THE RELATIONSHIP OF FARM SIZE TO ABILITY TO PAY FOR IRRIGATION WATER IN THE DRY LAKE AREA OF CANYON COUNTY, IDAHO

A Thesis

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by

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The thesis of Arthur Lee Coffing, "The Relationship of Farm Size to Ability to Pay for Irrigation Water in the Dry Lake Area of Canyon County, Idaho," is hereby approved:

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Arthur Lee Coffing was born in 1941 on a farm located near Mott, North Dakota. The first eight years of his education were spent at a rural one-room school. In the fall of 1955 he enrolled at Mott Lincoln High School. Four years later, he graduated with honors. Following graduation, he enrolled at North Dakota State University; eleven quarters later he graduated but continued on as a special student until June of 1963. In February, 1964, he enrolled in the Graduate School of the University of Idaho and in June, 1965, completed the requirements for the Master of Science degree, of which this thesis is a part.

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CHAPTER I

INTRODUCTION

I. PROBLEM

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 areas is found in the Dry Lake area of Canyon County. The uniqueness of this development is the fact that the water must be lifted 500 to 600 feet from the Snake River to the overlying plateaus before it can be applied. The engineers have proven it physically feasible to bring water to the arable land on the plateaus; however, the question that remains unanswered is the economic feasibility of such ventures.

In a short-run analysis, the initial projects at Dry Lake appeared to be very successful. Initial water costs were not appreciably higher than those on established deep-well irrigation projects in the county while yields were significantly higher than the county average. This, plus the fact that the land cost was low because the full tax rate does not apply to newly developed land, gave the project even more of an appearance of being highly profitable. This appearance of being highly profitable has led to the creation of other projects of both greater area and pumping height. Many of the planned projects call for pressure equal to 1000 feet of lift. Presently, development of these projects is not taking place because their proposed location is on government land controlled by the Bureau of Land Management. The Bureau will not allow development unless a project appears to be economically feasible, which means that a 320-acre farm unit should be able to pay all farming expenses and provide a decent living for the farm family. One of the primary purposes of this study was to provide the Bureau with farm cost analyses that can be used to judge the feasibility of future projects.

Stated specifically, the problem is: In the Dry Lake area, how do farm-size relationships affect a farm's earning ability on a per unit of output basis? In this study the earning ability will measure the capability of the farm to pay for high-priced irrigation water. The problem is simply one of determining the relationship between farm size and production efficiency; thus, it falls into one of the problem areas of agricultural economics. Dr. Earl Heady of Iowa State University says, "Although the subject has been the center of debate for several decades, little is actually known about the structures of long-run costs (the level of various short-run costs curves for units of different sizes) in agriculture."[1]

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[1]Earl Heady, Economics of Agricultural Production and Resource Use, (Prentice-Hall, Englewood Cliffs, N.J., 1952), p. 369.

This problem is important to the field of agricultural economics to the extent that it demonstrates how the relationship between size and production efficiency affects profits. Since the issuance of Dr. Heady's statement, some work has been done in this problem area but no conclusive evidence has been offered. It is not expected that this study will offer conclusive evidence to either the validity or nonvalidity of the theory that increasing farm size results in the capability to produce more efficiently, but it will contribute to what is already known about the problem area.

The answer to the specific problem will also have a direct bearing on the economy of Idaho. It may be that the results of the study will show that in the long-run this type of irrigation project is not economically sound. In such a case, it is conceivable that the Bureau of Land Management will stop allowing Desert Land Entry for projects of this type. At the other extreme, if small farms have the ability to pay the high water costs, the probable result may be that the Bureau will continue to allow entry on only 320-acre units with the requirement that each entry be farmed as an independent unit. In the latter case, it is likely that the high investment will continue to discourage or defeat most small developers and thus result in a longer development period for any given tract of land. Between the two extremes is the probability that the study will show that size increases give increasing production efficiency up to a certain point; past this point increases in farm size will result in either constant or decreasing production efficiency. Such a situation could lead the Bureau of Land Management to pick a range of efficient farm sizes which would be allowed to develop given areas.

During the 1963 crop year there were eleven farm units in the Dry Lake Project; of these eleven it was possible to obtain complete records of farm expenses for eight farm units. Thus this study is limited to a sample of eight farms ranging in size from 200 to 1800 acres. These farms were developed on privately owned tracts located in the Dry Lake area south of Nampa, Idaho. The area is nearly homogeneous in terms of weather, soil, and topographical conditions. Rotations are composed primarily of four crops: wheat, alfalfa seed, potatoes, and sugar beets. Only two of these farms included a livestock enterprise; one was raising race horses while the other was feeding steers. Neither enterprise was related to the size of the farm; therefore, this study will not attempt to determine what the effects of a livestock enterprise would be.

II. OBJECTIVES

The main objective of the study is to determine the ability of different sizes of farms to pay for irrigation water. This ability will be measured by the capability of the farm to produce high value crops at low costs.

Phrased in a different way, the objective of this study is to find the maximum that farms of various sizes can pay for irrigation water if, at the same time, all other factors of production are adequately rewarded. This, to some degree, will indicate the maximum value of water if irrigation is its highest use. This type of information can be of use to future studies which involve water rights or water values.

A secondary objective is to determine the economies of size of the various enterprises. This will reflect the competitive advantage of each enterprise on farm-to-farm, area-to-area, or possibly on state-to-state levels.

CHAPTER II

METHODOLOGY

I. HYPOTHESIS

As a working hypothesis, this study postulates that larger farms are able to pay more for water on a per-unit of output basis because economies of size exist within the various enterprises and because management is able to combine them efficiently. This implies that the ability to pay for water is dependent on both economies of size which may or may not be found in the various enterprises, and the capability of management to combine them in such a way that the farm will have size economies.

The alternative hypothesis is that economies of size do not exist in any of the enterprises; therefore, no matter what management does, it will be impossible for it to secure size economies by increasing farm size.

A third possible hypothesis can be stated in this form: Although size economies do not exist within any of the enterprises, ingenious management may be able to combine the enterprises in such a way that there will be size economies for the entire farm if its size is increased.

An example of this third possibility would be the case of a manager on a 100-acre farm who produces 100 acres of wheat, or 100 acres of alfalfa, or any combination of the two at a cost of say eight cents per dollar value of output;

however, on a 150-acre farm he is able to produce a dollar's worth of product for less than eight cents if and only if he raises say 79.3 acres of alfalfa and 70.7 acres of wheat. Thus, the increased return is due to management rather than to the existence of size economies within either of the enterprises.

Since the science of economics has not developed appropriate techniques to isolate and measure precisely the management factor, this study will not attempt either to isolate or measure this third possibility. Thus, analyzing the data will show that either the hypothesis or its alternative has the greater probability of being true.

Mathematically stated the hypothesis would be represented by the formula $Y_1 > Y_2 > Y_3 > Y_4 \; . \; . \; . \; . \; . \; . \; . \; > Y_n$ where Y_i is the cost per unit of output for the different farm or enterprise sizes and Y_1 represents the smallest size. The relationship between size and cost will be estimated by the simple curvilinear regression equation $Y' = \frac{1}{a + bx}$. The symbol "X" is the number of acres for which Y' is being estimated. The symbol "b" represents the relationship between the two variables. A positive "b" will indicate that size economies are attainable, while a negative "b" will indicate that they are not attainable.

The hypothesis contains two parts to test. One is concerned with the existence of size economies within the individual enterprise; the other is concerned with the ability of management to take advantage of these size economies. If one or more of the enterprise cost curves indicate that size economies exist, the regression coefficients for the relationship between enterprise size and production cost will be subjected to a level of significance test.

To test the second part of the hypothesis, the long-run average cost curve for the model farms and the long-run average cost curve for the real farms will be compared. A downward sloping long-run average cost curve for the model farms will indicate that with a long-run rotation, economies of size are attainable; if it does not, the indication will be that size economies are not attainable with that long-run rotation. An upward sloping average cost curve for the real farms will indicate that under the present rotation, size economies are not attainable, while a downward slope will indicate that they are attainable. Since the model farms will represent a long term rotation, it will be used as the criterion to judge the extent that management is utilizing the size economies that may be obtainable.

II. THEORETICAL BASIS

Introduction

The problem has been classified as one which concerns the added returns gained by an increase in farm size. In the marketing of most farm crops, a farmer receives the going market price for his commodities. How much or how little he markets has very little or no effect on the price because the quantities he sells are a very small percentage of the total output of any one commodity. For this reason, economies or diseconomies that result from farm size changes are measured on the costs' side of production rather than on the returns' side.

The problem is not one of returns to scale. Scale relationship simply means that all input factors as well as output always increase by exactly the same proportion. An example of this would be a 400-acre farm that is being farmed by four tractors, four full sets of machinery, and eight hired men. If the number of acres in the farm were to be increased to 500, to keep the same scale would require that five tractors, five sets of machinery, and ten hired men be used to farm it. All other inputs and output would also have to increase 25 per cent to maintain the scale relationship.

In most 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. The 100-acre increase that was mentioned in the above example would, in many instances, merely bring an increase in variable costs such as fuel and labor. In fact, it is unlikely that any two major inputs would increase by exactly the same proportion. Thus, an increase in acreage might cause a farmer's labor inputs to rise by 25 per cent while his depreciation costs only rise by 10 per cent. It is such a change that this study attempts to measure and compare.

<u>Definition of Size Economies</u>

True size economies are 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. For purposes of this study, a change in size is defined as a change in the number of acres rather than as a change in the number of inputs of any one resource. 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 of it.

This study assumes constant yields and prices; therefore, within the individual enterprise, it would be possible to use the production of one acre as the unitary measure and to use per acre costs for comparison. However, this method would not facilitate comparison between enterprises since it costs much more to produce an acre of sugar beets than it does to produce an acre of grain which, in the study area, is usually less profitable than the sugar beets. In order to facilitate inter-enterprise comparisons, the cost per acre of the different enterprises was converted to the cost of producing one dollar's worth of output. Using this measure it is possible, on a relative basis, to compare the costs of all sizes of the different enterprises.

Crop production costs are made up of two different types of costs; they are usually classified as fixed or variable depending on whether or not they vary with output. Fixed costs consist of such items as depreciation, taxes, insurance, and in some instances, opportunity costs. Variable costs consist of items like labor, fuel, machine repairs, and farm supplies.

Fixed Costs

In general, economies of size are due to declining average fixed costs rather than the result of declining average variable costs.[2] The reason for this is that the fixed costs of machinery make up a high proportion of total costs for the farm, and in many cases it is possible to reduce average fixed costs just by operating more acres to spread the cost over more output. These lower average fixed costs are the result of two tendencies that are connected with the operation of farm machinery and buildings. The first is that of indivisibility. Machines, and to a lesser extent buildings, are put into production in standard and generally unalterable sizes while farm size is infinitely variable. The result of this situation often leads to high average fixed costs on small farms or enterprises with very small acreages.

A hypothetical example of the effects of indivisibility would be the case of a farmer having less than twenty-five acres of potatoes and having a potato harvester and four

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[2]George J. Stigler, The Theory of Price, (New York; The Macmillan Company, 1947), p. 128.

trucks with which to harvest them. Such a situation would result in very high average fixed costs.

The effects of indivisibility are softened to some extent by the opportunity to buy used rather than new equipment; the opportunity to do or to hire custom work; the opportunity to rent rather than buy equipment; and the fact, that although a machine has a set size, within a certain range its capacity can be increased or decreased by working more or less hours. These softening effects do not totally annul the tendency of some inputs to be indivisible.

The second tendency that causes lower average fixed costs is that in general a large machine, when used efficiently, has lower fixed costs per unit of output than an efficiently used smaller machine. Data from a recent study of machinery costs show that a "two-plow" (20-29 HP) gas tractor has fixed costs amounting to forty-eight cents per hour while a "four-plow" (40-49 HP) gas tractor has fixed costs of seventy-four cents per hour of use.[3] Assuming that the larger tractor does twice as much work per hour, the difference represents substantial savings. This tendency holds true for other machinery also. The result is that a farm that efficiently uses a three-bottom plow and the corresponding set of machinery has or should be able to secure a fixed cost advantage over a smaller farm which can efficiently use only a two-bottom plow and the corresponding sizes of machinery.

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[3]Karl H. Lindeborg, Cost of Operating Farm Machinery, (University of Idaho; Moscow, Idaho, 1962), p. 2. (Memographed).

Variable Costs

As has been stated, it is usually theorized that most economies of size are due to a spreading of fixed costs rather than to more efficient use of variable inputs. However, there is good reason to believe that it is possible for some farms to obtain significantly lower variable costs also. An example of this can be taken from the previously mentioned machinery cost study.[4] A three-plow (30-39 HP) gas tractor has variable costs of eighty-three cents per hour while a four-plow (40-49 HP) gas tractor has variable costs of only eighty-seven cents per hour. Thus, using the larger tractor gives an relative variable cost savings and greatly diminishes average variable costs. Since variable costs also include labor costs, the advantage of using the larger tractor would be further increased by the value of the labor that is saved.

The above example and parallel situations are the rationale behind the theory that average variable costs per unit of output tend to be lower on larger farm sizes. It is not expected that this tendency will be present for all size increases, because at some level of output, variable physical inputs will be used at maximum efficiency; effect will result in a range where variable costs per unit of output are constant. Such is the case if it takes say forty cents of variable costs per hundredweight of potatoes on either a 100-acre or a 150-acre potato enterprise.

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[4] *Ibid.*

According to present variable cost theory, variable costs tend to rise after a very short range of constancy.[5] Once the rise starts, it tends to rise at increasing rates. Usually the reason given to explain this rise is that diminishing returns have set in on one or more of the input factors. According to current theory, in a problem such as this, the factor that is most vulnerable to diminishing returns is management.[6] A single manager may be able to supervise a given number of men and keep them working efficiently while two managers cannot keep twice as many men working with the same over-all efficiency. The problem is compounded when trucks, tractors, and other equipment are added. Another influencing factor is that as farm size expands so do the distances between fields and headquarters. These extra distances not only make the supervisory functions of management less effective but they also make both labor and machines less efficient because of the extra time required for travelling.

Relationship between Variable and Fixed Costs

From the explanation that has just been presented, it is possible to construct theoretical variable and fixed cost curves. These are presented in Figure I. By definition, in the long-run all costs are variable; however, empirical

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[5]Stigler, *loc. cit.*

[6]Heady, *op. cit.*, p. 358

procedures for this study separated 1963 total costs on each of the sample farms into the fixed and the variable components. Through the use of these farm sizes as estimates of the long-run levels of costs, the long-run average variable and the long-run average fixed cost curves can be obtained. These can be used to predict the make-up of the long-run total costs curve, but it must be kept in mind that the two component curves are relative rather than absolute. Because of this relativity one farm may have high repair (variable) costs and low depreciation (fixed) costs while a similar farm with the same average total costs may have low repair (variable) costs and high depreciation (fixed) costs.

<u>The Long Run Average Total Cost Curve</u>

<u>Definition</u>. By definition the long-run average cost, hereafter abbreviated LAC, is the lowest possible average cost of producing a unit of output at different farm sizes when the entrepreneur has adequate time to make all desired size adjustments; therefore, it is known as the long-run planning curve and is a prediction of the farm size that will obtain maximum size economies. It is also known as an envelope curve because the LAC is tangent to the various short-run cost curves and thereby tends to envelope them. (see Figure II)

<u>Relationship to the Short-Run Cost Curve</u>. The short-run average cost curve (SAC in Figure II) is a graphic representation of how costs might vary in any one production

period. In the case of a farm, this production period is taken to be one crop year. The SAC has been found to be "dish shaped" like the LAC curve, but generally it is thought to have much steeper slopes than the LAC curve. In the short-run, by definition, fixed resources cannot be varied but yields are variable. For an individual farm, the short-run average cost curve is found to slope downward due to the spreading of fixed costs over more units of output. Variable costs are theorized either to decrease or to remain constant until at some point diminishing returns set in on one or more of the fixed factors. For most farm situations, the limiting factor is the amount of land that is available.

Once diminishing returns have set in, to gain an additional unit of output requires the addition of increased larger amounts of variable inputs. The result is that the variable cost curve tends to rise at rapidly increasing rates after the point of maximum efficiency is passed. This causes the average total cost curve to rise very rapidly because each extra unit of output decreases average fixed costs only slightly while causing average variable costs to increase rapidly.

The definition of the LAC curve gives its relationship to the short-run average cost curves. In this study, only one point of the short-run curve will be depicted because each farm is being standardized by assuming constant yields. Underlying the standard yield assumptions is the assumption that these standardized yields and prices are the points of maximum economic efficiency for the respective enterprises. Consequently, by definition, the LAC curve will pass through this point for each of the respective enterprise sizes.

Theoretical Shape. As can be seen from Figure I, the LAC slopes downward, levels off, and then rises gently. Its shape is the outgrowth of the same factors that cause the variable and the fixed cost curves to assume their shapes. Thus if a size increase causes a decrease in both variable and fixed costs, LAC will fall sharply; if they stay constant, LAC will be constant; and if they both rise, LAC will rise. However, there is nothing that says that size changes will cause both variable and fixed costs to move in the same direction; it is entirely possible that an increase in farm size will cause variable costs to increase while fixed costs decrease or vice-versa. In such a case, the effect on LAC will be the net difference between the two curves. Sharply rising variable costs will offset constant or gently declining fixed costs and will cause LAC to rise. At other size ranges, the net effect may be that LAC will be falling because the declining fixed costs are able to overcome the effect of the rising variable costs. It is also possible that though one of the curves is rising and the other is falling, the net effect will be zero and LAC will be constant.

Interpretation of the LAC Curve. A downward sloping LAC indicates that economies of size are obtainable for a certain range of farm sizes; thus an expansion in size of any farm within that range will enable it to net more on a per unit of output basis. This means that a farm will have greater ability to pay high water costs as it grows larger. An upward sloping LAC curve means diseconomies of size; therefore, a contraction in the size of any farm within this range will give it greater ability to pay high water costs. A range of constant LAC means there are neither economies nor diseconomies of size; therefore, on a per-acre basis a small farm is just as capable of paying for high-priced irrigation water as is a large farm.

As has been shown in Figure I, the theoretical LAC contains all three possibilities, a range of economies of size, a short range of constancy, and a range of diseconomies of size. According to theory, it should be possible to determine the most efficient size for any farm firm under present-day conditions. Inasmuch as the same principles are involved, it should also be possible to determine the most efficient size for an enterprise by the same procedures. Once the LAC has been determined for each enterprise, it will be possible to construct model farms from a standard rotation which is suitable to the area and which takes advantage of the more efficient enterprises.

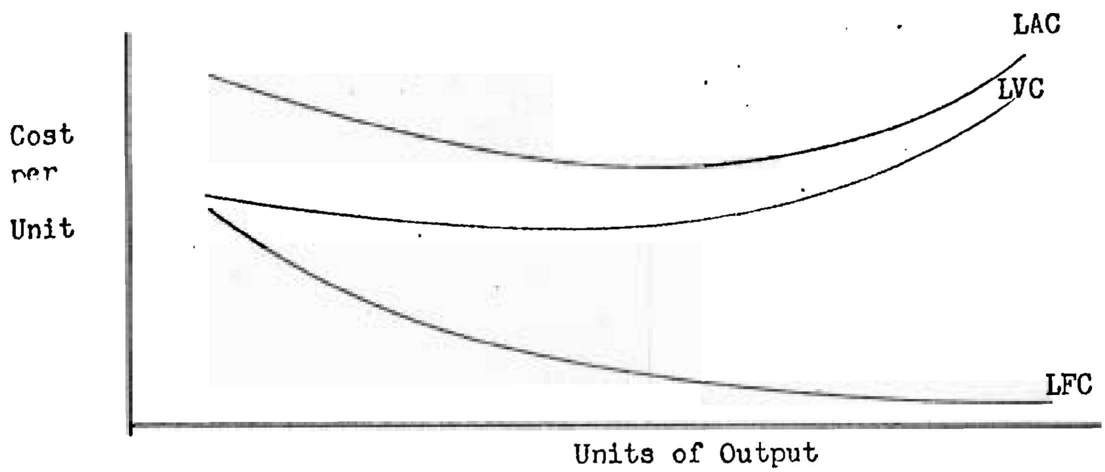

FIGURE 1

Theoretical Shape of the Long-Run Cost Curves

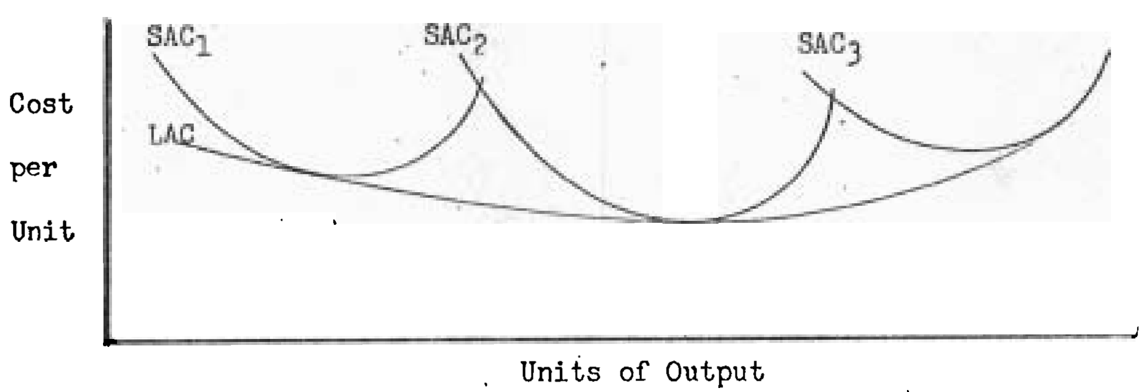

FIGURE 2

The Relationship Between the Long-Run Average Total Costs and Short-Run Average Total Costs

III. INPUT-OUTPUT RELATIONSHIPS

Management

This study does not attempt to define the precise production relationships between inputs and outputs on the sample farms or to measure the specific productivity of any of the factors which are associated with income earning capacity; therefore, to keep the scope of the study within the means to effect a conclusion, it has been necessary to standardize input-output relationships.

The basic assumption is that the sample is composed of better-than-average farm managers who are attempting to maximize profits; however, although they are better than average managers, none of them are really ingenious. This assumption is necessary if different levels of returns are to be explained on the basis of differences in farm size. If this assumption were untrue, it would greatly diminish the validity of the study by turning it into a study of differences due to managerial ability instead of differences due to farm size. Before an analysis of the data had been completed, it appeared that this assumption was true because these operators have better land, get higher yields, have larger farms, and, according to the county extension agent, are more ready to adopt new technology than the typical Canyon County farmer. Although there is evidence that these farmers are better than average operators, there was nothing in their farm records that indicated they were more than exceptionally good.

For the purpose of constructing model farms which can be compared with each other, it has been assumed that the model farms are owned and operated like corporations. This means that both management and capital are likely to be rewarded at standard rates instead of being rewarded with residual returns after all other expenses have been paid. Three of the sample farms were incorporated and large tracts of land were corporation owned; therefore, this assumption is not wholly unrealistic.

Application Rates for Seed, Fertilizer, and Frequency of Irrigation

In an attempt to eliminate managerial differences between farms, and to have a guide for setting up the model farms, it has been necessary to have a standard set of seeding rates, fertilization rates, yields, and both input and output prices. Tables I and II present these standard coefficients.

The data in Table I represent the typical input coefficients on the eight sample farms. The lower nine enterprises on Tables I and II appeared only once or twice in the samples and their acreages were a very minor part of the total acreage; therefore, no ranges of variation could be established for them.

The range in potato seeding rates was 1300 to 1500 pounds. For sugar beets the range was 12 to 15 pounds if pelleted seed was used and 4 to 6 pounds if monogerm seed was used. Pelleted seed was chosen for the model farms because it was used by more farmers than the single germ type. The rate of grain seed application varied from 2 to 2 1/2 bushels. Because none of the sample farms reported planting alfalfa in 1963, and since the year alfalfa is planted, the nurse crop bears the tillage cost, no attempt was made to determine seeding rate, seed cost, or the number of years the crop would grow before it had to be reseeded. On a yearly basis, the amount would be a minute part of total costs for the enterprise because first, initial seed cost per acre is small and second, to determine yearly cost due to seed, it would be necessary to divide the cost of the seed by the six to twelve-year life of the crop.

The range in fertilization rates ran from 180 to 300 pounds of actual nitrogen per acre and 150 to 225 pounds of actual phosphate per acre for sugar beets. For potatoes the range was 150 to 250 pounds of nitrogen and 150 to 180 pounds of phosphate per acre. The assumed rates for either beets or potatoes provide large enough residuals in the soil that most of the farmers felt that it was unnecessary to apply fertilizer to grain. Fertilization rates for alfalfa seed ranged from 50 to 100 pounds of nitrogen per acre while the application rate for phosphate varied from 0 to 80 pounds per acre.

The frequency of irrigation varies considerably from year to year depending on the weather. The data that are ok

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

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

**Not applicable because it is set out from roots instead of being planted.

presented in Table I are the farmers' own estimates of what they felt would be done in a typical year. Both year-to-year and between-farms ranges varied by one irrigation on either side of the typical number that is shown.

Yields, Seed Prices, and Product Prices

Table II presents yield and price data for the thirteen enterprises.

As noted in the previous section, the data for the lower nine enterprises of Tables I and II are based on very few observations. Very little secondary information is available; therefore, thedata that are presented are what were actually reported by the interviewed farmers. Exceptions are the enterprises, hay, onions, and beans; statistical information was available for these three crops. The data that are presented for them represent 1958-1963 averages.

The price of potato seed is the long-term average that was established by a 1962 cost study on potato production.[7] This figure falls within the range of seed prices that potato growers gave as seed cost for the 1963 crop. Since the yearly yield for southwestern Idaho has shown advances from 210 CWT per acre in 1960 to 280 CWT in 1964, it was decided that the 1955-1963 average would not be a good indicator for

[7]Kurt Moller, "Cost Economies Associated with an Increase in Size of the Potato Enterprise on Pump Irrigated Farms in South Central Idaho," (Master's thesis, The University of Idaho, Moscow, Idaho, 1963), p. 79.

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 lbs.	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 lbs.	.80 /lb.
Silage corn	.20/lb.	20 tons	7.00 /ton
Sweet corn seed	.20/lb.	2000 lbs.	.195/lb.
Dry beans	10.00/CWT	2425 lbs.	7.10 /CWT
Radish seed	.20/lb.	225 lbs.	.15/lb.
Parsnip seed	nr*	nr*	(Gross $300 per acre)

*nr Not reported.

future yields. Thus the assumed yield was found by averaging the 1962 and 1963 yields. This average is 16 CWT over the ten-year average.

Only one of the sample farms made use of a potato cellar in 1963. Therefore, to keep the study as realistic as possible, it was assumed that potatoes were marketed immediately after harvest instead of after a period of storage. Thus the selling price that is listed is the average October selling price for 1959-1963.

The seed price for sugar beets is the price that the farmers reported having paid. All farmers reported the same price; consequently, a range of price variation could not be established. The assumed selling price for sugar beets is the five-year average price for Idaho. It includes both the payment from the factory and the government subsidy. The per-acre yield is the average Canyon County yield for 1959-1963. The sample farms reported higher yields than this for 1963; however, several of the farmers indicated that they had had lower yields than this in both 1962 and 1964.

The price and yield for alfalfa seed are the state average yield and price for 1958-1963. Both the average state yield and the average state price fall within the range of prices and yields that were reported on the sample farms.

Irrigation Systems

To further standardize the farms, it was necessary to assume a standard type of irrigation system. The most common type found on the sample farms was a hand-move sprinkler system. This type of irrigation system was assumed for the model farms. Use of this type of system was assumed because many of the farmers reported dissatisfaction with the wheel-move system and much of the land is not level enough to use a gravity system. Typically the farmers reported that it takes a half hour per acre per irrigation for both the hand-move and gravity flow systems of irrigating. Also, they reported that moving a wheel-move sprinkler could be done in one fourth hour per acre per irrigation. These two rates are what was typically reported. Around these there was considerable variation. A 1949 study which was based on a sample of 69 hand-move sprinkler systems reported a range of .3 to 1.8 manhours per acre for each irrigation.[8] That study indicated that the large variation was to be expected. Labor for irrigation purposes was reported and assumed to be $1.50 per hour.

One of the objectives of this study is to determine the ability of various sizes of farms to pay for irrigation water. For this reason the study has been designed to find any residual returns that will be available to pay for high-priced water. In keeping with this design, water is treated as if it were free and has a source that is readily available for use. An example of such a situation would be a farm bordered

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[8] Roland C. Bevan and Max C. Jensen, Costs of Sprinkler Irrigation on Idaho Farms, (University of Idaho Experiment Station Bulletin #0287, Moscow, Idaho, 1952), p. 13.

by a canal from which any quantity of water could be pumped without charge. None of the real farms were in situations which would compare with this example; some of them did pump their irrigation water from a canal, but it was not free and there were limitations on the amount that could be pumped.

Pumping cost for lifting the water from its easily accessible source and sprinkling it on the fields was taken to be twenty-four cents per acre per irrigation. This is based on the estimates and on the records of several farmers who have dug catch-basins to catch any water that runs off their fields. The twenty-four cents is what they stated that it cost them to reapply this water.

The value of the irrigation system was assumed to be $93.00 per acre. Farmers reported that the rule-of-thumb guide for planning irrigation systems or additions to an existing system was $50.00 per acre for a gravity system, $100.00 per acre for a hand-move sprinkler system, and $150.00 per acre for a wheel-move sprinkler system. They also reported that their installation costs had been very similar to these. Current tax laws allow crediting 7 per cent of some types of new investment directly against income tax; this represents a direct saving to the farmer and in reality means that the new equipment actually cost 7 per cent less. For the hand-move system costing $100.00 per acre, a 7 per cent discount means it really only cost $93.00 per acre.

Average life for the hand-move sprinkler irrigation systems was assumed to be 20 years; on a straight line basis, this gives a depreciation rate of 5 per cent per year. This is the rate listed by the farm operators for this type of system; the same 5 per cent rate was also their estimation of what repair costs would be if they were averaged over the entire life of the system. This compared with a 15 year life and a 3.3 per cent repair cost listed by Pacific Northwest Bulletin # 3; with an extra 5 years of life it is expected that average repair costs would rise.[9] Thus the rates for both depreciation and repairs are assumed to be 5 per cent per year.

Opportunity Costs

Opportunity costs on capital inputs were assumed to be 4 per cent for land and building capital, 6 per cent for machinery capital, and 8 per cent for operating capital. The three different rates were assumed in order to reflect the risk involved in each type of investment. Although the length of the operating season varies for the different crops; the bulk of the work is done in the nine-month period of March through November; consequently it was assumed that operating funds are charged for nine months of use rather than for a full year.

Machinery Costs

Machinery costs are one of the main areas where economies of size may be found in farm businesses but due to the vast

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[9] Sprinkler Irrigation, a Pacific Northwest Cooperative Extension Publication, (University of Idaho, Moscow, Idaho, 1951), p. 13.

array of machine sizes, types, and costs it is difficult to compare total machine costs from one farm with those of another. These farms were no exception; the vast amounts of machinery and the different methods of depreciation that were used, made using the farmers' depreciation schedules an impossibility. In order to compare total machinery costs it was necessary to assume standard new costs and depreciation rates for each size of machine. All machinery was assumed to have a 10 per cent salvage value. Depreciation was figured on a straight line basis on the remaining 90 per cent of new cost. Thus a two-ton truck was assumed to cost $4000 without regard to the kind of deal that the operator had been able to make when he bought it. The same truck was assumed to have $360 of depreciation per year without regard to how much reported use it had during the year. Table VI on page 53 presents a simple depreciation schedule for a small farm to show the assumed prices and lives for many of the machine items that were used on the sample farms.

For insurance and tax purposes the current value of each machine was assumed to be half of its new cost. Thus the $4000 truck mentioned in the previous paragraph had a current value of $2000 no matter what its age was reported to be. It would have been possible to take the reported age of each machine and find the current value of the machine by using the depreciation formula, but using this method would have led to very high machinery investments for some enterprises merely because the most recent machine acquisitions had been directed toward a single enterprise. If that method had been used, it would have been necessary to allocate repair costs by something other than the tractor hours system because repair costs are related to the age of the machine.

<u>Custom Work and Contract Labor</u>

Due to the fact that many of the sample farmers hired custom operators to perform one or more of their field operations, it was assumed that this possibility existed for the model farms also. Table III presents the operations that were available and the rates that the farmers reported having paid. Rates for the operations that required hauling varied somewhat due to differences in the distances over which the hauling was done. It is the typical rate that is presented in Table III.

<u>Building Costs</u>

Annual building costs were determined by methodology similar to that used for determining machinery costs. Typically the sample farms had very few buildings other than the manager's house and a machine shed. Table V on page 39 lists a typical set of buildings and the length of the lives that were assumed for them; the repair costs for buildings were considered to be a part of depreciation costs and are not listed separately.

<u>Managerial Salaries</u>

The assumption that the model farms are owned and operated like corporations made it necessary to construct a

TABLE III.

RATES FOR CUSTOM MACHINE AND CONTRACT LABOR OPERATIONS

Operation	Rate
Injecting or Sidedressing Fertilizer	$ 2.00 per acre
Spraying	2.00 per acre
Hauling potatoes	0.07 per CWT
Hauling sugar beets	1.00 per ton
Loading and hauling alfalfa hay	2.50 per ton
Combining grain	7.00 per acre
Combining beans	10.00 per acre
Harvesting potatoes	0.25 per CWT
Harvesting sugar beets	2.50 per ton
Windrowing hay	1.00 per acre
Baling hay	5.00 per ton
Hoeing and thinning sugar beets	26.00 per acre
Weeding boiler onions	70.00 per acre
Hoeing sweet corn	10.00 per acre
Detasseling sweet corn seed	40.00 per acre
Harvesting sweet corn seed	25.00 per acre
Harvesting onion seed	250.00 per acre

TABLE IV.

SCHEDULE OF ASSUMED HOUSE VALUES AND MANAGERS' SALARIES

Size of the farm acres	Manager's Salary dollars	Value of the farmhouse dollars
200	5000	8000
400	6000	11000
600	6800	13000
800	7500	14000
1000	8100	15000
1200	8600	16000
1500	9000	17000
2000	10000	20000

schedule of managerial incomes, this includes both their money income and the house in which they live. These are presented in Table IV. Both wages and house values are based on what was found on the three incorporated farms and on what could be considered to be the value of the manager's skills if he were employed elsewhere.

Taxes

Tax rates on real property were reported at or very near $3.75 per acre. Real property was taken to include the sprinkler irrigation system because large parts of it are permanent fixtures. The value of the land, including the irrigation system was reported to be $600 per acre; the range of reported values ran from $500 to $800 for the newly developed land and up to $1000 per acre for some of the older land. The 1959 agricultural census valued Canyon County irrigated land at $493 per acre. These census data include some of the more inferior tracts and land values have increased steadily since 1959; therefore, the assumed land value of $600 per acre should not be very erroneous.

Taxes on machinery and equipment were determined by use of the formula given in the Tax Assessor's Manual. The general formula is as follows:

1. The present value of the piece of equipment is found by multiplying the original cost by a given depreciation schedule. According to this schedule, any six year old machine has a present value of 50 per cent of its new cost.

2. The present value is multiplied by the index factor of 0.365 to bring it into line with the 1937-41 non inflationary period.

3. This figure is multiplied by a 40 per cent assessment ratio. This gives the assessed value.

4. The assessed value is multiplied by the mill rate to determine taxes.

Inasmuch as it has been assumed that all machines are valued at 50 per cent of their new cost; this was used as their present value rather than attempting to use age to assess their value as the assessor does. All trucks were assumed to be two-ton models falling in the 20,000 to 22,000 pounds class. According to the Idaho Code, this weight class has an annual license fee of fifty dollars. Car and pickup licenses are set according to the age of the vehicle; it was assumed that each car or pickup pays a fee of fifteen dollars per year.

Insurance

Insurance was charged at the rates that are common in Idaho. These are $0.64 per $100 valuation for machinery and $0.55 per $100 value of buildings. These were charged against the average value of the buildings and machinery but not against the irrigation equipment because there is very little risk involved in owning it.

Rotation

To go from the standardized farms to the model farms it was necessary to use a rotation that would be soil conserving and yet would give high returns. The assumed rotation consists of one fourth of the land in alfalfa seed production, while the other three fourths are devoted to a three-year rotation consisting of sugar beets, grain, and potatoes.

According to reports by the farmers, this rotation would be conducive to the accumulation of humus and to the maintenance of fertility on a long-term basis. Since it is composed of commonly grown crops, it should not require any extraordinary managerial skills to raise them.

After per acre profitability was determined, it was found that boiler onions, onion seed, onions, dry beans, and sweet corn seed all had higher per acre profitability than did grain. However, they were not included in the rotation because the limited number of acres and the limited number of times that they appeared in the sample were not sufficient to justify including them in a long-run rotation.

Effects of the Assumptions

The assumptions were made in an attempt to segregate differences due to size by eliminating, as much as possible, the differences that are due to other causes. These assumptions all have the tendency to creat inflexible averages which may require adjusting if the models are compared with real world farms. Since the assumptions are based on long-term averages, they should have little or no effect on the outcome of the relative advantage of the different sizes. However, to the extent that the models use averages that are different from future price and yield averages, the amount of returns and the amount that can be paid for water will be in error.

IV. EMPIRICAL PROCEDURES

Introduction, Source of Data, and Definitions for the Standardized Real Farms and for the Model Farms

The primary data for this study were secured by personal interview during September 1964 with each farm operator and each land owner in the five 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 eight of the eleven farms that operated in 1963. Most of the actual 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.

From these basic data and from the standard coefficients that are presented in section III, of this chapter, a standardized cost budget was prepared for each of the sample farms. By using either direct or weighted formula allocations, it was possible to allocate each budgetary cost to the individual enterprise on which it was expended. Such things as contract labor or potato harvester costs could be allocated directly, while fuel, labor, and similar items had to be allocated according to a system of weights. After all costs had been allocated, enterprise budgets were constructed from them. A sample budget is presented in Table V.

The costs from each of the standardized budgets are designated as standardized real farms throughout the study. They contain the same rotational make-up as that of the sample farm from which they are derived.

From the cost budgets of the four major enterprises, twelve model farms were synthesized. Each of these four major enterprises was assumed to occupy one fourth of the area in the model farm.

Details of the construction of these two types of farms are the subject of this section. The major difference between them is the number and type of crop enterprises that make up the farm. Each model farm is made up of four enterprises while the number of enterprises which make up the standardized real farms varies from two on one farm to nine on another.

The budget presented in Table V is a replica of the eight budgets that were constructed from the sample data and from the input-output data that were presented and explained in the assumptions section. Because the farmers had kept only records for the entire farm and not for each individual enterprise, it was necessary to establish fine systems for allocating the cost of each item in the budget.

<u>Cost Allocation Systems</u>

<u>Direct Cost Allocation</u>. The most obvious and the most accurate method of allocating costs was simply to allocate them directly. With such things as seed, fertilizer, and

A SAMPLE STANDARDIZED FARM BUDGET

Item	Expenses	Allocation System	120 acres Sugar beets	80 acres potatoes	50 acres Grain
Seed	$ 4437	Direct	$ 900.00	$ 3312.00	$225.00
Fertilizer	10040	Direct	6300.00	3740.00	0
Spray	2520	Direct	0	2520.00	0
Gas and oil	1605	Tractor-hours	502.04	1037.96	65.00
Machine repairs	2299	Tractor-hours	736.11	1521.89	40.76
Machine hire	3442	Direct	2040.00	1320.00	81.92
Labor	4862	Direct	3832.25	670.75	359.27
Farm supplies and travel	1154	Acres	630.00	420.00	104.03
Irrigation power	658	Direct	374.40	211.20	72.00
Total operating costs	31017		15314.80	14753.80	947.98
Opportunity cost	1241		612.60	590.15	37.92
Total variable costs	32258		15927.40	15343.95	958.90
Per acre variable costs	129.00		132.73	191.80	19.72

TABLE V

continued

Item	Expenses	Allocation System	120 acres Sugar beets	80 acres potatoes	50 acres Grain
Irrigation equipment repairs	$ 1163	Acres	$ 558.00	$ 372.00	$ 232.50
Insurance	203	Direct	66.75	84.25	52.10
Irrigation equip. depreciation	1163	Acres	558.00	372.00	232.50
Machinery depreciation	4816	Direct	1549.00	2289.00	978.35
Building depreciation	587	Direct	205.04	154.96	227.40
Non-land taxes and licenses	366	Truck-hours	192.58	161.42	11.59
Land and building taxes	938	Acres	450.00	300.00	187.50
Opportunity cost on land	6000	Acres	2880.00	1920.00	1200.00
Opportunity cost on machinery	1547	Direct	495.75	690.25	361.00
Manager's salary	5000	Man-hours	2575.00	2295.80	129.22
Total fixed costs	21783		9530.12	8639.63	3612.24
Per acre fixed cost	87.13		79.42	107.99	72.24
Total costs	54041		25457.52	23983.58	4598.14
Per acre total cost	216.13		212.15	299.79	91.96
Total returns	72700		41940.00	26000.00	4760.00
Per acre total returns	290.80		349.50	325.00	95.20
Residual	18659		16480.48	2016.42	161.86
Per acre residual	74.67		137.33	25.05	3.24
Cost per dollar value of output	.743		.607	.922	.966

spray, a certain amount is used per acre and it costs a certain price; multiplying the two together gave per acre cost; and multiplying that by the number of acres gave the enterprise cost. Adding the respective enterprise costs gave total cost for the farm. If small discrepancies existed between the calculated total cost and what the farmers had listed, these discrepancies were eliminated by finding the percentage of the calculated total cost that each of the enterprise costs represented. It was then possible to allocate the actual cost for each enterprise, from these percentages. This procedure could have been followed for each item that used the direct system of cost allocation; but since it was desirable to eliminate as many managerial effects as possible, the enterprise costs are calculated from the standard rates and the standard prices. This eliminated the need to allocate actual total costs by percentages.

Tractor-hours Allocation. The second system of allocating costs was constructed from the reported performance rates for the various farm operations. An example of which is three acres per hour when plowing. From these it was possible to determine total tractor hours for the individual enterprises and for the whole farm. These totals do not include the custom tractor work which some of the farmers hired; therefore, the totals represent only work performed by the operator's tractors and hired men. Totals for the respective enterprises were converted into percentages and these were used to allocate costs for items on which this system was used. An example would be a farm that reports doing 1000 hours of actual tractor work per season; of this 500 of the hours are spent on his potato enterprise, 300 hours on his sugar beet enterprise, and 200 hours on his grain enterprise. Thus, the respective percentages would be 50 per cent for potatoes, 30 per cent for sugar beets, and 20 per cent for grain. The rationale behind the individual uses of the system are explained in the section on budgetary items.

Man-Hours Cost Allocation. The third system for allocating costs was constructed in a manner similar to that used for construction of the Tractor-Hours System. This third system is concerned with the man hours spent doing field work; it does not include contract jobs such as hoeing sugar beets, custom machine work, or custom hauling which can be allocated by the direct allocation system. Man hours for each phase of the field operations were determined by finding the machine time for the respective operations on each enterprise; this was multiplied by the crew size to get the man hours for the operation. Man hours for each operation and for irrigational purposes were totaled to get the total number of man hours for the enterprise and for the farm. The final step in constructing the system was to convert the enterprise totals into percentages.

The man hours system does not consider time spent by the manager as man hours and the system considers only the time spent working with irrigation equipment or with machinery. It is expected that non-field work will be enterprise directed in about the same proportions as field work. Individual cases where this system is used are explained in the section dealing with budgetary items.

Acreage Cost Allocation. The fourth system used to allocate costs was to allocate them according to acreage percentages. Thus if a 1000 acre farm has 400 acres of sugar beets, that enterprise will be allocated 40 per cent of the cost for items on which this system is used. Where it could be used, this system was very accurate because some expenses such as land taxes are charged on a per acre basis. Thus expenses that were on a per acre basis were allocated the same way.

Truck-Hours Cost Allocation. The fifth and final method of allocating costs was based on the number of hours that trucks were used for each phase of each farming operation. The system considers only work that was done by the farmer's own trucks; any hauling that the farmer may have hired is not included in the computation of the number of truck hours for the farm. Usually truck use was important only during harvest season; during other seasons, the time it was in actual use was almost negligible. The notable exception to this is potatoes which require a significant amount of seed hauling in the spring.

From the data, it was possible to obtain the number of hours that trucks were used on the farm. The last step in constructing this system was to determine the respective percentages for each enterprise. As one would expect, sugar beets and potatoes account for the largest share of truck use. Cases where this system was used are explained in the section on budgetary items.

Budgetary Items

Seed, Fertilizer, and Spray. Before proceeding further, it is necessary to explain what is included in each of the headings in the "items" column of the budgets and to explain how the respective data were obtained. Seed costs represent what the farmer would have had to pay if he had bought all of his seed, paid standard prices for it, and applied it at standardized rates that have been assumed for this study. It was necessary to calculate seed costs this way to eliminate price differences and inventory changes in order to facilitate the building of model farms. Cost for each enterprise and total cost for the farm were determined by the direct system of cost allocation. The procedures and the rationale behind them are the same for the determination of fertilizer and spray costs.

Gas, Oil, and Machine Repair Costs. Gas and oil costs are what the farm records listed minus the tax refund that had been received for gas used for non-highway purposes. Though the major share of the total fuel bill was used for field and hauling operation, leeway was left for other fuel uses such as farm business travel, burning weeds, and other miscellaneous uses. Since tractors are usually the main fuel users on a farm, gas and oil costs were allocated by the tractor-hours system of cost allocation.

An alternative method of determining gas and oil costs would have been a system whereby physical input coefficents are multiplied by the price of the inputs and the product is divided by the performance rate for the power unit. An example of this would be the case where fuel costing twenty cents per gallon is burned at the rate of three gallons per hour by a tractor that is plowing at the rate of three acres per hour. For the example, fuel cost would be twenty cents per acre. The reason that system was not used was to allow the investment in machinery to vary according to the needs of the farm. This was desired because increased farm sizes usually do not carry with them scale type increases in either variable or fixed costs. Items such as seed or fertilizer may increase proportionately because going from a 200 to a 400 acre farm will cause expenses for such things as seed and fertilizer to double if the same rotation is followed but it is very unlikely that machinery investment will double. If in such a case the machinery investment does not double, there are several possible explanations of why it has not. Several of the common explanations are presented below:

1. The current set of machinery is being operated more hours per season.

2. The operator is hiring custom operators to do the extra work.

3. Many of the machines were not being used at full capacity on the 200 acre farms. Thus adding certain machines enabled farming the added acres.

4. It may be that each machine was traded for one of twice the capacity but not of twice the cost.

5. Any combination of the four reasons listed above.

The foregoing paragraph listed the rationale behind the decision to allow individual farm requirements to determine machinery investment, and it listed some of the possible reasons why machinery investment might vary. From those five reasons it can be seen that many other things may also vary when machine investment varies. Gas and oil have been mentioned as one of the items where costs might vary; other items whose costs might vary as machine investment varies are machine repairs, machine hire, labor, farm supplies, insurance, machinery depreciation, non-land taxes, and the opportunity cost on the machine investment.

Machinery repair costs listed in the standardized budgets are taken directly from the records of the sample farms. No attempts were made to standardize them as a given percentage of total machinery investment or by figuring them as a set cost per hour for each machine. The reason for determining repairs costs in this manner is that there is a lack of information about either hourly or average annual repair costs for many of the machines that were encountered.

Machine repair costs were allocated by the tractor-hours system. The farmers indicated that non-tractor powered equipment such as trucks and self-propelled combines had significant repair costs but that the majority of repair costs were due to repairs on tractors and on tractor-powered equipment.

Machine Hire. This item includes all custom work that the individual farmers reported having done; however, it does not include contract labor. Total cost for the item was found by multiplying the custom rate by the number of units on which it was applied. Thus 100 acres of grain harvesting at $7.00 per acre would cost $700.00. The item was allocated by the direct system.

Labor. The item labor includes the expenses that were paid out for labor on the sample farms. It includes such things as social security taxes, medical payments, and payments for contract labor. It does not include the manager's salary or accounting and legal fees. Labor costs on the two farms with livestock enterprises were adjusted downward by the reported value of the labor which was devoted to the livestock enterprises.

The three different types of irrigation systems made another adjustment necessary to standardize the sample farms. This adjustment was necessary because the farmer's record book listed what had been paid for labor under his irrigation system, not what had been paid for labor under the irrigation system that was assumed for the model farms. The adjustment was made by finding the percentage difference between the individual farmer's irrigation coefficient and the standardized coefficient. This percentage was then multiplied by the number of hours that the farmer had used to operate his system; the product gave either the number of hours he would have saved or the number of extra hours he would have had to hire if he had used the standard irrigation system. The value of the hours which resulted from the difference between the systems was found by multiplication by $1.50. This product was then either subtracted from his total labor cost if his system was more efficient than the assumed system, or added to his total labor cost if his system was less efficient than the assumed system. The standardized coefficient for the assumed irrigation system was that half an hour is required to irrigate one acre every time it is irrigated. If a farmer reported that with his system he could irrigate an acre in one fourth of any hour, this meant that he was twice as efficient as the standard system and if he had operated under the standard system he would have used twice as many man hours for irrigation purposes. Thus under the standard system he would have had to pay an extra $1.50 for each hour that was used under his system. Differences between the standard number of irrigations and what each farmer reported were adjusted by a similar method.

To allocate labor costs, a combination of two systems was used. It was possible to use the direct system to allocate part of this cost because the item includes the cost of contract labor. The going rate for thinning and hoeing sugar beets was reported to be $26.00 per acre; thus for the sample budget on page 39, $3120 could directly allocated to sugar beets. The residual, $1742.00 for the budget in question, was then allocated by the man hours system.

Farm Supplies and Travel. The budgetary item, farm supplies and travel is the equivalent of a miscellaneous classification. It includes hand tools and other small equipment which normally are not entered in the depreciation schedule. It also includes the cost of farm utilities, business traveling done on commercial carriers, accounting and legal fees, and farm supplies such as rope and baler twine. The expenditures which make up this item are very diverse and it is doubtful that any one classification would account for a majority of the total expense for the item. Therefore, the most practical method of allocating the item was to do it on a per acre basis.

Irrigation Pumping Cost. This item is the estimated cost of lifting water from the assumed source and providing pressure to sprinkle it on the fields. It was determined for each enterprise by multiplying the standardized coefficient twenty-four cents per acre per irrigation, by the total number of acres that had been irrigated (i.e., the number of acres in the enterprise multiplied by the number of irrigations per season). Cost for the grain enterprise on the sample budget was found by the equation: $0.24 X 6 X 50 = $72.00. Costs for this item, as recorded by the sample farms, were neither meaningful nor applicable because no two of the sample farms had exactly similar water sources. In most instances the differences were due to the presence of water from one or more wells in addition to the river and canal water. The item was allocated by the direct system.

Operating Cost, Opportunity Cost, and Total Variable Cost. Totalling budgetary items 1 through 9 gave the total outlay or operating cost that would be made during the normal nine-month operating season. The opportunity cost on this type of outlay was assumed to be 8 per cent; therefore, the opportunity cost is figured on the basis of 8 per cent for nine months. Since the opportunity charge varies with the total operating cost, it must be added to total operating cost to get total variable cost either for the farm or for the enterprises. Dividing by the respective acreages gives per acre variable cost.

Irrigation Equipment Repairs. Inasmuch as machine repairs are listed as a variable cost, it would seem that irrigation equipment repairs also should be a variable cost. This is not the case because the farmers indicated that annual repair costs on irrigation equipment will average about 5 per cent of new cost and that very little of this 5 per cent could be attributed to the type of crop on which the system had been used. Also by definition, variable costs vary with the level of output; this item will not if it is calculated at 5 per cent of new cost per year. The methods for determining this item make it appropriate to use the acreage system of cost allocation.

Insurance. Expenses for this item were obtained by applying the assumed rates to the average value of building and farm equipment. It was not applied to the irrigation system because of the smallness of the risk that is involved in the ownership of it. In general, the sample farms had less coverage than was assumed for the standardized farms; however, the sample farms also had separate policies for liability coverage. Therefore, the excess assumed for the standardized farms is taken to be enough to cover the cost of liability insurance for the farm.

Irrigation Equipment Depreciation. Depreciation of the irrigation equipment was reported to be 5 per cent per year. This item will not vary with either type of crop or the output of it; consequently, it is treated exactly like the irrigation equipment repairs item.

Machinery Investment Costs. As was brought out in the theory section, the fixed costs that are associated with owning farm machinery are very important considerations when a study of size economies is made; therefore, determining and allocating machinery investment is one of the most important steps in the construction of the standardized farm budgets. A listing of the steps that were involved and a discussion of them are presented in the following paragraphs.

The first step was to compare the machinery lists for each farm with the farming operations performed in 1963. This was done in order that unnecessary equipment (i.e., equipment that was not used on the 1963 rotation) could be eliminated from the standardized depreciation schedules. Some of the machines that were eliminated were hay balers, milking machines, and manure spreaders. In a few cases it was necessary to add machines because the list of operations performed included them but due to age they had disappeared from the farmer's depreciation schedule. Commonly, the items that had disappeared were such things as plows and cultivators, things which have long lives but which often are rapidly depreciated in order to take full advantage of current tax laws.

The second step was to assume standard prices and lives for the various machines. This has been explained in the assumptions section; they were then depreciated by the straight line method with a 10 per cent salvage value. Table VI, page 53, presents a simplified example of a set of machinery and buildings' depreciation schedules and enterprises allocations.

Step number three was to allocate value and depreciation cost of each machine to the respective enterprises. All five systems of cost allocation were used in this step. Cars and

TABLE VI

A SAMPLE DEPRECIATION SCHEDULE

	New cost	10% Salvage value	Amount to be dep.	Est. life	Average value	Annual dep.	Al
Cars and Pickups							
Pickup	$2200	$ 200	$ 1980	12	$ 1100	$ 165	Ma
Car	3000	300	2700	10	1500	270	Ma
Trucks							
2 Internationals	7200	720	6480	10	3600	648	Tr
2 Potato beds	800	80	720	8	400	90	Tr
Tractors							
Int.400	2500	250	2250	10	1250	225	Tr
Int.B275	2800	280	2520	10	1400	252	Tr
Int.560	4300	430	3870	10	2150	387	Tr
Tillage Equipment							
3-B plow	600	60	540	12	300	45	Ac
10' disk	600	60	540	12	300	45	Ac
Packer	400	40	360	12	200	30	Ac
2R Potato planter	1700	170	1530	10	850	153	Di
2R Potato Cult.	600	60	540	12	300	45	Di
Beet Cult.	300	30	270	12	150	22	Di
4R Beet planter	1000	100	900	10	500	90	Di
Harvest Equipment							
Beet beater	1200	120	1080	8	600	135	Di
Beet harvester	2800	280	2520	8	1400	315	Di
Potato harvester	4500	450	4050	8	2250	506	Di
Potato digger	2000	200	1800	8	1000	225	Di
Miscellaneous							
Sprayer	600	60	540	12	300	45	Di
Total Machinery	39100	3910	35190	-	19550	3693	
Buildings							
House	8000	-	8000	25	4000	320	Ac
Machine shed	800	-	800	20	400	40	Tr
Total Buildings	8800	-	8800	-	4400	360	

ge	Annual dep.	Allocation system	80 acres of potatoes dep.	80 acres of potatoes average value	120 acres of sugar beets dep.	120 acres of sugar beets average value
00	$ 165	Man-Hours	$ 80	$ 533	$ 85	$ 567
00	270	Man-Hours	131	727	139	773
00	648	Truck-Hours	295	1642	353	1958
00	90	Truck Hours	41	182	49	218
50	225	Tractor-Hours	152	842	73	408
00	252	Tractor-Hours	170	944	82	456
50	387	Tractor-Hours	261	1449	126	701
00	45	Acres	18	120	27	180
00	45	Acres	18	120	27	180
00	30	Acres	12	80	18	120
50	153	Direct	153	850	-	-
00	45	Direct	45	300	-	-
50	22	Direct	-	-	22	150
00	90	Direct	-	-	90	500
00	135	Direct	-	-	135	600
00	315	Direct	-	-	315	1400
50	506	Direct	506	2250	-	-
00	225	Direct	225	1000	-	-
00	45	Direct	45	300	-	-
50	3693		2152	11339	1541	8211
00	320	Acres	128	1600	192	2400
00	40	Tractor-Hours	27	270	13	130
00	360		155	1870	205	2530

pickups were allocated by the man-hours system; trucks were allocated by the truck-hours system and tractors were allocated by the tractor-hours system. Specialized machines such as beet and potato planters could be allocated by the direct method; general tillage equipment costs were allocated according to the number of acres on which the machine had been used. The most common use of the machine was the criterion for deciding which system would give the most accurate allocation. This is the reason that cars and pickups were allocated according to man-hours rather than by tractor-hours or some other system.

Building Investment and Depreciation. Building investment and depreciation costs were determined in the same manner as were machinery costs. Costs for the main dwelling were allocated according to acres rather than man-hours because the value of the farm land includes the value of the dwelling. Machine shed and shop costs were allocated by the tractor-hours system; living quarters for the hired men were allocated according to man-hours; and granary costs were allocated directly to the grain enterprise.

Non-land Taxes and Licenses. The item non-land taxes and licenses is an estimation of what these taxes and fees would be on the standardized farms. According to The Assessors Tax Manual, the formula for calculating property taxes is; new cost times the percentage rate times 0.3651 times 40% times the mill rate. In keeping with the average value assumption for machinery, the percentage rate would be 50 per cent. Thus a set of machinery that had a new cost of $40,000 would have a tax cost of $290.00 per year if the mill rate were 100. To determine thetotal for the item, it was necessary to add licensing costs of fifty dollars per truck and fifteen dollars for each car and pickup. Cost allocation for the item was done by the truck-hours system because trucks represent one of the more significant parts of machine investment and they are subject to the additional fifty dollar license fee.

Land Costs. Land taxes and the land investment charge were based on the per acre valuation of the land; therefore, they could be directly allocated. The land investment charge is the opportunity cost of having that amount of money invested in land. Four per cent was the assumed interest rate and the value of the land was taken to be $600.00 per acre. This meant that each acre of land had a $24.00 opportunity cost expense without regard to the type of crop grown on it.

Land is not valued for tax purposes by the same method that is used to evaluate machinery; therefore, a standardized tax of $3.75 per acre was charged. The acreage system was used to allocate both land taxes and the opportunity cost on land.

Managerial Salary. The assumed manager's salary was allocated by the man hours system because a large part of a manager's time is spent in a supervisory capacity. On a small farm, it is likely that the manager spends half or more of his time doing the same work as do his hired men. In such a case, the man hours system would be even more applicable. The assumed schedule and discussion of the managers' salaries has been presented in the section on input-output relationships.

Total Costs. Total fixed costs for the farm and for the individual enterprises were determined by adding the fixed cost columns. Opportunity cost charges had already been made; consequently per acre fixed costs could be calculated by dividing the column totals by the respective acreages. Adding variable costs and fixed costs gave total costs and from this per acre costs were determined.

Total Returns. Total returns were determined by multiplying the average product price by the average yield for the enterprise. This gave a standard return per acre for each enterprise that could be used to calculate total returns for the respective enterprises. Total returns for the enterprise were totaled and this total was divided by the farm acreage to determine average returns per acre for the entire farm. Average returns per acre from one standardized farm to another showed considerable variation due to the vast differences between rotation.

Residual Returns. The residuals for the enterprise and for the farm were determined by subtracting total costs from total returns. It is listed as a residual instead of as profit because it measures the capability of the farm and of each enterprise to pay for water. It is an indication of the returns to size that may be possible for the farm to obtain.

Cost per Dollar Value of Output. This final item is the measure that was used to facilitate interfarm and inter-enterprise comparisons in order to determine where size economies may be found if they exist. It is calculated for the farm and for each of the enterprises by dividing total costs by total returns.

Enterprise Costs

Data for the individual enterprise were plotted on scatter diagrams with cost per dollar value of output on the vertical axis and enterprise size on the horizontal axis. Figure 3 depicts an example. From these scatter diagrams, least square curvilinear regression equations were calculated for the enterprises that had appeared in the sample five or more times.

If size economies were to be found in the enterprises, the relationship between cost and size would be indicated by a curve that slopes downward and to the right. Many different equations for curves would give a good estimation of a downward sloping long-run cost curve; however many of these equations are quite complicated and would be too sophisticated for the relationship between cost and farm size. The chosen equation was a simple curvilinear regression equation with the dependent variable expressed as a reciprocal of the cost. The equation has the form: $Y' = \frac{1}{a + bx}$

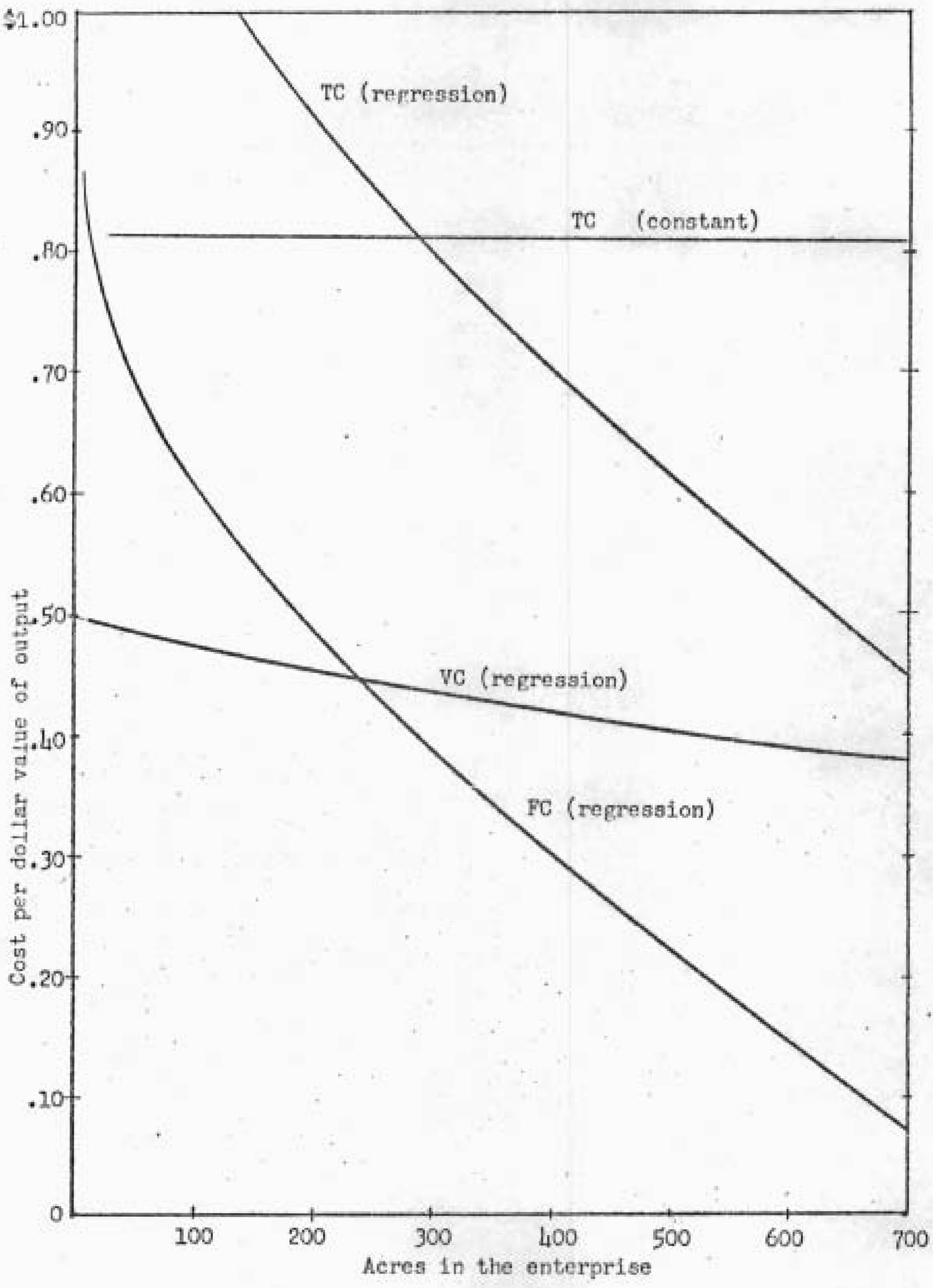

FIGURE 3

Example Long-Run Average Cost Curves for the Alfalfa Seed Enterprise or $\frac{1}{Y} = a + bx$. A discussion of the curves and their significance is presented in the next chapter.

Alfalfa seed, the example presented in Figure 3 appeared in the sample only four times. It showed some correlation between size and production costs but it was considered to be not significant because of the extremely small sample size. Consequently, alfalfa seed 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.

<u>The Standardized Real Farms</u>

Regression lines were calculated for the total cost data from the standardized budgets. These regression lines show how farming costs varied with size for the sample farms; consequently they are the long run cost curves for the standardized real farms. These curves were extended from 200 acres back to 160 acres and from 1800 acres to 2800 acres to facilitate comparison with the cost curves for the model farms. In the following two chapters they are presented, discussed, and compared with the cost curves for the model farms.

<u>Model Farms</u>

After calculating the regression equations for each of the major enterprises, twelve model farms were constructed from them. These models ranged in size from 160 to 2800 acres. A possible error may have been introduced on the small farms because acreages of sugar beets are all based on samples with sizes of more than 100 acres while the models assume acreages as low as forty acres. The same type of error is possible on the larger models because the largest sample of alfalfa seed was 340 acres, while the models extend this to 700 acres; however, constant costs here are probably more realistic than the low costs on the small sugar beet acreages.

As was explained in the assumptions section, these model farms were assumed to have four enterprises of equal acreages: grain, potatoes, sugar beets, and alfalfa seed. The alfalfa seed is a semi-permanent crop; the other enterprises are in a three-year rotation of potatoes following grain and followed by sugar beets.

An example of the construction of the model farms is, if producing alfalfa seed costs 81.4 cents per dollar value of output and the regression equations estimated that 100 acres of grain would cost 78 cents per dollar value of product, 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. 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 the example, the totaled per acre costs are $704.60 and the totaled per acre returns are $909.95. This gives a cost per dollar value of output of $0.774.

The twelve model farms that were constructed by this procedure are presented and discussed in chapter IV.

This step completed the procedures that were used to determine and allocate budgetary costs.

CHAPTER III

DATA PRESENTATION AND ANALYSES

I. SAMPLE FARM DATA

Description of the Area

Each of the eight farms was all or partly composed of 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 completely composed of land that had just been developed; the other five were farms that had been located in the area and had expanded as the new land was brought into production. Two of these five had access to canal water while the other three were irrigated with well water. Thus just within this small sample there were great differences in sources of water and costs of it. These differences have been eliminated by treating water as if it were a free resource in order to determine how much a farm can pay for it.

Leasing and 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 share lease system, a partnership, and combinations of these systems. Each farm was managed by an experienced farmer; the only exception was one member of a partnership had had no farm management experience; however, his two partners had previously managed farms. This study made no attempt to determine the methods used to finance the farm operations; however, some of the operators mentioned that this is a

Topography of the area is gently rolling and for large areas has made the use of sprinkler irrigation necessary. The soil is a fine sand and due to its "newness" 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. The climate in this area is well suited for the production of the four crops in the assumed rotation and to the production of many other crops that are being grown successfully elsewhere in Canyon County.

Rotations

The following table (Table VII) is a systematic presentation of farm size and the organization of the enterprises within the individual farms for the 1963 crop year. The differences between the rotations is due mainly to the proportion of the land within the farm that is part of the development project. This "new" land has given yields of potatoes and sugar beets that are much higher than the county averages for these two crops. 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.

In a long run situation, a sugar beet-potato rotation would reduce the fertility of the soil to a point where it would no longer be profitable to grow these crops continuously. Several of the farmers expressed the opinion that one non-row crop should be grown at least once every four years in order to promote the accumulation of humus. The assumed long-run

TABLE VII

THE SIZE AND THE 1963 LAND USE PLAN FOR THE EIGHT SAMPLE FARMS

Enterprise	The eight sample farms A acres	B acres	C acres	D acres	E acres	F acres	G acres	H acres	Enterprise Total acres	Enterprise per centage
Potatoes	80	130	0	0	400	787	40	80	1517	21.8
Sugar beets	120	103	148	265	160	353	347	711	2207	31.7
Grain	0	80	172	330	50	0	568	649	1849	26.6
Alfalfa seed	0	0	255	5	0	0	340	250	850	12.2
Boiler Onions	0	25	0	0	15	0	0	0	40	0.6
Alfalfa hay	0	60	0	0	0	60	0	0	120	1.7
Onions	0	0	0	0	0	0	85	0	85	1.3
Onion seed	0	0	0	0	0	0	90	10	100	1.4
Silage Corn	0	0	0	0	0	0	40	65	105	1.5
Sweet corn seed	0	10	0	0	0	0	0	0	10	0.1
Dry beans	0	15	0	0	0	0	0	35	50	0.7
Radish seed	0	0	0	0	0	0	15	0	15	0.2
Parsnip seed	0	0	0	0	0	0	15	0	15	0.2
Total acres	200	423	575	600	625	1200	1540	1800	6963	100.0

TABLE VIII

PER ACRE PRODUCTION COSTS FOR THE VARIOUS ENTERPRISES ON THE STANDARDIZED FARMS

Enterprise	Acres	Cost per acre	Enterprise	Acres	Cost per acre
Potatoes	40	$313.49	Alfalfa seed	5	$218.35
	80	301.88		250	98.95
	80	299.79		255	106.19
	120	254.28		340	130.36
	400	278.37	Alfalfa hay	60	97.23
	787	241.69		60	96.47
Sugar beets	103	227.89	Boiler Onions	40	170.23
	120	212.15		65	159.05
	148	255.22	Onions	85	171.12
	160	224.80	Onion seed	10	385.56
	265	222.51		90	277.37
	347	237.67	Silage corn	40	170.23
	353	214.53		65	159.05
	711	230.55	Sweet corn seed	10	202.30
Grain	50	91.96	Dry beans	15	117.85
	80	69.97		35	86.80
	172	78.22	Radish seed	15	556.42
	330	76.76	Parsnip seed	15	149.98
	568	88.00			
	649	82.10			

TABLE IX

ENTERPRISE PRODUCTION COSTS AS MEASURED BY COST PER UNIT AND COST PER DOLLAR VALUE OF OUTPUT FOR THE FOUR MAIN ENTERPRISES ON THE STANDARDIZED FARMS

Potatoes			Sugar beets			Grain			Alfalfa seed		
Acres	Cost per CWT	Cost per dollar of output	Acres	Cost per ton	Cost per dollar of output	Acres	Cost per bu.	Cost per dollar of output	Acres	Cost per CWT	Cost per dollar of output
40	$1.25	$0.965	103	$8.87	$0.652	50	$1.08	$0.966	5	$51.38	$1.557
80	1.21	.929	120	8.26	.607	80	.82	.735	250	23.30	.706
80	1.21	.929	148	9.93	.730	172	.93	.827	255	24.98	.757
120	1.02	.783	160	8.74	.643	330	.90	.806	340	30.66	.929
400	1.11	.856	265	8.76	.644	568	1.03	.924			
787	.97	.744	347	9.25	.680	649	.97	.862			
			353	8.35	.614						
			711	8.98	.660						

rotation eliminates these short-term rotation effects in the model farm. The rationale behind its assumption is explained in section III of chapter II.

II. ENTERPRISE COST DATA

Per Dollar Value of Output and Per Acre Costs

By allocating costs by the methods described in the empirical procedures section, the cost per acre and per dollar value of output were determined for each enterprise. The per acre costs for the various enterprises are presented in Table VIII. If these crops had had equal value per acre when they were sold, the economies of size of the various farms could have been determined directly from table VIII; however, the great difference in product values made it necessary to determine profitability in order to compare the enterprises.

If per acre costs could be used to indicate size economies, table VIII indicates that grain would be the best crop to produce. For the four crops in the long-run rotation, per acre costs were converted to cost per unit of output and cost per dollar value of output. This information is presented in table IV. Either of these two measures can be used to determine economies of size of the individual enterprises.

Size Economies

From the data presented in Table IX, it appears that only in the potato enterprises are economies of size obtainable. Neither the sugar beets nor the grain data show any definite trend for costs either to rise or fall; alfalfa seed appears to have a narrow range of economies of size and a wide range of size diseconomies. Any trends that exist are brought out by mathematical analysis of the data. The Figure 4 through 7 present least square regression curves for the variable costs, the fixed costs, and the total costs for each enterprise. There is a very small discrepancy between the regression LAC (average total cost) curves and those found by adding the average variable cost and the average fixed cost curves. The LAC curve representing the summation of the average fixed and the average variable cost curve is the one that is presented throughout this study.

Potato Enterprises. Figure 4 which presents the curvilinear 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. Despite the small sample, the regression coefficient for the LAC curve is significant at the 5 per cent level of significance. The downward slope of the average total cost (LAC) curve is due to the fact that both the average variable costs and the average fixed costs are declining over the entire range of sizes. Neither the average variable nor the average fixed cost curves are significant at the 5 per cent level. This is not surprising because it is possible for substitutions to take place between these two cost categories. Such substitutions are discussed in the theory section. Such substitutions do not greatly affect the LAC curve but do tend to decrease the accuracy of the regression estimates for the average variable and the average fixed cost curves.

The theoretical cost curves presented on page 19 depict a range of decreasing LAC, a range of constant LAC, and a range of increasing LAC. For the potatoes the LAC decreases over the whole range of sizes. Thus, the most efficient enterprise is the largest one that is found in the range; it is 700 acres.

Sugar Beet Enterprises. The regression curve for sugar beet fixed costs shows that it is decreasing as theoretically one would expect; the curve for variable costs increases which also is in compliance with theory. As theorized, this increase seems to be due to less efficient use of labor on the larger farms. Labor costs for the smallest sugar beet enterprise on one of the smaller farms were $42 per acre while those for the largest enterprise on the largest farm were $54 per acre.

The net result of the two curves is an almost constant LAC, (Figure 5). In the theoretical statement it was mentioned that a short range of constant LAC is possible, but in this case the range of almost constancy is so wide that it seems likely that influences other than enterprise are affecting the shape of the average total cost (LAC) curve. The low correlation coefficient of 0.00152 also indicates that influences external to the study are present. However, in this case the low correlation coefficient and the almost constant LAC are the result of balance between the negatively sloped fixed cost curve and the positively sloped variable cost curve rather than the effect of some external influence.

The LAC being constant, or almost so, all sizes of the sugar beet enterprise have the same efficiency over the size range found on the sample farms. The 300-acre enterprise size shows a slight decrease in total cost but the benefits of the increased efficiency are almost negligible.

Grain Enterprises. Regression cost curves for grain present (Figure 6) what might be considered theoretically classical shapes for cost curves for a firm. The fixed cost curve decreases throughout the full range of enterprise sizes; during the latter part of the range, this decrease is at a decreasing rate. The variable cost curve starts from a range of near constancy and increases at an increasing rate throughout its full length. The increasing variable costs seem to be due to less efficient use of labor because labor cost for the two smallest enterprises is seven dollars per acre, and for the two largest enterprises it is nearly thirteen dollars per acre.

The net result of the two component curves is a LAC curve that slopes downward for a short range, has a short range of constancy, and a range in which it increases at an increasing rate. For the grain enterprise, the most efficient size is 150 acres.

Alfalfa Seed Enterprises. The regression LAC curve for alfalfa seed enterprises (Figure 3 page 58) has a steep slope

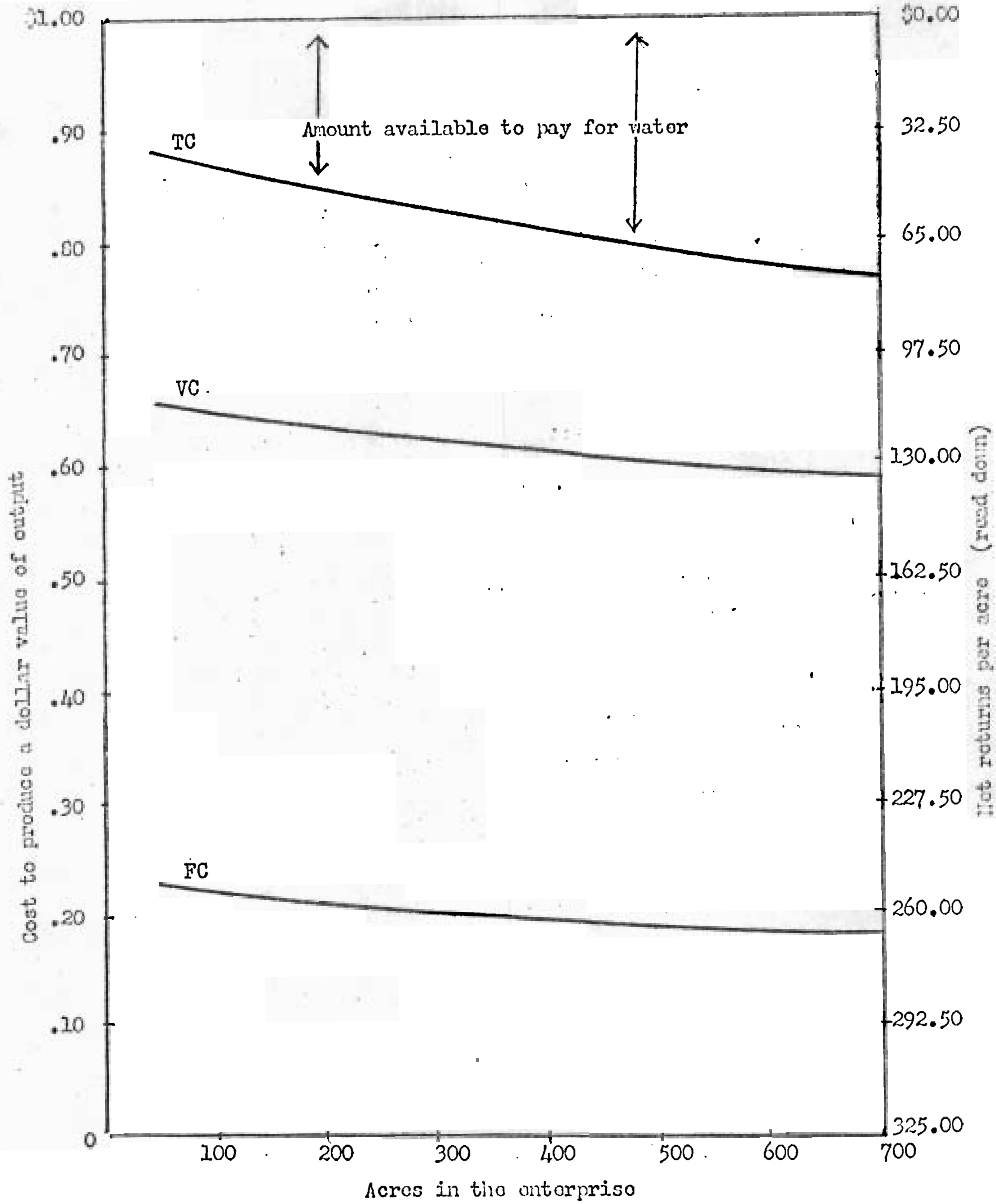

FIGURE 4

Long-Run Average Cost Curves for the Potato Enterprise

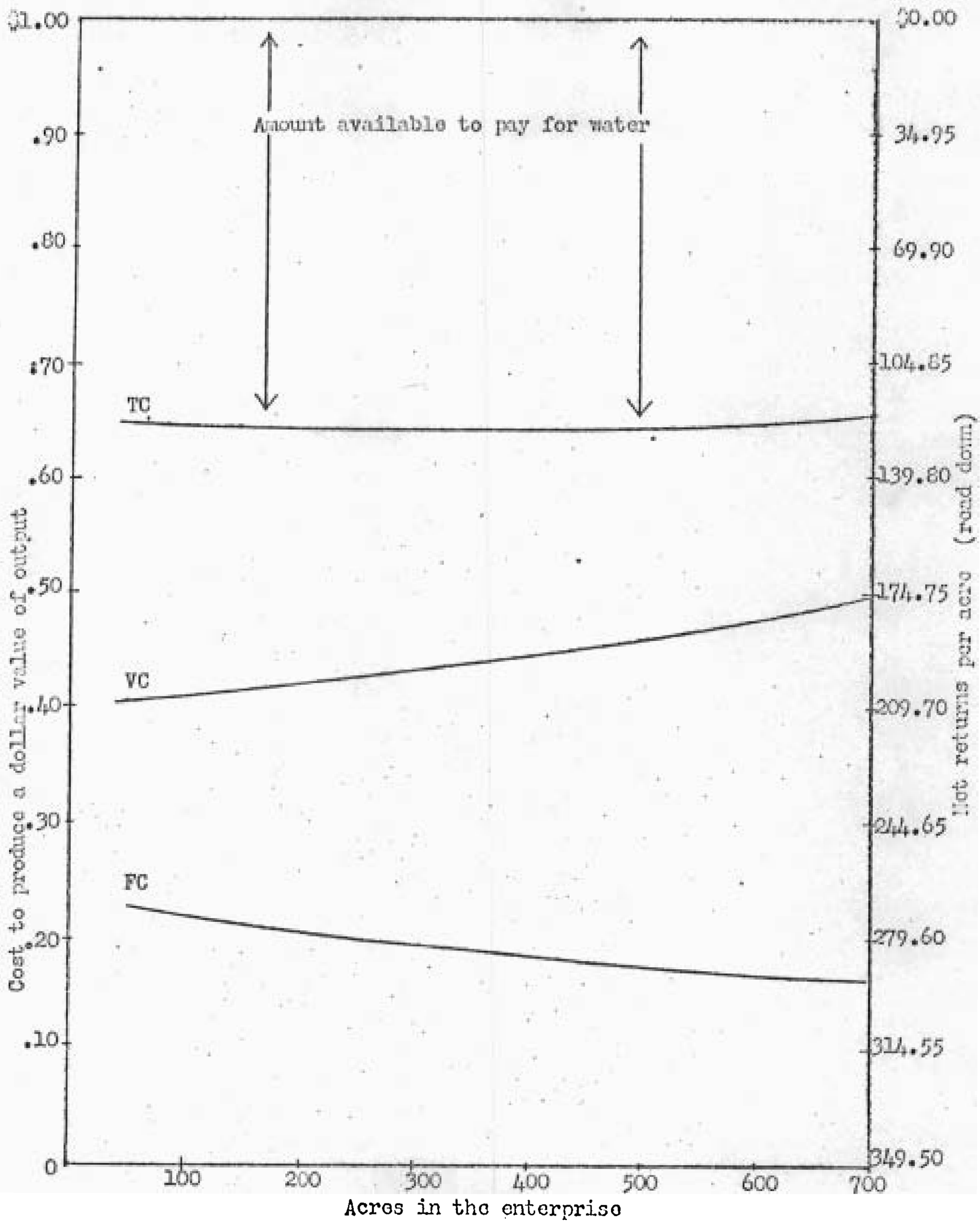

FIGURE 5

Long-Run Average Cost Curves for the Sugar Beet Enterprise

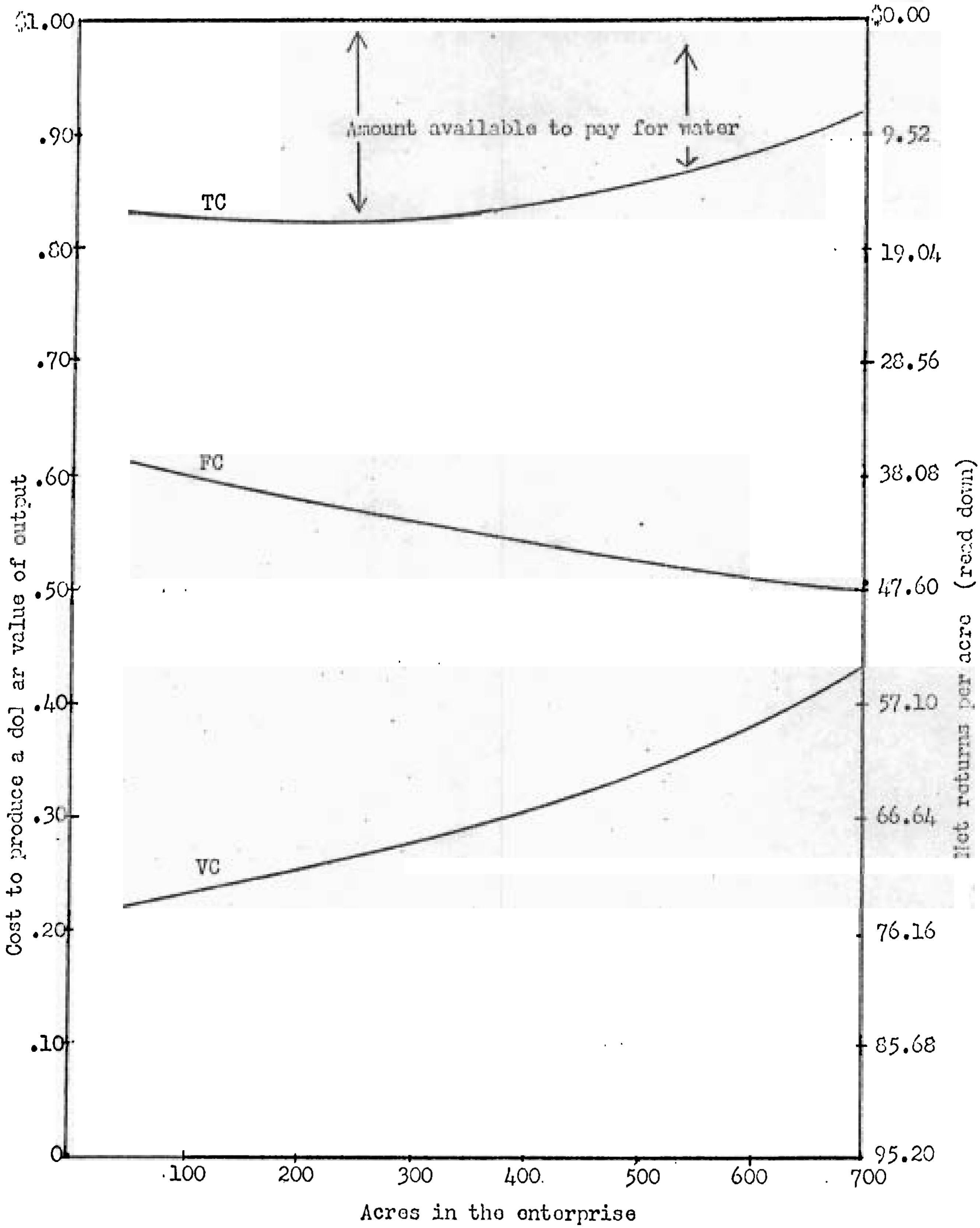

FIGURE 6

Long-Run Average Cost Curves for the Grain Enterprise

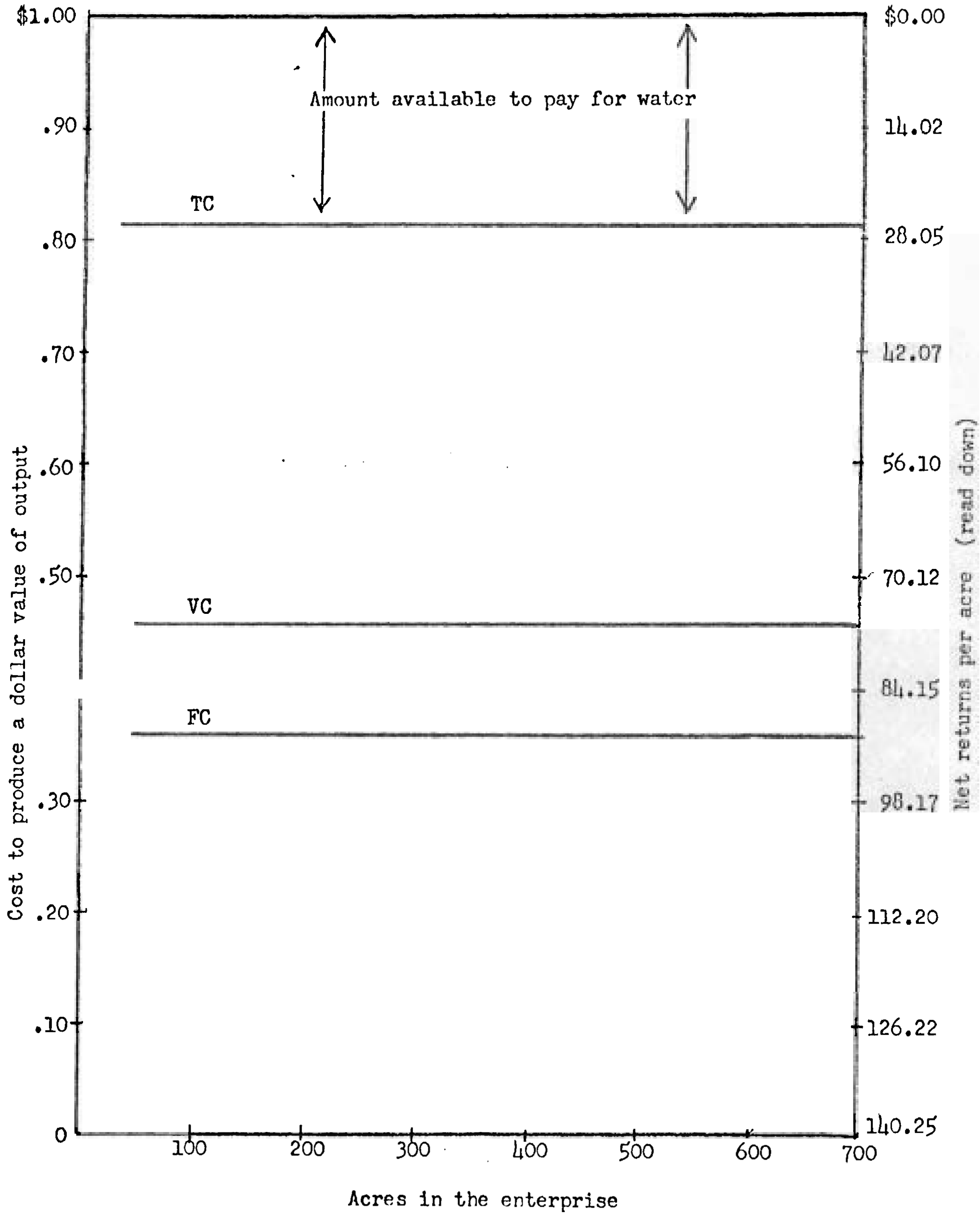

FIGURE 7

Long-Run Average Cost Curves for the Alfalfa Seed Enterprise for the entire range of sizes that were found on the sample farms. Most of the steepness is due to the decreasing average fixed costs although average variable costs are also decreasing. The correlation coefficient of R=.76 for the LAC indicates a good fit, but it is not significant at the 5 per cent level. The smallness of the sample made this equation very vulnerable to large estimating errors. In an attempt to reduce the size of these errors, weighted average costs were determined and were used to construct the model farms. These averages assume constancy for the three cost curves but they should have more possibility of being accurate than the regression equations. The curves for these weighted averages are presented in Figure 7.

III. SHAPE OF THE LONG-RUN AVERAGE COST CURVES

Model Farm Curve

Using the three regression equations for fixed costs, the three regression equations for variable costs, and the two constancy curves, twelve model farms were constructed from the assumed rotation. Make-up and costs for the model farms are presented in Table VIII. The long-run average cost curves for the respective enterprises and for the model farms are presented in Figure 9. This Figure uses a scale that emphasizes the nature of the curves better than did Figures 4 through 7.

The LAC for the model farms is "dish-shaped" as theoretically it should be; however, the shape is neither smooth nor symmetrical because the different enterprise LAC's do not follow the same trends at the same size ranges.

For farm sizes from 160 to 320 acres the moder farm LAC slopes downward at a fairly steep angle; from Figure 9, it can be seen that most of this steep slope is due to the economies of size that are being obtained in the grain enterprise. Exceeding 320 acres, the LAC goes through a range of only a slight downward slope, the change from steep to slight slope again is due to the effect of the grain LAC; however, this time it is because the grain LAC is going through a period of constancy. At 800 acres the downward slope the model farm LAC increases due to the increased downward slope of the LAC curve for sugar beets; at the same time grain costs are rising but the greater magnitude of the sugar beet costs are able to overcome the effects of the rising grain costs.

At 1200 acres the model farm LAC curve becomes almost constant, the small downward slope is due to the fact that potato costs are still falling enough to overcome the effect of the rising grain and sugar beet cost. 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 LAC tends to increase due to the increasing diseconomies of

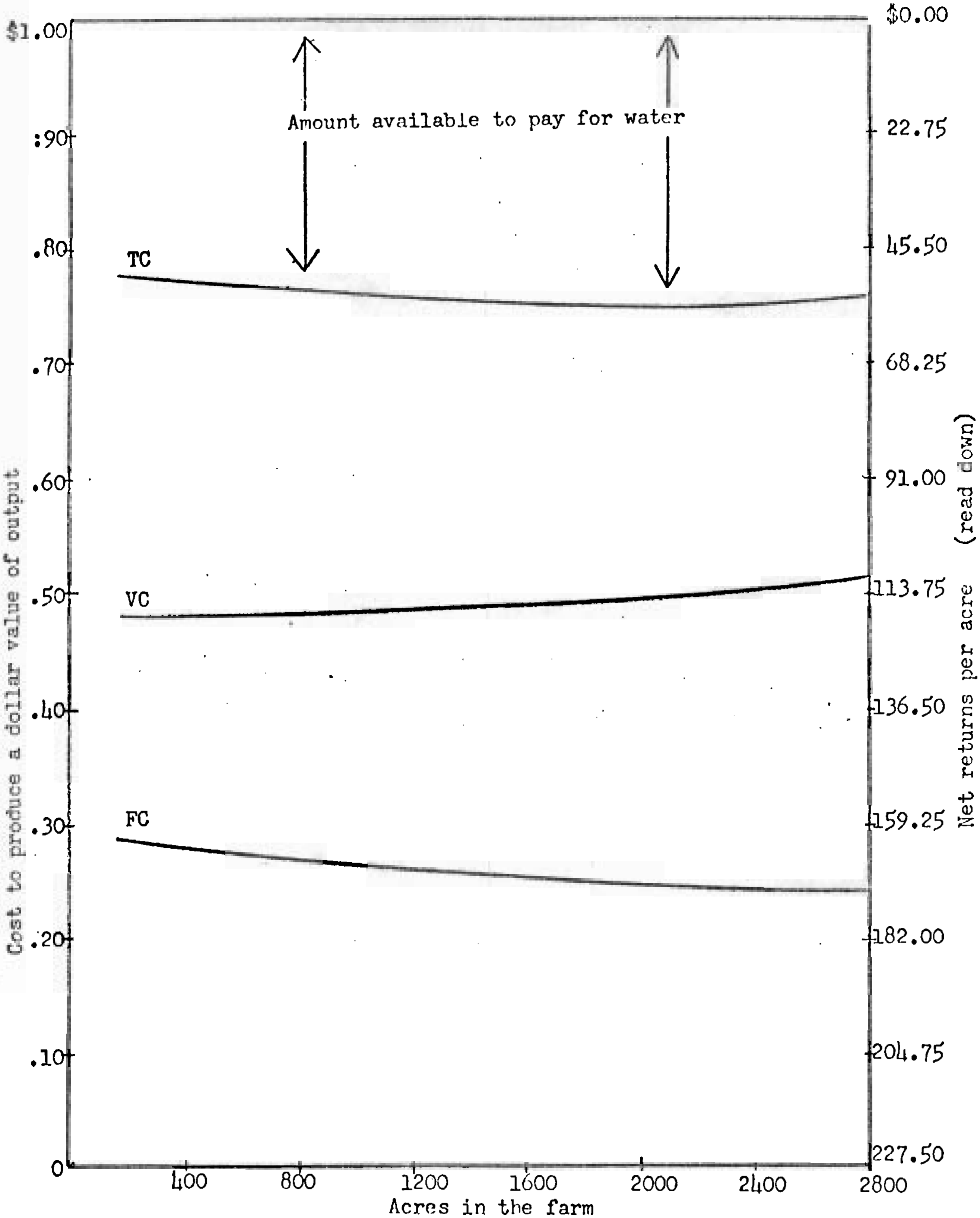

FIGURE 8

Long-Run Average Cost Curves for the Model Farms

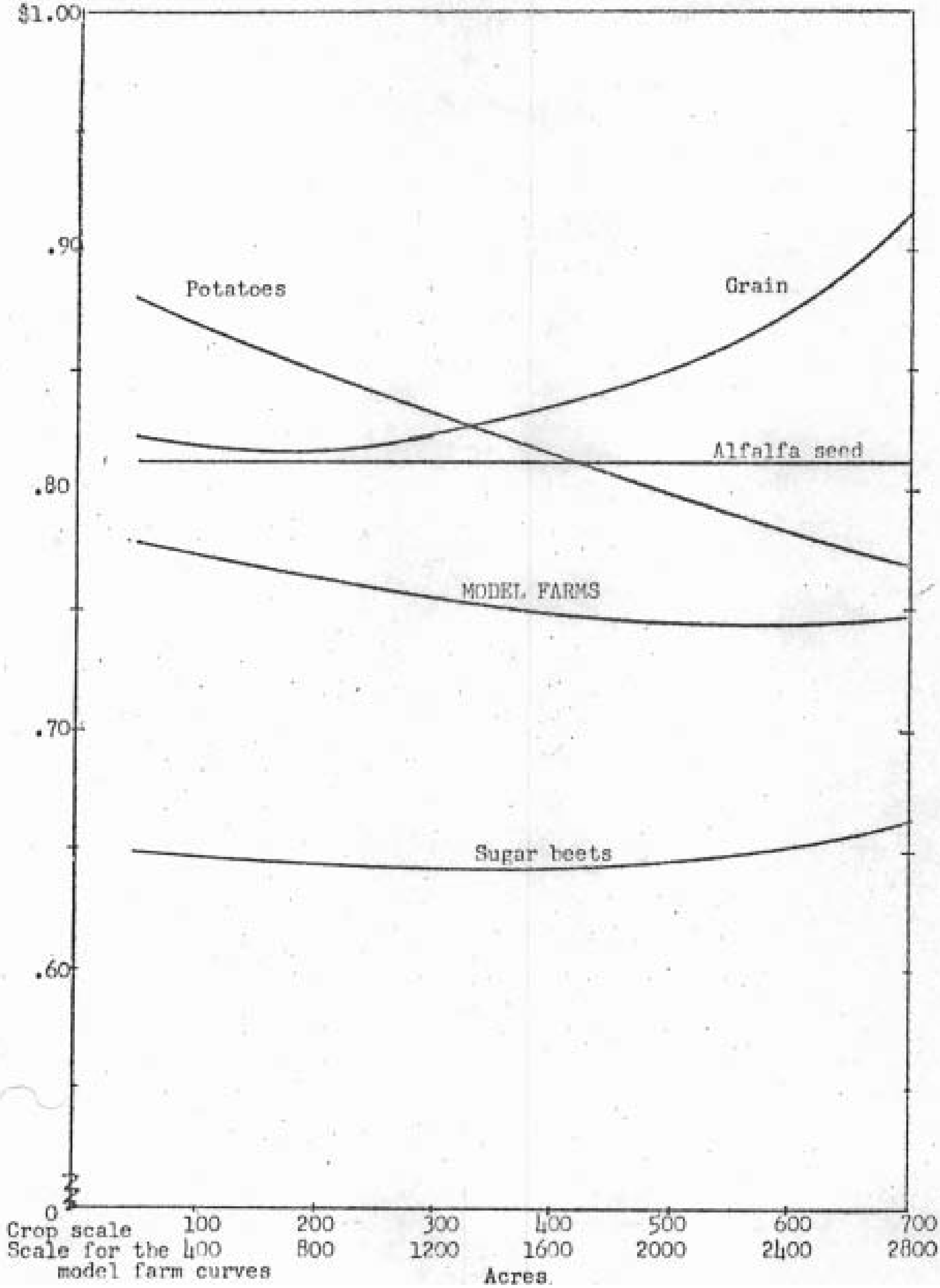

FIGURE 9

Long-Run Average Total Cost Curves for the Four Enterprises and the Model Farms

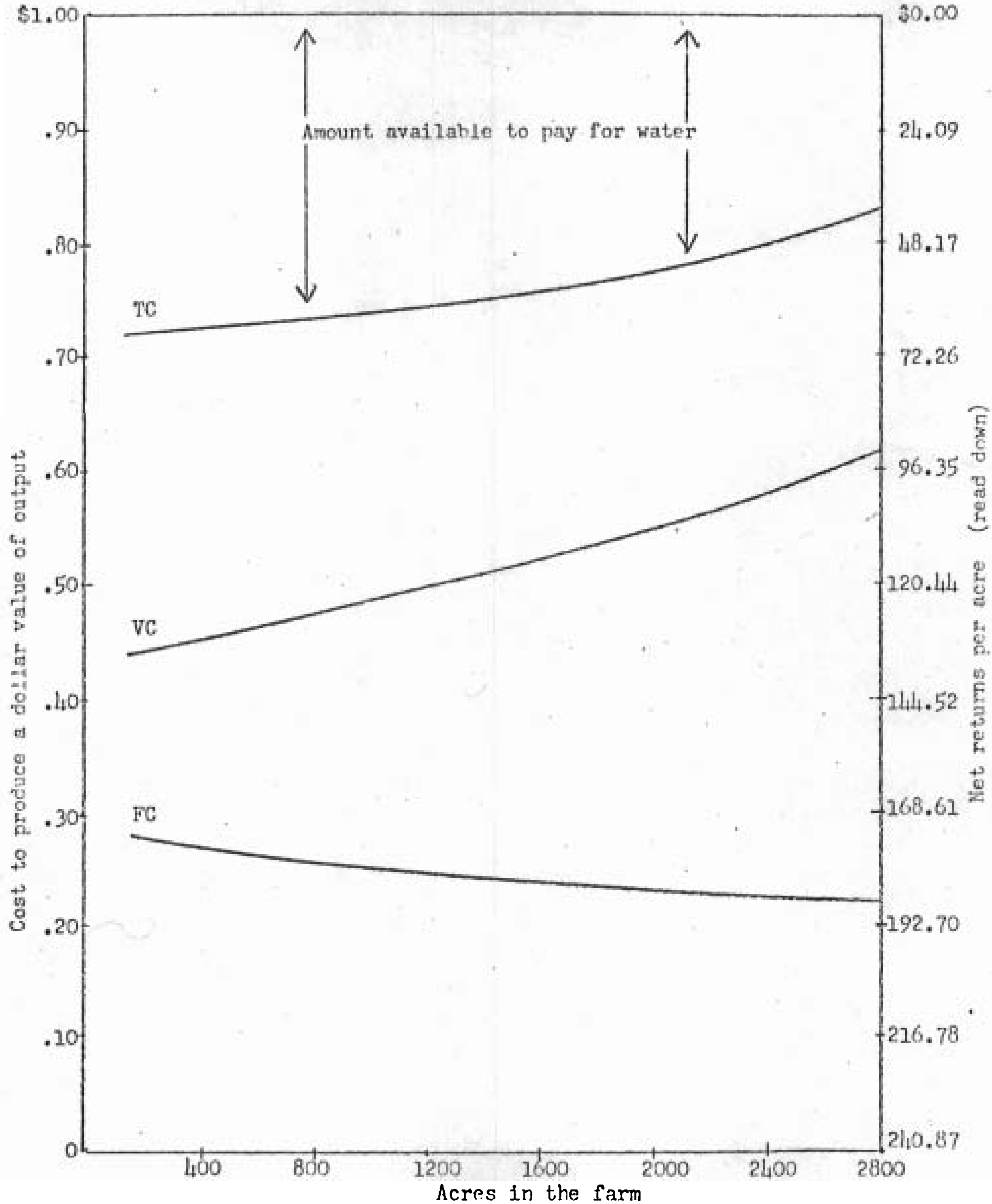

FIGURE 10

Long-Run Average Cost Curves for the Standardized Real Farms size that are manifested by the grain and sugar beet enterprises.

The different values of the crop products involved made it impossible to present the ability of the individual enterprises to pay for water in Figure 9 as was done in Figure 4 through 7, Figures 8 and 10, which show the long-run cost curves for the model farms and for the standardized real farms do show the ability to pay for irrigation water.

Standardized Real Farm Curve

Figure 10, which presents the regression cost curves for the standardized real farms shows that average fixed costs decrease through the entire range of statistical relevancy and through the extended range which makes possible comparisons with the model farms. Within Figure 10 there is a slight discrepancy because the costs were calculated from the individual enterprise regression function while the ability to pay for water of the standardized real farms is the average ability of each acre in the sample farms to pay for water. It was necessary to do this in order that comparisons between the two abilities to pay for water could be made.

The average variable cost curve for the standardized real farms (Figure 10) increases at a slightly increasing rate throughout its entire range. The LAC curve for these farms is nearly constant at small farm sizes but like the average variable cost curve, it increases throughout its entire range of sizes.

Differences

Differences Between the Total Cost Curves. Comparing the model farm curves in Figure 8 with the cost curves for standardized real farms in Figure 10 shows that in general the real farms can produce at lower cost per unit of output than can the model farms; only at the larger farm sizes would the model farms be more efficient.

The reason that the standardized real farms have lower costs per unit of output is because they are operating under a short-term rotation which better enables them to grow high-value crops. These crops, boiler onions, onion seed, onions, and sweet corn seed cause the higher average per acre returns than are being obtained on the real farms.

The main difference between the two LAC's is that the model farms have a long range of size economies while the real farm sizes face diseconomies throughout their entire range. Only after a size of 2400 acres is reached do the model farms face size diseconomies; even then, these diseconomies are not very large. According to theory, the model farm LAC is closer to what would be expected if the theory is applicable to the situation.

The reason that the standardized real farms have lower cost per unit of output is that they are operating under a short-term rotation that enables the growing of higher value crops. Average per acre returns for the model farms is $227.50, while for the sample farms it is $240.87. In the long-run, such a rotation is not practical because of adverse effects it has on fertility. Table VII presents the percentages of sugar beets, potatoes, grain, alfalfa seed, and of the other enterprises. It can be seen that grain, sugar beets, and potatoes are near the assumed level of 25 per cent of the total farm area and that alfalfa seed is only one half of its assumed level. Therefore, the average return per acre will be increased by each crop that grosses more per acre than does alfalfa. Included in this group are boiler onions, onions, onion seed, sweet corn seed, dry beans, and parsnip seed. These crops plus the effect of the percentage of sugar beets and potatoes that is over fifty per cent of total acreage havemade the $13.37 ($240.87-227.50) difference between the average per acre returns for the two types of farms. This difference is the cause of the two-cent difference between the two LAC's at the average farm size of 1400 acres.

Between the Fixed Cost Curves. Comparing the two average fixed cost curves for the two farm types (Figures 8 and 10 or appendix C) shows that they have very similar slopes but differed by two to four cents. This difference is the result of the fact that the crops which caused the higher per acre returns for the standardized real farms do not require a per acre increase in machinery and building investment. Thus the lower average fixed costs on the real farms are the effect of the higher per acre returns rather than of lower fixed costs per acre.

Between the Variable Cost Curves. In the two variable cost curves (Figures 8 and 10 or appendix C) lie most of the difference between the two LAC's. The group of crops that causes the rise in average per acre returns has high variable costs. Most of these high variable costs are due to labor. As was explained in the assumptions section, the use of a greater amount of labor often carries with it inefficiencies. These inefficiencies in labor and to a lesser extent in the other variable costs may cause the average variable cost curve to increase at increasingly rapid rates.

IV. CHAPTER-SUMMARY

This chapter of data presentation and analysis has shown that with a long run rotation, economies of size should be obtainable by larger sizes of farms. However, because the land is "new," a short-run rotation that gives lower costs per dollar value of output is being used on the sample farms. This extra production intensity results in rapidly increasing variable costs in some cases. For the size range studied, these variable cost increases are always larger than the decreases in fixed costs for any size increase; consequently, for the range of farm sizes that was studied, there were no economies of size being obtained on the sample farms when all enterprises were considered together. However, some diseconomies were found within individual enterprises.

CHAPTER IV

SUMMARY AND CONCLUSIONS

I. SUMMARY OF PROCEDURES

The study was originated and designed to find and measure any economies of size that might be attained in five new irrigation projects in southwestern Idaho. By contacting each land owner and farm operator in the area it was possible to obtain a sample consisting of eight farm units ranging in size from 200 to 1800 acres. For each farm, a summary of 1963 farming costs was prepared from the farm records and supplementary information. A list of labor requirements and field operations for the thirteen enterprises also was obtained. Through the use of five allocation systems the budgetary costs that had been obtained were allocated to the various enterprises. At times, it was necessary to standardize these costs to facilitate making interfarm and inter-enterprise comparisons.

After the farm costs had been allocated to the separate enterprises, they were totaled and analysed to determine if any economies of size existed within them. This analysis showed that the four major enterprises had a range of size economies. One of these four enterprises, alfalfa seed, did not appear in the sample often enough to give sufficient basis for plotting least square regression curves; therefore, it was taken to be constant. Using these regression equations, twelve model farms were synthesized from the four major enterprises. Cost curves for these model farms were then compared with those of the real farms.

The model farms showed a long range of small size economies and only after a size of 2400 acres was reached did the model farms face size diseconomies. Average fixed cost curves for the two types of farms had nearly similar negative slopes but the model farm curve was two to four cents higher per dollar of output along the entire range of sizes. This was due to the lower per acre profitability of the long-term rotation used by the model farms. Average variable costs for the model farms were almost constant, while those on the standardized real farms increased quite rapidly for the entire range of sizes. This increase was caused by the less efficient use of variable inputs for the larger farm sizes.

II. TESTING THE HYPOTHESIS

As a working hypothesis, this study posited that large farms have more capability to pay for water because economies of size exist within the individual enterprise and because management is able to combine the enterprises in such a way these size economies are utilized. The alternative hypothesis was that economies of size exist within the individual enterprise but management is unable to utilize them.

The analysis of enterprise cost data indicated that each of the four major enterprises had a range of size economies; however, alfalfa seed costs were taken to be constant because the lack of data did not permit finding a regression equation that would give reasonably accurate estimates. Thus the first part of the hypothesis was accepted because the regression coefficient for total costs on potatoes was significant at the 5 per cent level. Also the regression coefficients for the variable cost curve for the grain enterprises and the fixed costs curve for the sugar beet enterprises were significant at the 5 per cent level.

Comparing the model farm LAC with the standardized real farm LAC was the method used to test the second part of the hypothesis. The model farm LAC indicated that it is possible to obtain size economies within the major enterprises, however, the real farm LAC indicated that management was not obtaining them. Thus the visual comparison seemed to indicate that the alternative hypothesis should be accepted because the standardized real farms are not attaining any size economies. The two long-run planning curves (LAC's) cannot be tested statistically because the two regression coefficients are not computed from two independently drawn samples. Therefore, they cannot be considered to be estimates of a common population parameter (β). The reason that the real farms are not attaining size economies has been attributed to the effects of the short-term rotation that was used on the sample forms.

In a long-run situation the model farm curve indicates that small size economies can be attained by size increases up to 2400 acres. After this size is reached, size increases bring size diseconomies rather than economies. Consequently 2400 acres is taken to be the most efficient farm size in this area, but there is only a three per cent difference between costs on the most efficient farm size and costs on the least efficient one. The conclusion of this study is that in a long-run situation larger farms do have a slight cost advantage but it is very slight. This means that for a long-run situation, this study is accepting the main hypothesis because it has the greater probability of being true.

III. FULFILLMENT OF OBJECTIVES

The main objective of this study was to determine the ability of different sizes of farms to pay for irrigation water. The right-hand scales of Figures 8 and 10 indicate this for both the short-run for for the long-run rotations. Under the short-run rotation, (Figure 10) a 160 acre farm was able to pay up to $69.12 per acre for water. The regression formula also indicated that a large farm of 2800 acres can only pay up to $46.25 per acre for water.

The statistically relevant size range for Figure 10 was 200 to 1800 acres. For this range the regression equation indicates that a 200 acre farm can pay up to $68.88 per acre while an 1800 acre farm can only pay up to $59.10 per acre.

Under the long-run rotation as represented by the model farms, a 2400 acre farm was found to be the most efficient. With the assumed rotation, a 160 acre farm was able to pay up to $50.45, the 2400 acre farm could pay up to $57.65, and the 2800 acre farm could pay up to $57.08 per acre for irrigation water. Other specific indications of how the ability to pay for water varies with size can be seen in Figure 10.

The secondary objective was to determine the economies of size within the various enterprises. This was done and is presented in Figures 4 through 7. Of the three major enterprises, potatoes have the most economies of size; however for the range which was studied, sugar beets always had lower production costs per dollar value of output than did potatoes.

IV. CONCLUSIONS

The results of this study indicate that in a short-run situation, the small farm is in the more advantageous position; while in a long-run situation, the larger farms tend to have a small advantage.

V. IMPLICATIONS OF THE STUDY

The natural implication of the conclusion is that as water costs rise because of higher lifting and transporting cost, it will require larger farms to bear these costs. If conditions are the same as those assumed in the models, increasing water costs will force minimum farm size to approach the 2400 acre limit, and at this point development will tend to cease.

A second implication of the conclusion is that in the period immediately following development and in the transition period of moving from use of a short-run rotation to use of a long-run rotation, economies of size are probably not as important in the determination of farm size as are managerial ability and credit availability. These two factors lead to the development of farms of different sizes which are economic units at first, but which require size adjustments as time passes.

These two implications suggest that credit and managerial problems would be good subjects for future studies which concern the problems that are created by both the development period and the adjustment period through which a farm must go.

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APPENDIX A

Cost Data From Which the Estimating Equations Were Computed

TABLE X

Cost Data from which the estimating equations were computed for the standardized real farms

Acres in the farm	Costs per acre			Gross returns per acre	Costs per dollar value of output		
	FC	VC	TC		FC	VC	TC
200	$90.87	$156.36	$247.21	$339.70	.267	.460	.727
423	68.92	117.88	186.80	263.57	.261	.447	.708
575	62.66	73.66	136.33	180.63	.347	.408	.755
600	61.77	81.67	143.44	207.89	.297	.393	.690
625	73.88	177.65	251.53	318.05	.232	.558	.790
1200	55.96	170.72	226.68	320.66	.174	.532	.706
1540	55.25	104.67	159.92	188.00	.294	.557	.851
1800	52.63	104.78	157.40	220.05	.239	.476	.715

fixed costs $y' = \frac{1}{3.5470 + 0.00044413X^*}$ $r = 0.293$

variable costs $y' = \frac{1}{2.3250 - 0.0002335X^*}$ $r = 0.455$

Total costs $y' = \frac{1}{1.3882 - 0.00004137X^*}$ $r = 0.26$

*The number of acres for which the estimation is to be made.

TABLE XI

Cost Data from which the estimating equations were computed for the potato enterprises

Acres in the enterprise	Costs per acre FC	VC	TC	Gross returns per acre	Cost per dollar value of output FC	VC	TC
40	$249.80	$ 63.69	$313.49	$325.00	.196	.769	.965
80	247.53	54.34	301.88	325.00	.167	.762	.929
80	191.80	107.99	299.79	325.00	.332	.590	.922
120	172.91	81.37	254.28	325.00	.251	.532	.783
400	204.34	74.03	278.37	325.00	.227	.629	.856
787	185.00	56.69	241.69	325.00	.175	.569	.744

fixed costs $y' = \frac{1}{4.36361 + 0.00134312X^*}$ $r = 0.35$

variable costs $y' = \frac{1}{1.50584 + 0.0003315X^*}$ $r = 0.41$

Total costs $y' = \frac{1}{1.0740 + 0.00036016X^*}$ $r = 0.86^{**}$

*The number of acres for which the estimation is to be made.
**Significant at 5% level.

TABLE XII

Cost data from which the estimating equations were computed for the sugar beet enterprise

Acres in the enter rise	Costs per acre FC	Costs per acre VC	Costs per acre TC	Gross returns per acre	Cost er dollar value of output FC	Cost er dollar value of output VC	Cost er dollar value of output TC
103	$153.92	$ 73.97	$227.89	$349.50	.184	.384	.568
120	132.73	79.42	212.15	349.50	.198	.331	.529
148	164.14	91.08	255.22	349.50	.227	.409	.636
160	152.75	72.02	224.80	349.50	.179	.381	.560
265	151.40	70.91	222.51	349.50	.177	.378	.555
347	168.81	65.96	237.67	349.50	.168	.424	.592
353	157.45	57.08	214.53	349.50	.143	.392	.835
711	171.03	59.52	230.55	349.50	.149	.426	.575

fixed costs $y' = \frac{1}{4.86542 + 0.00310842X^{*}}$ $r = 0.75$

variable costs $y' = \frac{1}{2.74985 - 0.000635X^{*}}$ $r = 0.60$

Total costs $y' = \frac{1}{1.8067 - 0.000019576X^{*}}$ $r = 0.04$

*The number of acres for which the estimation is made.

TABLE XIII

Cost data from which the estimating equations were computed for the grain enterprise

Acres in the enterprise	Costs per acre			Gross returns per acre	Cost per dollar value of output FC	VC	TC
50	$ 72.24	$ 19.72	$ 91.96	$95.20	.759	.207	.966
80	48.66	21.29	69.95	95.20	.511	.224	.735
172	52.13	26.59	78.72	95.20	.547	.279	.826
330	53.22	23.55	76.77	95.20	.559	.247	.806
568	49.38	38.62	88.00	95.20	.519	.406	.925
649	47.19	34.91	82.10	95.20	.496	.367	.863

fixed costs $y' = \dfrac{1}{1.62235 + 0.0005951X^{*}}$ $r = 0.60$

variable costs $y' = \dfrac{1}{4.73757 - 0.034123X^{*}}$ $r = 0.915^{**}$

Total costs $y' = \dfrac{1}{1.19670 - 0.00010866X^{*}}$ $r = 0.009$

*The number of acres for which the estimation is to be made.

**Significant at 5%.

TABLE XIV

Cost Data from which the cost estimating equations were computed alfalfa seed enterprise

Acres in the enterprise	Costs per acre FC	VC	TC	Gross returns per acre	Cost per dollar value of output FC	VC	TC
5	$146.17	$ 77.18	$218.35	$140.25	1.006	0.550	1.556
250	45.52	53.44	98.95	140.25	.325	.381	.706
255	53.27	52.91	106.19	140.25	.380	.377	.757
340	51.35	79.00	130.36	140.25	.366	.563	.929

Weighting equations used to find the constant costs.

$$\text{Fixed costs} = \frac{(5 \times 1.006) + (250 \times .325) + (255 \times .380) + (340 \times .366)}{850} = \$0.361$$

$$\text{Variable costs} = \frac{(5 \times .550) + (250 \times .381) + (255 \times .377) + (340 \times .563)}{850} = \$0.453$$

$$\text{Total costs} = \frac{(5 \times 1.556) + (250 \times .706) + (255 \times .757) + (340 \times .929)}{850} = \$0.814$$

APPENDIX B

Per Acre and Per Dollar Value of Output Fixed, Variable, and Total Costs as Estimated for the Twelve Different Enterprise Sizes and for the Twelve Model Farms

TABLE XV

Estimated Per Acre Costs for the Four Major Enterprises and the Model Farms

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	40	40	40	40	160
Farm	FC	$50.63	$57.88	$80.73	$73.45	$65.67
Number	VC	63.53	20.66	147.99	213.85	111.38
I	TC	114.16	78.54	227.52	287.30	177.05
Model	acres	50	50	50	50	200
Farm	FC	$50.63	$57.69	$79.69	$73.13	$65.29
Number	VC	63.53	20.85	147.84	212.87	111.27
II	TC	114.16	78.54	227.53	286.00	176.56
Model	acres	80	80	80	80	320
Farm	FC	50.63	57.02	78.28	71.83	64.60
Number	VC	63.53	22.18	149.24	210.28	111.55
III	TC	114.16	79.20	227.52	282.11	176.15

TABLE XV (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	120	120	120	120	480
Farm	FC	$50.63	$56.17	$76.54	$71.83	$63.79
Number	VC	63.53	21.90	150.63	210.28	111.59
IV	TC	114.16	78.07	227.17	282.11	175.38
Model	acres	150	150	150	150	600
Farm	FC	50.63	55.31	75.14	71.18	63.07
Number	VC	63.53	22.66	151.33	208.33	111.46
V	TC	114.16	77.97	226.47	279.51	174.53
Model	acres	200	200	200	200	800
Farm	FC	50.63	54.71	73.05	71.18	62.39
Number	VC	63.53	23.48	153.08	206.70	111.70
VI	TC	114.16	78.19	226.13	277.88	174.09

TABLE XV (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	250	250	250	250	1000
Farm	FC	$50.63	$53.50	$70.95	$68.90	$60.99
Number	VC	63.53	24.47	154.88	203.78	111.57
VII	TC	114.16	77.97	225.43	272.68	172.56
Model	acres	300	300	300	300	1200
Farm	FC	50.63	52.89	68.85	67.60	59.99
Number	VC	63.53	25.64	156.23	201.82	111.81
VIII	TC	114.16	78.53	225.08	269.42	171.80
Model	acres	400	400	400	400	1600
Farm	FC	50.63	51.19	65.71	66.30	58.46
Number	VC	63.53	28.24	160.77	196.95	112.37
IX	TC	114.16	79.43	226.48	263.25	170.83

TABLE XV (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	500	500	500	500	2000
Farm	FC	$50.63	$49.60	$62.56	$64.02	$56.70
Number	VC	63.53	31.42	164.96	193.70	113.40
X	TC	114.16	81.02	227.52	257.72	170.10
Model	acres	600	600	600	600	2400
Farm	FC	$50.63	$48.10	$59.42	$62.72	$55.22
Number	VC	63.53	35.40	169.16	190.45	114.63
XI	TC	114.16	83.50	228.58	253.17	169.85
Model	acres	700	700	700	700	2800
Farm	FC	50.63	46.68	57.32	61.10	53.93
Number	VC	63.53	40.53	174.05	187.85	116.49
XII	TC	114.16	87.21	231.36	248.95	170.42

TABLE XVI

Estimated Costs per Dollar Value of Output for the Four Major Enterprises and the Twelve Model Farms

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	40	40	40	40	160
Farm	AFC	$0.361	$0.608	$0.229	$0.226	$0.287
Number	AVC	.453	.217	.422	.658	.490
1.	ATC	.814	.825	.651	.884	.777
Model	acres	50	50	50	50	200
Farm	AFC	.361	.605	.228	.225	.286
Number	AVC	.453	.219	.423	.655	.489
2.	ATC	.814	.824	.651	.880	.775
Model	acres	80	80	80	80	320
Farm	AFC	.361	.599	.224	.223	.284
Number	AVC	.453	.223	.227	.650	.490
3.	ATC	.814	.822	.651	.873	.774

TABLE XVI (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	120	120	120	120	480
Farm	AFC	$0.361	$0.590	$0.219	$0.221	$0.280
Number	AVC	.453	.230	.431	.647	.491
4.	ATC	.814	.820	.650	.868	.771
Model	acres	150	150	150	150	600
Farm	AFC	.361	.581	.215	.219	.277
Number	AVC	.453	.238	.433	.641	.490
5.	ATC	.814	.819	.648	.860	.767
Model	acres	200	200	200	200	800
Farm	AFC	.361	.574	.209	.216	.274
Number	AVC	.453	.244	.438	.636	.491
6.	ATC	.814	.818	.647	.852	.765

TABLE XVI (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	250	250	250	250	1000
Farm	AFC	$0.361	$0.562	$0.203	$0.212	$0.268
Number	AVC	.453	.257	.442	.627	.491
7.	ATC	.814	.819	.645	.839	.759
Model	acres	300	300	300	300	1200
Farm	AFC	.361	.554	.197	.208	.263
Number	AVC	.453	.269	.447	.621	.491
8.	ATC	.814	.823	.644	.829	.754
Model	acres	400	400	400	400	1600
Farm	AFC	.361	.538	.188	.204	.257
Number	AVC	.453	.297	.460	.606	.494
9.	ATC	.814	.835	.648	.810	.751

TABLE XVI (continued)

		Alfalfa Seed	Grain	Sugar Beets	Potatoes	The Farm
Model	acres	500	500	500	500	2000
Farm	AFC	$0.361	$0.521	$0.179	$0.197	$0.249
Number	AVC	.453	.320	.472	.596	.499
10.	ATC	.814	.851	651	.793	748
Model	acres	600	600	600	600	2400
Farm	AFC	.361	.505	.170	.193	.243
Number	AVC	.453	.372	.484	.586	.504
11.	ATC	.814	.877	.654	.779	.747
Model	acres	700	700	700	700	2800
Farm	AFC	.361	.490	.164	.188	.237
Number	AVC	.453	.426	.498	.578	.512
12.	ATC	.814	.916	.662	.766	.749

APPENDIX C

Graphs showing the Relationship Between the Levels of Fixed Costs and Between the Levels of Variable Costs for the Four Major Enterprise, the Standardized Real Farms, and the Model Farms

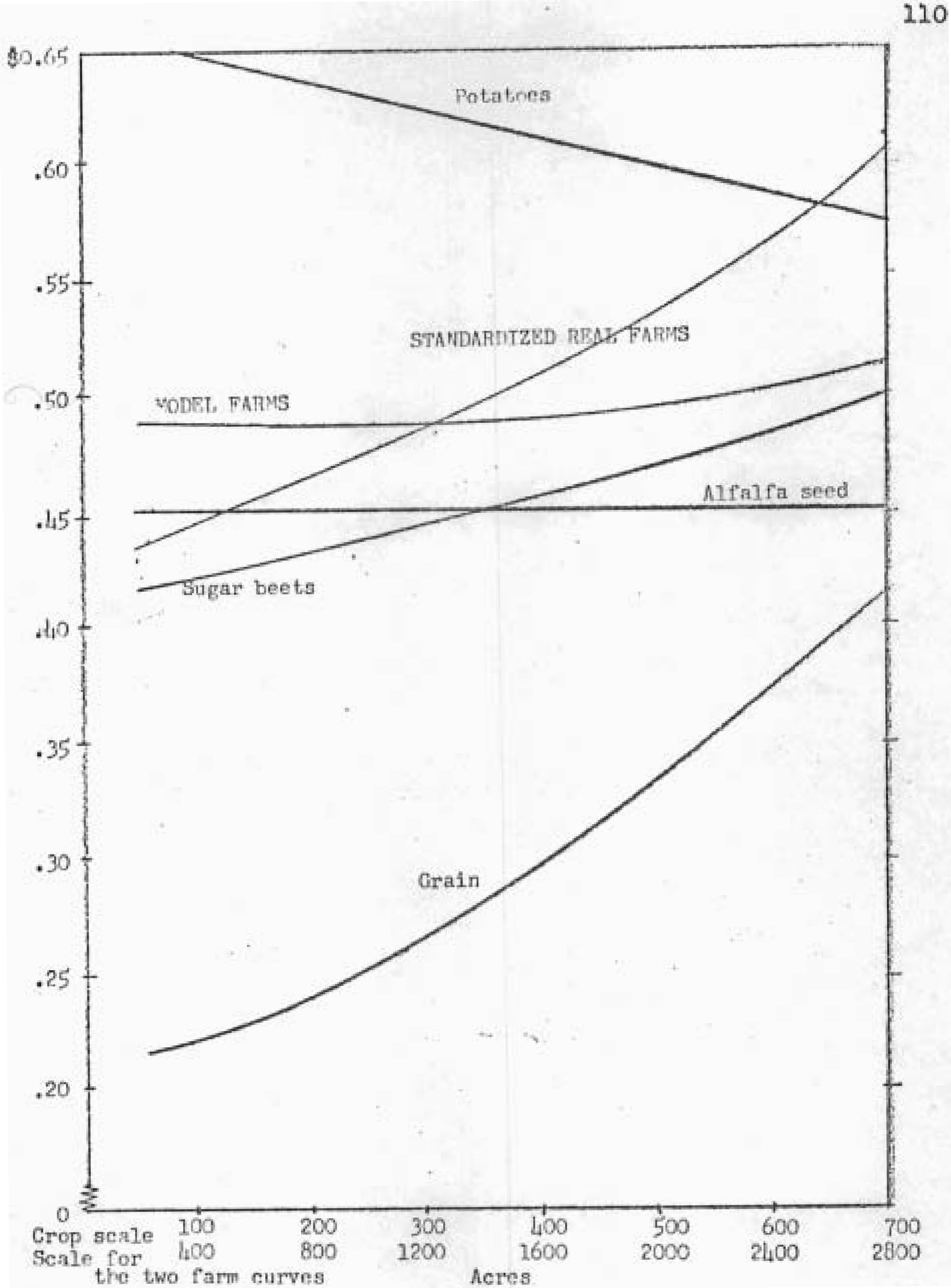

FIGURE 11

Average Variable Cost Curves for the Four Major Enterprises, the Standardized Real Farms, and the Model Farms

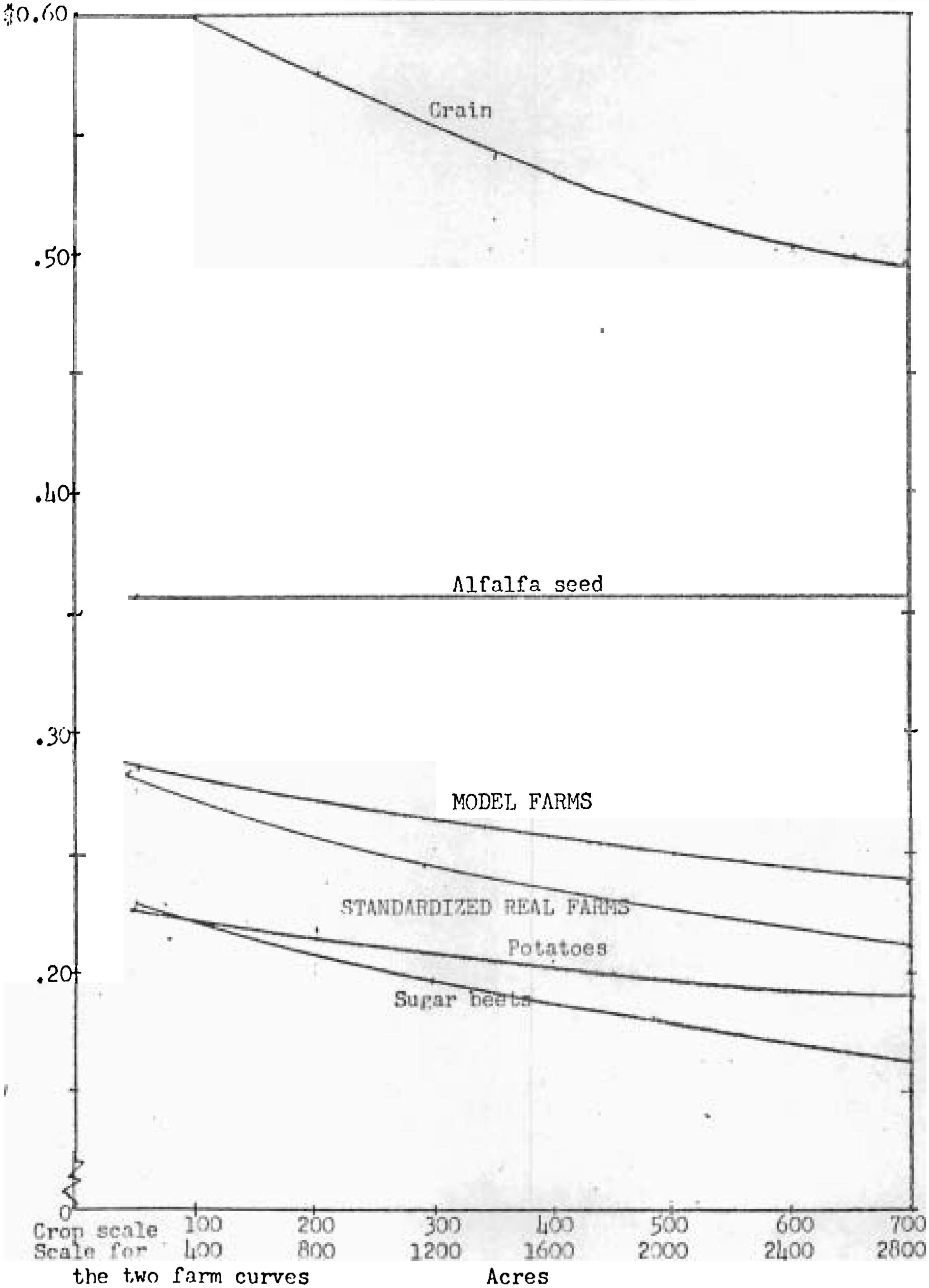

FIGURE 12

Average Fixed Cost Curves for the Four Major Enterprises, the Standardized Real Farms, and the Model Farms