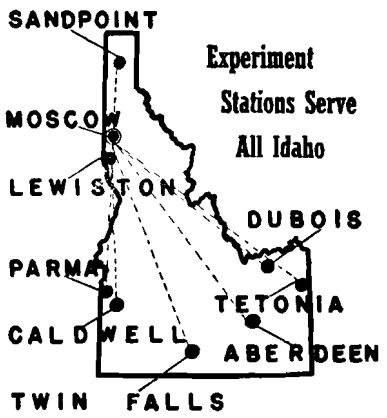


Idaho Agricultural Research

Progress Report

NO. 130

RELATIONSHIP OF PUMPING LIFT TO ECONOMIC USE OF GROUNDWATER FOR IRRIGATION

BY

RICHARD CHELINE
RESEARCH FELLOW

AND

ROBERT HAYNES
RESEARCH FELLOW

DEPARTMENT OF AGRICULTURAL ECONOMICS

Agricultural Experiment Station

UNIVERSITY OF IDAHO

College of Agriculture

This report deals with the first phase of an economic study conducted on the Upper Snake River Basin. The objective of this phase is to determine the optimum economic combination of the scarce resources available with respect to the price the farmers can afford to pay for pumped irrigation water from a ground water source.

The research upon which this report is based was supported by the Idaho State Reclamation Department. The project is continuing with support from the Idaho Reclamation Department and the United States Department of the Interior as authorized under the Water Resources Act of 1964, Public Law 88-379.

The project is sponsored by the Water Resources Research Institute, University of Idaho, Moscow, Idaho.

RELATIONSHIP OF PUMPING LIFT TO ECONOMIC USE OF GROUNDWATER FOR IRRIGATION

Richard Cheline and Robert Haynes

Introduction

Groundwater is being pumped to greater and greater heights. The economic impact of this is not presently known. Farm size, cropping patterns, irrigation system design and farm management are some of the factors which define how high water can be economically lifted.

It is the purpose of the research upon which this report is based to study these factors and define relationships between pumping lift and the various factors which affect the price one can afford for water. This problem is an integral part of the economic development of desert land in Idaho and many other areas of the west. More efficiency in the methods of pumping, in the application of water and in farming operations make it possible to take advantage of the economics of size by establishing relatively large farm units.

The size of farm units is not alone an economic question but involves also present laws and institutions.

Demand for irrigation water in desert land development is so high that the search for new aquifers and for the means of putting the water to work economically has been an expanding challenge to scientific ingenuity.

Modern technology allows water to be lifted greater distances than ever before, which means new sources of water can be utilized. In some areas pumping from deep wells causes a lowering of the water table with the result that prior estab-

lished wells pumping from lesser depths are going dry. It may be that water from the deeper wells is being put to better economic use than that pumped from the wells of lesser depth. The economic productivity of water used for agriculture is thought to vary significantly in some situations due to size of the farms using the water. The crop patterns and farm organization may vary significantly between the two sources of ground water.

Although economic considerations are not the sole criteria for allocation of water, knowledge of validly comparable economic values of water in different uses within agriculture will be very useful to water resources allocators (administrators, legislators or others).

Sources of Data

The estimates presented are based mainly on data obtained from personal interviews with twenty farmers and with machinery dealers, and other businesses in the area. Also data on pumping water from wells were supplemented with information supplied by the Idaho Power Company. Estimates are based partly on data obtained from previous studies in the area.

The twenty farms included in the sample were selected in consultation with the county agent in Cassia County. The data were gathered in August and September of 1966.

Location: South of the Snake River in Western Cassia County, known as Goose Creek area.

Type of Soil: Uniform sandy loam.

Farm Organization: Sixteen of the twenty farms interviewed were the typical owner-operator farms, the remaining four farms involved rented land operated as owner-operator. No incorporated farms were found in the area.

Production Requirements and Price Assumptions

The cost and return estimates in this publication are presented for use in studying the problems of deep well pumping and to provide information so that decisions on reasonable pumping lifts can be made.

In calculating the costs of the individual farm enterprises, a given set of production practices and a given level of equipment was assumed. Production requirements and prac-

tices were assumed to be under a situation of advanced technology, and that the land has reached its full production potential when the crops have the necessary amount of water available to grow a maximum crop. The farm managers were assumed to be above the average farm management level.

The prices of the inputs were based on the actual prices paid by the farmers in the area. The price variation between farms was adjusted on the basis of the prices the supplier of inputs charged. See Appendix Tables 1 to 5.

The prices of output were a ten-year average of prices received by farmers for the individual crop.

The capital requirements on the farms were assumed to be fulfilled without any restriction from the lending agencies.

The invested capital in the farm operation was charged an interest of six percent. That means, that the farm was entirely owned by the farmer. If this assumption is not true then an adjustment will have to be made between the interest actually paid and the interest rate charged on the investment. When the interest rate on the loan is six percent, there is no need for adjustments.

Land was valued at $400 per acre which is consistent with the values given by real estate agents in the area.

Representative Farm Budgets

In the three following budgets, all cost and return figures have been computed from Appendix Tables 1 to 5. The three representative farm budgets are presented for three different rotational patterns. These representative farm

budgets contain the same rotational make-up as was found on the sample farms from which they were derived.

All production expenses of fixed and variable costs are included in the budgets except returns to management and water. The labor costs of applying irrigation water to the crops are included in the budgets whereas the cost of delivering the water from the wells to the headgate is dealt with separately in the next section.

Results:

The amount of money available to pay for water for the entire farm is under Rotation 1, $36.28 per acre; under Rotation 2, $23.60 per acre; and under Rotation 3, $40.95 per acre.

These values include a return to management, however. The manager's own labor in hours is included under labor cost.

Comparing the water values under the three situations with the annual cost per acre of delivering the water (next section) should give some guidance in the economic feasibility of water resources development from ground water sources.

It should be pointed out that the water values under the three situations will not change with the pumping level; they will stay constant regardless of the depth of the well.

Caution:

It should be remembered that for this progress report the three representative farms were developed under a tentative basis. The final results will include different sized farms with more elaborate analysis.

Table 1

Representative Farm Budget for 400 Acre Farm

Rotation Plan 1

Item	Yearly Expenses and Returns				
	Potatoes 75 acres	Sugar Beets 100 acres	Wheat 75 acres	Alfalfa 150 acres	Entire Farm 400 acres
Production: Total Returns	$24,375	$22,440	$11,411	$17,250	$75,476
Inputs:					
Tractor	1,009	1,586	495	1,842	4,932
Implements	448	596	196	1,349	2,589
Labor	990	1,540	706	1,912	5,148
Hauling (stacking)	1,313	1,650	148	2,475	5,586
Harvesting	4,688	4,125	525	-	9,338
Spraying	206	-	338	-	544
Hoeing & Thinning	-	2,900	-	-	2,900
Seed	3,860	385	413	900	5,558
Fertilizer	2,268	3,320	1,320	1,275	8,183
Insecticide	-	-	-	225	225
Farm supplies (Miscellaneous)	375	500	375	750	2,000
Building depreciation	176	235	176	353	940
Insurance	78	105	78	121	382
Land Taxes	195	260	195	390	1,040
Interest on Land Investment	1,800	2,400	1,800	3,600	9,600
Total Cost	$17,406	$19,602	$ 6,765	$15,192	$58,965
Residual available to pay for water	6,969	2,838	4,646	2,058	16,511
Total	$24,375	$22,440	$11,411	$17,250	$75,476
Per acre Residual Net Income available to pay for water	$92.93	$28.38	$61.95	$13.72	$41.28

Table 2

Representative Farm Budget for 400 Acre Farm

Rotation Plan 2

Item	Yearly Expenses and Returns			
	Beans 135 acres	Wheat 70 acres	Alfalfa 195 acres	Entire Farm 400 acres
Production: Total Returns	$16,540	$10,650	$22,425	$49,615
Inputs:				
Tractor	1,790	462	2,395	4,647
Implements	783	183	1,753	2,719
Labor	1,789	659	2,486	4,934
Harvesting	1,350	490	-	1,840
Hauling (stacking)	112	138	3,218	3,468
Hoeing	351	-	-	351
Seed	1,215	385	1,170	2,770
Fertilizer	-	1,232	1,658	2,890
Spraying & Insecticide	-	315	293	608
Farm supplies (miscellaneous)	675	350	975	2,000
Building depreciation	317	165	458	940
Insurance	142	73	158	373
Land Taxes	351	182	507	1,040
Interest on Land Investment	3,240	1,680	4,680	9,600
Total Cost	$12,115	$ 6,314	$19,751	$38,180
Residual available to pay for water	4,425	4,336	2,674	11,435
Total	$16,540	$10,650	$22,425	$49,615
Per acre Residual Net Income available to pay for water	$32.78	$61.95	$13.72	$28.59

Table 3

Representative Farm Budget for 400 Acre Farm

Rotation Plan 3

Item	Yearly Expenses and Returns					
	Wheat 80 acres	Potatoes 80 acres	Sugar Beets 80 acres	Beans 80 acres	Alfalfa 80 acres	Entire Farm 400 acres
Production: Total Returns	$12,172	$26,000	$17,952	$9,802	$ 9,200	$75,126
Inputs:						
Tractor	528	1,076	1,269	1,061	982	4,916
Implements	208	478	477	464	719	2,346
Labor	754	1,056	1,232	1,060	1,020	5,122
Hauling (stacking)	158	1,400	1,320	66	1,320	4,264
Harvesting	560	5,000	3,300	800	-	9,660
Spraying	360	220	-	-	-	580
Hoeing & Thinning	-	-	2,320	208	-	2,523
Seed	440	4,117	308	720	480	6,065
Fertilizer	1,408	2,419	2,656	-	680	7,163
Insecticide	-	-	-	-	120	120
Farm supplies (miscellaneous)	400	400	400	400	400	2,000
Building depreciation	188	188	188	188	188	940
Insurance	84	84	84	84	65	401
Land Taxes	208	208	208	208	208	1,040
Interest on Land Investment	1,920	1,920	1,920	1,920	1,920	9,600
Total Cost	$ 7,216	$18,566	$15,682	$ 7,179	$ 8,102	$56,745
Residual to pay for water	4,956	7,434	2,270	2,623	1,098	18,381
Total	$12,172	$26,000	$17,952	$ 9,082	$ 9,200	$75,126
Per acre Residual Net Income available to pay for water	$61.95	$92.93	$28.38	$32.78	$13.72	$45.95

Cost of Pumping and Delivering Water

The physical and economic estimates presented here are based on data gathered from the twenty farmers and from the Idaho Power Company.

The costs include all the expenses of pumping the water from the wells and delivering it to the headgates. Labor costs of applying water were included in the representative farm budgets in the previous section.

The annual cost of water consists of depreciation and interest on the well, pump and motor, concrete or transite pipe, concrete lined ditches and siphon tubes. It also includes repair and maintenance on the above items, plus land leveling and electric power costs.

The length of estimated life of elements is presented in Table 4.

Table 4. Expected Life of Elements Involved in the Irrigation System

Investment	Years of Life
Well	Permanent
Land Leveling	Permanent
Electric Motor and Pump	20 years
Concrete Pipe	20 years
Concrete lined Ditch	10 years
Transite Pipe	25 years
Siphon Tubes	5 years

The annual costs for this equipment were computed from the total expenses of the entire life of the equipment based on a series of equal annual payments that would retire the initial expenses at the end of the expected useful life. Interest was charged on the unpaid balance at a rate of six percent per year.

The computed annual cost was then distributed among the crop enterprises on the representative farms on the following basis: 1) Well, pump and motor, concrete pipe, transite pipe, and power according to the percentage of pumped water that was applied to the respective crops; 2) Land leveling and concrete ditches according to the percentage of the total irrigated acreage devoted to the respective crops. The percentage of the water that was applied to the respective crops was determined from the water requirement for the crops in the area as set forth in University of Idaho Experiment Station Bulletin No. 291. The assumption was made that if crops were over-irrigated or under-irrigated, it was done uniformly. In the case of under-irrigation this would not be strictly true because the farmers indicated that if a choice had to be made, alfalfa would be sacrificed to obtain a return on the other crops. Some of the farmers utilize a relift system or reuse their water at a lower elevation on the farm. Others make no attempt to reuse their water but farmers below them do reuse it. It was assumed for the farms in the sample, that the increased cost to those who did not reuse waste water was offset by a decrease in cost to those who reuse water that they did not pump initially; that means, that the devi-

ation from the average cost per acre was offset.

The average cost of water per acre for the respective crops was based on the cost of the individual farmers interviewed weighted by the number of acres of the crop that the farmer had in his system during the 1966 growing season. The water cost per acre per year for the crops included in the standardized rotations for pumping conditions that now exist are:

Beans	$21.71
Grain	$25.10
Potatoes	$28.02
Sugar Beets	$28.75
Alfalfa	$31.49

For the average 400 acre farm, based on examining existing farms, the pumping system was considered to be two 200hp pumps each pumping 3.0 cfs. The pumping sequence of the average 400 acre farm was set as follows:

April	120hr
May	500hr
June	600hr
July	620hr
August	300hr
September	200hr
Total	2340hr

This sequence would deliver 2.90 acre-feet per acre. This is below the average for the 1966 pumping season (3.71 acre-feet per acre) which was unusually high since crops were irrigated before emergence. A five year average from 1958 to

1962 on the Northside Pumping Division of the Minidoka Project was 3.18 acre-feet per acre as reported in University of Idaho Research Bulletin No. 62.

To determine the permissible additional lift, the increase in cost was taken as additional column, stages, motor control equipment, increase in size of electric motor and electric power. Since the cost of a 200hp electric motor is already included in the current costs, the value of a 200hp motor is subtracted from the price of the larger motor required. The useful life of this equipment was taken as 20 years. The additional stages are 12 inches in diameter, provide 48 feet of lift per stage, and require 19.5 hp per stage. The prices of this equipment are $184 per stage and $192 per ten feet of column. This information on pump characteristics and cost was obtained from a pump manufacturer who has considerable equipment in the area. The pump efficiency at the stated conditions is 83 percent. The annual cost of the additional pumping equipment was computed in the same manner as was previously stated for the current costs.

The additional power cost was computed using Idaho Power Schedule number 24. The electrical efficiency of the motor was assumed to be 90 percent. This factor was applied to the horsepower required to operate the stages to evaluate the electrical demand which is used to compute killowatt-hours.

Rotation 1. The cost of water under rotation 1 is currently $28.96 per acre. This leaves $12.32 per acre or $4928 for the entire farm which may be allocated to management or for additional lift. If the assumption is made that the farm-

er and his family do all the labor exclusive of that involved with hauling, harvesting and hoeing and thinning, (see Table 1, Input item 3) and that this labor plus a return to management represents their only income from the farm, then Graph 1 shows the effect on the farmer's income of changing the distribution of the $4923 between additional lift and return to management. Returns to investment are excluded from the above analysis. The farmer also receives an income from his investment in the farm. If the residual is devoted entirely to additional lift, the limit is 230 feet.

Rotation 2. This rotation is borderline economically at current depths. The cost for water delivered is currently $27.07 per acre. This leaves a residual of $603. Graph 2 shows the effect changing the distribution of this residual between additional lift and return to management. The assumptions are the same as under Rotation 1.

Rotation 3. The cost for water is $27.01 per acre. This leaves $13.94 per acre or $7576 which may be allocated to increasing lift or as a return to management. Graph 3 shows the effect on the farmers income of changing the distribution of the residual between additional lift and return to management. If the residual is allocated completely to additional lift, water may be pumped from 350 feet deeper.

It should be remembered that these figures are based on the expansion taking place at the time of installment and not after the system is in operation. Altering existing equipment would be more expensive than making the original installation conform to these limits. Also, these figures for in-

creased lift are based on the efficiencies at the time of installation. As time passes and the efficiencies go down, more power will be required to pump the same amount of water, thus increasing costs.

APPENDIX

Explanation of the Cost Factors in the Enterprise Budgets

1. Tractor - The cost figures are based on data collected from more than 100 farms in Southern Idaho. The figures are approximations of typical operations and expenses of these farms.

2. Implements - cost per hour based on machinery studies made in Nebraska, New Mexico, Idaho and Wyoming.

3. Labor - utilizing information from farmers, county agents, and various county officials. $1.50 rate per hour was used.

4. Hauling - farmers information.

5. Harvesting - farmers information and custom rates.

6. Spraying - weighted average of the cost figures supplied by the farmers.

7. Hoeing and thinning - based on rates paid by farmers in the area.

8. Seed - based on local application rates and local suppliers' quoted prices.

9. Fertilizer - utilizing farmers' application rates and local dealers prices.

10. Insecticide - same as (9).

11. Farm supplies - utilizing farmers information. Included in this is telephone, traveling expense, and general time and expense pertaining directly to the farm operation.

12. Building depreciation - estimated and standardized from personal interviews. This includes shop and initial out-

lay for equipment in shop.

13. Insurance - utilizing state wide known rates including machinery, and crop insurance.

14. Land taxes - actual taxes paid by farmers.

15. Interest on Land Investment - land valued at $400 per acre. Interest rate 6 percent.

Table 1

Potatoes

Production Cost and Returns per Acre

	Unit	Quantity	Price per Unit	Value or Cost
Production (Output)	cwt.	250	$1.30	$325.00
Inputs:				
Tractor	hrs.	6.20	$2.17	$ 13.45
Implements	hrs.	6.20	varied	5.97
Labor	hrs.	8.80	1.50	13.20
Spraying hired				2.75
Harvesting	cwt.	250	.25	62.50
Hauling to cellar	cwt.	250	.07	17.50
Seed	cwt.	14.1	3.65	51.46
Fertilizer	lbs.	560	.054	30.24
Farm supplies (miscellaneous)				5.00
Insurance				1.05
Land taxes				2.60
Building depreciation				2.35
Interest on Land Investment				24.00
Total Cost				$232.07
Net Return to Water and Management				$ 92.93

Table 2

Wheat

Production Costs and Returns per Acre

	Unit	Quantity	Price per Unit	Value or Cost
Production:				
Wheat	bu.	85	$1.79	$152.15
Inputs:				
Tractor	hrs.	3.04	$2.17	$ 6.60
Implements	hrs.	3.04	varied	2.61
Labor	hrs.	6.28	1.50	9.42
Spray custom rate	acre			4.50
Combining custom rate	acre			7.00
Hauling				1.97
Seed	lbs.	110	5.00/100	5.50
Fertilizers	lbs.	160	0.11	17.60
Farm supplies (miscellaneous)				5.00
Building depreciation				2.35
Insurance				1.05
Land taxes				2.60
Interest on Land Investment				24.00
Total Cost				$ 90.20
Net Return to Water and Management				$ 61.95

Table 3

Sugar Beets

Production Costs and Returns per Acre

	Unit	Quantity	Price per Unit	Value or Cost
Production:				
Sugar Beets	tons	16.5	$13.60	$224.40
Inputs:				
Tractor	hrs.	7.31	$ 2.17	$ 15.86
Implements	hrs.	7.31	varied	5.96
Labor	hrs.	10.27	1.50	15.40
Hoeing & Thinning	acre	1.0	29.00	29.00
Harvesting	ton	16.5	2.50	41.25
Hauling	ton	16.5	1.00	16.50
Seed	lbs.	7	0.55	3.85
Fertilizer	lbs.	800	0.0415	33.20
Insecticide				0
Farm supplies (miscellaneous)				5.00
Insurance				1.05
Building depreciation				2.35
Land taxes				2.60
Interest on Land Investment				24.00
Total Cost				$196.02
Net Return to Water and Management				$ 28.38

Table 4

Beans

Production Costs and Returns per Acre

	Unit	Quantity	Price per Unit	Value or Cost
Production:				
Beans	cwt.	20.42	$6.00	$122.52
Inputs:				
Tractor	hrs.	6.11	$2.17	$ 13.26
Implements	hrs.	6.11	varied	5.80
Labor	hrs.	8.83	1.50	13.25
Combining custom rate	acre	1	10.00	10.00
Hauling custom rate				0.83
Hoeing	hrs.	1.73	1.50	2.60
Seed	lbs.	1.00	9.00	9.00
Farm supplies (miscellaneous)				5.00
Building depreciation				2.35
Insurance				1.05
Land taxes				2.60
Interest on Land Investment				24.00
Total Cost				$ 89.74
Net Return to Water and Management				$ 32.78

Table 5

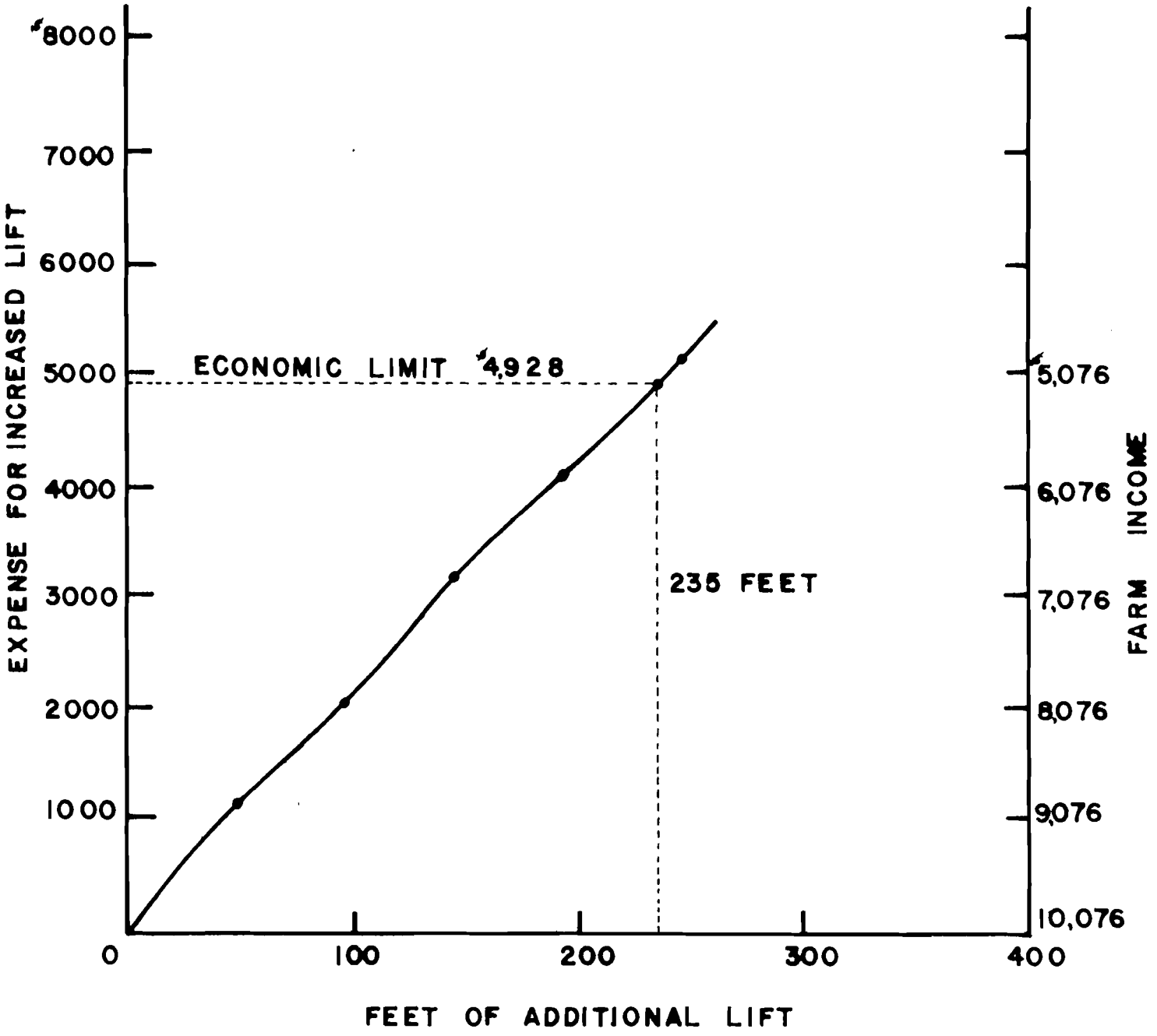
Alfalfa Hay

Production Costs and Returns per Acre

	Unit	Quantity	Price per Unit	Value or Cost
Production (output)	ton	5.0	$23.00	$115.00
Inputs:				
Tractor	hrs.	5.66	$ 2.17	$ 12.28
Implements	hrs.	5.66	varied	8.99
Stacking & Hauling	bales	165	0.10	16.50
Labor for all operations	hrs.	8.5	1.50	12.75
Seed	lbs.	12	0.50	6.00
Fertilizer (0-45-0)	lbs.	200	0.0425	8.50
Insecticide (hired)				1.50
Farm supplies (miscellaneous)				5.00
Building depreciation				2.35
Insurance				0.81
Land taxes				2.60
Interest on Land Investment				24.00
Total Cost				$101.28
Net Return to Water and Management				$ 13.72

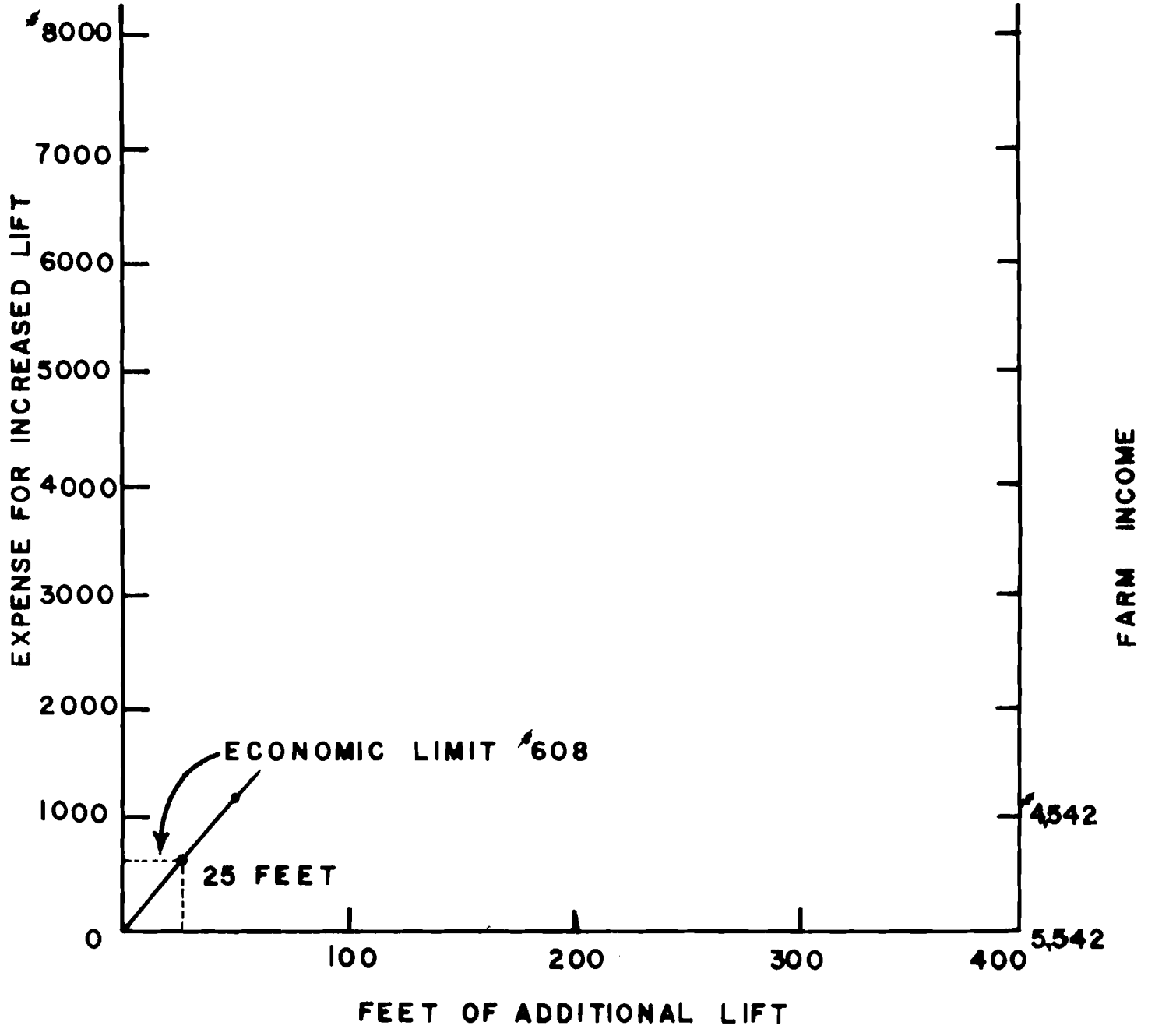
INCREASED LIFT VS. FARM INCOME

GRAPH I— ROTATION I



INCREASED LIFT VS FARM INCOME

GRAPH 2—ROTATION 2



INCREASED LIFT VS. FARM INCOME

GRAPH 3 — ROTATION 3