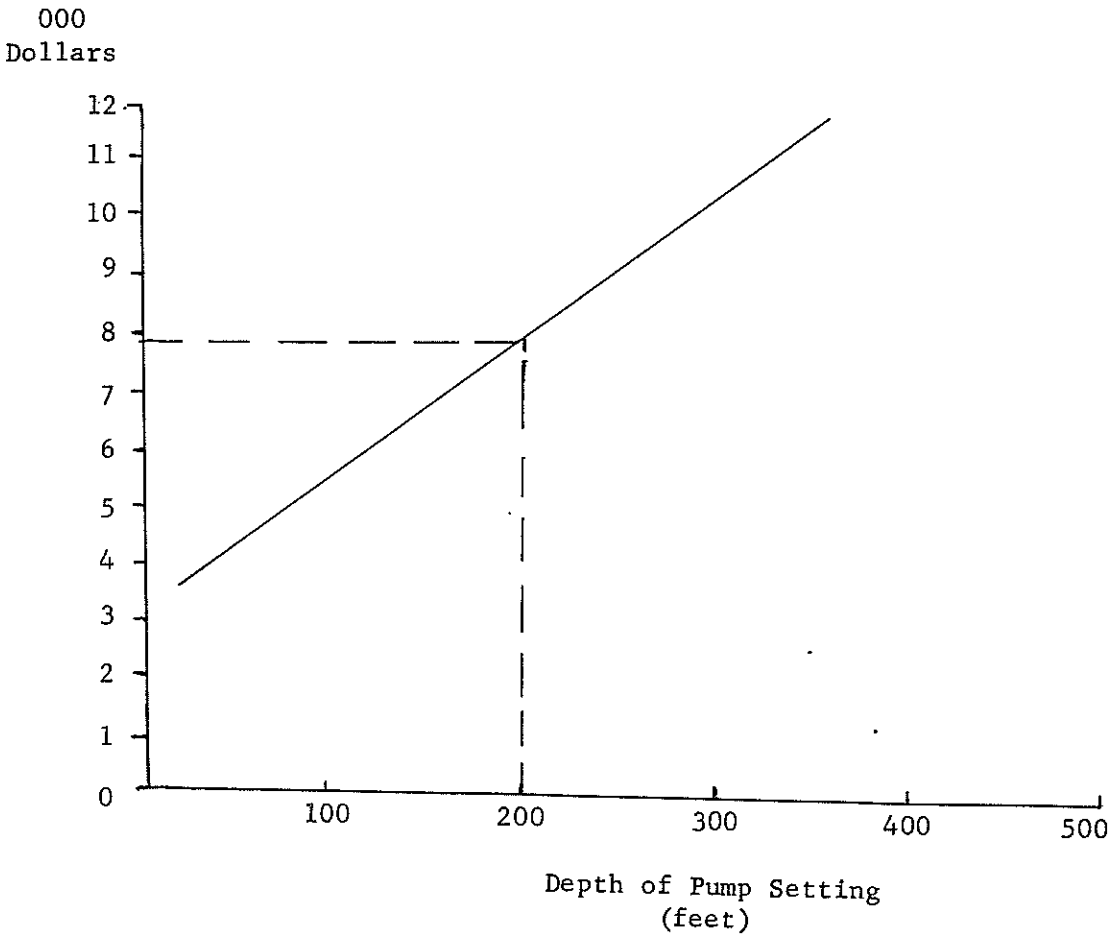


Table 2. Investment in Well, Pumping Plant and Depth of Pump Setting, New Mexico

Investment in	Group I 29 wells[1/]	Group II 32 wells[1/]	Group III 59 wells[1/]
	(Dollars)	(Dollars)	(Dollars)
Well	3088	1945	600
Pump	5355	2486	2121
Power Unit	2626	1185	1026
Total	11069	5616	3747
Depth:			
Drilled (ft.)	371	237	121
Pump Setting (ft.)	307	123	85
Lift (ft.)	277	111	77
G.P.M.	990	951	1190

1/ Group I - Curry County, Group II - Estancia Valley, Group III - Lea County.

Current estimates show that a 200 acre dry land farm in Lea County might expect a net return of $17.75 per acre. By adding an irrigation well the net income could be increased by about $14.68 per acre (table 3).

Table 3. Return per Acre from a 200 Acre Dry Land and Irrigated Farm in Lea County, New Mexico[1/]

	Per Acre $
Dry land:	
Net Income	$17.75
Irrigated:	
Net income before deducting cost of water	$48.51
Less dry land income	- 17.75
Residual return to water	$30.76
Less Current Cost of water	- 16.08
Net increase per acre	$14.68

1/ Cole, James F., Masters Thesis, New Mexico State University, August 1960, pp. 87-88

If we examine the yields of irrigated and dry land wheat and grain sorghum in Curry County, we find substantial differences (table 4). For grain sorghum there is a yield difference of 2748 pounds. Using a price of $1.75 per hundredweight the increase return would be $48.09. If we subtract out the cost of pumping water, we find a net increase in returns per acre of $29.65 when pumping with natural gas and $19.39 when using butane (table 5).

Table 4. Yield of Sorghum and Wheat, Curry County, 1957-60 Average

	Irrigated	Dry	Difference
Sorghum - pounds	3881	1133	2748
Wheat - bushels	33	14	19

Table 5. Costs and Returns Per Acre from Irrigation, Curry County

Sorghum Grain:		
Increase in Returns		$48.09
Cost of Water:		
Natural Gas	(2 acre feet)	18.44
Butane		28.70
Wheat:		
Increase in Returns		$34.20
Cost of Water:		
Natural Gas	(1.4 acre feet)	13.83
Butane		21.53
Cost of Water Per Acre Foot:		
Natural Gas		$ 9.22
Butane		14.35

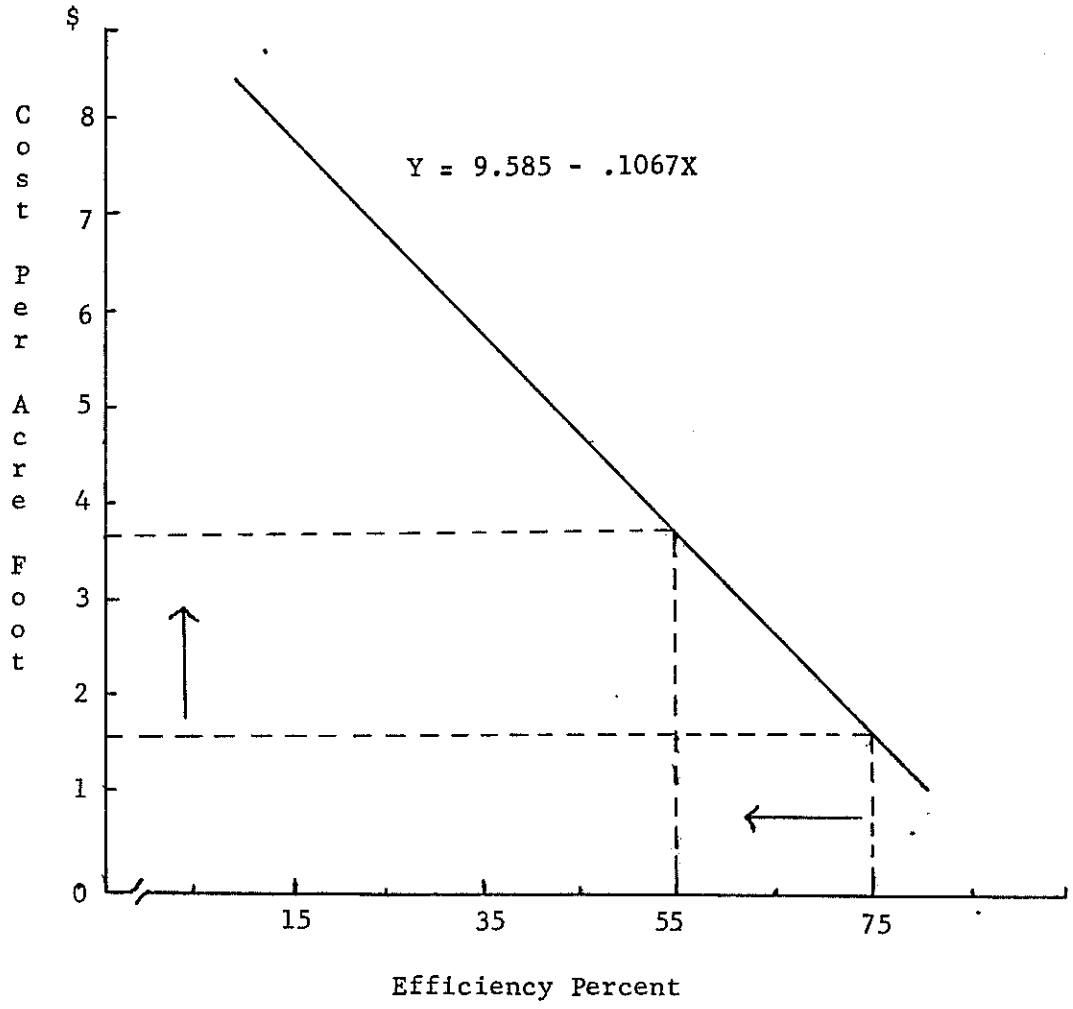
With wheat at $1.80 per bushel the net increase per acre after cost of pumping is deducted would be $20.37 using natural gas and $12.67 using butane.

I would like to examine now some of the economic factors of irrigation at the farm level. One of the important factors that effect the cost of pumping irrigation water is the efficiency of the pumping plant. Over-all efficiency of the plant is

determined by multiplying the efficiency of the pump by the efficiency of the power unit. For example, if the pump is 70 percent efficient and the power unit 50 percent efficient the over-all plant efficiency would be (.70 X .50) 35 percent.

Figure 2 shows that for every 1 percent change in efficiency for electric pumping plants in Lea County the operating (or cash) cost increase by 10.67 cents (Y = 9.585 - .1067X). This means that if the efficiency dropped from 75 to 55 percent the operating cost per acre foot would increase from $1.58 to $3.70.

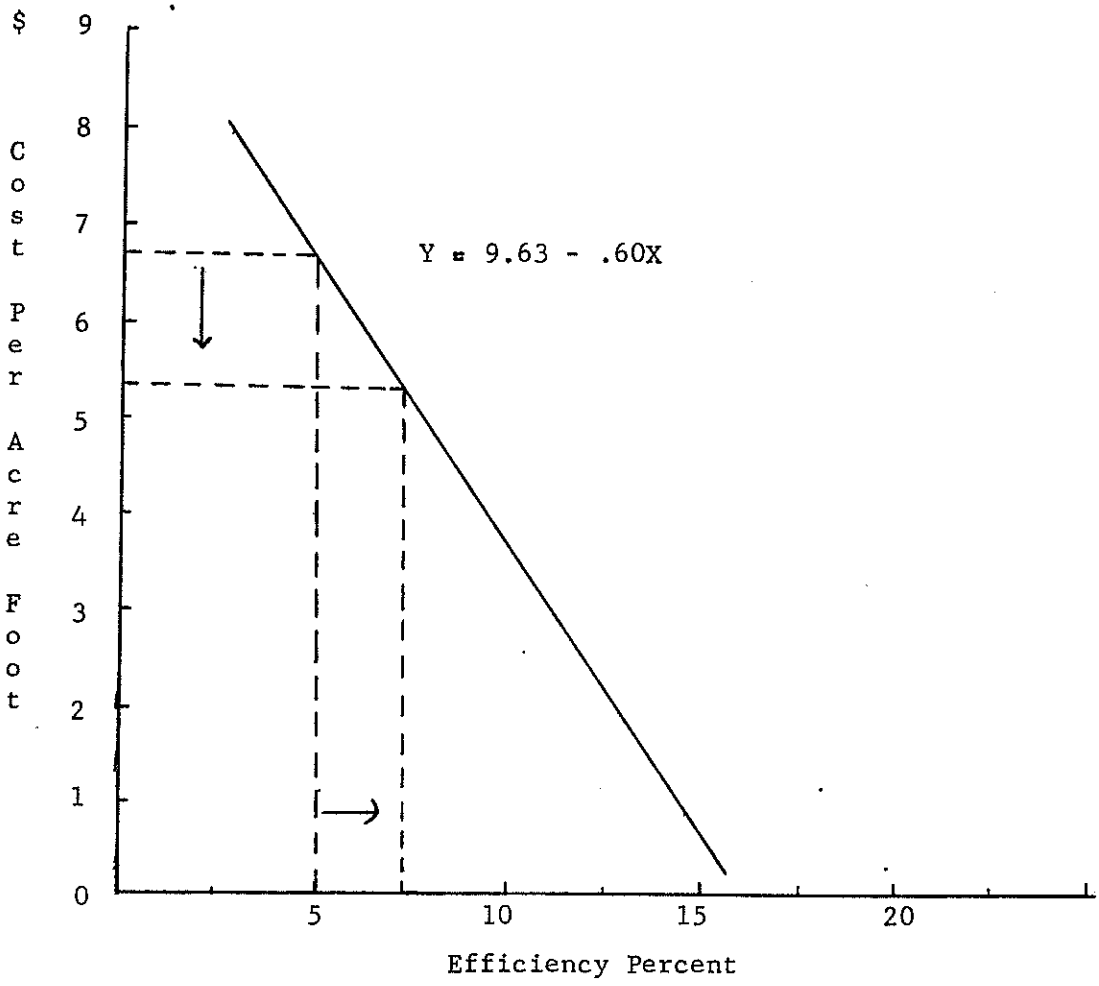
Figure 2. Operating Cost Per Acre Foot and Efficiency, Electric Power--Lea County



Since internal combustion engines are not as efficient as electric motors, we find that small changes in efficiency (of power units using butane or natural gas) are associated with rather large changes in costs. For every 1 percent change in efficiency for butane using plants in Lea County, there was a change in operating costs of 60 cents (Y = 9.63 - .60X). For example, if plant efficiency increased from 5 percent to 7½ percent (2.5%) operating costs per acre foot would decrease from $6.75 to $5.25 ($6.75 - (2.5 X .60) = $5.25).

Another factor that influences the cost of pumping irrigation water is the discharge of the well in gallons per minute (G.P.M.).

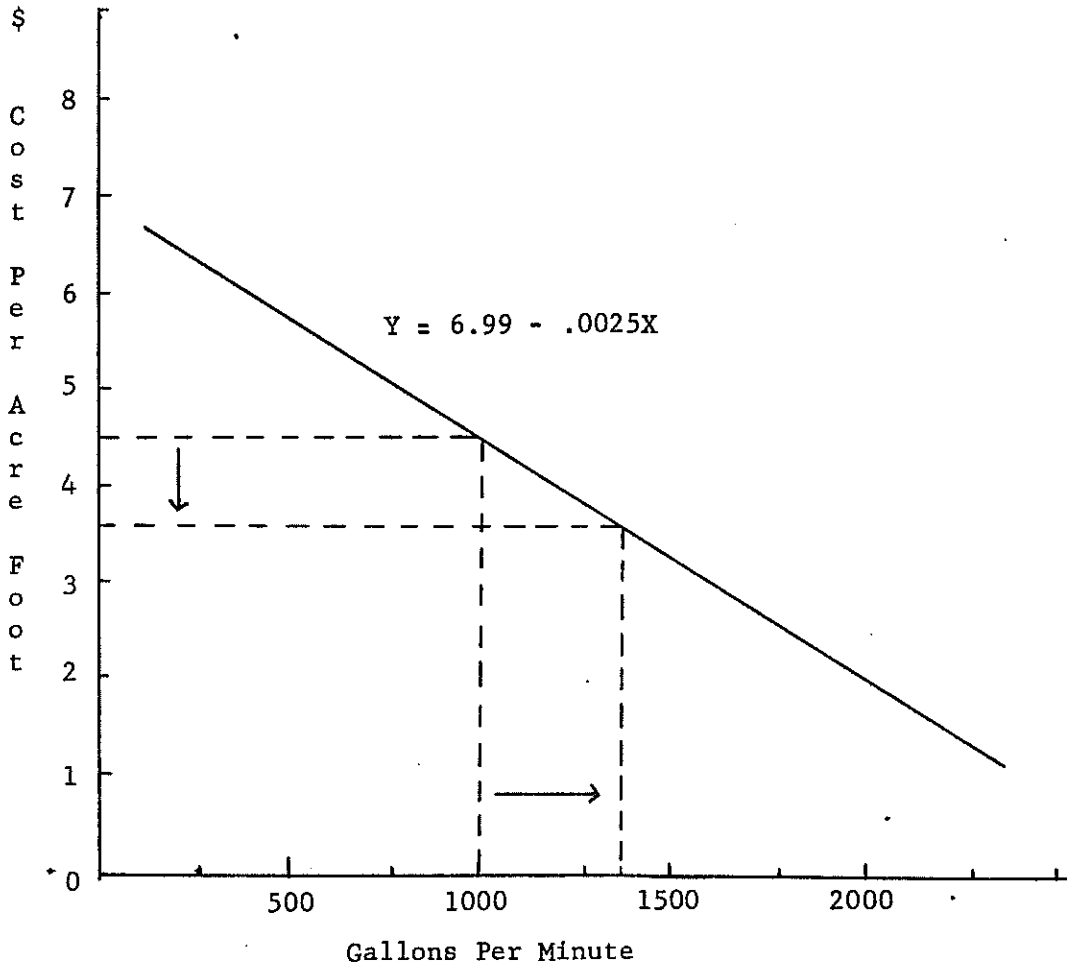
Figure 3. Operating Cost Per Acre Foot and Efficiency, Butane--Lea County



We found in Estancia Valley for electric power units that for every 100 G.P.M. increase in discharge the operating cost per acre foot decreased by 25 cents (Y = $6.99 - .0025X). If G.P.M. discharge increased from 1000 to 1400 the operating cost per acre foot decreased from $4.50 to $3.50 ($4.50 - (400 X .0025) = $3.50).

Findings in Curry County also indicate a definite relationship between total cost per acre foot and G.P.M. discharge.

Figure 4. Operating Cost Per Acre Foot and Discharge of Well Electric Power--Estancia Valley



For well pumping less than 400 G.P.M. the loss was about $16.00 while for those pumping over 800 G.P.M. the total cost per acre foot was just about half as much.

Table 6. Total Cost per Acre Foot and G.P.M., Curry County

G.P.M.	Cost
400 and less	$16.11
401 - 600	14.02
601 - 800	10.02
801 and over	7.99

The number of hours a pumping plant operates during the season affects the cost per acre foot. In general the more hours a plant operates during the season the lower will be the costs (table 7).

Table 7. Total Cost per Acre Foot and Hours Operated, Curry County

Hours	Cost
1900 and less	$12.09
1901 - 2500	11.76
2501 and over	8.94

Acre feet pumped per season is really a combination of the hours operated and G.P.M. discharge of the well.

It was found in Estancia Valley that plants pumping 50 acre feet per year had a loss almost three times that for plants pumping 400 acre feet (table 8).

Table 8. Total Pumping Cost per Acre Foot Estancia Valley

Acre Feet Pumped	Cost
50	$15.69
100	9.86
200	6.94
300	5.97
400	5.49

Cost of pumping is also affected by the kind of fuel used. This depends primarily on the cost per unit and varies in different areas of the state.

Findings in Curry County indicate that cost of pumping with natural gas is considerably less than with butane.

Table 9. Total Cost of Water and Kind of Fuel, Curry County

	Natural Gas	Butane
Hours run	2442	2246
Cost per hour	$1.15	$1.58
Per acre foot	322	263
Cost per acre foot	$8.68	$13.45
Cost per acre foot per foot of lift	2.74¢	4.71¢

Table 10. Annual Cost per Well, Curry County

Operating Cost	Natural Gas	Butane
Fuel	$ 892	$1,982
Repairs:		
Pump-Well	223	205
Motor	180	166
Lubrication & Oil	100	74
Labor (Servicing the plant)	40	35
Total	$1,435	$2,462

In many instances farmers can do something about the factors affecting the cost of pumping. However, we still hear complaints that cost of irrigation water is high -- I say this is all relative, and after you examine Table 11 I think you will have to agree that "Water is Plenty Cheap."

Table 11. WATER IS PLENTY CHEAP

Cost - One Acre Foot	
Pump Irrigation	$6.00
City Water	$195.00
Saline Water (conversion)	$651.00
Paid for Water in Dallas, 1956	$130,157.00
"Old Grand Dad"	$10,182,156.00