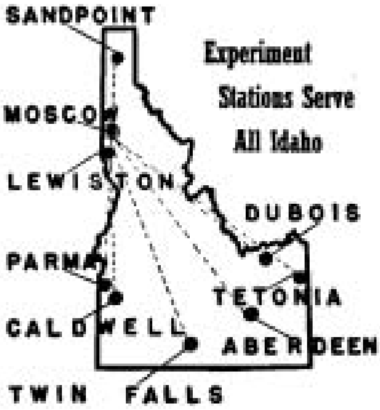

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Progress Report

NO. 112

WATER RESOURCES RESEARCH INSTITUTE

RELATIONSHIP BETWEEN FARM SIZE AND ABILITY TO PAY FOR IRRIGATION WATER

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SUMMARY

This study was conducted in the Dry Lake area at Nampa, Idaho, where 5 or 6 companies are pumping irrigation water from the Snake River to a plateau 500 to 600 feet above the river surface. Irrigation development costs of bringing the water to the headgates of the farms are not included in this phase of the study.

Data was secured for 8 farms by interviewing each farm operator and land owner. To make comparisons between farms and also between enterprises, the data were broken down into per acre variable costs, fixed costs, total returns, net income and the cost of producing a dollar's worth of output. The term "cost per dollar of output" is the ratio of costs to returns. This ratio makes it possible to compare high-valued crops with low-valued crops on a per acre basis. This is a very sensistive measurement. For example, one cent change in the ratio for potato enterprise means a change in net income of $3.25 per acre.

The budgeting method of estimating water values in irrigation was used in this study. Long-run planning cost curves were estimated from the budgets by using simple curve linear regression. From the regression equations for each of the four enterprises (grain, sugar beets, potatoes and alfalfa seed), 12 model farms were constructed.

The long-run average total cost curve for the model farms, which incorporates a long-run rotation and long-run price and yield expectations, indicated economies of size up to a farm size of 2,400 acres.

Net income -- the measurement of how much money is left over to pay for irrigation water after all expenses, including remuneration for management, land and investment, have been paid -- varied from about $50 to $57 per acre for all model farms.

ACKNOWLEDGEMENT

The authors wish to express appreciation to the farmers who cooperated by providing the information necessary for this study. Appreciation is also extended to B L M personnel in Boise who were very helpful in the initial phase of the study.

THE RELATIONSHIP BETWEEN FARM SIZE AND ABILITY TO PAY FOR IRRIGATION WATER

Arthur Coffing and Karl H. Lindeborg

During the past five years several large areas of Idaho desert land have been developed for agricultural purposes. One of the largest and best developed of these is the Dry Lake Area of Canyon County. The uniqueness of these new development projects is the fact that the water must be lifted 500 or more feet from the Snake River to the overlying plateaus before it can be applied. From the point of view of the engineer, it is physically feasible to bring water to the arable land on the plateaus; however, the economic feasibility of such ventures remains a question.

There are two aspects to the economic feasibility of such projects. The first is how much does it cost to deliver the water to the land. Factors like power, cost of the river pumps, depreciation and repair costs on the same, and investment costs on all irrigation equipment are involved here. The second part of the problem is how much can a farm afford to pay for irrigation water. Factors like size of the farm, type of crops grown, prices and farming efficiency are involved in the second part of the problem. This summary of preliminary results attempts to answer the second part of the problem. Final results and conclusions of both parts of the problem are to be published at a later date.

The purpose of this study was:

1. To determine the economic ability of different sizes of farms to pay for irrigation water.

2. To determine the economics of size of the various farm enterprises and for the entire farm operations.

DESCRIPTION OF THE SAMPLE AREA

Location

The Dry Lake area, being the oldest and best developed example of this type of irrigational land development was chosen as the sample area. Even here, many farms were in only their first year of operation in 1963; therefore, it was possible to obtain a sample of only 8 farms that had operated in 1963. Each of these 8 farms was all or partly composed of the land that had recently been developed from sagebrush desert into irrigated farm land by applying water from the Snake River. Three of the sample farms were entirely composed of new land that had just been developed. The other 5 were farms that had been located in the area and had expanded as the new land was brought into production. Two of these 5 had access to canal water while the other 3 were irrigated with well water.

Type of Soil

Topography of the area is gently rolling making sprinkler irrigation necessary on much of the land. The soil is predominantly a silt or silt loam and because of the arid conditions and limited plant life it is low in humus; however, most of the farmers expressed the opinion that it is just as productive as any soil type in Canyon County.

Farm Organization

Leasing the tenure systems were different for each of the farms. The sample includes typical owner-operator farms, incorporated farms, a half-share lease system, a one-fourth lease system, a partnership, and combinations of these systems. All but one farm was managed by an experienced farmer; the exception was that one member of a partnership had had no farm management experience; however, his two partners had previously managed farms.

A wide variety of crops was grown by the farms. Differences were due mainly to the proportion of the land within each farm that is part of the development project. The "new" land has given yields of potatoes and sugar beets that are much higher than the county averages for these two crops. Thus, in the short-run, extra high returns were being gained by devoting newly developed land to sugar beets and potatoes because of their extra yielding ability.

PROCEDURE

In theory, a problem of economics of scale is quite easy to handle. However, the problem at hand is not one of scale relationship but one of size relationship. True scale relationship exists only when all input factors are increased in the same proportion.

An example of this would be a 400-acre farm that is being farmed by 4 tractors, 4 full sets of machinery, and 8 hired men. If the number of acres in the farm were to be increased to 500 to keep the same scale, it would require that 5 tractors, 5 sets of machinery, and 10 hired men be used to farm it. All other inputs would also have to increase 25 percent to maintain the scale relationship.

In most actual farming situations increases in the size of a farm do not carry with them a proportionate increase in all the inputs that make up the operation. In fact, an increase in land would in many instances, merely bring an increase in variable costs such as fuel and labor. Thus, an increase in acreage might cause a farmer's labor inputs to rise by 25 percent while his depreciation costs only rise 10 percent. It is such a change that this study attempts to measure and compare in the form of size economies.

Economy of size is a measure of the ability of a larger farm to produce a unit of output at a cost lower than that of a smaller farm. Thus if size economies exist, a farmer should be able to produce 200 acres of wheat at less cost per bushel than he can produce 100 acres.

Source of Data

The primary data for this study was secured by personal interviews during September 1964 with each farm operator and each land owner of the 5 newly developed irrigation projects in the Dry Lake area. These interviews yielded 1963 cost data and information concerning both total crop acreages and the acreages for the individual enterprises for the 8 farms that operated in 1963. Most of the actual costs data were taken directly from the 1963 record summaries for each farm. A second interview in February 1965 furnished information concerning labor and machinery requirements for each stage of production for each enterprise.

Empirical Analysis

From the basic data the costs of input factors were calculated for each of the sample farms. Representative farm budgets were then constructed from the cost data.

These representative farm budgets are designated as "standardized real farms" throughout the rest of this report. These farms contain the same rotational make-up as that of the sample farm from which they were derived.

In constructing the standardized budgets it was necessary to use standard input-output coefficients in order to eliminate differences between the farms. Tables I and II present the seeding rates, fertilization rates, number of irrigations per season, seed prices, production prices and yields that were used in the standardized budgets. Also, it was assumed that each farm was using a hand-move sprinkler system and that water was delivered to the farm headgate. This assumption necessitated adjusting labor costs of each farm that had not used a hand-move system on all of its land.

In order to standardize return to management and to investment, it was assumed that the sample farms were operated like corporations and management was paid a set wage while investment was rewarded according to percentages that reflected the risk involved in making it.

Allocating each budgetary cost to the individual enterprise on which it had been expended was accomplished by using a direct allocation system for the cost that could be identified with a given enterprise. An indirect allocation system was used for cost items of a joint cost nature. For instance, such items as contract labor or potato harvestor costs could be allocated directly while such costs as full labor and other similar joint cost items had to be allocated according to a distribution system of weights.

The results of budgeting of the individual enterprise are shown in Table III and Table IV.

TABLE I

PER ACRE SEEDING RATES, FERTILIZATION RATES, AND NUMBER OF IRRIGATIONS PER SEASON FOR EACH ENTERPRISE FOUND ON THE SAMPLE FARMS

Enterprise	Seeding rate per acre	Fertilization pounds per acre N	Fertilization pounds per acre P_2O_5	Number of irrigations per year
Potatoes	1400 lb.	225	275	11
Sugar beets	15 lb.	250	200	13
Grain	2½ bu.	0	0	6
Alfalfa seed	na*	75	50	6
Alfalfa hay	na*	0	100	6
Boiler onions	40 lb.	100	100	8
Onions	4½ lb.	200	200	11
Onion seed	2½ lb.	200	200	8
Silage corn	15 lb.	200	150	5
Sweet corn seed	10 lb.	150	120	7
Dry beans	80 lb.	0	0	7
Radish seed	8 lb.	100	100	12
Parsnip seed	nr**	100	100	12

*Not applicable because none was planted in the year the samples were taken.

**Not reported

TABLE II

ASSUMED SEED PRICES, PRODUCT PRICES, AND PER ACRE YIELDS FOR THE ENTERPRISES FOUND ON THE SAMPLE FARMS

Enterprise	Seed price	Yield per acre	Product price
Potatoes	$2.96/cwt	250 cwt	$1.30/cwt
Sugar beets	.50/lb.	25.7 tons	13.60/ton
Grain	1.80/bu.	85 bu.	1.12/bu.
Alfalfa seed	nr*	425 lb.	33.00/cwt
Alfalfa hay	nr*	4.5 tons	20.90/ton
Boiler onions	1.00/lb.	6 tons	90.00/ton
Onions	1.00/lb.	425 cwt	1.10/cwt
Onion seed	6.00/lb.	1200 lb.	.80/lb.
Silage corn	.20/lb.	20 tons	7.00/ton
Sweet corn seed	.20/lb.	2000 lb.	.195/lb.
Dry beans	10.00/cwt	2425 lb.	7.10/cwt
Radish seed	.20/lb.	225 lb.	.15/lb.
Parsnip seed	nr*	nr*	(Gross $300 per acre)

*nr Not reported

Table III

EXAMPLE OF STANDARDIZED FARM BUDGET FOR A 250 ACRE FARM

ITEM	COST ALLOCATION SYSTEM	Yearly EXPENSES			
		ENTIRE FARM 250 acres	SUGAR BEETS 120 acres	POTATOES 80 acres	GRAIN 50 acres
Seed	Direct	$ 4437	$ 900.00	$ 3312.00	$ 225.00
Fertilizer	Direct	10040	6300.00	3740.00	0
Spray	Direct	2520	0	2520.00	0
Gas and oil	Tractor-hours	1605	502.04	1037.96	65.00
Machine repairs	Tractor-hours	2299	736.11	1521.89	40.76
Machine hire	Direct	3442	2040.00	1320.00	81.92
Labor	Direct	4862	3832.25	670.75	359.27
Farm supplies and travel	Acres	1154	630.00	420.00	104.33
Irrigation power	Direct	658	374.40	211.20	72.00
Total operating costs		31017	15314.80	14753.80	947.98
Interest charge on operating capital		1241	612.60	590.15	37.92
Total variable costs		32258	15927.40	15343.95	985.90
Irrigation equipment repairs	Acres	$ 1163	$ 558.00	$ 372.00	$ 232.50
Insurance	Direct	203	66.75	84.25	52.10
Irrigation equip. depreciation	Acres	1163	558.00	372.00	232.50
Machinery depreciation	Direct	4816	1549.00	2289.00	978.35
Building depreciation	Direct	587	205.04	154.96	227.48
Non-land taxes and licenses	Truck-hours	366	192.58	161.42	11.59
Land and building taxes	Acres	938	450.00	300.00	187.50
Opportunity cost on land	Acres	6000	2880.00	1920.00	1200.00
Opportunity cost on machinery	Direct	1547	495.75	690.25	361.00
Manager's salary	Man-hours	5000	2575.00	2295.80	129.22
Total fixed costs		21783	9530.12	8639.63	3612.24
Total Costs		54041.00	25457.52	23983.58	4598.14
Total Returns		72700.00	41940.00	26000.00	4760.00
*Net Returns		18659.00	16480.48	2016.42	161.86

* The cost of delivering water to the headgate should be deducted from this net return figure.

TABLE IV

EXAMPLE OF STANDARDIZED FARM BUDGET ON A PER ACRE BASIS
FOR A 250 ACRE FARM

Item	Yearly Expenses			
	Entire Farm 250 acres	120 acres Sugar Beets	80 acres Potatoes	50 acres Grain
Seed	$ 17.75	$ 7.50	$ 41.40	$ 4.50
Fertilizer	40.16	52.50	46.75	0
Spray	10.00	0	31.50	0
Gas and oil	6.42	4.18	12.97	1.30
Machine repairs	9.20	6.13	19.02	.82
Machine hire	13.77	17.00	16.50	1.64
Labor	19.45	31.94	8.39	7.18
Farm Supplies and travel	4.62	5.25	5.25	2.08
Irrigation power	2.63	3.12	2.64	1.44
Total operating costs	124.07	127.62	184.42	18.96
Interest charge on operating costs	4.96	5.11	7.38	.76
Total variable costs	129.03	132.73	191.80	19.72
Irrigation equipment repairs	4.65	4.65	4.65	4.65
Insurance	.81	.56	1.05	1.04
Irrigation equipment depreciation	4.65	4.65	4.65	4.65
Machine depreciation	19.26	12.91	28.61	19.57
Building depreciation	2.35	1.71	1.94	4.55
Non-land taxes and licenses	1.46	1.60	2.01	.23
Land and building taxes	3.75	3.75	3.75	3.75
Interest charge on land investment	24.00	24.00	24.00	24.00
Interest charge on machine investment	6.19	4.13	8.63	7.22
Manager's salary	20.00	21.46	28.70	2.58
Total fixed costs	87.13	79.42	107.99	72.24
Total costs	216.16	212.15	299.79	91.96
Total returns	290.80	349.50	325.00	95.20
Residual available to pay for water	74.64	137.35	25.21	3.24
Cost per dollar value of output	.743	.607	.922	.966

REGRESSION COST CURVES

In order to make comparisons between farms and also between enterprises the budgetary costs were broken down into per acre variable costs, fixed costs, total returns, net profit and the cost of producing a dollar's worth of output. The term "cost per dollar of output" is simply the ratio of costs to returns. The inclusion of this ratio made it possible to compare high-valued crops with low-valued crops on a per acre basis.

The relationship between acres and costs for all the standardized real farms was determined by using the ratio "cost per dollar of output" as the dependent variable and acres as the independent variable in simple curvilinear regression. The relationship was made linear by taking the reciprocal value of the dependent variable. That is, the estimation equation takes the form $1/y = a + bx$ where y is the dependent variable and x the independent variable (acres). The estimation equations were calculated in order to determine any trends that existed within the data. If size economies were to be found in an enterprise, the relationship between cost and size would be indicated by a curve that slopes downward and to the right. If larger farm sizes have neither cost advantages nor disadvantages, the curve would be horizontal, and if larger farm sizes have cost disadvantages, the curve would have an upward slope. Regression equations were estimated for the three enterprises: grain, sugar beets and potatoes, in addition to an equation for the entire farm operation.

Alfalfa seed appeared in the sample only four times. It showed some correlation between size and costs but it was not considered significant because of the extremely small sample size. Therefore, alfalfa seed production costs were taken to be constant and were found by multiplying production costs for each farm by the respective number of acres. These were totalled and divided by the total number of acres to obtain the constant cost.

The estimation equations have the following forms:

Potatoes: fixed cost
$$y^1 = \frac{1}{4.36361 + 0.001343X}$$

variable cost
$$y^1 = \frac{1}{1.50584 + 0.000332X}$$

Sugar beets: fixed cost
$$y^1 = \frac{1}{4.86542 + 0.003108X}$$

variable cost
$$y^1 = \frac{1}{2.74985 - 0.000635X}$$

Grain: fixed cost
$$y^1 = \frac{1}{1.62235 + 0.000595X}$$

variable cost
$$y^1 = \frac{1}{4.73757 - 0.034123X}$$

All enterprises combined (entire farm):

fixed cost
$$y^1 = \frac{1}{3.5470 + 0.000444X}$$

variable cost
$$y^1 = \frac{1}{2.3250 - 0.000233X}$$

y^1 is the reciprocal of the ratio "cost per dollar of output"; and X is number of acres.

These regression curves (illustrated in figures 1 to 4) show how farming costs varied with size for the sample farms; consequently they are the long-run planning curves for the standardized real farms. These curves were extended from 200 acres back to 162 acres and from 1800 acres to 2800 acres to facilitate comparison with the cost curves for the model farms.

RESULTS

Potato Enterprise Costs

Figure 1, page 15, which presents the regression curve for the potato enterprises, shows that it has size economies throughout the entire range of acreages that were found on the sample farms. The downward slope of the total cost curve is due to the fact that both the average variable costs and the average fixed costs declined over the entire range of sizes. Thus, the most efficient enterprise size was the largest one that is found in the range; it was 700 acres.

In monetary terms, net costs decreased from $287.30 per acre for a 40-acre potato enterprise, to $278 for 200 acres, to $263 for 400 acres, to $249 for a 700-acre enterprise. Over the same range, net returns would increase from $38 for 40 acres to $76 for a 700-acre enterprise. This represents an increase of 100 percent.

Sugar Beet Enterprise Costs

The regression curve for sugar beet fixed costs shows that these costs decreased as size increased; however, the variable costs increased. This increase seems to be due to less efficient use of labor on the larger farms. Labor cost for the smallest sugar beet enterprise on one of the smaller farms was $42 per acre while that for the largest enterprise on one of the largest farms was $54 per acre. The net effect of these two opposing trends is that large enterprises tended to have production costs that were the same as those on the small enterprises. The 300-acre enterprise size showed a slight decrease in total cost, but the benefits of the increased efficiency were almost negligible. See Figure 2, page 16.

Grain Enterprise Costs

For grain, the fixed cost curve decreased throughout the full range of enterprise sizes. During the latter part of the range, this decrease was at a decreasing rate. The variable cost curve started from a range of near constancy and increased throughout its full length. The increasing variable costs seemed to be due to less efficient use of labor because labor cost for the two smaller enterprises was seven dollars per acre, and for the two larger enterprises it was nearly thirteen dollars per acre.

The net result of the two component curves is a total cost curve that slopes downward for a short range, has a short range of constancy, and a range in which it increases. According to this sample, the most efficient size of grain enterprise was 150 acres. See Figure 3, page 17.

In actual expenditures, costs decreased from $79 per acre for a 40-acre enterprise to $78 for a 150-acre enterprise. After 150 acres they tend to rise so that a 500-acre enterprise could be expected to have costs of $81 and past this point production costs had a tendency to increase even more rapidly.

Alfalfa Seed Enterprise Costs

As is mentioned on page 11, alfalfa seed costs were taken to be a constant figure of $114 per acre. This figure is a weighted average of the four sample enterprises that were found. See Figure 4, page 18.

The Standardized Real Farms (all enterprises combined)

Figure 5, page 19, which presents the regression long-run average cost curves for the standardized real farms, shows that average fixed costs decreased throughout th^ entire range of statistical relevancy and through the extended range which makes

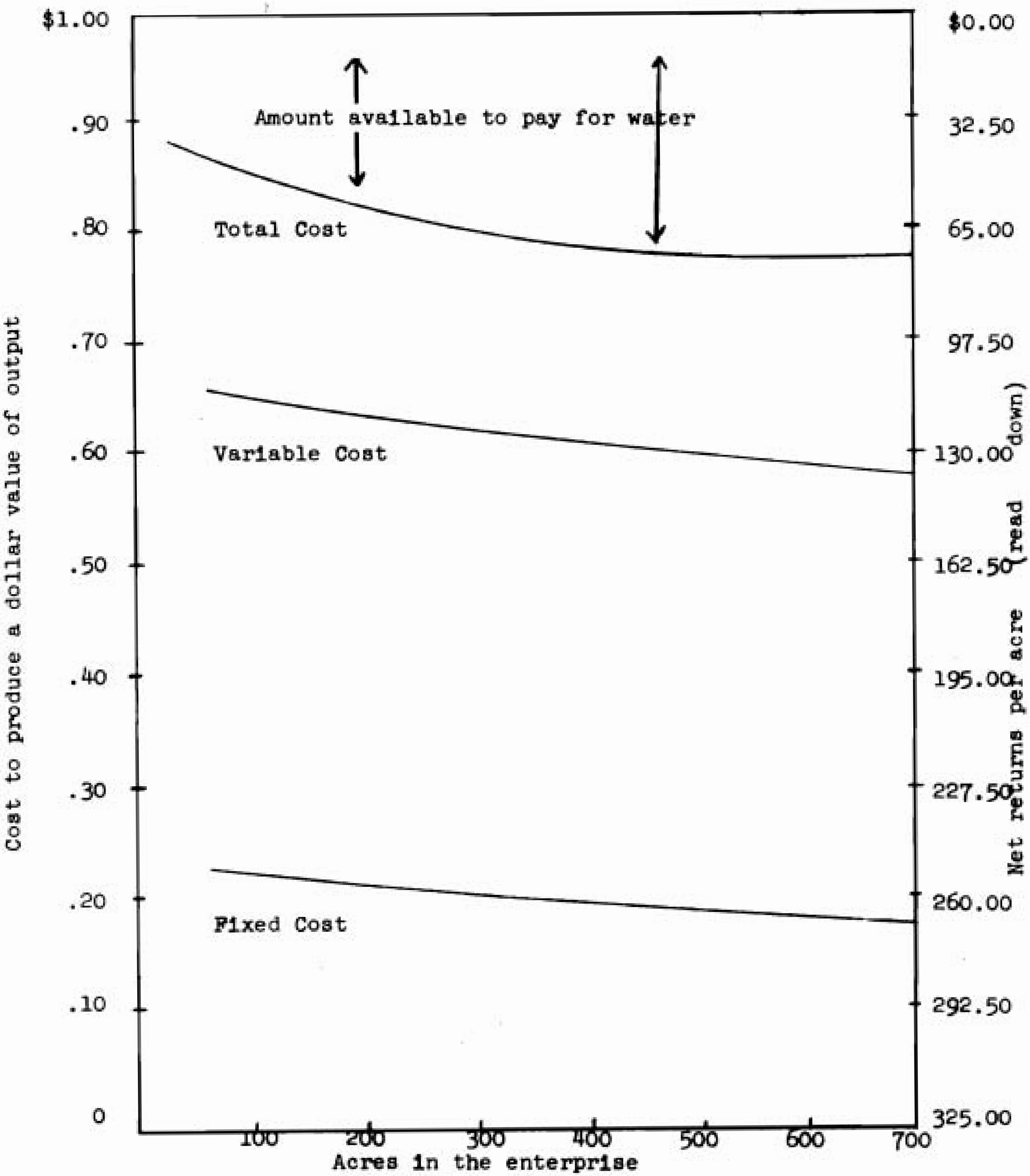

Figure 1

Long-run average cost curves for the potato enterprise.
(Estimated by curvilinear regression)

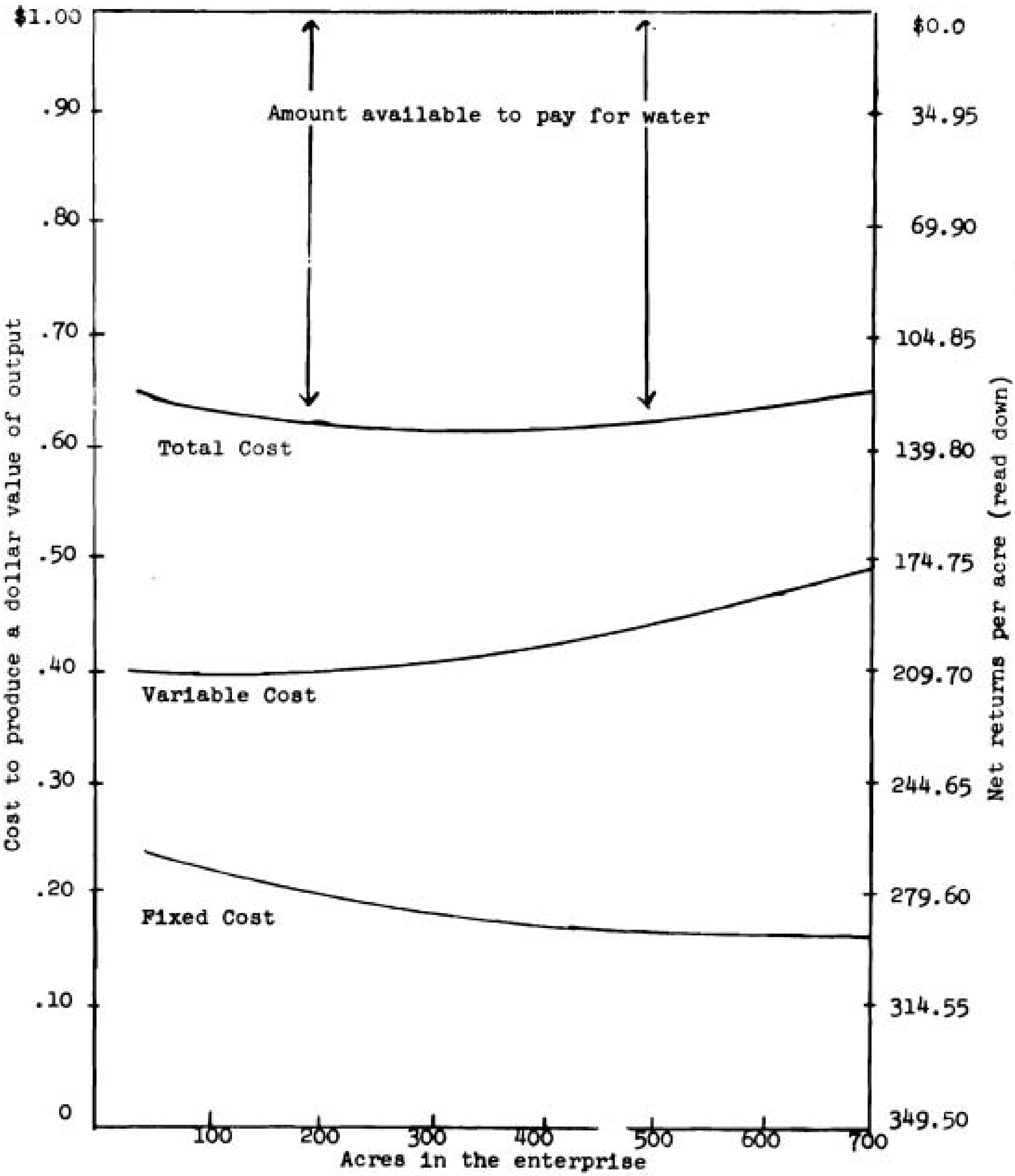

Figure 2

Long-run average cost curves for the sugar beet enterprise.
(Estimated by -urvilinear regression)

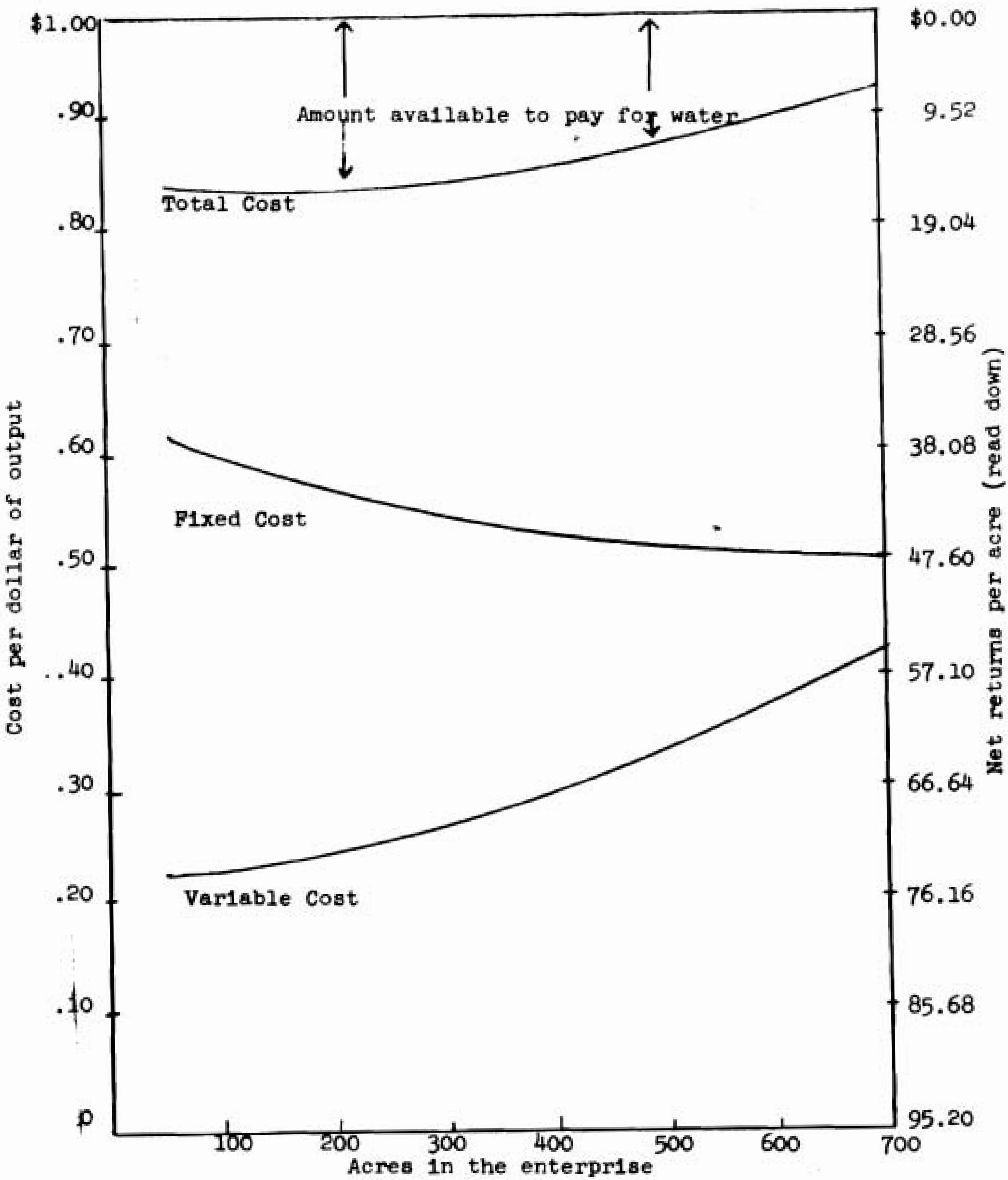

Figure 3

Long-run average cost curves for the grain enterprise.
(Estimated by curvilinear regression)

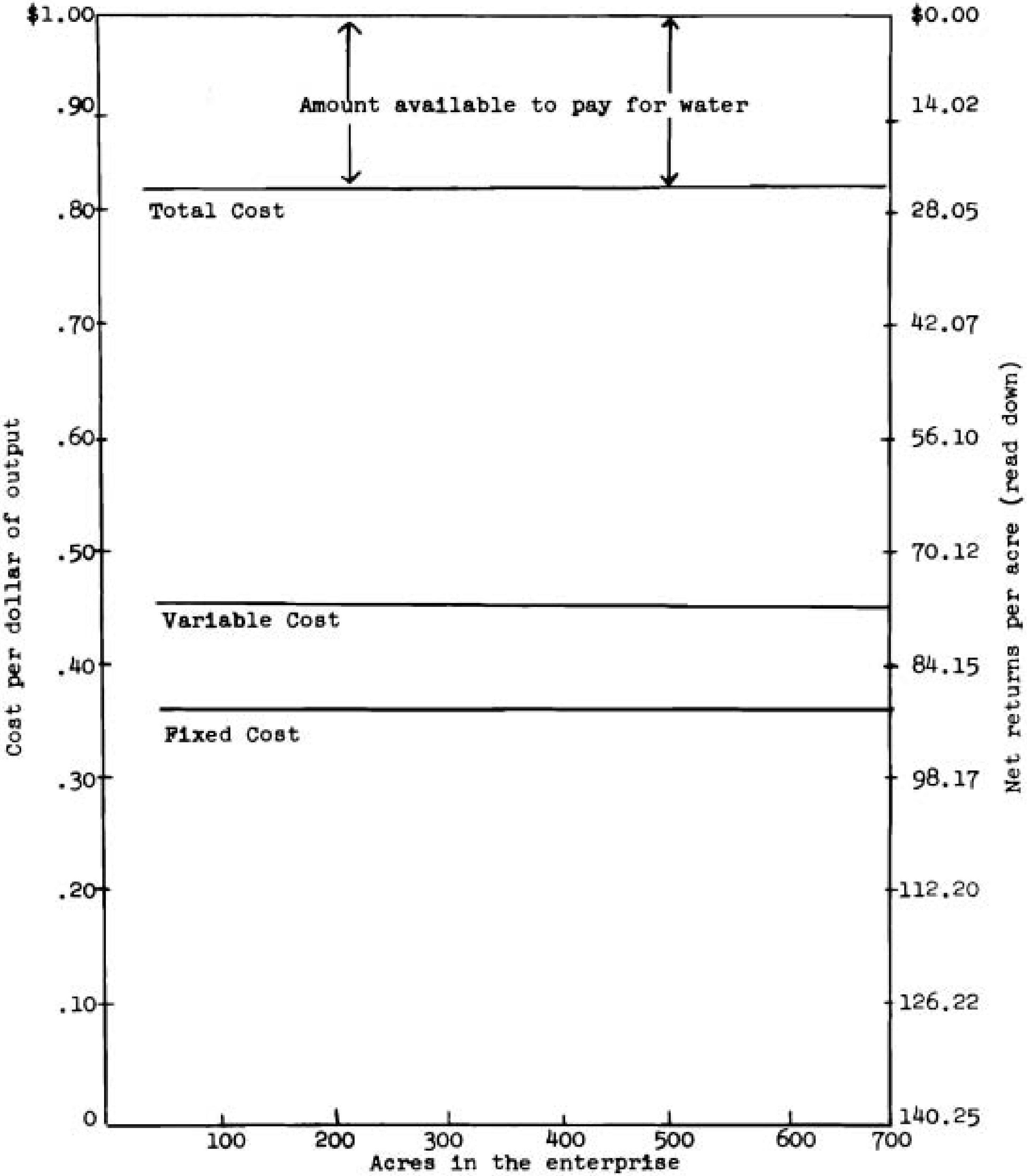

Figure 4

Long-run average cost curves for the alfalfa seed enterprise.

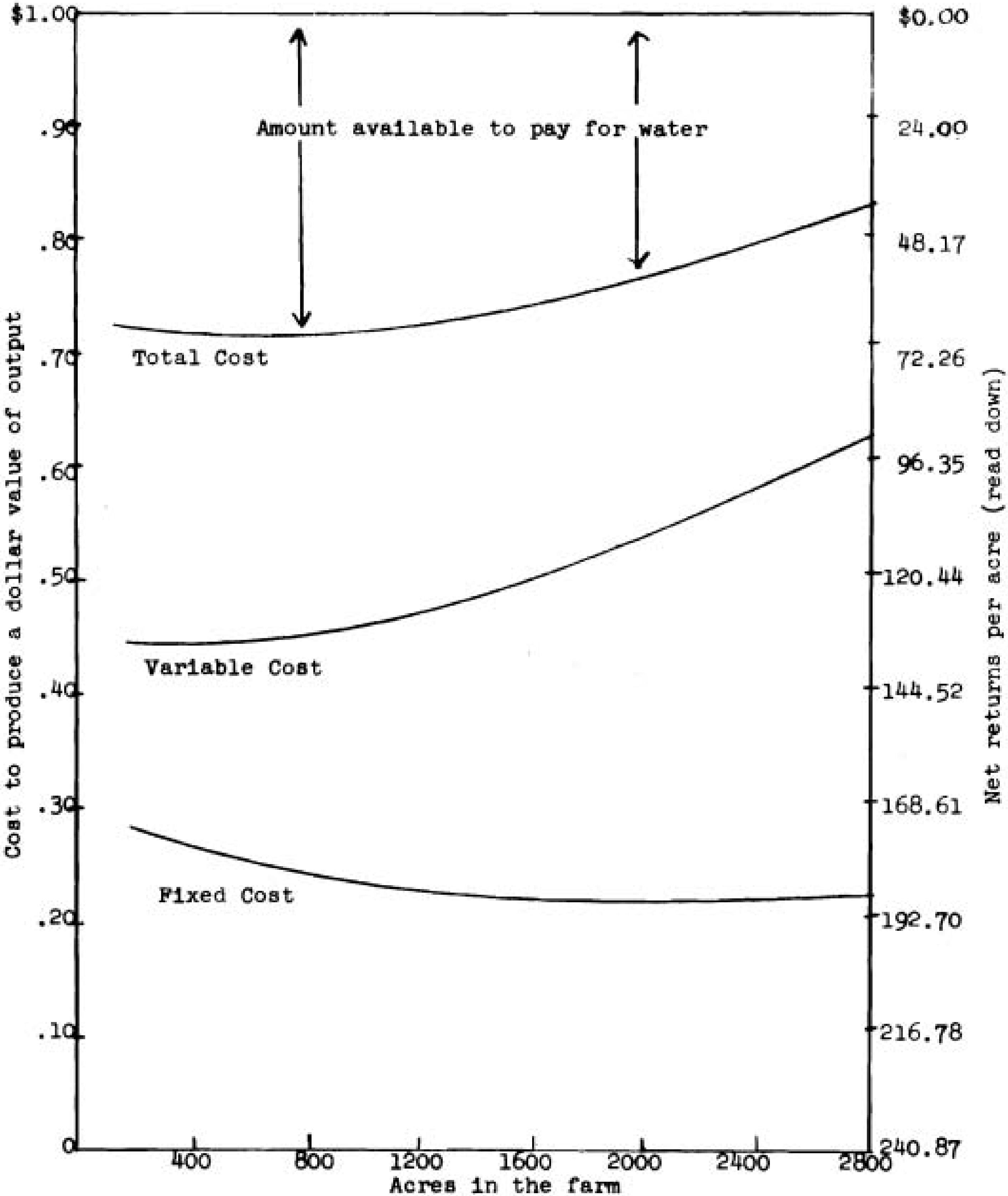

Figure 5

Long-run average cost curves for the standardized real farms.
(Estimated by curvilinear regression)

possible comparisons with the model farms. The average fixed cost curve for the representative farm decreased while the average variable cost curve increased at slightly increasing rates throughout the entire range of sizes. The planning curve for these farms was nearly constant at small farm sizes, but like the average variable cost curve, it increased throughout its entire range of sizes.

In monetary terms, it was estimated that a 160-acre farm could produce a dollar's worth of output at a cost of 72 cents, a 320-acre farm for 73 cents, an 800-acre farm for 74 cents and a 1200-acre farm for 75 cents. The diseconomy of size continues to increase and a 2400-acre farm has a cost of 81 cents per dollar value of output.

Construction of Model Farms

After calculating the regression curves for each of the four major enterprises, twelve model farms were constructed from them. The model farm is a prototype of farms that will be most likely in the future based on the available data. Each of the four enterprises was assumed to occupy one-fourth of the area in the model farm.

According to reports by the farmers, these crops would be conducive to the accumulation of humus and to the maintenance of fertility on a long-term basis. Since these are the commonly grown crops, it does not require any extraordinary managerial skills to carry out the program.

Alfalfa seed is a semi-permanent crop. The other crop enterprises are grown in a three-year rotation of potatoes following grain and followed by sugar beets. The outputs were computed using long-run yield and price expectations.

An example of the construction of a model farm follows: If producing alfalfa seed costs 81.4 cents per dollar value of output and the regression equation estimated that 100 acres of grain would cost 78 cents per dollar value of output, that 100 acres of potatoes would cost 90 cents per dollar value of output, and that 100 acres of sugar beets produced a dollar's worth of output for 64 cents, this gives a cost per dollar value of output of $0.774 and a net profit per acre of $51.34. The average cost for the farm is a weighted average and is found by adding the per acre cost for the respective enterprises and then dividing by the totaled per acre returns for the four enterprises. For this example, a 400-acre farm, the totaled per acre costs for four acres were $704.60 and the totaled per acre returns for four acres were $909.95. Table V gives a summary for the twelve model farms cost per acre, total returns per acre with the net return that can be applied to the cost of water; in addition to the comparison ratio of cost per dollar of output.

TABLE V

BUDGET SUMMARY FOR TWELVE MODEL FARMS

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
	Acres	40	40	40	40	160
	Total cost per acre	114.16	78.54	227.52	287.30	177.05
Farm	Total returns per acre	140.25	95.20	349.50	325.00	227.50
No.1	Residual available to pay for water	26.11	16.66	121.98	37.70	50.45
	Cost per dollar value of output	.814	.825	.651	.884	.778
	Acres	50	50	50	50	200
Farm	Total cost per acre	114.16	78.44	227.52	286.00	176.31
No.2	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	16.76	121.98	39.00	51.19
	Cost per dollar of output	.814	.824	.651	.880	.775
	Acres	80	80	80	80	320
Farm	Total cost per acre	114.16	79.20	227.52	282.11	176.15
No.3	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	16.00	121.98	42.89	51.35
	Cost per dollar value of output	.814	.832	.651	.873	.774

TABLE V (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
	Acres	120	120	120	120	480
Farm	Total cost per acre	114.16	78.07	227.17	282.11	175.38
No.4	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	17.13	122.33	42.89	52.12
	Cost per dollar value of output	.814	.820	.650	.868	.771
	Acres	150	150	150	150	600
Farm	Total cost per acre	114.16	77.97	226.47	279.51	174.53
No.5	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	17.23	123.03	45.49	52.97
	Cost per dollar value of output	.814	.819	.648	.860	.767
	Acres	200	200	200	200	800
Farm	Total cost per acre	114.16	77.88	226.13	276.90	174.04
No.6	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	17.32	123.37	48.10	53.46
	Cost per dollar of output	.814	.818	.647	.852	.765

TABLE V (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
	Acres	250	250	250	250	1000
Farm	Total cost per acre	114.16	77.97	225.43	272.68	172.56
No.7	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	17.23	124.07	52.32	54.94
	Cost per dollar value of output	.814	.819	.645	.839	.759
	Acres	300	300	300	300	1200
Farm	Total cost per acre	114.16	78.35	225.08	269.43	171.53
No.8	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	16.85	124.42	55.57	55.97
	Cost per dollar of output	.814	.823	.644	.829	.754
	Acres	400	400	400	400	1600
Farm	Total cost per acre	114.16	79.43	226.48	263.25	170.83
No.9	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	15.77	123.02	61.75	56.67
	Cost per dollar value of output	.814	.834	.648	.810	.751

TABLE V (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
	Acres	500	500	500	500	2000
Farm	Total cost per acre	114.16	81.01	227.52	257.72	170.17
No.10	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	14.19	121.98	67.28	57.33
	Cost per dollar value of output	.814	.851	.651	.793	.748
	Acres	600	600	600	600	2400
Farm	Total cost per acre	114.16	83.50	228.58	253.17	169.85
No.11	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	11.70	120.92	71.83	57.65
	Cost per dollar value of output	.814	.877	.654	.780	.746
	Acres	700	700	700	700	2800
Farm	Total cost per acre	114.16	87.21	231.36	248.95	170.42
No.12	Total returns per acre	140.25	95.20	349.50	325.00	227.50
	Residual available to pay for water	26.11	7.99	118.14	76.02	57.08
	Cost per dollar value of output	.814	.916	.662	.766	.750

Interpretation of the Model Farms

For the model farms, which incorporate a long-run rotation and long-run price and yield expectations, the total cost curve had a "dish-shaped" appearance. For farm sizes of 160 to 320 acres, total costs tended to decrease due to the economies of size found in the grain enterprise. See Figure 6, page 27. Between 320 and 800 acres, the total cost curve goes through a range of only slight downward slope, the change from steep to slight is again due to the effect of the grain enterprise; however, this time it is because grain costs did not decrease as size increased. At 800 acres, the downward slope of the total cost curve again increases due to the increased economies that are being found in the sugar beet enterprise.

At 1200 acres, the model farm total cost curve becomes almost constant, the small downward slope is due to the fact that potato costs are still falling enough to overcome the effects of the rising grain and sugar beet costs. This period of almost constant costs ends at 2400 acres where both grain and sugar beet costs which are increasing at increasing rates, overcome the effect of the decreasing potato costs.

For sizes larger than 2400 acres, the model farm total cost curve tends to increase due to the increasing diseconomies that are manifested by the grain and sugar beet enterprises. Thus, for a long-run situation, a 2400-acre farm was judged to be the most efficient size.

In monetary terms, it was estimated that a 160-acre farm could produce a dollar's worth of output at a cost of 77.8 cents while the more efficient 320-acre farm could do it for 77.4 cents, and the still more efficient 800-acre unit could do it for 76.5

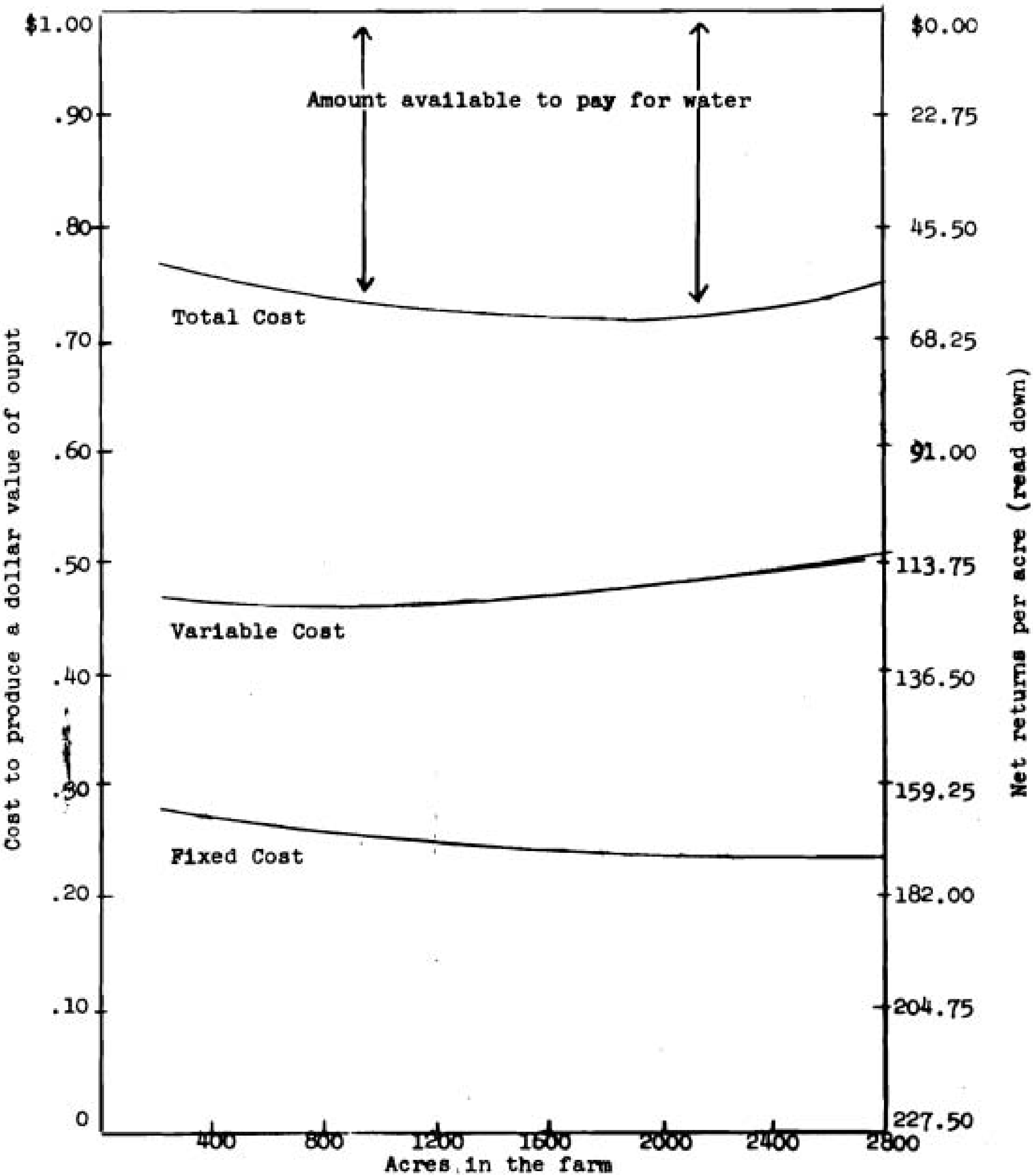

Figure 6

Long-run average cost curves for the model farms.

cents. As size increases, production efficiency continues to increase until a size of 2400 acres is reached. At this point it costs 74.6 cents to produce a dollar's worth of output; past this point, production efficiency tends to decrease.

It should be noted that the ratio "cost per dollar of output" is a very sensitive measurement. For instance, one cent change in the ratio for the potato enterprise means a change in net income of $3.25 per acre.

Net income is the measurement of how much money is available to pay for irrigation water delivered at the headgate of the farm. From Table V and Figure 6 it can be seen that the net income available to pay for water varies from about $50 to $57 per acre for the model farms. It is also evident that the sugar beet enterprise contributes more to the relative large net income of the farm than do the other three enterprises. This leads to the question if the inclusion in the rotation of sugar beets on an equal basis with the three other enterprises is valid. Production quotas may set a limit for many farms before the acres in this study have been reached. If this is the case and potatoes are substituted for sugar beets, then the net income will fall to about $36 per acre.

The conclusion that can be drawn from this study is that there is no good evidence that the larger farm has any particular advantage as far as farm operation goes. It may have some advantage in buying the inputs and also in selling the products of farm production. This advantage could also result if the farmer was associated with a buying and selling cooperative organization. The main problem in farm size may be the procurement of capital.

With the growing amount of capital needed for a mechanized agriculture, it may be that large-scale operations will excel in keeping capital continuously employed in the operation.